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# Motor Age

September 2014

Talk Shop Anytime



AUTOPRO WORKSHOP

Vol. 133, No. 9

Advancing the Automotive Service Professional Since 1899



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How you handle that phone call from the onset determines if the customer will bring their vehicle to you.



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The Hybrid Shop has named Dave Crawford as its new chief executive officer.

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A panel of telematics experts discusses the future of the technology at CARS 2014.

### NACE/CARS

## Today's telematics, tomorrow's needs

DETROIT — There is technology out there that is so surprising, it even helps reduce surprises. And start a car. And track driving habits. And play your favorite music. And so much more.

The idea of telematics has been around long enough now that most shops at least are familiar with the idea and basics of what is offered on today's vehicles. But what is out there today is just the start. There is much more coming down the pike quickly, as a group of industry leaders from the automakers and government organizations discussed at CARS 2014.

The number of vehicles with factory-installed telematics is expected to increase from 10 percent now to 62 percent in 2016, and Steve Coker, head Uconnect Operations, Chrysler Group LLC, adds that the connected vehicle has gone through an interesting transformation over the last few years, especially in the last 18 months. The biggest influence has been the smartphone. "Everything starts and ends with our customers, and increasingly their life includes (their smartphone)," he notes.

While "customers are used to being connected where they're at — they're connected at home; they're connected at work and they're connected when they walk around." Coker adds the overarching view of the panelists is that customers also want to be safe.

**[Telematics]** CONTINUES / PAGE 8

## BREAKING NEWS ASSOCIATIONS

### HAAS NAMED NACAT BUSINESS MANAGER

North American Council of Automotive Teachers, Inc. (NACAT) has named Bill Haas to the position of business manager. Haas is an industry veteran with more than 40 years of automotive service and repair industry experience.

Haas assumed the business manager role effective Aug. 1, 2014. The part-time position will allow Haas to continue his business management training, consulting and coaching through Haas Performance Consulting LLC.

"I look forward to working with the NACAT board and membership. This group has enormous talent and a passion for their profession," said Haas. "They take their responsibility of preparing the automotive technicians of the future

**[NACAT]** CONTINUES / PAGE 10

Discussion is on-going in [MotorAge.com](http://MotorAge.com) forums

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[Telematics]

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Eric Berkobin, vice president, engineering, Verizon Telematics, explains that collision avoidance, automatic braking, etc., are at the top of the list of customer wants on new vehicles. They also like vehicle health reports, he offers, as that information makes a customer feel empowered.

Bob Stewart, general manager, cus-

tomers care and aftersales, ACDelco/General Motors, echoes the statement, adding, "it's really the safety and security features that consumers want."

Coker does note that while his customers do value safety and security, mostly it's a feature that they don't always see in play and don't think about. Most often, Chrysler sees customers using their smartphones to remote start their cars — a nice feature of convenience that customers like.

"It's important to understand what the customers use every day," he states. "It really comes down to what do the customers like to make their lives easier and experience more comfortable."

At Volkswagen, it's safety first, says Frank Weith, general manager, Volkswagen Group of America. The car-maker works to integrate systems to keep the consumer safe when there are other factors like the consumer electronics industry coming into the vehicle.

Then there is the National Highway Traffic Safety Administration, which Roger Saul, director, vehicle research and test center at NHTSA, says has a riding interest in reducing traffic injuries and fatalities. The other big area is automated driving, and there is a lot of overlap between that and the technology available now and coming soon, he says.

The automotive industry has had some of this for a while, including adaptive cruise control, Saul adds. In the connected vehicle, there is an ability to augment the technology there now in radar with radio frequency that will allow cars to see around corners and be able to be more predictive of crashes and give more time to prepare for them.

All of the connectivity and customers' wishes to be kept safe adds up to a lot of data, something shops, engineers and automakers have been well aware of nearly since the starts of telematics.

"There is big data available," says Jules Polonetsky, executive director, Future of Privacy Forum. "There's all this data being collected and there's value in that data."

This information is relevant to today's shops as to how the vehicle is being driven, while insurers want to know how the driver drives and the fleet operators want to know where the drivers are. The diagnostic data is actionable, and can be provided to the consumer.

"We're not diagnosing vehicles, what we're really doing is getting you qualified leads. Maybe when we send an email to them, we send an email to you," Polonetsky states. "You can work your bays more like restaurant tables and be more efficient."

He feels that it is critical for policy makers to realize this is new and evolving, so they need to learn about it. "We're still at a point where we need to make sure we do these things in a sober and realistic way."

— *Tschanen Brandyberry*, managing editor



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**[NACAT]**

CONTINUED FROM PAGE 6

with the knowledge and life skills necessary to succeed very serious.”

Haas was Vice President of Education and Training for the Automotive Service Association (ASA) from 2000 to 2012. During that time, he worked with shop owners and managers, automobile manufacturers, insurance companies, part suppliers and program groups, tool and equipment companies, advisory committees, information providers, and many industry organizations.

“NACAT is excited to bring Bill on board as the new business manager. Bill brings with him an enormous amount of experience in the automotive industry,” said Rob Thompson, NACAT President. “In addition, Bill’s wide range of knowledge and contacts with people in the industry will continue to help NACAT grow and better serve its members. Dan Perrin will guide Bill through a transition in August, with Bill taking on the full duties and responsibilities Sept. 1.”

## Mitchell 1 honors top student, teacher

Jonathan Hladney from Brackenridge, Pa., recently was named the 2014 Mitchell 1 Automotive Technology Outstanding Student, while James K. Truxal of New Carlisle, Ohio was named the Mitchell 1 2014 Educator of the Year. Both men received the honors during the North American Council of Automotive Teachers (NACAT) conference held in Greenville, S.C.

Hladney graduated from Highlands High School in Natrona Heights, Pa., in June 2014. While in school, he received the National Technical Honor Society award twice, was a member of SkillsUSA and was employed as an apprentice technician at Spitzer Toyota/Scion in Monroeville, Pa. He will attend the Rosedale Technical Institute in Pittsburgh, in the fall, where he is enrolled in the automotive technology program, and is expected to graduate in March 2015. His ultimate career goal is to open his own automotive repair shop.

Truxal has been an associate profes-

sor of automotive technology at Sinclair Community College in Dayton, Ohio, since 1994.

In addition to maintaining his ASE Master and Advanced Level Specialist certifications, he participates in ongoing training to maintain his GM and Honda certifications, allowing him to teach in the GM Automotive Service Educational Program (ASEP) and Honda Professional Automotive Career Training (PACT) programs.

He is the coordinator for the Honda PACT program at the school, and has participated in SkillsUSA regional contests and Miami Valley Tech Prep Showcase.



Hladney



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- D. Check wheel bearings for excessive wear/play

Go to [MotorAge.com/sep14survey](http://MotorAge.com/sep14survey) to answer the question and enter the monthly contest from Federated Auto Parts.



## What about getting some help for your help?

Getting that good employee isn't easy, and your job doesn't stop once they start.

BY BOB SPITZ | WORKSHOP MEMBER

When repair shop owners say, "I can't find good employees." Here is what they are really saying: "I don't know how to help employees." How's that for a 180-degree shot right in the nose? Ugly isn't it? But it's fact.

When a business person is in the process of recruiting and hiring what they are really looking for is potentially great employees. Trying to hire great employees who are already top notch technicians who are trained in all the procedures of the business and never need to be told what to do because

they just magically know exactly what the owner wants all the time is very difficult. There are just not that many of them in the pool!

This is not just a fact a shop owner has to "deal with." This is about survival. It is something a shop owner needs to know all about. Otherwise that shop is going nowhere, and the owner finds him or herself stuck.

If the shop owner knows how to take willing new employees and turn them into real help, well then the shop owner knows how to help a new employee. It is as simple as that.

And just when it is looking nice and smooth and profitable, a 1,000-pound

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**BEST OF THE BLOGS** are articles written by bloggers on Motor Age's community pages

Pete Meier / Florida

### NACAT and CARS — my view

They say time flies when you're having fun, and I guess that's true considering all that has been going on lately! I've been busy on the road covering and presenting at two leading industry conferences.

The first I want to share is NACAT 2014. NACAT (North American Council of Automotive Teachers) holds an annual conference that focuses on both fellowship and training. ... I presented several sessions, and had full houses in each one. I was proud to be a part of Motor Age as instructor after instructor told me how much they enjoyed - and used - the materials we produce, from our print articles to our recorded webinars. It was very humbling to learn that the goals of our efforts were being met and appreciated by so many.

I wasn't home for long when I had to take another flight up north to the Motor City for the ASA (Automotive Service Association) NACE/CARS trade show and conference. The mechanical repair classes featured some well known talent, but overall attendance was smaller than hoped for. The techs were missing from the tech classrooms, and from the trade show floor. The section featuring booths of interest to the general repair tech was small compared to the collision side, and this is the one area I hope those in charge of NACE/CARS continue their efforts in developing.

Junius / Alabama

### Parts euphoria — hard to find

Mechanics need parts, preferably delivered quickly. Of course, if a part has to be ordered, it won't be delivered quickly, and in the small town where my shop has its roots,

if my parts guy tells me a part will be coming by UPS, I know it's probably going to be at least a day late.

And it goes without saying that there are some parts every parts house should have in stock. I once dealt with a locally owned parts store, and I'd call the owner/counterman asking for a case of brake parts cleaner, only to be told that he had only two cans in stock, but he could have the rest of the case the next day.

This happened regularly when I was dealing with that store. Furthermore, when one of his phone lines started giving trouble, he had that line removed so that he only had one working phone line, which meant a busy signal most of the time. Eventually his cup of iniquity filled to the point that I started using a chain parts store.



November 20<sup>TH</sup> 2014  
@ 8:00 PM

## Mastering Voltage Drop Testing

This may be a "basic" test but trying to use it still gives many of us headaches.



PAGE

6

RECAP OF

## NACE/CARS 2014

TSCHANEN BRANDYBERRY

Today's telematics, tomorrow's needs

PAGE

18

## COLUMN FOR THIS MONTH

PROFIT

## MATTERS

CHRIS "CHUBBY" FREDERICK

Avoiding the 5 big marketing mistakes

PAGE

96

## THE TRAINER VIDEO

PETE MEIER

A picture is worth a thousand words.

gorilla shows up. Often the employee needs help getting back onto their job when they have slipped.

If you can bring a person up to the level of doing consistent quality work then you have really helped that per-

son, all the while they are helping you. They know, they are proud of it and that helps them more than anyone may ever know. That is world-class help. There is not much better actually. Read more at [MotorAge.com/helphelp](http://MotorAge.com/helphelp).

LEARN MORE: [MotorAge.com](http://MotorAge.com) IS UPDATED CONTINUALLY

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### Educating your staff

Selling maintenance can be a fickle sell. Here is how you can educate customers about buying service.

[MotorAge.com/sellingservice](http://MotorAge.com/sellingservice)

### Practicing professionalism

While you're working on your business and not in it, your employees need to be practicing some skills, too.

[MotorAge.com/professionalism](http://MotorAge.com/professionalism)

### What is Elite Extra?

This short two minute video will give you a brief overview of just how Elite EXTRA works.

[MotorAge.com/eliteextra](http://MotorAge.com/eliteextra)

### TO WATCH NOW



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### SEPTEMBER

#### Understanding Hydraulics

Presented in partnership with ATSG.

NOV. 20 @ 8 P.M. ET

#### Mastering Voltage Drop Testing

Presented by *Motor Age* Technical Editor Peter Meier and G. Jerry Truglia of TST

### FROM THE ARCHIVES

#### Ignition System Testing

Presented by *Motor Age* Technical Editor Peter Meier and G. Jerry Truglia of TST, and sponsored by Federal-Mogul.



2014 ONLINE EVENTS

### Appropriate load when testing

Some instructors claim you should never use a test light for electrical troubleshooting, rather you should only use a DVOM. Well, sometimes, even a low impedance test light isn't enough to give reliable results.

### Vehicle registration data

Do you need vehicle registration statistics for market research or business planning? Vehicle registration data can help you evaluate new trends or market size across the U.S. or in a specific geographic location.

### Management Success roundup

The March 28 Management Success 2014 Spring Convention at Red Rock Resort in Las Vegas offered an opportunity for networking with other like-minded shop owners, many of whom run some of the top automotive shops.



STREAMING PROGRAMS

SEPT. 26-28

### Chicago Automotive Networking Conference (CAN Conference)

Chicago

OCT. 10-12

### Northwood University's 51<sup>st</sup> Annual International Auto Show

Midland, Mich.

NOV. 4-6

### AAPEX 2014

Las Vegas

NOV. 12-15

### Automechanika Argentina 2014

La Rural Trade Center, Buenos Aires



2014 INDUSTRY CALENDAR



## Noteworthy

comments from MotorAge's online communities

The best of what you're saying on [Facebook.com/MotorAgeMagazine](http://Facebook.com/MotorAgeMagazine), [@Motor\\_Age](http://Twitter) and [@PeteMeier](http://Twitter) and the AutoPro Network.

crackerlicker:

Problem is, who decides what's safe? More recent experience suggests it would be inept bureaucrats on an allocated funds binge.

John Ladd:

Historically, the federal government has done a better job improving the safety of cars than the manufacturers would have done left to their own devices. Seat belts? Air bags? Crash standards? I would support more legislation written in conjunction with input from auto experts outside the government.

Mike James:

Yes, a counter guy can make a difference in the way your day goes, but remember that this is a two-way street. If I had a dime for every time we had a guess at a year, only to learn the shop was off by a year or two, I wouldn't have to work my tail off anymore answering 300 calls a day.

larrybloodworth:

We often take customers out in the shop and show them their vehicle. If they dropped the vehicle off, we shoot a quick YouTube video

and email the link with the estimate attached as a .pdf.

Christopher Bishop via Facebook:

Trade schools are fine and we need more of them, but only time and experience make a good tech. Eventually the money is there, but to expect it right away is foolish.

Tim Collins via Facebook:

You can have five ASE certs and make more than a person with a bachelors degree now! A6 and A8 electrical and engine performance are like gold mines!



the community—  
join the discussion

[MotorAge.com/Community](http://MotorAge.com/Community)

## OPERATIONS

TAKE CONTROL  
OF YOUR BUSINESS

## IN THIS SECTION

- 14** Management
- 18** Profit Matters
- 22** Financial Figures
- 26** Shop Profile

read it on **MotorAge.com**

## TINY NUMBERS

Page visits to your website might seem like small figures but they carry weight.

/tinynumbers

## GAAS DELAYED

The GAAS Board of Directors voted to defer its educational event for 2015.

/gaasdeferred

## SET AN EXAMPLE

Avoiding bad behaviors in front of employees sets the tone, says CARS keynote speaker.

/avoiding

## MANAGEMENT



# PHONE SHOPPERS AND GOOD CONNECTIONS

## HOW YOU HANDLE THAT PHONE CALL FROM THE ONSET DETERMINES IF THE CUSTOMER WILL BRING THEIR VEHICLE INTO YOUR SHOP.

BY **BRIAN CANNING** | CONTRIBUTING EDITOR

**THE** perception from the outside might be that everyone does everything via the Internet, but anyone in the tire or automotive repair business still is very familiar with that voice-driven technology called the telephone. It is not that our customers love the sound of our voices as we describe the repairs and services we can provide to keep their cars safe and reliable, nor that they are calling to see how we are doing. But until Amazon figures out a way to sell an oil change, front-end alignment or brake service (with free delivery), our phones will remain a very important tool in driving sales and assuring our viability. Even our best most loyal customers call us because they have to, not because they necessarily want to. Because of this, our skills in the effective use of the telephone are and will remain critical.

A lot of the phone inquiries we get are customers or would-be customers asking us for a price. Taken at face value, this is a comparison that is dangerous for both us and that customer. But if we are able to listen attentively and establish

what the underlying issues are, we have a very real opportunity of converting this price shopper into a customer. That is only if we make that connection in a timely manner and only if we provide great reasons to come in and give us a shot.

My very strong advice is to avoid giving price quotes on any service involving repair over the phone and in particular services that would require diagnostics. There is no possible way we can give a good estimate without seeing and touching a car and anything we quote is likely to be inaccurate, giving this potential new customer every reason in the world to mistrust us from the outset. Instead, offer to set up a convenient appointment to check out their car so that we can

**JUST SCAN IT**

Scan this QR Code to read on your smartphone more ways to convert a price shopper. Or visit [MotorAge.com/priceshopper](http://MotorAge.com/priceshopper)

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give the customer a no charge estimate; avoid these sight unseen quotes at all costs. They are far too risky and nearly guaranteed to be wrong. If a phone shopper insists, as sad and difficult as it is, apologize sincerely and let them go. Your reputation is worth more than giving out bad information.

The very real truth is that phone shoppers ask about price because they don't know what else to ask about. Your great opportunity here, as you talk to that price shopper on the phone, is to move that conversation from the price to the actual problem, offering solutions your customer can be comfortable with. The vast majority of customers will be willing to explore a solution with us as long as we acknowledge them and the problem they are having with their car and as long as we are willing to accommodate them. Taking ownership of their concern and partnering with them in finding a solution is a great place to start.

Something very important to realize as you are reaching for that ringing telephone is that from the moment you answer, you have mere seconds to establish a rapport with whomever is on the other end. Rather than wasting those precious moments giving this customer or potential customer great reasons not to come in, my advice is to listen first and to talk about what you can do later. Though most of us of the human race try to think of ourselves as logical and rational in how we go about making decisions, the very real truth is that we buy with our emotions. Until we make some sort of connection with that human on the other end of the phone, our chances of making a sale are very slim. Slimmer if we are not listening attentively to what this customer or would be customer is asking for.

When a customer actually picks up the phone and calls, they are literally asking you for help, and we have the opportunity to be a life preserver that they will reach for or be seen as a shark circling in preparation for an attack. How will that customer or potential customer on the other end of that phone line see us and our shop? The answer to that question is likely to decide whether or not your shop survives, and whether or not your shop grows and prospers. That phone shopper needs help, is fearful of the

unknown and we have the opportunity to be there for them and in this, pick up a new customer; or, we can be everything they had feared in picking up the phone. Where it goes from here is entirely up to us.

Here are 10 important steps in handling a phone shopper:

- Introduce yourself to phone shoppers using your first name, being sure to ask their name.
- Call phone shoppers by their first name.
- Listen attentively to their needs before offering solutions.
- Highlight your desire to earn their business and have them as a customer
- Avoid giving price quotes over the phone, offering a free inspection and a good estimate instead.

**“If a phone shopper insists, as sad and difficult as it is, apologize sincerely and let them go. Your reputation is worth more than giving out bad information.”**

- Be very accommodating in offering to check a vehicle over as opposed to giving a phone quote.
- Set an appointment time and be there and ready to serve this phone shopper when they arrive.
- Don't talk price; talk safety, reliability, quality and value.
- Do whatever you have committed to doing for your customer, when you committed to doing it.
- Highlight your commitment to taking care of them and to solving their problem.

Remembering that most price shoppers are talking price because they don't know what else to ask us about, a concerted effort to understand who they are, what the underlying issues are, what type of a driver they are and how we can best serve their needs

Read more on ways you can convert that price shopper into a long-term customer.

[MotorAge.com/priceshopper](http://MotorAge.com/priceshopper)

will go a long way toward getting them to hang up that phone and drive in to our shop.


In survey after survey, convenience and not price are what automotive consumers identify as their number one priority and a willingness to “squeeze them in” will often move that phone conversation from

price to an appointment very quickly.

An even more effective technique is simply having a conversation on the phone shopper's level, mirroring their sense of urgency and using terms they can understand. Simply engaging our customers on their level, and in terms they can understand, might be a great way to turn those phone shoppers into new customers standing at our counter.

In picking up a phone and calling our shop for a price quote, a customer cannot know how knowledgeable or experienced we are. He or she cannot possibly know that we are honest or that we would go to great lengths to make sure their car was safe and reliable. That's our challenge every time we pick up that phone. Every time that phone rings there is an opportunity but only if we get past price and can talk about solutions.


Remember that humans call, connect and buy from other humans, not from your shop, not from your website and not from your ads. You need to be there, you need to be available and you need to speak the language.

That phone shopper is opportunity calling. What are you going to tell them? 



**BRIAN CANNING**  
CONTRIBUTOR

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](mailto:brimarc@hotmail.com)



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- \$1,959 Rent & Utilities
- \$3,498 Operating Costs

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# 5 BIG MARKETING MISTAKES

THESE ARE THE BIGGEST ERRORS YOU CAN COMMIT IN YOUR SHOP TODAY. HOW MANY ARE YOU GUILTY OF?

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR

**OVER THE** past several years, stabilizing car count has been one of the biggest challenges, even for the shops typically loaded with cars. I overheard one of our long-term coaches, Eric Twigg, tell a story in our marketing class. I thought you would enjoy the story and possibly learn from it.

I would like to introduce you to my friend Ed. He is a shop owner who was having a difficult time in his business. His cash flow was low, and he struggled to maintain a consistent car count. He saw winning the lottery as the solution to his financial problems. Every night, he said the following prayer, "Please let me win the lottery!"

Several weeks later, the Powerball drawing was announced and Ed did not win. Out of frustration, he looked up to the skies and yelled "My prayers were not answered!" Suddenly the clouds parted, and a voice was heard coming from above: "My son, work with me — at least go to the store and purchase a lottery ticket!"

Ed's story teaches us that if you don't have the right plan, you don't have a prayer when it comes to accomplishing your goals. In an effort to keep you from ending up like Ed, I have listed the five biggest marketing mistakes that you can make. Sometimes knowing what not to do is just as important as doing the right things.



## Lacking Clarity of Purpose

When I go to your website, what is the next action you want me to take? Do you want me to call, stop by, leave my email address, subscribe to your blog or like your Facebook page? The consumer isn't sure what you want. The call to action "Call today to schedule an appointment" eliminates the confusion in the mind of the consumer.

According to a recent national survey of the automotive industry, 68 percent of consumers call a repair facility before their visit, so having this as a call to action works well. You can also have this invitation included in your direct

mail piece, email signature, business card or any other literature you send.

## Ignoring W.I.I.F.M.

I have never been to your shop, but I bet your customers all tune in to the



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## “WHAT IS THE LIFETIME VALUE OF A NEW CUSTOMER THAT BUILDS A RELATIONSHIP WITH A SHOP? A NEW CUSTOMER WITH A RELATIONSHIP WILL TYPICALLY STAY SEVEN YEARS AND INVEST APPROXIMATELY \$7,000 ON AVERAGE.”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

same radio station. It can be found on W.I.I.F.M — What’s In It For Me. It’s great that you have ASE certified techs, a two-year/24,000-mile warranty and free WiFi, but how do those factors make my life better? Simply making a list of all your features without linking them to a benefit will keep you from connecting to what’s most important to your prospects. The most common benefits people care about are saving time, saving money, making money, avoiding effort, finding success, being pain free, having safety and security and living and loving.

Using these two words in your copy will allow you to connect the feature to the benefit: “so that.” For example, “We offer a courtesy shuttle so that you can get to work while we work on your car.” In this case, we have attached having a courtesy shuttle to saving time and allowing the customer to make more money by being able to get back to work. Mentioning the benefits that matter to your clientele will give you a competitive edge.

### Marketing to Everyone

Several years ago, I spent \$1,200 on a direct mail piece I sent to 1,000 prospects in a randomly selected zip code. My strategy resulted in one new customer that came in to get her free oil change and never returned. The lesson that I learned was that if you market to everyone, you market to no one.

Pastor Rick Warren, author of “The Purpose Driven Life,” used an interesting approach when developing a strategy to grow his church membership. He conducted demographic research on the reading, spending and shopping habits of his ideal member. He also found out their age and income information. He named this member “Sam.” Whenever he created an ad, he had Sam in mind to include a picture of someone in the same age group on the flyer. The ads were placed in publications that Sam read and the radio stations that he listened to.

Who is your Sam or “Sally?” There are several retention companies that provide resources to help you identify



who your ideal customers are. You also can review your existing database and identify those that were the easiest to work with, gave you the best reviews and spent the most money with you over a period of time. Knowing who you’re trying to reach allows you to link your features to the specific benefits that are important to your Sally or Sam.

### A Silver Bullet Mentality

Clients often ask me to give them the one idea that will fix their business. The answer that I give them is to try the lottery. This didn’t work for my friend, and there is a 99.9 percent chance it will not work for you. This is an example of the silver bullet mentality: the belief that there is one specific tactic that you can employ that will solve your car count and cash flow problems.

Successful marketing is a result of the application of the right methods over a sustained period of time. Having a consistent approach is key. The American Marketing Association (AMA) has concluded it takes anywhere from seven to nine “touches” to ensure you are remembered. The AMA reports you can contact someone up to 220 times in a 12-month period without irritating them.

Using a variety of contact methods will allow you to stay in the customer’s consciousness without pestering them. I would not recommend calling anyone 220 times, but making a thank-you call, sending a Facebook post and sending a maintenance reminder email would be a good way to use a mixture of the right methods to stay in touch.


### Marketing is an Expense

When sales get tough, the first area that many shop owners look to cut is marketing. This is the equivalent of cutting off your oxygen supply because your

health is failing. The one area that can revive and sustain you is often first to go. I believe that this happens so frequently because marketing is viewed as an expense instead of an investment. Investing a minimum of 4 to 7 percent of your gross sales will keep your business breathing and thriving.

Understanding the lifetime value of your ideal customer will help you to view your efforts in the right perspective. To calculate this, you simply take your average repair order (ARO) and multiply by the number of visits made in a one-year time frame. Next, you take that number and multiply by seven, which represents the average number of years that someone does business with a shop.

If you apply this formula with an ARO of \$350 and three visits a year for seven years, a new customer is worth \$7,350 to you ( $350 \times 3 \times 7$ ). Every touch gives you an opportunity to add more than \$7,000 in sales to your business. The initial investment of time and money can pay off in the long run if you stay the course.

If you can avoid the five biggest marketing mistakes, you will live like a lottery winner without purchasing a ticket! For a limited time we are offering a free interactive checklist of the most successful marketing methods used by shop owners across the country. Go to [www.ationlinetraining.com/2014-09](http://www.ationlinetraining.com/2014-09) to obtain a copy. 



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 Eric Twiggs, a long-term coach at ATI.

 E-mail Chubby at [cfrederick@autotraining.net](mailto:cfrederick@autotraining.net)





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# MAKING THE GRADE

## CAN YOU PASS THIS SHOP FINANCIAL MANAGEMENT QUESTIONNAIRE?

BY **BOB GREENWOOD** | CONTRIBUTOR



**ARE YOU** up to date with your business financial management guidelines to operate your shop today? Take the time to do the following test on these basic questions just to see where you sit.

The following 10 questions are provided to demonstrate the typical and basic information that a shop owner should be able to answer if he or she is going to manage the business profitability. If you are able to answer these questions, then you are well on your way to becoming a very profitable business.

1. In a profitable aftermarket automotive repair business, what should the average gross profit percentage be on the following:

- (A) Oil / Fluids
- (B) Tires
- (C) Batteries
- (D) Aftermarket Parts
- (E) Dealer Parts – Domestic
- (F) Dealer Parts – Import
- (G) Maintenance Labor (hourly paid techs)

(H) Diagnostic Labor (hourly paid techs)

(I) Total Sales including Labor

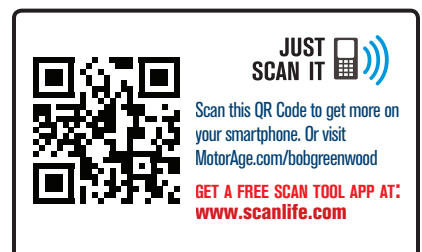
2. What are the total retail sales dollars required to achieve the following?

(A) A shop with a Gross Profit demand of \$56,600 operating at 57 percent GP

(B) A shop with a Gross Profit demand of \$41,270 operating at 63 percent GP

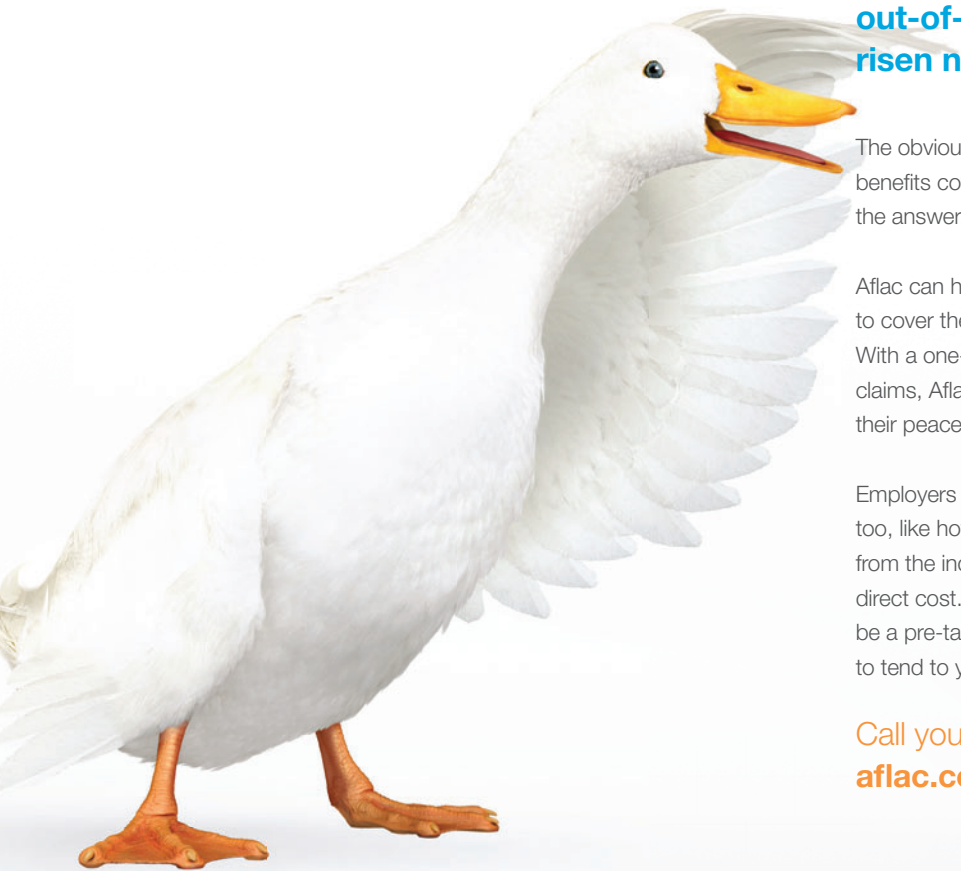
(C) A shop with a Gross Profit demand of \$49,280 operating at 70 percent GP

3. A productive technician is presently earning \$1,250 gross wages on a weekly basis. To maintain the payroll percentage at 30 percent of total gross profit, with an overall shop gross profit of 63 percent, what total retail dollar





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<sup>1</sup>2013 Employer Health Benefits Survey, The Henry J. Kaiser Family Foundation, August 20, 2013, <http://kff.org/report-section/2013-summary-of-findings/> Accessed 11/19/2013. <sup>2</sup>Aflac Company Statistics, October 2013, One day processing turnaround based on business days after required documents are received. Online claims available for Accident, Sickness, Cancer & Wellness claims. <sup>3</sup>Eastbridge Consulting Group. U.S. Worksite/Voluntary Sales Report. Carrier Results for 2012. Avon, CT: April 2013. **Coverage is underwritten by American Family Life Assurance Company of Columbus. In New York, coverage is underwritten by American Family Life Assurance Company of New York.** Worldwide Headquarters | 1932 Wynnton Road | Columbus, GA 31999

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sales would this technician have to produce to earn \$1,500 per week?

4. If you have four technicians being paid \$15, \$18, \$22 and \$30 per hour, what should your labor rates be for (A) Maintenance Labor (B) Diagnostic Labor (C) Re-flash labor?

5. A shop is averaging 94 percent gross profit on maintenance labor and 63.5 percent on total shop gross profit. The shop just leased a new piece of equipment to produce new labor for a payment of \$1,300 per month. What is the amount of labor per month that must be billed utilizing this piece of equipment to break even on the lease payment?

6. A shop that averages a total gross profit of 62.1 percent and nets 4.2 percent of total sales before tax so how much revenue must be produced to replace a \$1,200 bad debt?

7. What is the minimum total site efficiency percentage number for a successful shop today? What is the utopia total site efficiency percentage number to strive for?

8. How do you calculate average billed hours per RO/invoice?

9. How many average billed hours per RO/invoice should a successful shop average from their maintenance department?

10. If we sell a line-item at 60 percent gross profit. We have a sale on that line and reduced our price by 20 percent. How much more do we have to sell from that line only to maintain the same dollars we had before the price reduction?

I hope this quiz creates some positive internal discussion in your shop among your management team. Many shop owners and managers struggle with the basic math to run a business today, and I'm trying to point out that we all must continue to learn throughout our entire life. You can't shut business education down because things change, and so do many business formulas and guidelines that drive bottom-line profitability. The above questions are just the tip of the iceberg, and that is why shop owners and managers must continue to learn to work on their business and not just in their business.


To obtain the answers to the above questions go to [www.vehicleIM.com](http://www.vehicleIM.com), click on "Motor Age Sept. 2014 Answers" and enter the password "motorage" in the box.

The aftermarket is an exciting arena to run a business today. The opportunities to earn excellent net income are enormous to sustain a great career, but it takes a great deal of self-discipline to realize those dreams. As I have mentioned before in previous articles, "shop ownership is a position in the business today" and when the owner does not realize this, or accept it, that he or she must be totally accountable in that position, the shop usually has below profitability required to move forward and management just bought themselves a terrible job. Do not become an industry statistic. Understand the math; understand your business. 



**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 AAM approved instructors.

 E-mail Bob at [greenwood@aaec.ca](mailto:greenwood@aaec.ca)



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# SHOP PROFILE

A snapshot of one of the industry's leading shops

ALL CAR SPECIALISTS / SAN GABRIEL, CALIF.



## Survive and Thrive

This couple was up to the challenge and succeeded in their shop from the start.

BY **ROBERT BRAVENDER** | CONTRIBUTING EDITOR

**T**hink you like a challenge? How about Paul and Cheryl Brow of San Gabriel, Calif. They were married in 1983; one week later they opened All Car Specialists. “We found a building and worked with a friend to get it all cleaned up and prepared, and then we went on our honeymoon in Maui,” recalls Cheryl Brow. When they got back, they started that following Monday and have been working from the same location for the last 30 years.

Looking back, Paul Brow can testify that youth certainly had its benefits: “That’s when we used to be open till 9 or 10 (p.m.), six days a week,” he reports. “We did put in a lot of hours. For a repair shop back in the ’80s it was great. There were so many cars, we were booking two weeks in advance. We had a whole bunch of energy — it was great. But everything has changed; I see a lot of my friends not keeping up with the changes and they’re kind of suffering. People have a hard time putting out \$2,000 per year for the updates on just one car line, but that’s what it takes.”

Back then Cheryl’s father also owned a chain of auto parts stores, one of the largest in the San Gabriel Valley, which gave them a solid supply line for a while, but with retirements and market chang-

es that dried up. Because the Browns repair a wide range of makes and year models, from restorations to hybrids, a steady supply had to be secured.

“Now we have to buy from all these different distributors and their prices are going up, and that’s one of the hardest things that we have to deal with,” Cheryl explains. “And a lot of them are going out of business, so parts are getting harder to get. Sometimes we have to send our guys further out so that jobs that might have been done in a couple hours now take a day and a half.”

To help manage this problem, the Browns promoted an employee to parts manager, and he stays in contact with all the parts houses, relieving the service writers of this time-consuming duty. “You can’t learn too much in this indus-

### AT A GLANCE

#### All Car Specialists

Shop name

#### Paul and Cheryl Brow

Owner

#### San Gabriel, Calif.

Location

1

Number of locations

31

Years in business

12

Total number of employees

6

Number of technicians

#### 7,000 square feet

Shop size

8

Number of bays

60

Average vehicles per week

\$460

Average weekly repair ticket

\$1.4 million

Annual gross revenue

#### AAA, BBB, ASC, ASE, Bosch

Shop affiliations

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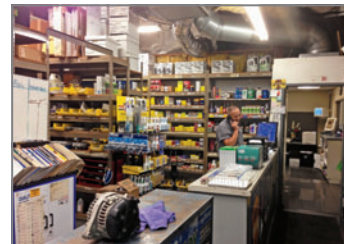
try," Cheryl comments.  
"It's always changing."

To that end, Paul Brow took up teaching — because it turns out education is a two-way street. Having been invited to head classes at nearby East Los Angeles College, Brow not only is able to mold the next generation of technicians and hire some of the more outstanding students, his position gives him access to dealer information networks.

"Most of the manufacturers are generous enough to open their (dealer) doors to teachers," says Brow, "because they want something out of it — they want our students." And it turns out he thoroughly enjoys teaching; two nights a week Brow puts in a full day at the shop before departing at 5:30 p.m. to conduct general automotive and automatic transmission classes until 10 p.m.

And with aging hybrids a growing market in Southern California, Brow has his finger on that as a member of the board of directors for Pasadena City and Rio Hondo Colleges, the latter having a large hybrid program. "What's also big with the schools is alternative fuels, and that's what I'm getting myself geared up for," Brow explains. "As a matter of fact I'm also part of the Automotive Service Council (ASC), and part of my job with them was seminar director, where I would put together these classes for hybrids."

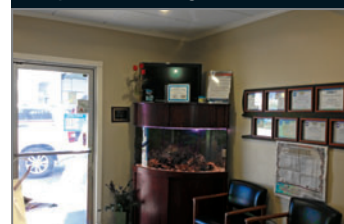
Brow points out that being in ASC's Chapter 5, the largest in the country, comes with its own perks. "We're linked in with a lot of really top shops, and we all work together; sometimes I'll have trouble with something that another shop has already dealt with, so we'll just get onboard with them. We also share tools, like this alignment tool that's \$12,000. That's the future, that's the way we're going to have to do things. These days if you're not linked up with somebody, your business is going to die." Read more at [MotorAge.com/allcar](http://MotorAge.com/allcar). 



Dan Rusin calls in a parts order from the parts department.



A Corvette Zr1 has its cooling systems checked, with lead diagnostic technician Long Diep in the background.




The customer waiting room.



**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](mailto:rbravender@comcast.net)



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# Gear Ratio Error Codes Slipping Away

**WHILE DTCS SIGNAL TROUBLE, THEY DO GIVE YOU A GOOD DEAL OF INFORMATION ON YOUR PROBLEM-SOLVING JOURNEY.**

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

## DIAGNOSTIC

Trouble Codes are no doubt quite helpful when diagnosing a malfunctioning vehicle. Sometimes, when the scan tool reports a never ending list of trouble codes like the ones seen from a 2005 Jaguar S-Type (X200) V6-3.0L in Figures 1 through 4, it might be a bit overwhelming to know where to start. In scenarios like this, my first approach is to know the history of the vehicle, if possible.

I do a cursory view of the electrical system, looking for fatigued wiring harnesses, pinched wires or wires melted on the exhaust or manifold. I inspect connectors looking for water intrusion and then conduct power and grounds tests. I repair any system voltage con-

cerns before proceeding any further. Hopefully by this time I've knocked out a few problems, but if not, the sleeves roll up and step-by-step diagnostics are performed based on which codes I believe might be causing other codes to set.

Through the years, it is interesting to see how the types of codes have developed with the advancement of technology and the variety of transmission types we now see. One such example is gear ratio codes being replaced with solenoid performance codes. As the title of the article goes, gear ratio errors are "slipping" away.

For years, we would see a generic ratio code P0730 for any gear error ratio fault and/or a P0731 for a first gear fault, P0732 for second, P0733 for third, P0734 for fourth and P0735 for fifth.

P0736 was for reverse and P0737 would be a generic TCM Engine Speed Output Circuit fault. Now, when you look up a code list for a 6-speed transmission, the generic P0730 series codes no longer are there. You might see a code list where it jumps from P0723 to P0741, no P0730 series codes listed at all.

Let's consider GM's front wheel drive 6-speed transmissions. Torque rating wise, they come as small as a 6T30 (1.2L) to as high as a 6T75 (3.6L). You will not find gear ratio error codes as much as you will find solenoid performance codes instead. Take for example a 6T30/40/45/50 series transmission (GF6). These transmissions have the computer mounted on the valve body inside the transmission (Figure 5, pg. 36). The combination of the TCM, solenoids and valve body together as an assembly has been called a Mechatronic unit with many European vehicles. GM uses what Delphi calls the Transmission Electro-Hydraulic Control Module or TEHCM (Q8) for short (Figure 6, pg. 36). This TCM/Solenoid body TEHCM assembly is mounted onto the valve body.

There are seven solenoids mounted into the TEHCM housing used to control shift feel and shift scheduling for six forward gears, converter clutch apply and one reverse gear. There is a line pressure control solenoid (Line PCS), a TCC PCS, PCS's 2, 3, 4 and 5

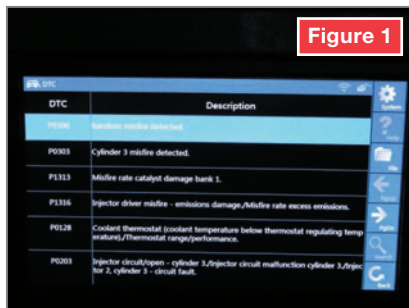


Figure 1

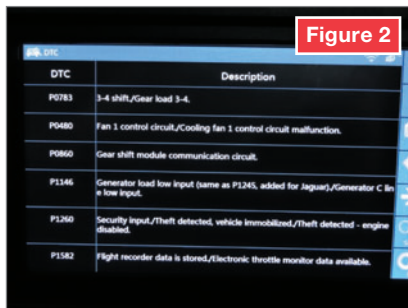


Figure 2



**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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and one On/Off shift solenoid.

Typically, when a TCM/PCM would command a specific gear, it would observe the input and output speed of the transmission with which it could calculate the current gear ratio. Once calculated, it should match the commanded gear and if it did not, a gear ratio error code would set for that specific gear.

General Motors has excellent data available regarding shift time along with the necessary pressure adjustments to maintain proper shift time as well monitoring gear ratio while in gear and the pressures to keep it there. These are all represented in shift time, TAP cells and steady state TAP cells (TAP — Transmission Adaptive Pressure). These PIDs are all great stuff for diagnosing shift concerns and gear ratio errors.

The tech's job from a diagnostic standpoint would then be to consider all that is involved in obtaining the specific gear that is at fault beginning with the solenoid or solenoids that are in play. From there you would work your way into the related valves and small parts in the valve body to the actual components themselves. Things like servos and bands, friction and steel plates, clutch drums and clutch pistons, seals and rings, bushings and accumulators. The list goes on.

Now, rather than having a gear ratio code, a performance code or codes are set for the specific solenoid or sole-

noids responsible in making the shift change and holding the gear. One of the main reasons for this change is that solenoids are primarily doing most of the work controlling both the shift and clutch pressure. There are fewer valves in the valve body as a result of this. However, the tech still needs to consider all that is in play when there is a performance code set for a shift/pressure control solenoid.

This brings us back to the seven solenoids used in the 6T30/40/45/50 series transmission. The codes for these solenoids offer both hydraulic and mechanical performance codes and as well as electrical malfunctions with the exception of the Line Pressure Control Solenoid. This solenoid only has electrical malfunction codes assigned to it at this time. The codes and their basic definitions are as follows:

### Shift Solenoid Valve 1 On/Off Normally Closed Solenoid

P0751 – Shift Solenoid Valve 1 Stuck Off

P0752 – Shift Solenoid Valve 1 Stuck On

P0973 – Shift Solenoid Valve 1 Circuit Low Voltage

P0974 – Shift Solenoid Valve 1 Circuit High Voltage

### Pressure Control Solenoid Valve 2 Normally High Solenoid

P0776 – PCSV2 Stuck Off (Hydraulic/Mechanical Performance Malfunction)

P0777 – PCSV2 Stuck On (Hydraulic/Mechanical Performance Malfunction)

P0965 – PCSV2 Performance (Internal Electrical Performance Malfunction)

P0966 – PCSV2 Circuit Low Voltage

P0967 – PCSV2 Circuit High Voltage

### Pressure Control Solenoid Valve 3 Normally High Solenoid

P0796 – PCSV3 Stuck Off (Hydraulic/Mechanical Performance Malfunction)

P0797 – PCSV3 Stuck On (Hydraulic/Mechanical Performance Malfunction)

P0969 – PCSV3 Performance (Internal Electrical Performance Malfunction)

P0970 – PCSV3 Circuit Low Voltage

P0971 – PCSV3 Circuit High Voltage

### Pressure Control Solenoid Valve 4 Normally Low Solenoid

P2714 – PCSV4 Stuck Off (Hydraulic/Mechanical Performance Malfunction)

P2715 – PCSV4 Stuck On (Hydraulic/Mechanical Performance Malfunction)

P2719 – PCSV4 Performance (Internal Electrical Performance Malfunction)

**Figure 3**

DTC	Description
P1549	Variable induction system 1 low/high input/intake manifold communication control A: circuit malfunction.
P1547	Heated oxygen sensor control module, bank 2 open/shorted.
P0705	Transmission range sensor A circuit (park, reverse, neutral, drive low input)/Traction control range sensor circuit malfunction.
P0731	Gear 1 Incorrect ratio.
P0735	Gear 5 Incorrect ratio.
P0741	Torque converter clutch solenoid - circuit performance or stuck off/Torque converter clutch system performance or stuck off.

**Figure 4**

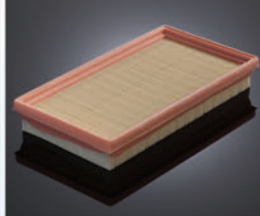
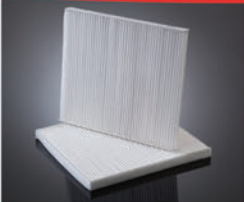
DTC	Description
P1429	Internal voltage regulator/Generator front right line failure.
P1432	Smart generator faults sensor/circuit/Generator charge system failure/generator "load" feedback circuit failure/Smart generator output circuit.
P1755	CAN engine control module/parking brake control module circuit malfunction.
P0271	System too lean (Bank 1).
P0274	System too lean (Bank 2).
P0301	Cylinder 1 misfire detected.



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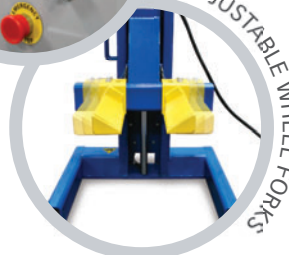
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P2720 – PCSV4 Circuit Low Voltage  
 P2721 – PCSV4 Circuit High Voltage  
**Pressure Control Solenoid Valve 5 Normally Low Solenoid**

P2723 – PCSV5 Stuck Off (Hydraulic/Mechanical Performance Malfunction)  
 P2724 – PCSV5 Stuck On (Hydraulic/Mechanical Performance Malfunction)  
 P2728 – PCSV5 Performance (Internal Electrical Performance Malfunction)  
 P2729 – PCSV5 Circuit Low Voltage  
 P2730 – PCSV5 Circuit High Voltage  
**Torque Converter Clutch Pressure Control Solenoid Valve Normally Low Solenoid**

P0741 – TCC PCSV Stuck Off (Hydraulic/Mechanical Performance Malfunction)

P0742 – TCC PCSV Stuck On (Hydraulic/Mechanical Performance Malfunction)

P2762 – TCC PCSV Performance (Internal Electrical Performance Malfunction)

P2763 – TCC PCSV Circuit Low Voltage

P2764 – TCC PCSV Circuit High Voltage

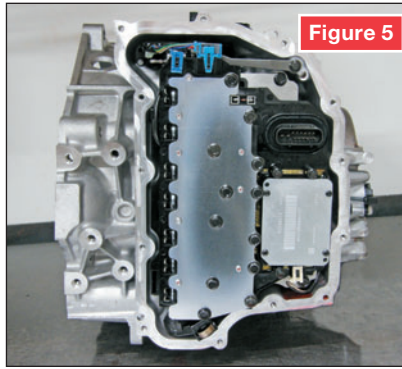


Figure 5

**Line Pressure Control Solenoid Valve Normally High Solenoid**

P0961 – PCSV Performance (Internal Electrical Performance Malfunction)

P0962 – PCSV Circuit Low Voltage  
 P0963 – PCSV Circuit High Voltage

You will notice in Figure 6 that there are four pressure control solenoids used to operate a specific clutch assembly. This is done through each of these solenoids having its own respective regulating valve. In other words, PCSV2 operates the 3-5-R clutch through a 3-5-R regulating valve to achieve 3rd,

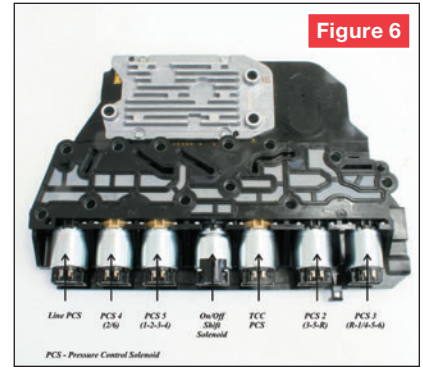


Figure 6

5th and Reverse gears. PCSV 3 works the same way through its own regulating valve to achieve 4th, 5th and 6th gears. PCSV4 is responsible for 2nd and 6th gears while PCSV5 controls the 1-2-3-4 clutch in gears 1st through 4th, both through their own respective regulating valves (Figure 7).

When a hydraulic/mechanical fault occurs with one of these solenoids (as mentioned earlier), the diagnostic process begins with checking the operation of the solenoid and its related valve(s).

Unlike the 6T70/75 version, the solenoids in the 6T30/40/45/50 TEHCM can be easily removed from the assembly for inspection, which would include the rubber sealing rings as well (Figure 8). Sources are becoming available to replace these solenoids separately should there be a failure without having to replace the entire TEHCM assembly. Hopefully that will work out well.

If the solenoid inspects well and

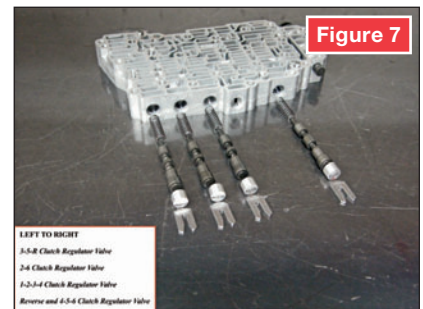


Figure 7



Figure 8



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its related regulating valve is functional, something is wrong inside the transmission.

General Motors provides detailed information for each of these codes. Circuit/System description, conditions for running the DTC, conditions for setting the DTC, actions taken when the DTC is set to name a few. It also provides Circuit/System Testing so the technician can quickly begin to separate whether his hydraulic/mechanical performance code is a minor or major repair.

Using PCSV2 as an example, if code(s) P0776 and/or P0777 has set and it has been determined that the solenoid is not the cause, it offers up the following suggestions:

1. Actuator feed limit valve compromising circuit supply fluid to the solenoids.

2. 3-5-R Regulator Valve sticking or stuck.

3. A check ball in the valve body not seating correctly

These would be considered minor in that the transmission would not have to be removed to make the repair. But if these all check out, with the 6T40 series style transmission, it's time to pull the unit and inspect the 3-5-R clutch assembly. If it were the 6T70 series type transmission, there is a rear cover that can be pulled to give these clutches a look (Figure 9). Not so with the 6T40 unit. It all needs to come apart as the 3-5-R clutch drum assembly is located at the rear of the case (Figure 10). The sealing rings on the ring tower in the bottom of the case would need to be looked at. The drum area where the rings seal would need to be inspected for grooving (Figure 11). And then of course the clutch assembly itself including the apply piston (Figure 12).

As you can see, moving away from gear ratio codes to solenoid performance codes simplifies the diagnostic process. This example was with a compact little 6-speed transmission using five clutch pack assemblies. Compact transmission designs with minimal clutch pack assemblies also simplify diagnostics. With 9-speed transmissions on the road today, the ones that have most of their solenoids doing the majority of the grunt work along with fewer valves in the valve body is a welcomed design diagnostically.

What is actually becoming complicated and difficult to deal with is programming. It is mind boggling to think of all that is involved in writing a program to make just one shift under various loads, speed and temperature in conjunction with ABS, engine torque management, fuel economy and emissions. Now times that by nine shifts, which includes skip shift technology, sport and economy modes, and we can see how easily programming can become a problem. So the less we need to contend with when it comes to the transmission itself, the better. Part of the diagnostic process when it comes to programming, it is always a good idea to check for any factory TSBs for any re-flash updates related to your specific or related fault code. *TLZ*

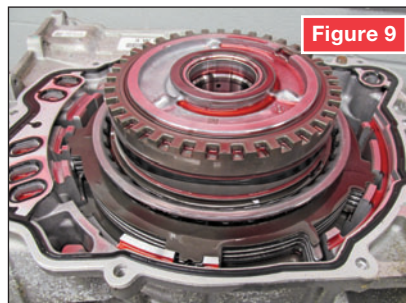


Figure 9

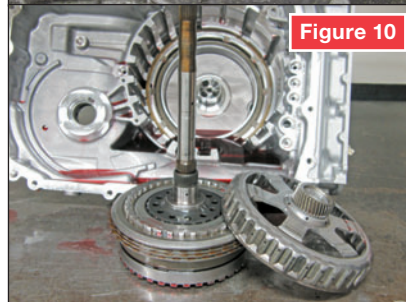


Figure 10

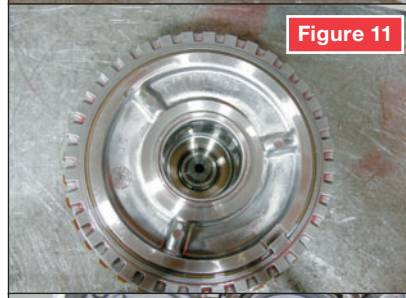


Figure 11

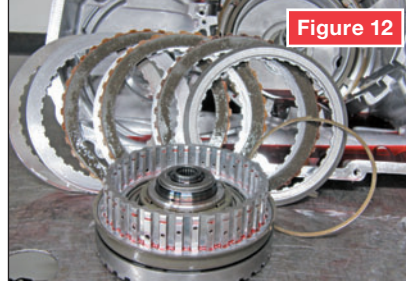


Figure 12



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**EUROPEAN  
DIAGNOSTIC  
TIPS**

**DIAGNOSING DRIVABILITY PROBLEMS ON EUROPEAN  
VEHICLES IS EASIER WHEN YOU HAVE A FEW  
DIAGNOSTIC TRICKS IN YOUR ARSENAL.**

BY **VANESSA ATTWELL** | CONTRIBUTING EDITOR

**E**uropean vehicles with drivability problems can and do get turned away from the service bays by many of the best technicians around because they're just not comfortable working on them. But it doesn't need to be that way.

True, the systems can seem a bit strange, and special tools often are needed to diagnose or repair systems properly. And it's also true that the parts on those vehicles can be really

expensive, so misdiagnosis just isn't an option. But there's good money to be made under those hoods, so it's worthwhile getting to know how to diagnose the problems and then fix the systems when they go wrong.

As tempting as it might be to avoid working on these vehicles, if you're up for the challenge it can be very rewarding and often not nearly as bad as you'd think. With a solid plan of attack and a few diagnostic tricks, you really can

diagnose and repair drivability concerns on European vehicles quickly, accurately and profitably. Here's how.

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## Here's the Plan

Older European systems were unlike anything most of us were used to, so it was tough to figure out how they even worked let alone how to fix them. However, from experience, vehicle control systems and components on newer models seem to be getting very similar to each other no matter where the vehicle was built, especially in the lower-priced vehicles. In fact, it's not uncommon to actually see another manufacturer's part number or logo on something when you open a vehicle's hood or open a parts box.

This is somewhat reassuring.

Because vehicles need the same things to operate properly no matter where they're from (air, spark and fuel in the right amounts at the right time with good compression/unrestricted exhaust also at the right time), this means that the faults that cause drivability issues also are becoming much the same among different types of vehicles, no matter where they're from.

For example, a heavily restricted air filter or a partially plugged fuel filter will cause, among other things, a lack of power in a vehicle no matter what

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type of vehicle you're working on or which logo is on the steering wheel.

Because the vehicles' needs are similar and the systems are similar, the diagnostic strategy for European vehicles' drivability problems is, therefore, very much similar as for other vehicles.

To diagnose the problem, begin by listing the things that could cause that particular issue and create a reasonable suspicion about what could be causing the problem (maybe by most likely to least likely), and then test each theory, taking readings and measurements and testing each system to eliminate or confirm your suspicions until you've located and corrected the concern, and conclude by verifying the repair.

You know, just like you could do for any other vehicle — really, it's not that bad!

## Just in Case

Just as with any other type of vehicle, it's a good idea to inspect the simple things first before you get too involved in the diagnosis.

If you've ever been deep into testing a system and then realized that a



Tempting as it might be to wiggle sensors and connectors during the preliminary inspection, remember that if you inadvertently fix the problem you won't be completely sure what caused it and what fixed it.



Of course, you may need special tools to perform some diagnostics, but don't you have to have them now for Asian and domestic repairs?



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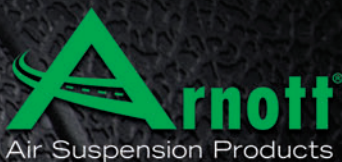


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blown fuse or something similar and obvious caused the problem, you know why it's so important to start any diagnosis by quickly inspecting the simple things that introduce problems into the systems.

Start by looking for what else doesn't work, possibly indicating a problem in a common or related fuse, ground, connector, splice or module.

Also check to see if any work was done on the vehicle recently, which might have caused the problem. Along those lines, see if the vehicle has an alarm or aftermarket systems such as remote starters or fog lights that might have gone bad after years of faithful service.

And finally, look for spills, goo, blockages, debris or junk under the seats or near the sensors that could affect operation. Coffee spills on consoles that then indirectly seep into control modules are not uncommon.

### Getting Started

A great way to begin diagnosing — besides checking for blown fuses and the like — is by looking for Diagnostic Trouble Codes (DTCs) even if the Malfunction Indicator Lamp (MIL) light isn't illuminated. And this brings up an important point: It's really important to know that without a good scan tool that can accurately and reliably read codes and data (not all of them can) you're in for a real diagnostic

challenge. In other words, you need the right tools to do the job.

True, you still can check for the obvious causes of the problem and you might get lucky, but in most cases — even if the MIL indicator isn't illuminated — hooking up a scan tool and checking for codes is one of the first steps in diagnosing any drivability problem. Checking for programming updates usually comes next, because sometimes the only way to repair a problem is by reprogramming a module, and it's nice to know that before wasting too much time testing other things. The reality is that without a good scan tool, diagnosis will be difficult if not impossible for all but the luckiest of techs.

When you've retrieved any codes or relevant data, checking for both service bulletins and technical tips is another important preliminary step, especially documents that mention updated parts to fix problems. Note that some manufacturers have both service bulletins and technical tips and they often have different information about different issues in them so checking thoroughly can pay off.

Additionally, searching the online technicians' resources (iATN, Identifix, etc.) is a great and completely responsible preliminary diagnostic step, because let's be honest, it's a fantastic resource for professionals, especially if you're not familiar with that system. However, randomly searching the Internet and chat forums (like customers seem to do) is definitely not the same thing as learning from your fellow professional techs about pattern failures or diagnostic steps. The first is a great way to get an idea of what could be going wrong before proving that that is or isn't the issue you're dealing with, the second can be full of very bad advice and horrible ideas.

Internet-assisted diagnosis might not be the most respected way of solving problems, but it certainly can be a time-saver when you're stuck.

### Where to Begin

Obviously there are many, many things that could cause drivability problems, and you'll need to narrow that huge list down as quickly as possible, because time is valuable.

A good way to prepare to diagnose the problem is by finding out from the



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customer things like when the problem occurs, if it's intermittent or constantly there, if it only happens when the engine is hot or cold or if the problem happened suddenly or developed gradually over time. Then use this information to eliminate or highlight suspect systems and prioritize diagnosis on the most likely faults.

If the problem developed over time, tend to suspect and investigate systems where things or deposits build up gradually such as air or fuel supply systems. If the problem appeared suddenly rather than developed slowly over time, tend to suspect electrical or electronic components and inspect those first. In other words, if a customer says, "All of a sudden the vehicle stat-

ed to misfire," suspect ignition components or modules. If a customer says, "The problem started as nothing but it's getting really bad," suspect air or fuel systems (and exhaust systems, too – blocked converters do happen).

If you do suspect an electrical problem, wiggling wiring harnesses and connectors before you've duplicated the concern might not be the best plan. You might inadvertently fix the problem without realizing it and then you won't be completely sure the problem is gone. Leave things as they are during the diagnostic stage; wiggle and poke later.

## Continuing On

There are a few key things that cause drivability concerns. From experience, one of the more common drivability problems European vehicles develop is a hesitation or lack of power, which may or may not set codes. This doesn't need to be difficult to solve, but you need to go in with a systematic plan of attack.

Air filters and housings usually are a good place to start looking for problems. If you've ever tried to run with a stuffed up nose, you'll understand why a plugged air filter can cause a hesitation. Engines need to be able to breathe freely, and performance suffers when they don't. One tip, our rodent and bird friends have been known to make nests in the filter housing using the air filter itself for nesting material, even if the vehicle is parked in an underground or covered garage. If that's the case, it's a good idea to wear a mask and gloves when removing the debris, because inhaling the fecal matter can cause respiratory problems.

Just as on any other vehicle, worn spark plugs can and do cause problems as does using the wrong plugs or the wrong gap. I mention this because a customer recently came in with plugs gapped to the widest spot on his gapping tool (he'd done his own tune up earlier). Damaged spark plug wires or coils also can cause drivability problems. If you suspect one of these components may be faulty, swapping a suspect coil to a different cylinder and checking if the problem moves along with it may help speed diagnosis.

A dirty throttle body or plate will also cause problems. This can be a



**It's wise to begin diagnosis by checking for codes, even if the MIL indicator isn't illuminated.**



**It looks innocent, but if coffee or drinks spill onto the console and run down into a harness or controller, the resulting drivability problem could be a diagnostic challenge.**



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## CLUTCH REPAIRS: MAKING USE OF SOMETHING WE NORMALLY THROW AWAY

**C**lutch replacement is a job that normally takes a good bit of time and we want the job to go right the first time.

The first and most common issue with a new clutch replacement is getting the hydraulic system bled of air. It is, easily, the most common problem on a new clutch install. With today's "fluidless / dripless" quick disconnect at the clutch slave cylinder, we disconnect the line coming down from the master cylinder, take the transmission out, replace the clutch and reconnect the line, and expect things to be perfect. However, that's not always the case. Air gets into the hydraulic system requiring us to bleed the system, and that can be much easier said than done.

With just a few quick steps, we can recycle part of an old concentric slave cylinder, that we would normally just throw out, to create a bleeding tool.

1. Drive the drift pin (Figure 1) out of the old slave cylinder.
2. Pull the quick disconnect (Figure 2) and the 2-inch piece of steel line out of the old slave cylinder.
3. Get a piece of 3/8-inch ID hose and push it on to the end of steel line (Figure 3).

You now have a bleeding tool that will help in making the critical job of bleeding the hydraulic system easier.

1. Connect the tool you just made to the line coming down from the master cylinder.
2. Submerge the end of the hose in a vessel of clean fluid. Insure that the hose always stays submerged in the fluid so no air is drawn back into the hydraulic system.
3. Have an assistant depress the clutch pedal slowly, while keeping a close watch on the fluid level in the master cylinder reservoir. Make sure that the fluid level in the reservoir does not go below the "low fluid" marks.
4. Repeat the process until all that is seen being pumped through the system is clean hydraulic fluid.
5. Disconnect the tool from the hydraulic system in the vehicle and from the quick disconnect up to the master will be bled of air.

This is an great example of recycling something we normally would throw away to make our job easier and more efficient.



Drift pin



Quick disconnect



Quick disconnect with hose attached

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tricky repair though, because the strong solvents in some cleaners can damage the component. Even if it doesn't, the system might need to relearn how to idle when the job is complete. This problem has happened on newer vehicles with high mileage, so it's worth keeping in mind during your diagnosis. This one is actually pretty easy to check — just look for build up in the passages. From experience, European vehicles do tend to be high-mileage units, so carbon buildup on valve seats is also a possible cause of drivability concerns.

Problems from a plugged fuel filter are common on older European vehicles simply because the fuel filters can be notoriously difficult to replace. And because this can be bad for the fuel pump, it's a good idea to check both fuel pressure and volume if you suspect something in the fuel system is malfunctioning. Sixty psi doesn't mean much if there's too little fuel volume to feed the engine's demand.

Along those lines, bad gas has become surprising more common lately, even though it's not usually one of the first things to be checked. If a customer mentions that the vehicle has been in a situation where bad gas is a possibility, like the vehicle being stored for extended periods of time or using questionable fuel additives, it might be worth investigating further. Another recent customer wanted to save money, so instead of using premium fuel he added multiple bottles of octane booster to each tank of regular fuel figuring if one is good, five is better. His logic with the octane booster is debatable, but adding that much additive is very wrong. He and the vehicle seemed normal in every other respect so this came as a surprise. It shows that a good discussion with the customer is so important when diagnosing problems — you just never know. If you disconnect the fuel line and notice the fuel is discolored or smells strange, you might have found the cause of the problem.

And as with any other vehicle, low compression or base engine concerns can cause drivability problems. This can build up gradually over time or develop suddenly — particularly after a timing belt change or head or block repair. Timing belts on European vehicles are notoriously tough to set up correctly. Being off by a single tooth on one of the cams can and does cause drivability problems. Painting your own match marks using white out before the old belt comes loose can really help prevent problems.

### Conclusion

Diagnosing drivability problems on European vehicles can be worthwhile and profitable. The systems are similar to ones you're likely already familiar with and the problems that develop are also very familiar. With a plan of attack, understanding of what can go wrong and how to prove or disprove those suspicions, and a good scan tool diagnosing the concerns can be relatively straightforward and your bottom line will thank you for it. *TZ*

### VANESSA ATTWELL CONTRIBUTING EDITOR

Vanessa Attwell is a Master Technician for two major manufacturers and has also worked on the bench of an independent shop. She has developed and delivered training for both vehicle manufacturers and independents, and helped develop government training and regulations standards.



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Figure 1



## WE HAVE A SNEAK PEEK FOR YOU OF THE NEW 2014 MODEL YEAR 09G TRANSMISSION.

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

**T**he folks at Continental Automatic Transmissions in Bridgeview, Ill., gave me a heads up of a new style 2014 model year 09G transmission now on the road (Figure 1). Arrangements were made to get this transmission into our facility in Miami so I could show you some significant differences that have occurred.

The very first difference seen is with the heat exchanger. It is now rectangular in design as opposed to being cylindrical (Figure 2). This is your first clue to the 09G face-lift. When the pan and filter come off there is a whole new surprise. All the solenoids have been redesigned and relocated (Figure 3). The smaller pass through

connector in all previous models contained wiring for the ISS, OSS and TFT sensors. This connector now contains wiring for the three redesigned solenoids closest to the manual valve. The larger pass through connector which used to contain all the solenoid wiring, now contains wiring for the ISS, OSS, TFT and the remainder of all the solenoids (Figure 5).

The line pressure and TCC solenoids used to be located in the upper far left of the valve body. They are now located to the bottom far left of the valve body (Figure 6). With the solenoids out of the bore (Figure 7), you can see that these solenoids are different, yet they both

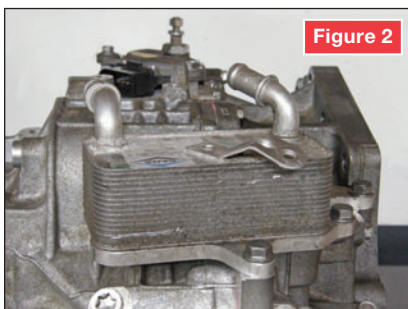


Figure 2

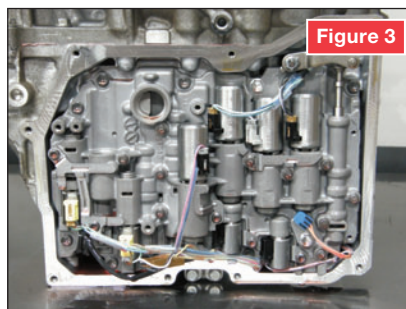


Figure 3

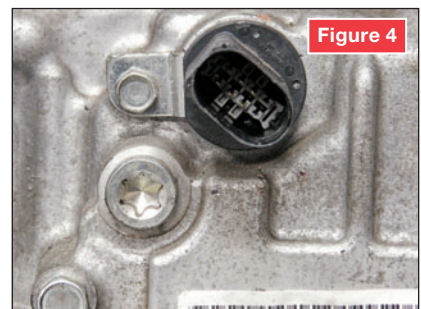


Figure 4





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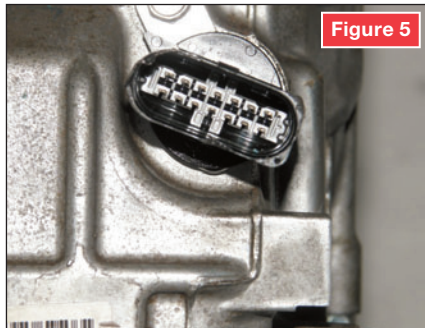


Figure 5

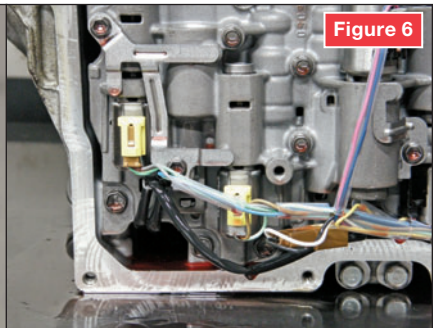


Figure 6

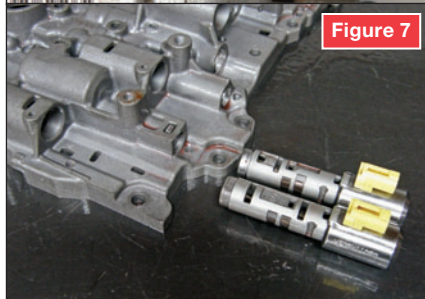


Figure 7



Figure 8

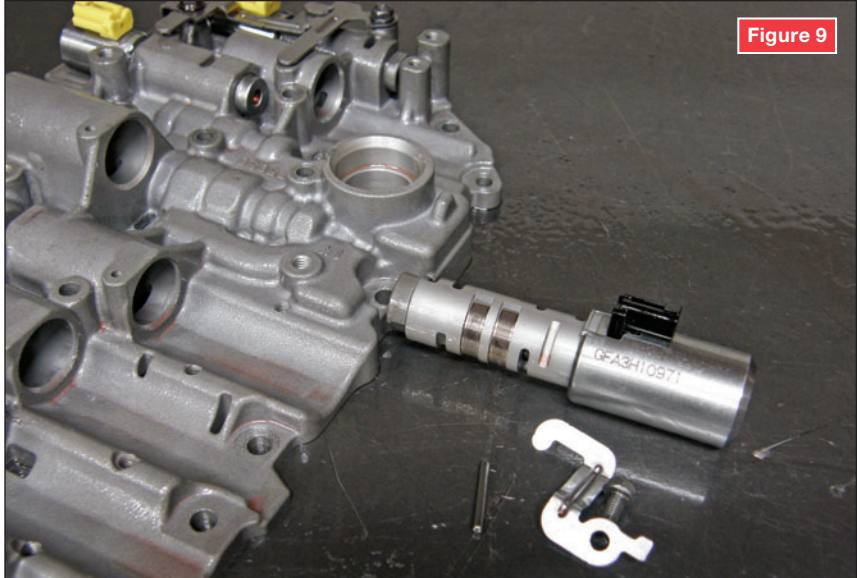


Figure 9

have the same yellow connectors. Care must be taken to be sure these solenoids are placed in the correct location and that the connectors do not get crossed.

The other solenoids also are notably different. They are much more robust than the previous more troublesome design. They have a similar look to the A6MF1 series solenoid, which has snap-in feed passage screens. The three solenoids closest to the manual valve also can be easily inserted into the wrong location (Figure 8). Care must be taken here as well. The most center solenoid (Figure 9) has its connector mounted to the solenoid differently from the others in an attempt to not get this solenoid in the wrong location.

The valves and small parts inside this valve body also are completely different than the previous design. Inside the transmission are parts differences to watch for, such as the differential bearings. They are smaller in diameter allowing an earlier cover to go over the bearing without you being aware of it. This might happen if you are trying to make this new design fit into an earlier model.

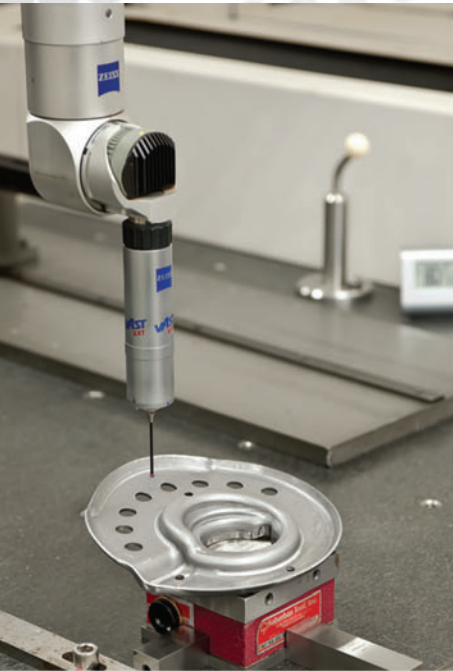
The starter might fight you getting it into a different housing but the salvage yard will sell you one that fits. Of course the transmission will not work as the wiring is totally different, but you will sure have a clunky transmission before you realize this is not going to work. *TZ*



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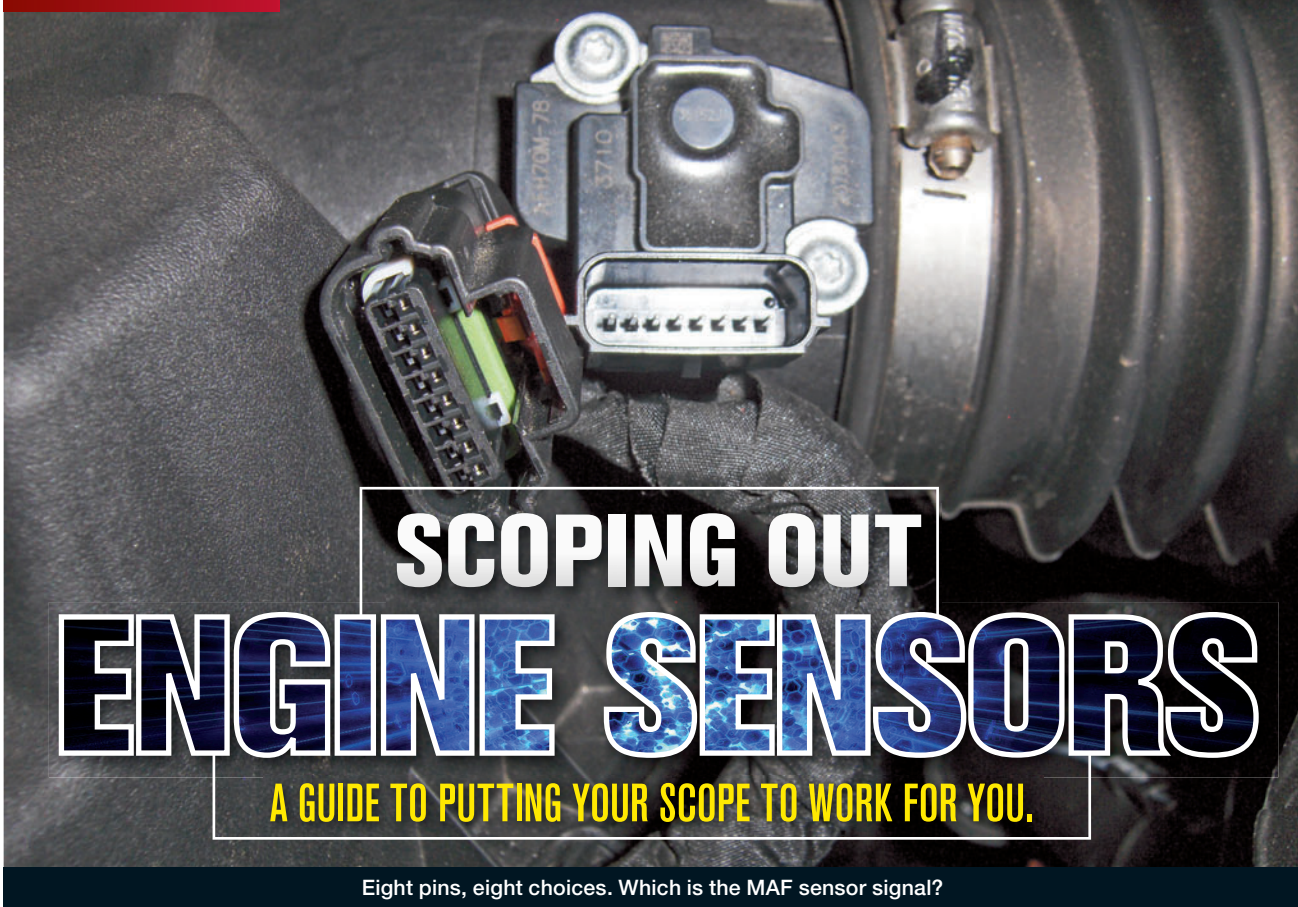
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# SCOPING OUT ENGINE SENSORS

A GUIDE TO PUTTING YOUR SCOPE TO WORK FOR YOU.

Eight pins, eight choices. Which is the MAF sensor signal?

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

**“H**ow do I know where to put my test leads and what settings to use on the scope?” That’s the most common question that comes up while I am teaching a scope class. Digital Storage Oscilloscopes (DSOs) are not much different than what you have used for years to test electrical circuits. If you can use a test light, logic probe or multimeter, you can use a DSO. Scopes take accurate measurements and provide a picture that offers information other testers miss.

Remember the graphs you had to draw in school? That is essentially how DSOs work. They take millions of samples and plot them on an X and Y axis, plotting voltage over time. You connect a scope the same way you would connect

a multimeter to test for voltage. The difference is rather than looking at voltage numbers you are looking at a waveform.

**Setting up for Success**

Just like your meter, you first have to pick between AC and DC voltage. AC should be selected to measure any circuit or component producing an AC voltage signal, like some speed sensors (vehicle and/or wheel), some cam and crank sensors and when looking for excessive AC ripple in the charging system.

Selecting AC also plays a role in some DC tests. By selecting AC, you remove the DC component of the signal and can focus on the changes in amplitude of the waveform itself. A great example is when testing relative compression using a current clamp.

For most testing, you set your scope to read DC voltage. You adjust the voltage scaling on the meter’s X axis in the same way you need to select your measurement scaling on your multimeter.

The first step to take when using a scope to take a simple voltage measurement is to make sure we have a good engine ground. Connect the black (negative) lead of the scope to a good ground

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(don't forget to scrape the alligator clip to the ground), followed by connecting the scope positive lead to the battery positive post. With your scope set to read DC volts, you should see a straight line being displayed as the waveform on the scope equal to the battery's Open Circuit Voltage (OCV).

Why don't I suggest connecting the ground of the scope to the battery? Many times there is corrosion, interference or noise from the charging system. Another reason is that many lead sets only have about a six-inch ground lead that is connected to the main lead set and that's not allowing the length needed to always ground to the battery. Use a ground close to the sensor or actuator.

A quick word on "floating" grounds. Many engine sensors are grounded through the Engine Control Module (ECM) and are purposely offset to avoid interference issues. If you measure the voltage drop on the ground conventionally, you'll get a reading of around 0.70 volt. This also will impact the amplitude of the signal, making it look weaker than it really is. Check the schematic of the sensor you are testing to see where best to place your scope's negative test lead.

### Let's Get Started

Let's try connecting to a very common sensor, a 4-wire O<sub>2</sub> sensor. We have a 1 in 4 chance of connecting to the correct wire. Of the wires going to the sensor, one has 12 volts for the heater circuit,

We have how-to  
info on in-cylinder  
pressure testing with a  
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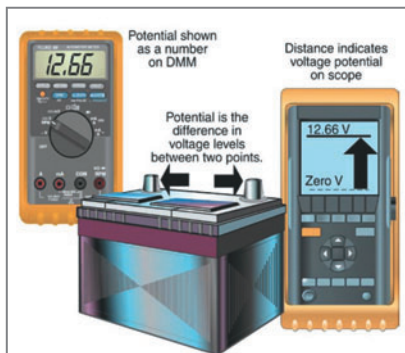
another provides the ground for the heater, a third is the ground for the sensor and the fourth is the signal wire that will be sending out about 450 mV. Once you've confirmed you have the negative scope lead connected to a good ground, you can start back-probing the connector to find the correct wire.

Of course, you can look up the info on the appropriate wiring schematic, and some scopes have a built-in library. Your scope setting should be about 200 mV per division or 2 volts per screen along with a time setting of 200 mS per division or 2 seconds per screen. Why did we pick those settings? What output would you expect to see from an oxygen sensor? What does the "Theory of Operation" section of your service information system tell you about how the oxygen sensor is tested by the ECM? These settings are a good starting point that will provide you with a waveform that oscillates from rich to lean as you raise the engine speed to 2,500 rpm.

Two wire sensors are easy to test, since we have a 1 in 2 chance of connecting to the correct wire. Once again let's make sure that we baseline our scope and test as we did before making sure we have a good engine ground.

Because this is a two-wire sensor, one wire will be ground while the other will be signal. Examples of two-wire sensors are the Engine Coolant Temperature Sensor (ECT), the Intake Air Temperature Sensor (IAT) and others. These sensors typically produce a varying voltage over time, and might use a "reference" voltage the ECM supplies. To set up your scope for the capture, set up the voltage scale so a full range of system voltage can be covered and configure the time divisions so two seconds are displayed across the screen. Comparing the actual reading these sensors are providing to the corresponding data Parameter Identifier (PID) on your scan tool is a great way to catch a "lying" ECM.

Two sensors we never want to see "lie" to the ECM are the Manifold Absolute Pressure (MAP) sensor and the Mass Air Flow (MAF) sensor. The ECM relies on one or the other to determine



For most electrical circuit and component tests, you'll connect your scope the same way you would your multimeter.



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how much fuel to feed the engine. The MAP is a three-wire sensor that typically has a 5-volt reference supply line on one pin, a sensor ground on a second and a signal line back to the ECM on a third.

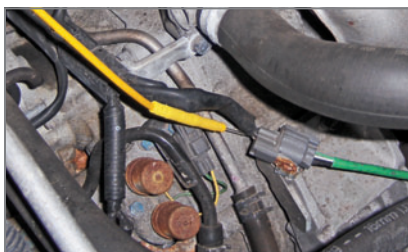
The wire you want to connect your scope to is the signal wire. The waveform will be a straight line of voltage about 3.2 to 5 volts. Normal operating voltage with about 18 inches of vacuum should be about 1 to 1.4 volts. Your scope settings should be 1 volt per division (or 10 volts per screen) and the time setting set at 200 mS per division (or 2 seconds per screen). If the time is set as suggested and the engine speed is raised quickly, the waveform will go from low voltage to high voltage making a hump in the waveform.

MAF sensors provide similar information to the ECM along with temperature information. No matter if it's an analog or digital sensor, the wiring is going to be the same; one wire will be the ground for the MAF, one will be the signal (this is where we connect the scope) and one will be the reference supply voltage from the ECM (typically 5 or 12 volts). The other two wires are for the IAT part of the sensor, with one being ground and the other reference. The scope will dis-

play a straight line if it's an analog sensor or a square wave if it's a digital sensor. The scope setting should be 2 volt per division or 20 volts per screen and the time setting set at 2 to 5 mS or 20 to 50 mS per screen. The waveform on the analog sensor should look the same as a MAP described above.

The Throttle Position Sensor (TPS) is another three-wire sensor that has a 5-volt supply, a signal (where we connect the scope) and ground. The scope setting

should be 1 volt per division or 10 volts per screen and the time setting set at 200 mS or 2 seconds per screen. The TPS is a potentiometer that produces a varying signal based on the position of the sensor. By rapidly opening and closing the throttle, you can look at the signal for any dropouts in what should otherwise be a smooth rise and fall. Other potentiometers can be tested similarly, like the Accelerator Pedal Position (APP) sensors used on many later model cars.



This oxygen sensor connector has four wires: two for the heater and two for the sensor. Only one provides the signal I'm looking for so I have a 1-4 shot of getting it right the first time.



Backprobes cause less damage to the harness than piercing the wires. In either case, make sure you reseal and repair any damage you caused to prevent future corrosion issues.

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Crank (CKP) and Cam (CMP) sensors that are DC sensors are also three-wire sensors that use a reference voltage (typically 5 or 12 volts), ground and signal. We connect our scope leads to a good engine ground and the signal wires. The waveform will appear on the scope screen as a square wave that will increase or decrease in frequency as amplitude always will remain the same on a good sensor. The scope setting should be 2 volt per division or 20 volts per screen and the time setting set at 2 to 5 mS or 20 to 50 mS per screen.

Magnetic crank and cam sensors can be a two- or three-wire sensor depending on whether or not the sensor has a shielding wire. Because these sensors produce an AC voltage signal, we need to make sure that the positive lead of the scope is going to the positive lead of the sensor. The scope setting should be 1 volt per division AC or 10 volts per screen and the time setting set at 200 mS or 2 seconds per screen. The settings are a good starting point but may have to be change on a no start engine with a low battery. The amplitude and frequency of the signal changes with crankshaft speed. Similar settings can

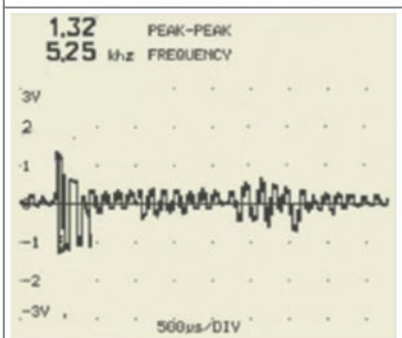
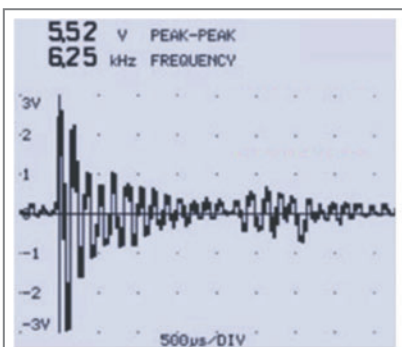
be used for the Antilock Brake System (ABS) wheel speed sensors that are the AC generator style.

The Knock sensor is an AC producing sensor mounted on the engine intake manifold or block that is used to detect detonation and/or preignition. It does so by measuring engine vibration. Connecting to this two-wire sensor is easy since it has one positive and one negative wire. The voltage signal on the screen to the right is too low and weak, causing by a defective sensor.

## Starting From Scratch

Take a look at an eight-wire MAF sensor from a 2013 Caddy CTS 3.6L. If you were working on this vehicle and wanted to test the MAF sensor, it at first might look a little intimidating and very confusing. The first step is to look at a wiring diagram; the one I use from MotoLogic is colored and allows me to highlight the wire I want to backprobe. This sensor has the IAT sensor 1, IAT sensor 2, Humidity sensor, MAF sensor and BARO sensor all in one housing. This frequency sensing signal will produce a square wave where the amplitude does not change but the frequency of the signal does as more or less air enters the intake manifold.

The two IAT signal wires will have only a few hundred millivolts on a hot engine, while the ground will have little to no voltage. The Humidity sensor most likely will read the same and the BARO will have about 1.3 volts KOER, which leaves you with a ground and the signal wire for the MAF. Without using a wiring diagram, you can backprobe all the wires until a square wave appears on the scope. When I was testing this sensor on the vehicle, I did not use a wiring diagram. Breaking things down into pieces and knowing what the waveform should look like makes scoping a breeze. **LTZ**



Conventional knock sensors can be tested by tapping the engine with a hammer and viewing the sensor response on your scope. The top image is “known good” while the bottom image is a defective signal.



**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.

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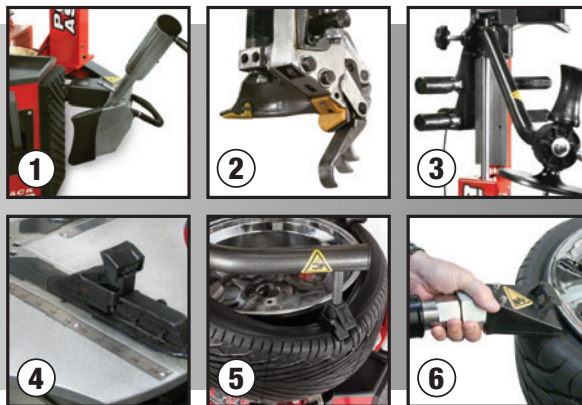


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## TECHNOLOGY

## ↘ UNDERHOOD

Figure 6



# DETECTING AND SERVICING CARBON ISSUES

## CA

THESE TIPS CAN LEAD TO A BETTER RUNNING ENGINE AND A HAPPIER CUSTOMER.

BY **BERNIE THOMPSON** |  
CONTRIBUTING EDITOR

**C**arbon comes in many forms, from the diamond in a ring to a graphite pencil. It has four electrons in its outer most electron shell that can form covalent chemical bonds. A covalent bond is where atoms share electron pairs. This allows carbon to be covalently bonded to one, two, three or four carbon atoms or atoms of other elements or groups of atoms.

Additionally these bonds are that of allotropy. Allotropy means that these bonds can form in different structural arrangements such as sheets, spheres, ellipses, cylinders, pentagons, heptagons, hexagons and tetrahedral. Carbon is a common element, and is known to form almost 10 million different compounds.

### Good and Bad Carbon

Where many of these carbon compounds are very useful, the carbon compounds that accumulate in the internal combus-

tion engine (ICE) are not. Even though the carbon compounds that accumulate in the engine are unwanted, carbon is very much a part of the ICE, because the



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lubricants and fuels used in the engine are carbon-based compounds.

The lubricant and fuel carbon bonds are formed with hydrogen and produce hydrocarbon chains. These hydrocarbon chains are refined from crude oil and contain various molecular weights. When these hydrocarbon chains are formed to produce lubricating oil, they contain heavier, thicker petroleum base stock that have between 18 and 34 carbon atoms per molecule. Lubricating oil creates a separating film between the engine's moving parts to minimize direct contact between the moving parts, thus decreasing heat caused by friction and reducing wear.

When these hydrocarbon chains are made for gasoline, they contain lighter petroleum base stock that have between four and 12 carbon atoms per molecule. Overall, a typical gasoline is predominantly a mixture of paraffins (alkanes), cycloalkanes (naphthenes) and olefins (alkenes). Fuel is blended to produce a rapid high energy release combustion event that propagates through the air in the combustion chamber at subsonic speeds driven by the transfer of heat.

As the ICE is operated, the fuel's energy is released in the combustion chamber. This occurs by a chemical change occurring to the hydrocarbon chains. The heat from the ignition spark (gasoline) or from the compression (diesel) breaks the hydrocarbon chains so the bonds between the carbon and hydrogen are separated. This allows the carbon to bond with dioxygen (O<sub>2</sub>), and the hydrogen to bond with oxygen (O); thus changing the hydrocarbon chains to carbon dioxide (CO<sub>2</sub>), and water (H<sub>2</sub>O).

However, if there is a lack of oxygen during the burning of the fuel pyrolysis

occurs. Pyrolysis is a type of thermal decomposition that occurs in organic materials exposed to high temperatures. Pyrolysis of organic substances such as fuel produces gas and liquid products that leave a solid residue rich in carbon. Heavy pyrolysis leaves mostly carbon as a residue and is called carbonization.

### Not All The Same

The carbon from a running engine can be produced from fuel or motor oil. Because both fuel and motor oil are hydrocarbon-based, either can produce carbon compounds that can accumulate over time. One would think that the mileage on the engine would be a good indicator of the carbon accumulation; however there are more variables.

Figures 1 and 2 show intake ports from 2004 Honda CR-V engines. The engines are identical except for the mileage and the operating condition under which the engine ran. One of these engines has run for 80,000 miles, while the other has run for 130,000 miles. If you examine the carbon within the intake ports, Figure 2 has more carbon accumulation than Figure 1. Your assumption may be that it has more miles as well, however this would be wrong. Figure 1 has 130,000 miles where Figure 2 has 80,000 miles on it.

The carbon accumulation within an engine will vary depending on the type of hydrocarbons the fuel is made of, the detergents added to the fuel base, the type of hydrocarbons the motor oil is made of, the operating temperature of the engine, the pressure the carbon is produced in, the load on the engine, the engine drive time, the engine drive cycle and the engine design.

It is important to understand that the carbon produced within an engine is not

all the same. The carbon in the combustion chamber is produced under high heat and high pressure. Due to the conditions within the combustion chamber, the carbon produced is denser and has low porosity; additionally the carbon thickness is usually low. If the carbon accumulations get heavier around the flat outer edge of the piston or head in the squish area, carbon RAP can occur.

The clearance between the head and piston will be minimal in the squish

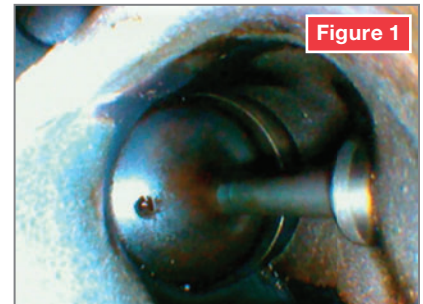


Figure 1

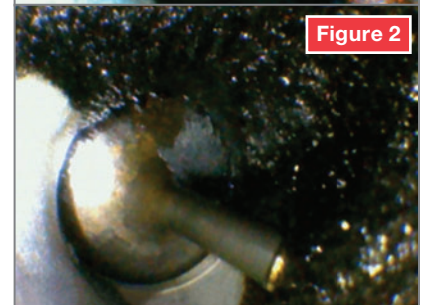


Figure 2



Figure 3

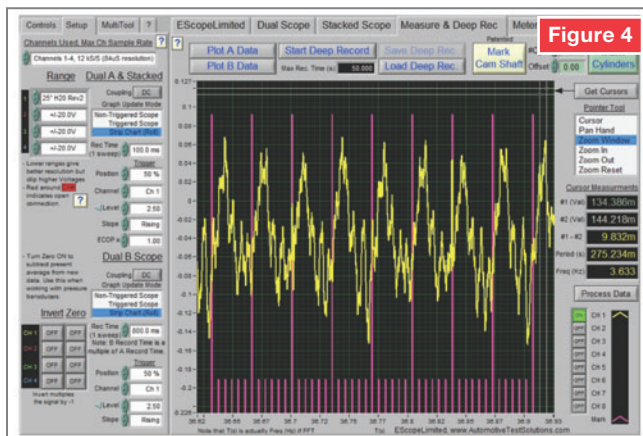


Figure 4

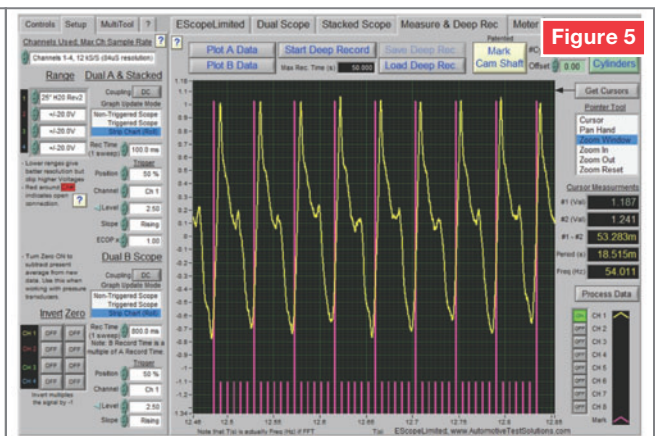
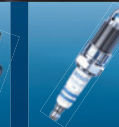


Figure 5



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area allowing the carbon accumulation to come in direct contact. This will produce a clatter sound that results between 1kHz and 10 kHz. This sound caused by combustion chamber deposit interference usually occurs at cold start and goes away in five minutes. This usually does not permanently damage the engine but produces an unpleasant noise.

These combustion chamber deposits will cause high tailpipe emissions and pre-ignition problems, which can cause serious engine damage. The detergent base added to the fuel is designed mainly to control combustion chamber deposits. Tier One fuels have additional additives in the fuel that work well to control carbon deposits. If these carbon accumulations are large, then an in-tank fuel additive should be used. These additives are poured into the fuel tank and can be effective in reducing this type of carbon build up.

The carbon in the intake is produced under low heat and low pressure. Due to the conditions within the induction system, the carbon produced has high porosity; additionally the carbon thickness can be quite high. The intake carbon accumulation can be produced in the throttle valve, the intake plenum, intake runner, intake port and the intake valve. These carbon deposits can disrupt the air flow into the cylinder causing performance and drivability issues. The more uneven the carbon accumulations, the greater the air disruptions.

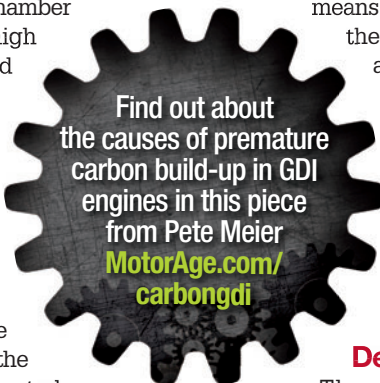
In Figure 3, an intake port is shown that has very heavy carbon next to an area with no carbon. This uneven accumulation will create heavy turbulence.

The multiport injector also can have carbon accumulations occur that disrupt and restrict fuel flow. These carbon accumulations usually occur from fuel droplets forming on the injector tip at hot engine shut down. These droplets can be formed from injector seepage or from the gasoline vapors condensing on the injector tip. The temperature of the injector tip bakes the hydrocarbon within the fuel creating carbon through pyrolysis. This carbon can disrupt the fuel spray pattern and can restrict the fuel flow. These fuel

injector carbon deposits create drivability problems, power loss, fuel economy and increase tailpipe emission.

If the engine is direct injected, the intake carbon accumulation will be very different. This is due to the carbon base having very little fuel in it. In a direct injected engine, there is no fuel directly delivered to the intake port or valve. This

means the detergent added to the fuel base does not get applied to the intake valve or port. This fuel flowing across the intake valve and the detergent is critical in order to keep the carbon from accumulating on the intake valve and port area.



Find out about the causes of premature carbon build-up in GDI engines in this piece from Pete Meier  
[MotorAge.com/carbongdi](http://MotorAge.com/carbongdi)

## Dealing with Carbon

The carbon accumulation within the ICE creates many different problems, such as determining if the engine has carbon accumulation present.

One way is to use a borescope; however this may be very difficult depending on the point of entry. If the fuel injectors are easy to remove, this is a good way to check for carbon accumulation. When checking with a borescope, you will need to check multiple intake ports. Because intake ports do not accumulate carbon at the same rate, different amounts of carbon will be present in different ports. Also, depending on the type of engine some intake valves and ports might have heavy accumulation while others have light accumulation.

The use of a pressure transducer with an exhaust amplifier is another way to check. In Figure 4, a 2000 Toyota RAV4 with 140,000 miles is shown before cleaning the induction system using a pressure transducer. In Figure 5, the same RAV4 is shown after cleaning the induction system. The exhaust pressure changes produced from the pressure transducer before and after cleaning are quite evident. The waveform created by the exhaust pressure makes it clear to see if carbon accumulation is present. The AUTOEKG made by Wynns (Figure 6), uses this exhaust pressure technology to check for combustion efficiency, and then rates the carbon accumulation in the engine.

Once you have determined that carbon is present, the next step is how to

remove the carbon from the engine. The carbon within the engine is chemically very close to asphalt. To start, it will be important to use quality chemicals.

Even with better chemicals, heavy carbon deposits may not be able to be removed without engine disassembly. When cleaning heavy carbon deposits, it is possible to cut through the carbon on the port floor, leaving the deposits on the port sides and top, this can increase the intake air disruptions, thus lowering power, torque and fuel economy. This usually occurs when trying to clean high mileage heavy deposited engines.

The method used to apply these chemicals is important. First the chemical must be able to reach the carbon deposit and soak it. This will need to be done by pressurizing the chemical and injecting it into the engine. During the cleaning phase, the engine rpm will need to be varied as the cleaner is injected into the engine with multiple snap throttles events.

The cleaner will need to be injected for at least 20 minutes. It will be important to use multiple chemicals to clean with. Many chemical companies make cleaning kits where there are three parts: a cleaner, a wash and a fuel tank additive. These chemistries work together and will make your induction cleaning more successful. In order to clean the induction system you may need to clean the engine multiple times.

If you are using a pressurized cleaning system and injecting the cleaner across the throttle plate, it will be necessary to have enhanced scan tools that can reset DTCs and relearn idle control functions. Some manufactures such as Nissan will need the idle air rate relearned when you are done cleaning the induction system. But most manufactures will auto learn the idle speed target and will not need to be relearned. **TM**



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

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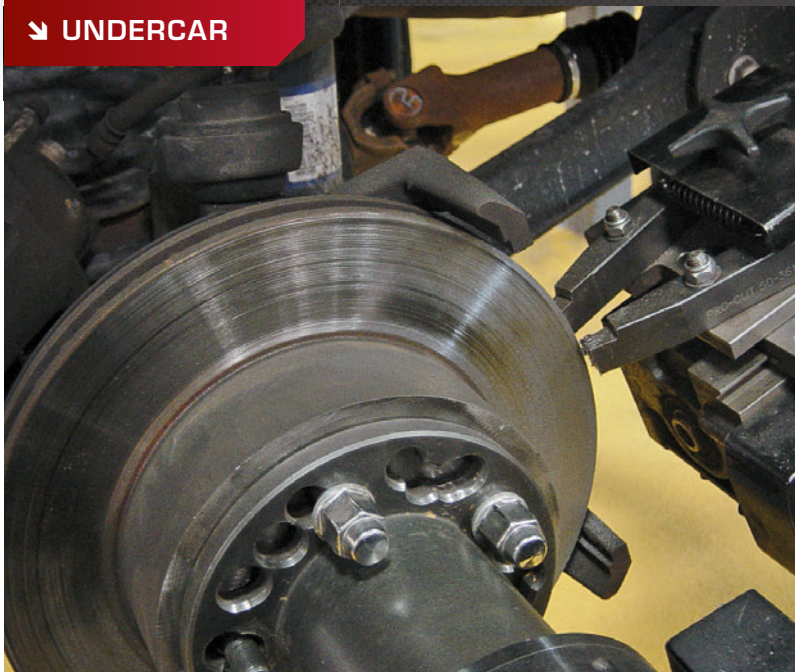


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# DISC BRAKE SERVICE THE RIGHT WAY!

## LIKE SO MANY 'ROUTINE' REPAIRS, IT'S AN EYE FOR DETAIL THAT SEPARATES 'GOOD' FROM 'GREAT.'

BY PETE MEIER | TECHNICAL EDITOR

**W**hen was the last time you looked at your work from the consumer's point of view? A recent repair to my personal Toyota Corolla (a fine 2007 vintage bare-bones sedan) put a \$350 hole in my wallet for a battery and alternator replacement. And I did the diagnosis and repair myself.

For many, \$350 is a large portion of their weekly income, and the last thing they planned to spend that money on was a car repair. When it comes to performing routine disc brake services, giving your customer their money's worth (and avoiding comebacks) requires attention to detail.

### In the Lot

"Customer requests complimentary brake inspection." How many of those repair orders have you been assigned? I've never had a customer take time out of their day just to have their brakes looked at. There always is an underlying reason, usually noise or pedal feel, that brought them into the shop. Make

sure your service writers get the whole story or that simple courtesy brake check might miss the real problem.

I've developed certain habits I perform on every car before bringing it inside. Notice the operation of all warning indicators during the bulb check. Make a note of any staying on that shouldn't. I also like to check the operation of all the interior controls to see if there are any hidden issues. Before starting the car, I like to pump off any accumulated vacuum in the brake booster (that should only take a few pumps of the pedal) and get a feel for the brake pedal's firmness and height. I also hold light pressure on the pedal for a few minutes to see if it tries to sink down, indicating a loss of pressure somewhere in the system.

Next, while still holding light pressure, I start the car and see if the pedal drops slightly as the booster vacuum builds. With some confidence that the hydraulics haven't gone south at this point, it's time for a short test drive.

First, I want to confirm the customer's underlying complaint. Most of my work



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orders, for example, would only say there was a "noise" and not much else. But you and I know that brake systems can produce a few different noises and they all have their own unique causes.

Grinding, or that sickening metal-to-metal sound, can be bad enough to make your teeth hurt and is a pretty obvious indicator that whatever friction material the pads originally came with is long gone. The question is not whether or not a repair is needed, but how extensive the damage is and what is it going to take to make it all right again. If I hear this noise, the rest of the test drive is cancelled and I head for the bay.

Squeals generally are caused by one of two things. First, it might be coming from a brake wear indicator and the squeal is trying to inform the owner that he'd better take his car in. A second cause for squeal is a vibration between the pad and the disc or caliper. Another, less common, noise is the

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scrub. This is a light, brushy kind of noise that I generally see related to pads that usually are not broken in properly and usually shows up as a comeback shortly after a brake service has been completed. Changing out good pads for ones with less than stellar reputations also can lead to this noise complaint.

In addition to listening for noise during the test drive, I try to gauge performance. Is the car coming to a stop as it should? Is there any funny feel in the brake pedal? Does the car try to drift to one side or the other when the brake is applied? Does the Antilock Braking System (ABS) work under a panic stop or is it working when it's not supposed to?

### In the Bay

Another habit I have is inspecting the tires, both for wear and for proper inflation pressure (even if the car comes equipped with a Tire Pressure Monitoring System (TPMS)). Brake pull and stopping effectiveness can be increased by tires that are lower than they should be. While I'm standing at each wheel, I also give them a good shake to check for obvious bearing wear and to look for loose steering and suspension components. Again, both play a role in brake performance and can impact brake operation.

With that done, I remove the wheels to take a peek at the brakes themselves. Is there any indication of overheating? Is

the brake pad wear even when compared both side-to-side and inner-to-outer? Is there obvious damage to the rotor's surfaces that would immediately require replacement to correct?

At this point, I have a pretty good idea of whether the customer is going to need the pads replaced and the rotors replaced or serviced. Before I go talk to my service writer (or to the customer), there's one more thing I like to check. I strip the caliper and rotor from each side, and then I like to physically measure the endplay in the bearing assemblies with a dial indicator. Most cars today use hub bearings that can be worn out but not detectable with a simple shake of the wheel assembly, understandable when the out of limit specification is typically 0.004 inch or so. Complaints of pedal pulsation often can be traced to worn bearings, both hub and tapered, and verifying the integrity of the bearings (no matter which type is used on the car you service) can help you properly correct an existing complaint and certainly avoid a comeback for one.

Finally, with the rotors off the car (though you can perform this on the car if you want to), I measure the rotor thickness variation to determine if there's enough material left to machine them. Notice I didn't worry too much about measuring lateral runout (in-and-out deflection) at this point. Had there been any pedal pulsation present, it's almost a given it is out of specification anyway. It's not a bad idea to mark the rotor's relative position to the hub prior to removal, just in case you need to put it all back together again. Getting a rotor clogged off a bolt hole or two can lead to excessive runout and the creation of a new complaint.

With the visual checks done, I can write up my parts needs and hand it off to the service writer. Included on every brake service I perform is a parts request for new caliper hardware, including any anti-rattle shims used. While it does add a little bit to the overall cost for the brake service, the difference in comebacks for noise, pedal feel and brake pad wear that results more than makes up for it.



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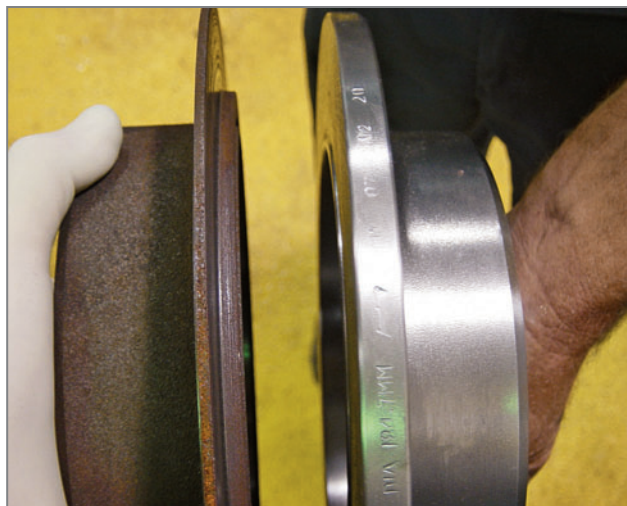
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## Rotor Service

When was the last time you checked your brake lathe for accuracy? The cones and hubs used to locate rotors on the lathe often are used in ways they were never intended. And they've never been dropped on the floor, have they? If the surfaces and mating points are damaged, it is very possible to resurface a rotor that has excessive lateral runout right from the start. Better yet, consider using an on-car brake lathe. Many OEMs recommend this tool to help prevent excessive lateral runout.

What's the big concern over lateral runout? It leads to pedal pulsation, and it takes very little runout to make that happen. Specifications for out-of-limits lateral runout is measured in the ten thousands of an inch! Here's what happens when lateral runout is excessive by even a little bit.

The "at rest" clearance between the pads and the rotor is very small. Rotors that have excessive side-to-side movement actually will rub against the brake pads as the "high" spots pass them. The rotor thickness begins to change in these spots, so when the pads are actually applied, they are forced to extend/retract in reaction to the varying dimensions. That extension/retraction is the pulsation you feel in the pedal. Your newly performed brake job will feel great on the initial test drive, but rest assured that if even a little too much lateral runout exists, the car will be coming back.

Another common contributor to excessive runout is rust build-up between the components. Make sure you clean the hub mating surface and the inside and outside of the rotor hat prior to machining either on the car or off.

The final rotor finish is a critical component to a successful brake service. Follow the recommendations of your brake lathe manufacturer on rough and final cutting techniques, including depth of the cuts and the speed of the lathe and bit feed. Finish off the rotor's finish with a 100 or 150 grit sandpaper block held to each side of the rotor for at least one minute.

Critical to avoiding squeals and contamination of the new linings is the cleaning of the rotor once you're done. Use only a mixture of hot water and dish-washing liquid to ensure all the small machining particles are removed from the rotor's surface. The use of aerosol cleaners can promote the retention of these fine shards. The cold refrigerant used as a propellant causes the surfaces to grip the debris, while the hot water causes the microscopic grooves to open and aid in releasing that material. Avoid touching them with your bare hands and don't allow grease or oil to contaminate them after cleaning.

I then lightly torque them in place with a few nuts I kept in my toolbox. The last step in rotor service is to verify the lateral runout is in spec by measuring it with a dial indicator on the car. If you find it outside of spec but have done everything right, rotate the rotor one bolt hole left or right and recheck.

## Caliper and Pad Service

One tip I haven't mentioned yet applies to the disassembly portion of the service. Somewhere along the line you'll need



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to retract the pistons in the calipers. To avoid causing problems in any of the systems tied to the brakes (ABE, TCS, ESC), be sure you open the bleeder screw before you put your C-clamp on the piston and start pushing. Contaminants in the system tend to settle in the caliper and the pressure you are applying, even by hand, can be enough to send debris into the hearts of solenoids.

Even before that, take a look at the piston seals, those rubber boots that become more and more exposed as the piston moves outward. Look for signs of tears or failure that would allow moisture and road debris to damage the piston itself. Pushing a rusted piston past the tapered seal keeping the brake fluid on the inside could be setting the stage for a serious system leak down the road.

The caliper assembly must be free to move, too. Make sure you thoroughly inspect the caliper mounting pins and bushings for damage and replace if necessary. If they come with the hardware kit, replace them regardless. Be sure to use an approved lubricant on them, and torque them to specification.

Also overlooked are anti-rattle components. Sometimes these are nothing more than thin metal shims between the pad and the pad mounts. Pads should install with some resistance. Too much play can allow the pads to move around with minor fluctuations in the rotor's surface or even bounce off of it when they are at rest, all leading to noise complaints.

Once the caliper mount is installed and torqued, install the pads. I like to place a touch of high-temperature lubricant on the contact points, but the backings are a different story. Every now and then, you'll get a pad that has an adhesive backing. No lube there! If not, I find a small coating between the backing and the piston (on the one side) or the mount-

ing fingers (on the other), helps control noise issues and prevent comebacks.

Remove the caliper assemblies from their hangers before reinstalling on the mounts. Whenever you have the caliper assemblies dismantled, be sure to suspend them with some form of hanger and never let their weight hang by the brake hoses. A few crafted coat hangers work for me, and the strut springs make for easily accessible points by which to support the calipers. Make sure the

hoses are routed but not kinked. Torque the caliper mounting bolts to spec.

Nearly every brake pad maker recommends break-in. Pads that are overheated when new can develop traits that only replacement will cure. The easiest one for me was the "30-30-30" break-in procedure. That refers to 30 medium full stops from 30 mph, with a 30-second break between stops. A final test drive to verify all is as it should be and you can turn the keys back over to the owner. *TM*

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

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# HEADING OFF COMEBACKS AND OTHER TALES

DON'T LET THAT CHECK ENGINE LIGHT MAKE YOU LOOK BAD IN FRONT OF YOUR CUSTOMERS.

BY G. JERRY TRUGLIA | CONTRIBUTING EDITOR

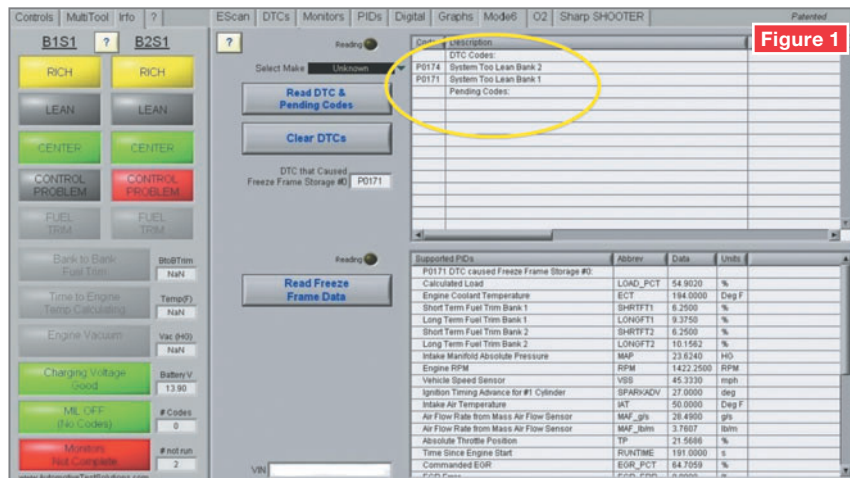
I have a few stories from the shop to share with you this month. The first shares a lesson on not getting caught with your pants down, another is a tale of a BMW clutch gone sour, while the third is just for your enjoyment! Let's get to it.

## A Leaking Lincoln

A new customer shows up at our door with a 2002 Lincoln LS (3.0 liter) complaining of a drivability issue and an illuminated Malfunction Indicator Lamp (MIL). Connecting our shop scan tool in Global OBDII mode found System Lean codes (P0171, P0174) for both banks stored in the Engine Control Module's (ECM's) memory. But when I check for codes and related data, I don't stop after checking the initial basics. Look closely at the screen capture in Figure 1. Do you see what I saw?

If you noticed the red warning that not all of the monitors had run since the last time the codes were cleared, you did see what I saw. In fact, to avoid being burned by a comeback I didn't cause, I make a habit of checking the monitor status on every car we service.

Why? Because the MIL light might return after my repairs and after the missing monitors run. Always remember that some codes, when set by the ECM, might cause testing in other systems to suspend until they have been corrected. As a tech, you perform flaw-



lessly and repair the original cause only to have your customer come back a day, a week or even a month later with the MIL back on. And all they know is they already paid you to turn that irritating light off once already. They don't want to hear, after the fact, that it is caused by a whole new problem. Learn the lesson I learned: If the monitors aren't all done when you get the car, advise your customer then and there that another problem might be hiding behind the one they came in with.

A quick look at Freeze Frame data and check of fuel trims at idle and at 2,500 rpm told me I most likely was looking for a vacuum leak as the cause of the System Lean codes. The fastest way to find out where the leak is, is to smoke the intake system, and our

smoke test pinpointed the leak to a failed PCV elbow. That's not uncommon for these engines especially when they have some mileage on them. The repair went without a hitch and I cleared the codes and took the car for a test drive.

Upon my return, I rechecked the monitor status and looked for pending codes (or first time failures that won't turn on the light until the second fail-

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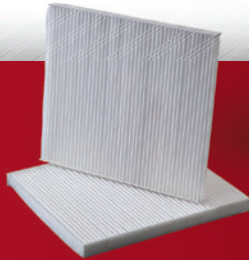
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ure). Sure enough, all but the EVAP monitor was complete and a new code was waiting its turn to frustrate its owner, a P0420 Catalyst Efficiency Below Threshold.

Good thing I had this all documented ahead of time!

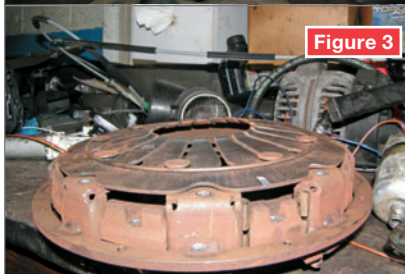
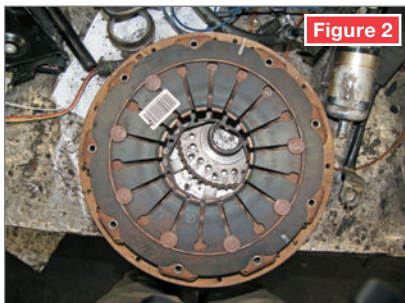
## Curing an Old Beemer

By Pierre Respault, TST VP

This older BMW came into a friend's shop with a host of complaints: erratic shifting, slamming into first and several dash lights on. Codes were found stored in the ECM including secondary air only on one bank, low voltage in several controllers and clutch position sensor faults. The vehicle had been sitting for more than a year, so for the time being I ignored the voltage codes.

This vehicle is equipped with a standard transmission that is computer controlled. When I scanned the transmission live data, the clutch position Parameter Identifier (PID) was extremely erratic with the engine running, but steady Key On Engine Off (KOEO). Our BMW service info said the clutch slave and position sensor were supposed to be replaced together. The slave has studs in it and the nuts are inside the bell housing, so the transmission has to be removed.

The clutch slave plastic end, fork and TO bearing were badly damaged, but the ultimate cause was popped rivets in the pressure plate. Notice the two rivet heads missing at the top and upper right positions (Figure 2).



In Figure 3, you can see the pressure plate's fingers are out of plane. This is why the feedback from the sensor was so bad and why the computer wasn't able to correct for the problem. I doubt the sensor itself was bad, but we followed BMW procedures and replaced the clutch, fork, pilot bearing, slave cylinder and sensor. This system needs to be initialized with a factory level scan tool or it will both not work correctly and destroy the clutch in a short time. After the repair, it shifted perfectly.

**“As techs, we understand the need to keep the engine’s filters clean and maintained. When was the last time you checked to see if your customer’s car was equipped with a filter for the air they’re breathing and inspected its condition?”**

## Out of Sight?

By Pete Meier, technical editor

Next time you're making the drive into work, take a moment to observe the cars around you. How many do you see that have every window rolled up tight in an effort to keep that nice air conditioned air inside (or to keep all that winter chill outside, depending on the time of year)? And cars made in the last 15 years or so seal so well you can almost feel the pressure change as you close the last door.

I think you'll come up with the same observation as I have. Most drivers like their cars sealed tight. Only one problem with that: contaminated air.

Did you know that unfiltered cabin air could be nearly six times more polluted than the air outside the car? And by pollutants, I mean things like pollen, dust, mold spores, diesel soot and smog. But that's not a problem for about 85 percent of the cars made since 2006. That's because they are equipped with a high tech device used to clean up that incoming air: the cabin air filter.


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First introduced in Europe in 1987 in an effort to protect passengers from pollen and dust, they quickly evolved to include traffic-related emissions like diesel soot and smog. But the idea really didn't catch on in the United States until the mid-1990s, and even then it was primarily used on the higher end of the OEMs offerings.

Cabin air filters have come a long way in a relatively short time. Most filters are able to filter out particles as small as 3 microns, with top-of-the-line filters able to screen out contaminants as small as 0.001 micron. To put that in perspective, a dot made with a sharp pencil is about 200 microns in size.

Cabin air filters not only play an important role in reducing airborne contaminants, but as a side benefit, they help keep the A/C evaporator clean. That helps reduce the potential for mildew and odor as well as ensure peak cooling performance. Left alone, a clogged cabin filter can impact A/C performance (by choking off air flow to the EVAP) and in some cases, has resulted in A/C compressor damage.

As techs, we understand the need to keep the engine's filters clean and maintained. When was the last time you checked to see if your customer's car was equipped with a filter for the air they're breathing and inspected its condition?

No, cabin filters are not just an add-on sale. They are as much a part of routine maintenance as servicing any other filter on the car. 



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](mailto:gtruglia@tstseminars.org)

# WHEN IT 'DIES'

IT'S A FOREGONE CONCLUSION THAT SOMEDAY EVERY MACHINE WILL 'DIE.'

BY RICHARD MCCUISTIAN | CONTRIBUTING EDITOR

Anybody who has taken money out of their pocket and bought steel on wheels, even in the form of a rusty/ragged old pickup, has, at the point of purchase, been fairly excited at the prospect of driving it for the first time as the owner. That feeling is multiplied when we're driving a newer vehicle. While all these rusty old hulks enjoyed that human attention at some point in their lives, we all know vehicles die – every one of them – sooner or later.

That being said, we all have known of vehicles that seem to survive for many decades, having been mollycoddled and maintained by gentle, loving owners until they become something of an oddity, like an aged person who is still living and functioning well for years after all of his or her children have died of old age. This “cars that don't die” syndrome is more prevalent in California, due to that state's stringent emissions regulations.



## ON THE LAST LEG

### 1996 CHEVY C1500

Vehicle Year/Make/Model

### 5.0L

Engine

### 4L60E

Transmission

### 278,438

Mileage

### IT WAS WORKING FINE, AND THEN IT "DIED."

Complaint

### When it Doesn't Quite Die

Short story No. 1: We typically don't do body work here except to adjust hoods, doors and tailgates, but this 2008 Mazda 6 had some cosmetic bumper damage. The short concrete post the owner encountered managed to pop past that soft bumper shell so as to shatter the plastic radiator support and in the process make a nice French curve arc out of the bottom of both the radiator and the A/C condenser. Neither of those were leaking, which was remarkable. The radiator support on this one was pricey but replaceable, and my student Bobby managed to get both of those heat exchangers and their housing replaced at about \$750. That one didn't die, but the Mazda suffered a black eye of sorts that we managed to straighten out.

Short story No. 2: We tackled a P047A – EGR Sensor 2 code on a 2009 TDI Jetta, which was an EGR sensor that had flat-lined. Don't get thrown by this — there are two of those sensors. Sensor 1 is at the passenger side shock tower and No. 2 is hidden in a flexible heat shield near the oil filler cap. Measuring sensor output voltage at both sensors, we replaced the one that wasn't delivering.

### When a Chevy CSFI Dies

This is the saga of my dad's 1996 Chevy pickup. In the spring, we replaced the intake manifold gasket for an oil leak concern — it was trickling down the back of the bell housing. In the process

of that repair, we replaced the plastic distributor and its cam sensor with a nice robust aluminum unit. We set the cam retard offset index to zero (that setting has been removed from the Genisys software for some reason, so we did it with the Autel MAXIDAS). There was another oil leak at the front of the oil pan that the previous owner had smeared with copious amounts of RTV that did nothing to mitigate the leak. That repair would have to wait until summer, though a few weeks later he mentioned some bucking and jerking that it would do from time to time. But it wasn't regular enough to duplicate easily, so I didn't take time to yank any codes.

When summer arrived, we found we had to replace not only the oil pan gasket but also the timing cover in order to stop the front leak. The exhaust had to be removed to get the flywheel cover and the oil pan off. The timing cover, which is supposed to be replaced if ever removed, was broken, but you couldn't see that until the oil pan was removed. The cover wound up being the reason the oil was leaking in that area.

After dad took delivery of the truck, the bucking and jerking got a lot worse to the point that it was losing power in a big way. He attempted to bring it back the following week, and it died on the road about 15 miles out. We had a local wrecker pick it up and bring it in.

The first thing I usually do on those Central Sequential Fuel Injection

Photos: Richard McCuistian



# SCAN TOOL SELECTION: INTEGRATION AND SPECIAL TESTS

**A**n inexpensive code reader can spit out DTCs and give you a definition, but is lacking when it comes to the need for resets, relearns and special tests. Many times this can be the difference between simply getting a car running again and actually fixing it for the long haul. How do you find the right scan tool to go beyond reading codes, and what does it need to do? Integration, speed and the availability of special tests should be a minimum requirement to justify your purchase.

## Why special tests?

Nearly every vehicle system includes a module that can provide a trouble code. However, not every code provides a great description of the vehicle issue or a roadmap to a fix. Most are a good start but without background knowledge or the right tests, you're just guessing at the problem.

When a code arises with no clear direction, look at your scan tools' special tests. The OTC Encore includes industry-leading special tests in ABS, airbag, body, suspension, steering, hybrid, tire pressure monitoring system (TPMS), park assist and instrument cluster modules for faster diagnosis.

Within your shop special tests can get you to and through a vehicle fix quickly, helping pinpoint a vehicle issue based on results.

Many drivability issues can be diagnosed and remedied quickly using one or more of the above special tests, so it's important to ensure your scan tool includes them. If you're looking for guidance, scan tool test procedures can be found on OTC's website.



## Integration Benefits

An integrated, fast-booting and quick response scan tool will keep you at the vehicle during a diagnostic session with on-tool and Web databases for repair information. These resources save time and help you diagnose and fix a vehicle faster. It's why more diagnostic tools today include testing, repair databases and common fixes, going beyond the scope of just reading codes. The key is finding which tool has the tests and integration that works best for you.

No scan tool in the North American market matches the coverage offered by OTC's Genisys Touch and Encore scan tools, including special tests and on-tool resources. Both tools are updated multiple times per year with new vehicle

coverage and special tests, with Encore recently adding Tire Pressure Reset procedures and capabilities along with HD diagnostics information.

## What's right for me?

The above rundown list some considerations when selecting a scan tool, to ensure you and your shop have what's needed. Do your research and ask to borrow one from a local distributor for a few days. Having the tool in-hand to test can help make your decision a bit easier. Just remember, a scan tool is a long-term investment and frequent updates, special tests and integrated resources can mean the difference between fixing a vehicle fast and a frustrating diagnostics session.

(CSFI) Chevys is check the fuel pressure, because if it's less than 60 psi, weird things happen. I had a fast student throw a \$71 fuel pump in it, and the pressure rose to the comfort zone I like for these — about 65 psi. I had the same student, Melissa, replace the fuel injection spider with a newer one that has electronic injectors at its tips. It was pricey (\$269), and I really didn't expect it to fix this problem, but since this was Dad's truck, replacing that spider was

something I wanted done. But she needed to be certain she was putting the injectors in the right ports, and she did.

I forgot to mention that I was getting crank and cam sensor codes on the scan tool. While the scope didn't show any problem with the cam/crank pattern, the fact remains that there is a GM Technical Service Bulletin (TSB) on replacing the crank sensor and adding a shim (02-06-04-059 Engine Runs Rough, Service Engine Soon Light On,

DTC P0300 OR P0335 SET), so that was done, too. The replacement sensor came with shims, by the way. Also interesting was that the Cam Retard Offset PID was showing -5 degrees before the crank sensor was replaced. Checking it afterwards showed a zero reading, which was what I wanted.

On the next Friday, while I was there by myself working on some other stuff, I started the Chevy and it sounded pretty good, so I figured I'd let it run a while. But then it began to deteriorate in a big way. I could see the cherry red glow of the catalyst on the pavement under the truck, so I switched it off. The brick wasn't rattling, and I didn't want to endanger a converter that might not

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This Mazda kind of took it on the chin from a concrete post. While the repairs were fairly simple, the parts were expensive – particularly that plastic radiator support, which had to come from the dealer.



The 2009 Jetta had a bad EGR pressure sensor – a remote relative of the DPFE sensor on Fords, only this diesel has two sensors. The funky foil wrap right behind the oil filler cap hides the sensor we replaced. Note the identical sensor at the end of the engine.

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be bad, so I had a student remove the Y pipe and converter.

The truck now would start and idle rough, sort of like it would if EGR was flowing at idle, but when you applied throttle, it would start backfiring out the exhaust at about 25 percent throttle and then totally shut down unless you let the throttle come below that spot where that was happening. The scan tool Parameter Identifiers (PIDs) didn't shed any light on this anomaly either.

The truck had new spark plugs, and fuel pressure was consistently at 65 psi, so I opted to snag a VCM from the local salvage yard. With that VCM plugged in, you could accelerate the engine without the die-out and backfiring, but it wasn't firing on cylinders 2 and 7, even though spark was present. A scope check revealed that those two injectors weren't even

getting signals. The same VCM fits V6 or V8 engines, the difference being the PROM chip, and so we jerked the PROM out of Dad's VCM and plugged it into the salvage yard PCM only to find that the backfiring/shutdown problem followed that PROM. A call to GM revealed they don't offer the PROM any more.

I found one aftermarket supplier who had new ones for \$200, but that was a non-starter. I called the salvage yard and received four more VCMs. I plugged them in one at a time and found one that made the Chevy run showroom good.



Read more from Richard as he shares his viewpoint on the automotive skills gap in the U.S. [MotorAge.com/viewpoint](http://MotorAge.com/viewpoint)

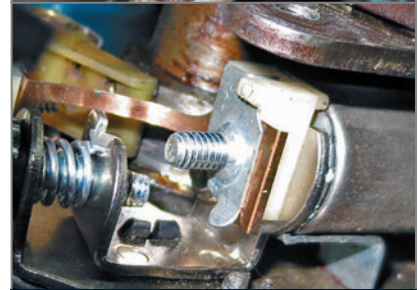
### A Vintage Caddy Adventure

In May, the president of our college showed me a photo on his smartphone of a 1971 Eldorado convertible that looked like something of a cream puff. He told me the engine had been replaced with

a rebuilt unit from a 1976 model, and he added that the transmission had been rebuilt as well. He asked me what he and his son needed to notice when they



The flywheel it came in with had seven of these. Even after we egged the bottom starter hole and moved the gears closer together, did this again after about 30 starts, the second flywheel lost a tooth very suddenly. Bobby was a trooper on this one — he had the transmission out twice.



When we finally got the Caddy spinning over, there was no spark, and this is what we found under that brand new distributor cap. We were told that the tire store didn't even look at the points because the cap and wires were new and they figured the points were new, too.

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went to consider buying it, and I told him that on a 43-year-old car, all bets are off.

When the car was purchased in that faraway city, it ran like a dream for more than 200 miles, but then it lost power to the point that it couldn't be driven. It was towed to a tire store, where the decision was made to replace the carburetor and the starter. The bill was about \$1,000, and the car was sitting there idling when the bill was paid, but the car only ran another five miles before it quit again and wouldn't start. A wrecker brought it the rest of the way home.

To begin, we needed to replace the flywheel, which was missing seven teeth, no two of them adjacent. This starter bolts into the transmission housing like a Ford, and there is virtually no adjustment possible without modifying something. Peering with a mirror through the big bell housing starter drive inspection hole while the starter drive was kicked in without spinning the starter, we noticed that the one of the broken teeth was at the drive. Even if the tooth had been there, the starter's teeth were barely making contact with the flywheel, so we yanked the transaxle, popped a \$60 ATD flywheel in there, egged the bottom starter bolt hole and moved the starter into better mesh with the flywheel.

Then we tried to start that 500 CID powerplant and found that we had no spark. With that brand-new distributor cap removed, we saw that the points

literally had come apart. Because these were plain old GM points, it was a snap to get a new set and a condenser. Even with the points replaced, the engine was kicking back. The firing order was right, but the distributor was a tooth off so that attempting to adjust the timing to 8 degrees rammed the vacuum advance against the A/C compressor. Someone moved the wires one position to fix that without pulling the distributor. My student Bobby straightened that mess out and set the timing right. The car started and ran like a dream until about two days later, when the starter popped another single tooth off the new flywheel.

The broken tooth lined up exactly with the starter drive gear, as if the tooth had popped off before the engine had even started to turn. We did see the driver gear ram those square-cut teeth without meshing a few times when we were watching it. Could the starter shear a flywheel tooth that way? The transaxle and the flywheel came back out, and I put both flywheels on my tire balance machine so as to spin them and check for runout. The old flywheel had lateral runout and the new one

had radial runout. The gears on the low side of the radial runout were showing signs of shallow gear contact.

On the second new flywheel, I used a high speed cutter to bevel the starter side of those square cut flywheel teeth to match the bevel on the starter drive in hopes of mitigating the gear-butting concern. We put it back together that way, this time with new flywheel bolts, since the other ones had stretched threads and were getting tired. We moved the starter close to the flywheel again using the egged bottom hole to adjust it, and the starter sounded better than ever. **ZZ**



**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.

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The top photo shows how sloppily the battery was mounted when we first opened the hood. Every time the car hit a hard bump, the battery terminal bolt would arc against the radiator support. We got a cheap universal battery tray and hold-down and mounted the battery the right way.

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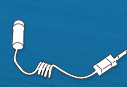
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### ENGINE CONTROL LINE EXPANSION

Standard Motor Products, Inc. debuts its latest TechSmart line expansion for 2014. TechSmart has added 28 new premium parts to its growing line of engine control products and solution-based parts. Highlighting this release are expansions to some of TechSmart's most popular categories: keyless entry transmitters (key fobs), electronic throttle bodies, park assist sensors, headlight wiring harnesses and more. These new products cover more than 9 million additional vehicles-in-operation (VIO) for domestic and import applications through model year 2013, according to the company.



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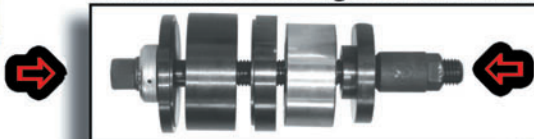
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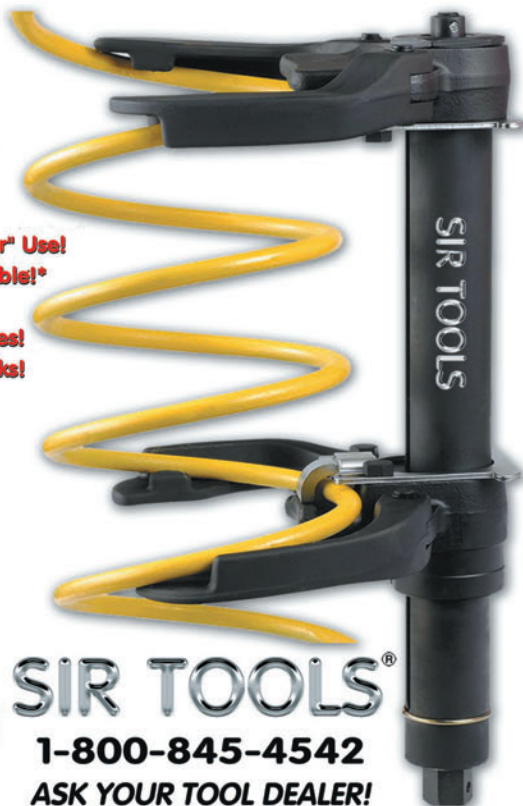
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Magneti Marelli

## HUNTER RELEASES POWERFUL NEW GENERATION SWING-ARM TIRE CHANGERS

Hunter Engineering Company has released a new generation of Swing-Arm tire changers with more rigidity, power and performance than models currently on the market. The TCX53 Performance, TCX51 Professional and TCX50 Standard tire changers are each heaviest in class with more stiffness to handle today's tough tires. Each tire changer also uses Hunter's PowerOut™ bead loosener for the most powerful in-class bead breaking capability.



Hunter Engineering

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## NEW MIRRORS FEATURE SIGNAL LIGHT

DEPO introduces 335-5409L/R3EFH1, the side view mirrors for Chevrolet Silverado/GMC Sierra 07-10 with signal lights. With knowledge and experience in auto lamp industry, DEPO has redesigned the internal components of the signal light and applied for a patent. In addition, the appearance of the signal light on the mirror surface is changed to DEPO logo. See more information on [www.maxzone.com](http://www.maxzone.com).



Maxzone

## AUTOMATIC LEVERLESS TIRE CHANGER

The new R80DTXF tire changer features an automatic bead lifter, variable speed turntable and bilateral bead loosener with direct hand-operated controls. It also offers a traveling drop-center tool, top bead assist rollers, dual lower bead lifting discs and a nylon non-marring wheel restraint device. A 31-inch capacity turntable with adjustable hardened-steel RimGuard wheel clamps help shops broaden their service range. Visit [www.rangerproducts.com](http://www.rangerproducts.com) for details.



Ranger Products, a division of BendPak Inc.

## FEDERATED OFFERS PREMIUM BRAKING PERFORMANCE FOR TODAY'S VEHICLES

Federated Auto Parts has developed an addition to its friction offering with a new co-label line developed and supplied by Wagner Brake. The new product line is a premium offering designed for professionals that was exclusively designed for Federated members and their customers. The line uses the highest performing formulas specific to each application and includes System Synergy Technology (SST), which is an OE approach to brake design that ensures the interaction of all brake components to provide the ultimate performance.



Federated Auto Parts

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# A PICTURE IS WORTH A THOUSAND WORDS

WHY LOOK AT SNAPSHOTS WHEN YOU CAN WATCH A MOVIE?

BY **PETE MEIER**  
**Technical Editor**

No doubt, modern scan tools and the data available to them has made diagnosing a variety of problems easier than ever. Of course, that's all conditional on first being familiar with the scan tool you're using, then understanding what all those data Parameter Identifiers (PIDs) mean and interact followed by how they monitor the system(s) you're troubleshooting.

So you've got that down pat. Now what if the scan tool reading is a lie?

Even with a factory scan tool, you have to remember that the information you see displayed on the screen is a report from the questioned electronic control unit (ECU), telling you what it thinks it is seeing from its input. If you really want to see what information the sensors are sending to the ECU, you should go straight to the source, the sensor itself, and take your own measurements.

And there are a couple of ways you can do that. You can use your trusty Digital Multimeter (DMM), a low amp clamp or my preferred tool of choice, the Digital Storage Oscilloscope (DSO).

The DMM can tell you if a sensor has good power and ground and what the signal reading is. It even can measure duty cycle or pulse width. But any measurement you take is a capture from a single moment of time, and if



there is a dropout of the signal occurring, your DMM may or may not help you catch that.

The DSO takes a bunch of stills and displays them all over time. Today's scopes, even the most inexpensive of the lot, have sampling rates fast enough to catch most of the circuit issues you'll need to find to cure a customer's complaint. Additionally, scopes with multiple channels (like having two, three or more DMMs hooked up at one time) can allow you to check all the electrical aspects of the sensor at one time – power and ground, voltage drop across the circuit, and signal quality.

Of course, the DSO is not limited to testing electrical sensors. If you are even somewhat comfortable with how to use

your DMM, making the move to the DSO to test any electrical circuit or device is easy. Watch this month's edition of The Trainer and see for yourself. [ZZ](#)

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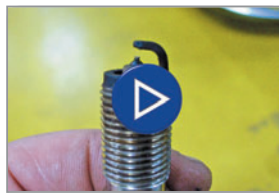


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