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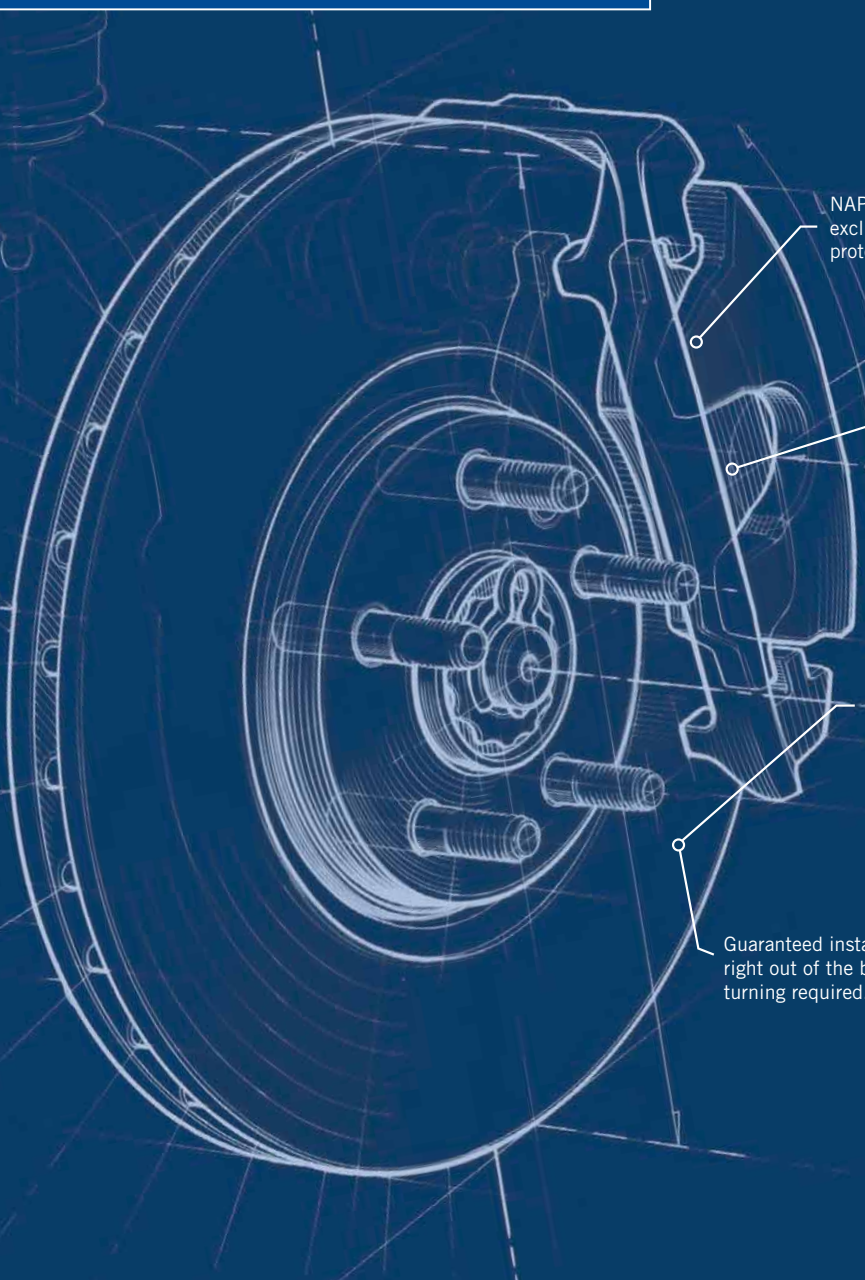


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April 2015

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AUTOPRO WORKSHOP

Vol. 134, No. 4

Advancing the Automotive Service Professional Since 1899

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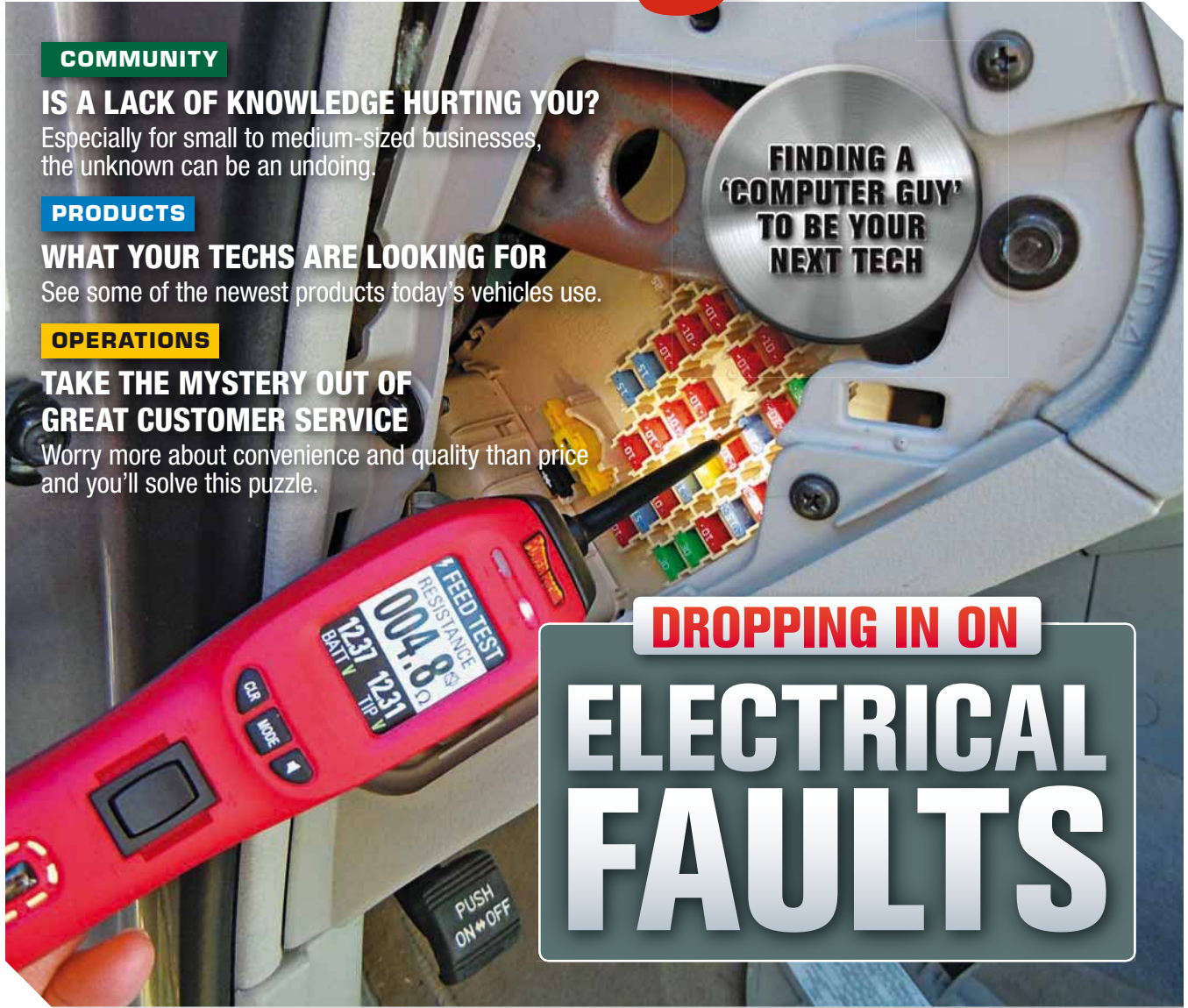
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12 Is a lack of knowledge hurting your business?

Especially for small- to medium-sized repair shops, the unknown can be an undoing to success.

plus **Stats & Trends**
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Q+A WITH

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The 2015 NAPA ASE Tech of the Year shares his thoughts on working in today's repair shop.

124 The Trainer When the compressor won't compress

A conventional clutch-driven compressor might not be engaged for a number of reasons. This month's edition of The Trainer looks at isolating the cause of an inoperative compressor clutch.

ONLINE COVERAGE



Upcoming Webinars & Archives

Check out our free and paid technical and transmission webinars throughout 2015.

MotorAge.com/webinars



Read new technical content for general repair and specialty shops each month.

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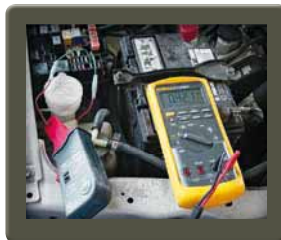
NEW VIDEO CHATS

Watch brief videos with today's industry leaders as they talk with Pete Meier and Tschanen Brandyberry in Google Hangouts throughout the year.



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The Trainer video series

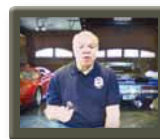
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DROPPING IN ON ELECTRICAL FAULTS

BY JAIME LAZARUS | CONTRIBUTING EDITOR

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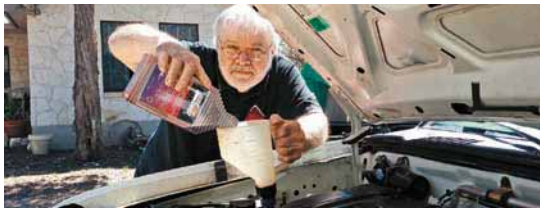
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ASE, AUTOMECHANIKA CHICAGO PARTNER FOR ONSITE ASE TESTING

8 Testing is offered on a first-come, first-served basis at this month's show.

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8 Those who pass an ASE test at Automechanika Chicago can get \$25 toward a Snap-on purchase.

INTERNATIONAL PRESENCE HEIGHTEN EXCITEMENT

11 Check out a few of the many international exhibitors at Automechanika Chicago.

PRODUCTS

DIESEL PARTICULATE FILTER

118 Liqui-Moly's Diesel Particulate Filter Protector reduces the minimum temperature for regeneration by more than 200°F.



Gasket maker line

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Multi V-belt



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ONLINE COVERAGE

THERE'S MORE ONLINE:

AUTOMECHANIKA CHICAGO TRAINING, SPECIAL EVENTS

Automechanika Chicago Presents Motor Age Training Live offers more than 100 sessions led by more than 50 top-notch instructors. In addition to the training courses, a number of certification opportunities and special events are scheduled throughout Automechanika Chicago. Here is a look at some of what is coming up at the event, April 24-26.

ALLDATA Demonstration

- April 24, 11-11:30 a.m. at the Service Repair Demo Stage

Schaeffler Demonstration

- April 24, 1-1:30 p.m. at the Service Repair Demo Stage

GMB Demonstration

- April 24, 4-4:30 p.m. at the Service Repair Demo Stage

Opening Night Reception

- April 24, 6:30-8:30 p.m.
- Navy Pier
- Transportation provided from partner hotels.

NGK Spark Plugs Demo

- April 25, 12-12:30 p.m. at the Service Repair Demo Stage

MACS 609 Exam

- April 26, time TBA
- \$15 fee due at the door
- Location at AMC TBA



Schaeffler will host Lunch & Learns during Automechanika Chicago at McCormick Place West in Chicago.

TRAINING

Schaeffler to host trio of Lunch & Learns at Automechanika Chicago

Attending Automechanika Chicago? You can join Schaeffler at one of three Lunch & Learn sessions that weekend. Lunch will be served during the Friday and Saturday presentations only.

There are three available times: Friday, April 24, 12-1 p.m.; Saturday, April 25, 12-1 p.m.; and Sunday, April 26 at 11:30 a.m. Each session is free.

Mike Geul, Technical Services Group Leader, United States/Canada, and Ruben Arenal, Technical Service Manager, Mexico, will present at each session.

Their presentation, "The Importance of Using OE Quality Parts," is an in-class discussion and training event. For the automotive service professional, standard quality is not always visually obvious. Parts may bolt-up, but may exhibit immediate off-the-lift problems or premature failure. With labor the lion's share of the repair bill, don't risk your time and reputation by installing inferior parts. Schaeffler is a leading development partner to the automotive OE market in North America. Through its aftermarket brands - LuK, INA, and FAG - Schaeffler's product range includes applications for chassis, drivetrain and engine.

Advanced registration is required to attend the Schaeffler Lunch & Learn. Lunch will be provided during the Friday and Saturday presentations.

Go to MotorAge.com/AMCSchedule for more information on this and other events, and to register.

BREAKING NEWS AUTOMECHANIKA

APRA HOSTING EDUCATIONAL SEMINARS

The Automotive Parts Remanufacturers Association (APRA) will hold complimentary educational seminars at Automechanika Chicago, April 24 and 25 at McCormick Place West.

The educational seminars will be held next to the APRA booth 2659/2660.

Mohammad Sammi, of Sammy's Auto Electric Service, will give three 30-minute presentations: "Trends in Design of the New Starters," "What's Up with New Alternators' Design, Power, and their Features?" and "Alternator and Charging System to PCM Interface."

Robert German, with Flight Systems Automotive Group will present "Remanufacturer of Electronic Diesel Controls," and "Remanufacturer of Diesel Fuel Systems."

To register for the seminars, visit www.apra.org.

Discussion is on-going in MotorAge.com forums

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INTERNATIONAL PRESENCE HEIGHTENS EXCITEMENT

BY JAMES. E. GUYETTE |
NEWS CORRESPONDENT

More than 400 exhibiting companies will fill the expo floor at Automechanika Chicago this April. Positioned to be the largest tradeshow and training event for the shop owners and technicians, this event will be held at McCormick Place West, Chicago from April 24 through 26, 2015.

Among the list of participating exhibitors, several international pavilions will be featured from Turkey, Italy, United Kingdom, China, Taiwan, India, Pakistan and Malaysia.

"International participation has always been a vital part of the Automechanika brand. The countries that are joining Automechanika Chicago are leaders in the automotive aftermarket industry and increase the value of the event as they educate the market," states Bridget Ferris, Automechanika Chicago show director.

Germany

MAHA currently is considered one of the most accomplished manufacturers of dynamometers, vehicle lifts and test devices. The product range covers applications for car, utility vehicle and agricultural machinery workshops and complies with the strictest quality standards. In addition to hardware, MAHA provides powerful software solutions for test system networking. This is accompanied by consulting services for the planning and implementation of construction projects and efficient direct check-in. The company's skills thus extend far beyond pure machine engineering.

Vibracoustic CV Air Springs GmbH

Rising to the challenges facing the evolving automotive market is what makes them unique. Vibracoustic CV

Air Springs recognizes that suspension design has a major role to play in helping customers succeed and differentiate themselves in an increasingly dynamic environment. A passion for productive design together with a full system expertise and close association with passenger car technologies allows for thinking outside the box, offering proven technologies adapted to the needs of the commercial vehicle sector.

Smart innovation means working in close partnership with customers, advising on suspension load requirements, building working prototypes and testing on site when required, ensuring an optimized solution every time.

Italy

In its more than 50 years of existence, Brembo has secured a prestigious place for itself in the automotive braking system sector.

This position can be held only through continuous innovation in products and services, maintaining the highest possible quality levels, offering competitive prices and focusing the utmost attention on safety, individual and public health and respect for the environment.

Taiwan

Jonnesway Enterprises is a well-recognized brand established in 1983. With more than 30 years of history in the professional and industrial tool market, Jonnesway has successfully distributed to 107 different countries around the world and established more than 4,000 solid distribution channels. Jonnesway is committed to provide total solutions for professional mechanics to perform their everyday duties with more efficiency and effectiveness. With a full range of products, including hand tools, air tools, automotive repair tools, and tool trolleys with mechanic tool sets, Jonnesway has received unanimous applause from all over the world.

Get additional details on the event and a complete listing of exhibitors showcasing the newest tools, equipment and products in the market at www.AutomechanikaChicago.com



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ASE GUIDES

QUESTION OF THE MONTH



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☑ **SURVEY:** With so much learning going on April 24-26, we thought we'd change things up. Which historical fact is NOT true?

- A. On Oct. 7, 1997, the Chicago City Council approved a resolution absolving Mrs. O'Leary's cow of all blame for the Great Chicago Fire.
- B. The Great Chicago Fire raged from Oct. 8-9, 1871, destroying 3.5 square miles and 7,450 buildings over 27 hours.
- C. William B. Ogden was elected the city's first mayor in 1837.
- D. Chicago was founded by a French immigrant named Pierre deChikagou.

Go to MotorAge.com/apr15survey to answer and enter the Federated Auto Parts contest.



Is a lack of knowledge hurting you?

Epecially for small to medium-sized businesses, the unknown can be an undoing.

BY ROBERT SPITZ | WORKSHOP MEMBER

In most small shops, those that have been in business for longer than five years and are doing somewhere between \$5,000 and \$25,000 in sales a month, the owners have come from the technical side of the business. Their time is spent primarily fixing cars.

Other shop owners have pushed their monthly sales up into the \$25,000 to \$45,000 range. In those shops, the owner tends to be the service writer and oversees the rest of the business. Their technicians fix most of the cars. In a small percent-

age of shops the owner hires a service writer, while continuing to work on cars himself. Sometimes owners bring in their wives or girlfriends to help out and eventually handle customers.

What all the shops in this range have in common is that their business grew to a certain level of monthly sales and then ran into a barrier that seemed to stop the business from growing and expanding.

Common barriers: Having problems finding good help, not enough customers, working too many hours, not making enough money, owners are overwhelmed and owners have to handle every problem and check on

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Brian Albright

Another record year for recalls

According to data released by the National Highway Traffic Safety Administration (NHTSA), the auto industry recalled nearly 64 million vehicles for safety problems in 2014, a new record.

Of the 803 recalls, 123 resulted from NHTSA investigations or contacts with automakers, according to coverage in the *New York Times*.

"These figures demonstrate the need for vigorous, effective oversight to remove safety defects from our highways," NHTSA Administrator Mark Rosekind said in a statement. "When defective vehicles or equipment put Americans' safety at risk, NHTSA will act."

An estimated 46 million cars with unfixed recalls were still on the road at the end

of 2014, according to data from Carfax reported in *Insurance Journal*.

Bolt On Technology

5 tips for preparing for shows

5 Tips for Preparing for Trade Shows Are you heading to the VISION Hi-Tech Training and Expo? What about AAPEX? Of course, there are dozens of trade shows in between. Before you travel to any of them, you may want to consider some advance planning. The trade show floor can be intimidating. Hundreds, if not thousands of exhibitors, countless booths, an unending array of things to see, try out and learn more about. The experience can be overwhelming. But, with a bit of advance preparation, you and your auto repair shop staff can get the most out of trade shows in 2015 and for years to come. Visit the AutoPro Workshop to read more about our tips for trade show success.

Brian Albright

WIN names most influential women

The Women's Industry Network (WIN) announced this year's list of the Most Influential Women (MIW).

The four honorees are Cheryl Boswell, CFO, DCR Systems, Duluth, Ga.; Lauren Fix, President, Automotive Aspects, Lancaster, N.Y.; Lisa Siembab, Owner, CAR-STAR Berlin, Berlin, Ct.; and Ruth Weniger, CEO, Airbag Solutions, Ivins, Utah. "Each year, women from different facets of the collision repair industry are selected for their passion and commitment to progressive and positive evolution of the industry," said Denise Caspersen, WIN chair. "There is so much opportunity for women to have rewarding careers — the sky is really the limit for those with skill, creativity and a strong work ethic."

May 23rd 2015
@ 6:00 PM

Diagnosing the BUS

We take a look at finding faults in the Controller Area Network in May's webinar.



PAGE

8

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Q+A WITH TOM PALERMO

NAPA TECH OF THE YEAR

One owner's ideas on today's repair shops.

PAGE

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THE TRAINER VIDEO

PETE MEIER

When the compressor won't compress.

everything or else it doesn't get done right. The barriers become unsolvable. Owners try everything they can think of to solve the problems.

Their solutions: Close the shop, sell the shop or turn the shop over to

a family member, hope it will get better and keep on doing the same thing until they retire or die. These owners have resigned themselves to the "fact" there is nothing that can be done about these problems. **ZZ**

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The Medium Duty Truck Workshop
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Noteworthy

comments from MotorAge's online communities

The best of what you're saying on Facebook.com/MotorAgeMagazine, Twitter (@Motor_Age) and in the Motor Age Magazine group on LinkedIn.

Geronimo Arango via Facebook:

The reason is because people want free diagnostic. How can a technician afford the thousands of dollars in tools and give free diagnostics. Can a lawyer give free diagnostics? Poor wives and kids.

Ehren Korshus via Facebook :

The problem is that everyone wants their car repaired for free. HVAC techs and electricians make a decent wage because they're regulated and require a license

to perform repairs. If the automotive repair industry would do the same, we could charge a decent price that would make most techs \$50-\$60k/yr.

Jess Mckimmy via Facebook :

A technician shortage is a good thing. For technicians. Our industry has been so saturated with willing participants that there are shops that are open 24/7. As the old guys retire and the younger guys say forget this, it's gonna "right size" our industry. Only the guys

who want to be here WILL be here.

Rick Wilson via Facebook:

Yes there is a shortage of good young techs. There is also ample opportunity for young techs to make it in this field. How you apply yourself is up to you. I admit it may not be the best paying field, but if you love your job then why let someone tell you any different? Do what you do and do it well. No matter what field you are in you owe your employer 100 percent or you find another job - plain and simple.



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Q+A WITH TOM PALERMO

SHOP OWNER,
NAPA ASE TECH OF THE YEAR



THE LATEST NAPA ASE TECH OF THE YEAR SHARES HIS THOUGHTS ON WORKING IN TODAY'S REPAIR SHOP.

During the fall NAPA Leadership Meeting in Atlanta, NAPA's 2015 Technician of the Year, Tom Palermo, and his wife Kendra, were honored. On the surface, Tom is a Master Technician with extensive training and a highly successful shop, but there is much more than meets the eye.

MA: How do you relay your dedication to training onto your technicians?

TP: At Preferred Automotive Specialists, Inc., we provide training for all of our technicians. By doing this, it motivates them to attend without worrying about the cost. All of our techs attend local classes at the NAPA distribution center. We also encourage and provide the resources for every person who works on a vehicle in our shop to attain ASE certification. Being educated really takes them to the next level and that is extremely important to us. I strongly believe that no matter how rudimentary the training may be, there is always something to take away from it, as long as you are willing to learn.

MA: Explain your motto, "We are in the relationship business."

TP: I view my employees and my customers like family. I care about what happens to them in their personal and

professional life. Private customers are much easier to build a relationship with because you know that the customer needs their car to get to work, go to the grocery store and/or pick up their kids from school. This is the same attitude we have towards fleet customers. They need their vehicles on the road to be productive in the operation of their business. They become part of the family, and that is really the heart of the business. If you care about your customers on a personal level, they will not only continue to come back, but they will tell others in their lives to come back as well. Word of mouth is still the best and most effective form of marketing.

MA: What other forms of marketing are effective in your shop?

TP: For our non-fleet customers, we use a CRM company that takes care of our digital marketing needs. They run our website, Facebook, Twitter, Google+ and other social media outlets. It is nice to have people that take care of this and do it well because it takes the burden off us at the shop. For fleet customers, we have a marketer that solicits fleets. When it comes to our fleet customers, word of mouth really is the best way to attract more business. Fleet companies and their managers know me, and my dad, Joe Palermo, and want us servicing their vehicles.

MA: You are part of a NAPA AutoCare Business Development Group. What are the advantages of being part of a group like this?

TP: I cannot put enough emphasis on what it means to be a part of a group like this. It is great to hear what everyone else is doing. Now, I'm not saying that you want to do everything other AutoCares are doing, but you can always pick out a few things to try that have worked for someone else. We are a tight-knit group that is not intimidated by each other or competitive about customers. This is something that I have not seen outside NAPA AutoCare. We all know there is enough work to go around. Not long ago, I led a BDG meeting on how to acquire fleet customers.

MA: You have a close relationship with NAPA as your supplier. How does this help your daily business?

TP: The relationship is invaluable. The ability to pick up the phone and call any number of people knowing that they will respond to your request as quickly as possible is a great feeling. We want to fix every vehicle as fast as we can. NAPA does the best job at making sure that happens. My dad (Joe Palermo) started his first repair shop 42 years ago. We have bought parts from many different suppliers and I can assure you that NAPA is the best — and not just because of the product. **ZZ**

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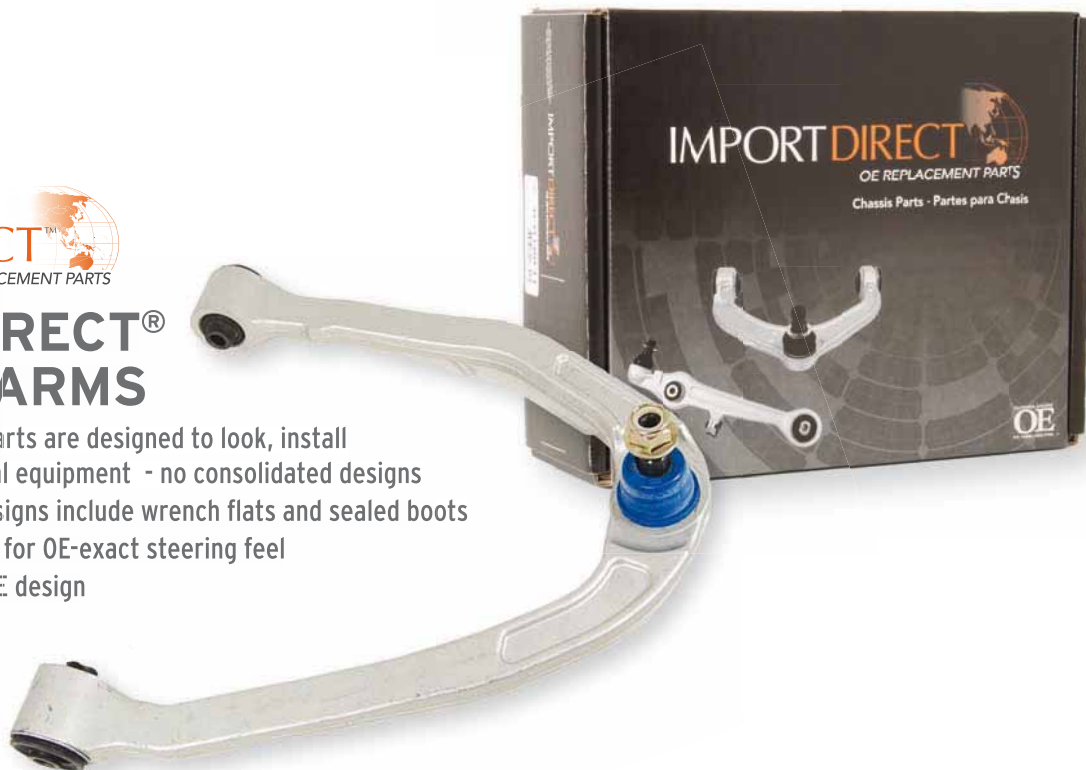
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& YOU'LL SOLVE THIS PUZZLE.

BY BRIAN CANNING | CONTRIBUTOR

GREAT service is nothing more or less than befriending our customers (treating them as we would want to be treated), doing whatever they would ask of us in keeping their cars safe and reliable and going to great lengths to exceed whatever it is they expect of us. Maybe that is understanding that they are in a hurry and providing them with a loaner so they can get to work and not have to worry about how long their car will take. Maybe it is just dropping them at home. Convenience and quality are and have remained very high among customer expectations. With many among us assuming price objections instead, it is no wonder so many of us are challenged by customer service.

Maybe it is time we stopped assuming, start listening and give customers what they want. A customer can go anywhere and get lousy service and reasons to not come back. Maybe we should concentrate on giving them good reasons to come back every time.

Despite the fact a great many of us within the tire and automotive repair world believe price is everything and that our customers don't want to hear about anything beyond what they came in for, our job as automotive professionals is to advise our customers on the service and repair items we notice while inspecting and working on their cars. There is no doubt

there are a few (very few) customers out there that do not want us looking at their car beyond what they came in for, but for them and for all of our customers, a big part of our job is letting a vehicle owner know the things that will keep their vehicle safe and reliable.

The vast majority of our customers expect this and we have to develop a comprehensive formal and structured process that assures we are able to advise our customers on the condition of their car every time they come into the shop. I am sure most of us would rather not hear about the few pounds we need to lose that our doctor recommends in the midst of our physical, or the cavities our dental hygienist notices in the middle of a cleaning. Nonetheless, their job, like our job, is to report and advise on the things they find and on the things that are due. Our profession and our expertise demand we communicate our concerns. Our customers can choose to buy or not to buy, but our responsibility is very clear.

I had a great former client of mine who owns and operates nine beautiful, state of the art shops in and around Charlotte, N.C., invite me down to mystery shop several of his stores.

The first store I visited on this warm and bright Carolina morning was their newest store located in Highland Creek, and I would have to say that in the many times I have done this type of thing, this was by far the best service experience I have ever



IN THIS SECTION

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been a part of. The plan was for me to avoid the manager (Lauren) and time it so that one of her service advisors would assist me.

As it turned out, Lauren was training my intended victim, and as I approached the customer service area (no counters in this state of the art facility) Lauren stepped forward to assist in getting me taken care of. This easily could have been a bad experience for both me and her service advisor, but Lauren kept me well engaged while she had Mike, her service advisor, go through the various steps in getting me into the system.

Great attention was given to understanding how I happened to be there, what I needed, how I used my vehicle and if I had any issues I was aware of. In the midst of this, my wife and I were welcomed, introduced to any of the crew that were in our vicinity and in every way made to feel welcome and taken care of. We were directed to a customer waiting area that was big, roomy, comfortable and well equipped. Within a few minutes my vehicle was taken into the shop.

As I wandered the lot, stretching my legs after our long drive down the day before, I was approached by Chris, the technician who was working on my car, who like everyone else in that store, introduced himself to me and indicated that he wanted to show me several items he had noted in checking out my truck. Normally I am a little nervous about technicians talking to customers, but Chris was both friendly and informative. At just the right moment after Chris had showed me the several items, Lauren appeared under the car and escorted me up front to go over the inspection. This whole effort never took on the touch or feel of a sale, rather it was a concerned service provider informing me of the condition of my truck and the several items I would need to address to keep it safe and reliable. When I indicated I would not have time that day to get the work done because I had an appointment I was offered a loaner and when I expressed a preference to bring the car in later in the week, an appointment was immediately set up at my convenience.

Any customer coming into this store and having the benefit of a service experience such as this, would not only leave with a good understanding of the condition of their vehicle but also with the feeling they belonged, that they were

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cared for and that they were appreciated. How incredible is that!

I would certainly highlight the extraordinary job done by Lauren and her crew but would also compliment the efforts of all of the stores I visited. And though there were things that we probably could have done differently or better, the overall performance was very good. In every case I was greeted, in every case I was welcomed and in every case my truck was thoroughly inspected. Most importantly, in every case I was given great reasons to come back.

Ten items to remember and watch out for:

- Take the time to get to know your customers and understand what their expectations are of you.
- Convenience, integrity and quality are uppermost in most customers' minds and too often those of us in the automotive world present price as our greatest selling point. Find ways to be convenient for your customers, sell yourself and sell the quality you represent. Value always will outsell price.
- Develop a comprehensive vehicle inspection process that includes factory scheduled maintenance and service history.
- Courtesy checks are the most effective and useful way to exceed your customers' expectations. Do them and use them.
- Stop being reluctant to make maintenance recommendations. If a car needs

a service or repair, recommend it and let the customer either elect to do it or not do it. Your job is to inform and recommend.

- Stop being reluctant to make recommendations on a customer's first visit. If a vehicle legitimately needs work (maintenance service or repair), make the recommendation.

- Don't forget about suspension work. My truck had 108,000 miles and has the original shocks. Motorist Assurance Program (MAP) standards say that shocks and struts should be replaced at 50,000 miles.

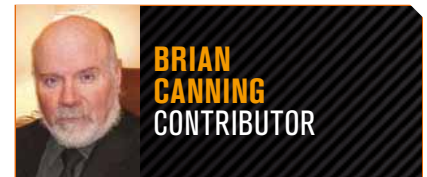
- Don't forget about the timing belt. My truck had the timing belt replaced at 100,000 as it should have been, but nobody asked me about it.

- Don't confuse great customer service with efficient customer service. Great customer service will have them coming back. Efficient customer service might or might not. Great customer service always makes your customers feel good about coming in. Efficient customer service doesn't make them feel anything.

- Find ways to exceed your customers' expectations and try make every service experience something worth remembering for your customer

Are your customers receiving the kind of service you want them to and the kind of service they deserve? Maybe, maybe not. The occasional use of a mystery shopper should give you and your staff members a clear idea of what you are doing well, what you might need to work on and eventually make you much more confident in answering that question.

If you go to a restaurant and get lousy service, would you go back? It doesn't matter how good the food or wine list is, if you get lousy service the chances are good you will go somewhere else. What happens to your customers when they get lousy service? *ZZ*



Brian Canning is 30-year veteran of the automotive repair industry. He has been a leadership coach, Goodyear service manager, retail sales manager for a distributor, run a large fleet operation and headed a large multi-state sales territory for an independent manufacturer of automotive parts.

✉ Email Brian at brimarc@hotmail.com



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THE SEARCH FOR A GOOD TECHNICIAN

MAYBE THERE ARE COMPUTER-MINDED YOUTHS IN YOUR AREA WHO JUST NEED SOME NUTS AND BOLTS TRAINING.

BY CHRIS “CHUBBY” FREDERICK | CONTRIBUTOR

WE ALL have difficulty finding good technicians. One of my recent ideas was to create a video showing parents the financial opportunities that are possible for their children in owning a successful independent automotive repair shop. My feeling is the parents who are helping with the decision need to see a career path that could end in a successful financial future. Our industry could use seasoned technicians that could help us baby boomers retire someday and create opportunities for the next generation. I was listening to our service advisor instructor Randy Somers explain his theory on finding technicians.

Randy said nowadays it seems that kids are not getting into the business like they used to. I remember when every school parking lot was filled with old Mustangs and Camaros, and the kids who hung around talking about cars were called “motor heads.” Those kids are the ones that ended up becoming technicians in our industry because they had a true passion for working on and fixing up their cars and trucks. Where do we find that person now? Maybe you don’t. The hiring experience has changed drastically, and you have to change with it. Perhaps we can help.

Make Tuners Apprentices

Look around the school parking lots now and what do you see? Kids driving Mom’s BMW sometimes, but also a lot of little four-cylinder Civics, Preludes, etc., and the group we call “tuners.”



Now it seems that kids are all into computers, and it is hard to find someone interested in getting their hands dirty working on cars. My teenagers are in the group that you would call tuners. They are more interested in video games and computers than working on cars. They are being steered by vocational schools, mentors and parents to pursue the computer industry. Their idea of working on a car is to hook up a laptop to it and then start adjusting spark and air fuel mixture.

The more time that I spend with these kids the more I start to realize that they all seem to want to work on cars and, in fact, consider themselves pretty good at it. This started me thinking that maybe the shortage of technicians is not based on kids not wanting to work

on cars, but maybe it is based more on our perception of what a technician is.

My perception of a technician is someone who knows how to use his or her hands to do the “nuts and bolts” of our industry. After that technician completes an apprenticeship, so to speak, we decide if she or he is a keeper and send them to training to learn diagnostics or computers so that they will become an A tech. Maybe the shortage of technicians is due to the simple fact that we do not recognize what the new technician looks like. Maybe the new technicians are the tuners out there who already have the computer skills but need training on the nuts and bolts. Maybe it is just a matter of us embracing the changes in our industry instead of resisting them.

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“WHAT IS A GOOD FINAL STEP BEFORE ACTUALLY HIRING SOMEONE? TAKE THEM AND THEIR SIGNIFICANT OTHER TO DINNER WITH YOUR SIGNIFICANT OTHER SO YOU BOTH CAN SEE IF THE NEW HIRE WILL BE A GOOD FIT.”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

After all, if we agree that the industry is changing, doesn't that include the people in the industry as well?

That thinking needs to start at the independent level and work its way up to training, recruiting and even high school vocational schools. This is one area of potential techs that we need to take advantage of. We need to point those people who are interested in computers toward the fact that the average vehicle on the road contains loads of computers. If we could harness that desire to be in the computer industry and tie it into the automobile industry, then we would have a whole new fresh group of techs entering our field.

I have had clients who say that they have tried these so-called tuners with their knowledge of computers, and that they did not get good results. That these so-called computer guys were not as good as we thought they could be. Well, I agree that if you hire someone that is good with a laptop and make them an A tech they will probably fail.

What I am suggesting, though, is that these potential techs have good computer base skills to build upon. With careful training and handling that they can become the best of the best. After all, how long does it take to become an A tech? I would say that you measure that in years, not months, so don't expect immediate results. Rather look at the long-term goal, and I believe they fit right into that vision. Proper training and motivation are all keys to successful employees no matter what their skill level is.

Slower Economies Help Independents

One of the biggest things in the financial news right now is the economy slowing down in the second and third quarters. The truth is that a slower economy is actually better for the independents than it is for a dealership. I take that information and couple it with what I hear from ATI clients all over the United States that they have independent shops in their town closing up also.

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Not that we wish bad on anybody, but we have a unique opportunity here. We can look at this as a sign that reinforces the notion that the end is near, or we can look at this as a sign that opportunities await. If the reality is that last year the search for a tech was hard, that they were not beating down our doors to get a job with us, then it has to be true also that not only are there more customers available but more technicians with the closing of all those shops out there.

Would You Hire Them Again?

One habit I have found that is very consistent in our industry is that we, as a group, keep bad people too long. Ask yourself this question: Is there anyone in your employ right now that, if given a choice, you would not hire again? If the answer to that is yes, I have someone that I would not hire again, then my next question is why do you still have them?

Now is an excellent time to look at replacing under-performers with over-achievers. The availability of technicians leaves no excuses to put up with bad attitudes on good techs, good atti-

tudes on poor techs, or even worse poor techs with poor attitudes.

Now that we have established that there are numerous avenues for recruiting technicians, how do we go about getting them?

Are You Ready to Hire?

One of the real keys is, are you even ready to hire? I get it; you are looking for someone now and have done the homework and the groundwork for that successful hire. Have you laid out all the things that will make that new hire succeed? Are you looking in the right place for the right type of person? My dad used to say, “You can't fish for trout in a catfish hole.” As for newly hired techs, you always positively must make sure that you start them off the right way, not let them develop bad habits that you will try and break later.

We have created a checklist that can help make sure that you:

- Are looking in the right spot for the right person.
- Have a checklist for the traits that you want.
- Have the groundwork laid for a smooth hiring transition.
- Have a training path to guide them to success.

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Chris “Chubby” Frederick is the CEO and founder of the Automotive Training Institute. ATI's 108 associates train and coach more than 1,150 shop owners every week across North America to drive profits and dreams home to their families. Our associates love helping shop owners who are having the same struggle as many of them have had, and who are looking for the same answers – and in some cases looking for a lifeline. This month's article was written with the help of ATI coach and former shop owner Kim Hickey.

✉ E-mail Chubby at cfrederick@autotraining.net



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NET PROFIT: THE ELUSIVE NUMBER SHOPS MUST LOOK FOR

IT'S OK — AND EVEN ADVISED — TO GO SEARCHING FOR THIS IN YOUR BUSINESS.

BY **BOB GREENWOOD** | CONTRIBUTOR

THE independent sector of the aftermarket service and maintenance industry seems to have a tough time understanding that a business must make more income than just an amount to cover the operating expenses and a basic management wage.

Net profit is that number at the bottom of the income statement that stands out all by itself after all expenses have been listed and totaled. This number usually is expressed in a “before tax” denomination, therefore, the company will pay corporate tax on this number (assuming it is a positive), or a proprietorship (non-incorporated business) will pay personal tax on this number.

The objective, in a business operating an automotive maintenance shop, should be to “net” a minimum of 10 percent of total bay sales before tax but after all operating expenses including a professional management wage has been earned. A business has a right to gross profit, but it must earn its net profit.

I have talked to many shop owners who treat net profit seemingly like a dirty word. “Well, if I make net profit I will

have to pay tax,” or “Well, a guy who makes a \$100,000 or more must of ripped somebody off” or “With the cost of everything in this business, you can’t make a good net profit anymore. I wish the old days were still here.” With comments like these running rampant throughout our industry, no wonder the industry is not as profitable as it needs to be.

The scary truth is the average five- to eight-bay shop is missing \$90,000 to \$125,000 net profit out of its current business coming through the door, yet for some reason we don’t want to talk about that and discover where it is and what is required in order to go after it. Instead we hear, “I need more car count.” This is so wrong and the math, once studied, does not lie. We have all the car count required but we are not looking after it properly. We are not executing our professional responsibility to our current clientele. It is time to learn how to change that and reap the rewards for doing so.

It is truly time to understand reality. Net profit is not a dirty word; it is required for survival. It is required to pay for updated equipment and software. It is required to hire and retain highly skilled and competent staff. It is required for facility improvement and expansion. It is required to reduce and pay out business debt. It is required for outside investment to ensure the owner has a retirement program. It is required for business growth. It is required to reduce the level of owner stress in a business.

It is time this industry understands and embraces this concept of net profit and have a long love affair with it. And if management can’t seem to do that, then maybe it’s time the business get a prescription for some steroids.

Juicing It Up

With all the liability exposure, the high investment required in capital items and the long hours of duress many shops endure trying to make their business work, why would an owner want to risk a \$200,000 to \$700,000 investment to buy himself/herself a job? This owner would be far better off for himself, his family and the industry to cash out and get a good job as a competent technician or service advisor. He would make more money with no risk.

A proper business plan must be built each year to see what revenues are required to pay management a professional salary, pay above average marketplace wages and earn enough net income to grow the business. The business must grow in all aspects, especially in areas such as increasing its client base, staff, equipment, inventory and facility.





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This planning is not an overly difficult procedure, but it will take some time to calculate, study and analyze whether the facility the business runs in is capable of reaching the revenues desired and to drive the necessary net income required. The shop should be capable of paying management a \$125,000 to \$150,000 salary and netting a minimum of 10 percent of total bay sales before tax.

If the shop does not plan for that level of net income, something in this industry usually happens: there is none. Watching the sales and bank balance go up and down is not planning for net income. To net a minimum of 10 percent or more of total shop sales and pay management a professional salary, a business owner must strategically plan the business to operate

**BOB
GREENWOOD**
CONTRIBUTOR

Bob Greenwood, AAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), a company focused on providing business management resources and development for the independent sector of the automotive aftermarket industry utilizing the Internet environment. Bob has more than 36 years of business management experience within the independent aftermarket industry, consulting independent retail shops on all facets of their business operations. Bob is one of 150 worldwide AMI approved instructors.

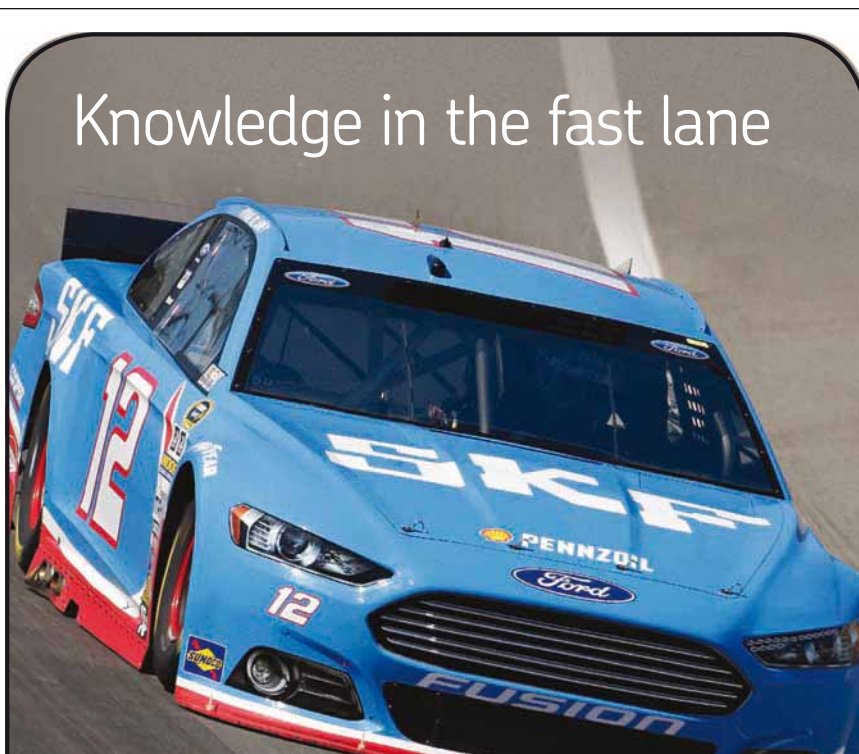
E-mail Bob at greenwood@aaec.ca

in today's competitive environment. If he/she does not know or understand how to do that, then business management education/development is a must, otherwise their very fabric of family security is definitely at risk.

This business is not worth cheating time away from your children or losing a family over. Do yourself the biggest favor ever in your business career, learn how net income works and is earned in your business today.

Do not get caught in the noise of the industry, "Well, it's different in my marketplace," "That's big city stuff, not reality where we are" and all the other excuses one will hear.

Net income development should be the very first issue to be addressed and understood before 2015 is over so the next three to five years can be celebrated with a new vision and true optimism for a bright and financially secure future. *ZZ*



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SIX STEPS TO A SOCIAL STRATEGY



IDENTIFYING WHO YOU REACH AND WHAT SETS YOU APART ARE JUST THE FIRST TWO QUESTIONS TO TACKLE ON THIS JOURNEY.

BY **MICHELLE BIZON** | CONTRIBUTOR

SOCIAL media is serious business. You wouldn't open a new repair shop without a detailed business plan. The same is true for launching your social media presence. Especially considering the level of competition out there these days, winging it is no longer an option. It's easy to enter your email address, pick a username and just go through the motions, but, ultimately, that won't impact your bottom line.

As a small business owner with a shop to run and a shoestring marketing budget, who's not looking to make a big punch without breaking the bank? By planning ahead and executing with

confidence, you can save yourself the time, money and headaches associated with an off-color tweet gone awry or a negative review wreaking havoc on your online reputation.

Even if you've been active on social media for a while now — and, especially, if you have that creeping feeling in the back of your mind that you could be doing so much more with it — getting back to basics to re-evaluate your strategy periodically is a valuable practice.

What Differentiates You?

Start by taking a look at your brand. You — and your business — are more than just the sum of the services you

offer. What makes you unique? What do your die-hard customers love about you? What organizations do you support in your community? What's your story?

By distinguishing how you want to portray yourself and what you stand for, you can create a clear, consistent message for your social presence. This should be cohesive with the messaging across all of your other marketing channels. Social media is just one piece of the puzzle that is your overall brand. Be sure to design it to fit with the other pieces.

Who is Your Customer?

Social media isn't about adding logos to your repertoire. It's about people. As you flesh out your social strategy, keep in mind that it must be customer-centric. Of course, you'll develop business goals around your strategy, but, ultimately, your success depends on the support of your customer base.



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These individuals will make up the bulk of your community online, at least at the beginning, and happy customers make the best advocates. Building community takes time, but it's worth it.

Take a look at the demographic data for your customer base. What age are they? Are they single or married with children? Do they all live within a certain ZIP code, or do you draw in prospects from far and wide — or even from across the country with online services?

The more detail you can add to the picture of your customer profile, the better you can cater to those folks online. Defining your audience will allow you to determine what type of content to share and even the language you should use in your posts. This step will be even more important if your ideal customer is a great deal different from you in personality, sense of humor or life stage.

Where is Your Audience?

Your customers will give you a good indication of where you should be active on social media. Do a little sleuthing. Are they tweeting up a storm? Do they post photos from your shop on Instagram? Many social sites have location-based filters, so you can search for activity posted in your town even beyond specific mentions of your business.

If you're still having trouble tracking your audience down, it's time to look at the competition. Where are they active? If they're particularly strong on one platform, it's a good sign that you should explore your options there, too. Do the same research into other organizations and/or publications in your area.

In the end, the easiest option may be to just ask. If you already have your social pages set up or have an email database, consider creating a survey to ask your customers how you can best serve them online. Don't disregard the value of asking in person either. You may get the most in-depth answers by going straight to the source.

What are Your Goals?

It can be a struggle to balance the customer-centric nature of social media with business objectives. Yes, as with all marketing, you need to cater to your

customers, and social media can be a fun venue for doing so. You can't just jump into the sandbox and yell, "Buy my stuff!" However, it's also not all about sitting around the campfire and singing "Kumbaya."

What is it that you'd like to accomplish by building your social media presence? Increase customer retention? Build awareness? Send traffic to your website? Lower your customer acquisition cost? There must be a point, or you'll never know whether you're being effective.

You're playing a long game, but each step should get you a little closer to the mountaintop. Break down those big goals, so you can see what they mean for your day-to-day work. Let's say you're looking to improve customer retention. One avenue for achieving that goal may involve working to increase your star rating on Yelp. From there, you can drill down further to actual activities: asking your customers to leave reviews and then committing to post responses to said reviews.

By nailing down specific objectives, you can also distinguish what will prevent you from achieving them. Audit whatever social sites you've already created and the skills of anyone within your business who is contributing to your online presence. You might need to ask Jennifer to overhaul your Google+ bio to include better keywords. You might need to ask Sam to up his hashtag game on Twitter. You may even need to invest in some tools, resources or outside help to assist you in managing your social media responsibilities.

How Will You Execute?

When you reach the execution stage, it's time to get concrete. What topics should you address? How frequently should you post, and to which networks? Reference the research you did in defining your audience and determine the best practices for the sites you're growing. These answers will inform your content development. For instance, you may only want to post on Facebook four times per week, but you should aim for more than three times that on Twitter.

From there, delegate responsibilities within your organization or hire outside

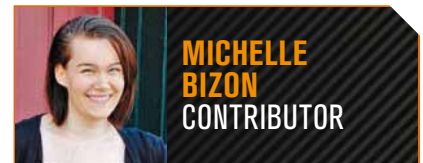
help to support your goals. Be honest with yourself about your resources, time and even preferences. If you say you want to post to Instagram three times per week but know you get cooped up in the back office, you'll need to assign someone as a photographer. If you'd rather spend time under the hood of a truck than sit at a computer, find a member of your office staff to keep an eye on your Google reviews.

How Will You Measure?

None of the work you've done above will matter if you have an ignorance-is-bliss attitude. The only way to improve continually is to measure continually. Most networks offer some form of built-in analytics to help you gauge your process. That way, you can see which posts, posting times and topics are resonating with your audience most strongly. Are you reaching thousands with your Memorial Day contest? You'll know to run a similar one for Halloween. Getting crickets from your latest sweepstakes? You'll know you need to try something else.

Stay on the Ride

With your strategy in place, you're ready to put your plan into action. Keep in mind that it will take time to see results, and you may need to tweak your strategy along the way. While sticking to a regular evaluation schedule to measure your progress is perhaps the step most likely to fall by the wayside, it's crucial. It will take more than a day to get to the top of the mountain you're scaling, and you don't want to be without a compass. *ILL*



Michelle Bizon is the Social Media Manager at Moving Targets. Her team helps hundreds of businesses engage their community, protect their online reputation and define their competitive advantage. Moving Targets is a print and digital marketing firm with more than 20 years of automotive industry experience. They help businesses build trust through campaigns that seamlessly blend print and digital messaging to reach customers at home, at work and on the go.

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OPERATIONS

SHOP PROFILE

A snapshot of one of the industry's leading shops

BUCHTEL MOTORS / DENVER



Turnkey Enterprise

Has anything you've bought on Craigslist been as successful as this shop turned out to be?

BY **ROBERT BRAVENDER** | CONTRIBUTOR

Most independent shops start out as a vision of being your own boss, of building success on your own accomplishments. David Estes realized this through an unusual route: He bought a shop on Craigslist.

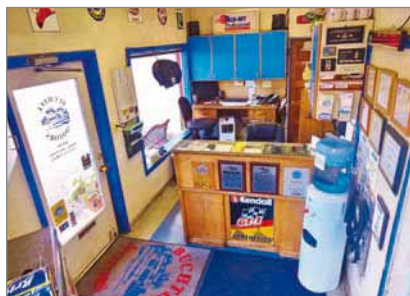
"It's been my dream to own and operate an automotive shop since I was 15 years old," he states. "When I saw this particular shop come up for sale, I interviewed the staff, and between the shop's location and longevity, it was what I wanted: a knowledgeable and friendly staff, one that doesn't go in for high pressure sales. I just didn't want that kind of stigma for auto mechanics anymore."

Located in a trendy section of Denver, Buchtel Motors is on South Pearl Street, "the hip epicenter of the Platt

Park neighborhood," according to *The Denver Magazine*. The building itself is an old corner gas station, rich with retro vibes. "That was part of its appeal," says Estes. "I liked the vintage look. I knew it would appeal to a lot of customers."

Estes came into his automotive passion ordinarily enough; his father was a Master Tech for 41 years until recently retiring. But this Houston native had to fulfill a greater passion first: he followed his girlfriend to New York City where she was starting a career in public relations. Amy Estes — yes, she married him — was following her own dream of going to the Big Apple, "and he supported me in that," she says.

Estes finished college at NYC's City University with a degree in business management and "went the corporate route," eventually becoming Director of Operations at a company involved in the automotive aftermarket. "I learned a great deal about product marketing, manufacturing, branding and business



The customer service and parts counters.

BUCHTEL MOTORS

David Estes

Owner

Denver

Location

1

Number of locations

31

Years in business

4 / 3

Total number of employees/techs

2,200 square feet

Shop size - main location

4

Number of bays - main location

25

Average vehicles serviced weekly

ASA, BBB, NAPA

Shop affiliations

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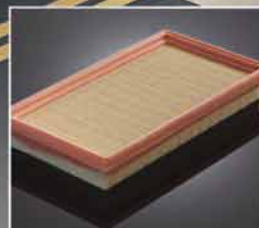
operations," he reports. "But the dream of owning and operating an automotive shop lived on."

Looking for a facility in Colorado, they found two or three (you really can get anything on Craigslist), self-financed the Buchtel purchase and hit the ground running. Estes brought his dad in to evaluate the operation and help for a while; Amy took over public relations.

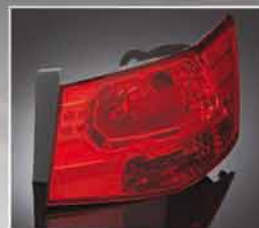
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“It was really neat to see them work side-by-side,” she says of the father-and-son team.

“Yeah, he worked for free,” laughs Estes. “It worked out pretty good because it was a busy time of year, and I was really contemplating whether I had the workload to support an additional tech. He helped me make that decision as well.”

Being truly turnkey, Estes kept most of the technicians. “A lot of it is just updating the software, the equipment, the tools,” Estes notes. “The previous owner kind of fell out of that over the last 10 years. Currently we’re updating all of the computer systems, management software, customer service retention methods. The techs now have iPads; we can go and remotely check in cars, send texts, pictures and quotes via that. No more handwritten hardcopies, line item stuff.”

And according to Amy, Estes did an amazing job of earning the trust of his employees in a very short amount of time. “That’s the foundation of being an effective leader, to make sure folks trust and respect you,” she says, “and he’s done that in little ways.”

Like ordering pizzas on Fridays, having some drinks at the end of the work day, talking about the week and what they needed to focus on. “And every time one of the tool companies come by, David buys something,” Amy reports. “It doesn’t have to be huge, but

it’s a new tool to give to the techs that says, ‘You’re important to me.’”

In the beginning Estes drove most of the shuttle runs. “I dealt with customers first hand, did a lot of meet-and-greets,” he recalls. “A lot of people were surprised that the owner was driving them home, and I felt that it was a great opportunity to reassure these customers that we have the same great service, same great people; nothing’s changed. I did that for like the first two and half months, almost every day.”

Amy focused on Internet presence and community involvement. “I think for a shop like Buchtel the website is critical,” she explains. “While an 80-year-old customer may have been coming here since the ’70s, we might also have an 18-year-old who’s a freshman at (nearby) Denver University, along with everyone in between. How each of those individuals get their information is very different, so we utilize every (Internet) platform available.”

But Amy’s biggest contribution so far has been getting involved in the numerous community events that characterize South Pearl Street. “In the short amount of time that we’ve taken over ownership, we’ve had a role in almost every event that they’ve had. We’re actually stepping outside and saying, ‘Hey guys, we’re here.’ I think that’s really helped us spread the word about who we are, and our commitment to the



The unique customer waiting area at Buchtel Motors.

community and to our customers.”

Of course the shop has a deep legacy and will remain Buchtel Motors, but the Estes’ are talking rebranding. “Right now the logo is simply the building,” says Amy. “While it has a lot of presence on its own, we feel that the power of Buchtel Motors is in the capabilities of the techs. So David recently purchased an old 1955 Ford F-100 and he’s been working with the techs on restoring it. We hope to integrate that truck with the logo; maybe put it on some apparel we can give customers to thank them for their business — different ways to promote the company.”

And as the Estes’ complete their transition, Amy marvels over the past year. “I think it’s rare in life to watch not only one dream come true but two, and people being supportive in that, especially this day and age. I’m really proud of the fact that we’re more than just husband and wife; we’re champions of each other.” **TL**



ROBERT BRAVENDER
CONTRIBUTOR

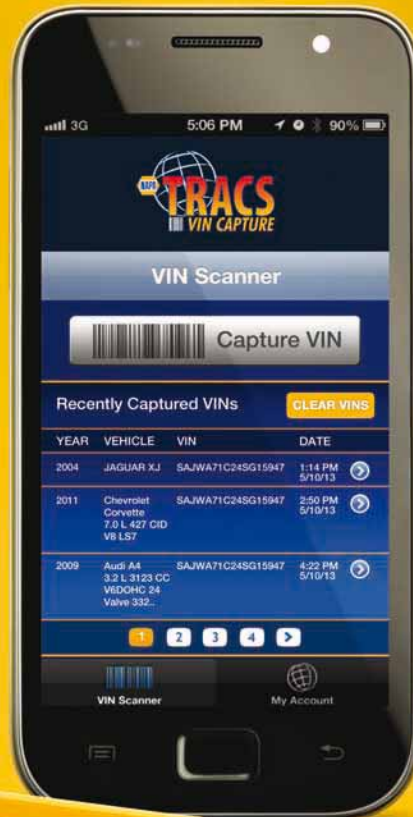
Robert Bravender graduated from the University of Memphis with a bachelor’s degree in film and video production. He has edited magazines and produced shows for numerous channels, including “Motorhead Garage” with longtime how-to guys Sam Memmolo and Dave Bowman.

Email Robert at rbravender@comcast.net



Three of the four bays at Buchtel Motors.

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The Dual Clutch DCT W6DGA Transmission

A LOT OF WEAR AND TEAR ON THESE CLUTCH ASSEMBLIES COULD PUT ONE ON YOUR DOORSTEP SOONER THAN YOU MIGHT REALIZE.

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

GETRAG is the maker of several Powershift Dual Clutch transmissions, both wet and dry, and is beginning to show up for repairs outside of warranty. The most common of them is the wet clutch 6DCT470 in Mitsubishi's Lancer EVO and Ralli-Art vehicles (Figure 1). Mitsubishi calls it a 6-speed W6DGA transmission, which it matched up with its 2.0L Turbo engine.

For those who have yet to be introduced to the basic operation of this style transmission, the double wet clutch arrangement is quite ingenious. Briefly, there are two input shafts (one inside the other) that spline to their own clutch drive hubs. The C1 clutch assembly, when fully applied, drives the odd gear drive hub for 1st, 3rd, 5th and reverse gears. The C2 clutch assembly, when fully applied, drives

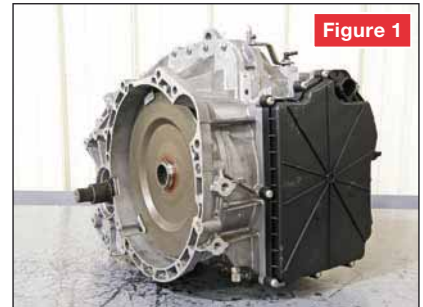


Figure 1

the even gear hub for 2nd, 4th and 6th. Both clutch housings are driven at engine speed.

The way in which these two input shafts mesh with their related output shafts allows for shift forks to preselect both an odd and even gear. For example, upon start up, first and second gear can be immediately selected. When a forward drive range is selected, the odd gear clutch (C1) is commanded to be engaged. Once a shift into second is required, the odd gear clutch is released as the even gear clutch (C2) applies.

As speed increases, the computer prepares for the next shift by disengaging first gear engaging third. Once a second to third gear shift is needed, the C2 clutch releases and the C1 clutches apply. The shift can be very swift making it a perfect transmission for performance vehicles. In fact, a man named Adolphe Kégresse designed this concept back in the late-1930s. By the mid-1980s Audi and Porsche used

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Figure 2



WAYNE COLONNA

is President of the Automatic Transmission Service Group (ATSG) in Cutler Bay, Fla., and a frequent speaker/instructor for transmission training around the globe.

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this concept in their race vehicles. Today, Getrag calls its design of it as its Powershift Transmission.

With these two clutch assemblies constantly applying and releasing, eventually they will need to be replaced and would be one reason why one may show up on your doorstep. If the drum assembly needs to be removed, it would be best to place the transmission into neutral before pulling the transmission out of the car. A scan tool can verify a neutral state has been achieved by seeing a 0 mm reading for each fork (Figure 2). If this cannot be achieved, it will need to be done manually on the bench. This can be done by removing the spring loaded detent bolts (Figure 3) using their threaded holes as access points to center the shift rails in the neutral position. Having the synchronizer hubs in the neutral position makes it easier to remove the clutch drum assembly.



Figure 3

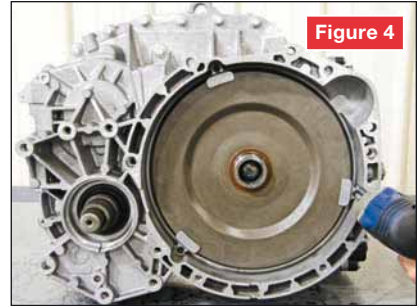


Figure 4

To gain access to the drum assembly, three clutch cover tabs need to be removed (Figure 4). The inner and outer diameter of the clutch cover is rubber bonded making it a bit of a challenge to remove it without damaging the cover. For this reason it has been referred to as a sacrificial cover. The manufacturer intends for it to be replaced but if the bonded rubber is still good, a little patience is all you need to walk it out of the housing and save yourself a few bucks. If the drum assembly is replaced

with a new one from the dealer, it will include a new cover

Once the cover is removed (Figure 5), the clutch housing assembly comes into view. This assembly is held fast to the sealing ring tower via a spanner nut. This will require a special tool to unscrew it from the tower. As you look at the center of the clutch housing, there are four access holes (Figure 6). A long pick can be inserted into one of the holes to align the slots that are in the two internal clutch drive baskets so



Figure 5

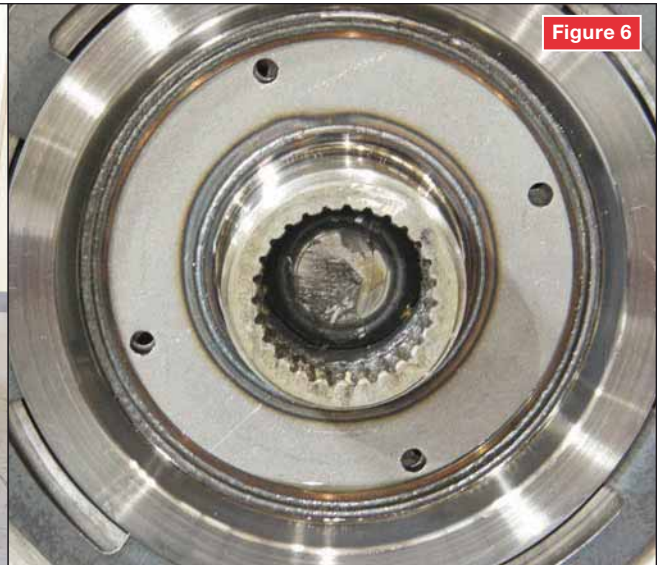


Figure 6



Figure 7



Figure 8

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that a special tool can reach the spanner nut (Figure 7).

The unit shown in this article was shipped in from the Netherlands by Automatic Choice to the Alto Products location in Atmore, Ala. It was there where this unit was disassembled. At the time, this special tool was not available so Alto's in-house tool and die department made one (Figure 8).

Once the tool was in place the spanner nut was loosened. It only takes about six or seven complete counter-clockwise rotations to fully release the spanner nut from the ring tower (Figures 9, 10 and 11). With the unit being on its side, care will be needed to remove the housing assembly by giving it a slight lift for it to clear the sealing rings (Figure 12). Otherwise, the unit

could be placed on to its back to release the spanner nut and lift the assembly out of the transmission.

If you are careful, this drum assembly can be disassembled to replace clutches and molded pistons. It is highly recommended to mark parts before disassembly to be used for alignment when reassembling the housing to eliminate the possibility of vibrations.

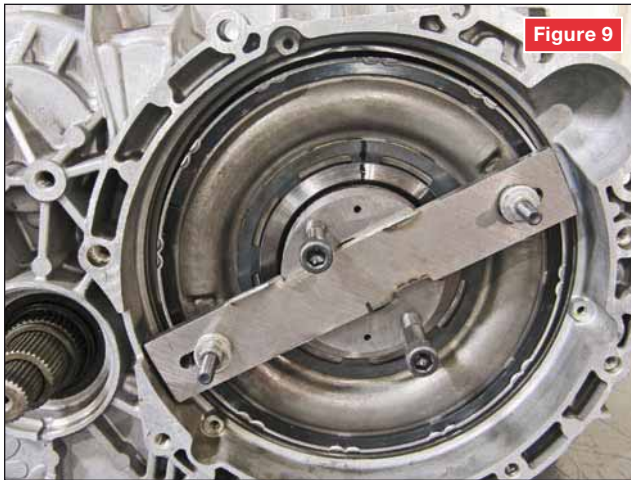


Figure 9

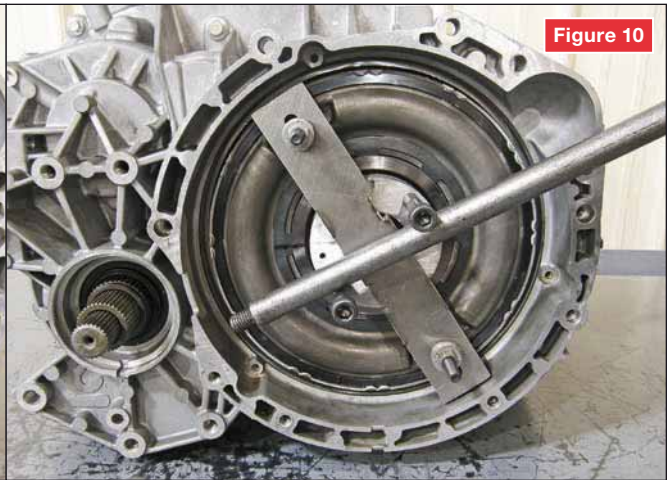


Figure 10



Figure 11



Figure 12



Figure 13



Figure 14



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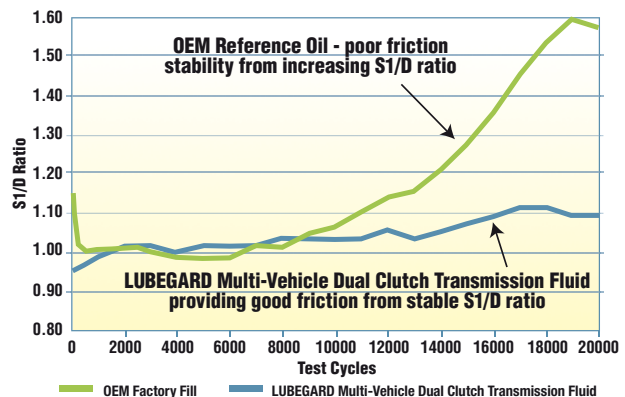
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FIGURE 1
SUPERIOR FRICTION STABILITY OF LUBEGARD'S MULTI-VEHICLE DUAL CLUTCH FLUID



The S1/D measurement is commonly used to assess the overall friction quality between the lubricant and the clutch system. A stable S1/D ratio indicates good friction stability and an increasing S1/D ratio indicates poor friction stability. Degradation of friction performance can be seen with the OEM factory fill after 10,000 cycles which could lead to loss in overall operating efficiency. LUBEGARD's Multi-Vehicle Dual Clutch Transmission Fluid ensures good shift quality over the life of the transmission.



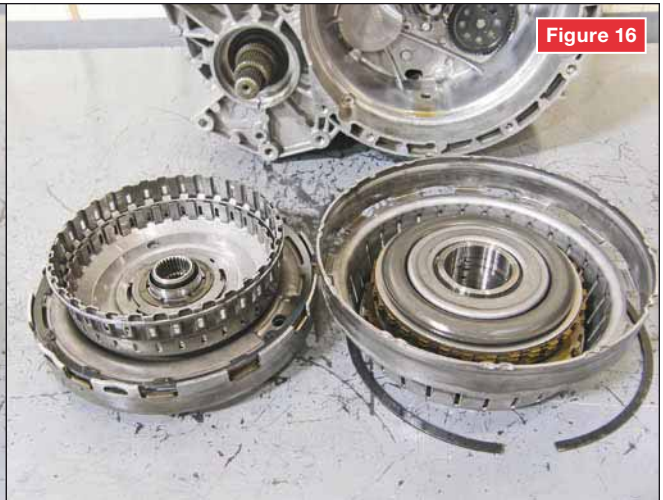
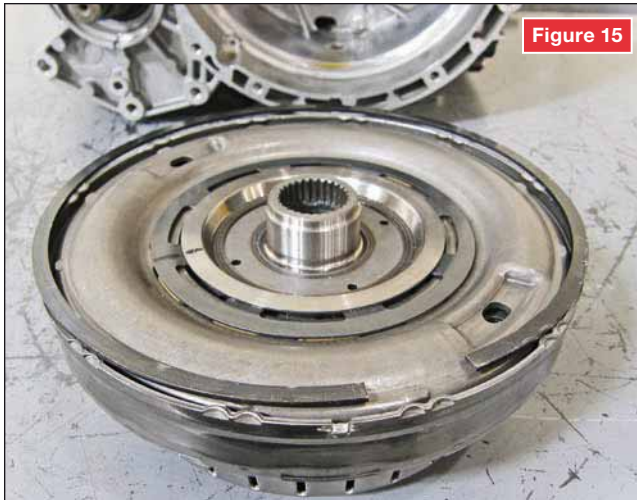
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The drive pump gear is part of the back cover (Figure 13). The inner diameter of this gear is a snap ring that holds the cover to the ring tower sleeve. This cover has enough flexibility to depress the cover without bending it. It needs to flex just enough to clear the snap ring from the integral pump drive gear (Figure 14). The assembly is then flipped around where

the large selective L-shaped snap ring holding the cover to the drive hub and damper assembly can be removed (Figure 15).

The damper housing, C1 and C2 clutch drive baskets and the spanner nut can be separated from the back cover containing the two clutch assemblies (Figures 16 and 17). Alto Products developed clutch and piston

kits providing the means by which this assembly can be rebuilt. It is important to note that all friction plates have spiral type oil grooves making them direction sensitive (Figure 18). Pay attention to their direction upon disassembly. It is imperative that they be installed exactly the way they came out; otherwise shift quality will be affected.



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Getting ahead of myself, whether you rebuild the double clutch assembly or replace it with a new assembly, a "Tech In" process will need to be conducted using a capable scan tool. Bob Nuttall from Autotech sent in screen shots using a Solus Ultra (14.4 version software) to get the job done. This critical procedure will ensure proper operation of the double clutch shift strategy.

After the work is completed with rebuilding the assembly or a new assembly was obtained, to install it properly requires a bit of finesse. Nuttall offers his experience on how he successfully installs the drum assembly.



Figure 17

He makes a tool using 1½-inch PVC pipe flange as a base. He inserts a 4-inch length piece of 1½-inch PVC pipe into the base and he then fastens a 1½-inch PVC pipe coupler over the pipe. The coupler needs to have a 2.41-inch O.D. and a 2.11-inch I.D. for this to work properly as this is the end that will go into the drum assembly and align the spanner nut (Figure 19).

He also suggests that while the drum assembly is set aside waiting for installation, that drive spline hub side of the assembly be supported by a couple of 2x4s or equivalent. This will prevent the spanner nut from being pitched against the clutch drive bas-

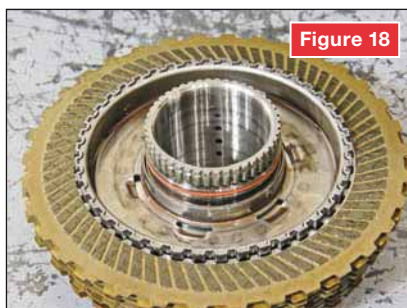


Figure 18

kets making the alignment of the nut more difficult.

Once the drum is ready to be installed, he inserts his PVC made tool into the assembly to align the spanner nut. The assembly is then flipped over where Mitsubishi's special tool (part No. MB992332-01-1) is inserted



Figure 19

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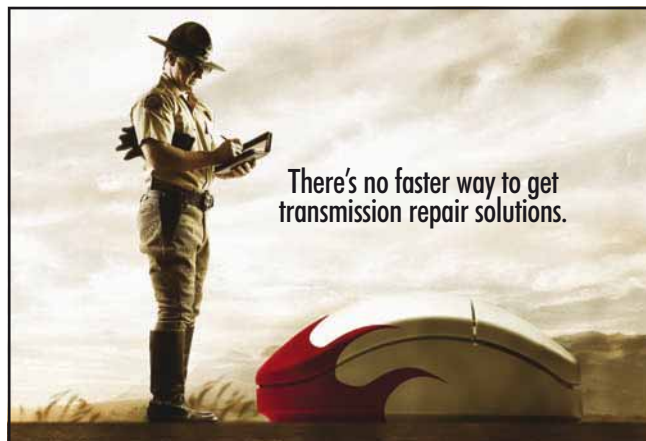


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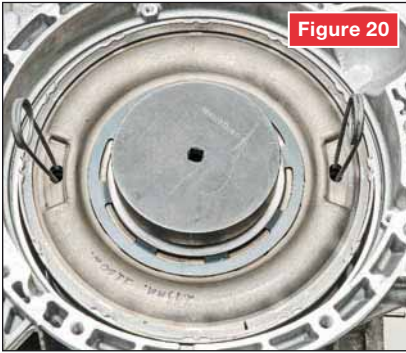


Figure 20

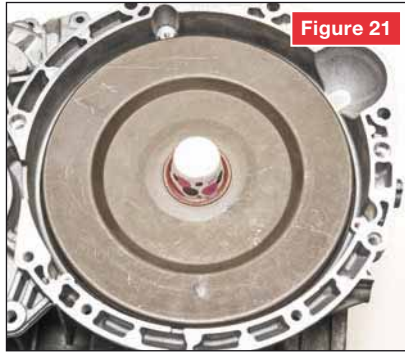


Figure 21

through the four holes in the cover, past the two drive clutch basket slots and into the spanner nut flange area. Modified striker handles are then used to lift the drum up off the alignment tool and carefully placed into the transmission (Figure 20). As the drum is inserted into the transmission a slight lifting with rotation will be needed to allow the input shaft and pump drive gear to engage.

When the assembly is fully seated, the outer edge will be above the cover tab bolt pads by approximately 3/4 of an inch. The spanner nut can now be

carefully threaded into the support tower using the special tool. It will take about six or seven turns for it to be fully seated. Once it is in place, torque the nut to 66 inch pounds plus or minus 8 inch pounds.

To finish the clutch replacement the sealed cover needs to be installed. The inner and outer seals need to be lubricated before installation. To prevent damage to the inner seal during the installation process, special tool M992314-01 can be purchased. Bob simply uses a 3 oz. Solo Bath cup (Figure 21). Once the cover is in place, it can be carefully



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tapped down using a dead-blow hammer followed by the installation of the 3 clutch cover tabs and you are done. Once the transmission is installed the Tech In programming will be required for the job to be complete. **TM**



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↘ TRANSMISSIONS

**THE
KEY
QUESTION**

**DO YOU NEED OEM-SPECIFIC
FLUIDS? IT MIGHT NOT BE A
SIMPLE YES OR NO.**

By 2015, the list of OEM-specified and required ATF has more than 100 types available.

BY **PATRICK BURROW** | CONTRIBUTOR

When you answer questions about automotive lubricants, some recurrent questions are about automatic transmission fluids (ATF) and their applications. Perhaps the most asked is, “Do I really need OEM specific fluids?” Like most technical questions, the answer never is a simple yes or no.

Before 1990, there were basically two ATFs — DEXRON/MERCON ATF and Ford Type F ATF — in every shop and used to service everything. A few OEMs (Chrysler and Toyota) had their own fluids, but service choices were simple and new vehicle warranties were short.

The changes started with the advent of electronically controlled transmissions. Engineers quickly found one of the most important factors for maintaining shift quality was having an ATF that did not change viscosity during the fluid’s life. This was possible, but required improved additive packages, better viscosity index (VI) improvers and high quality base oils. The fluid specifications at that time were changed to require performance that could be obtained only by using these new additives and synthetic base oils.

These programs successfully produced shear stable ATF with outstanding oxidative stability to meet the new, extended OEM warranties. The only problem was these new fluids did not shear down to a viscosity that met the requirements of the new 6-speed transmissions (the same thing is true for 7-, 8-, and 9-speed automatics) that had reduced sump volumes, higher fluid turnover rates (aerodynamic shrouding inhibits air flow over hot transmissions) and increased temperatures from heat generating electronics in the transmission itself. When you factor in reducing viscous drag in the transmission drivetrain, it became obvious to many OEM engineers that reduced viscosity ATFs would be a winner.

New transmissions were designed for them, and each transmission manufacturer had its own requirements for frictional properties and a desire for a new profit center developed around exclusive use of its OEM-branded fluid available through the dealer network. OEM service departments were programmed to deny warranty if “improper” fluid (anything not sold by them) was used for non-dealership service. By 2015, the list

of OEM-specified and required ATF has more than 100 types available. When you include all types of automatic transmission fluid like CVT and DCT fluid, the list gets even bigger and more complicated.

The Original Question Again

With that said, back to the question, “Do I need OE specific fluid?” Because the U.S. automotive aftermarket is the dynamic free market entity that it is, there always will be an oil company that is willing to take the same technology it sells to OEMs and package it for consumers available at their favorite source for non-OEM lubricants. Recognizing the need for shear stable synthetic ATF, many manufacturers have products designed to meet the OEM requirements for automatic transmission fluid.

Because OEMs have different engineering requirements, some new synthetic transmission fluids are conventional viscosity (6.8-7.5 cSt at 100°C), while other synthetic automatic transmission fluids are reduced viscosity (5.5-6.5 cSt at 100°C) “fuel-efficient” formulations.

When determining what to use, following OEM reasoning helps. Some

Photo: Lubegard

OEMs view reduced viscosity ATF as reverse compatible to older transmissions (GM (DEXRON VI) and Honda (Honda Genuine DW-1)). Ford, Chrysler and Toyota do not and have multiple, specified OEM fluids to meet specific requirements. Aftermarket fluids will have a product information sheet (often on their website) that gives you viscosity information, so picking an equivalent is not difficult. Because frictional properties are what drove much of the proliferation of OEM specific fluids, this must be factored in when selecting replacement fluids.

Up Next, CVTs

The next group of automatic transmissions to consider is the CVT transmission. Just like conventional automatic transmission, it requires frequent service and fluid changes to provide the longevity modern motorists have come to expect. A common mistake made is that CVT fluid and conventional ATF are similar. CVT fluids provide many of the same functions of ATF like hydraulic system operation, cooling and wear prevention.

Where they differ is frictional properties. ATFs are designed to slip clutches properly with no shudder or chatter, where CVT fluids are designed to have a very specific coefficient of friction that allows them to protect the sheaves and belts/chains from wear without excessive slip, making them what we call traction fluids. Using OEM fluids can make sense during the warranty period (CVT transmissions can be expensive), but there are synthetic CVT fluids available in the aftermarket that meet OEM specified fluids' quality and frictional requirements.

The final type of automatic gearbox we are starting to run into is the dual clutch transmission (DCT). There basically are two types: wet clutch and dry clutch. Dry clutch is used on smaller cars with lower power output engines. Wet clutch often is

a high performance option and is gaining popularity because its automatic mode allows the gearbox to shift itself. Dual clutch fluids are the same type of fluid for dry or wet applications. The mechanical/electronic systems (mechatronics) that cause the gear shifts on the dual shaft setup require a fluid similar to ATF.

Because there is a dual mass flywheel that conveys power to the selected shaft/gear wet clutch, the fluid has frictional properties like an ATF to slip the wet

clutch properly for smoother shifting. This is where the similarity ends. The DCT fluid contains a much higher level of extreme pressure (EP) anti-wear additive than ATF to ensure gear drivetrain longevity. This requires a fluid formulated to meet the anti-wear requirements of these types of fluids. Again, the North American automotive aftermarket has DCT-specific synthetic fluids to replace expensive or hard to get OEM transmission fluids. *ZZ*



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**PAT
BURROW**
CONTRIBUTOR

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 E-mail Pat at pat@LUBEGARD.com

Figure 1

THIRD CLUTCH BURN OUT



CAN WORN FEED PIPE BUSHINGS REALLY CAUSE ROTATIONAL DAMAGE?

BY WAYNE COLONNA | POWERTRAIN PRO PUBLISHER

It is not unusual for a 2000-2004 Honda or Acura vehicle using a 5-speed, 3-shaft style automatic transmission to come in to the shop with the third clutches destroyed (Figure 1). Many times rotational damage of the piston, return spring and spring retainer accompanies the third clutch burn out (Figures 2, 3 and 4).

The main shaft, counter shaft and secondary shafts are each supported by their own bearings secured in the main case cover (Figure 5). Over time, vibration combined with torque causes these bearings to wear into the case allowing for unwanted shaft side play. Stationary hydraulic feed pipes in the end cover that fit into these shafts run hard against the rotating bushings inside the shafts (Figure 6). The wear caused by shaft side play not only damages feed pipe sealing capabilities

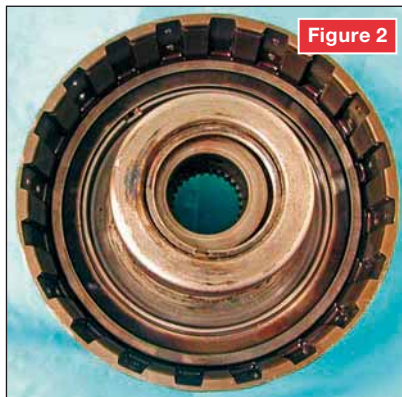


Figure 2



Figure 3

dropping clutch pressure (4th and 5th clutch main shaft, 3rd clutch counter shaft, 2nd clutch secondary shaft), damage also can extend to the sealing rings on the front of the main shaft.

When this happens to the main shaft, the rings cut into the regulator valve body compromising converter pressure.

In fact, one symptom this causes that rebuilders Max Deese in Chicago experienced is a sudden stall while waiting at a stoplight.

It is understandable how the third clutch can burn out due to a pressure loss caused by worn feed pipe bushings, but the rotational damage? Jesse

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Zacarias of Elec-Tran discovered a computer strategy which briefly pulses the third clutches on and off during a forced 4-2 downshift. Factory manuals show this clutch being pulsed on and off during an engagement from Park to Drive without mentioning the 4-2 shift strategy. The purpose of this brief pulse of the clutch is to assist in a smooth shift transition. After 80,000 miles or so when shaft alignment begins to be compromised, this forced 4-2 downshift becomes a problem. The third clutches are being applied (albeit briefly) during high rpm conditions with less pressure control resulting in clutch burnout with rotational damage.

When rebuilding this transmission, it is imperative to restore shaft alignment along with shaft bushing and tube wear otherwise repeat failure is imminent. Companies like Slauson Transmission parts recondition these cases so that bearing pocket wear is a thing of the past. Bushing tool kits are available in the aftermarket to remove and replace shaft bushings. Honda clutches and fluid are a must with the exception of Raybestos' GPX® friction plates (Figure 7). It is very compatible to Honda fluid and due to its unique friction material and special grooved patterns. This tends to provide cooler operating temperatures and endurance of this clutch pack which is especially suited to the demands placed on this particular assembly. In fact they have announced a new

friction they call the HT plate, which is totally different in material and grooving.

This newly added HT plate emerged from continued studies they originally conducted with groove designs to see what impact it had on durability and performance with the GPX plate. The fluid flow dynamics with this new plate's unique groove patterns and friction materials (Figure 8), is expected to positively impact durability, performance and clutch drag reduction. Starting with several Toyota transmissions (U660, A750 and A760), these frictions also will find its way into some Ford and GM units as well. *TL*

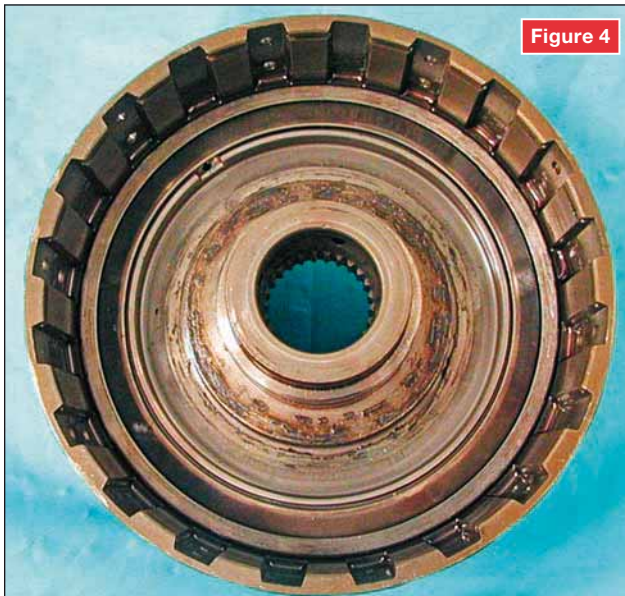


Figure 4

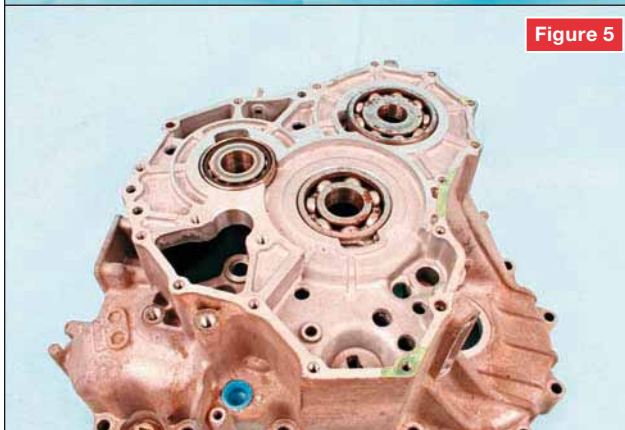


Figure 5

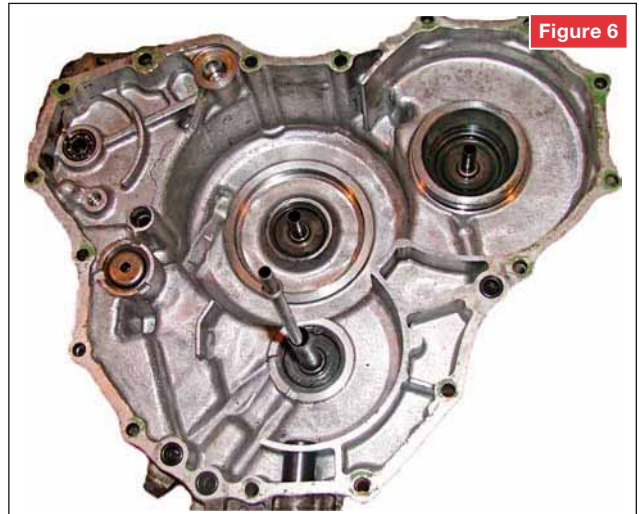


Figure 6

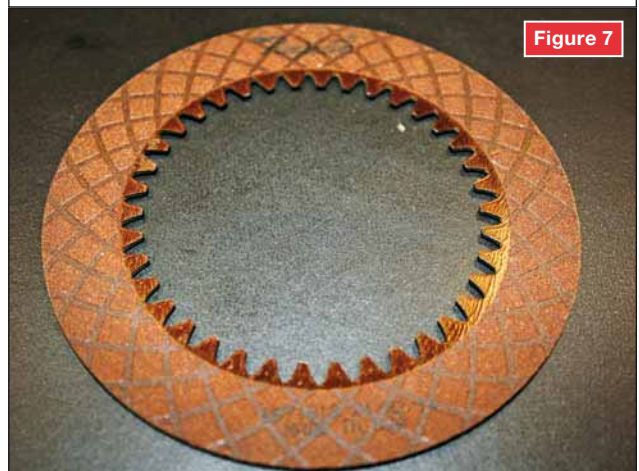


Figure 7



Figure 8

TECHNOLOGY

THE NUTS AND BOLTS OF AUTOMOTIVE REPAIR



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DRIVABILITY

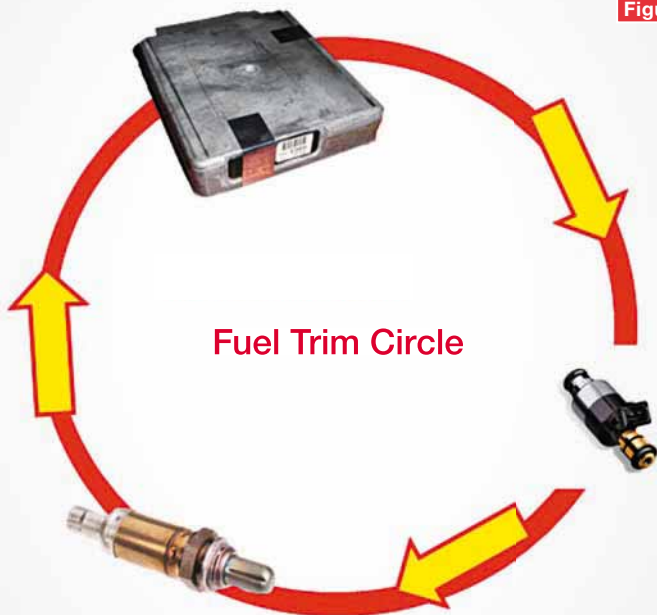


Figure 1

DRIVABILITY FROM THE FRONT SEAT

The graphic shows the fuel trim control path. The PCM commands the fuel injector pulse width and fuel is injected into the engine air stream. The oxygen sensor reacts to the air/fuel ratio in the exhaust and sends its feedback data to the PCM. The PCM makes a correction from the oxygen sensor feedback data and pulses the fuel injector. This is repeated over and over as long as the engine is running in closed loop.

USING FUEL TRIM AND SCAN DATA TO SNOOP OUT DRIVABILITY PROBLEMS.

BY ALBIN MOORE | CONTRIBUTING EDITOR

The fuel trim Parameter Identifiers (PIDs), both short term fuel trim (STFT) and long term fuel trim (LTFT), on your scan tool can provide much needed information when it comes to analyzing drivability problems quickly and efficiently. Fuel trim data is nothing more than the scan tool displaying what the engine computer is doing with the fuel injection pulse width to keep the air/fuel ratio where it needs to be.

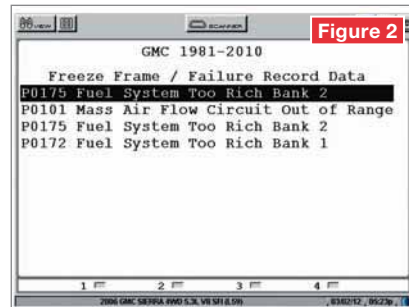


Figure 2

Diagnostic trouble codes stored in memory.

Things like airflow restrictions, changes in fuel pressure, camshaft timing and fuel quality always will show up in the fuel trim data on your scan tool. Only a few PIDs are needed: throttle position, engine rpm, engine load, STFT and LTFT for all cylinder banks, oxygen sensor voltage for all sensors and MAF data if you are working on a MAF engine.

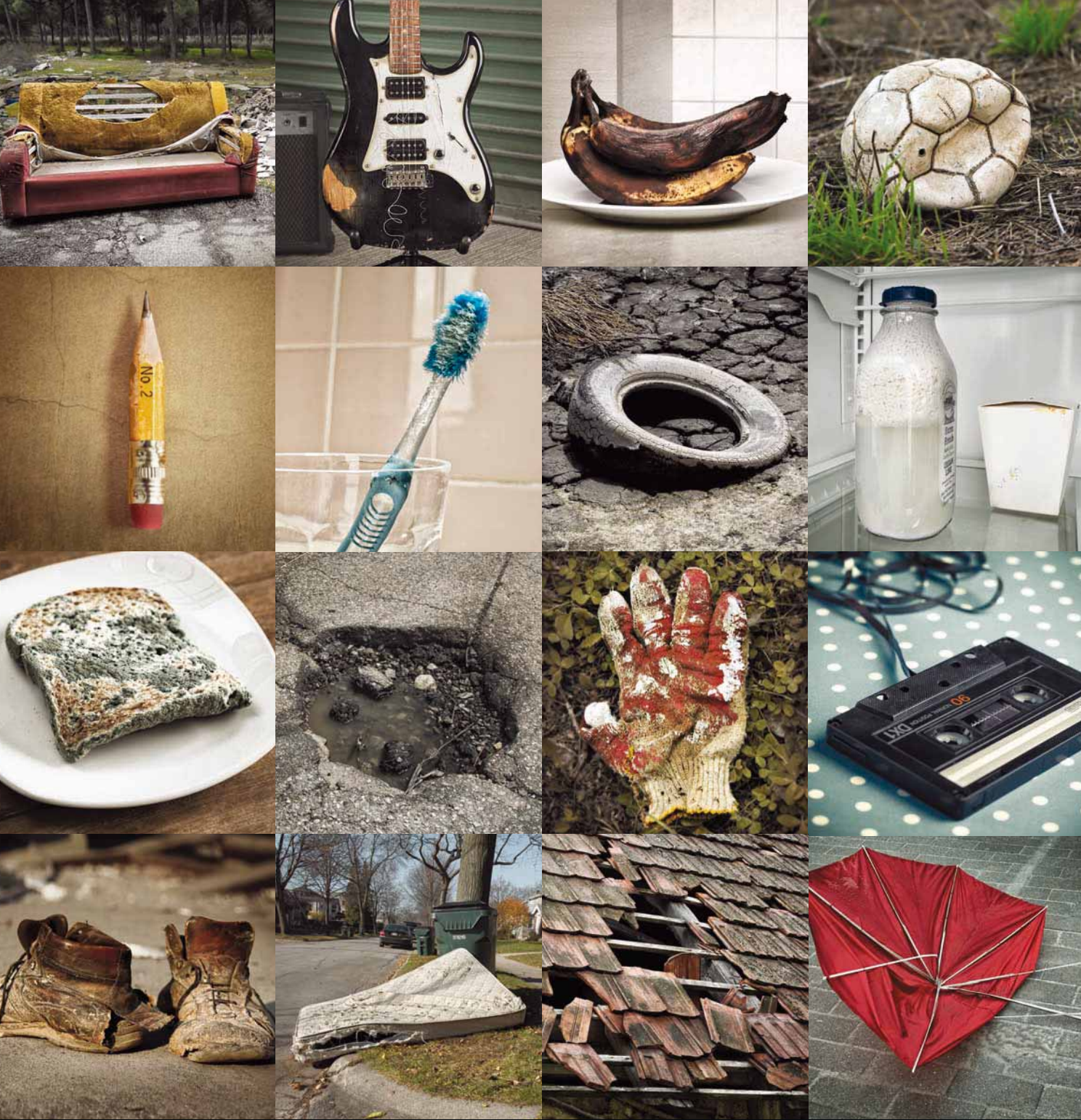
Recap of Fuel Trim

Fuel trim is nothing more than the corrections in fuel injector pulse width the Engine Control Module (ECM) makes. The fuel trims start with STFT, which is the product of the feedback from the oxygen sensors. As STFT is captured, the fuel trim correction is moved to LTFT, where it is stored in fuel trim cells. Here the LTFT data is stored in the trim cell lookup tables so the ECM has the correct fuel trim data each time the engine speed or engine load is changed.

The oxygen sensors will notice anything that alters the normal air mass or normal fuel mass entering the engine. These sensors give their feedback to the ECM and the module will make a correction in the fuel injector pulse width. This goes on as long as the engine is running in closed loop. By using a scan tool to graph the fuel trim data, the technician can get a good direction on most any drivability problem.

Sitting in my bay is a nice looking 2006 Chevrolet Avalanche. The odometer shows the vehicle has traveled 135,000 miles, the engine is

Photos: Albin Moore



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the popular 5.3 VIN Z flex fuel powerplant with an automatic transmission attached. The only complaint on the vehicle is the Check Engine Light is illuminated. Test driving the vehicle uncovered no apparent drivability problems.

With a scan tool hooked up, three Diagnostic Trouble Codes (DTCs) were found in memory: P0101 (MAF circuit out of range), P0172 (system rich bank 1) and P0175 (system rich bank 2). If we take these DTCs at face value, the problem could be something as simple as a misreporting Mass Air Flow (MAF) sensor. Before you shotgun a new MAF on the vehicle, though, let's fire up the scan tool, create a custom PID list, take a quick test drive and use the captured data to analyze the problem.

The Testing Process

Data PIDs I'm recording on the test drive are engine RPM, throttle position (TPS), MAF grams per second, engine load, LTFT for both banks, STFT for both banks and oxygen sensor voltage for all four oxygen sensors. These few PIDs will give you all the needed information you need to analyze the problem and determine if the P0101 DTC is caused by a misreporting MAF sensor or not.

The vehicle was taken out and data captured at an idle, at a Wide Open Throttle (WOT) acceleration up through one transmission shift, then at a short ¼ mile cruise. Because the test parameters are the same for all vehicles I diagnose, I have a preset route that allows for consistent results in a safe manner.

System Analysis

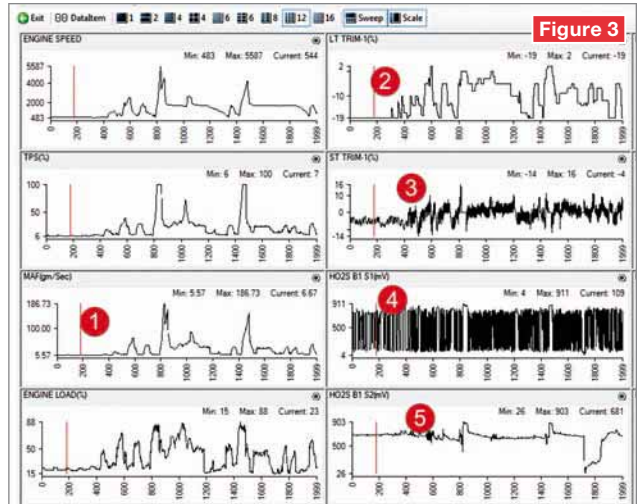
Start the problem analysis with Figure 3, point No. 1, MAF data. The MAF data displays 6.67 G/S of airflow. A rule of thumb for MAF is, "with the engine at idle and all loads turned off, the air mass should equal 1 gram/second (G/S) per liter of engine displacement, at 500 rpm."

The air mass shows 6.67 G/S with an idle speed of 544 rpm. This looks a little high to me, but file this piece of information in your mind to use at a later date. Point No. 2, LTFT, is showing a negative 19 percent pulse width correction. This data is screaming unmetered fuel in the air stream, in other words, there is too much fuel for the amount of air flowing into the engine.

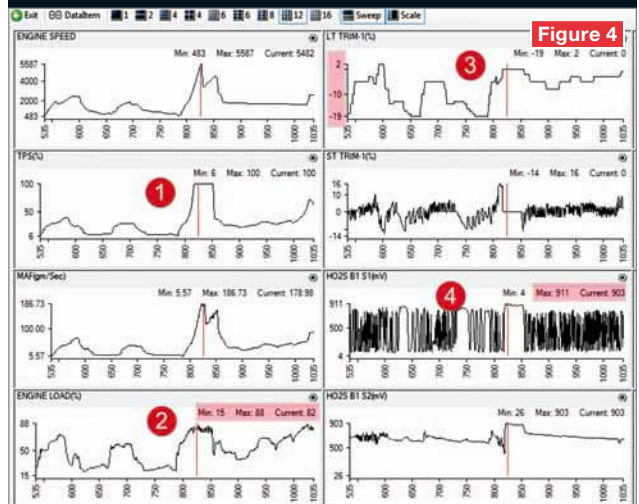
Point No. 4, STFT is showing a negative 4 percent correction, so if we add the long term and short term fuel trim together to get total trim, the scan tool is showing a total negative 23 percent of injector pulse width correction. Point Nos. 4 and 5, oxygen sensor voltage, show the engine is running in closed loop and is in proper fuel control. This platform will stay in closed loop at all load conditions from idle through wide-open throttle.

Figure 4 is the data collected at wide-open throttle acceleration, or the Volumetric Efficiency (VE) portion of the test drive. Data point No. 1 is showing the engine at wide-open throttle. Point No. 2, engine load, is showing a maximum of 88 percent load at wide-open throttle at the 1-2 shift point. This is a little low for this platform. The known good value should be 99 percent engine load. This is another piece of information to store in your mind.

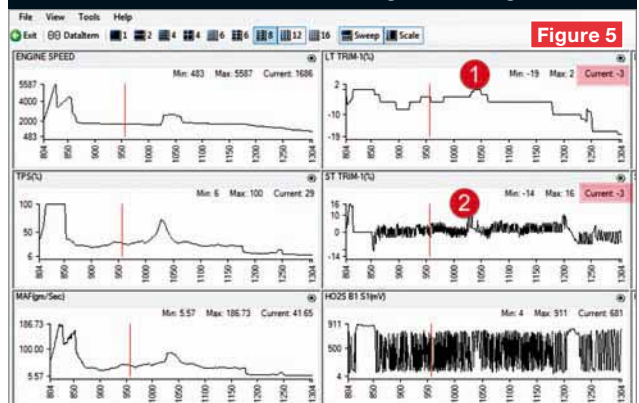
Point No. 3, LTFT and STFT are both showing zero percent correction. This is normal, since the fuel enrichment is taken



Data captured on the first test drive. The cursor is set with the engine is at idle.



Data captured on the first test drive. The cursor is placed where the engine was at wide open throttle where the transmission made its shift from 1st gear to 2nd gear.



Data captured on the first test drive. The cursor is placed where the vehicle is on level road at cruise.

care of with the fuel enrichment strategies. Point No. 4, front oxygen sensor voltage is showing both banks above 900 millivolts, which is telling us there is plenty of fuel available during the maximum power demand the engine is under.

Let's move on to Figure 5, taken during the cruise portion of the test drive. Point Nos. 1 and 2, LTFT and STFT are showing a total trim of negative 6 percent. This looks normal, although I would be happier with a total trim of zero percent.

Putting the Pieces Together

One thing that stands out from the data from the first three data captures is the higher than expected airflow at idle. I would be happier with 5.5 G/S airflow. The other is the negative 23 percent total fuel trim, making me wonder where the extra fuel is coming from. Is this excessive fuel problem caused by a MAF sensor that is incorrectly reporting the airflow into the engine, a dribbling injector, or a fuel quality issue? The recorded scan data speaks for itself. After all, the reason for using scan data is to get the problem to come to you, the technician, sitting in the comfortable front seat.

At wide-open throttle, the engine load is too low. I would expect to see 99 percent engine load, and the scan tool only displays 88 percent. This engine load is a product of the airflow being reported to the ECM.

During cruise, the total trim is a little out of line at negative 6 percent. There is one more test I would like to do, using a volumetric efficiency calculator as a tool, to see if the MAF is doing its job. This will be one more tool to help out with the MAF diagnostic process.

When using a volumetric efficiency calculator, be aware that things like a restricted exhaust or air intake, or retarded camshaft, can and will affect the calculations. The volumetric efficiency calculator must be used along with the fuel trim data to ensure its accuracy. Take a look at Figure 6. The calculator shows the Chevy's volumetric efficiency is only 65 percent, absolutely too low.

By using the captured data, MAF data at idle, engine load PID and VE calculator and understanding the criteria for a P0101 DTC, I have determined the MAF is not reporting correctly. In fact, it is over reporting at idle, and under reporting at high engine loads. I can now pull the trigger on a new MAF sensor with confidence that it is the cause of the code. But what about the others that had set?

Inputs:		Input: Altitude Off True Barometric pressure, Not both			Figure 6	
3	Your Actual MAF Value in gms/sec	Engine Displacement in Liters	RPM	Altitude in Feet	Barometric Pressure**	Override V
4	186.70	5.3	5548	1000	0.00	0.00%
5	Temperature °F			*Relative Humidity %		
6	60	80%			Input value above ONLY if you know the vehicle's true VE at the specified RPM range. Input as decimal i.e. 75% = .75	
7	Temperature and relative humidity have small impacts on VE calculations.					
8	If left blank, calculations assume 50° F and 50% Relative Humidity - on average air					
9	*Input relative humidity as a decimal (i.e. .80 = 80%)					
10	*Input relative humidity as a decimal (i.e. .80 = 80%)					
11	Outputs:					
12	MAF reading should be about (in grams/sec)					
14						
15	Percentage difference					
16	Allow for a +/- 8% margin of error					
17	Actual Volumetric Efficiency					
18						
19	Under Calculating Air flow (negative %) will give positive fuel trim.					
20	Over Calculating Air flow (positive %) will give negative fuel trim.					

Results of a volumetric efficiency calculator using the MAF data as a tool to verify a misreporting MAF sensor.

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New MAF Installed

With a new MAF sensor installed on the vehicle, the vehicle needs to be taken on its "after the repair" test drive. The same data always should be used to prove out the repair that was used to find the original problem. In this case, the recorded data has changed a little, one problem has been fixed, but there is still a problem that is shown in the fuel trim. Let's examine the data and see what it tells us.

Looking at other data captured, we can see the results of the whole test drive but concentrate on point No. 1, the idle MAF data. This is showing 5.6 G/S, which is inline more with a 5.3 engine at idle. Point 2, though, the fuel trim still is not correct. I don't think the DTC P0172 and P0175 have been fixed and if the vehicle is shipped like it is, it will be back with the Check Engine light glowing once again. At that point, the diagnostic work to fix the real problem will come out of my pocket. The total fuel trim is showing a negative 14 and negative 12 on bank 1 and 2, respectively.

Moving to the WOT VE test's point No. 1, the engine load is now at 99 percent, which is correct. Point No. 2, the total fuel trim is behaving correctly for the wide open throttle, and point No. 3, the oxygen sensor voltage is showing there is a good supply of fuel to the injectors, and the proper amount of fuel is being injected into the air stream.

The cruise portion of the data found in Figure 9 tells a different story about the fuel/air ratio, with a total trim of negative 18 on bank 1 and a negative 15 on bank 2. One more test is needed, - we need to plug the scan data into the VE calculator and see how the results pan out.

The VE calculator in Figure 7 shows the VE calculation of 86 percent, which is very good for this engine. This is evidence the new MAF sensor has fixed one problem, but there is still an over fueling issue lurking in the wings.

If this were a dribbling fuel injector, or fuel injectors, I would expect the fuel trim to be different between the two cylinder banks, and if it were a leaking fuel pressure regulator, I



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would expect to see the fuel trims very high at idle and lowering with the vehicle at cruise. This scan data is waving the flag of a fuel quality issue. I do not want to open the hood and

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connect a fuel pressure gauge; it's cold outside and I want to find the problem in the comfort of the front seat.

Finding the Second Problem

The vehicle we are working on has the VIN Z engine under the hood; this is a flex fuel engine. The scan tool is the place to go to see what the engine management system is doing with the flex fuel calculations. Take a look at Figure 8 and point No. 1. The scanner is displaying a fuel alcohol content of 47 percent alcohol. If this vehicle were in a place where E85 could be purchased, the displayed number might be correct but in my area, there is no E85 for sale, only E10. Before you leave the scan data, note the loop PID at point No. 2. This vehicle will stay in closed loop at all driving conditions, including wide-open throttle.

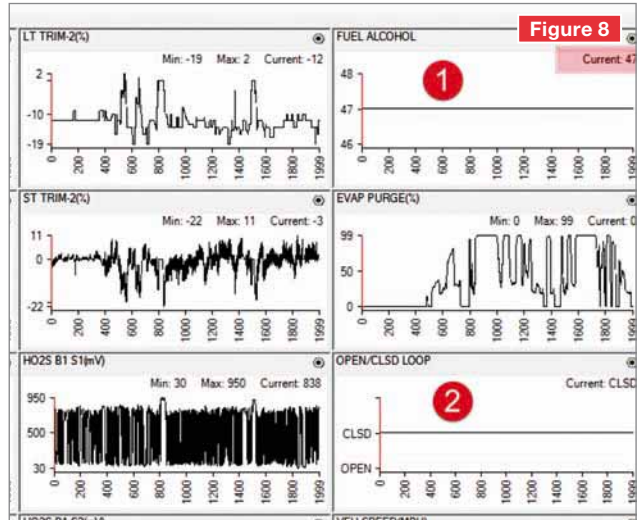
The next step was to test the actual alcohol content of the fuel in the gas tank, and I found there was only 6 percent alcohol. Now the scan tool has waved the red flag about the negative fuel trim problem. The fuel/alcohol content is not being reported properly. Because alcohol has less BTU (British thermal unit) per pound than gasoline, there is less energy per pound in the fuel being reported than the fuel that is in the tank and the ECM is commanding a longer fuel injection pulse than is required for E10.

This vehicle uses a virtual alcohol sensor where the oxygen sensors are used to make the fuel/alcohol calculations. Is there a possibility the misreporting MAF sensor has something to do with this miscalculation of the fuel/alcohol?

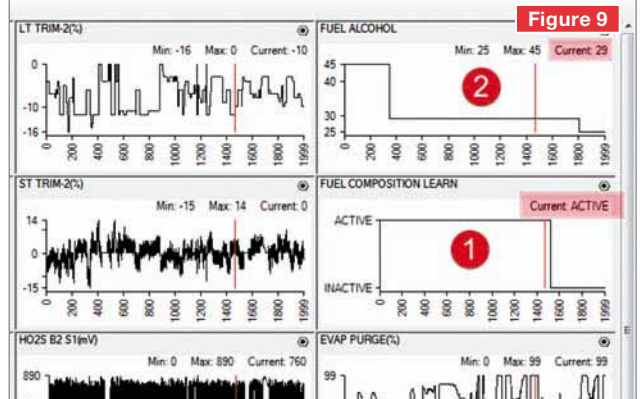
A fuel composition relearn can be commanded with a scan tool, but I opted to do it the manual way to verify the system would work properly on its own. I added four gallons of fuel to the fuel tank and drove the vehicle. This allowed the system to do its relearn on its own. The relearn was done, with no change in the fuel alcohol content.

Searching service information, I found TSB 06-06-04-010E, which outlines this problem very well. An ECM reflash is required to fix the software problem that is causing the miscalculation of the fuel's alcohol content. The reflash was performed, another four gallons of fuel was added to the fuel tank and the vehicle driven. Figure 9, points Nos. 1 and 2, shows the ECM running the fuel composition calculation. The first time the calculation was run, the system reported 25 percent alcohol.

The next data capture was taken after two refueling events. The total fuel trims run around negative 4 percent and at point No. 1, the fuel/alcohol content is showing 25



Scan data showing the reported fuel/alcohol content. In this case, the fuel/alcohol content is being reported at 47 percent. Something is wrong with the virtual fuel/alcohol calculations.



Scan data showing the PCM doing a fuel composition relearn. Because the virtual fuel/alcohol sensor depends on fuel trim as its main input for proper calibration it is very important to have the fuel trims working properly.

percent alcohol content. I find this consistent with this vehicle platform. The fuel/alcohol content is always reported higher than what is measured in the tank. This causes the total fuel trim to run at a slight negative rate.

Learn to use your scan tool. It makes problems like this come to you and makes them easy to solve. **ZZ**



Results of a volumetric efficiency calculator using the MAF data as a tool to verify the MAF is reporting properly.

ALBIN MOORE
CONTRIBUTING
EDITOR

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

✉ Email Albin at bwrench@yahoo.com

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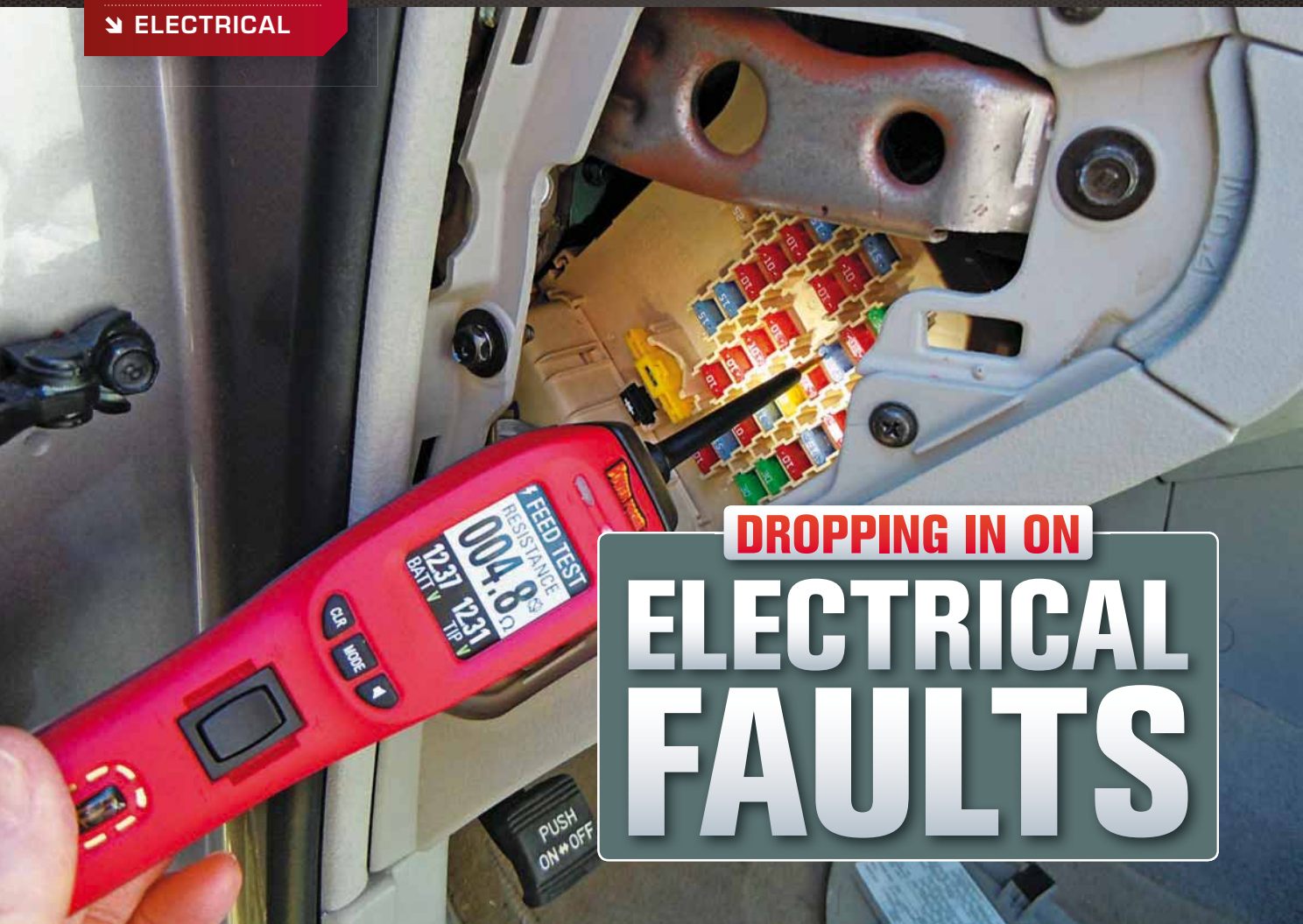
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BY JAIME LAZARUS | CONTRIBUTING EDITOR

Those who know me know I talk to myself. Actually, I just think out loud (a lot). Sometimes in frustration I might ask questions out loud, even when no one's in the room. Fortunately, I don't always answer my own questions. With the intention of having fun and at the same time attempting to educate, in this article I took some literary freedoms and imagined "Jaime has a conversation with his split personality."

Jaime, I frequently hear the term "Voltage Drop Testing." What is it?

In its simplest terms, voltage drop testing is the measuring of the voltage differences that may be present at various points in a circuit. The truth

is, every circuit has some voltage drop. Even the best made wire (conductor) doesn't have the same number of electrons available at its end as it has at its source. The difference is considered the "drop."

That doesn't sound very technical. Is that all there is to it?

Is anything we write about simple? Like the commercials say, "But wait! There's more!" Remember high school physics? (No, I don't mean the girl we liked in that class.) We were taught, among other things, that "Energy cannot be created nor destroyed — but it can be transformed into other types of energy." In fact, that is exactly what we're doing when we bring a vehicle

to a stop. We are converting kinetic energy (vehicular motion) into thermal energy (heat) when braking friction is used to slow us down.

More physics — an electron at rest (will remain at rest)...

There is one condition that must be present in order to have a voltage drop. That is, the circuit must have been intended to be in operation. In other words, the circuit was completed between the battery positive and the battery negative terminals, of course, with control circuits and a load in between. If the circuit isn't completed, electron flow will not occur. Electron flow can be measured in volts (V or E) and amperes (amps, A or I) and is

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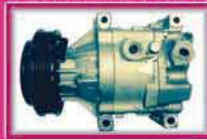
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affected by resistance (R). Ohm's Law is $E=I \times R$. Here is a simple concept to remember: If there are not enough pathways for amperage to flow, the volts will decrease in numbers (voltage drop), and usually heat is produced as well.

TMI! Too Much Information! You're hurting my brain!

This is the same reason power companies generate a lot more electricity than their consumers use. A certain percentage of what's produced is lost in transmission; some is lost transforming it to what we use in our homes and businesses, but typically the vast majority of energy lost is in the form of heat (just like when braking). It isn't that the energy is gone, but it has been changed into another form, leaving less energy (power) available at the end of its line.

So, what does that have to do with voltage drop testing or with auto repair?

Well, as we all know, today's automobiles have a lot more electronic gizmos than the cars did even a few years ago. Just like the power company's electricity, the heat generated by the loss of electrons traveling from the car battery, through all the electronic devices and back to the battery again, is why there aren't any cars made without air conditioning anymore. Don't believe me? Then name one car that has A/C optional. OK, just kidding.

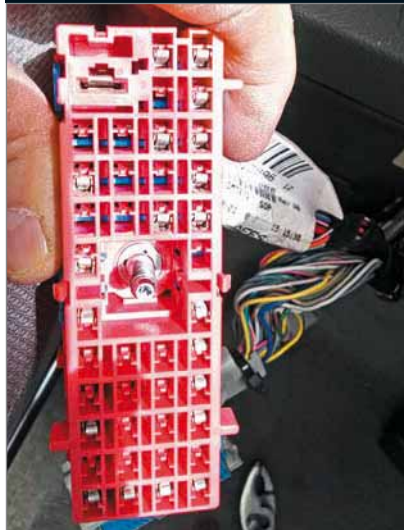
Really! Get serious! Why should we care about a little loss of voltage?

We generally don't have to "care" about the voltage drop that is engineered into a circuit. Think about it — if every circuit has a certain amount of electron loss then the smart engineer will build a tolerance into the circuit allowing for it. It's only when the amount of energy lost causes something to not operate as designed that we even concern ourselves with it.

Let's take for example, a simple circuit used to illuminate a light bulb. There should be a supply voltage, a switch, the load (bulb) and a ground. If our supply voltage is as it was intended, and is measured the same at one conductor of the bulb (assuming the other conductor is grounded), the bulb should burn brightly. But, if there isn't the same voltage measured at the bulb as what is supplied (a drop in voltage)



Lots of places for problems in a fuse box.



Junction box connections can be damaged if not handled properly.

and all other conditions are the same, will the bulb burn as brightly? No, not as brightly as it was designed to be. If our supply voltage is correct at its source but not at the bulb, all we have to do in order to make the bulb illuminate brightly is determine where the difference lies. Doing so is performing a voltage drop test.

Dim wit! Why else do we need voltage drop testing?

The typical result of an excessive voltage drop is an unusual or unexpected operation of the device intended to be controlled, that is in the circuit that shares the fault. Just like the dim illumination mentioned, any device can "act up" if its circuits have enough of a



This DLC has been mangled by improper testing.



Where circuits connect, corrosion can lie.



Damage that looks minor, like this Nissan TCM wiring, can cause voltage drop, and resulting circuit malfunctions

voltage drop. Not all circuits are as simple as the one in my previous example. Can you imagine what might happen to a multiplexed network whose gateway module experiences a severe drop in its power supply?

What about circuits that fail to operate correctly — some of the time? Some failures are intermittent. The usual methods of addressing intermittent electrical problems consume extraordinary amounts of time. Fortunately, today's technicians have tools that weren't available until recently that help them find intermittent voltage drops more easily.

Isn't it comical how the repair order that includes the word intermittent

causes so many technicians to develop sudden fevers and sore throats, requiring them to go home for the rest of the day, possibly longer? Most of us would rather not chase a problem that only occurs under certain conditions but would prefer to use that time more productively. Therefore, a systematic approach and proper tooling are absolutely essential when finding the cause of intermittent voltage drop problems.

So smarty-pants, are you saying I've been diagnosing wrong?

No, not at all! Wait. How have you been diagnosing voltage drops?

What I am saying is, just as automotive technology has kept on changing, we might need to change our diagnostic procedures in order to keep up. Today we have complex wiring systems that are more sensitive to influencing factors, therefore are more susceptible to intermittent operation. Because it is likely we will see more and more of these, we must learn how to find them as soon as possible so we can get back to "making the gravy." Recognizing that some procedures require more time than others is our first step.

OK, simple or complex, what can cause a voltage drop?

Well, since you asked, lots of things can cause an undesirable loss of voltage in a circuit. Think of anything that might affect the conductivity of a circuit and you'll know what to look for when the circuit voltage doesn't equal supply voltage. If two terminals are not mated correctly, it might not be able to carry a load. If the integrity of the wire insulation has been violated, the wire might have corroded (oxidized) resulting in the amperage flowing to be slowed (which then results in the production of heat — remember energy loss?) and in a voltage drop. Almost all of us have seen a loose or a corroded ground attachment. Those can also cause voltage drops. What about carbon in between a relay's contacts? Yes, those cause a change in voltage as well. The list goes on.

What other tests should we do in conjunction with a voltage drop test?

Knowing how many volts are missing when compared to how many were available is only part of the information we



Before you shove in a meter tip, make sure you've studied the wiring diagram.



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need in order to be able to say there is something wrong. We must take into consideration what percentage of affect the measured voltage difference has on the circuit. For example, would a one-volt-drop have the same effect on a 1 amp circuit as it would on a 200 amp circuit? Think about that for a moment.

Now you're making my brain really hurt. Are we gonna use foul language?

No, silly! But you know every now and then, we let four-letter words slip out, especially this one: math. We sometimes have to understand it mathematically to correctly condemn a failed component. For example, shouldn't we calculate how much of an impact a 1 volt drop has on a starter circuit before we condemn the starter? How much affect would it have on a Throttle Position Sensor (TPS)?

In addition, we should keep in mind what the customer's complaint is, all the while calculating if the voltage drop we find is substantial enough to cause the complaint. Finding and fixing a voltage drop that doesn't solve the complaint might be in the customer's best interest but isn't worthy of remuneration. In other words, the customer should not be expected to pay for the fixing of a leaking muffler when the vehicle came in because the engine doesn't start (unless of course,

the replacement muffler miraculously allows the engine to start).

The really important question is: How do we perform a voltage drop test?

I'm glad you asked that! I'll answer with a question: Can we drive across the country from one coast to the other? Of course we can, but if aided with an accurate road map, could we do it more efficiently? So, the first step to diagnose a voltage drop is performed by obtaining and analyzing the wiring diagram of the affected circuit. Consider the wiring diagram to be your road map.

Because we know what causes a difference between supply voltage and circuit voltage, it becomes a process of elimination finding where the circuit fault has developed. Remember, the fault must be present while you measure the voltage at various points in the circuit! The saying, "You can't fix something that's not broken," is true. There are proven, reliable methods to use that when combined with your Digital Volt-Ohm Meter (DVOM) and with some relatively new tools on the market, you too can become an expert at determining where circuit faults are.

But, how can I force an intermittent problem to be present when I test it?

While serving in the U.S. Navy, we took the ship out weeks before a scheduled long deployment to stress



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her. We ran her hard just to see where her weak points were. We looked to see if anything might fail under the most adverse conditions — while we were still close to our home port — so if anything "gave" we would be able to take care of it then, not while underway overseas somewhere. We put the ship under a heavy load.

Isn't there enough stress in our lives?

To find the location of the fault in a circuit we stress it — we load the circuit. What that means is we infuse the maximum amperage that the circuit was designed to handle and measure the voltage at certain points. Exactly where those points are is determined by many factors including ease of access, which components are involved, whether there is a module in the circuit, etc.

What do you mean by "measure the voltage"?

Well, there two common methods used to measure voltage differences in a circuit. In the first method, we would leave our negative DVOM lead attached to the battery negative terminal while we used the positive DVOM lead to sample at various locations in the circuit, one of which would be the point in the circuit that is closest to our power supply. All readings would individually be subtracted from our supply voltage reading — any difference is a voltage drop.



Windshield or coolant leaks or battery fumes can lead to problems.



This GM UHFB had severe corrosion.

In the second method, we would attach our positive DVOM lead to the point in the circuit that is closest to our power supply, then using the negative DVOM lead, sample the voltage at various locations of the circuit. The difference (the voltage drop) will be displayed on the DVOM screen.

Did you notice I used the phrase, "point in the circuit that is closest to our power supply?" I did so because not all circuits use the battery as their source of voltage. Although most do, some are ignition fed, some might originate in a module, etc. We need to know how much our source voltage is in any case.

Also, did you notice there is no math required when using the latter method? The meter read the difference and displayed it. Did you also notice the latter method is a one-step process, unlike the first method? Whichever method is chosen should produce the same voltage drop reading. Remember, these tests should be performed only when the circuit is in use, or is intended to be, or one that is loaded.

Will voltage drop testing decrease my diagnostic time?

You are guaranteed that it will not. That is, not if you don't use it. All too often there are components replaced

needlessly when the problem was actually an excessive voltage drop. That isn't cost effective or profitable. We should always take a few moments to verify circuit integrity before condemning any component. If we perform our diagnosis accurately, in the case of an excessive voltage drop, the component wouldn't be replaced (wasted time) and our diagnostic time would be far less than it would be otherwise.

How much slower does a starter turn with a 1 volt drop in the battery cable? How much more heat is created, decreasing the life expectancy of that starter? What effect does that have on the battery itself? Can it affect the computer systems in the vehicle?

Jaime, it's been fun chatting with you. Now that we better understand voltage drop testing, do we want to reminisce about that girl in high school? *WZ*



Corrosion caused plate layers to warp.



Jaime Lazarus is an ASE Master Technician with L-1 certification. He has regularly presented technical seminars since 1985. He recently taught instructors at the North American Council of Automotive Teachers conference and the NASCAR Technical Institute.

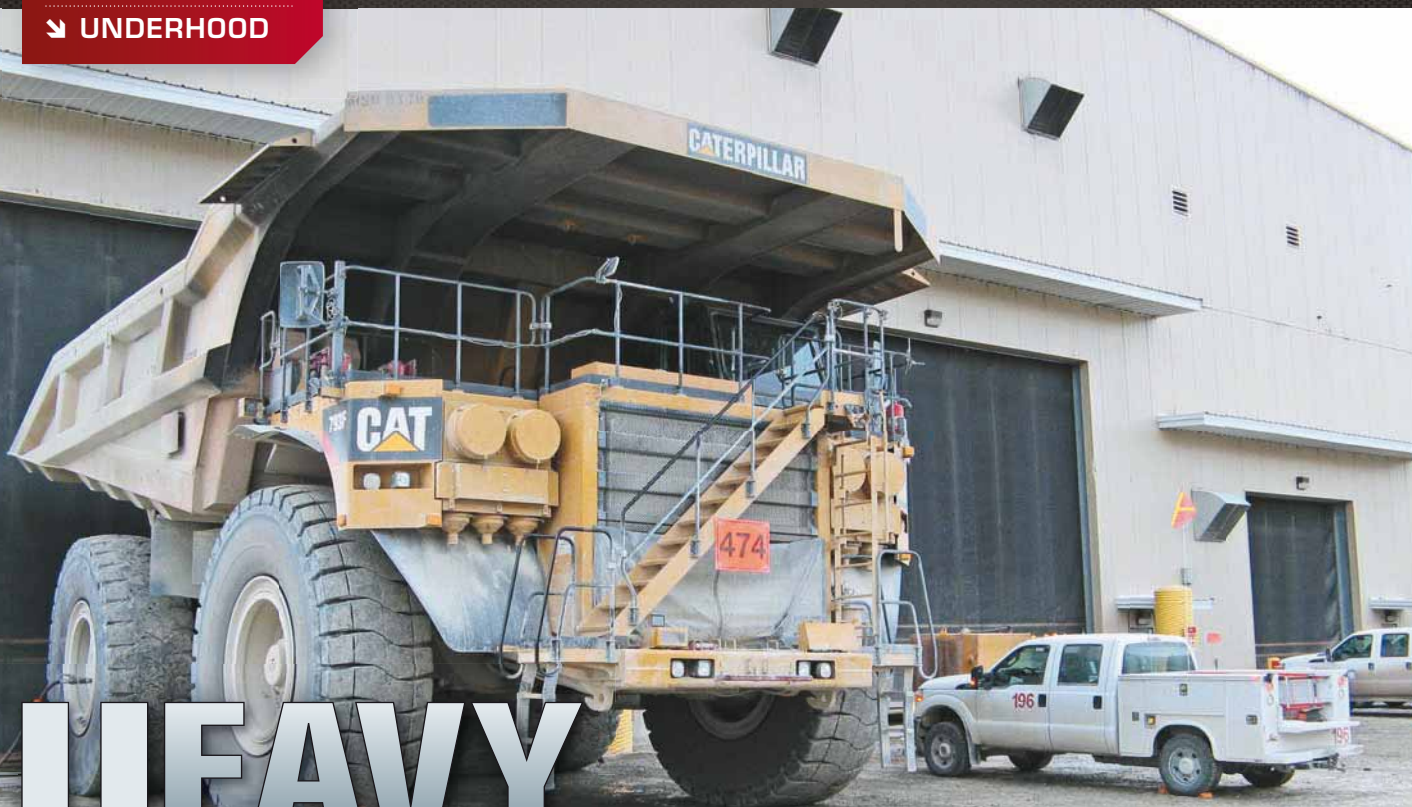
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HEAVY DUTY DIESEL SERVICE

The Caterpillar 793F off-highway truck has a payload of 250 tons and is the workhorse of many open-pit mining operations.

MUCH OF THE NEW TECHNOLOGY USED IN HEAVY-DUTY DIESELS WAS PIONEERED IN THE AUTOMOTIVE WORLD.

BY **TONY MARTIN** | CONTRIBUTING EDITOR

Editor's note: While you'll probably never have to service a rig as big as the ones Tony is involved with today, we thought you'd enjoy a story about how the big boys are maintained. They share more in common with that diesel pickup you're working on than you might think.

Over the years, off-road equipment has maintained a reputation as being somewhat primitive; they were bigger, heavier and noisier, and had much dirtier emissions than the engines found in light-duty applications. While light-duty diesels have held a technological edge for many years, the gap is closing as emission regulations get tighter for the high-horsepower machines.

The mining industry is case in point, where emission control regulations are a relatively recent phenomenon.

Off-road machines didn't get a lot of scrutiny from environmental regulators in the past, mostly because they were few in number and represented a much smaller share of the overall emissions inventory. It was only a matter of time, however, before big diesels would have a much higher set of expectations to live up to.

Caterpillar's line of mine haul trucks is a good example of how far the off-road equipment industry has come in recent years. The newest models have higher power, lower fuel consumption

and reduced emissions, and these goals were primarily achieved using technology that was developed in light and medium-duty diesels. In this article, we will take a look at the Caterpillar 793F off-highway truck and compare its technology and service procedures with those of light-duty diesels.

793F Overview

The Caterpillar 793F is a heavy-duty mine haul truck with a 250-ton payload. The 793F is 25 feet wide by 44.9 feet long, and is 21 feet high when the

Photos: Tony Martin



The 793F is powered by a 16-cylinder version of the C175 diesel engine. This engine produces 2650 horsepower and meets EPA Tier II emission standards.

dump bed is down. When the bed is raised, its forward edge rises to 45.5 feet. When service is performed with the dump bed up, the bed must be "pinned," meaning that a large cable is used to prevent the body from dropping if the hydraulics were to fail.

The powertrain is unusual by automotive standards. The torque converter is attached directly to the engine, but the torque is then transmitted by a driveshaft to the transmission, which is incorporated into the rear drive assembly. The transmission has six forward speeds, which propels the 793F to a top speed of 37.3 mph. For machine management purposes, the higher speeds can be locked out electronically.

The 793F is powered by a 16-cylinder version of the C175 diesel engine, which is rated at 2,650 hp at 1,750 rpm. The C175 (named after its 175 mm cylinder bore) also is available with 20 cylinders for even bigger machines such as the 400-ton 797F off-highway truck. Airflow through the C175 cylinder heads is reverse from most V-type engines, as the intake manifolds are located outboard and the exhaust exits towards the engine center. This provides a shorter route for the exhaust to make its way directly into the C175's four turbochargers.

Boost air from the turbochargers is sent to the air-to-air aftercooler (ATAAC) located at the front of the 793F. This cools the engine intake air, which increases air charge density and, in turn, power output. An important benefit of the ATAAC system is that lowering boost air temperatures results in lower combustion temperatures. This has a net effect of reducing NO_x formation, which helps greatly with emissions compliance.

Four air filter assemblies (one for each turbocharger) are mounted on the front of the truck, and each assembly is equipped with a primary and a secondary filter element. The secondary elements are located inside the primaries and act as a last line of defense should the primary element fail. The air cleaner system also utilizes six pre-cleaners, which drop large particles out of the intake air stream before it enters the primary filter element. The pre-cleaners need to be cleaned at the same time that the filter elements are serviced.

The C175 crankcase holds 82 gallons of motor oil, which is changed easily using a quick coupler on the front bumper of the truck. A service pump is connected to the quick coupler to pull the used oil out, and then new oil is

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metered in to the same fitting using a pressurized line from a large lube holding tank.

Draining and filling the 291-gallon cooling system also is easier than you'd think. Coolant is drained into a portable holding tank below the truck and then is pumped back in to the system through the same drain port. Pushing the coolant in from underneath eliminates trapped air and puts the machine back into service that much faster.

The standard fuel tank holds 750 gallons, but an optional fuel tank can be installed that brings the capacity up to 1,300 gallons. There are a total of five fuel filters in the system; fuel is first sent through two 10 micron primary filter/water separators near the fuel tank. After passing through

the engine-driven transfer pump, the fuel is then sent through two 4 micron secondary filters and finally a single 4 micron tertiary filter. The fuel can't be too clean!

After replacing the filters, priming of the fuel system is accomplished using an electric pump that is connected in parallel with the transfer pump. The engine ECM directly controls the electric primer, but also has a manual switch located near the secondary fuel filters. The filters are installed dry and then fuel is pumped through from the tank using the electric primer. Aside from priming the system, the electric primer is also used to increase fuel system pressure during engine starting.

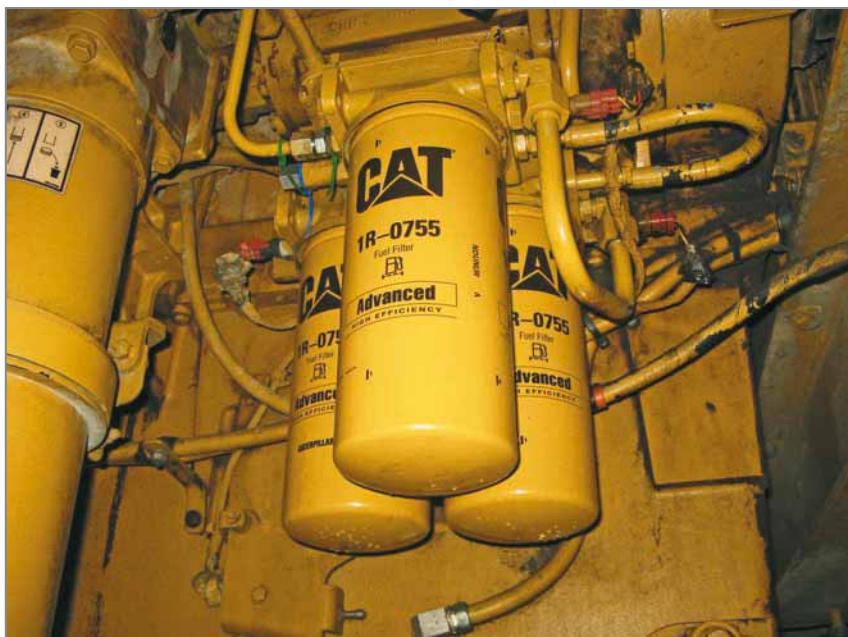
Service Philosophy

In the mining industry, the big machines pay the bills. These machines (such as haul trucks and loading units) cost millions of dollars and generally run 24 hours per day, seven days per week. Failures are extremely costly, primarily due to lost production. Thus, every effort is made to catch failures long before they come to pass and minimize unscheduled downtime.

As opposed to the automotive industry where service is performed at specified mileage intervals, off-road machines use operating hours to determine when service is sched-



A communications adapter is used to connect a laptop computer's USB port to the nine-pin data link.



The C175 uses two secondary and one tertiary fuel filter; all are rated at 4 microns.

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uled. For example, a PM (Preventative Maintenance) for a 793F haul truck would take place every 250 hours or roughly every two weeks. Not all PMs are equal; in other words, a 500 hour will look different from a 250 hour, and so on. However, the engine oil and filters are changed every 250 hours regardless.

During a PM, fluids and filters are changed, a thorough inspection of the machine takes place and oil samples are taken from virtually every major component. These oil samples are analyzed for particles or fluid contamination, and the information is used to prompt further attention or schedule service.

There are two schools of thought regarding scheduling of major service: time-based and condition-based. A time-based approach would allow only a certain number of hours to be run on a component before it would undergo a Planned Component Replacement, or PCR. The number of hours a component would accumulate before a PCR is often based on experience. Allowing a component to run to destruction may appear to wring more value from it, but introduces a whole dimension of uncertainty to the equation. There is no telling when it will fail, or where the machine will be when it fails, and could also damage a valuable component core.

While time-based PCRs work, a more sophisticated approach is to monitor the condition of the component using oil sampling, vibration analysis, etc. and then replace it when it starts to show signs of failing. This



Laptop-based scan tools dominate in the heavy-duty diesel industry. Caterpillar ET software is used to perform similar functions to those found in automotive scan tools.



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can get more hours out of a component and has the added advantage of catching a failure that would have occurred before a component reaches its normal time-based limits.

An engine is typically ready for a PCR around 18,000 hours, and will undergo a mid-life service around 9,000 hours. A mid-life involves changing out of certain critical assemblies while the engine is in-frame, including fuel system components such as the high-pressure fuel pump and a complete set of injectors. This is all scheduled service; predictable and relatively easy to manage as opposed to sudden breakdowns.

C175 Fuel System

The C175 fuel system is a high-pressure common rail (HPCR) design, which is capable of producing injection pressures of up to 26,100 psi. HPCR is a technological quantum leap and allows for tremendous flexibility in injection timing, rate, and quantity. This gives it a major performance advantage over the mechanically-actuated EUI systems that were used with previous generations of high-horsepower Caterpillar diesels.

One of the distinct advantages of an HPCR system is its ability to break a diesel injection event into five or more separate pulses. Back before electronics were incorporated into diesel injection systems, fuel was dumped into

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an engine cylinder in one shot. This lack of control resulted in tremendous pressure rises in the cylinders and the loud cylinder knock that diesel engines were once known for. The high cylinder pressures also produced high combustion temperatures and excessive NO_x emissions.

HPCR made it possible to add fuel little bits at a time, moderating the cylinder pressure rise and taking the sharp edge off the diesel's personality. Now, an HPCR diesel engine is quieter, produces fewer emissions, and yet is more powerful.

HPCR was pioneered in light-duty diesels and has gradually made its way into high horsepower applications. The major challenge with HPCR

is the tight clearances between moving parts. This precision requires ultra clean fuel and sterile service procedures, which are always desired but not necessarily achieved in the mining industry. As you can imagine, mining is a challenging environment for any technology that requires strict cleanliness during service.

The injectors used in the C175 are configured similar to those used in the HPCR-equipped Cummins turbodiesel. Like the Cummins, they utilize a solenoid actuator and a quill tube to connect the injector body to the common rail fuel manifold. The quill tube and other high-pressure connections in the C175 fuel system use spherical ball and conical sealing joints, which

must be inspected carefully before they are reused.

HPCR Service

To diagnose a C175 fuel system issue, the technician can retrieve diagnostic data in two different ways. The quickest method is to use the Advisor panel located on the 793F dashboard. Advisor is connected to the CAT Data Link, which is one of three networks used on the 793F and will provide access to the machine and engine ECMs. Navigating to the Service menu in Advisor gives the technician access to live data, diagnostic codes, as well as a data logger function.

For more comprehensive diagnostics, the technician will need a laptop-based scan tool with Caterpillar ET (Electronic Technician) software. The computer's USB port connects to the nine-pin data link using a communications adapter, similar to those used with laptop-based automotive scan



The serial number of the injector is used to find its trim file, which is calibration software for that specific injector.



The HPCR injector and quill tube used in a Caterpillar C175. The quill tube makes metal-to-metal contact with the body of the injector.



(Left) Ultra cleanliness and exact torque procedures need to be top priorities when changing injectors in a C175.

WHAT ARE TRIM FILES?

High-pressure common rail injection systems are designed for precision in every sense of the word, and it is extremely important that the injectors all flow fuel at the same rate. Building an HPCR injector is expensive to begin with, but if the manufacturing tolerances are tightened to the point where every injector flows almost the same, it becomes costly enough to be impractical. In order to bring costs down, an alternative is to loosen the manufacturing tolerances and then use software to compensate for flow variances.

This is the strategy used in the manufacture of the HPCR injectors for the C175. Each finished injector is tested at the factory, and is rated according to its flow characteristics. A "trim file" is then created for each injector, which is software that is uploaded to the engine ECM when an injector is installed. The trim file tells the ECM how to adjust the pulses to the injector to balance it with the others. For example, an injector that flows less than the baseline number would have a longer pulse sent to it by the ECM. This strategy reduces the cost of the injector hardware but makes them perform as though they all had the same flow rate.

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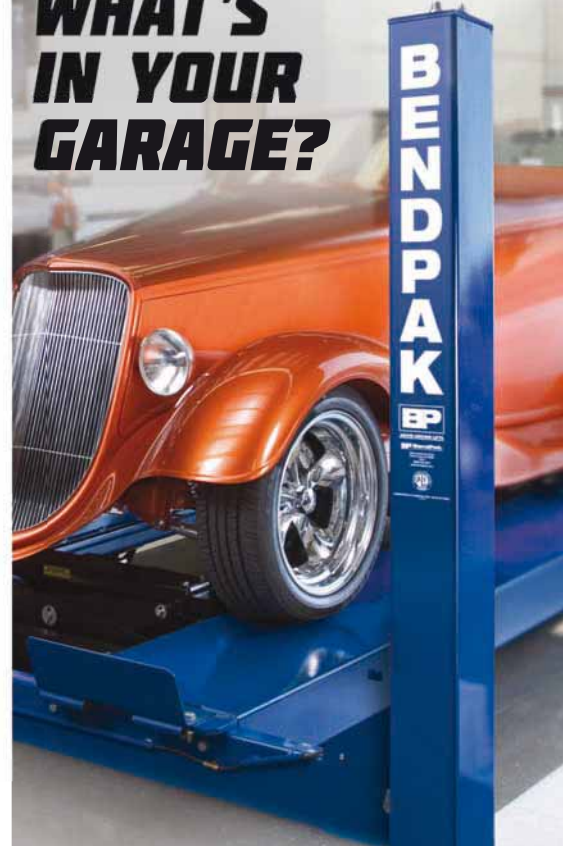
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tools. Caterpillar ET has similar functionality to other automotive factory scan tools, such as viewing live data, retrieving and clearing trouble codes, bidirectional controls and reflashing modules.

Caterpillar ET plays a critical role during an injector replacement on a C175. Before the high-pressure fuel system is opened up, ET is used to determine the pressure in the fuel system common rail. Pressures in an HPCR system can be dangerously high and could severely injure a technician if precautions are not observed. Once ET indicates that fuel pressures are reduced to safe levels, the job can continue.

Replacing a C175 injector requires strict attention to detail. Above all, everything must be clean! This includes the technician's clothing; if the tech is dirty from previous jobs, they should put on a new set of coveralls and a fresh set of rubber gloves. The top end of the engine should be pressure washed and dried off with compressed air before the cylinder's valve cover is removed.

Torque specs and sequences are critical when installing the new injector. The O-rings on the injector body should be lubricated with clean motor oil, as well as the ends of the injector quill tube. Experienced technicians keep a cheat sheet handy (a smart phone works good) with the torque instructions as they are too detailed for most to memorize. Before the injector is installed, make a note of its serial number (available on the injector hold-down bracket) as well as the cylinder it is being installed in.

Once the injector(s) have been installed, the next step is to perform a trim calibration with Caterpillar ET. A CD with the necessary trim files is packaged with each new injector, but these files can also be downloaded from the Caterpillar service information website. This procedure is used whenever injectors are replaced or swapped between cylinders.

Once the trim calibration is complete, the fuel system can be primed using the onboard electric pump. Since the scan tool is already connected,

Caterpillar ET can be used to command the pump on to finish the job. Wrap it all up by clearing the trouble codes, and the truck is ready to go back into service.

Certainly, there are significant differences in the maintenance procedures used with high-horsepower diesels. However, the big engines are becoming much more sophisticated as they adopt technology that was refined in automotive diesels. This trend will only continue as emission control regulations get tighter for off-highway equipment. *TM*



TONY MARTIN
CONTRIBUTING
EDITOR

Tony Martin is an associate professor of Automotive Technology at the University of Alaska Southeast in Juneau, Alaska. He holds Canadian Interprovincial status as a Heavy-Duty Equipment Mechanic. He also holds 18 ASE certifications, including CMAT, CMTT, L1 and L2.

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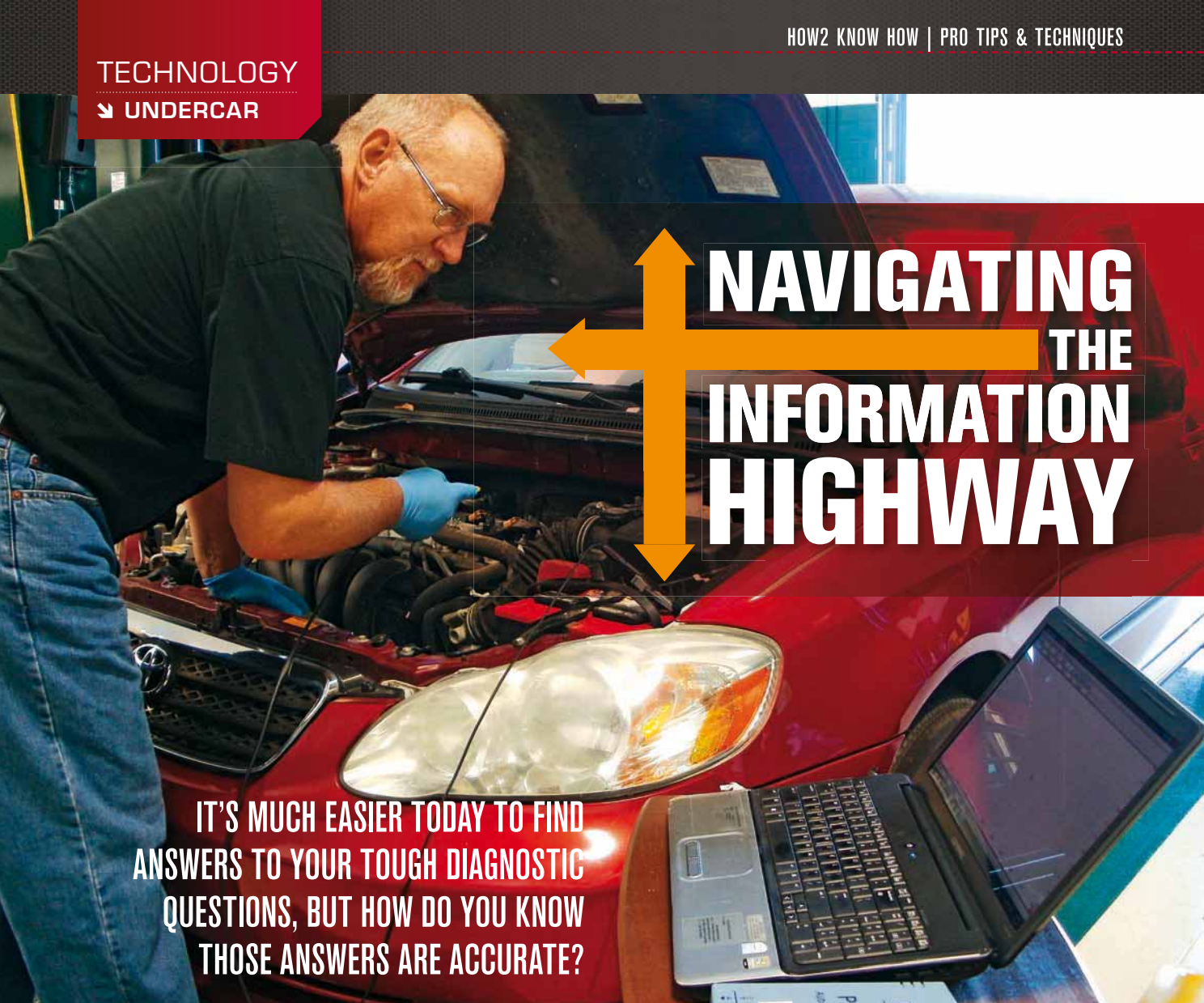
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NAVIGATING THE INFORMATION HIGHWAY

IT'S MUCH EASIER TODAY TO FIND ANSWERS TO YOUR TOUGH DIAGNOSTIC QUESTIONS, BUT HOW DO YOU KNOW THOSE ANSWERS ARE ACCURATE?

Any successful technician will tell you that success in repairing today's cars is dependent on good information.

BY **PETE MEIER** | TECHNICAL EDITOR

If you came across a new troubleshooting or repair problem when you first started in this business, you asked the guys you worked with their opinions. If you had a decent relationship with other area shops, you might even have given one of them a call. With the birth of the Internet, all that has changed. "Google it" is now a part of our everyday vernacular, and many of you report that you do just that when faced with a repair challenge today. There is only one problem that existed way back when that is still true now: How do you know the information you are getting is good information?

As the technical editor for this maga-

zine, I know the importance of verifying my sources before reporting to you. The same is true when you are seeking answers online to the challenges that face you on a daily basis. You must be able to verify the validity of the resource you are relying on, or else you'll just be "shotgunning" parts in the hope problems will go away. Many so-called repair recommendations I've seen posted on popular social networks (Facebook, Google+) are actually scary and go against every professional standard for repair we have. These "fixes" could actually place you or your customers in danger and/or open you to criminal and civil liability.

To help you navigate the informa-

tion highway, here are some proven Internet resources you can rely on. This list is not all-inclusive, but I'm sure it will give you a good start.

International Automotive Technicians Network

If you've been even an occasional reader of *Motor Age* since I started as a freelance contributor some 10 or so years ago, you know that I highly recommend membership in the International Automotive Technicians Network, more commonly referred to simply as iATN. This professional online resource first began in 1995 and during the last 20 years has grown tremendously, now boasting more than 80,000 members

Photo: Pete Meier

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There are several features that make iATN a worthwhile resource. One is the variety of forums available to every member with only a few forums restricted to sponsoring members only. These forums are broken down into two basic categories: technical and non-technical. Among the technical offerings are forums on Technical Theory, Technical Discussion and Technical Tips, as well as more specific topics like HVAC and Transmission. The non-technical forums provide areas to discuss Industry Events, Industry Issues, Shop Management and much more. No tech or shop owner is perfect, and we can all learn something from the experiences of others, and these forums provide an outlet to do just that. Even if all you do is spend your time reading, you can't help but grow professionally.

A second extremely valuable resource is the TechHelp feature that

allows you to ask other iATN members for assistance in diagnosing or repairing a particularly stubborn problem. But don't think for a moment that this feature and the forums are there for you to seek out the quick and easy answers! This is a site for professionals, and you are expected to have done your homework and have already performed basic testing in an attempt to find the solution on your own. Unfortunately, there are many with basic memberships that seem to think iATN stands for "I ain't testing nothing!" If you're one of them, the more seasoned members soon will correct your oversight.

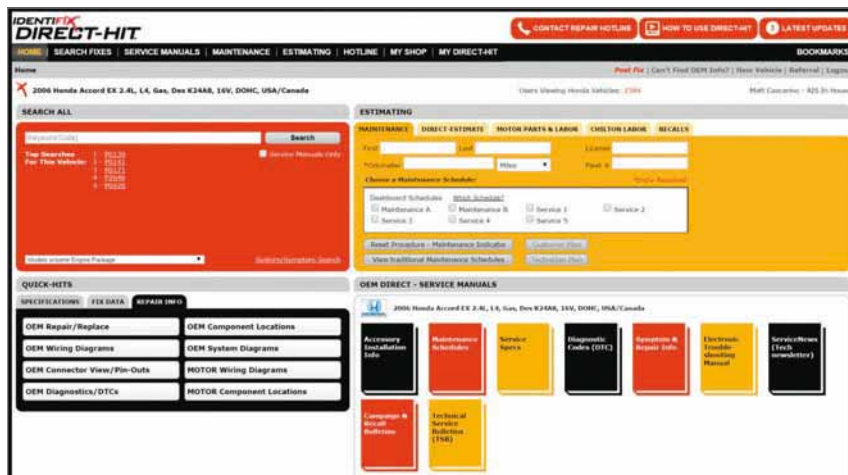
Basic memberships are free to professionals who can show a minimum of four years experience or evidence of ASE certification. But to truly unlock the power of iATN, you absolutely should consider becoming a sponsoring member. The cost for a single individual membership is only \$19 a month,

and business sponsorships go up from there capping out at \$45 a month. That gets you access to 20 years worth of information, all searchable with a very user-friendly search engine. Want to see what a "known good" crank/cam sensor scope pattern for a 1995 Chevy Lumina looks like? Odds are it's in the database of more than 68,000 files covering scope patterns, scan tool captures and more. You can also search the archived forum and tech help requests (over 2.2 million records on file) or look for help on a particular Diagnostic Trouble Code (DTC) or symptom.

The resources in iATN also make great learning aids for those of you charged with training the next generation of technicians. If you are an automotive educator, iATN has a special program in place that provides premium access for your automotive program including students and educators. Imagine the learning that can occur by having your students follow a TechHelp request, maybe even attempting to come up with the solution before the request is finalized. And the forums offer a wealth of material that can be used as study assignments to supplement what you are already doing in your classroom. Contact iATN to learn more, or come see iATN President Scott Brown present his session, "Using iATN In The Classroom" at Automechanika Chicago later this month.

Identifix

Identifix began in 1987 as an automotive repair hotline service that provided repair assistance to professional shop owners and technicians who were look-



DirectHit accesses the thousands of confirmed repairs stored in the Identifix archives and also hosts OEM service information.



(Left) Using Google to find an answer to a tough repair problem should be one of the last resources you use. Too many experts online are anything but "expert" at fixing cars. (Right) One of Identifix's 45 OE specialists works with a tech on a stubborn VW problem.

Photos: (TOP, BOTTOM RIGHT) Identifix; (BOTTOM LEFT) Pete Meier

ing for a trustworthy second opinion or additional expertise on a particular vehicle or vehicle system. According to the Identifix "DirectHit" website, they have logged more than 4 million calls to date. This hotline service is still a core part of the company; employing 45 ASE Master certified and OEM trained technician consultants.

By being actively involved in helping techs solve real issues, they have been able to build a database of confirmed fixes and streamlined diagnostic processes, now numbering over 600,000 in their Hotline Archives. It's that database that makes up the heart of their online service, DirectHit. This is a searchable tool that accesses all that archived information and can be searched using a number of filters to help you quickly locate potential matches. Results include a description of the problem, diagnostic steps to take to confirm the problem and the most common solutions reported.

Often, these results can highlight pattern failures, system or component issues that become known as a common cause of a customer concern. Another popular term is "silver bullets," and they can be fixes that soon become taken for granted. If you do suspect the problem you are



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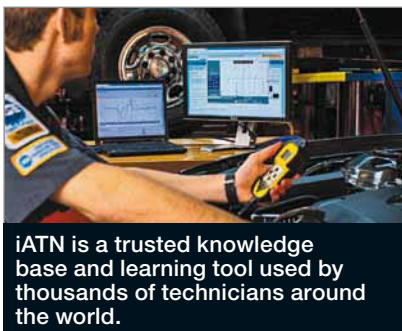
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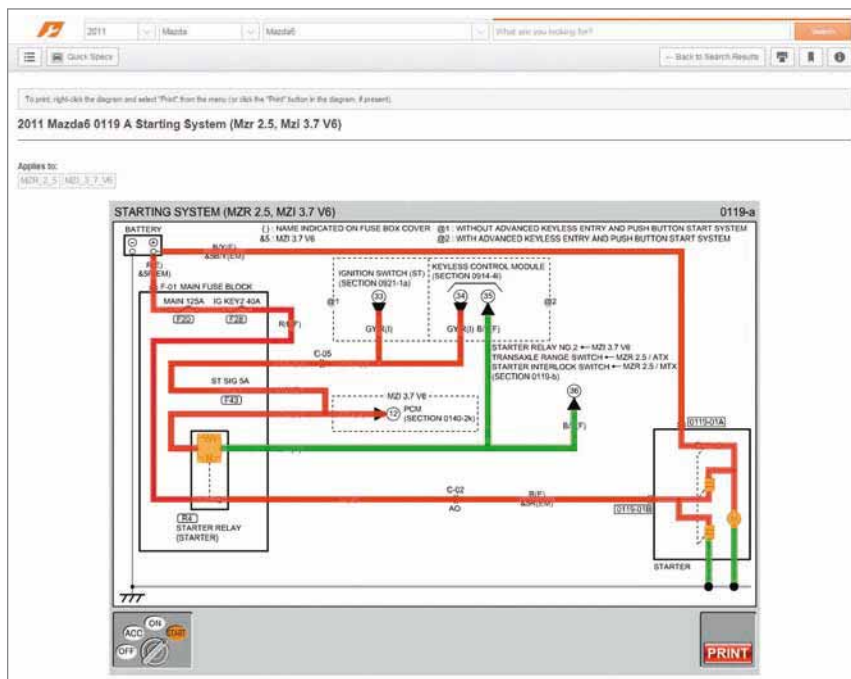
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working on meets the requirements to be considered a candidate for a silver bullet fix, be sure you perform a few quick tests to confirm the repair will solve the issue. If you run into a stubborn case, you can always access the hotline for assistance.

Other features round out the Identifix offering. Users can build a maintenance record and recommendation list for their customers, and use the tools provided to create a repair estimate. Recently, Identifix has improved the DirectHit platform by adding direct access to OEM service information currently covering about 30 different makes. These aren't just links to the OE sites, but a feature built directly into the DirectHit service and available to all DirectHit subscribers.

View wiring and connector pinout diagrams, Technical Service Bulletins (TSBs), factory specifications and more

without having to open another browser window. If you'd like to find out more, you can log on to the DirectHit site at www.identifix.com and click the "Test Drive" button to try it out.

Service Information Providers

There are several sources for repair information. Mitchell 1, ALLDATA and MotoLOGIC are arguably the top three sources of aftermarket information and every manufacturer offers access to their OE service sites.

Let's do the OE sites first. The National Automotive Service Task Force (NASTF) is primarily responsible for opening the door to OE service information for the independent so I think they deserve a plug here. Membership in the NASTF is free, and you can show your support for their efforts in keeping the service repair

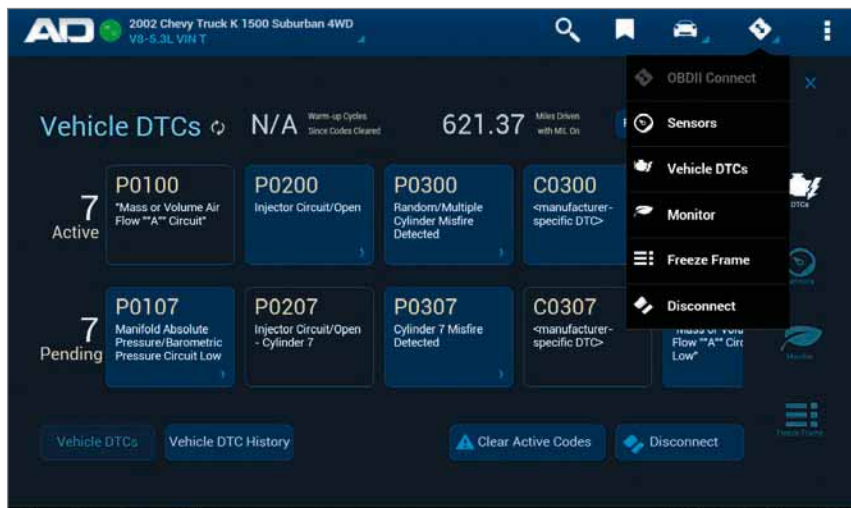
and collision repair playing field level by going to www.nastf.org and filling out a small form.

Many of you are aware of the issues in securing and programming many modules that are considered part of a vehicle's security system and the hassles that often accompany the process. NASTF has a program in place to make that a lot easier. You may have also heard of the coming shift in diagnostic access to the vehicle via a common portal.

That is another topic NASTF is actively involved in. Got a car that you're having trouble finding the information you need to fix it? NASTF can help there, too. And they are doing a whole lot more, all with the goal of making your ability to correct your customers concerns equal to the ability of the dealer to do the same.

OK, back to the OE sites. On the NASTF home page, you'll see a tab marked "OEM Service Websites." Choose that selection and you'll get a list of all the OEM service sites by manufacturer and the links to those sites. Visit a few and you'll find that many have a lot of information available without a subscription but to get to the full menu you'll need to pay a fee based on how long you want access. As an additional benefit, many OE sites offer access to the same training materials they make available to their dealer techs. You can thank NASTF for that, by the way.

Before the Internet and NASTF, independent shops had to rely on aftermarket sources of repair information. Way back in the day, it came in print form and I don't mean like the Haynes manual you see in the parts store. Think



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Chris "Chubby" Frederick, CEO



Mitchell 1's ProDemand, as are others, is mobile friendly making it easy to get the info you need right at the car.

Photos: (LEFT) ALLDATA; (RIGHT) Mitchell 1

Library of Congress-size books! With the incorporation of the desk top computer into repair shops, some aftermarket suppliers began offering the same information on computer discs (CDs), and sent subscribers quarterly updates to keep the information as current as possible. Today, though, changes are happening so fast that your service information needs to be updated continuously in order to keep up.

The latest offerings include Mitchell 1's ProDemand, ALLDATA Mobile and MotoLOGIC. All have their unique features and benefits, and all offer some form of trial run so you can try them out for yourself. If you're currently a Mitchell 1 "OnDemand" customer, you are already a ProDemand subscriber – you just need to make the switch. Mitchell 1 and ALLDATA are incorporating "experience based repairs" into their systems and are beginning to build their own fix databases similar to what iATN and Identifix have already done with one exception. Both are farming information from their subscribers to add even more depth to their databases and have incorporated some form of community on their platforms that allow their subscribers to interact with one another; sharing tips and repair shortcuts or offering assistance to one another.

MotoLOGIC is the newcomer to the bunch and seems to be popular with techs who have tried it. It is populated with OE service information straight from the source. All three seek to be as user-friendly as they can and anyone comfortable at a desktop keyboard should find navigating their way through a relatively painless exercise. And all three have their strengths and weaknesses, with many shops opting to make more than one service available to their techs.

Just "Google" It

No doubt the Internet has opened a universe of information to repair professionals. Not only are the resources I've shared so far based in cyberspace, nearly every model of vehicle has at least one enthusiast forum where Internet "experts" seek to enlighten those who will listen. Search YouTube for auto repair videos and you'll find a large listing of experts ready to solve your problem. Social media outlets like Facebook and Google+ have sprouted auto repair groups populated by

talented professionals and ignorant DIYers alike. And then there are the numerous "Ask An Expert" services that often contain answers that are anything but.

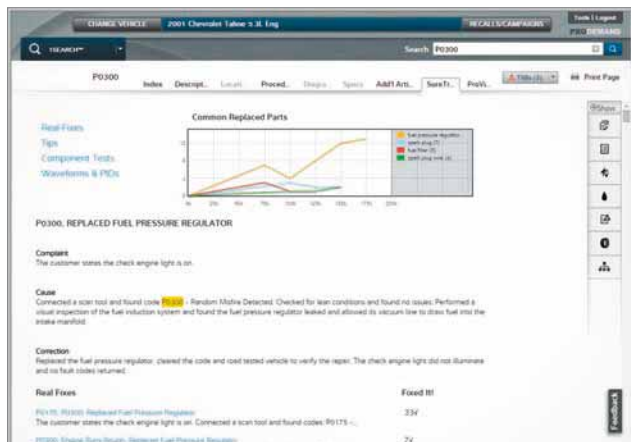
Even with the obvious downfalls, I was surprised to learn that many techs are quick to pull out their smart phones and look for an answer to their diagnostic dilemma by asking Siri (the automated iPhone voice) how to fix that problematic car the boss assigned them to. And really, I have no problem with getting help this way if you've already performed the basic tests and have done a little homework prior to your quest. But as I remarked earlier, don't rely solely on those search results before you spend your customer's money. Verify that the proposed fix is actually going to be the RIGHT fix first. If that's a challenge for you, get the training you obviously need and it's highly likely you won't need Siri's help to fix that car in your bay. You know, kind of like the training we're offering for free in Chicago in a few weeks. **W**



PETE MEIER
TECHNICAL EDITOR

Pete Meier is an ASE certified Master Technician and sponsoring member of iATN. He has over 35 years practical experience as a technician and educator, covering a wide variety of makes and models. His primary goal is to bring working techs the information they need.

Email Pete at pmeier@advanstar.com



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Photos: Mitchell 1

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ANOTHER TYPICAL DAY

EVAP AND MAF CODES WERE THE RULE FOR THIS DAY IN THE SHOP.

BY **G. JERRY TRUGLIA** |
CONTRIBUTING EDITOR

With young techs working in my shop, I find myself spending as much time in the bays with them as I do upstairs working on my training materials. While it makes for long hours and hectic days, it also keeps my own diagnostic skills sharp, and I enjoy passing on what I've learned to the guys.

Toyota EVAP Fault First

First up is a Toyota Avalon (even though the Toyota Scan tool ID'd the vehicle as a Camry) with a V6 3.0L engine that came in with the Malfunction Indicator Lamp (MIL) illuminated. We found a P0446 (Vent Control Malfunction) Diagnostic Trouble Code (DTC) stored in the engine control module (Figure 1). After reviewing the associated Freeze Frame data, I showed them how to access the Mode \$06 section of our scan tool in order to view the last onboard test results. We found the Mode \$06 (Figure 2) results showed that the evaporative emissions (EVAP) system monitor had only passed three of the four tests. The failing test was the "Vapor Leak # 2."

With so many different EVAP systems out there, it's important to always look up information in your service information system on how the one you're working on operates. This Toyota EVAP system uses these components: Vapor Pressure Sensor (VPS) measures the vapor pressure in the EVAP system, Vacuum Switching Valve (VSV) normally closed, canister closed valve (CCV) normally OPEN and another VSV for pressure switching. All are used to detect abnormalities in the EVAP system. The system captures DTCs when HCs (hydrocarbons

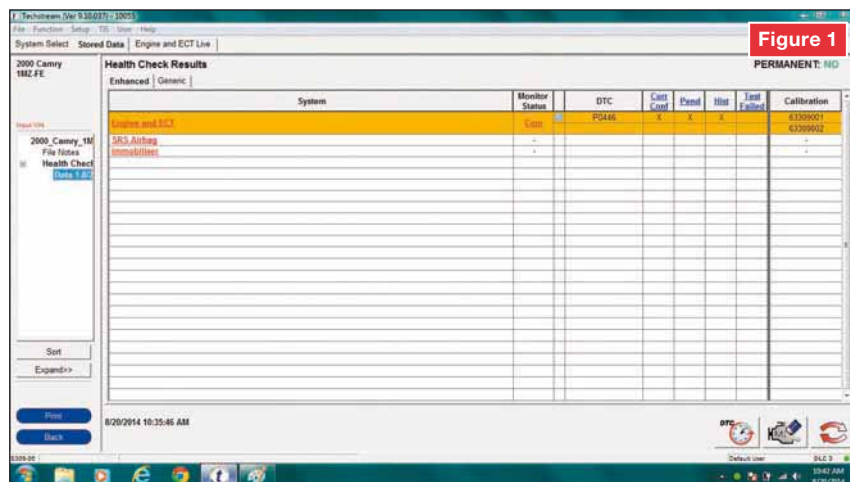


Figure 1

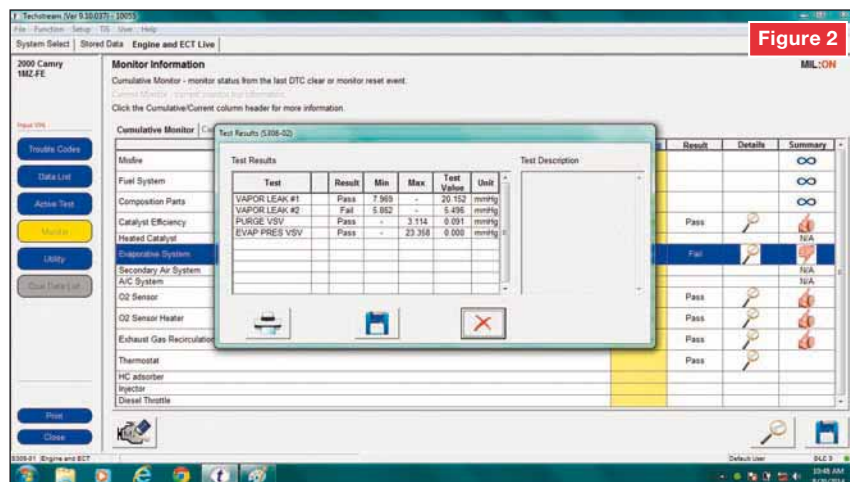


Figure 2

or raw fuel) leak from the components, or when the vapor pressure sensor malfunctions. The Powertrain Control Module (PCM) then decides whether there is an abnormality in the EVAP system based on the vapor pressure sensor signal readings.

With a good understanding of the system, our next step was to connect a smoke machine to check for leaks. The smoke test results found that the front vacuum switching valve (VSV) and the rear canister closed valve (CCV) both were weathered and not working as designed. We installed a new front VSV along with the rear

CCV (it came as an assembly with the complete charcoal canister). We test drove the vehicle and rechecked Mode \$06 test results to see if all four now got a passing grade.

The results were all passes, so we gave the vehicle back to the owner. We told her to drive it for a week then come back so we could make sure there were no other issues. A week later, the MIL still was off and the EVAP problem was a confirmed fix.

Another EVAP Problem

Next is a 2007 Hyundai Sonata 3.0L V6 came in with a P0442 (Small Leak

Photos: G. Jerry Truglia

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Figure 3

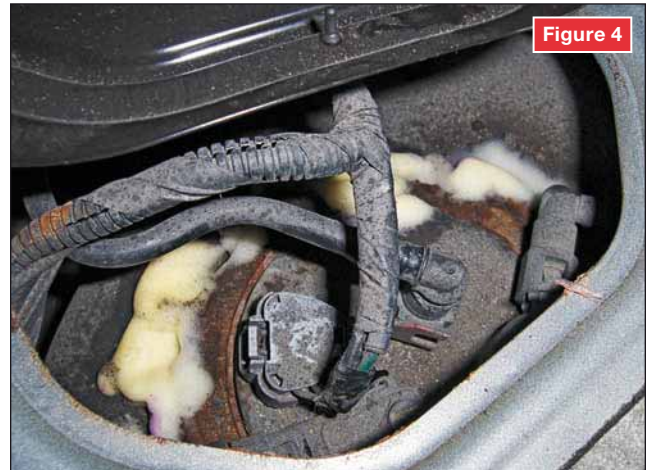


Figure 4

– EVAP) DTC. This seemed like it was going to be a tough one to find the leak on, because we could not find any smoke coming out anywhere on the vehicle. The smoke machine flow meter gauge ball was just above the limit (barely falling in the failing zone), meaning the leak was going to be really small just as described by the DTC.

We decided that we had to use a different procedure in finding this leak, so we replaced the smoke machine with the BullsEye leak detection tester. The BullsEye leak detection system uses CO₂, a gauge that has a scale to identify a leak, a CO₂ leak detector and special pink foam that turns yellow when a leak is detected (CO₂ is present.) As we were checking under the vehicle for leaks with the leak detector, we found that the detector indicated a leak coming from the top of the fuel tank. Luckily for us, on a Hyundai it's easy to get to the top of the tank area (Figure 3), because there is an access cover under the rear seat.

When we removed the access cover, the BullsEye leak detector went crazy, confirming a leak at the fuel pump locking ring and gasket. We thought for a second that maybe we just missed the

smoke coming out, so out of curiosity we reconnected the smoke machine to see if smoke could be seen escaping from the fuel pump locking area. With the smoke machine reconnected, it still indicated a leak on the units flow gauge but we could not find any traces of smoke escaping. We thought that this was odd since the smoke machine had helped us so many times in the past, but this time it was coming up short.

We reinstalled the BullsEye on the vehicle and sprayed the area with the special foam. It provided us proof of the leak since the pink foam turned yellow (Figure 4), indicating that CO₂ was leaking from the locking ring. Because this fuel tank is a composite type and not metal, we knew that the O-ring and locking ring were most likely the only problem. We ordered the new O-ring and locking ring from the Hyundai dealer and used our special tool (Hyundai special lock ring removal and installation tool is needed to remove or install the lock ring) to remove and install the new parts. We tested the system once again and found no leaks, confirming our repair.

A Drivability Problem Next

So far, so good. Nothing too complicated, and the 2002 SAAB 95 2.3 Turbo with a P0101 and low power complaint should be the easiest of the day. We asked the vehicle owner when they first noticed the problem and if any work or maintenance had been performed recently. The vehicle owner told us that she keeps up on all the maintenance on her vehicle. We started our diagnosis with a visual check to make sure there were no broken or loose

hoses that were causing the problem. Because our visual came up short, we connected the SAAB factory scan tool to check all the systems on the vehicle.

Next we checked the Freeze Frame records to see if it would pinpoint any data that could be helpful to us during our diagnosis. We followed that by removing the air boot from the throttle plate and found that the screen for the Mass Airflow Sensor (MAF) was very dirty. We cleaned it with CRC MAF cleaner and were successful in restoring the sensor's performance, but we had to find why it was so dirty in the first place.

One lesson I've learned being in this business so long is never fully trust that the vehicle has been maintained just because the owner says so. When we lifted up the vehicle to remove the air filter, we found that this vehicle in fact was not maintained, and you can see why. We installed a new air filter (Figure 5), replaced the PCV oil trap and hoses, and cleared the DTC. A test drive later confirmed that the complaint was corrected. Just two simple maintenance items fixed this vehicle. 🛠️



Figure 5



G. JERRY TRUGLIA
CONTRIBUTING
EDITOR

G. Jerry Truglia, president of Technicians Service Training, has been in the auto repair business for a long time as a tech, shop owner and nationally recognized trainer/author. He founded TST to bring affordable training to his fellow techs and shop owners.

✉️ Email G. at gtruglia@tstseminars.org

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MANY OF OUR SERVICE BAY 'TREKS' ARE DESTINED TO TAKE US TO NEW FRONTIERS.

BY RICHARD MCCUUSTIAN | CONTRIBUTING EDITOR

I remember one period back in the mid-1990s when we were seeing a lot of fuel pump failures. The vehicles would come in on the hook with no fuel pressure, and I'd check to see if the inertia switch was tripped. Then I'd toss a fuel pump in there, fire it up and test drive it, and all would be well. I was fully aware of the possible wiring concerns and whatnot, but I had seen so many fuel pump failures that I didn't see the need to spend a lot of time data mining.

I got a little too comfy with that pattern, and there came the day I drew a work order on a Taurus that my neat little routine didn't fix. I got that hook rider in my service bay, didn't hear the pump, checked the inertia switch and replaced the pump, all to no avail. The new pump didn't run either, and I felt like a dummy when I discovered a

chalked up ground wire at the battery terminal. I'm an honest guy, and as I perused the notion of removing the new pump from the tank and reinstalling the old one, I was hit with the realization that if I did that, the old pump could (and probably would) fail within our service warranty window and then I'd be stuck with having to do the next repair for free. The ground chalk was erased and the new pump remained in the tank. I could have saved a life, who knows?

Navigating Wisely

This Lincoln's driver had driven it bucking and jerking with the Check Engine light on for about three months until her father drove the vehicle one day, felt the problem and told her something needed to be done about it, and so it wound up at my shop. We drove it, felt the jump, snagged some cam sensor codes and scope patterns (verifying cam misalignment issues) and postulated there might be a phaser problem.

The PICO scope pattern we got from the two cam sensors and the crank sensor pointed to a concern on the No. 1 bank's camshaft. Was it a phaser or not? We removed the sensor, bumped the engine over until the three-prong side of the No. 1 bank's phaser's trigger wheel was lined up with the hole and looked to see if the arrowed "L" symbol on that gear was out of line with the center prong. If the phaser was out

of phase, the arrowed L and the prong won't eclipse.

This one seemed to be a shade off, but not enough to account for the pattern we got, so it was time for exploratory surgery. With the valve covers and the timing cover off (no small feat), we discovered the real problem, which, it turns out, is more common than phasers. The straight fixed slide on the upper stretch of the No. 1 bank chain had disintegrated and that chain had been whipping around in there to make some pretty serious marks on the inside of the cover.

This one would get a couple of phasers after all, along with new timing chains and all the stuff that goes with it. The guy I had doing the job was (and is) one of the most conscientious and careful second semester students I've ever seen, and I kept everybody out of his way while he plowed into that Navigator with one of the computers rolled over to where he was working. This B level job would have been a 14-hour flag for a line guy.

Those Crazy Others

Four more vehicles rolled in while the Navigator was under repair: a 1999 Town Car with a stubbornly steady number four misfire, a 2002 Taurus the owner said had an under-load bite at 45 mph (all too familiar), a 2004 Tahoe with an intermittent no-start problem and a 2001 F150 with electrical



JUST STUNNED

2005 LINCOLN NAVIGATOR

Vehicle Year/Make/Model

109,547

Mileage

5.4L V6

Engine

4R75E

Transmission

BUCKING AND JERKING WITH MIL ON.

Vehicle Complaint

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gremlins — the instrument cluster was remaining illuminated with the key off, complete with fluttering odometer segments and leaving a dead battery after sitting overnight.

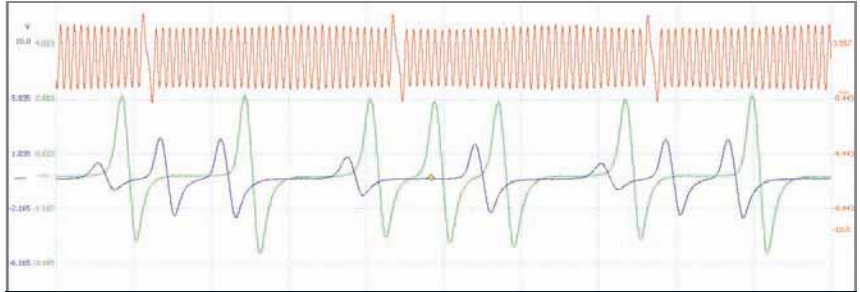
The Town Car's No. 4 plug well was loaded with coolant, which led us to examine the heater hose fitting right above it. Sure enough that pressed-in hose pipe was leaking coolant into the spark plug cavity. That one got an intake manifold.

The Taurus wasn't so cut and dried. The only concern the customer voiced when I wrote that one up was the 45 mph irregular misfire bite, and he said he already had replaced the spark plugs and wires. The next morning, I fired it up to drive it into the service bay for preliminaries only to discover that it was surging dreadfully. It ran so bad it would barely pull off in any gear when it was cold. There was no need to go for a test drive. All of this nonsense would need fixing before anything else was done.

After some scan tool PID-sifting that didn't help very much, I unplugged the MAF sensor on a hunch and it ran about 60 percent better. While cleaning that MAF might be in order, we replaced it with a reman from the parts store. The MAF was dirty due to a used-up air filter that wasn't just clogged, it had been compromised. It was one of those cheap ones that shrink with age, and it had several rotten holes in the pleats.

With the air filter in such bad shape, it was no surprise to remove the fuel filter and find it was plugged so badly I was concerned that it might have damaged the fuel pump. But afterward, the pressure was fine. After we got all the preliminaries done, we drove it again with the IDS running Power Balance and found the bite that was his original concern. He had cracked the No. 1 spark plug, and after we replaced that, the bite was gone.

The Tahoe was a frontier that was more interesting than the Taurus and a bit trickier. I had yet to experience the hard start it came in for, but we changed the engine oil and replaced the air and fuel filters. That fuel filter was so old, it was rattling when we shook it. Our DTC scan showed a P0178, which pointed to the Fuel Composition Sensor. But when we chased that one, we were



This cam sensor pattern pointed us to a possible cam phaser on bank 1 (at least from our perspective), and so we began our diagnosis with that in mind. If the phaser was all that needed replacing, it could be done fairly quickly. The phaser turned out not to be the problem.



You can see that the composite slider is gone from this top photo. He had removed the broken pieces of it before I could get a photo. The bottom photo shows both timing chains in place and in time, with the slider(s) in place and the tensioners installed.

confused by a 56 hz reading we measured with a meter on the signal wire that conflicted with the scan tool PID reading of 43 hz. Should we believe the PCM or the actual measured value? Was the PCM smarter than our meter? The scan tool showed a 37 percent alcohol reading. The simple fact is that the FCS is such an expensive part (\$700 list

price), it would be kind of spooky to toss one of those bad boys on a whim or a hunch. I wanted confirmation of some kind. After all, if this was the problem, why wasn't the no-start concern more consistent?

The F150 wasn't a frontier for me, and since I had worked at the Ford dealer, I knew where to look for this electrical

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1967 Richard Petty



1968 David Pearson



1969 David Pearson



1970 Bobby Isaac



1971 Richard Petty



1972 Richard Petty



1973 Benny Parsons



1974 Richard Petty



1975 Richard Petty



1976 Cale Yarborough



1977 Cale Yarborough



1978 Cale Yarborough



1979 Richard Petty



1980 Dale Earnhardt



1981 Darrell Waltrip



1982 Darrell Waltrip



1983 Bobby Allison



1984 Terry Labonte



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1987 Dale Earnhardt



1988 Bill Elliott



1989 Rusty Wallace



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gremlin problem. I had a couple of students remove the fuse panel/junction box, pried the cover open on it and found that the laminates were wet and green due to a leaking windshield. Moisture damage to this very important box can cause any number of electrical concerns, and so, a few hundreds of dollars later, this one drove out with a new junction box on its way to the glass doctor to have that water leak fixed.

Maxima Mystery

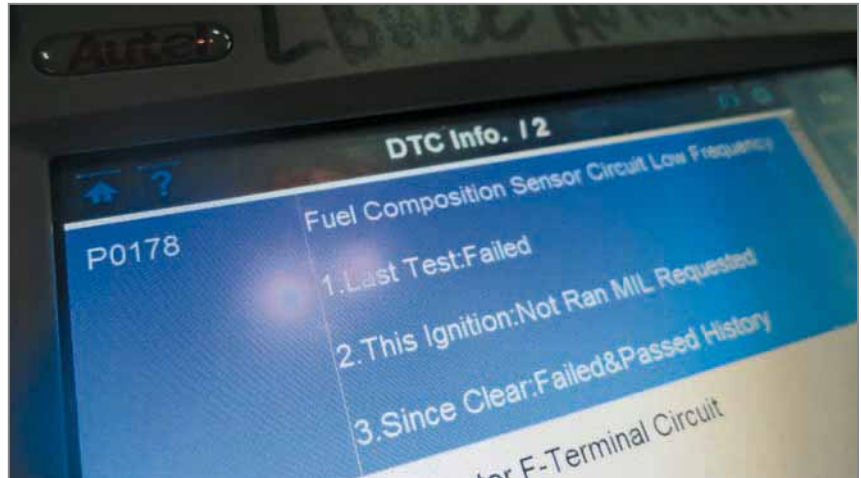
While the Navigator was undergoing the final stages of its chains-and-phasers surgery, I got a call for a repair from the owner of a 2002 Nissan Maxima her husband had diagnosed. He decided it needed a starter, because sometimes the existing one would only click rather than spinning. When I settled into the seat and turned the key, and the Maxima's V6 spun very aggressively for about 40 seconds before it fired up. The driver's husband was standing right there, but he hadn't mentioned this long crank-hard start issue, which was probably at least part of the reason the starter was dying. This wasn't a frontier for me either. I had the idea it probably needed a cam sensor on one bank or the other, and I said as much as he was headed out the door.

Amber, one of my newer students, replaced the starter and then bench tested the old one. In spite of the fact that the old starter spun so well on the car, it would only click during the bench test. With the new starter in place, the long crank happened again, and I stabbed the EASE WVI's green connector into the DLC (which is the quickest way to grab a code) and got the P0340 I expected. The cam sensor on bank No. 1 would be our next move, but first we had to spray wash away about a pound of accumulated greasy crud from the sensor and its connector.

When the parts store arrived with the replacement sensor and it was installed, the Maxima fired up so fast the crank barely made a full round on starter power. With some battery terminal maintenance and a few more simple checks, the Maxima was done.

Tahoe Frontier Conquered

The owner of the Tahoe had called earlier that morning to suggest that I



This code was a hint, but my thinking was that if this was truly a problem, why was the no-start intermittent? The weather seemed to have nothing to do with it; the symptom knew no season from what the owner said. But the one constant was that it would always happen after a four-hour soak, and four hours later it would start.

TC Pwm Solenoid Command		Off	
Fuel Alcohol Content	0...100	37	%
Fuel Comp. Sensor Frequency	0...255	43	Hz

These numbers seemed to have been the reason for the P0178 code, even though a really good meter read 56 hz, which didn't agree with what the PCM was seeing. With no problem duplication, I wasn't about to toss a \$700 sensor on there!



This Tahoe stubbornly started the way it was supposed to every time we tried it for two full days. Finally, on the morning of the third day, the problem reared its ugly head and all it would do was spin over.

put it outside the shop for the night, which was going to be pretty chilly, and while I had her on the phone, I decided to start it up. All it would do was spin like the Maxima, but with no eventual start. She did say that when it pulled this stunt, you could leave it sitting for several hours and it would start and run just fine.

One way or another, we were in business, and I shoed her off the phone so I could concentrate, fearful that the Tahoe would decide to start. We had an rpm signal (I scoped it and

it looked great). We had fuel pressure, strong spark and clicking fuel injectors. What about fuel quality? I discarded that as an issue because it started so well most of the time.

I poked around in Identifix and noticed that a couple of shops had run across problems like this that were caused by the Fuel Composition Sensor, but that sensor still was too expensive to take a chance on. So I opened a hotline call on it and got my verification from the GM guy. The P0178 was a strong indicator (56 hz



The F150's inside junction box had this wet green crud showing on the end of the laminates, a surefire cause of weird and far-reaching electrical problems. I previously had seen this one at the dealer, and every single time it was because of a leaky windshield seal. This one was no different.



When we finally duplicated the no-start and discovered the spark plugs were wet (which would be an overfueling issue due to false data from this FCS), we also discovered that we could floorboard the accelerator to put it in clear flood mode, drying the plugs so it would start.

notwithstanding) that the FCS was indeed the cause of this nonsense. I yanked a spark plug and found it very wet. Could the PCM be over-fueling the Tahoe thinking there was more alcohol in the tank than there actually was?

A call to the customer confirmed that her son, who drove the Tahoe, never used E85 — he pumped only regular into that cavernous gas tank. We ordered the Fuel Composition Sensor when the owner green-lighted it and let the truck sit all night before installing the sensor. A follow up since has

verified that the hard starting concern is fixed, albeit at a pretty stiff price.

Navigator Frontier Conquered

The student who was working on the Navigator studiously was putting every little part, bracket and wire harness back in place (which is demanding for any student, but this guy is good). He spun the fan back onto the water pump pulley and tightened it with the fan wrench, filled it with coolant, and turned the key. It fired right up, and the



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RICHARD MCCUISTIAN
CONTRIBUTING EDITOR

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.

E-mail Richard at rwm19@mail.com

new timing chains rattled for about a second until the oil pressure tightened the tensioners. The air suspension compressor kicked in and raised the Navigator on its bags, and it sat there purring like a kitten.

I'll be the first to say that, as an instructor, it's kind of spooky to give a job this complicated to a second semester student. But I as I watched this guy carefully observing virtually everything the shop manual told him to do, I knew early on that this one would go well. And it did. While the job was under way, I told him that he would feel like Superman when he heard that 3-valve fire up and run right.

My prediction was correct, but I must confess that, when I heard that Navigator light off, I felt as super as he did. We weren't stunned by these phasers. We had breached our final frontier, at least for that week. *TLZ*



ACDELCO: YOUR TOTAL TRAINING SOLUTION

You wouldn't go to a surgeon who doesn't stay abreast of leading-edge technology, so why would drivers trust their vehicle care to a shop whose technicians are stuck in the past?

ACDelco believes training is key to maintaining your edge in a constantly changing aftermarket environment. It also knows every minute a technician isn't working in the bay represents a potential for lost revenue.

That's why ACDelco's industry-leading training combines a variety of proven delivery methods to ensure maximum learning benefits for service professionals. More than 400 courses range from traditional instructor-led technical training courses and seminars to a wide selection of online courses that offer the latest available business and technical updates.

ACDelco's 24/7 online courses allow participants to train at their own pace and schedule. They also align with hands-on courses that are considered the gold standard of industry training. And, with Virtual Classroom Training, ACDelco offers the benefits of live instructor expertise with the convenience of the internet.

Most training is offered at no-charge to qualifying members of the ACDelco Professional Service Center program; and Key Fleet, Fleet Parts Purchase Program and Regional Service Center accounts. Training is available to non-program participants for a nominal charge. Last year, technicians completed nearly 100,000 hours of ACDelco training.

Here's a look at what ACDelco offers:

Tech-Assist courses are brief, web-based technical courses with no prerequisites.

Self-Study Training courses generally are less than an hour of web-based technical training, and available 24/7 at no charge. Three basic levels are intended to help the non-technical employee or customer better understand various vehicle systems.

Web-Based Training (WBT) online courses typically cover under an hour of technical training and are available 24/7.

Simulation courses include web-based interactive technical training, and are available 24/7.

Virtual Classroom Training courses last one to two hours and are presented by an ACDelco instructor. The training is presented live via the internet, using animations, graphics and videos related to the content.

Seminars are presented by an ACDelco professional, usually during the evening. Seminars last three-four hours and are interactive and fast-paced.

Instructor-Led Training courses run either a half or full day and are presented by an ACDelco instructor. Training uses vehicles and hands-on exercises.

Video on Demand Digcourse offer technicians the ability to view previously recorded content at any time. They



are searchable and include the ability to navigate through specific topics. They're also compatible with smartphones and tablets for additional convenience.

ACDelco recently introduced other convenient ways to deliver training:

TechTube Videos are short, vignette-style (three to seven minutes) videos focused on specific technical procedures or field concerns.

Half-Day Training gives technicians the full benefits of instructor-led training in half the time. Four-hour sessions are conducted at a dedicated training center and provide hands-on exercises that give technicians the opportunity to apply diagnostic skills to real concerns using actual vehicles.

The ACDelco Learning Management System, or LMS, is the hub for accessing and tracking training. To access the LMS, go to acdelcotraining.com, create a new user account with your organization's six-digit number, and you're ready to go.

Use the ACDelco 2015 Course Catalog to browse the training portfolio. Launch online training directly from the LMS site 24/7, or search for and enroll in training coming to your area if you're looking for face-to-face training.

Once you register, the LMS will generate emails to remind you of your upcoming training. We'll even text you if that's more convenient. Manage your preferences in your profile so we can better accommodate your needs. You even have the ability to view your training progress at-a-glance and print-off certificates of completion. Your ASE certifications can also be added to your training completion paths to show your accomplishments.





CREATING A TRAINING PLAN FOR YOUR TEAM

Shop owners today face many challenges, not the least of which is keeping their team ready to provide exceptional customer service for their customers and their vehicles. While most shop owners fully understand the need to be able to 'fix' the cars they also need to be able to serve the customer. And to enable their team with the skills needed to 'fix' what's in their bays, most shop owners send their techs to some sort of training every year. The problem is that in most cases they simply send them to whatever happens to be coming to town, or is free or is focused on a problem that kicked them the week before last. This type of shotgun approach might have some positive results but in most cases lacks success and, in fact, negatively impacts the growth of the team long term.

Advance Professional Driven by Carquest wants to help shop owners better understand how to become Learning Managers in their business. The position of Learning Manager essentially provides for a clear and consistent learning plan for every job role in the business. This learning plan first fully understands each job description and the learning needs of each position. The Learning Manager must identify the best learning resources and methodologies whether it be Instructor Led Training (ILT) or Online Training (OLT) or a blend of both. Let's consider the steps necessary to build a learning plan for your business.

First the Learning Manager must fully evaluate and understand each job role so everyone in the business is in agreement with each role. This means including the entire team in the process. The Learning Manager must be able to organize the skills for each role in a logical order. For instance a technician must first understand basic electronics before learning about testing with a labscope. Once each

job role is established the next step is to identify which courses from your supplier will fit. This is followed by evaluating your techs so you know where they best fit in the learning path for each job role. There is no magic to this formula, only hard work. There are no really good skill assessments other than observing your team first hand, matching their performance to their job role standards and adjusting the course content for each job role to meet the needs of your team. So you're probably saying, 'That's a lot of work! Is there any help available?' Of course there is!

Advance Professional Driven by CARQUEST is about to release the new Advance Professional Training Center in May of 2015. This powerful learning management system gives the Learning Manager the tools necessary and both the ILT and OLT content needed to create custom job roles that can be managed easily via the web. The Training Center provides access to all of the award winning CARQUEST Technical Institute instructor led class schedules and calendars and tracks the teams attendance for each class. It also delivers the incredible variety of MotoSKILL online course content with over 200+ titles. OLT content types include ASE Test Prep, Interactive Technical Courses, AVI Video Courses and our all new e-Simulations which challenge a technician to solve a real problem on a virtual vehicle using simulated tools that act like the real thing. As well the Training Center allows the learner to print their certificates for both ILT and OLT courses, print their transcript, view their progress, download the latest workbooks for their ILT courses and complete training certification paths designed by your Learning Manager.

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Fully Integrated

"What we mean by a fully integrated tool is the ability to search, using the tool, Web resources and forums via Wi-Fi, as well as on-tool databases of code definitions and fixes," said Ed Lipscomb, OTC Senior Product Manager, Diagnostics. "There's no walking away from the car to search, you can do it all right at the fender."

Of course, what good is a fast scan tool without the vehicle coverage you need to back it up? Behind Encore's seven-inch touch screen is a wealth of OEM-level coverage, more than 30 years to be exact, for Asian, Domestic and European makes and models.

How the System Works

Once Encore pulls a code, it relies on well-known resources and embedded video to offer a fix. The system automatically searches its on-tool database, relying on millions of experience-based and reported fixes. The databases, including Code-Assist™, Repair-Trac™ and Symptom-Assist™, combine to search more than 30 million confirmed fixes, specific to vehicle year, make and model.

"We've made diagnostics easier, faster and more efficient with the Encore," added Lipscomb. "We take the code, search the Web and the tool, giving you the most likely fix, second most likely and so on." Not only does it offer the technician a fix, embedded video can help guide the repair.

Additionally, Encore scans Identifix® Direct-Hit® and Google, requiring technicians to enter their Identifix Direct-Hit login just once to enable automatic searches for fixes during vehicle scans. OTC is also currently expanding to integrate IATN into the Encore.

Extent of Coverage

For a technician, nothing beats an all makes/all models tool. One purchase to service all vehicles saves money and expands the opportunity to profit.

As a scan tool in the OTC family, Encore boasts OEM data providing broad and deep coverage from late model 2013 all the way back to the early 1980's, including Domestic, Asian and European vehicles. The data, from generic to



OE-specific codes, also includes component locations, specs, test procedures and TSB references for quick access and quick fixes. Encore also features bi-directional testing and vehicle data stream.

Proof is in the Product

Automatically searching onboard resources and integrated technician networks, including likely fixes and guidance, provides the type of guidance needed to find the issue, make the fix and keep you working – and profiting. While a scan tool is not an end-all to fixing a vehicle, Encore gives you what you need in a simple, familiar layout in the Android system. Other tools on the market offer similar services, but none in a complete package like the Encore, nor at the tool's price point.

The bottom line? Encore offers an intuitive, fix-it-quick scan tool for all makes and models service, backed by OTC's trusted diagnostics coverage.

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WHEEL SERVICE TRAINING

BendPak-Ranger recently celebrated the opening of a brand new state-of-the-art training center located at their headquarters in Santa Paula, CA. The classroom features the latest in technology and will be used primarily to train their dealer and support network on proper use, maintenance, and repair of their expanding wheel service equipment product line. The fully functional building spans over 1500 square feet with ample room allowing dealers, customers and service providers the opportunity to learn installation and service techniques directly from Ranger certified experts. Students and dealers benefit from this hand-on training situation as they learn how the equipment works in a familiar shop setting.

The Santa Paula, CA based facility offer hands-on training for Ranger's tire changers, wheel balancers, aligners, brake lathes and other commercial product lines, as well as application workshops.

The new training center illustrates Ranger's commitment to growth

by providing their sales team and customers with a high-quality facility and the best training and information possible. Several classes are offered in both English and Spanish. To ensure the highest level of interactive training for students, the facility has installed demonstration equipment with fully functioning models as well as high-tech computer and audio/visual equipment.

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- o Engineered for vehicles that require full synthetic or blended oil. Dual layer synthetic media reinforced with a durable metal screen.
- o 99 percent[†] Dirt Trapping Efficiency
- o Silicone anti-drainback valve holds a reserve of oil in the filter to help protect the engine during start-ups.

FRAM Pro® Quality filter designed for conventional oil
 Advanced Engine Protection[†]

- o Engineered for vehicles that use conventional oil with short change intervals.
- o 99 percent[†] Dirt Trapping Efficiency

FRAM Pro® Air Filters Quality air filtration
 Airflow Protection

- o Air filters prevent dirt and dust from entering the engine
- o A new air filter can increase airflow, horsepower, and improve overall engine performance

FRAM Pro® Cabin Air Filters Quality cabin air filtration
 Cabin Air Protection

- o Cabin air filters clean the air that flows through a vehicles ventilation system, protecting the driver and passengers from dust, dirt and allergens

FRAM Filtration

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 1-800-890-2075

www.framproseries.com

[†] FRAM Group testing of average filter efficiency of FPS8A, 3387A, and 4967 or equivalent FRAM Pro Synthetic® models under ISO 4548-12 for particles greater than 20 microns

^{††} When compared to FRAM Pro® models





TOP 6 INSTALLATION VIDEO TIPS FROM CARDONE

Check out these popular videos highlighting quick tips that will help you properly diagnose vehicle issues and avoid common installation problems. Simply scan these QR codes, and the videos will automatically play!



Simple Power Steering Contamination Test

Nothing lasts forever, including hard-working power steering fluid and hoses. Here is a quick way to show your customers why they need to flush their steering system and/or replace their steering hoses. Visual proof works best!



Power Steering Pump Misdiagnosis: Dirty Reservoir Screen

Watch this video on a common misdiagnosis on many late-model, import and domestic power steering pumps. Learn how to spot and properly correct this problem.



Aluminum Caliper Installation Tips

Aluminium brake calipers are lightweight, but soft. This short video offers tips on how to install aluminium disk brake calipers without damaging the threads.



Step-Bore Master Cylinder Bench Bleeding Procedure

Step-by-step demonstration of a step-bore master cylinder bleeding procedure using CARDONE's bleeder syringe (part# 10-5000MCB), which cuts typical bleeding time in half!



1993-2005 GM Wiper Motor Crank Arm Calibration

The proper way to calibrate the wiper motor crank arm on 1993-2005 GM hidden park wiper motors. Following these instructions will ensure your wipers do not park in the middle of your windshield.



Limit Switch Reset Procedure for Nissan & Toyota Anti-Pinch Window Lift Motors

Detailed how-to video on resetting the window lift motor limit switch on Nissan and Toyota vehicles equipped with anti-pinch capabilities.

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DUAL CLUTCH TRANSMISSIONS: THE AUTOMATIC GEAR BOX IS HERE

LUBEGARD COMPLETE DCT Fluid is designed for DCT transmissions that are now optional or standard equipment in over 14 OEM applications.

DCTs (also known as twin clutch or double clutch) operate like two manual transmissions working in parallel. One clutch handles the odd-numbered gears (1st, 3rd, and 5th) while the other handles the even gears. The clutches engage and disengage simultaneously for smooth torque delivery to the drive wheels.

There are two types of DCT transmissions currently available. Wet clutch (clutches are cooled and lubricated by oil) and dry clutch (clutches are not lubricated). DCT transmissions are similar in design and operation and have similar fluid requirements.

Wet DCTs require a significantly larger amount of fluid than dry clutch DCTs ranging from 6-10 quarts of fluid for single sump units (dual sump units will also contain 4-5 quarts of manual trans fluid).

The fluid designed for DCT transmissions has to lubricate both the gearbox and the clutches. This requires the lubricant used to have the properties of a manual and automatic transmission fluid. Good frictional properties with gear, synchronizer and bearing wear protection must be provided by the fluid. In addition, these fluids must contain superior shear stability qualities while also providing excellent thermal and oxidative stability.

Drain intervals vary by OEM but most current DCTs require an oil change at 30,000 miles. Currently specified OEM DCT fluids use "synthetic" DCT fluid and are ready to be changed by 30,000 miles according to the "blogs" and OEM enthusiast sites. This is an application that requires an excellent fluid or they do not last.

The additive package in LUBEGARD

COMPLETE DCT Fluid has been modified to meet the requirements of extreme pressure and high shear stress in the gear train, while providing excellent thermal stability and long term frictional stability.

LUBEGARD COMPLETE DCT Fluid provides a DCT fluid solution that meets all of the requirements of dry and wet clutch DCT transmissions. Because the actual design of the gear train and mechanical/hydraulic transmission controls are similar in both wet and dry clutch applications it is possible to have a DCT fluid that protects the gear train and provides the proper frictional properties for the wet clutches.

When the vehicle with a DCT transmission comes into your facility it is very likely the fluid in that transmission will need to be serviced. You should always follow a systematic approach when evaluating the need for DCT transmission service to avoid claims you performed an un-needed service.

- Interview the vehicle owner and establish service history, mileage since last service, profile vehicle use to determine driving style and type of driving (normal duty or severe duty) to determine service frequency. Severe duty usually means cutting the normal duty service interval in half. If owner manual specifies 60,000 miles for normal driving it will now drop to 30,000 for severe duty driving.

- Educate the vehicle owner about reduced service intervals based on actual vehicle use (most drivers will find they fall into the severe duty category) and get their permission to inspect their vehicle (if the mileage or driving style indicates this is necessary).

- Perform an initial inspection and look for any leaks or wet spots, leaking or damaged lines, corrosion or damage to the pan or transmission. Inform customer if there are problems before service.

- Remove a small amount of oil from



the transmission (consult the owners manual or OEM service procedure for method) and submit the used oil sample to physical analysis (is it dark, does it smell burned) or a fluid analysis spot sheet (if that is used) to determine if there is any obvious degradation of the fluid. Do not be afraid to involve the customer in the decision making process.

- If service is deemed necessary and customer approval has been granted replace DCT fluid according to OEM recommendations.

- Road test the vehicle after service to verify proper shifting and performance.

If you follow these simple procedures you will avoid legal problems and will provide your customer with products and service that will allow them to get the most value and dependability from their vehicle.



REPAIR INFORMATION CAN BE A VALUABLE TRAINING TOOL

Change. It's the one certainty in the automotive industry. With technologies like driverless cars, pedestrian detection and driver state assessment systems (just to name a few) all coming in our future, lifelong learning will be a reality for everyone in our industry. Shops are already facing increasingly complex vehicles in their bays, but shop owners and technicians are not the only ones who have to keep up. Information providers like Mitchell 1 are also continuously updating data to reflect the latest and greatest innovations that auto manufacturers are introducing to the market.

Clearly this trend isn't going to change any time soon. One of the most important ways that techs can stay current with the industry is by having the latest repair information available quickly. This is the driving force behind Mitchell 1's ProDemand® repair, diagnostic and maintenance information software. The editorial team at Mitchell 1 is continuously updating and adding to the millions of pages of OEM repair data that power the ProDemand engine, so users always have up-to-date vehicle content available.

Another way to keep pace is to understand what vehicle repair issues other techs are dealing with in their shops. This is what SureTrack®, the diagnostic module in ProDemand, is all about. SureTrack is constantly delivering new real-world information based on the latest repair experiences of thousands of professional technicians. The database currently contains tens of millions of these "Real Fixes," and new content is being added at the rate of about 200,000 new Real Fixes per month.

ProDemand with SureTrack also delivers component tests, a vast database of "known good" values and waveforms, plus component failure graphs. These features add to the core OEM and real-world insight to help technicians not only diagnose problems more effectively, but also understand how the systems in the vehicle function.

For technicians who want a more interactive experience, the SureTrack community provides an opportunity to ask questions and share information with their peers. This resource offers some of the very best learning a technician could ask for – it's like on-the-job training from professionals who have faced the very same vehicle problems in their bays.

Some of the newest features in ProDemand that help techs stay on top of their game include:

Top 10 Repair List – With every vehicle search in ProDemand, techs get a jumpstart toward the correct diag-

nosis and repair with detailed information about the top 10 most common component failures, diagnostic trouble codes (DTCs), symptoms and lookups for the vehicle selected.

Quick Links – This is the fastest route to the most commonly accessed information in ProDemand: technical bulletins, common specifications and procedures, a DTC index, electrical component locations, fluid capacities, tire fitment and wiring diagrams.

Smarter Searches – Type in a symptom, trouble code or component and ProDemand's 1Search™ feature delivers a list of verified fixes that have resolved the same symptom for other technicians. It's an excellent starting point to direct technicians quickly to an accurate diagnosis and repair.

ProView – Once a code or symptom is selected in ProDemand, the ProView feature provides all of the known fixed components for that code or symptom, or multiple codes and symptoms, based on real-world content. This allows technicians to quickly see the most commonly repaired components and plan a diagnosis strategy to resolve the problem.

You might not have thought about your repair information resource as a training tool. But along with formal training and certifications verifying your knowledge, it's good to think about other ways to stay current with the industry. Isn't it nice to know that the tools you're already using to repair vehicles can also help you keep your skills honed and ready for the advanced vehicles that will be arriving in your bays?



Mitchell 1

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Poway CA 92064
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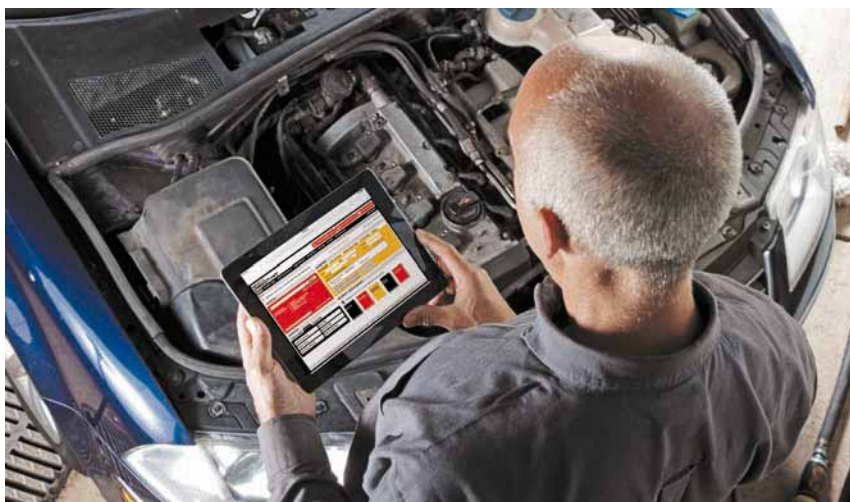
BUILD EXPERTISE AND CONFIDENCE WITH DIRECT-HIT

Even the best technicians are looking for that extra edge to help them fix more cars in less time. Direct-Hit, Identifix's award-winning online tool, gives you that edge with proven, real-world diagnostics, and quick access to genuine OEM repair information to finish the job with speed, accuracy and confidence.

Direct-Hit is not about cutting corners on vehicle diagnostics and repair. It's an extension of technicians' expertise, helping automotive professionals of any skill level to raise their game and their confidence in a job done right the first time. Even master certified techs use Direct-Hit for the experience-based knowledge they need to quickly solve complex vehicle issues, along with routine service information for the "gravy" work. So you can save time on every car, every day.

With Direct-Hit, you get proven short-cut tests and confirmed fixes to help you find your fix faster than factory flowcharts. Our diagnostic test procedures are created from millions of calls to our Repair Hotline, and written by our own factory-trained, ASE Master, L1 Carline Specialists. Fixes are collected from over 100,000 techs in the field, and validated by our master techs before being posted to Direct-Hit for reliable information you can trust.

Direct-Hit gives you access to genuine OEM service & repair information on more than 35 vehicle makes, domestic and import. You get factory information in its purest form. It's not rewritten, edited or modified in any way. This is the real stuff, the exact same information available to the dealership technicians, now at your fingertips in Direct-Hit. You can link to R&R procedures, wiring and pin-out diagrams, specifications and more right from your diagnostics; or go directly to the service manual infor-



mation you need with Supercharged Search® technology that considers language across all OEMs to help you find exactly what you need without worrying about exact keywords.

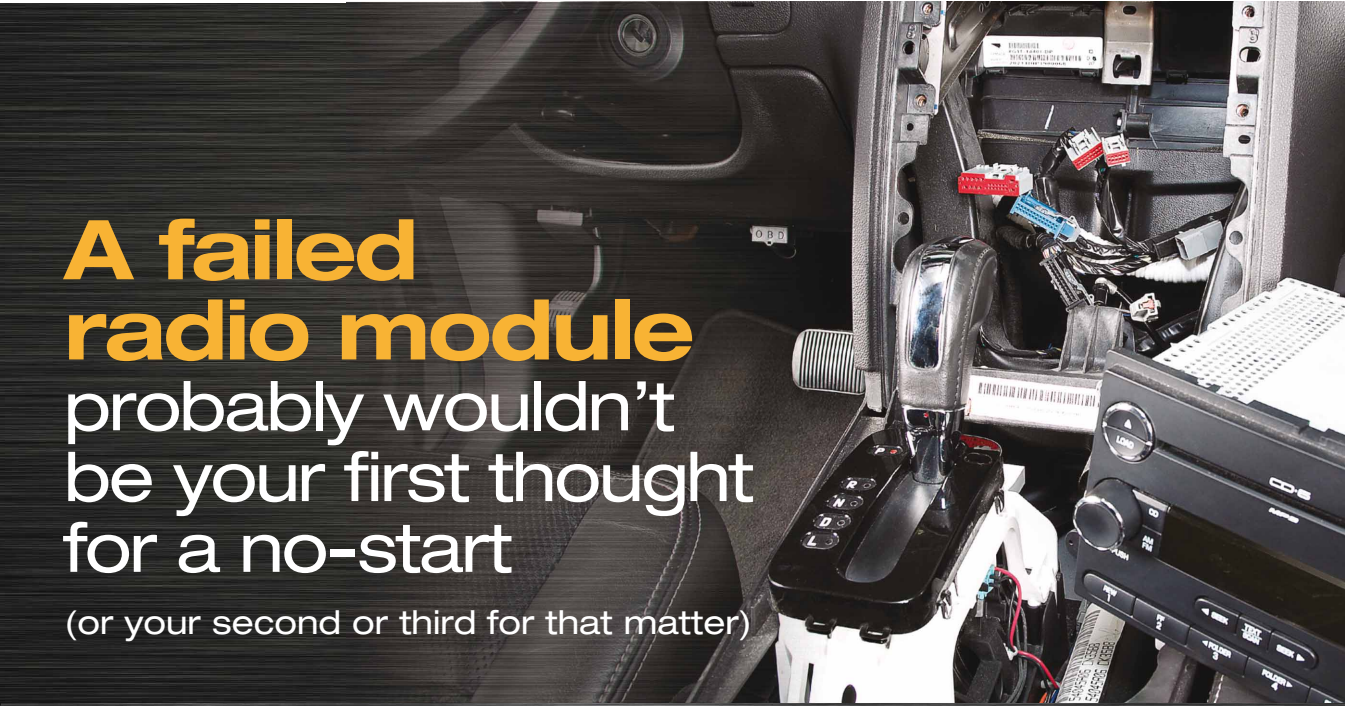
Direct-Hit's Factory Scheduled Maintenance plans give you the confidence to educate your customers on the benefits of regular vehicle maintenance to keep them safe on the road while generating additional revenue for your shop. You can run a comprehensive maintenance plan in under a minute and present manufacturer-recommended service in plain-talk language your customers can understand and trust, not only explaining what may need service, but why their vehicle should be properly maintained. You even get maintenance reminder reset procedures. For confident and professional estimating, Direct-Hit gives you the most current and reliable information from MOTOR, combined with the convenience of parts order-

ing for increased productivity. Quickly build and save estimates that you can print, or even email directly to your customers for their approval.

In a business where time is money, you can't afford downtime learning how to use a new tool. That's why Identifix provides free and unlimited training whenever you need it. Whether your staff wants to learn more about new enhancements, or you're getting a new technician up to speed, Identifix offers personal online training, weekly webinars and an entire library of how-to videos with step-by-step navigation of Direct-Hit's most time-saving features – all so you can get the extra edge you need to stay productive and profitable.

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'05 Buick LeSabre 3.8L towed in. The engine will start and stall if the starter relay is bypassed. The power windows, power locks, radio, interior lights and Instrument Panel Cluster will not display or function. The scanner will not communicate with the vehicle.

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ADVANCED DIAGNOSTIC TRAINING FOR TECHNICIANS

N GK Spark Plugs offers Advanced Diagnostic training geared toward the modern technician, combining the instruction of hands-on industry techniques and OEM expertise in a contemporary, lecture-style atmosphere. Focused on further defining diagnostic skills relating to emissions and ignition components, our training enables technicians to adapt to transitional industry trends.

As emission systems technology advances, the diagnostic process also changes. Using diagnostic strategies, including those for wideband and AFR sensors, will increase the shop's bottom line and reduce time spent on emissions related repairs. The Advanced Diagnostic and Drivability training delves into methods vital for any experienced or entry-level technician, service manager or instructor, covering the following:

- Wideband and oxygen sensor heater types and testing
- Forming diagnostic strategies using:
 - o Short Term Fuel Trims (STFT)
 - o Long Term Fuel Trims (LTFT)

- o GM Adaptive Fuel Control (AFC)
- o Ford Keep Alive Memory (KAM)
- Extensive coverage for diagnosing P0400, P0420 and P0430
- How to properly analyze sensor waveforms
- Mode 2 (\$02) Freeze Frame data
- Mode 6 (\$06) Test results
- The use of bi-directional controls when testing emissions and diagnosing Mode 9 (\$09)
- Smoke testing procedures for:
 - o Chrysler LDP Valves
 - o Catalytic converters
 - o Subcomponents of the emissions system

For more information on the features and benefits of NGK Advanced Diagnostic training, call our toll-free technical assistance line at (877) 473-6767 Option 2.

NGK Spark Plugs (U.S.A.), Inc.
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LIFT THE SHIM, TAKE A LOOK



Next time you get a set of brake pads or pull an old set off a car, peel or pop off the shim and look for the NRS symbol stamped into the backing plate. It should be in the center of the pad and is the ultimate symbol of safety and quality when it comes to brake pads.

On pads without the NRS logo you may notice flaking paint, rust, holes in the backing plate and maybe delamination.

The pad with the NRS logo you will see a plated pad that is corrosion resistant, ears that are perfectly formed and 100 percent of the friction surface still on the pad even if it is worn down to the last few millimeters of friction material.

The backing plate is the foundation of any brake pad. A brake pad with a NUCAP backing plate using the NUCAP Retention System (NRS) is more stable

and will not flex due to higher quality steel and better engineering.

NRS' hundreds of steel hooks create a permanent bond with the friction material. The NRS mechanical attachment holds the friction material better than any adhesive. NRS allows brake pads to be run down to the last few millimeters of friction material, while still maintaining 100 percent retention. NRS has earned the reputation of being "bulletproof" in its resistance to shear loads, corrosion and heat.

Aftermarket brake pads may use black steel for their backing plates which is a poorer quality steel. The steel stamped may have inclusions and corrosion may have already started. This creates a very flimsy foundation for the rest of the brake pad. It is all held together with sprayed on glue. Over time, the glue will fail and flexing of the pad will cause the friction material to delaminate from the backing

plate. Corrosion will cause this process to happen faster by getting between the friction material and backing plate, causing rust jacking.

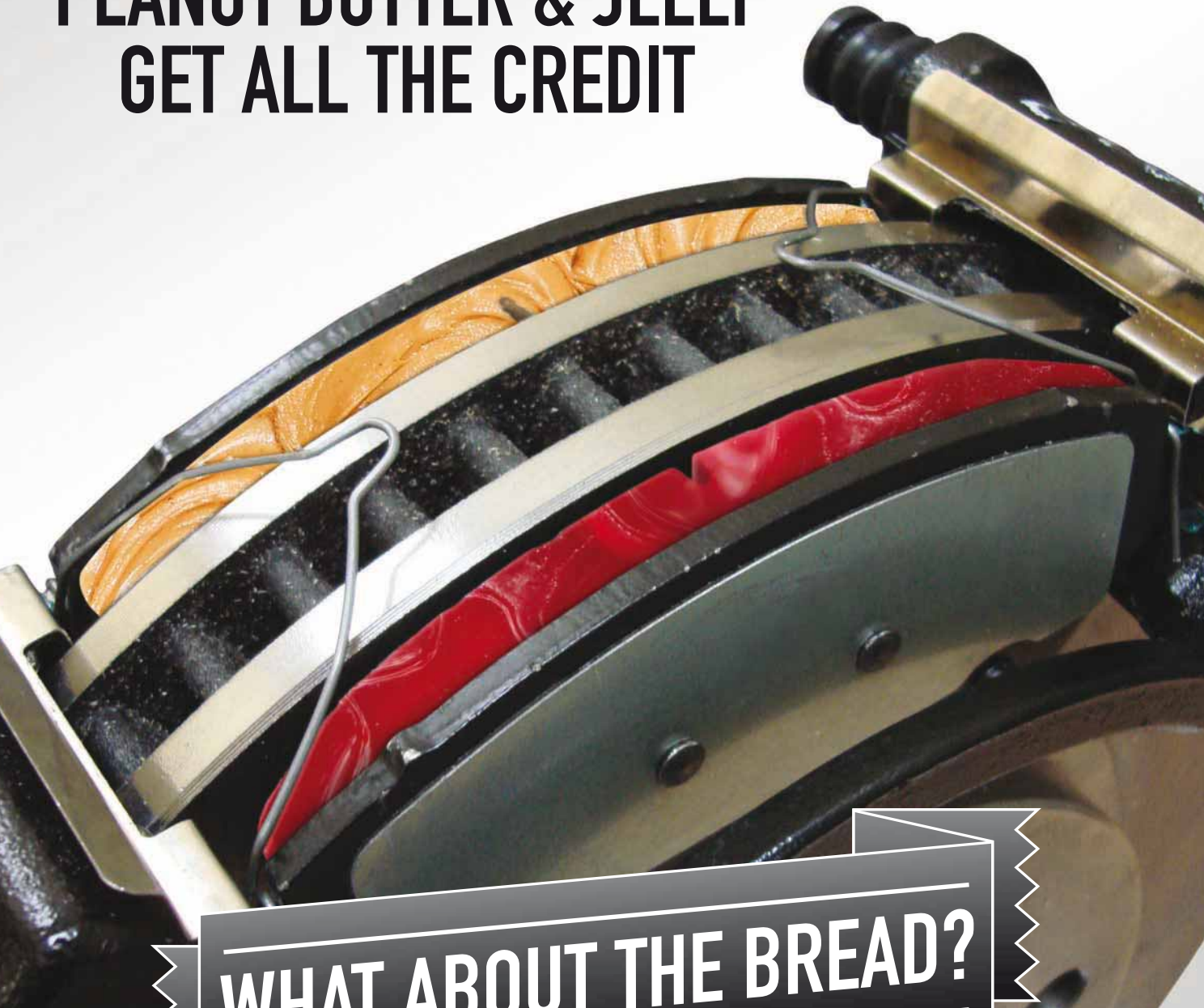
A NUCAP backing plate has more value than a conventional backing plate, and, if they use a NUCAP backing plate they can eliminate processes like glue application, painting and reduce oven times to cure the raw brake pad. They can save on raw materials, capital equipment and even energy. Plus, it is a greener process.

NUCAP is so confident in NRS technology, they have a 100 percent Brake Pad Performance Guarantee. The guarantee covers all brake pads manufactured with the NRS Retention System against delamination for the useful life of the pads and will reimburse customers a flat \$250 for the cost of their brake pads and labor.

For more information, visit www.techtips.com.



PEANUT BUTTER & JELLY GET ALL THE CREDIT



WHAT ABOUT THE BREAD?

Without the bread you'd have a mess
Start investing in "Bread Pads"



NUCAP has an answer for that with Innovative OEM approved Backing Plates - **The Bread**. NRS™ mechanical attachment technology provides the most secure bond of friction material to plate, resulting in reduced noise, greater durability and increase safety. Brake Pads equipped with NUCAP Technology's disc brake shoes improve brake system performance, product value and WILL NOT FAIL. For details visit www.nucap.com





THREE WAYS TO EXPECT MORE FROM REPERT LIVE

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REPERT LIVE

For everyone that demands a bit more – “Expect More” from Schaeffler Automotive Aftermarket. Schaeffler is pleased to introduce REPERT LIVE, the new training brand from Schaeffler.

For the automotive service professional, substandard quality is not always visually obvious. Parts may bolt-up, but may exhibit immediate off-the-lift problems or premature failure. With labor the lion’s share of the repair bill, don’t risk your time and reputation by installing inferior parts. Trust the technical and training experts from Schaeffler.

We are committed to provide our customers with the practical tips and diagnostic information needed to get the job done right the first time. Whether through tradeshow demonstrations, regional REPERT LIVE

events, or customized training clinics, Schaeffler offers in-person technical and diagnostic training to the North American automotive aftermarket through REPERT LIVE.

Industry Tradeshows and Customer Events

The integration of REPERT LIVE into the Schaeffler tradeshow booth puts increased focus on the service repair facilities and installers. Our technical and product experts conduct training and demonstrations throughout the event. In-booth activities include:

- New innovative products and technology
- General and application specific technical tips
- Hands-on demonstrations
- In-depth technical training
- Failure diagnosis
- Best practices installation education
- Interactive discussions

REPERT LIVE Events

New in 2015, Schaeffler is pleased to introduce the new REPERT LIVE Events. Automotive service professionals will join Schaeffler product and training experts for a one-day compre-

hensive, hands-on diagnostic and technical training event designed just for them. Schaeffler experts will provide detailed product and vehicle system training, proper installation methods, as well as tips/tricks and best practices on clutch systems, engine components, wheel bearing & hub assemblies, and brake and chain systems. Between training sessions, participants will have the opportunity to get into a go-kart and test their racing skills. Schaeffler will be hosting events this year in Los Angeles, California and Toronto, Ontario.

Training Clinics

A standard technical training clinic includes interactive seminars and hands-on demonstrations designed to reduce bay-time, improve repair processes and increase customer satisfaction.

Schaeffler REPERT LIVE technical training curriculums are developed for the service professional at both the intermediate and advanced levels. We collect all our technical expertise and training so it can be accessed from a single source. Product and sales training is also available for automotive sales teams including distributor, store and jobber sales personnel.

Our REPERT LIVE trainers can develop a customized curriculum that will suit your company and customer’s needs.

For more information about any of our REPERT LIVE training offerings, please contact our team at 1-800-274-5001.

2015 Calendar of Events

Tradeshows:

Automechanika Chicago

Chicago, Illinois

Friday, April 24 thru Sunday, April 26

AAPEX – Industry Week

Las Vegas, Nevada

Tuesday, November 4 thru Thursday, November 6

REPERT LIVE Events

K1 Speed – Torrance (Gardena)

Los Angeles, California

Saturday, June 13 and Sunday, June 14

Grand Prix Kartways – Downsview Park

Toronto, Ontario, Canada

Saturday, June 27 and Sunday, June 28



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LuK, INA, and FAG have built a legacy of pioneering technologies, earning their place as the engineering partner and supplier for nearly every original-equipment vehicle manufacturer worldwide. Schaeffler Automotive Aftermarket has an equally strong heritage as a systems innovator in the replacement market, developing unique products and solutions engineered to provide flawless performance, unbeatable durability and high customer satisfaction. We are MORE than just products and technology, we are committed to the success of our aftermarket partners and offer unique solutions for mutual success.

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NAPA KNOW HOW: SERPENTINE BELT SYSTEM MAINTENANCE

To ensure the best component performance, longest life span and fewer customer comebacks relating to their drive system, shop owners and Service Advisors need to explain to their customers the importance of preventive maintenance – including the need to replace critical wear parts before they fail. The belt, automatic tensioner, idlers, pulleys and powered accessories are all highly integrated in a serpentine drive system. Critical drive belt components should be repaired and maintained with this “system” approach in mind. As a rule of thumb, it’s important to start inspecting the serpentine belt system at 60,000 miles, and replace worn components by 90,000 miles, or as advised by the manufacturer. NAPA Belts/Hoses refers to this process as “I60/R90.”

The most important component in the serpentine belt system is the automatic tensioner. The tensioner and belt are designed by OEMs to work as a system. They must be replaced at the same time to maximize system life. Not replacing them together will lead to problems, such as belt slip, which decreases accessory efficiency, generates false trouble codes and creates noise. Belt slip can also generate enough heat to damage the grease in accessory pulley bearings. The alternator is especially vulnerable to heat damage because the pulley is much smaller, turns faster and has a higher bearing load.

Belt slippage can be caused by a worn tensioner, contaminated or misaligned pulleys, a high mileage belt with more than 5 percent material loss, or a belt that has stretched or is too long. Some cracks are a normal part of belt aging for older neoprene belts; however, more than three cracks in a three-inch section of one rib means



the belt has reached 80 percent of its intended life and needs to be replaced.

Although some neoprene replacement belts are still sold in the aftermarket, the industry standard for original equipment and replacement belts is a highly crack-resistant elastomer known as EPDM. Belts made of this typically run 100,000 miles with no visual cracks, so material loss is a better indicator of wear for EPDM belts.

Like tires on a highway, belts gradually lose rib material over time. Material loss of as little as 5 percent can cause belt slip, noise and performance problems, including early component failure. Protect your customer’s investment by understanding that today’s belt and tensioner are manufactured with the same product life cycle and should be replaced together. Replacing one and not the other may lead to customer comebacks.

Also remember that when other drive components such as the alternator are ready to be replaced, chances are the belt also has considerable mileage and

wear. Installing a new belt rather than reinstalling an old one will save your customers money. The installation cost is already built into the job you’re performing. In fact, the labor savings alone make the belt “free” to the customer, compared to paying additional labor on a separate belt replacement job.

Now that you know more about I60/R90 and the system maintenance approach, head into your nearest NAPA AUTO PARTS store or reserve your parts online at napaonline.com.

NAPA AUTO PARTS

1-800-LET-NAPA

customersupport@napaonline.com
napaonline.com or www.napabeltshose.com





ROTARY LIFT NETWORK OFFERS TRAINING AND MORE

Although new shop equipment can improve technicians' working conditions and save them time in the long run, the initial adjustment to a different way of doing things can be challenging. That's why Rotary Lift distributors and Rotary Authorized Installers (RAIs) offer factory-authorized training with every vehicle lift purchase. They can show lift users how to properly operate their new Rotary Lift products, and also provide general lift safety guidelines. This training can be conducted when the lift is installed or at a later date, depending on the facility's schedule.

There are nearly 400 RAIs located across the United States, providing Rotary Lift with the largest service and repair network in the vehicle lift industry. RAI companies are located in all 50 states and most metropolitan areas, so help is never far away for customers who need it. In order to maintain their skills and knowledge of the Rotary Lift product line, all RAIs attend training sessions at Rotary Lift's headquarters in Madison, Indiana.

Factory-authorized training for customers is not the only service that set RAIs apart from competitors. Thanks to a new Rotary Lift initiative, lift owners across the country can also turn to RAIs for annual lift inspections. Rotary Lift now requires each RAI company to have at least one Automotive Lift Institute (ALI) Certified Lift Inspector on staff.

ALI Certified Lift Inspectors are proven qualified to inspect any manufacturer's vehicle lifts in accordance with ANSI/ALI ALOIM-2008, the national standard covering vehicle lift operation, inspection and maintenance. There are already more ALI Certified Lift Inspectors in Rotary Lift's



RAI network than in any other manufacturer's distribution channel. Rotary Lift is the first manufacturer to support the ALI Lift Inspector Certification Program with a certification requirement for its service network.

In addition to training technicians on new products and inspecting lifts, RAIs offer a full slate of installation services. RAIs are the only distributors who are authorized to install Rotary Lift's SmartLift®, the world's best-selling inground lift. They are the exclusive providers of Rotary Lift warranty work, and they offer enhanced warranties with each lift installation. To ensure fast service, RAIs keep most common Genuine Rotary Parts™ in stock.

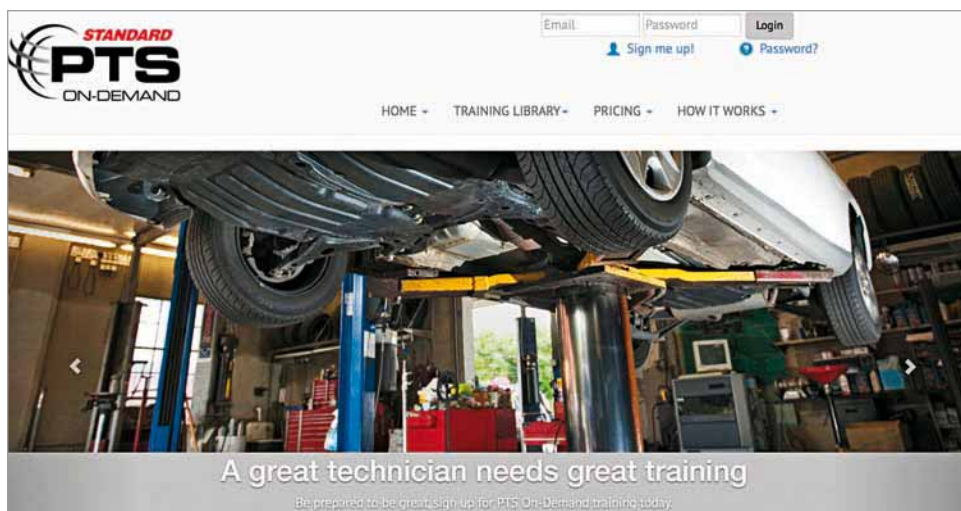
The expert training, installations and assistance provided by RAIs help Rotary Lift continue its 90-year tradition of offering unmatched customer support. For more information about Rotary Lift's industry-leading RAI network, visit www.rotarylif.com/Support/RAI. Rotary Lift also provides answers to frequently asked lift buying questions online at www.rotarylif.com/Support/FAQ.

Rotary Lift
2700 Lanier Drive
Madison, IN 47250
Phone: (800) 640- 5438
userlink@rotarylif.com





GET TRAINING FROM SMP WHEN YOU NEED IT, WHERE YOU NEED IT



Standard Motor Products (SMP) continues to provide online training that is geared to help busy automotive technicians learn new automotive technologies, improve their diagnostic skills, update their tool knowledge, and refresh skills and techniques.

In particular, SMP has made training easy and convenient. The company's PTS On-Demand is a 24/7/365, affordable, and convenient training curriculum that is entirely digital-based. There is no need for a technician to leave the workplace or the comfort of their home to participate in a class.

SMP continually enhances the company's PTS Training and recently launched an annual subscription package for accessing the entire library of training for the popular PTS On-Demand Training Program.

The new annual subscription package can be purchased at any outlet that carries Standard brand parts. The purchase includes a USB security key, a lanyard, and instructions for accessing the annual pass. Once the technician is fully registered, the entire PTS On-Demand Training Program is available for a full year.

Each month, Standard adds new topics to the curriculum with plans for at least 12 new classes each year. The recently launched annual subscription provides exclusive access to downloadable and printable class handouts and certificates of completion.

Training classes are designed with direct input from a working group of master technicians. The training is designed to provide specific, practical, expert advice on how

to work on today's complex automotive products.

A few of the new training being offered in the next few months includes:

1. Voltage Drop Testing
2. OE Scan Tool Update
3. Brain Teasers: Diagnostic Puzzles
4. Variable Valve Timing Tips and Tricks
5. Diesel No-Start Diagnosis

With more than 90 one-hour topics already available, the on-demand format provides easy access for busy automotive professionals to easily fit into their schedules. They can either take one class each month or spend a weekend catching up on multiple classes they've personally selected to review.

This latest addition of on-demand training is a continuation of SMP's belief that a great technician needs great training and that each individual should be prepared to be great.

For more information, visit <https://pts.smpcorp.com/standard>.





WORLD PAC TRAINING INSTITUTE (WTI) PROVIDES ADVANCED TECHNICAL AND BUSINESS EDUCATION

WORLD PAC Inc. and the WORLD PAC Training Institute (WTI), the company's division focused solely on providing the Aftermarket with the highest quality advanced technical and business training available in the industry, are committed to supporting independent professionals through education.

"Our mission at the WORLD PAC Training Institute (WTI) is to assist customers in growing and increasing the profitability of their business through education," says Mario Recchia, WORLD PAC Senior VP of Marketing. "WTI course materials are created explicitly for the independent service center, and are designed and taught by our experienced, professional automotive instructors. Our goal is to establish and maintain relationships with our customers that generate long-term sustainable value."

The WTI technical training program provides advanced level diagnostic training for independent repair professionals. The complexities of properly diagnosing and repairing late model vehicles requires training that, until recently, has not been readily available to independent service center professionals.

The WTI business development program provides training in the management of the repair shop business. The tools provided in these classes help managers increase productivity, increase profits, and assist with improving troubled areas of the business.

Established in 1997, the WORLD PAC Training Institute (WTI) has trained over 40,000 independent repair professionals. In 2009 the WTI also launched a biennial Supplier & Training Expo (STX) that currently hosts over 1000

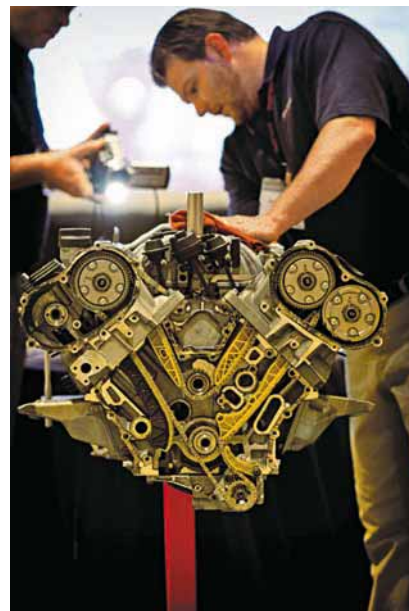
WORLD PAC customers and offers 500 total hours of training presented by more than 50 of the industry's most respected instructors.

"WORLD PAC is dedicated to providing our customers the very best training in our industry," said Bob Cushing, WORLD PAC President and CEO. "We take great pride in continuing to offer training curriculum designed to meet the demands of growing the independent repair professional's business."

"WORLD PAC's total value proposition focuses on an ease of doing business approach," says Mario Recchia. "We have a vested interest in the success of our customer. The WORLD PAC Training Institute (WTI) is a great opportunity to help us better serve their needs now and in the future."

The WORLD PAC Training Institute (WTI) is just one part of WORLD PAC's total value proposition. The company specializes in an advanced wholesale distribution model with complete inventory of original equipment automotive parts for import and domestic vehicles, as well as a comprehensive WORLD PAC Tools & Equipment Services (TES) division. WORLD PAC also offers a suite of amenities such as speedDIAL, the company's industry leading online catalog and fulfillment ordering software, the WORLD PAC app and VIN scanner, OE Detailed Schematic Parts Diagrams, proprietary Digital Delivery systems, customer marketing solutions (CMS), and a vast company-owned fleet of vehicles and drivers providing multiple same-day deliveries from over 120 regional distribution centers across the USA, Canada and Puerto Rico.

Headquartered in Newark, CA, USA, WORLD PAC is an importer and distributor for original equipment and quality aftermarket replacement automotive



parts. With over 120,000 sku's and 11 million applications covering 40 plus car lines, the company provides brand recognized automotive parts directly to independent import and domestic service centers in the US, Canada and Puerto Rico, and also offers customer services such as their highly praised technical and business training, as well as targeted marketing solutions.

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www.worldpac.com



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DIESEL PARTICULATE FILTER PROTECTOR

Liqui-Moly presents the Diesel Particulate Filter Protector. Simply pour this additive into the fuel tank. It reduces the minimum temperature for regeneration by more than 200°F allowing the filter to regenerate even on short trips and thus keep it working perfectly, the company says. Technicians can use this additive themselves when the car is being serviced as well as sell it to customers who they know use their car primarily for short trips. Diesel Particulate Filter Protector is a preventative additive for use before problems become acute.

For more information, visit www.liqui-moly.de.

Liqui-Moly

COIL-ON-PLUG SPARK TESTER

The tester provides an easy way to check ignition systems with coil-on plugs. Applications include Ford, Chrysler, Mitsubishi, Nissan and more. It is the quickest way to test for no-start conditions. An inductive test cannot be performed, because there are no plug wires. High visibility white lettering makes it easy to read the gap measurement from 0 to 40k. The round knob provides easy gap adjustment and the 12-inch ground wire comes with a shielded clip. The standard plug wire tip can be unscrewed so the tester can be used on small engines and some motorcycles. This tool is used when it is necessary to test ignition systems with coil-on plugs, including Ford, Chrysler, Mitsubishi, Nissan and more, according to information from the manufacturer.

For more information, visit www.lislecorp.com.

Lisle Corp.



AIR SPRING FOR SPECIFIC BMW

Arnott Air Suspension Products offers a new Left Rear or Right Rear Air Spring for the E61 Chassis 2004-2010 BMW 5 Series Wagon with Self-Leveling Rear Suspension. The air springs — OEM Nos. 3712675602 and 37126765603 — are in stock for immediate shipping, marking yet another milestone in the ongoing expansion of the company's line of high-quality, affordable air suspension replacement parts for BMW vehicles in particular, and luxury cars, trucks, and SUVs in general, it states. The air spring retails for \$184, and is available from Arnott as part number A-2755. In North America, the part is backed by Arnott's Limited Lifetime Warranty; it carries a Two-Year Limited Warranty in the rest of the world. A detailed installation manual is included to ensure a quick, safe and successful remove and replace procedure.

For more information, visit www.arnottindustries.com.

Arnott Air Suspension Products



RADIATOR FILLER COVERS

While owners of 1982-1992 Camaro models have a massive selection of engine, suspension and performance products readily available, when it comes to basic replacement parts such as radiator filler panels, availability can be a problem. When the supply started to dwindle and enthusiasts turned to online classifieds and junkyards for replacements, Classic Industries took action by adding quality OER reproductions to their Camaro product line. OER reproduction radiator filler covers for 1982-1992 Camaro models are manufactured to factory specifications from injection-molded plastic and feature correct contours and mounting provisions. Designed to install under the hood and fill the area between the front bumper cover and the radiator support assembly, the company reports.

For more information, visit www.classicindustries.com.

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Genuine Parts

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MULTI V-BELT

The CONTI UNIPOWER TOUGH GRIP multi V-belt with textile surface developed by the ContiTech Power Transmission Group provides the ideal solution in extreme conditions. The special automotive drive belt greatly minimizes noise buildup when accessories like the air-conditioning system, power-steering pump or generators are in operation. The belt's special feature is that the pulley side consists of a fabric reinforcement, and is thus highly resistant to wear, the company says. The quiet drive belt features convincingly high wear resistance that is required for starter-generator applications. The pulley side of the new CONTI UNIPOWER TOUGH GRIP is covered with a special fabric impregnated to enhance anti-slipping and anti-wearing properties. The warp-knitted fabric on the sectioned side is ultra wear-resistant, capable of absorbing high dynamic stress loads and stretchable longitudinally and transversely. It ensures optimum grip under extreme conditions.



www.continental-corporation.com Continental Corporation

GASKET MAKER LINE

Permatex has repackaged its Ultra Series RTV Gasket Maker line in new, advanced and easy-to-use tubes. The new packaging contains the same industry-proven Ultra Series formulations and the same amount of fill in the tube, but makes it easier to apply the product more evenly



and consistently. The new tubes are made with a multi-layer plastic film that makes them more flexible and durable so they resist cracking and separation. The new tubes also provide a better barrier against moisture than traditional foil tubes. The multi-layer plastic film eliminates tube crinkling, so the interior stays smooth, according to information from the company. This makes it easier to get all of the sealant out from the tube and prevents any of it from being trapped inside. The newly designed tube's screw-on cap fits securely over the nozzle and keeps unused product from curing prematurely. In addition, the tube's screw-on cap allows upright storage on a shelf, saving space both at the retail level and in your shop. And with the elimination of a blister card, there's less waste to accumulate in landfills.

www.permatex.com Permatex

AUTOMOTIVE PRODUCTS GUIDE

MERCEDES SMART CAR WHEEL HUB SOLUTION FROM SKF

SKF has developed a cost-effective front-wheel hub solution for the 2013-2008 Mercedes Smart Car. Designed as a front-wheel hub only, part No. BR930861K includes three precision-machined pins that make it easy for an installer to press the hub unit into the knuckle assembly without having to replace the knuckle itself.



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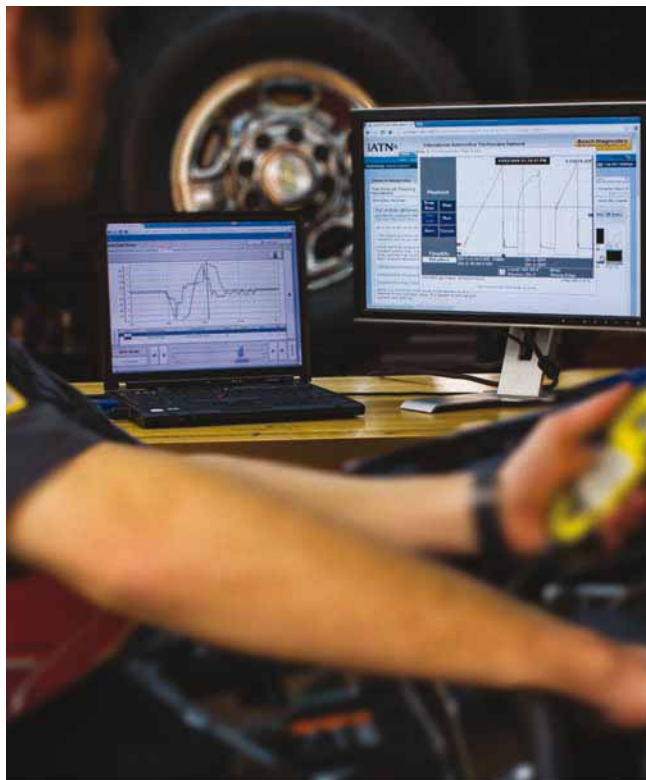
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RANGER INTRODUCES NEW MULTI-SPEED TIRE CHANGER

Ranger Products, a division of BendPak Inc., is bringing yet another new tire changer to market. Their new R980ATF is a variable speed model that performs on a wide variety of wheels. It is equipped with a powerful variable-speed motor and gear box that work systematically at multi-speeds allowing operators to match turntable rotational speed with varied tire and wheel combinations.



Ranger Products, a division of BendPak Inc.

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Coats

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MotoLOGIC® Repair & Diagnostics is a Web-based tool for automotive technicians, featuring unedited OE repair and diagnostic information for most major manufacturers. Its advanced search function delivers instant results based on virtually any search criteria and includes more than 26 million articles of repair and diagnostic information. To learn more about MotoLOGIC, available from MOTOSHOP™ Technology Tools, visit www.motoshop.com/motologic.



Advance Auto Parts Professional

TECH500 TPMS TOOL WITH TIA TECH TIPS INSIDE

No other TPMS tool manufacturer is as committed to delivering MARKET FIRST technology than Bartec! The Tire Industry Association's TPMS Relearn Chart is packed full of important service information. By linking the data in the TIA chart to the Bartec TPMS tool, technicians can be more accurate and efficient when diagnosing and repairing TPMS. The Tech500 shown is resting in the new Wall Mounted Charging Cradle, sold separately.



Bartec

DUAL-HEAD LEAK DETECTION FLASHLIGHT

Tracerline® Vio-Blu™ (P/N TP-9357CS) is a versatile dual-head flashlight that makes all automotive trace dyes glow brilliantly. It features a UV LED on one end that works best with popular PAG and ester A/C dyes, and a super-bright blue light LED on the other that's ideal for fluorescing oil-based dyes, including difficult-to-fluoresce yellow dyes. Comes complete with a belt holster and fluorescence-enhancing glasses.



Tracer Products

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Mitchell 1

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NAPA's Platinum filter offers technology for the latest advancements in synthetic oil and performance oil filters. Featuring a host of oil filter innovations, including wire-reinforced, fully synthetic media, ultra-durable hydrogenated nitrile compound ant drain back valve (where applicable), this oil filter provides the ultimate protection in the NAPA family of oil filters. Visit www.napafilters.com for more information.



NAPA

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WORLD BRAKE RESOURCES (WBR) is a complete braking solution for Asian, domestic and European vehicles. Products include WBR brake rotors with Run True™ Technology, WBR Dual-Technology brake pads, WBR Premium and Premium OptiSelect calipers, WBR Quiet-Clip Technology hardware kits and WBR brake shoes. All WBR products offer professional quality with proven performance and are available exclusively at WORLDPAAC.



WORLDPAAC

AD INDEX

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WHEN THE COMPRESSOR WON'T COMPRESS

ISOLATING THE CAUSE OF AN INOPERATIVE COMPRESSOR CLUTCH.

BY **PETE MEIER**
Technical Editor

April historically is the time of year that our focus shifts from work the cold weather drives, to work the warmer days of summer bring to our shops. At the top of the list is A/C work, and more than one of our readers has made the observation that car owners who typically have no money to spend on safety related repairs seem to have no problem spending money to stay comfortable. And even though the air conditioning systems on newer platforms are experiencing fewer failures than ever, there still are plenty of older systems that need work.

Oh, help me, but I do love A/C work! It's relatively easy, and the associated flat rates generally are very kind to the A/C technician.

A common concern during A/C season is, "My air conditioning doesn't work; it's just blowing hot air." If you've done even a little bit of A/C troubleshooting, one of the first things you do is verify that the interior controls all are working: air flow is controllable from the floor vents to the defrost, the recirculation control does indeed close off the flow of outside air, the temperature door allows the air flow to move from the evaporator core to the heater core before entering the cabin and the blower is operating across all speeds.

With the system set up to provide "Max" cooling, you expect to feel



some coolness coming from the center ducts. If not, it's probably time to take a peek under the hood to see if the compressor is spinning.

What do you do if it isn't?

A conventional clutch-driven compressor might not be engaged for a number of reasons. Often, a low system charge is to blame, but before we jump to that conclusion there are other causes to consider. How about a bad compressor clutch relay? Or a faulty pressure sensor not allowing the Engine Control Module (ECM) to activate the clutch? Or a mechanical failure in the clutch itself?

These are just a few possible causes, and in this edition of The Trainer, we'll show you how to narrow down the list of possibilities using current draw in the

clutch circuit. Not only does this technique work for the compressor clutch, it can also be applied to any circuit that is controlled by relay. [ZZ](#)

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