Motor Age®

Advancing the Automotive Service Professional Since 1899

August 2015

Talk Shop Anytime

You Tube AUTOPRO WORKSHOP

Vol. 134, No. 8

COMMUNITY

THE SEARCH FOR A QUALITY TECHNICIAN

There may be computer-minded youth in your area who just need some training.

TECHNOLOGY

EXHAUSTING THE POSSIBILITIES

Exhaust systems are much more than mufflers and tailpipes.

OPERATIONS

GENTLE REMINDERS FOR BIG BUSINESS

Provide visible, searchable and sharable content to ensure a full waiting room.

PRACTICAL ASIAN DIAGNOSTICS

A COLLECTION OF LESSONS LEARNED

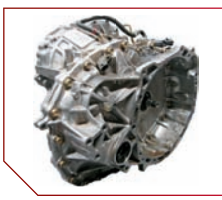
GET A BLUEPRINT TO MORE EFFICIENT SHOP PRACTICES AT MOTORAGE.COM/BLUEPRINT

TRENDING

SERVICE CONTRACTS

This often overlooked profit center can help shops retain customers

Motor Age Vehicle Protection



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SECTION 3C

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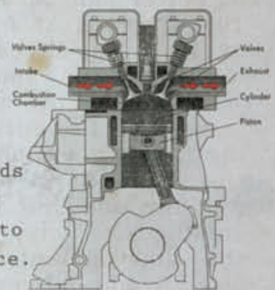

Fig. 2–Engine Fuel System

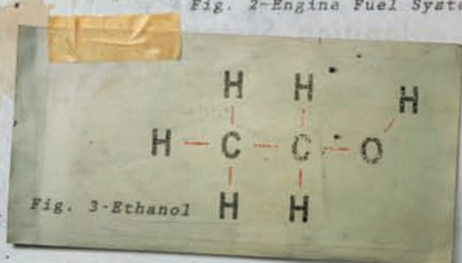

Fig. 3–Ethanol

Ethanol is a solvent that attacks metal surfaces, allowing water in the fuel system to have a faster and more corrosive impact.

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Talk Shop Anytime
AUTOPRO WORKSHOP

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OPERATIONS

MANAGEMENT

GENTLE REMINDERS FOR BIG BUSINESS

BY **BRIAN CANNING** | CONTRIBUTOR

10 Provide visible, searchable and sharable content in the waiting room.

PROFIT MATTERS

DON'T LET YOUR SPONGES DRY OUT

BY **CHRIS "CHUBBY" FREDERICK** | CONTRIBUTOR

14 New employees are sponges ready to soak up new information and training

FINANCIAL FIGURES

ARE WE IN DENIAL?

BY **BOB GREENWOOD** | CONTRIBUTOR

18 Shop owners must be open to embracing change.

SHOP PROFILE

WHAT'S IN A NAME?

BY **ROBERT BRAVENDER** | CONTRIBUTOR

26 When a shop is called Smith Auto Repair, you have to do something to stand out a bit.

TRENDING

4

Motor Age® Vehicle Protection

SERVICE CONTRACTS AS A PROFIT CENTER

BY **LARRY SILVEY** | CONTRIBUTING EDITOR

4 Often overlooked, service contracts aim to attract and retain customers with high quality coverage.

MOTOR AGE LAUNCHES SERVICE CONTRACT PLAN

4 Extended service contract plan is available for independent shops.

SHOP OWNERS SHARE SUCCESS TIPS AT NAPA EVENT

4 NAPA Expo 2015 welcomed 18,000 attendees in Las Vegas for training, education and networking.

RAYBESTOS SWEEPSTAKES TO GIFT THREE VEHICLES

4 Contest is open to Raybestos distributors and Brake Parts Inc. customers until Sept. 4 and will gift Chevy Sonic delivery vehicles.

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SHOP OWNERS SHARE SUCCESS TIPS DURING NAPA EXPO 2015
NAPA Expo 2015 welcomed 18,000 attendees from around the world to gain insight on shop success stories.
»» MOTORAGE.COM/NAPAEXPO

MITCHELL 1 FINAL SHOP MANAGEMENT WORKSHOP
The workshop, which is scheduled for Oct. 1-3 in Orlando, Fla., is designed for shop management software users to learn about new features.
»» MOTORAGE.COM/SHOPMANAGEMENT

ALI LIFT OFFERS INSPECTOR CERTIFICATION
Attend ALI "Five Days to Victory" training at the College of Southern Nevada in Las Vegas Nov. 1-5 to earn certification.
»» MOTORAGE.COM/FIVEDAYS

NEW GREEN STANDARDS FOR SERVICE AND REPAIR SHOPS
Green Service Standard announces $10,000 in grant funding to train employees about vehicle green scores and ratings.
»» MOTORAGE.COM/GREENGRANT

RAYBESTOS SWEEPSTAKES TO GIFT THREE CHEVROLET SONIC DELIVERY VEHICLES
Sweepstakes is open to Raybestos distributors and Brake Parts Inc. customers until Sept. 4.
»» MOTORAGE.COM/RAYBESTOSDELIVERS

BETTS SPRINGS MANUFACTURING LAUNCHES NEW VIDEO SERIES
New educational YouTube channel explains rigorous quality control, production and manufacturing processes.
»» WWW.MOTORAGE.COM/BETTSVIDEO

Motor Age
Vehicle Protection

SERVICE CONTRACTS

An overlooked profit center: service contracts

BY **LARRY SILVEY** | CONTRIBUTING EDITOR

"Eighty-five percent of motorists who acquire service contracts through a repair facility will typically return to the same shop for claim repairs" says Rick Bale, managing director for Century Warranty Services, Inc.

That being the case, shouldn't all shops offer service contracts to their customers?

"Absolutely," says Bale, "Connecting the customers with high quality coverage is good for the shop and for the customer."

Some shops have dabbled in selling service contracts but most shop owners have overlooked service contracts not realizing that they are a key tool for retaining customers. They give shops the opportunity to build long-term relationships with customers who prefer to have their service work performed by the very businesses that helped them protect their vehicles from costly repairs.

Having this connection with customers also creates opportunities that make it easier for shops to recommend other necessary services such as regular maintenance during visits when repair claims are made. The opportunity to add parts and service revenue over the life of the contracts from both repair claims and customer pay maintenance is clearly present because the customers' perspective is that they've bought one stop peace of mind from someone they trust for the protection and care of their vehicle.

"From the shop owner's perspective, offering service contracts aligns with a shop's core business of maintaining and repairing vehicles versus other prospective profit centers," says Bale. "It's wonderful if some shops can afford to start other retention businesses such as a car detailing operation, but the required investment in a new enterprise can be challenging or even crippling to them. Yet it doesn't cost anything to offer service contracts."

[service contracts] CONTINUES / PAGE 6

Photo: Motor Age

BREAKING NEWS

CONTRACT PLAN

MOTOR AGE LAUNCHES NO-RISK, TURNKEY SERVICE CONTRACT PLAN

Motor Age has launched an exclusive extended service contract plan for independent automotive repair shops to offer to their customers. Designed to be a turnkey solution to help shops boost their profits, the plan is called the Motor Age Vehicle Protection Plan (MAVPP).

"The beauty of this plan is that everything to assist a customer with obtaining quality coverage — administration, marketing, sales and claims — is handled by coverage specialists for shop owners so that they can tend to their core businesses," said Jim Savas, VP/GM of *Motor Age* and the UBM Advanstar Automotive Group. "Moreover, it is risk free because it does not require financial or personnel investments.

[contract] CONTINUES / PAGE 6

Discussion is ongoing in MotorAge.com forums

[contract]

CONTINUED. FROM PAGE 4

Connecting the customer with high quality coverage is good for customers and good for shops."

This is made possible by *Motor Age* partnering with Century Warranty Services, Inc., (CWS) one of the nation's premiere service contract providers and Automotive Product Consultants, Inc. (APC), a leading industry marketer who powers the program."These companies have achieved great success in the service contract business by being customer-focused," Savas said. "It takes a company of Century's caliber to handle claims professionally, promptly and fairly, which, of course, reflects favorably on the shops offering the contracts."

Rick Bale, managing director at CWS, said company officials are ecstatic to partner with *Motor Age*. "Century Warranty Services and its affiliates have been providing premium contracts in the automotive arena since 1978 and are excited about doing the same in the independent repair sector by teaming up with its leading resource."

According to Bale, MAVPP claims will be handled through CWS, which was established specifically to serve non-auto dealer channels. "An accurate and timely claims process will be supported by veteran team members, many of whom are ASE Certified and Master Tech claim adjusters," Bale said. "To make sure that a shop's customers get a plan that suits their needs, a variety of coverage levels are offered ranging from covering only catastrophic drivetrain failures to covering virtually all mechanical and electronic components."

"One of the features that makes MAVPP ideal for independent repair shops is the Portal Referral System (PRS) powered by APC," said Savas. "PRS is an easy-to-use desktop tool installed on the shop's computer to provide customers immediate information on available Century plans and then connect customers to coverage specialists to handle the details.

"Shops can use PRS four different ways depending upon how involved they would like to be with the sales process." Savas explained. "Shops have the option to simply provide their customers information, quotes or start the sales process before turning the details over to coverage specialists, thus saving shops from performing any processing task."

For more information about the MAVPP, please contact Bob Olsen at (866) 225-7135.

[service contracts]

CONTINUED. FROM PAGE 4

Protection against mechanical breakdowns are foremost on customers mind during a customer pay service visit. However, many customers are likely unaware that they are still eligible for coverage outside their factory warranty. This creates the perfect opportunity to raise the issue and offer valuable protection to shop customers. Once they are informed that they are eligible, they are primed to learn about how they can protect their vehicles. "The key to selling service contracts is to assist customers by making the best coverage options available that specifically matches their vehicle, driving habits and needs", Bale says. "Customers want professional consultation when considering a service contract, not a hard line sales approach. After all, that's what they want from service advisers when discussing maintenance and repair options for their vehicles."

"Typically, with service advisers concentrating on the daily tasks of writing up vehicle repairs, they are not prepared to offer advice or to sell service contracts", says Bale. "Selling service contracts involves training service advisers or having a third party specialty firm standing by to handle it for them." He adds, "Both options are possible depending on a shop's particular needs."

Because service contracts help achieve the ultimate goal of taking care of a vehicle, offering them should be viewed as a customer service that is easily incorporated into an adviser/customer exchange. For example, Bale says that, "a good time to bring up the subject is when a service adviser reviews the results of a multi-point inspection on the customer's vehicle or when the customer is picking up their vehicle."

Summing up, Bale says, "Offering service contracts is a practical and effective way to exceed the customer's expectations, which also happens to be beneficial to shops."

ASE GUIDES QUESTION OF THE MONTH

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☑SURVEY: Technician A says that fuel trim data can be used to isolate which side of a dual exhaust system is restricted. Technician B says that exhaust leaks can be hidden from a casual visual inspection. Who is correct?

A. Technician A
B. Technician B
C. Both A and B
D. Neither A nor B

Take the test, and then click on the link to register for the free prize drawing from our partner, Federated Auto Parts!

FROM THE BLOG SPHERE

The search for a good quality technician

There may be computer-minded youth in your area who just need some training

BY **CHRIS "CHUBBY" FREDERICK** | CONTRIBUTER

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

Randy said nowadays it seems that kids are not getting into the business like they used to. I remember when every school parking lot was filled with old Mustangs and Camaros, and the kids that hung around talking about cars were called motor heads. Those kids are the ones that ended up becoming technicians in our industry because they had a true passion for work-

MotorAge.com **BEST OF THE BLOGS**

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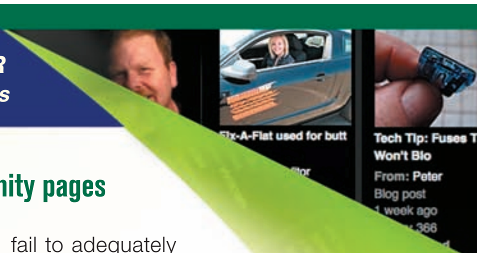

BEST OF THE BLOGS are articles written by bloggers on Motor Age's community pages

Move past business burnout to dwell on the future

by Bob Greenwood

Over the last 6 months, has there been a time when you just wanted to give up? Every business person can relate to that question, and let's be honest, every business person has experienced partial burnout because of being under staffed, which creates a self-overworked syndrome.

So let's stop feeling sorry for ourselves and understand what has taken place.

There is so much change and discipline required to be in business today. And often the longer you have been in business the easier it is to say, "The heck with it," and plan to give up. These shop owners and managers may end up putting their head in the sand. Re-read the headline of this article because it is very true. If you give up trying to be the best version of yourself, your actions will haunt you. Tremendous regret will stay with you for the rest of your life, and you may end up saying, "If I only stuck with it and got things done…"

Many business people enter a stage called Business Normalcy Bias. When you are in a state of Business Normalcy Bias it means you are overwhelmed with all the change that is required and simply believe these changes can't happen. So you say, "Why should I keep trying?" Let's look at the formal definition of normalcy bias and bring it into context for the shop owner who is going through this.

Wikipedia explains the normalcy bias as "a mental state people enter when facing a disaster. It causes people to underestimate both the possibility of a disaster occurring and its possible effects. This often results in situations where people fail to adequately prepare for a disaster. The assumption that is made in the case of the normalcy bias is that since a disaster never has occurred, then it never will occur. It also results in the inability of people to cope with a disaster once it occurs. People with a normalcy bias have difficulties reacting to something they have not experienced before. People also tend to interpret warnings in the most optimistic way possible, seizing on any ambiguities to infer a less serious situation.

The normalcy bias may be caused in part by the way the brain processes new data. Research suggests that even when the brain is calm, it takes 8–10 seconds to process new information. Continue reading at MotorAge.com/dwell.

ing on and fixing up their cars and trucks. Where do we find that person now? Maybe you don't. The hiring experience has changed drastically and you have to change with it. Perhaps we can help.

Make tuners apprentices

Look around the school parking lots now and what do you see? Kids driving Mom's BMW sometimes, but also a lot of little four-cylinder Civics, Preludes, etc. Continue reading at MotorAge.com/search. MA

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Servicing the serpentine belt

Auto designers would love nothing more than to remove every accessory drive you see on the front of the engine. Until they do, it is important that we stay on top of the service and repair of these systems.

MotorAge.com/drive

Hybrid conversions can save fleets money

Many large corporations are converting their conventional vehicles to hybrid drives using systems like the one we discuss here.

MotorAge.com/conversions

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Noteworthy

comments from *MotorAge*'s online communities

The best of what you're saying in the Motor Age Magazine group on LinkedIn

Raymond Massenberg, Automotive Coordinator, AAA Michigan wrote:
GM said in a statement that they intend to cut Chevy, GMS powertrain warranty to 60,000 miles based on discussions with customers.

Peter Gold, CEO, Inview Vehicle Trim Cooporation:
Less warranty coverage. Are you nuts? Decrease the value of the vehicle at trade in. That's real marketing stupidity. What is next, bumper-to-bumper warranty coverage for ninety days or fifty miles, whichever comes first?

George Brown, Diagnostic Specialist/Shop Manager, Dolan Lexus:
Dealership flat rate techs should rejoice, it will mean fewer years of their repair times being tied to the warranty rate. Other than that I don't believe it will have a tremendous impact on the majority of consumers. Most higher mileage repairs ultimately relate to consumer maintenance and operating habits. The real cost savings may be in not having to warranty as many borderline abuse cases. The consumer who maintains the car to begin with, will feel no impact what so ever.

Jeremy Cathey, Nissan Service Tech, Nissan Dealer 18054:
Lowering warranty repairs should start at the manufacturing design stage, better built vehicles equal less money to dealers for warranty repairs. This equals happy customers with owner loyalty and customer retention.

join the community—join the discussion MotorAge.com/Community

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ABRN.COM

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Get advice from industry experts to ensure the best transfer efficiency, partnered with the best finishes possible.
ABRN.com/boost

Waiting for aluminum
Shops can do plenty to prepare for aluminum before they even see a 2015 Ford F-150 at their door.
ABRN.com/waiting

Benefits of giving back in collision repair
Most businesses today already know they need to give back, but it may be hard to understand how to measure the benefits of return on investment.
ABRN.com/benefits

AFTERMARKETBUSINESS.COM

Pep Boys considers possible sale
The Pep Boys announced that its Board of Directors has commenced a review of strategic alternatives to enhance shareholder value.
AftermarketBusiness.com/pepboys

U.S. House Subcommittee addresses telematics
The U.S. House Subcommittee on Commerce, Manufacturing and Trade held a hearing entitled, "Vehicle to Vehicle Communications and Connected Roadways of the Future".
AftermarketBusiness.com/telematics

Global business is good
Business conditions in the global automotive aftermarket are good, according to the leading suppliers exporting their products into international markets.
AftermarketBusiness.com/global

2015 INDUSTRY CALENDAR

September 9-11
AutoCare Association Fall Leadership Days
Austin, Texas

November 2-5
AAPEX 2015
Las Vegas, Nev.

November 3-6
SEMA 2015
Las Vegas, Nev.

November 4
NASTF General Meeting
Las Vegas, Nev.

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TAKE CONTROL
OF YOUR BUSINESS

IN THIS SECTION

read it on MotorAge.com

FEDERATED NAMES CO-MAN VENDORS OF THE YEAR
KYB Americas, NGK, Anchor Industries honored
/coman

TRW ADDS 52 NUMBERS TO CHASSIS PROGRAM
Supports TRW's position as leading provider
/trwchassis

ATTEND ALI TRAINING FOR LIFT INSPECTOR CERTIFICATION
Hosted by College of Southern Nevada, Nov. 1-5
/ali

MANAGEMENT

GENTLE REMINDERS FOR BIG BUSINESS

PROVIDE VISIBLE, SEARCHABLE AND SHARABLE CONTENT TO ENSURE A FULL WAITING ROOM

BY **BRIAN CANNING** | CONTRIBUTING EDITOR

THERE is no doubt that social media has changed the marketing landscape for service providers across all industries, but the challenges for the automotive repair industry are both complicated and critical to our growth and survival. Another persistent complication is the incomplete job we have done as an industry in selling our customers and potential customers on vehicle maintenance, resulting in our customers being more enthusiastic about a dental appointment than bringing in their car for an oil service. While accepting and realistic in looking at the relationship many shops have with their customers, social media and the use of "snackable" content can be a great way to move customers' perceptions in a more favorable direction. Our customers might never look forward to visiting us with uncontrolled anticipation and glee; however, if we can get them to acknowledge and accept that we are there to assist them in keeping their car safe and reliable, we have accomplished something significant.

Snackable content is small bits of information and gentle reminders that tell us of goods and services we might need, and they do this in a way that is eye catching, relevant and digestible. To be effective, snackable content needs to be visible, searchable and sharable. Humans are highly visual and process visual representations thousands of times faster than written text. To complicate this even further, humans have very short attention spans and if we are going to try to get their attention, we need to be highly graphic, highly visual and at the same time bite-sized and snackable.

Photo: Thinkstock


12
9
3
John Bean

Consumers today do not go anywhere without their phones, staying connected to the world no matter where they are, no matter what they are doing. If we are able to engage them while they are sitting in our waiting room, we are way ahead of the game. Though it was from another age and for a traditional marketing effort, an aspiring player in the fast food industry simply asked, "Where's the beef?" It kept us reminded and aware of that important consumer product, making no effort to force feed us those many and well established features and benefits of our burger, but in just asking the question, consumers were reconsidering their burger choices. Very subtle and very effective! These days, along with the short video that made up this traditional marketing effort, we'd be more likely to have a chart detailing the benefits of our square burger with our web address prominently displayed. Better yet, a large flat screen in our waiting room, showing a continuous loop of helpful information and tips on ways to use our beef-laden burger to its greatest benefit, all tied to our website, where our customers could find additional useful information. Snackable content teases their appetite; our website is where customers can go when they are ready to order lunch.

As painful as it might be, the time has come to retire that shock display from the 90s and to think about setting out pamphlets on tire care and graphic reminders that we can check the A/C, tires or battery. They should be prominent, appetizing and visible. Our waiting room should be a pantry with a variety of snacks within easy reach of our customers.

Popular automotive snacks:

- Get ready for winter
- Get ready for summer
- Women's car care perspectives
- Your car's battery
- Car Care Month (April and October)
- Tires and Alignment
- Shocks and Struts
- Air Conditioning
- Cooling Systems

A crucial consideration in all of this is our website, which in very real terms is the window into our business. If our website is confusing or difficult to navigate for a customer or potential customer, it will not matter how good a shop we are or how relevant our snackable content is, consumers will move on until they find a shop they like. A great website is the first picture many consumers will have of us and our shop and it is critical to make a great first impression. Behind the snackable content in our waiting room, and behind our marketing efforts using social media, a great website is key and central to our success. All these efforts need a home and in this day and age, that home is our website.

Much more than isolated reminders, snackable content is something you will want to use and not just in your waiting room, but most especially in your use of social media like Facebook, Twitter and Instagram. The ultimate goal here is to give customers and potential customers both rational (cheapest, best quality, appointments) and emotional (I really like this guy!) reasons to actually show up at our shop. The reality in today's market is that customers are not going to show up at our counter before they check us out online and check out our online reviews. Snackable content is an important step in highlighting our desire and ability to keep a customer's car safe and reliable and equally important is defining (at least in part) how the world will see us. If we are a Honda specialist who is set up to do maintenance services and we take appointments, our snackable content should highlight these points.

Most automotive repair consumers really do want to do the right things to keep their car safe and reliable. As an industry we have not always done right by our customers. Far too often we have not taken the time to know them and understand their needs. It really is a matter of relationships and we, of the automotive repair industry, have often been efficient in getting our customers in and out of our shop, but have done a less than stellar job of engaging and getting to know our customers. Again, they come to us because they have to, not because they necessarily want to. There is no better way to enhance those relationships than communicating our care and concern for the customers and their cars. Snackable content in our waiting room and in our efforts with social media is a great way to say we care without scaring them away. They have to like us before they can love us, and before they can like us, they have to know we are there. Snackable content is giving them a taste of who we are and what our shop represents without dragging them to the table and forcing them to eat.

Snackable content in our waiting rooms and in our outreach efforts with social media are great ways to move customers in the right direction. When done right, these snack-sized bits of information can get our customers thinking about getting an alignment, replacing their cabin air filter or checking the condition of their battery, without the tension and anxiety that often accompanies our verbally making service recommendations or suggestions. We, as service advisors and service managers, still need to talk to our customers about these things while our customers' cars are making their way through our shop. However, snackable content gets our customers thinking about what will make their car safe and reliable before we open our mouth, and it does so as useful information, without the added pressure and anxiety that often accompanies the sales process.

When automotive repair consumers in our market area are asking "Where's the beef?" what are we going to say?

With effective use of snackable content that answer is much easier.

Here's the beef, can I get you a biggie fry and a four-wheel alignment to go with that? MA

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

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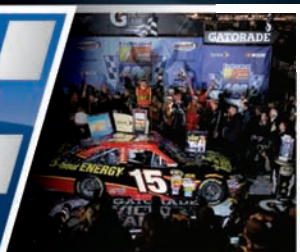

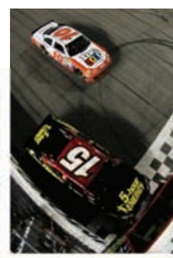

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DON'T LET YOUR SPONGES DRY OUT

NEW EMPLOYEES ARE MOIST SPONGES, READY TO SOAK UP INFORMATION AND TRAINING – TAKE ADVANTAGE

BY **CHRIS "CHUBBY" FREDERICK** | CONTRIBUTOR

HAVE you ever tried to introduce something new to your staff? A new tool, a new way of doing things, a new product or a new process? You were excited about how this would benefit the business, the staff and the customers, and you couldn't wait to get started. The only problem is some or all of the staff didn't see it quite the way you did. They liked the old way and didn't want to change. You asked, you coached and you even demanded they do it, but the results you got were minimal. They just couldn't or wouldn't grasp it. This month, ATI Coach Geoff Berman is going to help you solve this problem. Geoff says there is a very good reason why they don't want to change. Their sponge is dry. Let me explain.

It starts when you hire them

Jim Collins said, "People are not your best asset, the right people are!" Sometimes we hire the wrong people and those people will always be a struggle, but often we hire the right people, and we just don't provide the right environment for them to grow. We do not invest in them and nurture

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"WHY DOES IT TAKE MOST NEW HIRES SO LONG TO LEARN SHOP OPERATING PROCEDURES? MOST ADULTS HAVE TO READ, WRITE AND HEAR NEW INFORMATION SIX TIMES FOR 62% RETENTION."

CHRIS "CHUBBY" FREDERICK [ATI CEO]

what is important to us and to our business culture. The result is a good employee ruined, and by the time we realize it, it's too late to recover.

Let's say you have a spill to wipe up and you reach for a sponge. You aren't going to go right at the mess. You're going to first get the sponge wet, wring it out, and then wipe up the spill. When you're done, you will rinse out the sponge and put it aside. Now let's say it is a few days later and you need to wipe up another spill. Now that the sponge hasn't been used, it has become dry and hard. You can't wipe the spill like that. The sponge is not going to do a very good job absorbing. So you once again get it wet, wring it out and proceed to wipe the mess.

Your new employee is that moist sponge, ready and eager to absorb. This is the time to cram as much information and learning (training) in as you possibly can before the employee dries up. The bad news is you only have up to a year before that happens. After that, they cannot absorb until their sponge is moist again. That's why you end up beating your head against the wall when introducing change to existing staff. You are trying to teach a dry sponge, and they cannot soak it up. Eventually they may get it; and if that does happen, you have spent time before the change began to be absorbed. And all that time was necessary to moisten the sponge enough first so that then the knowledge could sink in.

Think of all the time you spend with staff that has a dry sponge. Over and over and over again you keep working on the same thing. The time you invest in this could be five or ten times the effort you would spend with a new moist sponge. The answer to this dilemma is training. Most shop owners I speak with don't really understand what training truly is and what it takes to train someone properly. It is like investing in your retirement. The sooner you get started, the larger the payoff when you retire.

Training is crucial

For most shop owners, training looks a lot like this: "You can put your toolbox here. Meet Jim our service advisor. Here is where we stock the supplies you will need, and here is the shop bathroom. We work from 8:00 to 5:00 and you can go to lunch from 12:00 to 1:00. Any questions?" Now this may be a bit of an exaggeration, but I'm guessing it is not that far from the truth.

Training should be specific and clear. It should have a start and an expected end and all of this should be in writing and explained to the new employee. This way you both start off on the same page and know what to expect from each other. If this is done correctly, not only will the new employee learn more but they will do better long term. They are more likely to stay longer and to like what they do and where they do it. You have made your vision clear, and they can now choose if they want to be a part of that vision or not.

Have you ever heard this: "My toolbox has wheels for a reason." This is someone looking for a temp job. They are already planning their exit before they even start. That sponge could be so dry it isn't even moist at the interview. Yet we hire them and wonder why we can't get them to see things the way we want them to.

I'm guessing you're reflecting on current and past employees. You can identify those you never should have hired and those that you ruined because you did not provide the proper structure and training. The good news is it is much easier to do this right than you think.

Download free checklist

You can download our outline for how this training process should look and tips on how to create your own. We will also include a list of what every new hire should know regardless of the position you hire them for. If you would like your own copy of the ATI New Hire Training Checklist, for a limited time you can get it free at www.ationlinetraining.com/2015-08.

Is that all?

Training alone is not going to get the job done. We must learn to be masters of our interviews and be able to paint the picture of life in our shop in a way that excites the interviewee. We must learn the right questions to ask to discover if they are a good fit for our business and to help them decide if we are a good fit for them. If after an interview like that we make a hire, it is likely to be a good hire. Back that up with an excellent training process and continue to reinforce your culture, and the sponges in your shop are likely to never completely dry up. MA

CHRIS "CHUBBY" FREDERICK
CONTRIBUTOR

Chris "Chubby" Frederick is the CEO and founder of the Automotive Training Institute. ATI's 108 associates train and coach more than 1,250 shop owners every week across North America to drive profits and dreams home to their families. Our associates love helping shop owners who are having the same struggle as many of them have had, and who are looking for the same answers — and in some cases looking for a lifeline. This month's article was written with the help of ATI Coach Brian Hunnicut.

E-mail Chubby at cfrederick@autotraining.net

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ARE WE IN DENIAL?

SHOP OWNERS MUST OPENLY ADDRESS CHANGE

BY **BOB GREENWOOD** | CONTRIBUTING EDITOR

WHILE watching, listening, and examining how our sector is moving forward, one has to ask if we are truly in denial.

It appears at times that all levels of the aftermarket are like deer staring into the headlights and commenting, "What's that?" Not enough change is taking place at the grassroots level of the service provider shop or, for that matter, at the jobber and warehouse level, as everyone is doing the same old thing and expecting different results. As you may be aware, that is the definition of insanity!

Let's wake up!!

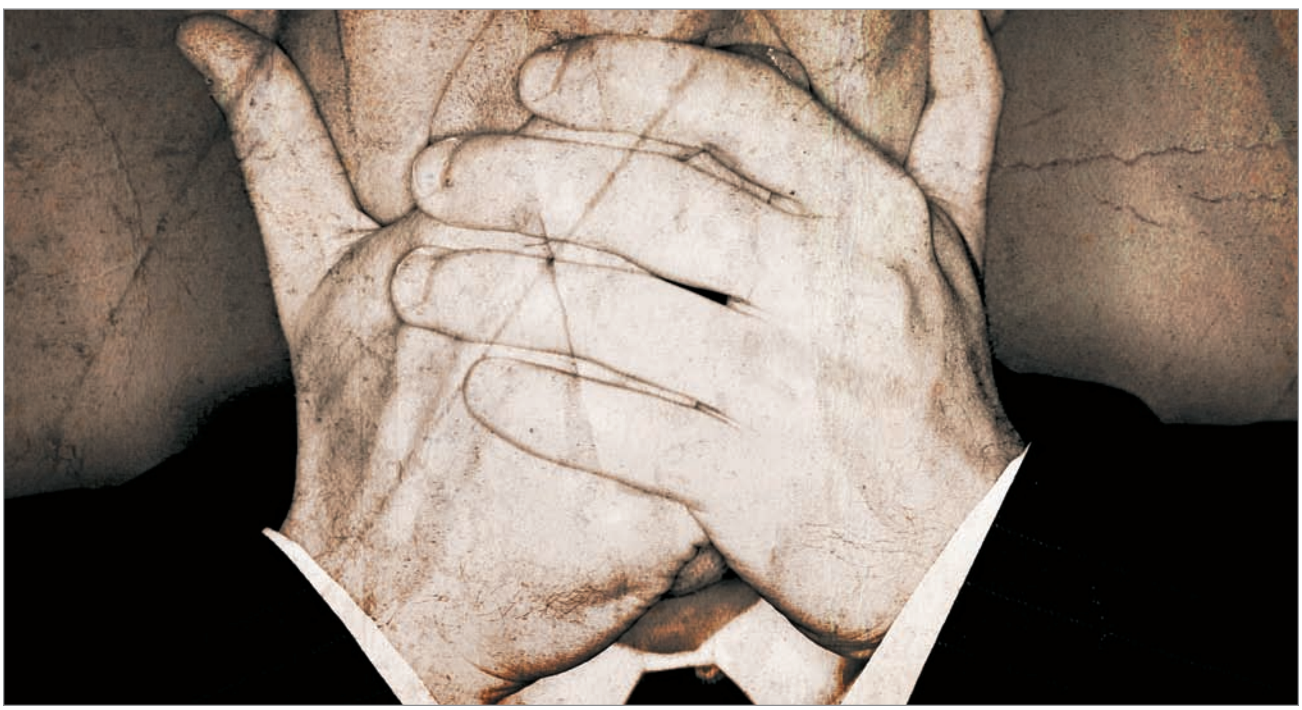
We totally need to address reality, which means openly addressing change. That change must include a total review of how we do things to ultimately service the consumer at an absolute professional level that is required to capture their business and trust. Yes, it can be painful. However, this is our livelihood. True positive change is painful, but has so many rewards in the end.

Consider the following facts:

1. Shop owners/management and their staff must learn a new paradigm in how to measure and execute internal processes within their business clearly and as professionals, which in turn leads to understanding their responsibilities. We are now going to be transitioning from a preventative maintenance world to a service-on-need world. Telematics is entering the aftermarket and we have to change the way we think about the business. Shops must learn to conduct their day-to-day affairs as a complete team. How do they now conduct their day-to-day business to build trust with their clients, their customers?

2. Parts suppliers must understand that it's not just about selling parts 100 percent of their time, but it truly is about survival and growth of their customer/client base so they have someone to sell parts to in their future. They should honestly ask themselves how they can help to secure their future and what processes they have to do now to learn to engage today and to secure their prosperity for tomorrow. What do we have to do and what do we invest in to make this work? Does 100 percent of our staff understand what we should be doing together each day to secure our future?

3. Is every level of the aftermarket prepared to commit and invest into our future or are we living for this day, this month, this quarter and considering



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every dollar leaving the company as an expense? It is imperative that everyone re-adjust our thinking to the reality of our regional, national and global economics we are confronted with today. We must ask and examine based on our actions today and our current philosophy, what our business and industry will look like seven years from now, which is really our tomorrow.

I submit to everyone that we have reached the crossroads of moving from a trade to a true profession at all levels. Now, perhaps the aging/old people in the sector can't grasp that and will grumpily rebut this statement. However, the next generation of the aftermarket will now clearly know the difference. Thank you, vehicle technology. Thank you, challenging economy. Our opportunity to really make this transition over the next three years is here and every level must believe in the opportunity if the aftermarket wants to be more of a dominant player in the national economy.

This is no time to doze off or fall asleep. Opportunity is pounding at the door. Are you ignoring it or too old to hear it?

Are you up to it? If you don't understand it, then I recommend entering the necessary business courses available so you can learn about it, understand it and "get it."

If you don't believe this, then respond to this article and let me know how you see the future unfolding. But I must warn you of one thing that many of us fail to mention in any presentation made within the industry: remember, ultimately it's all about the client/consumer experience. Are we providing that for such a grudge purchase?

So make a defined list as to how you are addressing this issue to ensure you are perceived as being unique.

Don't talk to me about "added value" anymore — that is just another form of discounting, in essence providing more for the same price. It's time to truly get past this and address the real question: What makes us unique and how do our internal processes define that?

The opportunity for the aftermarket is huge. It is so positive. But I submit it will take vision, dedication, investment and an unheard of amount of self discipline to realize the incredible financial opportunity in front of all of us. If you don't see this, then either get up to date with your education, or (it's about time someone said it) please leave the industry, as you are part of the problem. MA

BOB GREENWOOD
CONTRIBUTOR

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

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EXPONENTIAL EXPANSION

SHOP ENHANCES GROWTH BY ADOPTING INNOVATIVE BUSINESS STRATEGIES

BY **ROBERT BRAVENDER** | CONTRIBUTING EDITOR

Techway Automotive is only four and a half years old, but its growth has been—to put it mildly—explosive. This Dothan, Ala., business started in a 5,000-sq.-ft. facility, but recently moved into a 33,000 square feet building.

Currently Techway has 14 lifts, an alignment machine and the overhead cranes left by the previous tenant, which the shop uses to pull bodies off the company's bread and butter: diesel pickup trucks.

Besides repair, they also rebuild engines where other shops favor ordering new ones. "(One shop) had pulled the head off this lady's truck, told her she had a damaged piston and would have to replace the whole engine," says owner Brian Ordway. "With the head off, why not just rebuild it? We rebuilt that engine for less than $10,000; they were going to replace it for $16,000."

Since Ordway goes the extra mile by using ARP head studs and installing all necessary engine updates, he's working out a deal with a regional Ford dealer to build more durable motors like this, complete with Techway's warranty. They're currently in the process of buying cores.

"We keep everything in stock," he continues. "We've got $200,000 worth of inventory sitting back here. If it's under the hood of a diesel pickup we've probably got it. We do everything else too: oil, brakes, alignments. Whether it's Asian or European, I've got quality technicians who can fix just about anything. We are ASE Blue Seal of Excellence, the only one within 75 miles; we just got picked up direct with a diesel supplier, and we're in the process of going through the Bosch training where we're going to be Bosch diesel service dealer."

Ordway has also spent two and half years participating with the Automotive Training Institute (ATI). "We'll soon graduate from their re-engineering program and become alumni," he comments. "If I had known what they would do for us, I would have joined sooner. It's expensive, I'll say that right up front, but it was worth every penny."

With its procedures and systems, ATI helped Techway set up a pay plan for the employees, establish human resources, and write an employee handbook. "We do a meeting with them once a week for about 30 minutes," says Ordway. "We go over our weekly numbers and goals, what we need to work on. Our coach has been invaluable; I can call, bounce ideas off him, and he'll give me advice."

The expansion has also allowed for other opportunities. "I've started some internet sales and I've got a couple people trying to get that going. We're doing about $30,000 a month right now, low gross, low profit, but that will expand. I'm in the process of hiring an outside sales guy to go out try to sell some of these parts to other shops because we buy in such volume. It's kind of crazy how fast things have taken off. Nobody believes it when I say we've only been in business four and half years. And they'll say 'who's your investor?' There isn't one; I'm like everybody else, working week to week."

"To me the first thing you have to do is take care of the customer. There are times I'll give a customer something because they think that they are right even though they may be wrong. Sometimes it's worth giving something away just to keep the customer happy, keep them coming back," he says.

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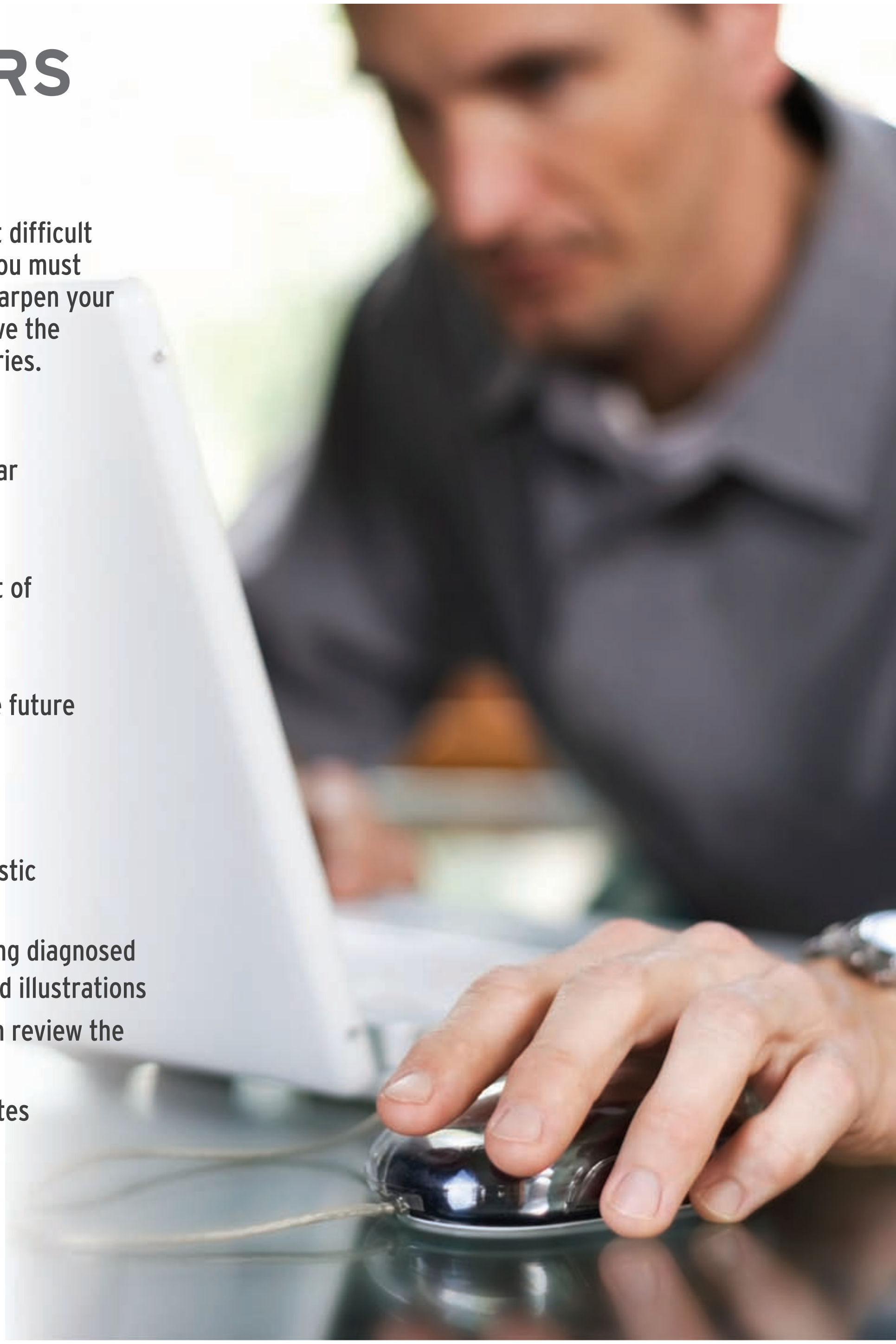

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WORTH THE WAIT

ENGAGE CUSTOMERS IN YOUR WAITING ROOM TO ENSURE LONG-TERM RELATIONSHIPS

BY **MIKE GIBLIN** | CONTRIBUTING EDITOR

SHOP owners spend a lot of time and money trying to figure out how to grab the attention of potential customers. Yet, they so often forget about the one place where they have a captive audience on an almost daily basis — their own shop waiting room. Marketing to your waiting room offers the opportunity to drive additional sales, build your brand and foster long-term customer relationships.

The truth is, your waiting room already serves as a marketing platform whether you intended it to serve that purpose or not. Customers are making judgments about your operation and the quality of service based on the first impression they get when they walk in the door. A clean and welcoming lobby area staffed by friendly employees provides customers with a sense of comfort and confidence about your service and operation.

But imagine walking into a shop where the coffee looks like it had been brewed three days ago, the magazines are messily strewn all over the furniture, which is torn and tattered, and the employees barely acknowledge your presence when you approach the front desk. There is a good chance you might turn around and walk right back out the door. If you stayed, you would probably question whether the lack of attention in the waiting room was an attitude reflected in other parts of the operation.

Don't be that shop. Even if you have a small waiting area or try to limit the time customers are in the waiting area because or your emphasis on speed of service, make sure your waiting area is clean, well-organized and that staff greet everyone who enters the shop.

Now, let's say you want to go a few steps further in exploring your waiting room's potential as a marketing vehicle. If you're not ready for a full-court press, one easy first step is to use the space as an area to educate customers about who you are as a business and what you value.

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For example, you might consider posting information about your community involvement – whether in the form of a small banner listing the causes or charities you support or by displaying certificates of appreciation or thank you notes you may have received for you sponsorship. It's also nice to display photographs of your team actively engaged in community service projects. This approach shows customers that you care about the local community in which you serve and it also gives them the opportunity to get to know you and your team in a different light.

Along that same vein, highlighting your employees in your waiting room is another way to develop a relationship with your customers and increase loyalty. If you have an employee of the month program, I suggest featuring that employee's photo, title and years of service somewhere in your waiting area. This a great way to better familiarize your customers with your staff. It can also work to establish your shop, in the minds of the customer, as one that is willing to take the time and effort to recognize and reward exceptional work – a fact that should leave customers with the feeling that your employees have more motivation to do a good job and that you value results and quality.

Another method of creating credibility for your employees — particularly your technicians — is to display certifications or licenses that take a lot of work to achieve or hold special value in the industry. These showcase your shop's dedication to education and training and prove the competence and knowledge of your staff.

At my family's service station, we found that seeing these difficult-to-obtain industry distinctions was an immediate confidence builder in our customers that we could effectively tackle the job at hand and it elevated the trust they had in our services.

On the flip side, we also found success by publicly recognizing our customers. We would have a "customer of the month" whose picture was prominently featured in a place where other customers could see it in our waiting area. The program started when I asked a high-profile, regular customer of ours if I could take her photo and display it. Initially, we offered a free oil change or some other discount if a customer "made the wall," but after a while, seeing their photos displayed became more important to customers than receiving a discount or perk. We had customers wanting to be a "customer of the month," and it became a great way to garner buzz and connect our shop to the community.

So far, we've discussed marketing approaches for your waiting room that are subtle in nature and really focus on developing brand awareness and long-term customer relationships for your shop. If you decide you want to use your waiting room to also increase your business sales, technology can play an integral role.

If you can afford it and have the room, I highly recommend mounting a flat screen in your waiting room to display your marketing messages. Think of your flat screen as a roving billboard that you can easily customize, thanks to a slew of user-friendly slideshow applications. I suggest developing a two-minute slideshow that changes every six to eight weeks and includes a mix of offers, educational information and the occasional personal tidbit, such as team photos, a call-out to your employee of the month, etc..

The educational information you feature should spur a dialogue between customers and the front counter staff. A list of frequently asked questions is a good place to start because it provides a way for you to address common questions while also highlighting the unique features your shop offers. Maybe one of your defining characteristics is that you provide a warranty for all your work. That fact alone might lead a customer who is delaying some major repairs to book the service with your shop because they know they're protected if anything goes wrong.

Another option is to tie your messages to seasonal events. Reminding customers about getting an A/C check before summer road trips or winterizing their cars in the fall can serve as strong calls to action. Remember to tailor the information you incorporate into your slideshow to your specific market or specialty. If you're based in a college town, your display might include safety tips and maintenance schedules – advice geared for younger, inexperienced drivers. If you're in a tourist town, you might consider offering guidance about the terrain and tips for driving in weather conditions common to your area.

The offers you include should also be customized for your market or niche. Oil changes are something everyone needs, but if your specialty is tires, then be sure to provide a promotion geared towards that product.

Lastly, don't forget to inject your presentation with items that help reinforce your brand identity. Posting testimonials from current customers or news about important employee milestones, such as weddings, births or significant work anniversaries, or local community events you sponsored helps build allegiance and trust among you and your customers.

Remember that marketing to your waiting room is a relatively inexpensive proposition and if you capture additional sales from one out of every five customers that visit your lobby, that's a meaningful return for a minimal investment. MA

MIKE GIBLIN
CONTRIBUTOR

Mike Giblin has spent most of his career helping automotive companies attract more customers and increase profits. He currently serves as president of U.S. operations for Kukui Corp., a developer of marketing software solutions for the automotive repair industry. An industry veteran, Giblin is a former ASE-certified master technician who managed his family's San Francisco Bay Area-based repair shop for 25 years.
Mike believes that because the auto repair industry is complex, it requires an amazing skill set to be successful. He is excited to share what he knows with shop owners.

E-mail Mike at mike@kukui.com

SHOP PROFILE

A snapshot of one of the industry's leading shops

SMITH AUTO REPAIR / YAKIMA, WASH.

What's in a name

High level of experience, working relationships keep business thriving

BY **ROBERT BRAVENDER** | CONTRIBUTING EDITOR

When a shop is called Smith Auto Repair, you have to do something special to stand out a bit. Fortunately Smith's reputation is firmly founded on electrical repair, having started off rebuilding generators, alternators and starters nearly 70 years ago in Yakima, Wash.

"We're in a high agricultural area, so we did everything for everybody," explains Jim Thomas, the current owner. "We did heavy equipment like agricultural tractors, commercial vehicles — and still do. We have always tried to be the shop that could find the solution for these different pieces of equipment. What we did as a rebuilder was to bring the unit in, such as a starter motor, tear it down and analyze it."

Like CSI investigators, Thomas' technicians can deduce if a starter had a tune-up issue or bad glow plugs, since evidence of excessive cranking is pretty obvious once it's taken apart. But knowing the market as they do, their insight sees beyond the technical problems.

"We can look at these units and tell the owner, 'maybe you've got a guy with a hearing problem; he's trying to start the equipment while it's running,'" elaborates Thomas. "We are able to give our clients feedback like this, which is invaluable to our customer base — and that's a value-added type of approach to business."

Of course if an equipment owner also had an errant Cadillac that won't crank over when hot, or experienced issues with early Chevy generators that had power steering pumps mounted on the back, these "oddball" projects found their way into the shop, which helped Smith Electric evolve from rebuilding and supply to all-out repair.

"A lot of that work has to do with our experience level," Thomas maintains. "When you're an auto electric specialist, certainly a lot of those problems are figured out pretty quickly, (to where) we've developed a close working relationship with area dealerships, auto parts stores and other repair shops. Plus we now have all the proper test equipment and scan tools."

For example, Thomas reports they use a Midtronics battery tester, which is a little more sophisticated than the more commonly used load tester. "We find problems that get by a lot of places, even the dealers. But then we'll use a load tester and sometimes find problems that our other equipment misses, so now we do both because we've learned over the years that you've got to be sure what the battery is capable of doing, other-

SMITH AUTO REPAIR

Jim Thomas
Owner

Yakima, WA
Location

1
Number of locations

69
Years in business

7/2
Total number of employees/techs

6,000 square feet
Shop size - main location

1
Number of bays — main location

$950,000
Annual gross revenue combined

ASA, ASE, BBB, ERA, APRA
Shop affiliations

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Photos: Smith Auto Repair

wise you're dead in the water."

"Cover the basics" is a criteria Thomas feels is missed more than anything, so before they even put a scan tool on a vehicle, questions are posed, like are the cables corroded? Is the battery bad? Is there a voltage drop in the system? What is the real issue? "Our guys will go out and test the positive, and it tests great," he notes, "but then go to the negative side and get a three-and-a-half volt drop. Replace the negative cable, clean up some connections —poof — end of problem."

"We find problems that get by a lot of places, even the dealers,"

– says Thomas about his process using battery testers

Smith still does a lot of heavy equipment and commercial vehicles. "We get into Class 6 and 7 mid-size diesel trucks. We don't get too much into Class 8, full-sized semis, since they're handled by bigger shops — and quite frankly, take up so much space. But we do get into RVs, a lot of pusher diesel work, gas units, V-10s; again it comes back to the situation where maybe it isn't a mechanical issue but a problem with batteries not charging, an on-board inverter that's giving troubles, or maybe even the house-side batteries not working properly."

Restoration projects are also not uncommon in the wide-open market the shop deals with. The cars can range from street rods to full-on concourse d'elegance restos. "Like anything, it's one of those things where you take what comes in," Thomas relates. "We don't go out and solicit it heavily, but because we're one of the places that will do this work, the business comes to us. Whether you get a tractor that's being restored or somebody who decides to renovate a wood boat, we get into the re-wiring and upgrading."

One of the things Smith's specializes in is restoring old generators from the 1920s or 30s. "Customers will want it to look and run like it did when it was brand new," says Thomas. "We'll strip it down, bead-blast all the paint off of it, and paint it back to the exact factory colors, all the things needed to make it original. If it's a numbers matching vehicle, of course we'll make sure that all of the housings are correct."

Another niche market they've had success with is building custom speedometer cables. "Older agricultural trucks are only used four months out of the year during harvest, but still have to have all of the right safety equipment, including speedometer functions," Thomas explains. "A Class 6 truck with an old mechanical speedometer has a cable that's 30 feet long."

Should this break, creating a new cable is less expensive and less hassle than converting the vehicle over to an electronic speedometer with a speed sensor. "So we looked at what it would take to get into this market and found a speedometer shop that was going out of business," reports Thomas. "We were able to buy all the tools and inventory at 10 percent on the dollar. We then learned what needed to be done and it's actually been a fair business for us."

While the shop's been around for 69 years, Thomas bought out the original owners 30 years ago, and he proudly reports that his son is in the process of taking over the business from him; by the time you read this, Matt Louis will be the new owner. "I'm phasing out," he laughs, "at the same time training him to take care of all the nuances of business, run our very experienced crew, and continue to grow the company."

No doubt Smith Auto Repair & Electric will continue to stand out. MA

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

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The JF011E to the JF015E

FREQUENCY OF THIS POPULAR TRANSMISSION PUSHES SHOPS TO TAKE ON REPAIRS

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

THE JF011E (as it is called in Dodge and Jeep applications), is a JATCO-made CVT, which is also referred to as the RE0F10A in Nissan and the F1C1A in Mitsubishi (Figure 1). With this transmission having such a presence on the road today, it comes as no surprise that many shops have chosen to take on repairing this simple transmission.

Figure 1

Unlike the Honda CVT that doesn't use a torque converter, this transmission does (see *Tackling CVTs*, July 2015). As a result, this transmission uses a forward and reverse clutch in front of the pulley assembly rather than a start clutch between the pulleys and the differential.

I bring this up in preparation to introduce the replacement CVT for the JF011E simply called the CVT-7 or, traditionally you can call it the JF015E/RE0F11A/FICJB transmission, depending on the application.

This CVT-7 transmission still uses a torque converter, but it has a low clutch, high clutch and a reverse clutch assembly located between the pulleys and the differential; much like the Start Clutch in the Honda CVT. It is quite an interesting CVT and a very nice one to work on. But before we get to this new transmission, let's cover a little about how the JF011E works and some of the problems the shops are seeing.

With this unit having a torque converter, along with a forward and reverse clutch in front of the pulley assemblies, there is no need to release a clutch when coming to a complete stop. The clutches simply provide forward or reverse direction through a planetary while the pulleys provide the continuously variable ratios. The torque converter operates in a conventional way meaning that as a fluid coupling, when

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

Photos: Wayne Colonna

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at a stop in gear, the engine will not stall. During certain driving conditions, a clutch inside the converter will apply, providing a direct power link from the engine to the transmission. This means converter-related diagnostics will be similar when compared to typical automatic transmissions.

One issue that is common with this style of CVT is a delayed engagement into gear. (This was briefly mentioned in *Can it be fixed?* May 2015.) In it was a shop's experience with a 2007 Nissan Altima. It had originally come in for one problem, which once resolved brought their attention to a 2 to 3 second delayed engagement into reverse and drive. Nissan has a bulletin stating that this is normal (NTB10-147). If the delay was much longer, they did have some TCMs that required re-programming to resolve the problem.

One of the solenoids on the valve body is called the Lock-Up Select Solenoid (#4 in Figures 2 and 3: two different style valve bodies are shown — Nissan/Mitsubishi and Dodge/Jeep). This solenoid controls the positioning of the Select "Switching" Valve in the valve body (#4 in Figure 4). By doing so, this solenoid controls two different functions. During drive and reverse engagement, this solenoid will place the "switching" valve in a position where it will direct pressure to the Select "Control" Valve (#5 in Figure 4). This "control" valve will reduce line pressure going to the Forward Clutch or Reverse Clutch for a smooth gear engagement. The Lock-up Select Solenoid can then position the "switching" valve where pressure is directed to the Torque Converter Lock-up Control Valve (#3 in Figure 4) for torque converter clutch apply control.

This is a Normally Closed On/Off solenoid, which when in P/N, the TCM sends 12 volts to the solenoid. Once the desired gear is selected (D or R), within approximately five seconds power is cut to the solenoid by the TCM. This explains the normal three-second delay into gear. This also means, besides possible TCM issues, engagement problems can arise due to a malfunctioning Lock-up select solenoid, select switching valve or select control valve, as well as a flow control valve problem in the pump. This valve will be covered near the end of this article.

From a diagnostic standpoint, when it comes to pressure testing, transducers are most favorable in CVT applications. Pressures can reach more than 800 psi with some CVT transmissions. This transmission is equipped with having a complete set of pressure taps for keener diagnostics. The forward and reverse clutch, the secondary and primary pulley, TCC release and TCC apply and main line pressures are all available (Figure 5, secondary pulley tap located front side above axle as seen in Figure 6).

This transmission also has primary and secondary pulley pressure transducers inside the transmission (Figure 7). In some cases, checking the voltage signal on these wires is easier, safer and quicker to do should pulley pressures need to be monitored. However, Mitsubishi eliminated the use of the secondary pressure transducer with 2010 model year vehicles.

When 0 psi is in the system, approximately 0.5 volts will be seen. As pressure increases inside the pulley this voltage signal will increase proportionally. When 4.5 volts is seen it indicates approximately 870 psi of pressure is present inside the pulley chamber. With a 0.5 volt equal-

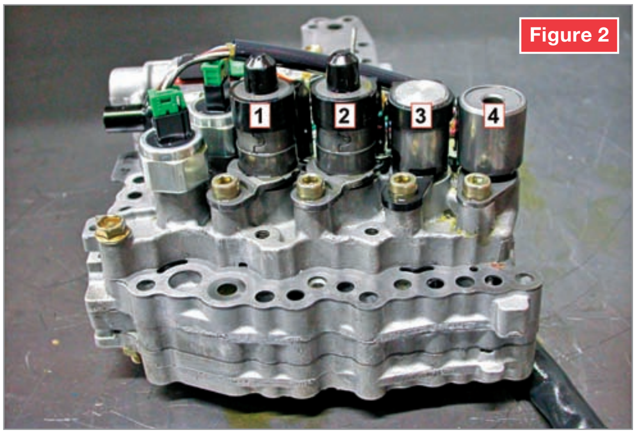

Figure 2

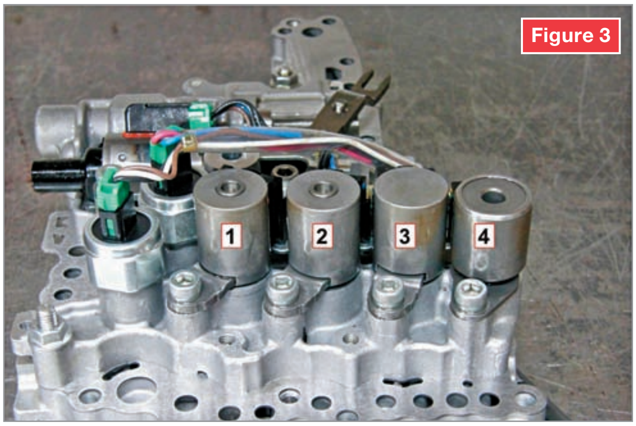

Figure 3

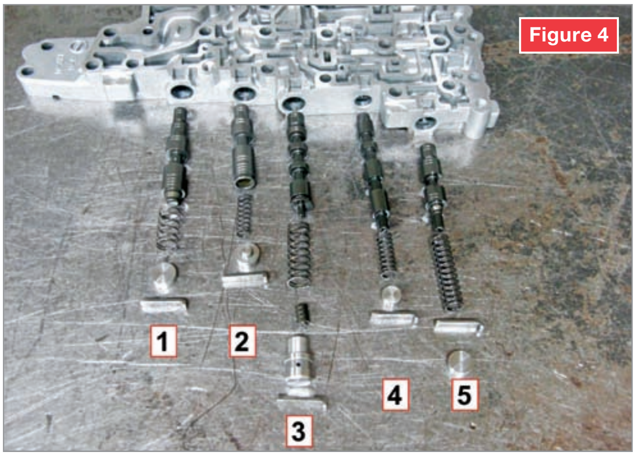

Figure 4

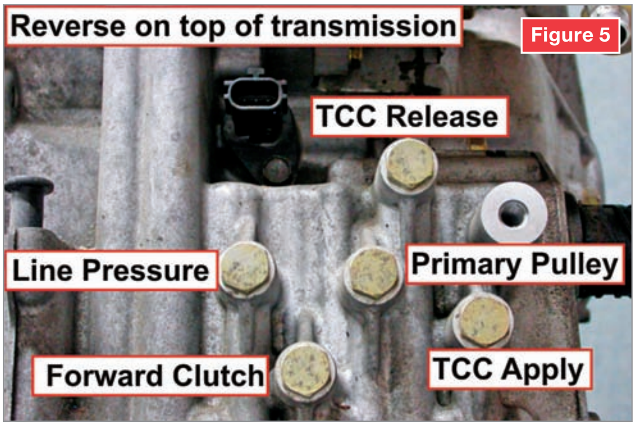

Figure 5

ing 0 psi to 4.5 volts equaling 870 psi, by plotting out the numbers in-between this range, approximate pressures can be determined. For example, 2.5 volts would represent an approximate 435 lbs. of pressure inside the pulley chamber. Having both pulley voltages graphed out on a scope or digital graphing multi-meter is a nice way to see the pressures vary between these two pulleys.

The case connector containing these wires is next to where most of the pressure taps are located on the case (Figure 8). Some confusion can take place here if you are not careful. Dodge, Jeep and Mitsubishi use the same terminal numbering system with their wiring diagrams while Nissan is totally different, as seen in Figure 9. The functions are identical meaning that the wires internally go to the same solenoids, pressure transducers, TFT sensor and EEPROM with all four manufacturers.

Dodge, Jeep and Mitsubishi terminal number assignments are as follows:

1. Pressure Control Solenoid (PCS)
2. Secondary Pressure Control Solenoid (SPCS)
3. Lock-Up Control Solenoid (LCS)
4. Lock-up Selection Solenoid (LSS)
5. + For Pressure Switches and ROM
6. Dodge only — ground (G301) for PCS, SPCS & LCS
7. Secondary Pressure Sensor Signal
8. Stepper Motor
9. Stepper Motor
10. Stepper Motor
11. Stepper Motor
16. ROM
17. TFT Signal
18. Primary Pressure Sensor Signal
19. Ground Pressure Sensors, ROM, TFT
21. ROM
22. ROM

Nissan terminal number assignments are as follows:

2. Pressure Control Solenoid (PCS)
3. Secondary Pressure Control Solenoid (SPCS)
12. Lock-Up Control Solenoid (LCS)
13. Lock-up Selection Solenoid (LSS)
20. + For Pressure Switches and ROM
23. Secondary Pressure Sensor Signal
6. Stepper Motor
7. Stepper Motor
8. Stepper Motor
9. Stepper Motor
1. ROM
17. TFT Signal
25. Primary Pressure Sensor Signal
19. Ground Pressure Sensors, ROM, TFT
11. ROM
16. ROM

Another area of confusion that could take place is that Dodge and Jeep use an external ground for 3 of the 4 solenoids through terminal 6. Nissan and Mitsubishi ground all their solenoids internally.

Dodge/Jeep solenoid check:
PSC — 1 & 6 = 6.5 ohms
SPSC — 2 & 6 = 6.5 ohms
LSC — 3 & 6 = 6.5 ohms


Figure 6

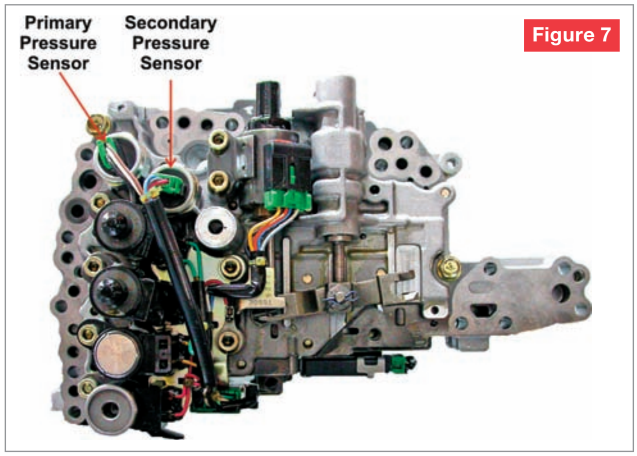

Figure 7


Figure 8

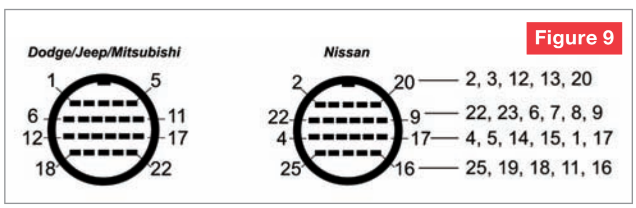

Figure 9

LSS — 4 & Case Ground = 28 ohms
Mitsubishi solenoid check:
PSC — 1 & Case Ground = 6.5 ohms
SPSC — 2 & Case Ground = 6.5 ohms
LSC — 3 & Case Ground = 6.5 ohms
LSS — 4 & Case Ground = 28 ohms
Nissan solenoid check:
PSC — 2 & Case Ground = 6.5 ohms


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SPSC — 3 & Case Ground = 6.5 ohms
LSC — 12 & Case Ground = 6.5 ohms
LSS — 13 & Case Ground = 28 ohms

Since we are on the subject of wiring, some 2006 and up Dodge Calibers may experience a complaint of the Check Engine Light coming on, accompanied with numerous solenoid circuit faults, such as P0962-963 Pressure Control Solenoid fault, P0966-967 Secondary Pressure Control Solenoid, P2770 Lock-Up Control Solenoid, P1723 Lock-Up Selection Solenoid, P0848 Secondary Pressure Sensor, P0712-713 Transmission Fluid Temperature, P0843 Primary Pressure Sensor. These codes could be intermittent and may also include Stepper Motor Control issues.

The cause may be that the wiring harness leading to the case connector on the transmission is corroded and/


Figure 10

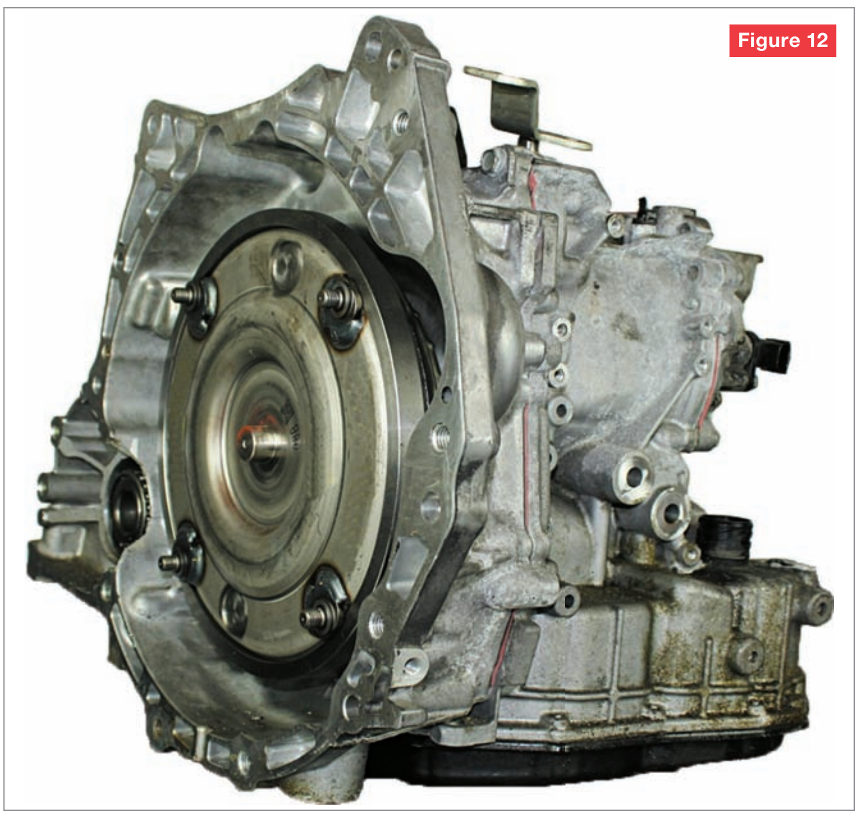
Figure 12

or partially disintegrated by battery acid dripping down on to the harness. An ATSG member was kind enough to send in a picture of this, as you can see in Figure 10. This problem occurs because the drain tube exits the bottom of the tray, right above the transmission wiring harness.

The wiring will obviously need to be repaired as necessary. To correct the problem will require re-routing the drain tube away from the wiring harness, or purchase the new drain tube under Dodge part number 05054250AC.


Figure 11

Another issue that had occurred with the Dodge Calibers was a gear ratio error code P0730 coming up. Pressure checks were made and nothing seemed to be wrong there. The condition of the fluid and pan looked good. With the valve body removed the push belt and primary pulley sheave faces were inspected and all looked good there. A close look at the data list with a scan tool revealed a loss of an input shaft speed signal. When the sensor signal was repaired, all worked well. Sometime later a bulletin was issued by Dodge (21-014-08) stating that vehicles built before March 20, 2008 came up with this code when it should have produced a P0717 for a loss of an Input Speed Sensor signal. A re-flash took care of this concern. This is good to remember, as every now and again this problem still seems to surface. It appears that not every Dodge Caliber has received this update.

As mentioned previously, another common problem with this transmission is the flow control valve in the pump wearing out its bore (Figure 11). This causes a loss of pump volume leading to slipping or delayed engagement problems (much longer than 2 to 3 seconds). Interestingly enough, the same is true with the new JF015E (Figure 12) replacing the JF011E unit. In fact, Yoram Levy from Edmond Garage has already dealt with worn valve bodies, particularly with the TCC Regulator Valve. He has also seen leaking high clutch pistons, a loss of a speed sensor signal due to an internal speed sensor ring not spinning and input shaft-bearing noises. The good news is that it is a very nice transmission to repair. With the right tools, it all comes apart and goes back together again very easily, including the primary and secondary pulleys. We'll take a glance at this transmission next month. MA

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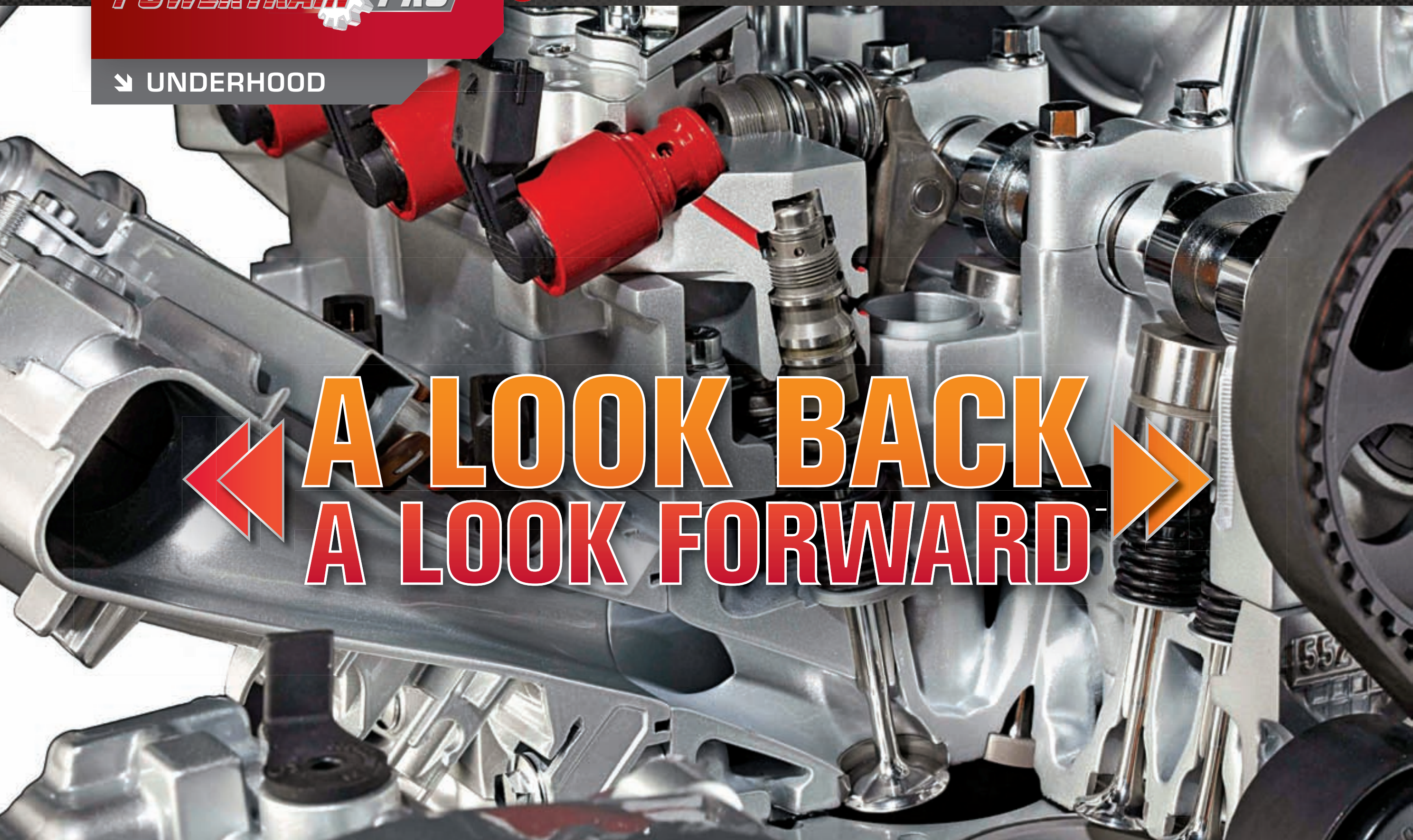
UNDERHOOD



The Fiat Multiair system is a simpler alternative to BMW's Valvetronic system. Both eliminate the pumping losses caused by the throttle plate restriction, using the intake valves to regulate incoming air.

A LOOK BACK A LOOK FORWARD

HARD TO BELIEVE HOW FAR WE'VE COME, EVEN HARDER TO BELIEVE HOW FAR WE'VE YET TO GO.

BY **PETE MEIER** | DIRECTOR OF TRAINING

My very first job was pumping gas at the service station where my dad filled up his work van and got the family station wagon's oil changed. I was not yet 16 years old, and the year was 1974. Gas had risen to a shocking $0.55 a gallon in response to the Organization of Petroleum Exporting Countries (OPEC) oil embargo that started the year before and all of a sudden, those little clown-size cars that were coming out of Japan and boasting double-digit fuel economy didn't appear all that silly anymore. Once a nation that feasted on the world's resources, Americans got a quick lesson on just how dependent we'd become.

Today, that double-digit fuel economy foreign compacts were offering wouldn't even come close to the average fuel economy being achieved by modern mid-sized sedans. And the quest for further gains in fuel economy continue, mandated by a little thing called CAFE, short for Corporate Average Fuel Economy, a series of regulations enacted by Congress passed in reaction to the OPEC embargo of the '70s.

The good old days

I drove to work in a 1966 Dodge Dart 4-door equipped with a 318 cid *(Editor's note: That's cubic inch displacement for you young techs. We didn't list engine sizes in liters back then!)* V8 mated to an automatic three-speed transmission. I don't remember the fuel mileage that old beast was capable of, but at the time no one really cared. Before the embargo, gas only cost $0.20-0.25 a gallon! I do know that, like most cars of that era, mileage was a single-digit calculation unless you really kept a light foot on the pedal and never drove in the city.

About the time the embargo was in full swing, the average Joe was taking his frustration out on anyone and anything he could. One popular story that floated around was the guy that had just bought a new (Chevy, Ford, Dodge – it varied depending on who was telling the story) and was getting 100 miles to the gallon. When he took the new car in for service, he bragged about this impossible number to his service writer. Later that day, the owner returned for his car only to be told that the carburetor installed was a "special prototype" that should never have made it past the last line check and they (the dealer) had been instructed to replace it with another and return the magic carb back to the factory. The end of this story also varied quite a bit depending on the storyteller and covered everything from getting his magic part back by force

Photo: Fiat

Military interest in the man-made diesel goes beyond the fuel's cost per gallon. This plant can be built anywhere, cutting the costs of getting the fuel to the field.

Photos: Audi

Not long after Audi's partners success in creating diesel fuel, another succeeded in making an alternative to gasoline called "e-benzin."

to being escorted off the property by federal agents who were pledged to guard the prototype with their very lives.

Any truth to that story? I doubt it, especially if you look at the designs of the time. Carbureted engines, mechanical points ignition systems, and (by today's standards) sloppy mechanical fit. Couple that with a thirst for BIG engines, meaning a lot of air being sucked in and a lot of gasoline being consumed. As a comparison for you out there used to only liter displacements, consider that the Dodge 440 cid V8 would roughly be the equivalent of a 7.2 liter in today's vernacular and you get the idea.

But the embargo changed all that. Families were turning in their big gas guzzling sedans and wagons for smaller, lighter cars with tiny little 4-cylinder engines. These early cars had doors less than half the thickness of the steel battle wagons we were trading in and engines that were anemic in performance compared to what most of us were used to. And even they were grossly inefficient compared to what is available today on any dealer lot.

What's driving the change?

In 1975, Congress passed the Energy Policy and Conservation Act (EPCA) in response to the OPEC embargo. Part A of Title III of the EPCA established the Corporate Average Fuel Economy (CAFE) standards for automobiles under the direction of the Department of Transportation (DOT). Without going into a whole lot of detail, the gist is that the government requires the automakers to meet a fuel economy goal based on a calculated average of the models they sell. Back in 1978, that mark was 18 miles per gallon (mpg). Today, the mark the OEMs are challenged to meet is 54.5 mpg by the model year 2025 – only a few short years away by engineering and development standards.

But what is the driving force today? The embargo is a reference in a history book for most and America is no longer dependent on foreign oil according to many sources. Yet fluctuations in oil production and instability in the future market still impacts us as a nation. It wasn't all that long ago when we all saw gasoline prices double and triple in cost, and if you have a long commute (as I did), that extra cost placed a heck of a strain on the family budget.

Other factors are also now in play; environmental factors like the concerns over pollution, global warming and diminishing resources. Argue the reality of any of these topics to your heart's content, but it's hard to argue with the idea of cleaner air and renewable energy sources.

Getting to the goal line

Coincidence or luck, the mid-70s was also the time computer technology was beginning to grow. Engineers knew how to make internal combustion engines more efficient and have for decades, but the technology needed to make those engineering dreams hadn't been invented yet. As a result, most of the initial changes were more like Band-Aids applied to existing powerplants. If you can remember the late '70s through the early '80s, you'll know what I'm talking about. Electronic ignition was soon supplemented by computer-controlled fuel injection – but the injection was fed through a throttle body not that too far removed from the carburetor we were used to.

It takes a long time to develop an engine design, and in defense of the OEMs they were suddenly put into a position of trying to meet standards that weren't even on their radar a few years earlier. Soon, though, we began seeing the first fuel sequential fuel injection systems, with single injectors feeding single cylinders and the throttle body now only used to regulate the air flow into the motor. New terminology and acronyms were being introduced just as fast and all of a sudden we needed something called a scan tool to repair performance concerns we started calling driveability problems.

Over the last three decades, engineers have taken the available technology and applied it to the same internal combustion engine that I started learning on, with one major exception. Today's engines are high performance powerplants in every way, producing more power per liter than the hot rods of the '60s and '70s and doing it while sipping fuel at rates unheard of back then.

Onward and upward

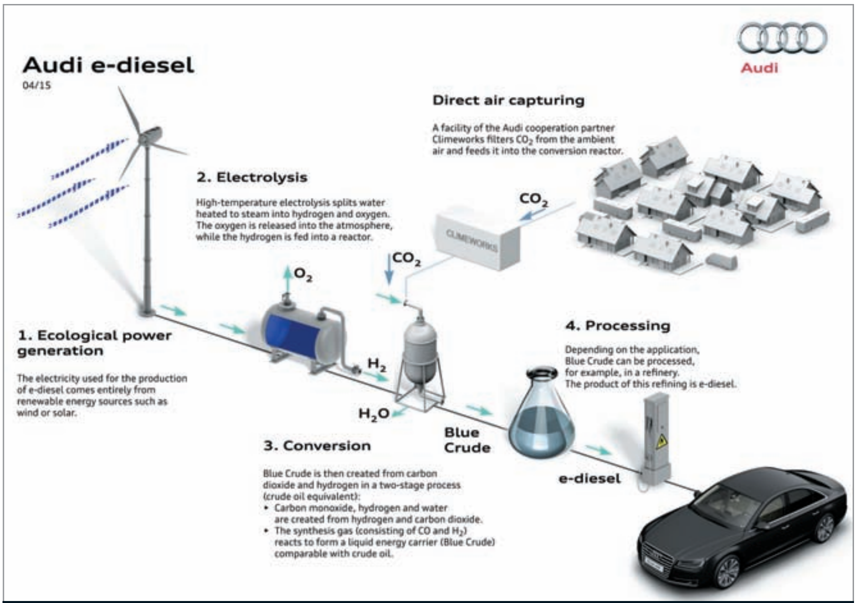
An internal combustion engine can be tuned to run very efficiently at any single rpm/load combination. Engineers can play with ignition timing, valve timing and opening/closing rates, and even the engine's compression ratio to achieve that efficiency.

The challenge is to make it run efficiently at ALL rpm/load conditions.

You've seen the technology that is allowing just that. Let's take a look at some of the highlights and maybe take a peak at what may be just down the road.

Variable valve timing: The idea for variable valve timing is not a modern one, and patents can be traced back to the 1920s. Even then, engineers were seeking ways to alter the valve opening duration to match the engine's rotational speed. After all, air has mass and that impacts the time needed to completely fill the cylinder. As speed increases time available decreases, so it would be nice to get that fill started sooner – similar to the need for advancing the ignition timing.

Depending on the source, it seems that Fiat deserves credit for the first functional variable valve timing system. Developed by Giovanni Torazza in the late 1960s, this design used hydraulic pressure to vary the fulcrum of the cam followers and provided for both variable timing and valve lift. The pressure changed according to engine speed and intake pressure and the typical opening variation was 37 percent.



Who says you can't turn water into fuel? Audi's "blue crude" is diesel fuel made from water and CO_2.

Photo: Audi

While Fiat may have credit for the first functional design, it appears Alfa Romeo was the first to use a variable valve timing system in production cars. The 1980 Spider 2000 used a mechanical system developed by Giampoalo Garcea. Nissan and Honda both introduced electronically controlled systems in the late '80s. The Nissan system altered cam phasing to improve idle quality and low-end torque while the Honda VTEC actually switches to a separate cam profile at higher engine speeds to improve peak power.

Once a unique design feature, the impact these systems can make on achieving fuel economy goals has made them almost a standard for current engine designs.

Valvetronic and Multiair: BMW was the first to actually find a way to overcome the "pumping losses" caused by the restriction posed by the throttle plate in the throttle body assembly. Rather than use the plate to regulate the amount of air into the engine (to control engine speed), the Valvetronic system instead uses the intake valves for the job by varying the amount of lift and opening duration. But it's a complex system, using an additional electronically actuated cam to vary the lift.

The Fiat system is much simpler. It essentially achieves what the BMW (and Nissan) system does by using hydraulic fluid running through narrow passages connecting the intake valves and the camshaft so the two can be decoupled. This system is modulated by an electronically controlled solenoid, and there are effectively two modes. When the solenoid is closed, the incompressible hydraulic fluid transmits the intake cam lobe's motion to the valve, as in a traditional engine. When the solenoid is open, the oil bypasses the passage, decoupling the valve, which then closes conventionally via spring pressure. For example, to shut the valves early, as in a part-load situation, the solenoid would be closed initially and then open partway through the intake cycle. Modern solenoid design, along with a carefully structured control program, makes the system possible. Aside from the fuel economy and emissions benefits, Fiat claims Multiair also results in a 10 percent horsepower boost.

And engineers are working on the next step, "camless" valve trains that will be able to alter valve opening/closing in response not only to engine rpm/load but also the needs of each individual cylinder.

Variable Compression Ratio: Another "not new" idea is varying the engine's compression ratio to match need. At higher loads, a low compression ratio is desired to minimize maximum pressures and strain on the engine components. Higher compression at part load can help reduce emissions. And these engines already exist, but primarily in labs used for research. The complexity and cost are still prohibitive to apply the technology to production cars.

But that may change. FEV, an international engineering group with roots in Germany, offers a design that could be implemented in both diesel and gasoline engine designs. The FEV design uses a connecting rod with an eccentric located at the small end, where the piston pin mounts the piston to the rod. Combustion forces and inertia are all that is needed to move the piston from one end of motion to the other, effectively providing a compression range that can be engineered to whatever specification the automaker desires. The force of compression or intake vacuum actually moves the eccentric, and engine oil pressure supplied by the normal big-end lubrication circuit simply locks the device in one position or the other. A spool valve at the bottom of the connecting rod end cap slides from side to side to vary the position, by way of a control device mounted in the oil pan. According to the company, the reaction time from high to low is 0.2 – 0.6 seconds.

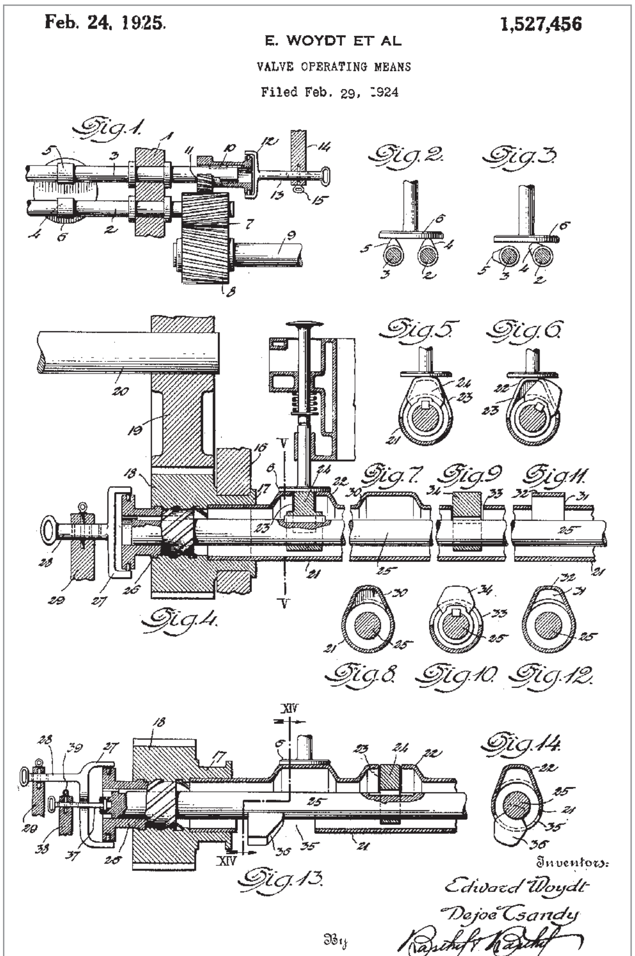


Photo: U.S. Patent Office

Old designs are new again. This is a variable valve timing design patent drawing from the 1920s.

Synthetic fuels: Not really an engine related topic, but I thought it would be of interest when considering all the claims you see on the Internet about running your car on water. Well, Audi has done just that – created diesel fuel using water and CO_2.

The base fuel is referred to as "blue crude," and begins by taking electricity from renewable sources like wind, solar or hydropower and using it to produce hydrogen from water via reversible electrolysis. The hydrogen is then mixed with CO_2 that has been converted into CO in two chemical processes and the resulting reactions produce a liquid made from long-chain hydrocarbons – this is blue crude, which is then refined to create the end product, the synthetic e-diesel.

Audi says that the carbon dioxide used in the process is currently supplied by a biogas facility but, further adding to the green impacts of the process, some of the CO_2 is captured directly from the ambient air, taking the greenhouse gas out of the atmosphere.

Just weeks after producing its first batch of synthetic diesel fuel made from carbon dioxide and water, Audi has laid claim to another synthetic, clean-burning and petroleum-free fuel called "e-benzin." Audi's project partner Global Bioenergies created the fuel. In late 2014, Global Bioenergies started up the fermentation unit for a pilot program to produce gaseous isobutane from renewable biomass sugars such as corn-derived glucose. Gaseous isobutane is a sort of raw material for the petrochemical industry that can then be refined into a variety of plastics, fuels and other applications.

The next step in the process was to run the material through a conditioning and purification process, allowing it to be collected and stored in liquid form under pressure. Some of it was then sent to Germany to be converted into isooctane fuel, creating a pure, 100-octane gasoline. Isooctane is currently used as an additive to improve fuel quality, but could also be used as a stand-alone fuel. Audi calls the final, refined form of the fuel "e-benzin" and claims that it burns clean due to its lack of sulfur and benzene. Also, its high grade enables it to power engines using high compression ratios for more efficiency. Audi will test the fuel composition and conduct engine tests to see how it performs before eventually trying it out in vehicle fleets and says it could see the fuel being used in consumer cars on a large scale "very soon."

Both allow fuel to be made anywhere, making it a very interesting proposition to the military. While the cost of the synthetic diesel, for example, may be higher than conventional diesel fuel, the costs to get that fuel to the battlefield makes it much higher — both in terms of dollars spent and human lives placed at risk.

Yes, if the past few decades have taught us anything it's that things change. Expect the same going forward, but at a much faster pace. MA

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TECHNOLOGY
THE NUTS AND BOLTS OF AUTOMOTIVE REPAIR

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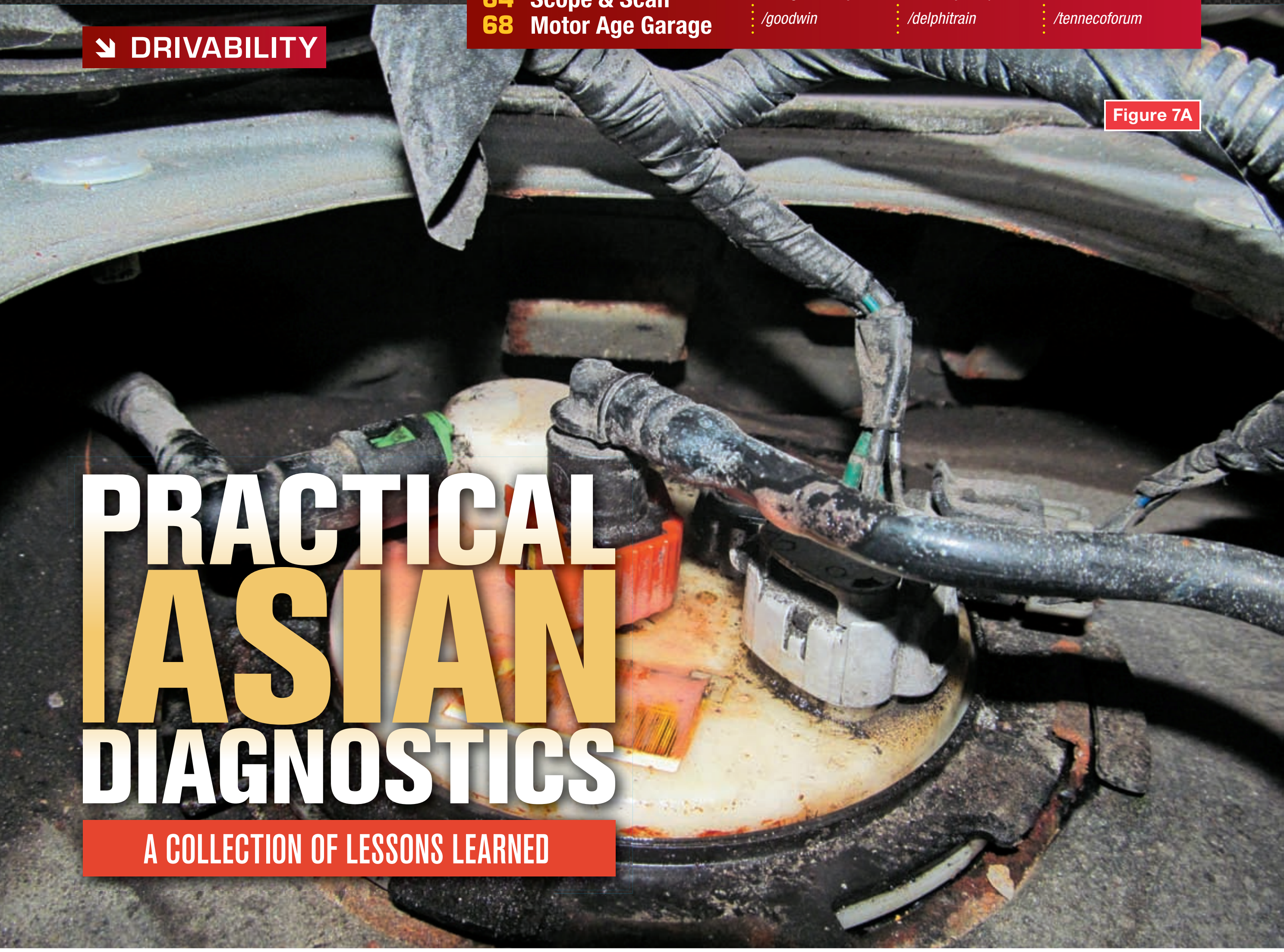


Figure 7A

PRACTICAL ASIAN DIAGNOSTICS

A COLLECTION OF LESSONS LEARNED

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

This article contains a mixed bag of some common Asian diagnostic tips and techniques on a variety of vehicles. As you read through the different vehicle problems, you will learn what diagnostic route I rode to diagnose and fix the concerns. In some of the different examples I will explain what I used to test and confirm that a component was either good or bad. Never just change a part; but rather test it, then move on to the next logical step in your diagnostic routine. And use what God gave us — our brain, eyes, ears, nose and hands. Combine that with good service information and you will have a successful diagnosis.

Toyota Camry P0171

One of the most common vehicles that shows up in our bays is the Toyota Camry. A common problem that this vehicle will display is an illuminated Malfunction Indicator Lamp (MIL) caused many times by a P0171 (System Lean-Bank 1) Diagnostic Trouble Code (DTC). As part of my usual diagnostic routine, I first performed a visual inspection on this particular Camry. I noticed that the Mass Airflow sensor (MAF) and Air Fuel Ratio sensor (AFS) had been replaced. Seeing a bunch of new parts on a vehicle that other shops have installed without resolving the problem is nothing new to me. Before replacing any sensor or actuator, the first thing to do is "test and not guess," confirming whether the components are operating in the proper range or not.

The important thing to know about the Toyota AFS sensor is at idle on a good running engine, the voltage reading on your scan tool should be 3.3 volts. To check the sensor, induce a vacuum leak to see if the sensor reading changes from the idle voltage reading. If the voltage reading goes up with

Photos: G Jerry Truglia

an induced vacuum leak, the sensor is able to correctly read a lean condition. To check to see if the sensor is capable of reading a rich condition, add some propane to a vacuum port while making sure the voltage goes below 3.3 volts. Since the sensor tested good on both lean and rich conditions, I moved on to testing the MAF sensor.

To perform an MAF sensor test I like to use the EScan scan tool that makes testing the sensor easy. The scan tool has a Sharp Shooter tab that incorporates an easy test feature to test Volumetric Efficiency (VE). In order to perform this test properly all you have to do is input the correct engine size, temperature and elevation. Once the correct information has been typed in, drive the vehicle while depressing the throttle pedal to Wide Open Throttle (WOT) a few times. (Note: Perform this test from a rolling start in first gear, followed by a WOT acceleration through the second gear upshift. Do this in a safe section of road near your shop and always obey local traffic laws in the process.) The tool will display the results based on what the VE table calculations test results currently are compared to the actual results. This is a very accurate and time-saving test that allows me to confirm if I have an induction problem. Problems could be related to a clogged air filter, intake manifold, valve problem including carbon build up and even a clogged exhaust. The tool will graph two lines; the red line is based off the engine size, temperature and evaluation while the yellow line displays the test results. The example (Figure 1) displays a lower than acceptable reading along with turbulence on the yellow graph, indicating a clogged exhaust. If the test results were normal the yellow line would be over the red line, indicating that the intake system was good.

Now if you don't have this tool, don't worry. You can perform a similar test, though not as accurate, by using any Generic/Global OBD II that graphs. Select the Calculated Load Parameter Identifier (PID) from the list and graph it. Once the selection is set up, start the engine and take the vehicle out for a test drive. You will need some clear space so you can depress the throttle pedal to it's WOT limits a few times. For safety reasons, make sure you are in a safe area and that someone else is driving while you are operating and viewing the scan tool test results. After achieving WOT a few times, it's time to view the graphed results of Calculated Load (Figure 2), making sure the graph obtained at least 90 percent at WOT.

Our problem Camry had passed both tests so I decided to dig a little deeper and do more research. I had completed my visual inspection, scan tool query and checked for Technical Service Bulletins (TSBs), but found nothing that provided information for my P0171. My next step was to check Identifix and iATN to see if there is any information that could assist me in solving this problem. Bingo! Identifix had some good information on the most common problems reported on the 2007 Toyota Camry. It reported the abnormal brake pedal feeling that I had experienced on one of my test drives. The Identifix information stated that sometimes there is a symptom of a hard or harder than normal brake pedal that is caused by a ruptured diaphragm in the brake power booster. The scan tool data on Long Term Fuel Trim in Freeze Frame was at +7, indicating that there was a problem that can be from many different sources. I have come across some Toyotas that had a P0171 due to intake gasket problems, but the DTC usu-

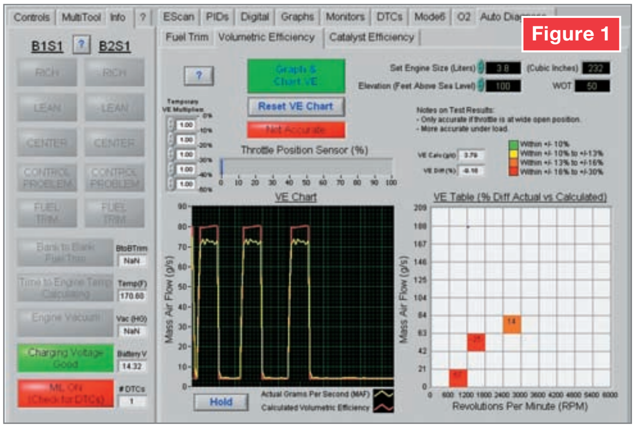


Figure 1

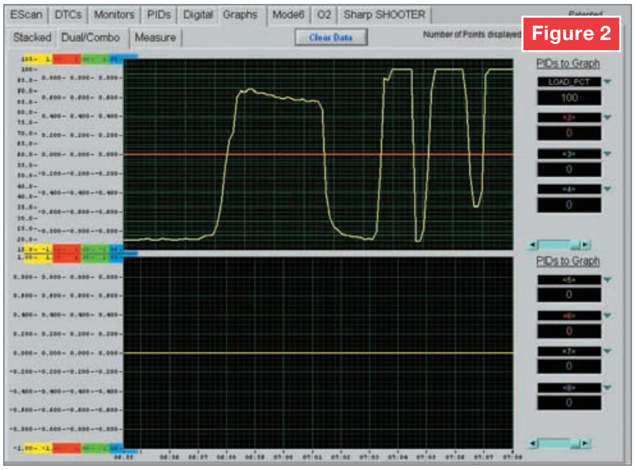


Figure 2

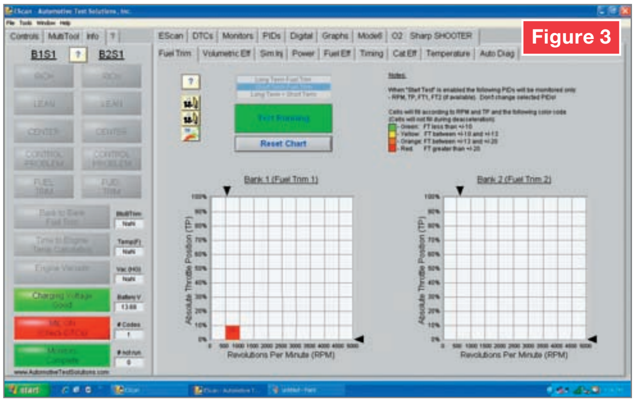


Figure 3

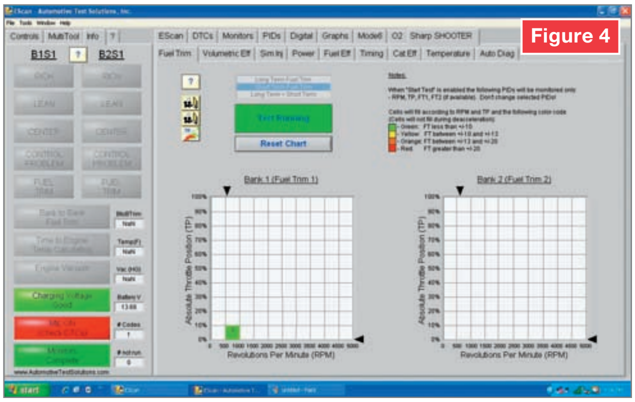


Figure 4

ally sets when the engine temperature is cold. The Freeze Frame data indicated that the DTC on this vehicle occurred when the engine was at operating temperature so that ruled that problem out.

Since I already had the EScan connected to this vehicle, I thought that I would check the fuel trim at idle while I depressed the brake pedal as suggested in Identifix. On the EScan, there is a separate test for fuel trim that is located in the Sharp Shooter tab section (Figure 3 & 4) that would allow me to view live results in either Short Term Fuel Trim (STFT) or Long Term Fuel Trim (LTFT) as I depressed the brake pedal. As you can see from the test results on the tool, STFT at idle was high while I was depressing the brake pedal and good when my foot was off the pedal. This vehicle was diagnosed and repaired quickly with a little help from my friends at Identifix and with the replacement of the brake power booster.

Nissan running lean

Recently, a 2012 Nissan Altima P0171 came in from another shop that had already diagnosed the vehicle with a P0101 MAF sensor problem. Since this vehicle did not exhibit any driveability problems associated with an MAF sensor, the shop made the right decision not replacing the MAF. The tech was sharp enough to avoid a case of tunnel vision and replacing an MAF that had nothing wrong with it. I have seen this shop improve over the years as they have learned not to throw parts at a vehicle and spend more time on research and diagnostics instead. During their preliminary inspection and diagnosis, they found that the MAF should not be replaced before updating the Engine Control Module (ECM) first. They used their service information to search for test procedures and TSBs, and found NTB12-051 for the P0101. This vehicle indeed needed a reflash of the PCM and not the MAF sensor to be replaced. Since this shop does not want to invest the time, money or education in performing reflash/reprograming, they brought the vehicle to me.

The procedure for reflashing a Nissan vehicle requires a bit more time compared to other vehicles. Since I don't own the Nissan factory tool, I was going to reflash this vehicle using my Drew Tech J2534 box. The procedure for Nissan is a bit different than others since you have to purchase their Nissan ECU Reprogramming Software (NERS) for $270 before purchasing the file needed to reprogram the vehicle. Before reprogramming any vehicle, make sure that the ECM DTCs are cleared, all accessories are off, key fobs other than the one needed to start the vehicle are not in range and most importantly a proper battery maintainer (not a battery jumper pack) is connected to the battery. Do not interrupt the procedure in any way including opening doors, windows, hoods or trunk. Be careful setting up the wiring from the OBD II diagnostic connector to the tool and laptop. On some vehicles during the reprograming procedure, the windows may go up pinching or pulling the wire from the connections. This can lead to bricking a computer and costing you a lot of money. The safe thing to do is close the door latch, making it seem to the vehicle that the door is closed followed by connecting the wire to the tool/laptop. The 45-minute reprogramming procedure yielded the proper results, clearing the P0101 DTC (Figure 5) and extinguishing the MIL.

Another misbehaving Nissan

A 2007 Nissan Maxima came in with an illuminated MIL and an idle problem after the vehicle had a throttle body cleaning service. The first step after interviewing the vehicle owner was a visual inspection that yielded no results to the stalling problem. The next logical step is to connect a scan tool to see what DTC(s) is causing the MIL to illuminate. The scan results came up with a P0507 (incorrect idle speed) DTC. I am sure over the years that you have come across an idle problem on Nissan vehicles many times. In some cases there is no illuminated MIL and just a problem with a high idle, making the diagnosis a bit more difficult. Some techs find it very difficult to resolve this problem and get the idle back to normal. Most likely they are only following the procedure that their scan tool displays. If

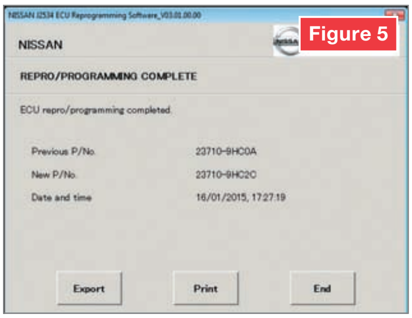
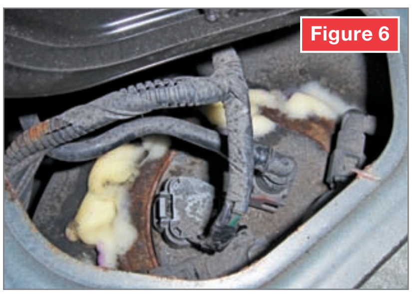


Figure 5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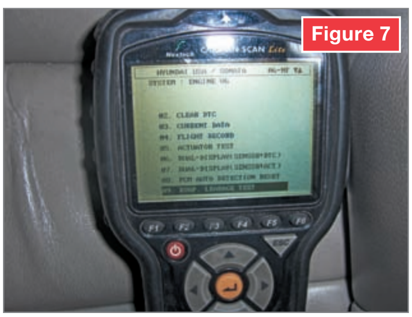
Figure 7

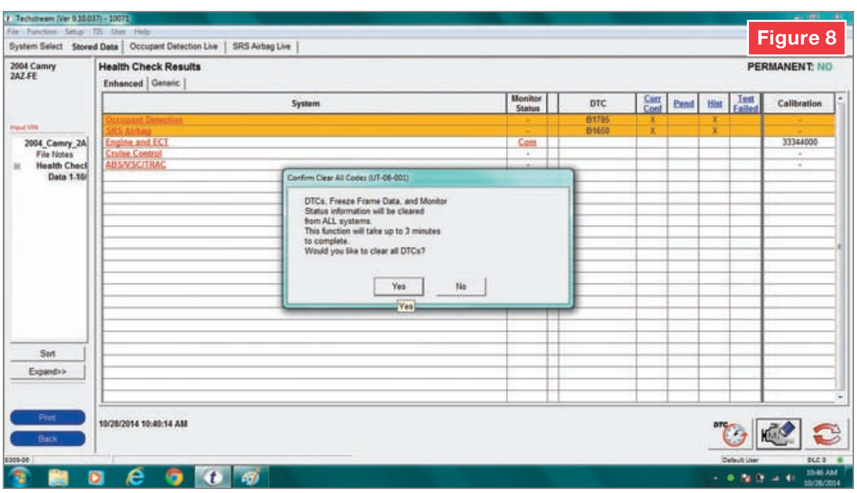

Figure 8

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they are not performing a very important step they won't be successful in relearning the idle.

When I am teaching anything about an idle driveability problem on a Nissan, I use an example from Identifix. The suggested procedure is to disconnect one or more fuel injectors. It's always a good idea to turn the key or power button to the off position before unplugging any solenoids/injectors. Depending on whether the engine is a four or six cylinder will make a difference with how many injectors need to be disconnected. I usually disconnect two injectors on a four cylinder and three on a six cylinder. That usually lowers the idle down enough for the idle relearn procedure to start running. After I have been successful in getting the idle lower I follow the procedure on the scan tool and complete the idle relearn. Now the vehicle is back idling normal by just following proper service information.

A Korean intervention

Our next problem vehicle is a 2007 Hyundai Sonata that came in with a P0442 (EVAP Small Leak Detected) problem. When we encounter a small Evaporative Emissions system (EVAP) leak we know that it's sometimes going to be very difficult to find where the leak is coming from. In the case of this EVAP leak on this Sonata, it may be more difficult than normal to locate the leak. See, we had this Hyundai in before with two EVAP leaks that happened a few months apart from each other. On one occasion, the EVAP leak was very difficult to locate because the leak was barely over 0.020." We were using our normal method to locate the leak by using our smoke machine. The smoke machine was able to show us that the leak was about 0.022" but we could not locate any signs of smoke. At first we thought that the leak may have been from the charcoal canister, but it was not. We confirmed this by using CO2 along with our smoke machine and gas analyzer. We use this method to look for a rise in CO2, indicating the area of the leak.

As we were moving the gas analyzer probe from the front of the vehicle to the rear we found an area near the upper side of the gas tank where the reading went up. We found dirt and rust on the locking ring of the fuel tank sending unit only after we switched to a new EVAP tool called BullsEye. There was no sign of smoke leaking from this area, but when we used the BullsEye leak detector it went off right at the ring. The next step was to spray on the BullsEye foam that will change color from pink to yellow if a leak is present. Since this tank is composite, we ruled out a rust hole in the top of the tank. With the foam on the connectors and around the O-ring and on top of the sending unit we were able to identify the (Figure 6) locking ring and gasket was leaking. We installed the new O-ring and locking ring with the special Hyundai fuel tank sending unit tool and retested (Figure 7) the system using the Hyundai EVAP test on our scan tool. The customer was happy and drove the vehicle around for a few months and down to Florida.

Months had passed by and guess what, the vehicle owner called us up and said his MIL light was back on. We scanned the vehicle and found a P0442 and used the Hyundai EVAP (Figure 6) test to confirm the concern was still present. We used the BullsEye tester again and found that this time the fuel pump module had become porous. The leak was coming from the plastic on the (Figure 7) fuel pump module. We installed a new fuel pump module and O-ring followed by retesting the system that now passed with flying colors.

I was wondering why there was no smoke coming from the leak area and decided to see if I could determine the reason. As a good practice we baseline our smoke machine before using it so we know the machine is introducing smoke and working properly. We performed this smoke experiment with the fuel sending unit out of the tank while we were flowing smoke into the system. When we looked deep into the tank it seemed that smoke was coming in and being pulled down into the fuel and disappearing. We still love and use our smoke machine, but when we can't find the smoke after resetting the timer button on the machine more than twice we know there is either a leak in the fuel tank or in the canister.

Toyota SRS

My friend Armine called me about his 2004 Toyota Camry that had an illuminated air bag light on the dash.


Figure 9

When he drove the vehicle to the shop, I decided to connect the Toyota Techstream to the vehicle. The following DTCs were stored in the vehicle (Figure 8): B1785 Occupant Detection LH Collision Detection and B1650 SRS Airbag. An attempt by a shop closer to where he lives tried clearing the DTCs, but they came right back. The shop most likely used an aftermarket scan tool that did not have the ability to perform a Zero Point Calibration for the B1785. The problem with this DTC was not caused by an accident, but most likely from something heavy that contacted the seat frame. Since there was no damage to the seat frame, I continued diagnosing the B1650 DTC. One way a B1650 can set is if the airbag sensor assembly center receives signals from the Occupant Classification ECU, it determines whether or not the front passenger airbag assembly and the front seat airbag assembly RH should be operated. So after reading the DTC definition in our service information, it seemed like the Zero Calibration would fix both DTCs if the procedure was successful. I performed the procedure successfully, and the vehicle was now fixed. So what caused the problem? Take a look at the rear bumper, (Figure 9). See the two holes? It looks like the bumper was hit by something or hit something hard. Maybe an NYC parallel parking job (I say with a smile)? MA


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DEALING WITH AFS

Drew Technologies Mongoose cable provides full factory functionality for Toyota Lexus Scion

UNDERSTANDING THE OPERATION AND TROUBLESHOOTING OF AIR/FUEL RATIO SENSORS

BY **DAVE MACHOLZ** | CONTRIBUTING EDITOR

The days of the zirconia upstream oxygen sensor are now behind us. Vehicle manufacturers have moved forward on to what is commonly known as the air/fuel ratio sensor, or AFS. With the change in the technology has come a steep increase in the price of the replacement part, which means you need know how to diagnose sensor and air/fuel related faults.

This month, we will focus on Asian AFS operation, diagnosis and replacement with a focus on what you need to know to fix it right the first time.

Understanding the feedback strategies

When a spark ignition engine is in open loop operation, it is using a feed-forward strategy for operation. The Engine Control Module (ECM) is looking at inputs such as engine load and RPM, as well as adjustments for air and coolant temperature and is commanding an injector pulse width to match fuel to the incoming air at a specified ratio.

Typically the AF ratio being commanded is 14.7 parts of air to 1 part of fuel by weight. This ratio is commonly known as the stoichiometric ratio. While it has been commonly taught that the ECM is primarily commanding stoich, it is not a fixed rule.

In closed-loop operation, the AFS is used to provide feedback to the ECM and reports the actual air fuel ratio to the ECM. While the AFS is the primary sensor for feedback, the ECM uses the downstream oxygen sensor to make secondary adjustments for the catalyst.

Why is AFS important now?

For years we have continued to learn about the zirconia oxygen sensor. Among the things we were taught was that 450 millivolts was stoich, right? Well, it is, but so is anything in the range of 200-800 millivolts. Yes, you read that correctly. The zirconia oxygen sensor's range is typically in the area of 100-900 millivolts and as such the ECM/PCM doesn't truly know how rich or how lean the air fuel mixture is. Until the sensor reaches the 200 millivolt range on the lean end and 800 millivolts on the rich end the sensor is assuming stoich.

These of course are not hard and fast numbers every time, as the range will vary slightly depending on the sensor temperature and based on the sensor manufacturer.

In order to maintain stoich on a system with an upstream zirconia-type O_2 sensor, the ECM had to toggle the fuel command rich and lean in order to keep the AF ratio within the 200-800mV range.

This toggling of AF ratio was an inefficient way of maintaining stoich. The zirconia-style oxygen sensor can only accurately see a very narrow range of air/fuel ratios. In fact, it really only sees stoich. Again, it cannot accurately report how rich or how lean the mixture is.

The AF Sensor is considered a wide-range sensor. What does that mean exactly? It means that it can accurately see a wide range of air/fuel ratios.

This has become increasingly important to manufacturers as they try to improve fuel economy and tailpipe emissions. The ability to see the exact AF made the switch to the AFS truly a no brainer. With the accuracy of such a sensor also comes the ability to command a variety of fuel ratios for specific engine load and operating conditions.

Keep in mind that AF sensors may look similar to their O_2 sensor coun-

Photos: Dave Macholz

terparts, but they in fact function much differently.

Sensor voltage? Or Amperage output?

The most important difference to be aware of between the AFS and the O_2 sensor is how they operate internally. My advice is to maintain your focus on how to diagnose these sensors in particular. Do not get caught up in their overall operation. While they all achieve a wide-range sensor result, they all are designed by different engineers and different manufacturers. Attempting to memorize sensor voltages can prove to be a bit overwhelming.

While the zirconia O_2 was a voltage generator, the AFS actually outputs a current flow (amperage). When the engine is running at stoich there is no current flow. When the engine is running lean the current flow increases. When the engine is running rich the current flow polarity changes and you get a negative current flow value.

What happens when you can't keep control of the ECM? Find out at MotorAge.com/control

The ECM then takes these values and converts them into a voltage. The voltage range will again vary from manufacturer to manufacturer with no standard voltage for stoich. For example, Toyota uses 3.3 volts as stoich. Anything below 3.3 is rich and anything above 3.3 is lean. Each manufacturer's voltage value can be treated the same.

The question I am always asked is which value should be used in diagnosis? The answer is whichever one you are comfortable with.

AF sensors may look identical to their O_2 sensor counterparts but they function much differently.

In the Techstream screenshot provided on page 56, I graphed both AFS voltage and AFS current. You will see that the graphs are identical. Why? Because the ECM converted the current into a readable voltage value.

Keep in mind the voltage output of an AFS is opposite to that of the zirconia oxygen sensor. Values higher than the stoich voltage are lean and values lower than the stoich voltage are rich.

Take the time to find and use the simple solution

If you put me on the spot and asked me what the stoich voltage value was for each manufacturer I would probably have a hard time remembering them all. I try not to remember any piece of information that I know I can look up. However, the more accurate reason I have a hard time remembering the stoich voltage values is because I don't use voltage or amperage for diagnosis. I use lambda.

Lambda is such a perfect solution that manufacturers including Toyota and Honda provide it as a PID. They even go as far as teaching their techs to use lambda instead of voltage or amperage. It's really simple once you get the hang of it.

Lambda is a fantastic tool for diagnosing AFS and related complaints. Lambda is a ratio of available oxygen compared to the combustion processes' demand for oxygen. Lambda is equal to 1.000 when there is balance between available oxygen and demand for oxygen. In other words, lambda is equal to 1.000 when the current air fuel ratio matches the desired air fuel ratio.

This formula is known as the Brettschneider formula, named for Robert Brettschneider who first proposed it in 1979 in a technical paper published by Bosch. While his original formula is quite complex, it is extremely useful in determining air/fuel ratios and imbalances. iATN.net provides a lambda calculator on its website. You can access it at MotorAge.com/lambda.

The lambda calculator will allow you to enter values from an exhaust gas analyzer to determine lambda. Why is this important? Well, if you had a misreporting sensor, there is really no better way than using the gas analysis and plugging the numbers into the calculator. While this doesn't happen all that frequently on the Asian products, it is a good idea to keep this method in your back pocket for future reference. By the way, don't get rid of that old gas analyzer!

If you should suspect that you have a sensor that is not reporting properly the best method to follow is to plug your five gas values into the calculator. Once the numbers are plugged in, you can use your calculated lambda value to determine the actual running condition of the engine.

For example, if your calculated lambda number is .997, it is pretty safe to assume that the engine is running at stoich. If the calculated lambda value is less than or greater than 1.000, multiply the lambda value by 14.7. The product of your multiplication is the determined AF ratio.

For example, if the lambda calculator value is .887, multiply .887 x 14.7. Your resulting AF ratio is just about 13:1, which is slightly on the rich side.

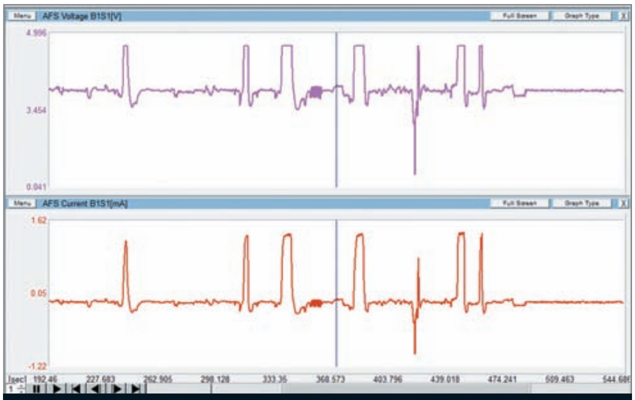
For another example, suppose that your lambda calculator returned a value of 1.250. Again, multiply 1.250 by 14.7. The air fuel ratio is roughly 18.4:1, which is lean. Practice doing this a few times and you will have the hang of it. Always remember a lambda value of less than one is a rich mixture, while a value of greater than one is a lean mixture.

If you are having trouble trusting the calculator, you can always use manual testing methods to drive the mixture lean or rich and plug the values into the calculator to see the change in lambda value.

While I prefer to use a scan tool to do so, you can substitute pulling off a vacuum hose to create a lean condition. To drive the mixture rich, the use of propane is another option. The bottom line with both methods of

RICH <14:1-??	STOICH 14-15:1	LEAN >15:1 - ??
800mV-1V*	200-800mV*	0V-200mV

The zirconia oxygen sensor can't accurately tell how rich or how lean the engine is running.



When comparing AF sensor Voltage and Amperage the graphs are identical.

$$\lambda = \frac{[CO_2]+\left[\frac{CO}{2}\right]+[O_2]+\left(\left(\frac{H_{cv}}{4}\times\frac{3.5}{3.5+\frac{[CO]}{[CO_2]}}\right)-\frac{O_{cv}}{2}\right)\times([CO_2]+[CO])}{\left(1+\frac{H_{cv}}{4}-\frac{O_{cv}}{2}\right)\times([CO_2]+[CO]+K1\times[HC])}$$

Where :

[XX] = Gas Concentration in % Volume.

K1 = Conversion factor for FID measurement to NDIR measurement.

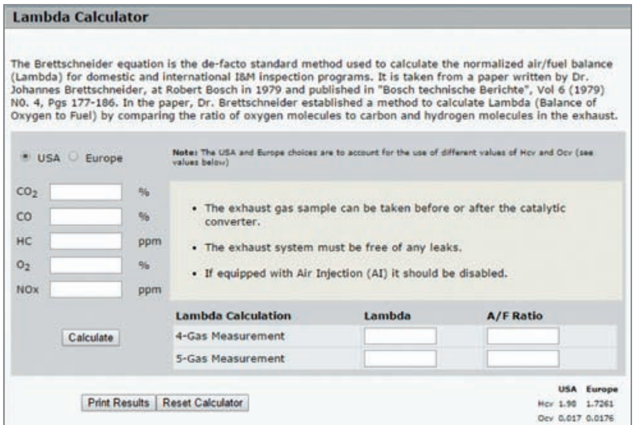
H_{cv} = Atomic ratio of Hydrogen to Carbon in the fuel.

O_{cv} = Atomic ratio of Oxygen to Carbon in the fuel.

For Gasoline, K1 is 6.0, Hcv is about 1.800 (depending on the actual mix), and Ocv is 0.00, except for oxygenated fuels.

The Brettshneider equation is the preferred method of determining Lambda

Photo: iATN



A lambda calculator can help find a skewed AFS

Photo: iATN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Call 800.336.7202 or contact your local Dickies Representative. www.dickiesdelivered.com testing is that you are looking for a near instantaneous change of the sensor values. While most newer vehicles will code if a sensor is lazy, manually inducing a rich or lean condition can provide some peace of mind that the sensor is reporting rapidly.

As with any diagnostic routine, the best way to learn is by doing. Try these simple formulas and test methods on known good vehicles before trying to fix a problem vehicle.

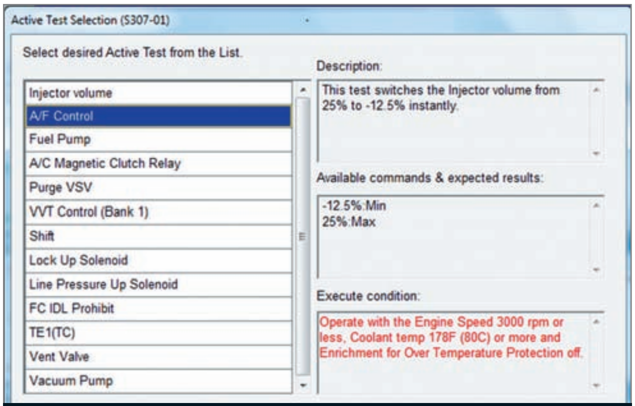
Air / Fuel Ratio	Lambda
17.5:1	1.19
14.7:1	1.00
12.5:1	.85

To use Lambda in diagnosis you can simply take the lambda value and multiply it by stoich (14.7).

12:1	12.5	13	13.5	14	14.7	15	15.5	16	16.5	17	18	18.5
2.4	2.6	2.7	2.9	3.1	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0
-.54	-.42	-.35	-.25	-.12	0	.06	.15	.18	.23	.30	.40	.42
.82	.85	.88	.92	.95	1	1.02	1.05	1.09	1.12	1.16	1.22	1.26

A comparison of AFR, Voltage, Amperage and Lambda values for Toyota Vehicles

Most 2003 and new Toyota products use active AF control to test the AF and O2 Sensors as well as catalyst efficiency



Techstream active tests for AFS provide a great way of testing AFS response

Lambda = Current A/F Ratio ÷ Stoich

Current A/F Ratio = Lambda× Stoich

To effectively use lambda in a vehicle diagnosis, you can simply take the lambda value and multiply it by stoich (14.7).

Stoichiometric Ratio:

14.7:1

3.3 Volts

0 mA

1.00 lambda

Put factory tooling to use

Toyota factory tooling is the least expensive factory tool on the market. A Techstream Lite Mongoose cable from Drew Technologies retails for around $500. Techstream software can be purchased through subscription at www.techinfo.toyota.com.

The Techstream provides a great active test for the AF sensor. This test provides the abilities of manually creating rich or lean conditions by changing the fuel injection volume or pulse width. With the scan tool you can now achieve the same desired conditions from the driver's seat of the car.

The active test allows you to toggle the air fuel ratios instantly rich or lean while graphing the sensor response. This is my go-to test when I suspect a lazy sensor. Many aftermarket scan tools provide similar functionality.

To scope or not to scope?

Using a digital storage oscilloscope for AFS is not a realistic or worthwhile venture. Remember that the AF sensor outputs a current flow, and as such we would have to use an inductive current clamp to graph the value on the scope. Being that the sensor generates just milliamps, the use of a highly accurate low current clamp at a cost of over 700.00 needs to be used. My advice: take the $700 and take your significant other on a weekend getaway.

When it comes to diagnosing AF sensors, it is important to remember that the manufacturer has gone to great lengths to build diagnostics into their ECM. Diagnosis should be done primarily with a scan tool. In the case of Honda and Toyota, these sensors are relatively reliable. Many of the early problem sensors resulted in published Technical Service Bulletins (TSBs), and using TSBs as a first step in diagnosis is a best practice when fixing Asian vehicle fuel control faults. Always remember the K.I.S.S. method. Diagnostic routines should not be complicated. Use the information provided here to work smarter and not harder. MA

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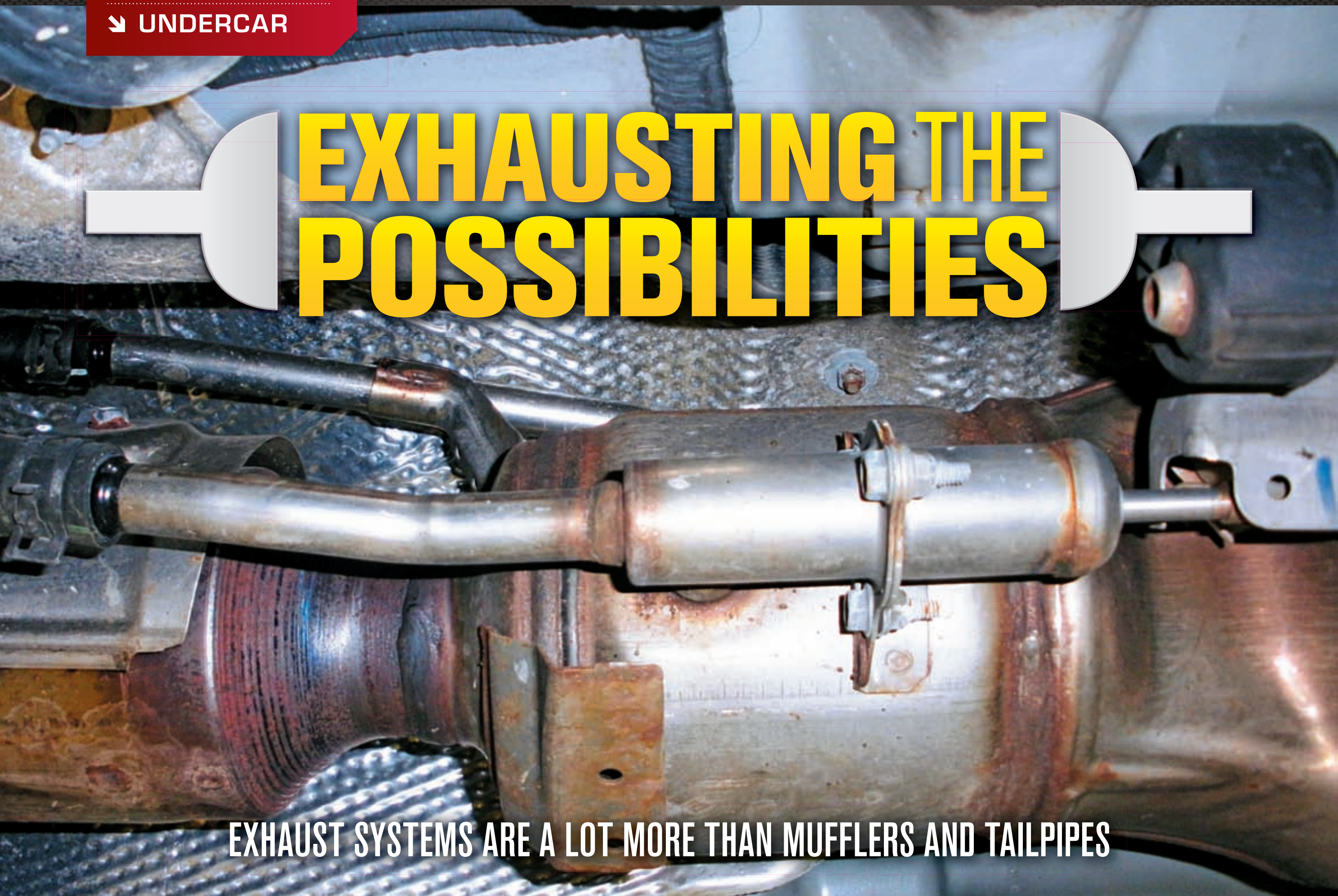
EXHAUSTING THE POSSIBILITIES



EXHAUST SYSTEMS ARE A LOT MORE THAN MUFFLERS AND TAILPIPES

GEN III Prius models (2010 and newer) use an exhaust heat recirculation system to aid in cold engine emissions. It takes the place of the insulated tank hot coolant storage systems. The line at the bottom is the cooler of the two lines while the line on top (partially obstructed in photo) is the hotter return line that has the warmed coolant that has travelled around the recirc unit's outer perimeter. The actual main catalytic converter is in two stages. Since the exhaust heat recirc system is in the middle, it almost appears as if there are 3 catalytic converters!

BY **DAVE HOBBS** | CONTRIBUTING EDITOR

Whether you're a muffler/undercar specialist working on exhaust systems every day or a drivability tech working on them occasionally, you've inevitably banged your head on a few tough exhaust system problems, and technology changes haven't made the exhaust repair game any easier. This article will bring you up to date with technology, tools and techniques you need to get today's exhaust systems running quiet, running clean and passing OBD II monitors/state emission tests.

If you think your job is hard, imagine the life of an exhaust system component. Exhaust systems basically have three tough jobs to do.

Exhaust System Job 1 – Move air

It's all about volumetric efficiency. Engine designers want to make the engine breath as efficiently as possible, but also keep things quiet. Pressure waves from exhaust if allowed to expand, help to provide cylinder "scavenging" in order to clear the combustion chamber of exhaust. The less residual exhaust in the cylinder, the more room there is for power-contributing oxygen on the intake stroke that follows the exhaust stroke. Tuning exhaust header/manifold shapes and lengths is just as important as tuning the intake manifold runners. Crossovers have traditionally helped. Since each cylinder pushes a positive pressure wave of exhaust gas one exhaust stroke at a time, an exhaust pressure pulse from the left side of a V engine passes the crossover tube in the exhaust, creating a negative pressure (vacuum) wave. This vacuum pulse helps to pull out the exhaust pulse that just began its voyage out of the cylinder on the other bank of a V-configured engine. Adding to those exhaust "puffs" of positive pressure are just as many "whiffs" of negative pressure.

Exhaust System Job 2 – Quiet things down

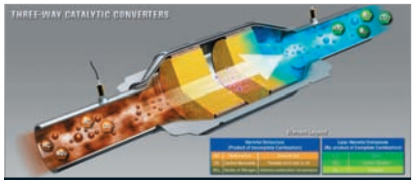
Mufflers are obviously needed for the street but will limit the exhaust system's No. 1 job — Volumetric Efficiency

Photo: Dave Hobbs

(VE). Reduction of the muffler's back pressure (resistance to flow) most always means an increase in sound decibels. OEM mufflers typically use a multiple chamber approach with some insulation inside to help dampen the sounds that don't get cancelled out in the chambers. Sound waves bouncing off the walls of the various chambers crash back into the incoming sound waves causing a cancelling effect. Aftermarket mufflers such as the Cherry Bomb muffler I installed on my first car (a 1961 Chevy) are still around in much the same form as they always have been: straight mufflers with a single internal pipe with small holes that allow exhaust gasses (and sound) to move outwardly into the surrounding insulation material lowering noise levels somewhat. Modern aftermarket exhaust system manufacturers have made great advances in these types of performance mufflers to afford better VE and still have decent noise levels. Variable displacement engines take on a whole new exhaust signature when a pair of cylinders from each bank (GM and Dodge) or an entire bank of 3 cylinders on a V6 (Honda) are shut off. For this reason, manufacturers like Tenneco (Walker Exhaust) have turned to variable tuning of the exhaust to offset the different/additional noises experienced in these fuel sipping variable displacement modes. Corvette Stingrays beginning in 2014 have been equipped with this new technology. It works similar to variably tuned intake manifolds by controlling throttle butterflies near the muffler outlets in order to change the flow and sound note of the exhaust.

To help noise matters further, many newer vehicles have seen greater popularity with active sound management inside the cabin. Honda's Variable Cylinder Management (VCM) uses an active noise cancellation via the OEM audio system for several years, an idea that has caught on with other OEMs. Add a microphone inside the vehicle to monitor road noise frequencies, exhaust drone, etc. then create equal but opposite (delayed) sound waves to cancel out objectionable noises. I recently drove a new Chevy Equinox V6 equipped with an active noise cancellation system and there was a distinct improvement in cabin noise.

Top and Middle Photos: Walker Exhaust, Bottom Photo: Dave Hobbs



The catalyc converter has been around for over 40 years now. The definition of catalyst is "causes or accelerates a chemical reaction, but in the process is not effected by that reaction."

Dual-walled exhaust pipes were not all that uncommon a few decades ago, but were dropped primarily due to cost. Thanks to the need to keep the exhaust hotter in order to warm up the catalytic converter, they've made a comeback.

Catalyst expectancy is similar to that of any other major component of the vehicle. It has been said that "most cats don't die natural deaths – they are killed by what comes into them." Engine oil, silicates from coolant and WAY too rich exhaust mixtures can make the best converters fail fast! Physical damage (broken substrate) can be detected by a modest wrap with a compound / rubber mallet but beware – smack on too hard and a good one is now broken!

Exhaust System Job 3 – Get the catalytic converter to light off

This requirement part is obvious – converters need to be 350 - 450 deg. F (on average) to light off (begin cleaning up exhaust) and will operate without damage somewhere in the 450-850 deg. F. range. They may see temps as high as 1200 deg. F. under adverse conditions. Sustained temps very much above that can lead to substrate failure. On the cold side of the discussion the age-old problem with converter light off is the time it takes. By the time you get that first couple of miles driven prior to light off you've already polluted more than your next 50 miles of driving! This is why the "pup" converters (downsized) have been split into 2 sections with the first being moved very close to the exhaust manifold outlet. Exhaust pipes and manifolds with an inner wall surrounded by an outer wall were not uncommon several decades ago. One failure sometimes experienced is due to thermal shock. Sudden cooling (driving through a flooded spot in the road, for example) can collapse the inner wall of the pipe. There is a simple test for this passed down to me from my dad who never played golf but always had a golf ball in his tool box. You roll the golf ball into the exhaust pipe inlet (removed from the manifold) and it should come out the other end (removed from the cat/muffler). If there was a double wall pipe with a collapsed inner wall the ball won't pass through. Double wall exhaust pipes seemed to drop off the radar for a few decades until OBD II began to evolve and the need to get the cat lit off quick required some drastic measures. The extra wall provides insulation to keep hot exhaust gasses hot during warm up so they can pass that heat to the converter for quicker light off.

The modern three-way converter uses advanced catalyst chemistry to store and release O_2 when coupled with a closed loop fuel system. This system utilizes one or more O_2 sensors to oscillate the fuel mixture between lean and rich conditions. These oscillations are the reason you see a good O_2 sensor switching from rich to lean in a very rhythmic fashion. The oscillating rich/lean fuel commands combined with the O_2 storage and release on the catalyst surface, allows for the best oxidation/reduction of all three emissions IF the A/F ratio is right and there are no exhaust leaks. Remember those positive and negative pressure (puffs and whiffs) associated with multi cylinder engines explained in exhaust system job 1? Those "whiffs" pull in ambient O_2 concentrated air that all but eliminates the chances for accurate fuel control and OBD II cat efficiency monitor accuracy.

Catalytic Converters – Exhaust system king of cost!

Monolithic three-way catalytic converters with a ceramic substrate have been the norm for many years. They're comprised of an outer heat shield, stainless steel outer shell and a porous ceramic "honeycomb" substrate with a wash coat containing noble (expensive) metals such as platinum, rhodium and/or palladium. Surrounding the extremely dense ceramic substrate is an insulation mat that resembles a blanket. The mat protects the ceramic substrate (sometimes called the 'brick') from physical shocks, allows for some expansion and contraction and insulates the shell from some of the heat produced inside the converter. Gold (in very small doses) is being used in some newer converters which explains why some diesel oxidation converters on over the road trucks have as much as $1,000 of precious metals in them.

Three-way converters are named as such due to the 3 pollutants they address. The first pollutant is CO or Carbon Monoxide. CO is a byproduct of incomplete combustion. The second pollutant is HC or Hydrocarbons. HC is basically unburned fuel. CO and HC are formed at higher levels when the ideal stoichiometric mixtures (14.7:1 for spark ignited engines) run lower (richer). The third pollutant is Nitrogen Oxide or NOx. NOx is formed when Nitrogen combines with Oxygen due to high temperature combustion conditions. Those same conditions often result in spark knock/detonation. The easy way to remember when NOx is produced is to remember that when you hear "knocks" (ping) you are making NOx. NOx is formed at higher levels when the mixture goes higher (leaner) than stoich. NOx is often more likely to occur with overheating, lack of proper EGR flow/variable valve timing operation or insufficient fuel octane. All of these add air to the fire and your experience adding O_2 to your cutting torch flame reminds you of what air does to the temperature of a fire! Of course dripping injectors, restricted air intake, skewed coolant sensor (showing colder than it really is), and too much EGR can be the causes of air fuel mixtures lower than stoich (richer).

In order to achieve as close to 100 percent three-way converter efficiency as possible the job of the engine management system (including the O_2 sensors) is to maintain stoich under most all conditions. This will keep the converter from loading up with excessive HC that it can't oxidize and prevent it from running so hot the ceramic substrate turns into Mt. Saint Helens.

Gen III Prius - Hot and cold running water to the cat?

That's exactly what this exhaust heat recirculation system has on GEN III Prius models (2010 and newer) to aid in cold engine emissions. It takes the place of the insulated tank hot coolant storage systems used in Gen II models (2004-2009). One line at the bottom side of the exhaust heat recirculation unit is connected to a temperature actuated mechanical control valve. The valve forces exhaust to reroute within the outer shell of the recirc unit past the coolant passageways inside the unit. The other coolant line continues the circulation process of coolant back up to the engine. The unit is situated between the section of the converter closest to the exhaust manifold and the lower section downstream. Don't confuse this unique emissions gadget with the early Gen I Prius (and earlier Lexus models) which used an electronically control vacuum solenoid to control a diaphragm that rotated a mechanical valve towards the front of those converters in order to route exhaust gasses on cold starts into an outer chamber of the converter containing hydrocarbon adsorbers. This also lowered cold start up emissions keeping those vehicles in the "AT PZEV" (Advanced Technology Partial Zero Emission Vehicle) club.

Turbochargers boost VE for increased performance, but can also be a source of exhaust leaks and even an exhaust restriction in rare instances. Make sure any exhaust diagnosis includes a thorough look at the turbo.

This C6 Corvette muffler cutaway shows the holes in the inlet's baffle that allow sounds to move into the first chamber then on into the second chamber to be absorbed by the muffler acoustical 'insulation'. Exhaust finally passes on out of the outlet as certain frequencies of sound waves cancel each other out.

Top Photo: Dave Hobbs, Bottom Photo: General Motors

Diagnostics — Exhaust restrictions

Besides the collapsed inner wall of a dual wall exhaust pipe restricting the proper flow of air movement out the tailpipe, there are a host of other causes and diagnostics techniques to keep in mind. The muffler's internal structure can come apart or the insulation can dislodge and plug it up. Most mufflers are directional too, so don't forget to check to see if the last tech working on the vehicle put a muffler on backward. When the converter substrate loads up with carbon, soot and other contaminates it can increase the exhaust system's back pressure first to the point where power is reduced (runs well at idle low speeds but can't get up to highway speed) and then progress to the point of restriction where the engine won't start. If you can't get exhaust out, you can't intake air in.

1. Vacuum Gauge: The classic vacuum gauge test is still my first pick if I can get to a source of manifold vacuum. The simple process is to connect the gauge, record the vacuum at idle then rev the engine up to 2000 RPM and hold there for a few seconds. The initial throttle opening will naturally cause the vacuum to drop but as the engine gets up to the 2000 cruise RPM the gauge should recover and stabilize at a reading higher than the idle speed reading. A gauge that drops and stays down indicates a possible restricted exhaust and the cue to go on to step two. Passing this test isn't a guaranteed good health test of the converter and muffler but failing the test IS your justification to get some additional diagnostic time approved to perform an exhaust back pressure test.

2. Back Pressure Gauge: Most engines will allow you to remove the pre-cat O_2 sensor in order to screw in a backpressure tester. Typically, 1.5 PSI or less means NO restrictions. 1-5 PSI to 2.75 PSI means MAYBE (consult OEM service info). 2.75 PSI or more means you have a restriction. Got excess back pressure? Reinstall the pre-cat O_2 sensor and remove the post cat O_2 sensor and install the back pressure gauge downstream from the cat. If backpressures are way down, the converter was the culprit. If the pressure gauge reads high, the restriction is downstream in the resonator/muffler.

3. Compound/Rubber Hammer: Giving the converters, resonators and mufflers a sharp "rap" with a compound hammer to locate a rattle is simple enough. If something is banging around in a converter when you smack it that something could be intermittently causing an exhaust restriction.

Photo: Dave Hobbs,

Flex couplings like shown here on this Prius are common and prone to leakage. Inspect, jiggle, inspect again. Don't just listen for leaks. Make sure you use a smoke machine or effective alternate method to test for a leak when you experience a PO420 cat efficiency code (false air coming in via the leak can make a PCM think the cat is bad when really all you have is an O_2 sensor breathing in fresh air instead of true exhaust samples).

Photo: General Motors

The exhaust uses a pair of butterfly valves to adjust the sound when the cylinder deactivation system is in V4 mode. Optionally, use a dual-mode active exhaust with two extra electro-vacuum actuated valves to open for even MORE noise!

There is one caution however. Do NOT bang too hard! There is no spec for how hard is too hard. How hard do you hit an electronic module to test for intermittent circuit board connections? According to Joe Bacarella at Tenneco/Walker Exhaust there have been numerous cases of techs hitting converters hard enough to make a perfectly good ceramic substrate a broken substrate. The converter should NOT rattle nor should it sound hollow. Hollow means the substrate is gone.

Diagnostics — Exhaust leaks

Exhaust leaks can at times be very difficult to find. Cracked pipes/manifolds, porous welds, bad donut gaskets, loose clamps, loose mounting bolts and warped manifolds are just a few common leak sources. Beyond using your ears and/or automotive stethoscope there are numerous methods out there to find leaks. A gas analyzer works to locate less than obvious leaks if you have one. Most full service shops have a smoke machine for evap leaks which can also be used for exhaust leaks. Since smoke machines put out very low pressure you may want to supplement this tool with a leak detection machine designed for turbo vehicles. Smoking an induction system with higher pressures makes for a realistic test on turbo and supercharged engines. If you don't have a smoke machine, there are some imaginative techs that have used everything from a leaf blower fastened to the exhaust to shop air (funneled into the exhaust pipe via a smoke machine cone exhaust adapter). Of course you'll need to couple your rubber cone and blow gun to the exhaust with a pressure regulator dialed down to no more than 10 PSI. That's enough for realism and not too much to create leaks that were not there before you worked on it. Adding some Sea Foam into the intake while the engine is running will create some smoke (don't overdose it though). Keep in mind besides audible leaks (and smells) exhaust system leaks can throw off the engine management system's O_2 sensor readings.

Diagnostics - P0420 / P0430 Catalyst Efficiency DTCs

Engine management systems use the Pre-Cat and Post-Cat O2 sensor activity to pass or fail catalyst efficiency DTCs. (P0420 and P0430) Exhaust dilution via exhaust leaks make the O_2 sensors prone to tell the ECM there is a lean fuel mixture problem or false air. Or the ECM might see the false O2 sensor signatures as a sign the cat is not working. In addition to checking for exhaust leaks, here are a handful of diagnostic tips to help you with these codes.

1. Do your electronic research. Pulling DTCs (all of them) and researching the web (TSBs, software updates, tech tips, etc.) become the essential first steps on cat efficiency diagnostics.

2. Check for proper fuel control. The converter's peak operating efficiency range is 14:62 to 14.77 (Lambda .995 to 1.006) which means if the A/F is not right the cat will struggle to work correctly. Scoping the O_2 sensors, observing fuel trim numbers, looking for false air and mixture imbalances (1 lean cylinder creating 3 rich cylinders after fuel trim) can wreak havoc on a converter's performance. It is easily spotted on an ignition scope pattern, however.

3. Contamination (poisoning the cat). As discussed previously, always make sure the oil consumption, coolant leak or customer's fuel additive addiction is fixed FIRST before a replacement converter is installed.

4. Make sure your replacement converter is correct. Quality and construction often go with price, and as you've probably experienced before, some vehicles just are not going to stop setting the P0420. Some lesser expensive replacement converters literally have less noble metal in them. They may pass a tail pipe test but still fail the OBD II efficiency test. Today's exhaust systems are neither simple nor cheap. As Ben Franklin once said, "The bitterness of poor quality is remembered long after the sweetness of low price has faded from memory." MA

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YOU CAN'T FIX IT THE OLD WAY

REPAIRING CARS TODAY REQUIRES COMPUTER SAVVY

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

As you are working on today's vehicles you won't be able to fix many different vehicle problems unless you are able to reprogram the vehicle. Our case in point is a 2006 Ford Explorer with a 4.6L V8 (Figure 1) that came in the shop with an EVAP circuit and O_2 heater circuit problem. The associated Diagnostic Trouble Codes (DTCs) were P0141 (O_2 heater Circuit Bank 1 Sensor 2), P0161 (O_2 heater Circuit Bank 2 Sensor 2) and P0443 (EVAP System Purge Control Valve Circuit). Other than these DTCs, the vehicle ran fine, but with the MIL illuminated the vehicle would not pass inspection.

The first place to go after the customer interview and a visual inspection is the service information. We decided to start our search with Identifix since they do a good job covering old problems and provide OE information. We found the same DTC information listed on Identifix suggesting a wiring issue or a defective PCM could cause the concerns. We decided to start our formal diagnosis by checking the P0443 EVAP circuit first since it would be easier. The DTC description stated that this DTC can set if the EVAP canister purge valve circuit output driver is out of range. The PCM test fails when the solenoid is outside of the minimum or maximum limits that are set for the commanded state. The possible causes for this code are VPWR (vehicle power circuit) circuit open, EVAP canister purge valve circuit shorted to ground, damaged EVAP canister purge valve, EVAP canister purge valve circuit open, EVAP canister purge valve circuit shorted to VPWR or a damaged PCM.

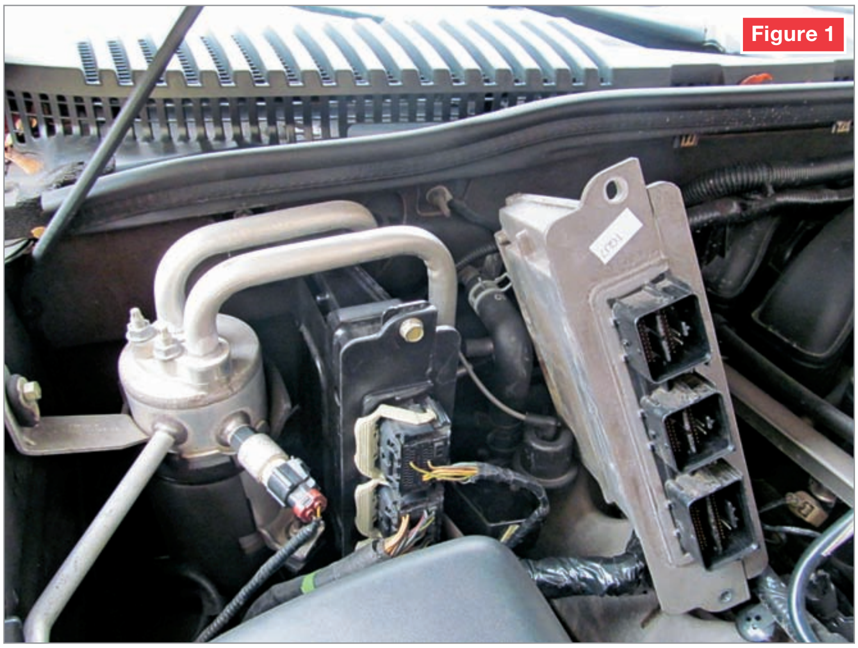
Figure 1

With all of those possibilities it is easier to check out the load first to see if there is power and ground along with checking if the solenoid works. Since the canister purge valve would be easy to test right at the load, we started there. We disconnected the wiring to the purge valve with the ignition key off and turned it back on to check the indexing of the two-wire connector to confirm which one of the two had power. Using the index information, we used a PowerProbe to manipulate the solenoid. The PowerProbe tip was connected to the B+ side of the solenoid and the ground wire to the other side along with a mini amp clamp that was placed around the ground wire. Now we could check the load, the EVAP solenoid, to see if it works and how much amperage the solenoid would draw. This test was one easy, complete way to diagnosis that circuit without following a long task.

In the past I have seen many solenoids drawing excessive current that would burn the circuit open. The testing we performed confirmed that the solenoid did function as designed and did not cause a high current draw that would damage the PCM. The test concluded that the purge solenoid was drawing about 430 milliamps, assuring that the valve had the ability to function properly.

With the purge valve out of the way

Photos: Jerry "G" Truglia

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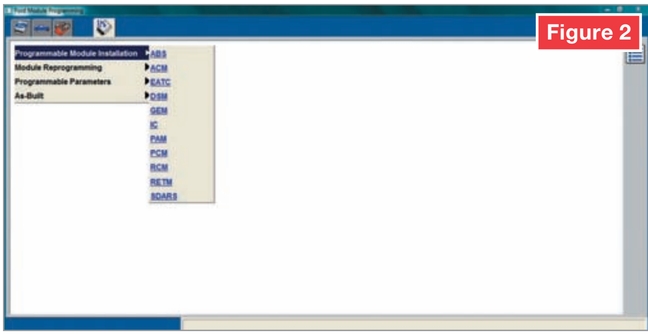


Figure 2

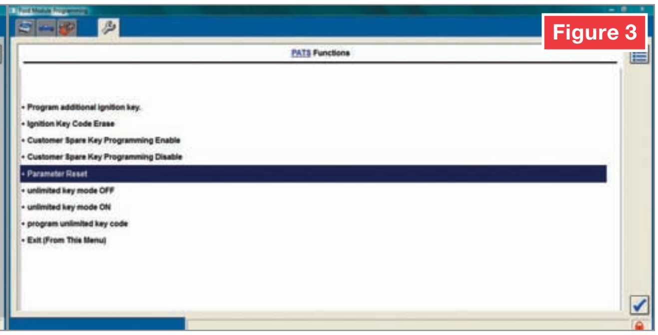


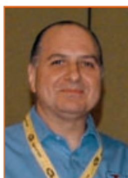
Figure 3

we now could move on to testing the O_2 heaters. This part of the diagnosis was going to be a bear to check since this 4.6L V8 hardly had any room to get to the connectors, so we decided to test where it was easiest: at the PCM. Service information suggested checking power at fuse 42 or at the circuit breaker. Since this vehicle had a fuse and not a circuit breaker, we checked it for power before moving on to a more difficult test. Since the fuse was good, we had to check the PCM, which was located on the right side of the passenger engine compartment making it easy to test for voltage and current draw. Now that all the easy tests were done we had to move on to test the O_2 sensor heaters at the source.

We struggled to get the connectors apart, due to the tight space, but once we did, we installed jumper wires to the heater power and ground circuits. We once again used the Power Probe and connected the tip to the B+ side and the ground wire to the ground side of the circuit, along with an amp clamp attached. We proceeded to check for heater current as we depressed the power button on the Power Probe. There was normal current draw Bank 1 sensor 1 heater circuit. We moved on to the Bank 2 sensor 2 and found that also was drawing the correct current. With test results indicating that all the circuit components were good it was now time to condemn the PCM.

Remember before replacing the PCM, the most expensive fuse on the vehicle, always check for excessive current draw from components that will damage a computer. Since all the solenoids on the affected circuits did not test for excessive current it left only the PCM. We called around to aftermarket part stores trying to locate the PCM that was not available. We then called the two different Ford dealers that told us they did not have it, but they can special order. The price of a new PCM was more than $800, making the repair more difficult for the vehicle owner to swallow. The vehicle, as I stated earlier, ran well, the only problem was the MIL was illuminated and it would not pass an inspection. The owner asked if there was a possibility in getting a junkyard PCM that can just be plugged in and fix the problem. I explained to them that it may be possible in locating a used unit but that the engine would not start without reprogramming the PCM. This is also true if the unit was purchased from Ford; nothing works without programming it. I also explained that I would need all the vehicle keys and key fobs so I could program them in to the PCM. After calling salvage yards for over an hour I came up empty handed.

Then I remembered the company I told you about in last month's column, AutoECMs.com. The company will ship you a unit to try and if it doesn't work or you don't want it, you can return the unit for the fee and shipping. Since I was confident the PCM was defective I purchased the unit and installed it. With the used unit installed, I knew the vehicle would not start without reprogramming it. I had connected my IDS to program the unit, but as luck would have it my laptop that the Ford IDS was on was having a Microsoft problem. I did not want to take the chance in destroying the PCM so I decided to program the unit using my Drew Tech J2534 device that's on a different laptop. As you can see the software (Figure 2) looks just like the IDS and works similar with the exception that I had to access the file and pay for it. I proceeded with the first programming screen that provided the vehicle specification that needed to be confirmed. The second screen had the mileage and the VIN information that needed to be corrected since this was a used PCM and did not match the vehicle's VIN. The following screen had a dropdown menu that allowed me to select Programmable Module Installation. That opened another drop down menu, allowing me to select the PCM module that needed to be programmed. I selected the PCM and followed the screen prompts that instructed me to turn the key on and off until I reached the screen that requested the VIN information. Once on the VIN screen I typed in the correct VIN. That moved me into the PATS (Passive Anti-Theft System) screen. Now I needed at least two Ford ignition keys along with any key fobs. I selected the (Figure 3) Parameter Reset that walked me through the programming screens for the keys and fobs. The procedure went through without a problem, allowing the engine to start so I could test drive the vehicle. With all the monitors "Ready," I was confident that I had repaired the DTCs of the EVAP system and the O_2 heaters. The customer's car passed inspection without further incident. MA



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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BREATHING FREE

LEARN TO CONSIDER THE ENGINE'S ABILITY TO BREATHE WHEN DIAGNOSING DRIVABILITY CONCERNS

BY **DAVID DECOURCEY** | CONTRIBUTING EDITOR

Let's start this discussion by asking some basic questions: What would occur if the fresh air (intake) system became restricted? What would occur if the valve timing was out of correlation? What would occur if an exhaust valve did not open in an OHC engine? What would occur if large amounts of carbon had built up on the intake runners-ports or the backsides of the intake valves? What would occur if the pressure in the exhaust system became elevated?

When I think of the word "restriction," the first thought that comes to mind is resistance. If there is a restriction in the air intake system of a 4-cycle engine, isn't that a resistance to the incoming airflow? Keeping in mind the keywords restriction and resistance, let's discuss our previously asked questions.

Restricted air

If the proper amount of air that was designed to be ingested into the engine was being restricted, what drivability conditions would occur?

- Rough/unstable idle
- Lack of power
- Misfiring cylinders
- Poor fuel economy
- Other drivability symptoms

POWER LACK

2009 HONDA CIVIC
Vehicle Year/Make/Model

60,000
Mileage

1.8 LITER
Engine

LACKS POWER WHEN ACCELERATING
Complaint

I had previously worked on a 2004 Ford Explorer (4.0 liter) with 50,000 miles on the odometer and equipped with an automatic transmission, which had all the driveability symptoms listed above. The engine was not breathing as designed. After a visual inspection, I decided to review the scan data (PIDs), looking for my diagnostic direction. As I attempted to raise the engine speed repeatedly, the (calculated) barometric pressure value (BARO) in Hertz (Hz) would decrease with each RPM increase. This led me to believe that there was a restriction/resistance to the incoming fresh air. I shut the vehicle off and started to break down the fresh air intake system components. During a recent vehicle service, a large paper towel was left on top of the air cleaner element, and the air cleaner cover was reinstalled. The paper towel was drawn into the intake duct work from the vacuum created in the intake system and became entangled with the MAF housing, causing the restriction.

Valve timing

If the valve timing is incorrect (the crankshaft and camshaft are out of correlation), then the valve opening and closing events would not be in sync with the ideal piston position. (This can be either a single overhead cam engine or one or more camshafts of a multiple cam engine.)

This mechanical issue will create a breathing issue for the engine — there will be a resistance to air flow (improper volume of fresh air) entering the engine and into the cylinder. An example of this is the piston, while being drawn to Bottom Dead Center, being unable to create the proper level of negative pressure (vacuum) due to the intake valve opening later than designed. Or there can be resistance to the exhaust gases exiting the cylinder if the exhaust valve was closing too early, leaving unwanted exhaust gases in the cylinder after the exhaust stroke. The intake camshaft affects the compression process, while the exhaust camshaft affects the combustion process.

Valve timing correlation issues can be created by worn timing belts, sticking hydraulic tensioners or seizing pulleys of timing belt driven components (such as water pumps, idler pulleys or tensioner pulleys). A valve timing issue can also be created by a camshaft-to-camshaft gear out of correlation.

As a mobile diagnostic technician, I am called typically numerous times per year to shops where these mechanical issues have occurred. Typically, the technician has installed and reinstalled the timing belt several times to make sure it was properly timed, but the

Photos: David DeCourcey

engine still has the same symptoms. The engine runs rough and misfires, or the engine will not start. I have the technician remove one spark plug if it is an inline engine or one spark plug from each side of a V-bank engine. With the use of a pressure transducer installed in place of the plug, I will know within minutes if the valve timing is off by observing the waveform that is captured by my scope.

I had the technician remove one spark plug and with the use of a transducer and my scope, I knew within minutes that the exhaust valve timing was severely off, preventing the exhaust from leaving the cylinder at the correct time. In the exhaust camshaft of the 2001 Toyota Corolla (1.8 liter DOHC engine), the cam gear alignment pin sheared off and the gear began to reposition itself (out of correlation) at the end of the camshaft. The engine ran rough/misfiring, then stalled out at a traffic light, and became a no start.

A closed valve

If the exhaust valve did not open in an OHC engine, would this create a breathing issue for the engine? Yes, it would.

2004 Ford Explorer 4.0 litre restriction in air intake system

2001 Toyota Corolla 1.8 litre DOHC. The cam shaft alignment pin sheared off, creating a cam gear-camshaft correlation issue.

Let's think about the engine's four strokes for a moment:

- During the intake stroke, the piston would draw the air/fuel charge into the cylinder through the open intake valve. This is the result of negative pressure created by the piston being pulled downward towards BDC. With the intake valve open, the piston is actually pulling against the throttle plate, creating a negative pressure within the intake manifold that will draw fresh (atmospheric) air in.
- Next, the power stroke would normally compress the air/fuel charge.
- Then the energy being created would push the piston downward.
- Before BDC, the exhaust valve would begin to open, and as the piston was traveling upward to TDC it would push the spent gases out of the cylinder and into the exhaust system.

But if the exhaust valve didn't open as the piston was traveling to TDC, wouldn't the gases in the cylinder start to compress again? What normally occurs at 360 degrees of crankshaft rotation? Valve overlap occurs. This is when the intake valve opens before TDC and the exhaust valve closes after TDC.

So back to our mechanical issue. If the gases build up again in the cylinder because the exhaust valve did not open, wouldn't this pressure buildup enter the intake manifold and displace the negative pressure when the intake valve opened just before the piston reached TDC?

This mechanical issue will cause multiple cylinders to misfire. Very common are occurrences of cam followers becoming dislodged due to high mileage lifter wear, over-revving the engine while driving and low oil levels while operating at higher RPM and load conditions as well as lack of maintenance issues that allowed sludge to form in the lifter galleys and lifter oiling ports.

Carbon buildup

We all have had experiences with driveability complaints created by excessive carbon buildup on the backside of the valves, intake runners and ports. Yes, it does impede the airflow into the cylinder creating excessive turbulence. This can lead to rough/unstable idle conditions as well as misfires. Not to mention the carbon absorbing some of the fuel

Pressure transducer being used for diagnostic purposes.

Boroscope being used for proper diagnosis and verification.

Case study vehicle — internal boroscope view of the damaged catalyst substrate.

charge as well as creating lean conditions within the cylinder.

Excessive exhaust back pressure

Checking for excessive exhaust back pressure should be part of your baseline test. When a vehicle has drivability issues, it is part of mine. We listed all the possible drivability symptoms the vehicle could have when the engine is not breathing properly. I see too often that a technician will first inspect the air filter housing and fresh air intake ducts, then literally stop at the timing belt when he observes the crankshaft (CKP) and camshaft (CMP) alignment marks are correct, even though he/she may suspect an engine breathing issue is creating the driveability issues.

I believe there could be several reasons for this:

- Not having a full understanding of how an engine breathes and the variables involved;
- The difficulty of accessing an HO2S for removal for testing purposes or not wanting to deal with damage threads in the bunt or with the sensor itself, which could lead to a high cost for parts and labor to repair just to perform an exhaust back-pressure test; and
- Not knowing what amount of exhaust pressure is acceptable and what is considered excessive.

It has been my experience with diagnosing vehicles that have large volume intake (vacuum reservoir) manifolds (especially the late-model vehicles with movable intake runners) that the use of a mechanical vacuum gauge doesn't reveal the information I am looking for in most cases, when compared to older vehicles with low plane intake manifold designs where the mechanical gauge reveals more information.

For example, I was diagnosing a misfire that was created by a burnt valve in a 2000 Dodge Caravan FWD with a 3.3 liter engine. The vehicle had more than 150,000 on the odometer and was equipped with an automatic transmission. The use of a pressure transducer confirmed the valve was not sealing, and the cylinder leak down tester verified my diagnosis. Even though the misfire was severe, the vacuum remained steady at 19in/Hg. I like to see 21in/Hg from a good breathing/mechanically sound engine. I would have expected to see a much lower value or at least some movement with the mechanical gauge, but that was not the case. I find the use of a vacuum transducer is much more informative with the late model vehicles, or vehicles with large volume intake manifolds.

Lack of power

The first step is to verify customer's complaint; this may require a test drive to duplicate the concern. But this is not the time to be attaching any diagnostic equipment.

The engine had a normal idle speed and snapping the throttle repeatedly in the bay did not reveal any issues. The road test was different and revealed a lot of need-to-know information.

- Moments before the lack of power became evident, the engine started to have a steady misfire. Not enough to prevent high RPM operation at first, but the more aggressive the acceleration was, the sooner the lack of power issue would occur.
- The MIL lamp was blinking during the misfire events, and when the load and RPM was decreased, the MIL stayed on steady. After cycling the key off then restarting the vehicle, the lack of power was no longer present and the vehicle could be driven under light load conditions.

The vehicle was then brought into the service bay where a visual inspection was performed. There were numerous new body and mechanical components replaced on the front of vehicle because of a recent collision.

Is the lack of power complaint a

EXHAUST BACK PRESSURE — QUICK EXPLANATION

Exhaust back pressure will vary from vehicle to vehicle due to the different configurations (length of piping, numbers and placements of the catalysts and the mufflers themselves) and the inside area available for the expanding exhaust gases.

I usually see 0-1.5 psi at idle, and 3.0 -4.5 psi on a hard snap on a naturally aspirated engine. I would strongly suggest making your own library of exhaust pressures. Anytime you have a vehicle equipped with an EGR pressure valve/transducer (Chrysler, Toyota, Nissan, etc.), tee into the exhaust side and take a quick reading using a good quality exhaust pressure gauge.

Exhaust pressure has to do with the volume. As with any gas, an increase in volume results in an increase in pressure. With a low throttle opening, the exhaust gas base will be low. As the throttle opening increases so will the exhaust gas base. The exhaust gas base has thermal energy that is trying to expand the gas base as it is forced out of the exhaust chamber into the exhaust port, by the upward movement of the piston. This means the volume is increased by the temptature of the gas as well as the (exhaust) gas base. There are two forces at work as the combustion chamber is being scavenged. First the upward movement of the piston forcing the volume out of the cylinder and secondly is the force of the exhaust moving through the inside area of the exhaust system. The exhaust gas base contains mass. As the exhaust (mass) is accelerated through the inside area of the exhaust system it creates a siphon effect that pulls the exhaust gas out of the combustion chamber. In order to have this siphon effect, the velocity of the exhaust flow must be as high as possible. This means during the design of the engine the exhaust port area will be calculated for the range in which the power will be produced. Most vehicles operate below 50% throttle opening a majority of the lifespan of the vehicle. Which means the velocity of the exhaust will be set at a lower throttle opening were the power is needed. This however will create resistance (exhaust back pressure) at higher exhaust gas volumes (greater throttle openings).

COMMON CAUSES OF RESTRICTED EXHAUSTS

- Broken up substrate
- Collapsed inner wall pipe in exhaust
- Broken off baffle in the muffler
- Severe bend/kink in an exhaust system

result of the misfires at higher RPMs and loads? The engine was equipped with an (ETC) Electronic Throttle Control. And the answer to the previous question is yes — the misfires were putting the engine management system into a Limited Power Mode. This mode is activated when the driver intent cannot accurately be determined or when the output of the engine's power is impaired, during a mechanical issue, for example.

Could this vehicle be suffering from an engine breathing issue? This was my thought at the time of the diagnosis, due to the present symptoms.

One of the quickest tests I can perform is to place a pressure transducer in place of a spark plug and start the engine. The pressure transducer waveform (once learned) can reveal a lot of information about the mechanical condition of the engine, such as cylinder compression levels, valve timing, valve opening and closing events and cylinder sealing. This information can help reveal the root cause of the misfires or eliminate these possible mechanical issues as being the root cause.

Pressure transducers (positive/negative) will save a lot of shop diagnostic time and money. For instance, if you want to check the engine valve timing to see if it is correct all you need to do is observe the details of the pressure transducer waveform. The only time you would be removing front engine covers is to verify your diagnosis or perform actual repairs, if needed. You can observe valves not opening or closing without removing engine components first by observing the waveform. There are other benefits as well.

The pressure transducer waveform in most cases can also identify restricted exhaust systems. Using the pressure transducer for this diagnostic step can save time and money because you do not have to remove an oxygen sensor, and it removes the risk of the threads being damaged during removal or reinstallation while performing an exhaust back pressure test.

The Honda's waveform pattern is of one cylinder with engine idling. It reveals normal compression levels (all four cylinders showed the exact same details), valve timing, valve open and closing events and no cylinder sealing issues. But remember, this engine had no symptoms when idling; this is a baseline test.

Next, I performed a "snap throttle" test.

This in-cylinder pressure that remained through the entire snap throttle is the result of a restriction in the exhaust system not allowing the gases to properly exit the cylinder during the exhaust stroke. Since my baseline pattern showed that the cam/crank correlation was correct, the only culprit left is the exhaust itself.

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Case study vehicle — internal boroscope view of new catalyst substrate.

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BALL JOINT KIT

American Axle & Manufacturing, a manufacturer of axle components, driveshaft components and repair kits for OE vehicles, has announced the availability of a new ball joint kit for some 2500 and 3500 model RAM trucks. The front drive axle in the 2500 and 3500 RAM truck changed in the 2013.5 model year. Part of that modification included replacing the ball joints. AAM's new ball joint kit for 2013.5 and newer 2500 and 3500 RAM trucks with a front 9.25" beam axle includes the upper and lower ball joint, ball joint seal, nuts, and wheel hub bolts.

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Stop & Go

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MOOG® hub assemblies from Federal-Mogul Motorparts are now available with several innovative, application-specific enhancements designed to provide superior durability and performance and trouble-free ABS system function.

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This precise preload is set at the manufacturing plant, which helps prevent over- or under-torquing (an installation error that can adversely affect the preload and result in premature part failure and even loss of vehicle control).

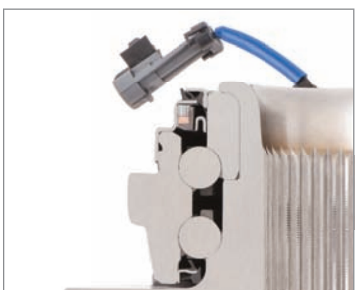
Each of these robust units also features precisely matched, high quality bearing raceways and rolling elements engineered for superior, longer-lasting performance with minimal noise and vibration under a full range of operating conditions.

A number of additional, application-specific enhancements further increase hub durability and service life. These include premium molded ABS shield and socket connections that promote a highly stable system signal, and an abrasion-resistant ABS cord that prevents sensor failure, another common cause of ABS signal problems.

Poor or inadequate connection points between the ABS sensor wire and the hub assembly cap and/or vehicle harness connector can result in frayed wires or wire "pull-out." Hub assemblies with a loose or exposed connection point at either the cap or connector are susceptible to contamination and water intrusion that can cause the ABS to stop working and illuminate the ABS malfunction indicator light.

For applications susceptible to these problems, MOOG hub assemblies utilize a molded harness connection point supplemented by a molded cap connection point. MOOG molds and encases the integrated ABS abrasion-resistant cord into the cap at the connection point for unequaled strength. In addition, the connection point is extended 6mm for optimal defense against contamination and water.

Premium molded ABS shield and socket connections promote a highly stable system signal. Exclusive, application-specific ABS cord material is proven to decrease ABS wire failures.



Roll-form construction helps ensure consistent, optimal bearing preload. Each unit's preload is precisely set at the manufacturing plant to help prevent over- or under-torquing.

Several innovative, application-specific enhancements make MOOG hub assemblies the ideal choice for vehicles requiring significantly enhanced durability and increased load capacity.

Many standard ABS cords are made of fiber or rubber, which tend to be susceptible to abrasion or moisture. On some applications, sensor wire abrasion creates signal faults that can only be resolved by replacing the hub.

The application-specific MOOG ABS cord is specially constructed with a blended polyurethane material that provides superior ABS protection, increases abrasion resistance and protects against environmental conditions. This cord – unique to MOOG – is proven to decrease ABS wire failures.

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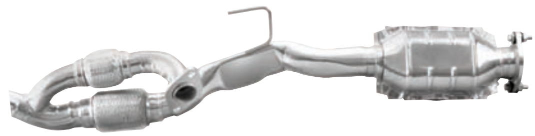
BOLT-ON COMPONENTS



Advance Professional Driven by Carquest stocks the complete line of quality Walker Exhaust Systems. Walker products feature direct-fit, bolt-on components that allow for easy and quick installation with no cutting or welding. As the largest OE exhaust manufacturer, shops can count on Walker products for a perfect fit. For more information about the complete line of Walker Exhaust Systems, call your local Advance or Carquest delivery location.

Walker Exhaust Systems

NOISE DETECTION SYSTEM

The Steelman®PRO Bluetooth™ ChassisEAR – NVH is a state of the art noise and vibration detection system that uses Bluetooth technology to transmit unwanted noises from a vehicle to a Windows PC or Android Smart Device for analysis. Bluetooth ChassisEAR's user friendly software can also record sound from up to six different channels for later playback for customers and colleagues.

Steelman

NEW BENDPAK LOW-RISE LIFT PICKS UP WHERE OTHERS LEAVE OFF

BendPak recently unveiled its new LR-5T — a 10,000-pound capacity low-rise lift that accommodates passenger cars and trucks thanks to a newly designed lift platform, specialty adapters, wider driver capability and increased lifting capacity. Convenient built-in storage trays mean lug nuts and other small parts are always within reach.

BendPak

GET MORE CARS IN YOUR SHOP

Discover how one auto repair shop owner went from near-bankruptcy to a million-dollar-a-year success, and how you can copy every single piece of advertising and marketing that he uses to get a flood of new, repeat and referral business into your shop, too—all with less time, effort and stress than ever before! Visit www.HighTorqueMarketing.com.

High Torque Marketing

MITCHELL 1 BRINGS DATA TO YOUR SHOP

Mitchell1®

Since 1918, Mitchell 1 has been the industry standard for quality repair data to the motor vehicle industry. Mitchell 1's comprehensive family of products includes complete OEM and real-world repair information, estimating and shop management software and marketing services to help automotive and commercial truck professionals increase efficiency, productivity and profitability.

Mitchell 1

FUEL SYSTEM CLEANER

Gumout® Multi-System Tune-Up contains polyether-amine (PEA), a nitrogen-based detergent found in any truly effective fuel system cleaner. PEA is stronger than most other cleaning agents and can withstand the high temperatures found in the combustion chamber. PEA helps Gumout complete fuel cleaners remove carbon deposits from across the entire fuel system, while also preventing future carbon buildup. Learn more at Gumout.com.

Gumout

ADVANTAGE LINEUP GROWS

ACDelco has added four new part numbers to its popular Advantage battery line. Applications cover Ford, Lincoln, Mazda, Mercury, Nissan, Chevrolet, Buick, Cadillac, Pontiac, Subaru, Suzuki, Chrysler, Dodge, GMC, Honda and Jeep. They're available through the Advantage Sea Container program. ACDelco Advantage batteries are designed to provide reliability and durability at a value price, and with an 18-month full replacement warranty.

ACDelco

CAREER OPPORTUNITIES

TYC GENERA®

Sales Account Executive (Brea, CA)

Are you aggressive, outgoing and thrive in a challenging environment?

We are an Automotive Parts Distribution company seeking confident, motivated and fast learning individuals with excellent communication skills. Key responsibilities include setup and grow potential customer accounts and sales; develop sales programs on multiple product lines within assigned territory; establish and meet business development targets and annual forecast. Business travels required. BS degree + 3 years sales experience.

Please submit resume to tina.ahd@genera.com.

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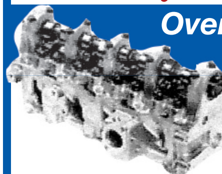

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CHRYSLER	3.4 V-6 OHV $157.00	**KIA**
2.4 DOHC $315.00	4.3 V-6 OHV VORTEC $170.00	1.6/1.8/2.0 DOHC $445.00
3.9 V-6 MAGNUM $170.00	4.8/5.3 V-8 OHV $220.00	**TOYOTA**
5.2/5.9 V-8 MAGNUM $195.00	5.7 V-8 OHV VORTEC $220.00	2.2 CAMRY $340.00
FORD	**JEEP**	**VW**
2.0 SOHC $290.00	3.7 V-6 SOHC $340.00	1.8 TURBO DOHC $685.00
3.0 V-6 OHV $175.00	4.0 STRAIGHT 6 LATE $315.00	
4.0 V-6 OHV $195.00	4.7 V-8 SOHC $315.00	*FACTORY DIRECT PRICING*
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TEXTAR HIGH CARBON BRAKE DISCS

Textar, the world's leading manufacturer of OE brake pads, offers a range of German engineered, high carbon brake discs for European applications. Utilizing the know-how that comes from over 100 years of developing OE brake pads, engineers at Textar have developed a perfectly matched brake disc to ensure the ultimate braking performance of your car. This new range of high quality brake discs are manufactured to precise German specifications and are available at WORLDPAC. Visit www.worldpac.com

WORLDPAC

MOBILE DEVICE BUILT TOUGH

Two Technologies Inc.® unveiled the newest member of its ultra-rugged handheld devices, the N5Print — an all-in-one device that takes communications, data input, credit card transactions, photography, scanning and on-the-spot printing to a higher level of convenience and performance. The unit's 13MP color camera, audio and video recording functions empower drivers with the ability to capture multiple types of data and store it in the N5Print's 16GB internal memory.

Two Technologies

WORLD BRAKE RESOURCES COMPLETE BRAKING SOLUTION

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

WORLDPAC

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

GET DIAGNOSTICS FOR LIFE

OTC has launched a Diagnostics for Life program and new Bravo 2.0 software in North America for the Encore diagnostic tool. Producing a lifetime warranty on hardware, expanded technical service hours and a software overhaul, efforts were based on direct Encore owner feedback. The software update will allow Encore users to see a faster, more stable tool with additional vehicle coverage and a reduction in screen-to-screen waiting times.

OTC Tools

LEAK DETECTION KIT

The Tracerline® EZ-Ject™ A/C and Fluid Kit pinpoints leaks in A/C and fluid systems. It features the only concentrated, premium-quality, OEM-approved fluorescent dyes in the industry. The star of the kit is the TP-8655 OPTI-PRO™ Plus, a cordless LED leak detection flashlight with on-board recharging. Also included are an EZ-Ject™ A/C dye injector, EZ-Ject R-134a/PAG multi-dose A/C dye cartridge, Dye-Lite® All-In-One, Dye-Lite Rite Blend™, a smart A/C charger and fluorescence-enhancing glasses.

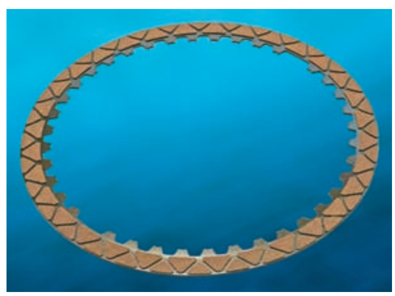
Tracerline

FAST-ADJUSTING PLIERS

The new 10-inch Cobra QuickSet pliers, an addition to KNIPEX Tools' flagship line of Cobra Water Pump pliers, features a new slide and lock system that makes repetitive tasks easier and more convenient than ever before. QuickSet pliers, once locked onto an application with a push button, stay locked in that position for repetitive use. The tool's speed comes from its easy-to-use sliding handle method.

KNIPEX Tools

WET FRICTION TECHNOLOGY



BorgWarner supplies its latest wet friction technology for ZF's new 8- and 9-speed automatic transmissions. The 8-speed transmission features BorgWarner's multi-segment friction plates with intricate groove designs, and the torque converter for the 9-speed transmission utilizes a piston plate with BorgWarner proprietary friction material.

BorgWarner

AD INDEX

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FIRE IN THE HOLE

A LESSON IN THE PROPER CARE AND SERVICE OF THE IGNITION'S BUSINESS END – THE PLUG

BY **PETE MEIER**
Director of Training

Consider the harsh environment spark plugs have to live in. High temperature, high pressure environments requiring high voltage potential to overcome and allow that much needed ignition spark to travel across the gap between electrodes. With all the challenges the spark plug has to face in its normal everyday life, why add to those challenges with improper inspection and replacement techniques?

"Aw, c'mon Pete – I've been turning a wrench for decades, and I've installed thousands of spark plugs. What's the big deal?"

Just like every other system on the car, spark plugs have changed over time to handle the increasing demands placed on them. Proper service involves taking the extra time to make sure that, like our medical counterparts, we "first do no harm."

What is the proper service interval for plug replacement, for example? Do you know what the proper torque is for the plug you're installing? Heck, are you even using a torque wrench on the plugs?

What about the use of an anti-seize compound on the plug threads? Should you or shouldn't you? Does that brown/black stain around the base of the porcelain on the old plug indicate a fault, and if so – what kind? Should you check the gap on all the new plugs before installing or just throw 'em in, as is?

See, I told you there was a lot more to know about spark plugs, their care and service. And with some help from the experts, we'll all learn the answers together in this month's edition of "The Trainer." MA

WATCH THE HOW2 VIDEO NOW

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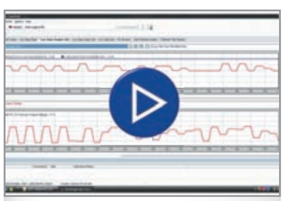

The long and short of fuel trims
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When the compressor won't compress
MotorAge.com/apr15trainer