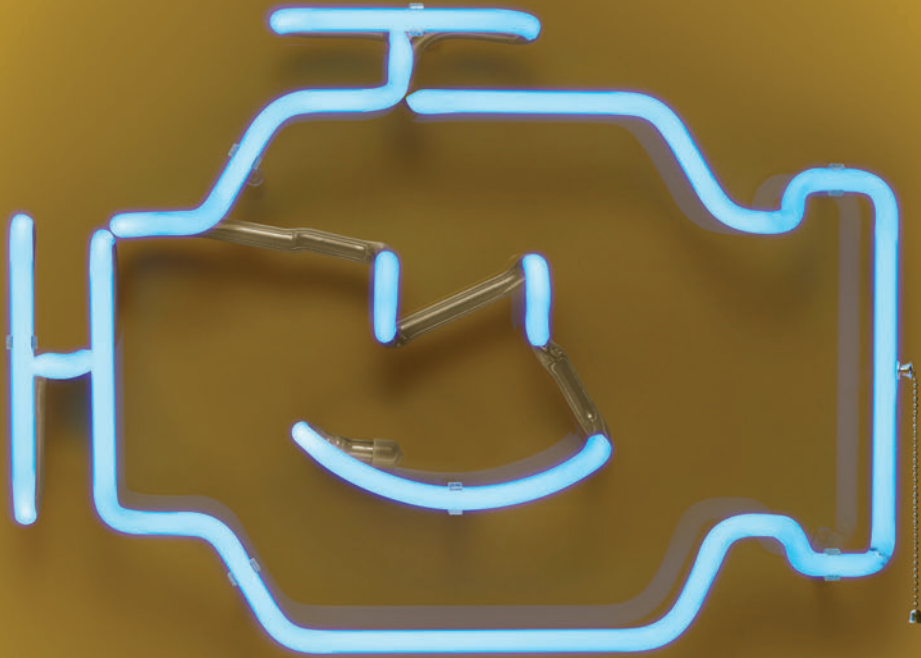


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Talk Shop Anytime



Vol. 133, No. 8

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PRODUCTS

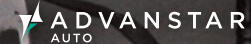
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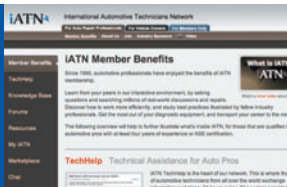
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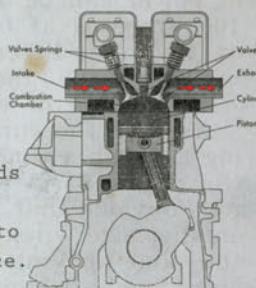


Fig. 2-Engine Fuel System



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COMMUNITY

12 Professional talk when it comes to today's technicians

If you want professional employees to work in your shop, then you need to pay them professional wages.



Q+A WITH

14 Mike Bailey, Oklahoma City repair shop owner

Having customers buy new cars doesn't scare this veteran shop owner.

plus **Stats & Trends**
Noteworthy

FROM THE
BLOG SPHERE

BEST OF THE BLOGS
TOP VIDEOS CALENDAR

96 The Trainer Diagnostics and using your senses

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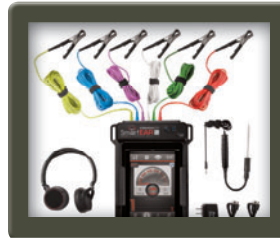
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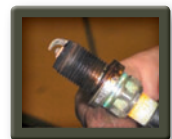
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TECHNOLOGY



UNDERHOOD

MANAGING THE EVAP MAZE

BY **DAVE HOBBS** | CONTRIBUTING EDITOR

76 Successfully solving one of the top 10 most common DTCs.

DRIVABILITY

COMPOUNDED HUMAN ERRORS

BY **JAIME LAZARUS** | CONTRIBUTING EDITOR

60 How much easier would it make our jobs if ignorance didn't play such a major role?

ELECTRICAL

NEEDLES AND NUMBERS

BY **RICHARD MCCUISTIAN** | CONTRIBUTING EDITOR

68 The evolution of instrumentation takes us fully into the digital age. Are your skills moving at the same pace?

SCOPE & SCAN

PLUGGING ALL THE LEAKS

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

82 This month we look at avoiding the return of the MIL light and tips on leak detection.

MOTOR AGE GARAGE

FIXING THE FIX

BY **MICHAEL MILLER** | CONTRIBUTING EDITOR

84 Sometimes the hardest faults to find are the man-made ones.

POWERTRAIN PRO



UNDERCAR

SKYACTIV: KEEPING THE ZOOM IN ZOOM-ZOOM

BY **TIM JANELLO** | CONTRIBUTING EDITOR

46 Mazda takes a total approach to design as it implements this new technology.

ATSG TECHNICAL TRAINING

FINDING THE DIFFERENCES

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

56 Examining the differences you will find in the 6R140 Torqshift 6 valve body.

POWERTRAIN PRO COLUMN

EXPLORING MORE OF THE DSG WORLD

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

36 In the second part of a look at the Dual Clutch Gearbox, we examine the most common one you will see here in the U.S.



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...AND MUCH MORE

OPERATIONS



MANAGEMENT

SELLING THE VALUE OF SERVICE OVER PRICE

BY BRIAN CANNING | CONTRIBUTOR

16 You would buy value a cup at a time, so focus on that in your sales pitches.

PROFIT MATTERS

THE SECRET TO SELLING MAINTENANCE

BY CHRIS "CHUBBY" FREDERICK | CONTRIBUTOR

22 Learning this lesson now can change the effectiveness of your sales staff.

FINANCIAL FIGURES

SEARCHING OUT A COACH

BY BOB GREENWOOD | CONTRIBUTOR

26 Are you ready to take the most important step in your business?

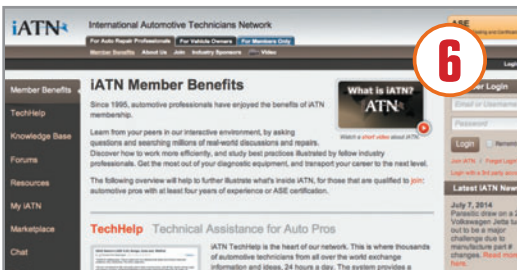
SHOP PROFILE

DOING THE RIGHT THING

BY ROBERT BRAVENDER | CONTRIBUTOR

32 This shop's owners and staff put their money and time where their mouths are.

TRENDING



IATN TOPS 80K MEMBERS

6 The International Automotive Technicians Network recently surpassed 80,000 active members for the first time in its 19-year history.

AMI TURNS 25

6 The Automotive Management Institute this year celebrates 25 years of providing management training to repair shops.

HONEST-1 INTRODUCES 'REVOLUTIONARY' WARRANTY

10 The full-service auto care company now offers a 3-year, 30,000-mile nationwide warranty on repairs.

TST, ATSG, ATTS JOIN AUTOMECHANIKA CHICAGO

10 The trio of training organizations will lead technical classes at the inaugural event in 2015.

PRODUCTS

BATTERY LINE EXPANSION

90 EnerSys has expanded its ODYSSEY Performance Series battery product line to include the Group 48 battery.



90 Fuel system cleanup

91 Transmission pans



94 APG Management suite



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»» AFTERMARKETBUSINESS.COM/SELLPRICE

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Cars.com released a report on consumer perceptions about the cost of repairs, and execs discussed the results with us.

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The screenshot shows the iATN website interface. At the top, it says "iATN International Automotive Technicians Network". Below that are navigation tabs for "For Auto Repair Professionals", "For Vehicle Owners", and "For Members Only". There are also links for "Member Benefits", "About Us", "Join", "Industry Sponsors", and "Video". On the right, there's a "Login | Join" button and an "ASE Voluntary Testing and Certification" badge. The main content area is titled "iATN Member Benefits" and includes a "TechHelp" section. A sidebar on the left lists "Member Benefits", "TechHelp", "Knowledge Base", "Forums", "Resources", "My iATN", "Marketplace", and "Chat". A "Member Login" form is on the right with fields for "Email or Username" and "Password", and a "Login" button. Below the login form, there's a "Latest iATN News" section with a date of "July 7, 2014" and a headline about a "Parasitic draw on a 2007 Volkswagen Jetta".

RESOURCES

iATN membership exceeds 80,000

The International Automotive Technicians Network (iATN®), www.iatn.net, now has more than 80,000 active members, the largest number ever in the network's 19-year history. Members are located in 160 countries and collectively share 1.9 million years of experience on iATN.

"Although we've crossed the 80,000 member threshold, iATN members are the minority of the industry: they are the professionals who understand what it takes to survive in our increasingly challenging profession. Members here find that by networking with fellow professionals, they are continuously expanding their knowledge on systems, tools and best practices that often elevate their careers to the next level. iATN provides a platform that allows members to communicate with each other interactively by sharing case studies, solving vehicle problems and sharing tips that cover the gamut of challenges facing the automotive service industry," says Scott Brown, president of iATN.

Technician Thomas Perkins adds, "iATN has shaped my career by giving me the connection to my peers and allowing me to review case studies. The people connection and the Waveform Library both have been invaluable."

The primary membership benefits of iATN include TechHelp, where thousands of automotive technicians from all over the world exchange information and ideas 24 hours a day. Members also have access to more than 20 different technical, shop management and auto industry web forums and the extensive iATN Knowledge Base.

The Knowledge Base includes the FIX Database with more than 200,000 real-world vehicle fixes, Forum Archives with millions of iATN web forum discussions, and the Waveform Library with 35,000 waveforms, scan data

[iATN membership] CONTINUES / PAGE 8

BREAKING NEWS

TRAINING

AUTOMOTIVE MANAGEMENT INSTITUTE TURNS 25

This year marks the 25th anniversary of the Automotive Management Institute (AMI), a provider of management education for the automotive service and collision repair industries. The Institute currently offers more than 1,300 approved courses, a faculty of 300 approved instructors and the Accredited Automotive Manager (AAM) designation. To date, its programs have attracted 230,000 enrollments throughout North America.

The Institute was founded 25 years ago based on the concept that there was an abundance of technical education in the market, but very little industry specific management education. At the start, AMI offered 26 courses taught by 10 instructors. Today, courses are offered on a

[AMI] CONTINUES / PAGE 8

Discussion is on-going in MotorAge.com forums

Photo: iATN



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MODULES



[AMI]

CONTINUED FROM PAGE 6

range of topics including marketing and sales, operations and service, management and administration, financial management and personnel management and human resource development. Students can choose from formats like webinars, online courses, DVD-quality downloads, self-study workbooks and traditional classroom settings.

“After 25 years, many shop owners would not be in business if not for the management education they received from AMI,” – Steve Loudon, shop owner

“When students take an AMI course, they immediately can apply what they learn to the day-to-day operation of their business,” says Tony Passwater, AMI Board of Trustees chairman and president of AEII in Indianapolis.

Steve Loudon, a founding member of AMI and owner of Loudon Motorcar Services, Inc., in Dallas, says, “After 25 years, many shop owners would not be in business if not for the management education they received from AMI. For them to succeed in the future, management education is a must.”

Loudon also is one of the first to earn the Institute’s AAM designation. In the past 25 years, more than 1,700 students have completed 120 credits of education and graduated from AMI with the AAM designation.

Jerry Holcom, owner of S & S Service Center, Inc., in Kansas City, Mo., and a graduate of the class of 1996, has a total of 712 AMI credits, the most earned by an AMI student. “Over the years, as I found I needed some training or a refresher on a particular topic, it was great to look through the catalog by subject and find just what I was looking for. And with AMI’s new monthly webinars, I can plan an hour off for my entire front counter staff and help keep them (and me) pumped up with some great ideas.”

[iATN membership]

CONTINUED FROM PAGE 6

images, component photos and other vehicle specific images, documents and videos that have been uploaded to the network.

“In a very large part, I owe my career to iATN because without them I probably would have been stuck in some job without any training or networking. I highly recommend it,” says technician John Bridgwater.

Automotive educator and technician Michael Joachim states, “It (iATN) is my window into the world. It’s my way of finding out what’s going on in shops and service bays all throughout the U.S. and the world.”

iATN was founded in 1995 and is the largest online community of automotive technicians, repair shop owners and other allied service professionals in the world. For additional member testimonials, visit www.iatn.net.

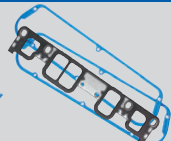
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HONEST-1 INTRODUCES 'REVOLUTIONARY' WARRANTY

Honest-1 Auto Care will become the first national full-service auto care company to institute a nationwide 3-year, 36,000-mile warranty on repairs. This new nationwide warranty gives customers the ability to have covered warranty coverage and service at over 35,000 authorized repair facilities across the country.

"We want our customers to feel at home the moment they enter an Honest-1 Auto Care," Honest-1 Chief Operating Officer Rissy Sutherland says. "By introducing our one-of-a-kind, 3-year, 36,000-mile warranty, we are showing our customers in a new and meaningful way that they are our partner and that we stand behind our work no matter where they are so that our customers can have the comfort of peace of mind in their repair needs. They are a partner rather than another number on a repair ticket."

Every Honest-1 Auto Care location will participate in the 3-year, 36,000-mile warranty program, and the benefit to the customer is free of charge. If select part does not perform as expected, the customer will call a toll-free number and be referred to a nearby repair shop where the part will be replaced at no cost. There are nearly 35,000 shops in the United States where Honest-1 Auto Care customers can get the repair taken care of.

TST, ATSG, ATTS JOIN AUTOMECHANIKA CHICAGO

The Advanstar Automotive Group has announced partnerships with Technicians Service Training (TST), Automotive Technician Training Services (ATTS), and Automotive Transmission Service Group (ATSG) to help develop a comprehensive training program that meets the needs of technicians and shop owners alike for Automechanika Chicago 2015. Pete Meier, Advanstar Automotive Group's Director of Training, will spearhead the effort.

"These quality organizations are known for conducting outstanding technician training programs in the U.S. and around the world," Meier explains. "In addition to helping us structure the core service dealer training program, they will assist in attracting the 'who's who' of instructors for the event and in teaching some of the courses."

Meier, an ASE Master Technician and technical editor of *Motor Age*, said *Motor Age* and *Auto Body Repair Network (ABRN)* recently conducted reader surveys to understand what mechanical and auto body repair shops are looking for in a training program. This feedback will help Advanstar, TST, ATTS and ATSG develop the type of high-end technical training that will compel automotive technicians to attend the show.

To learn more about Automechanika Chicago, visit www.AutomechanikaChicago.com.

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ASE GUIDES

QUESTION OF THE MONTH



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SURVEY: Contributing Editor Mike Miller shares a story on an EVAP gross leak problem that never leaked when tested manually, yet failed consistently when the ECM tested it. He performed some basic diagnostic steps first. Which of the following steps listed below would NOT be considered as a proper first step when diagnosing any powertrain-related DTC?

- A. Check for applicable TSBs
- B. Retrieve stored DTCs
- C. Check Mode \$06 data
- D. Read up on specific system operation

Go to MotorAge.com/aug14survey to answer the question and enter the monthly contest from Federated Auto Parts.



Professional talk when it comes to today's techs

If you want the professional employees, pay them professional wages.

BY LARRY SILVEY | PUBLISHER OF CUSTOM CONTENT

I have heard countless times how important techs are to the automotive aftermarket. From manufacturers. From distributors. From auto parts retailers. From the industry associations. From shop owners themselves.

Let's think about that for a second in terms of the real world. I don't think it outlandish to think a technician would be married and have a couple kids — you know, a family of four. If we take that scenario, the poverty guideline for that family is \$23,550, which means the average tech makes \$12,450 more than someone caught on the poverty

line. At such a minimum level, it's clear that this difference is not discretionary income; rather, it's survival income. There's always the possibility that technicians can pass on marriage or get a divorce if they are married. In either case, \$36K just might cut it for a bachelor living in his parents' basement in Small Town, USA.

At \$36K, you might think I'm talking about the tire busters or the oil and lube jockeys. Well, that's another abysmal story that I'll save for another day. I'm talking about those we as an industry want to flaunt as professionals. They are technicians, not mechanics! Those who actually diagnose and

MotorAge.com

BEST OF THE BLOGS

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

Lance_Boldt

It came from Middle Earth

The Production Department at AutoNetTV is known by the rest of our company as "Middle Earth." We shy away from sunlight and like the room dimly lit. At least that's what other's think. We are actually normal people who live normal lives. Well, for the most part. We like to think of ourselves as the glue that holds this company together.

We take pride in what we do and are always pushing ourselves to create better and more inspiring content that will educate the motorist on how to better care of their vehicle. We are always looking for new tools to make us more efficient and productive. The strange thing that happens though is that when we find a tool that does this, we often just raise our standard of quality. For example, a new piece of 3D rendering equipment allows us to do better looking content in the

same amount of time, so what happens is the production-quality bar gets raised but we don't necessarily get more efficient from a time-savings standpoint.

Our motto is "continuous improvement in the art of creating." If that improvement is better looking content, then maybe we're achieving our goal. Shop owners similarly are always trying to improve their processes and technician training to achieve a better overall shop performance. At the end of the day, you can buy all the fancy equipment that is out there, but the thing that is going to have the most meaningful effect on the customer is the personal touch that you add to the customer's experience.

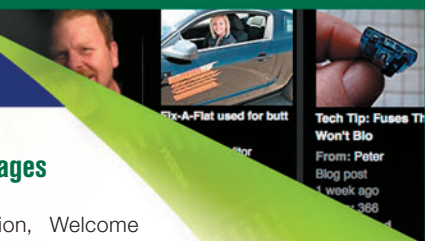
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solution, Welcome Station™, the first-ever self-check kiosk designed specifically for the automotive repair industry. With our tablet-powered tool, your shop can join airports, grocery and convenience stores, as well as restaurant chains in simplifying the customer experience. Our touch screen kiosk delivers faster business results, better accuracy and increased up-selling and profit generation opportunities with each customer check-in.

This easy-to-use self-check system frees up service advisors and enables both new and returning customers to quickly and electronically notify shop staff of their arrival, select the vehicle and which services they'd like to have performed and whether they are dropping off, or will be waiting.



Aug. 21
@ 8:00 PM

Ignition Testing

Learn the ins and outs of ignition system diagnosis in this *Motor Age*/TST webinar, sponsored by Champion.



PAGE
6

IATN REACHES
80,000 MEMBERS

INDUSTRY NEWS

The info center sees more growth.

PAGE
14

Q+A WITH
MIKE
BAILEY

SHOP OWNER

Relationships boost business.

PAGE
96

THE
TRAINER
VIDEO

PETE MEIER

Diagnostics and your senses.

repair vehicles. Those who have the intellect and skills of an engineer, but have chosen to work on cars.

Of course, the paltry \$36K is an average. Some technicians do much better than that. But before you start

panning with excitement, only 10 percent of the technicians make more than \$60,000. Then there's the downside: at least 10 percent is making much less than the \$36K. Read more at MotorAge.com/protalk. **ZZ**



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A look in the A/C accumulator

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The training impact

While focused on the collision market, this video illustrates how similar the problems we face are with theirs.

MotorAge.com/trainimpact

Elevating our image

Mike Bailey, an Oklahoma City shop owner, has some ideas on how to better the industry's image.

MotorAge.com/elevate

Certification: an ROI tool

ASE's Tony Molla explains how to boost business and get a real return on the investment into ASE certification.

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2014 WEBCAST SCHEDULE

AUG. 21 @ 8 P.M. ET

Ignition System Testing

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

SEPTEMBER

Understanding Hydraulics

Presented in partnership with ATSG.

NOV. 20 @ 8 P.M. ET

Mastering Voltage Drop Testing

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



STREAMING PROGRAMS

What affects car count?

In this first podcast, Workshop member Management Success discusses the five areas of business that affect car count, attitude toward customers and more.

Giving back

Longtime industry member Paul Baffico talks about his service in the U.S. military and how he continues to serve today.

Timing functions

This video takes a look at the P0014: Variable Valve Timing function, common failure causes and checking for misfire causes with a lab scope.

SEPT. 26-28

Chicago Automotive Networking Conference (CAN Conference)

Chicago

OCT. 10-12

Northwood University's 51st Annual International Auto Show

Midland, Mich.

NOV. 4-6

AAPEX 2014

Las Vegas

NOV. 12-15

Automechanika Argentina 2014

La Rural Trade Center, Buenos Aires



2014 INDUSTRY CALENDAR



Noteworthy

comments from *MotorAge's* online communities

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

Mike79nova:

Well I agree with the article but also have to say the industry needs to change its pay. After completing my Ford asset training, I worked 80 hours for 40 hours of pay. I spent 40 hours a week sitting on my toolbox and 40 hours after hours working on scraps left over. It's no way to start a life and constantly worrying about paying expensive tool bills.

loosenutjust:

I get tired of hearing people who have survived the industry for a number of years say, "Everyone's got to start at the bottom and earn their way up. That's how I did it," as an excuse for treating the new guy like dirt.

Michael Evans via Facebook:

They have no excuse. They should have read the owners manual. I've seen a few 30k+ oil changes because the sales people told them it was "maintenance free."

John Teller via Facebook:

I had a customer take his new car home and change his own oil. It came back with a rod knock. I told him it was oil contamination. He said impossible! I installed 5 quarts of Slick50!

Eduardo Jordan via Facebook:

They could be cracked out of the box from handling. Pay attention to gap and overall when it comes to new plugs.



the community—
join the discussion

MotorAge.com/Community

Q+A WITH MIKE BAILEY

OWNER, CAR DOCTOR,
A REPAIR SHOP IN OKLAHOMA CITY



**CUSTOMERS BUYING NEW VEHICLES
DOESN'T SCARE THIS OWNER. HE ALREADY
HAS GREAT RELATIONSHIPS IN PLACE.**

BY **GARY MCCOY** | CONTRIBUTOR

The list of accomplishments for Mike Bailey is quite long and impressive. Bailey, the owner of Car Doctor automotive repair shop in downtown Oklahoma City, has been a NAPA/ASE Technician of the Year for 14 of the last 15 years.

Car Doctor has been a NAPA AutoCare member since 1999, and Bailey is the current chairman of the NAPA AutoCare Business Development Group. Bailey has been involved in the leadership committee of the Car Care Professionals Network at the Auto Care Association and has been an L1 Certified ASE Master Technician for more than 25 years.

What he is most passionate about is helping customers with the maintenance and repair of their foreign and domestic vehicles.

MA: Please share your thoughts on the perceived technician shortage.

MB: We're still seeing a shortage, and I know that tends to be regional. Working at the national level, I'm familiar with some of the places in the country that have lost a lot of the dealerships and have seen an influx of technicians. Whereas we didn't lose one dealership in the Oklahoma City area, so we didn't have this mass

influx of dealership technicians that all of the sudden were unemployed. I know that happened in other parts of the country. We're still dealing with a shortage of quality technicians, trained technicians. The other component is mostly governmental; the component of the tax burden, some of the regulations, some of the requirements. Once again, that affects a little larger shop in most cases, not smaller shops, but we see it also with some of the environmental regulations. I think that's going to sweep across the nation in the next few years. The environmental requirements are probably going to get stricter, not lighter. I think that's something we all need to be looking for in the next few years.

MA: How do you handle the older and newer vehicles on today's roads?

MB: The average age of vehicles is 11.4 years now, so we're definitely seeing cars of that era still coming in and being serviced. I think that's part of the economic issue. People aren't replacing their cars as often as they were, and they're seeing the value of doing maintenance and doing the repairs on a car that they don't have a payment on, that the insurance is relatively inexpensive for and that they



know. They've had the car since it was new; they're seeing the value in keeping that vehicle on the road.

I think the more customers go out and look for used cars, the better that's going to help our market. New cars don't really scare me that much. When I have a customer that says they want to go buy a new car, that doesn't scare me. I know I'm not going to see that customer for a little while for a lot of services with the dealer giving away oil changes and some of their programs. But because I've already built a relationship with that customer, that customer knows me and I think most customers that leave under those environments I see back within two years if not sooner. So I don't panic about that. If anything, I see it as an opportunity to be able service a later model vehicle that I normally wouldn't have gotten to service. *ZZ*

Photo: Gary McCoy



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OPERATIONS

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OF YOUR BUSINESS

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- 16** Management
- 22** Profit Matters
- 26** Financial Figures
- 32** Shop Profile

read it on **MotorAge.com**

TOOLBOX TIPS

Lista International offers tips around toolboxes to improve repair shop efficiency

[/listatips](#)

VETERAN HONOR

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OHIO WINNER

Andy Kovesdi of Ohio won an all-expense paid trip to a Super Workshop.

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MANAGEMENT



SELLING THE VALUE OF SERVICE OVER PRICE

YOU WOULD BUY VALUE A CUP AT A TIME
FROM OTHER PLACES, SO WHY NOT FOCUS ON
VALUE IN YOUR SALES PITCHES?

BY **BRIAN CANNING** | CONTRIBUTOR

A FEW years ago, I worked with a very capable, very dedicated shop owner from Holdrege Neb., who, when talking about price versus value, rightfully said, "Price is what you pay, value is what you get." Though very simple and basic, truer words have never been spoken.

Price doesn't matter when there is sufficient perceived value; it is as simple as that. It doesn't matter if we are talking about a gallon of gas, a pound of hamburger, a transmission flush, a cup of coffee or a four-wheel alignment, if the customer feels the value, price does not matter. The key, of course, is selling and highlighting value.

I remember talking to an exceptional former client of mine that owned a great European specialty shop in Spokane, Wash. We were talking about the great job he had done in getting his parts margins in line and specifically about how he was able to raise his parts prices to where they needed to be while not creating a backlash of customer objections. He described what a local diner owner recently had done this in a similar circumstance.

This restaurant owner was determined that he needed to raise his prices, but knew that his many regulars would react poorly if it was just a matter of that same greasy cheeseburger they had been buying for years suddenly costing \$6 instead of the normal \$4.50. There would be no obvious reason that could explain the price increase and he knew his customers would be very likely to object. He also knew that to stay in business and to keep up with his expenses, he needed to raise his prices. What he did in the end was paint the place inside and out, redecorate the dining room, buy new silverware and glassware, update the menu with several upscale and healthier offerings, touch up the bathrooms and even invest in upgraded uniforms for his wait staff.



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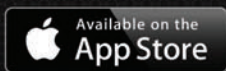
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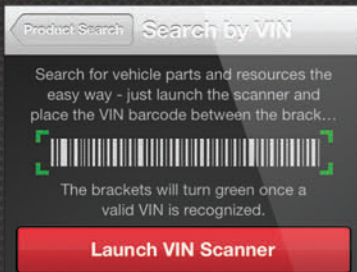
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“IN THE AUTOMOTIVE REPAIR INDUSTRY, WE TEND TO BE HYPER SENSITIVE TO PRICE, THOUGH THE FUNNY THING IN THIS IS THAT OUR CUSTOMERS ARE FAR LESS CONCERNED ABOUT PRICE THAN WE ARE.”

BRIAN CANNING [CONTRIBUTOR]

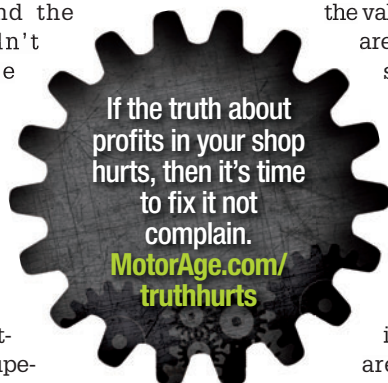
Though in the end the cheeseburger didn't change much, the plate upon which it sat was much nicer, as were the tables and the room and the whole customer experience. In plopping down the same greasy burger, customers suddenly were treated to something far superior to what they had been

used to, and that \$1.50 increase in price didn't matter. What these customers got for their \$6 obviously was worth it. A higher price is what they paid, but much greater value is what they got. This former client of mine, who has always made customer service a big priority in his shop, found ways to make the existing great customer experience even better and guided his customers past the significant price increases they were experiencing, to a clear understanding of the value they were getting for those dollars spent. Value, if it is there, trumps price every time.

Building a Brand

There are no absolutes to selling. Customers are a fickle and unpredictable bunch, very apt to go their own ways and do their own thing but there is no doubt that the sales process is much easier and more simplified if we believe in and have confidence in the parts and services we provide. Though customers come into our shops prepared to spend money, it sure does not mean that they are not leery of us and worried about what our intentions are.

Though our customers are very dependent upon their cars and want them to be safe and reliable, they are not necessarily happy to spend money and not necessarily trusting of us in this process. Our job as shop owners, as service managers and as service advisors is to inform and educate our customers on the repairs and services needed to keep their cars safe and reliable. In a larger sense, our job is to sell them on us and



the value we represent. If we are successful here, the selling of the repairs and services will be much easier.

In the automotive repair industry, we tend to be hyper-sensitive to price, though the funny thing in this is that our customers are far less concerned about price than we are.

Customers want value for the dollars they spend. In survey after survey, our customers list quality, convenience, reliability and support after the sale as being much more important than price. But for some reason we of the automotive repair industry go to market stressing price over these other factors every time. Value always trumps price!

Being a shop that has highly capable technicians, that installs quality parts and stands behind the repairs and services performed, that is convenient or offers drop-off service, is a shop that will enjoy high retention rates as well as consistently high customer satisfaction. There is value in all of this for our customers and would be customers.

In the marketing world, they would call this association between price and value a function of branding. Branding is our conscious decision to present our business in a specific light, such as quality of service or honesty and this has both internal and external benefits for our shop. Externally, we create perceptions and an identity that clicks with our customers and would be customers. In essence, we create an identity that resonates with customers and in this process, we form emotional relationships with our customers. The emotional aspects of branding are important because though many customers try to be logical, informed and aware in making their repair and service decisions, all of us buy emotionally.

Branding is the emotional and psychological relationship we have with our customers and would-be custom-

ers. Hopefully in this branding effort, we elicit positive and confident emotional responses. Highlighting the quality of our parts, our strong warranty and our efforts after the sales to make sure our customers are taken care of is a great way to make a customer feel good about their association with us and their decision to have us work on their car. Remember that customers that see value are buying customers. They are also customers that keep coming back.

Internally, branding serves to keep us and our staff members aligned with one another and also aligned with our customers. It is a way of not only assuring that all of us talk the talk, but assures we all also are walking the walk. If we are careful in our branding and believe in the value in the parts we sell and in the value in the services we provide, our presentations will be consistently confident and consistently successful. Price is what our customers pay, but this value is what they get. Value is what keeps our customers happy and coming back.

There is a great internationally known company from Seattle that we all know and would recognize. They sell at a price that is higher than anyone else in their market but with an apparent value that has their customers coming back again and again. They sell value a cup at a time and sell millions of cups each and every day.

If you were offered a hot steaming cup of value, would it be Tall, Grande or Venti? I would definitely go for the Venti, no matter what the price! ☞



**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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THE SECRET TO SELLING MAINTENANCE

LEARNING THIS LESSON NOW CAN QUICKLY CHANGE THE EFFECTIVENESS OF YOUR SALES STAFF.

BY CHRIS “CHUBBY” FREDERICK | CONTRIBUTOR



IF YOU want to stabilize your car count and hold onto customers through their purchase of new cars, you are going to have to be proficient at selling maintenance. I was listening to a story from Nebraska shop owner and ATI coach Rick Johnson, who explained how he coaches service advisors to learn the secret to selling more maintenance. Let's hear what Rick has to say.

As I talk to shops, I often am surprised at how a few shops can sell a lot of maintenance and others will tell me no one

is buying. I hear that all the customer wants to do is just an oil change or just fix the check engine light and that's it. I ask them if they are making estimates on the maintenance and they say, "Yes, but that no one is buying." They have all the reasons not to buy memorized: Christmas-time, tax time, too cold, too hot — just to name a few. The shops that are selling often are located in the same state and sometimes the same towns as the other shops that have customers who aren't interested. I find that intriguing, don't you?

This got me to thinking back to when I was the service advisor in my shop and how things changed before my eyes. When I first opened my shop, I never had to advertise the first few years and we were always booked out two or three weeks. Ninety-nine percent of the cars were still carbureted, and most customers just handed me the keys and said something like, "I think the carburetor needs cleaning and possibly a tune-up."

We would bring the car in and sure enough the carburetor was in need of a cleaning and kit, and the spark plugs were black and worn. I would call the customer and tell them what it needed. Nearly every time I got the answer to go ahead, it needs it. That was that! They did not ask for an estimate, did not need explanations of what or why — just do it. Man, those were the days, right?

Sell Yourself First

Then along comes fuel injection and cars being built better and having fewer breakdowns. My schedule went from being booked out three weeks, to me being happy if we had work lined up for today and a few jobs tomorrow.

I knew I had to do something, and the industry started talking a lot about the need to sell maintenance. I bought a transmission flush machine and started



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“WHAT IS THE BIGGEST MISTAKE WE MAKE SELLING MAINTENANCE? ASKING FOR MAINTENANCE DOLLARS BEFORE EDUCATING THE CUSTOMER.”

CHRIS “CHUBBY” FREDERICK [ATI CEO]

selling transmission flush service. As time went along, I bought all styles of flush machines and tried to present and sell as many services as I could, as long as they were needed. I did pretty well with some clients, but with a lot of them, I just could not seem to get them to buy, and I didn't know why.

Then one day my flush equipment dealer told me about training it offered to learn more about the flushes. I decided to go, as I realized I needed to learn more about the flushes since I could not sell a power-steering flush or brake flush or an intake cleaning to anyone, it seemed — Christmas-time, tax time, too hot, too cold, you know the story.

I attended the one-day training and man, were my eyes opened! I learned the science behind the chemicals and saw firsthand the flushes being performed and the difference they made, and the light bulb turned on. I came home to the shop and started selling flushes like nobody's business. It became easy to sell maintenance.

A few months after I attended this class, my chemical salesman stopped in and said the distributor wanted to know how I was doing what I was doing. I asked him what he meant, and he said I had become the biggest seller of their products in my state! And all I could tell him was that learning about the flushes gave me the buy-in and confidence I needed to sell them.

Educate Your Customers

The other day I realized what the problem really is when it comes to selling maintenance, the “secret,” you might say. That secret is education, both mine and my clients'.

I was very lucky or fortunate the first few years I was in business, because my customers already were educated on their vehicles' needs and problems. They already had carburetors overhauled and tune-ups done multiple times. They knew what needed to be done by the way their car ran and what to expect when the repairs were made — that their vehicle would run like new again. Sales were made before their cars



were dropped off for the most part.

Most drivers today never have had a carburetor overhauled, and for those who have, it is a far distant memory. Most drivers today have never had a car on the back of a tow truck. They probably have not had their car run rough or not start; and for the most part, every time they want to go somewhere in their beloved car, they put the key in the ignition and gas in the tank and they go.

Imagine having a customer come to your shop today in a car they have driven for four years. They've never had an instance in which the car would not start, it's never left them stranded and as far as they can tell, it runs just as good today as the day they bought it. After you perform the oil change and inspection, you tell them that by mileage the car is due for a timing belt and transmission service. The first thing they ask is, “How much?” You tell them \$1,000 and they say, “No, not today.”

You tell your boss, no one is buying maintenance. The reality here is that Mr. or Ms. Customer is thinking “My car is running great. Seems to be shifting just like it did the day I bought it.” They can't understand why you are asking them to spend \$1,000 on a car that, as far as they are concerned, is running perfectly.

To ask for maintenance dollars before educating the consumer is wrong, wrong, wrong. The key is to realize that you need to educate the client on what you are asking them to buy. Go over the features and benefits of the service and make sure they clearly understand what it is you are asking them to spend their hard-earned money on, and that by investing in maintaining the vehicle, they will prevent more of their money from being spent on expensive repairs. It might sound like a lot to say, but shortcut this process at your peril.

Talk About the Investment

Now let's go back to our example of the customer with the 4-year-old car needing a timing belt and transmission service. This time we explain to them what a timing belt is and what it does. Use flip charts or one of the many software animation tools that show what it does and what happens if it breaks.

Explain to them that they have an interference engine, if the belt breaks, it will ruin the engine, and to replace the engine could cost up to \$6,000. Then explain to them what the purpose of transmission fluid is, how the contaminated fluid no longer can protect the transmission and that the transmission can cost upward of \$4,000 to replace.

Once you have fully educated the customer and they are fully aware of what these maintenance services will do, then and only then do you tell them their total investment is only \$1,000 — 10 percent the price of repair. You have more training and sales tools than ever before, but you have to take the time to use them. I can assure you that you will sell a lot more maintenance if you slow down the sales process and educate.

We have performed a lot of research in this area and created a great 15-minute interactive tutorial to help our clients improve maintenance sales. We are opening it free to our *Motor Age* readers for a limited time. Get full details at www.ationlinetraining.com/2014-08.



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

E-mail Chubby at cfrederick@autotraining.net

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SEARCHING OUT A COACH

ARE YOU READY TO TAKE THE MOST IMPORTANT STEP IN YOUR BUSINESS?

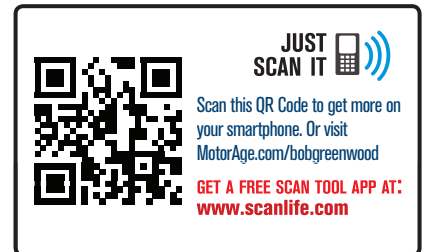
BY **BOB GREENWOOD** | CONTRIBUTOR

THERE are shop owners across North America who have worked diligently on their business for years compared to in their business as so many owners have found themselves trapped.

These silent minority owners understand the difference between cost and investment into the business and that working on the business means that net income is a word they embrace. The business must provide a professional income for their own family and their staff, build a great loyal clientele and customer base as well as develop a historical record that the business has a progressive system in place to sustain profitability and grow through on -

going evaluation procedures so it can be sold (succession) down the road.

Everything appears to be on track for those progressive shops, but how can an average shop reach that level when the path for the next five years is far from crystal clear?



Perhaps you are one of those shop owners who is ready for the next step in your business.

The next step, which today many progressive shops don't talk too much about, is the understanding of having a personal business coach and mentor working behind the scenes with them on their business.

This is and should be a very humbling step and process to go through. It is very private and confidential; it is personal; it is focused; it makes



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people throughout the shop accountable. Everything is measured monthly in the business, and most important, if you truly are an entrepreneur capable of taking direction from proven processes, it brings incredible results.

A professional coaching and mentoring service is not something you just sign up for. It is service that you must apply for. This is not a program about volume, it is a special relationship of absolute trust and clear communication.

The best quality and proven coaching and mentoring services specialize in the independent automotive aftermarket service shop business. That is their only industry sector. They evaluate the business, continuously viewing the business from the outside, including at 5,000- and 10,000-foot levels. That is required today to see how the auto care industry is evolving and what issues will affect their clientele. The business coach supports the owner completely through open accessibility as well as provides the necessary management and staff business training to move things forward.

The coaching/mentoring service has a procedure and process for their new potential clients to take before they are even accepted as a client, because it will be a three- to five-year contractual relationship. In all cases there will be a minimum prerequisite of having attended certain business courses they put on within the past year and a half to ensure the owner has an thorough understanding of today's business realities and how they are going to approach the business. It also always will involve a complete in-depth analysis of the business' financial statements for the past two to four years.

The reason for this is because the service company wants to know that a minimum of an additional \$75,000 to \$100,000 in gross profit per year is buried in the current business which, when pulled out, provides an excellent return for the business for the fees being invested for the service. Also interviews with the owner and spouse are completed to ensure the owner and spouse are committed to the business changes that the coach knows will be required, and most importantly, that the coach/mentor

and owner's personalities can work together. Too many shop owners think the coach will "do it for me," which means they don't get it, compared to the understanding of what the owner is really looking for, which is "what should I do, where do I direct my time and efforts and how do I do it" to get the results?

Paying it Forward

The service is very in-depth, but when you think about it, the coaching/mentoring service must be in-depth as running a professional automotive service shop is the most complex retail business in the marketplace today. This is why a quality coaching/mentoring service can be in the area of \$2,500 to \$3,000 per month for a three- to five-year term. Most shop owners would automatically say, "I can't afford that," but that means the owner is not thinking like an entrepreneur and has closed the door before even looking into the next room.

When the coaching service is a quality service, their fees turn out to be equivalent to a low cost part time employee. The better coaching services actually, through a contract, guarantee a 2.5 to 3.0 times return on the annual investment each year the client is making. That is why quality coaching demands a rigorous initial investigation as it should be. Volume programs are not the answer today in the long run.

The coach/mentor is not going to take the shop on if the service does not provide a proper financial return. No business coach will accept a client that is set up for failure, and that is why they are very specific as to their processes of evaluating potential clients. An entrepreneurial thinking shop owner understands that and will be looking for the return for the investment to be made before the service is going to be accepted.

The business coach is looking at the owner's capability, attitude of being able to do what he/she said they would do as well as the true desire to grow their business. You can have all the systems, procedures and quality advice available to you, but if the owner can't follow through with his/her responsibility and do what they said they will do, the coach will not allow that owner onto his team.

Once the business coach has at least six and maximum of eight clients, he or she will organize a confidential focus group because then like mind-set owners can get together, with the coach as the facilitator, to share valuable marketplace experiences and information, evaluate each others businesses using the same measurement criteria (comparing apples with apples) and analyzing internal business processes. This provides more accountability of each member to ensuring things are on track to getting done. Talk is cheap; it is the results that are important.


The aftermarket must move into the 21st century and start embracing modern techniques and services that moves their business forward. The shop owner no longer can do it all him/herself or operate on his/her own, like being on an island, thinking they know it all and are aware of all the changes coming down the road that will affect their business. This is an in-depth profession today, and the business capabilities must be put in place to ensure the success of the enterprise.

When you are ready for a true coaching business system, take the time and compare each offering in writing. Finally, always have your lawyer review and advise you of the contractual arrangements into which you are about to enter. This is the right way to do business, totally open, up front and in print.

So I ask again, are you ready for the next most important step in your business to ensure its survival and prosperity?" Slow down and investigate the opportunities. It might be the best exercise with your time that you ever do for yourself and your business. *TL*



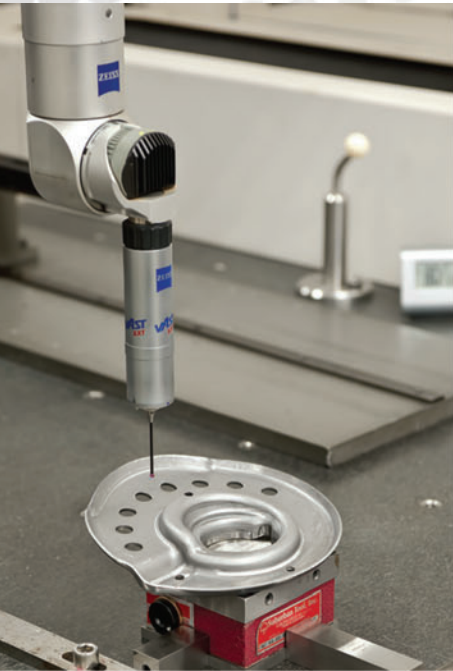
Bob Greenwood, AAM, is president and CEO of Automotive Aftermarket E-Learning Centre Ltd. (AAEC), a company focused on providing business management resources and development for the independent sector of the automotive aftermarket industry utilizing the Internet environment. Bob has more than 36 years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

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OPERATIONS

SHOP PROFILE

A snapshot of one of the industry's leading shops

TONY'S AUTO SERVICE CENTER / PHOENIX



Doing the right thing

This shop's owners and staff put their money and time where their mouths are.

BY **ROBERT BRAVENDER** | CONTRIBUTING EDITOR

The Guidos are a legacy in the Arcadia neighborhood of Phoenix. Tony Guido Sr. opened his first full service station there in 1958. Following his father into the business, Tony Jr. eventually started his own company in 1988, naming it Tony's Auto Service Center, partly in honor of his dad, all of which was mentioned when *Motor Age* first profiled the shop back in 2011.

But the real legacy isn't in the name, but in the family's principled approach to doing business. Tony Sr. lived and worked by a strict ethical code, which he passed on to his son and daughter Catherine, the company's general manager.

"At home, that was just the way it was," she recalls. "Our parents taught us about money, but also about treating people fairly. We feel that if we do the right thing, customers are going to come back to us. We still have customers from my dad's station. We don't know how to do it any other way."

Their integrity is so renowned they've actually won awards for it: in 2013 the Better Business Bureau (BBB) Business Ethics Award, and the 2014 BBB International Torch Award for Ethics. And this isn't just automotive, this is for any business in their size cate-

gory in the world. The BBB describes the purpose of these awards "to promote and foster the highest ethical relationship between businesses and the public through voluntary self-regulation, consumer and business education and service excellence."

Tony Jr. has stated that the company will take no shortcuts, sell no inferior parts, employ no untrained or unscrupulous technicians and offer no "shady deals" or "bait and switch."

"Ethics is communication at a heart-to-heart level," he writes. "It goes beyond logic and beyond dollars and cents. It runs far deeper than common sense, because ethical practices affect the well-being of people. There is no double talk and no pretending. Ethics is a bond of trust, person to person, that can be depended upon."

AT A GLANCE

Tony's Auto Service Center

Shop name

Tony Guido, Catherine Guido

Owners

Phoenix

Location

1

Number of locations

26

Years in business

9

Total number of employees

5

Number of technicians

3,000 square feet

Shop size

7

Number of bays

70

Average vehicles per week

\$498

Average weekly repair ticket

\$1.5 million

Annual gross revenue

AAA, BBB, ASE, ASA, AMI

Shop affiliation

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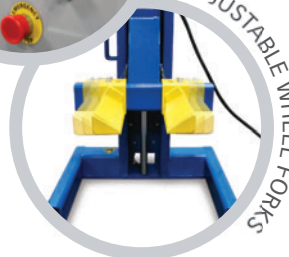
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And the staff doesn't rest on their laurels; they have ethics classes and reviews throughout the year. "We chose to do it the ethical way instead of trying to make the most money," Catherine Guido states. "Obviously we're a business, we want to make money, but we want to make sure no one goes away from here saying they were ripped off or pressured. That's a big thing — we do not pressure our customers to buy; that's where our ABCs come in."

This triage technique has the staff prioritizing repairs for customers so they don't have to buy everything all at once. "You can have a leaking rack and pinion for a year before you have to actually go and replace it," Catherine points out. "So we have them come in every few months, check their fluids, make sure that they're full. They'll fix it when they can, and they always come back and do it."

"If we make a mistake, we fix it," she continues. "We go above and beyond to fix something that wasn't even our fault; oftentimes we'll give the customer a break and fix it for them anyway. If they have a problem and they can't afford it, we find a way to make it affordable for them, either by helping them ourselves or putting them in touch with someone else who can. We could sell like some shops, but our customers come back to us over and over again, so we're not afraid of not getting the sale."

Then there's the company's community service, where they aggressively pay it forward. "We do a neighborhood program where we have a few elderly customers who live alone," she explains. "We have extra house keys here, and a deal with the mailmen to check up on them if their mail's not picked up. We have another customer who has to have a certain amount of (health) tests done; we drop him off and pick him up a couple times a year."

Other community projects include helping the Detour Company Theater, a non-profit organization offering performing arts opportunities for people with physical and mental handicaps. "We bought them a 19-passenger van to help them get to their shows, which are sometimes out of state," Catherine explains. "Besides maintaining that for them, we also help move their sets." Likewise employees and their families



(TOP LEFT) The team at Tony's is (front row, from left) Don Lafferty, Catherine Guido, Ronald Hunt; (middle row) Tyler Grant, Jose Fierro; (back row) Scott Petrie, Chuck Parke and Michael Swanson. (MIDDLE LEFT) Customers see the shop's plethora of awards upon entering the business. (BOTTOM LEFT) Techs work on a vehicle in one of the shop's seven bays. (TOP RIGHT) A larger heavy-duty bay also is featured at the Phoenix business.

pitch in for celebrations like the Detour's annual Christmas party.

And with 10,000 neighbors in their zip code alone, Tony's Auto Service Center helps a lot of schools in the area. For fundraising auctions they donate \$50 to \$100 gift certificates to be used at the shop, as well as conduct car care clinics for high school and college students.

"We have kids come in here and we teach them the basics," Catherine outlines. "How to change a tire, check oil, know what the warning lights mean, when to pull the car off the road so they don't ruin it before they know it. We also have car care clinics for adults — mostly women, not too many men come in. They may not want to learn how to change oil, but they want to know if they're being ripped off."

And finally there is their matching funds program. "Even though there are only 10 employees here, Tony matches every employee who gives to charity," she states. Once an employee opts for a certain amount of money to be taken out of their weekly paycheck, at

the end of the year Tony Jr. matches that fund.

"We live and work in the community, and we want to make sure it survives," Catherine explains. Of course Tony's does the average amount of the usual marketing: coupons, mailers, fliers, newspaper ads. But what really seals the deal is the reputation they've earned; the only place their altruism is publicizing is on the company's website, but word gets out probably just through sheer volume. Now that's a legacy. *MA*



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



IN THIS SECTION

- 36** POWERTRAIN PRO Column
- 46** Undercar
- 56** ATSG Technical Training

BACK IN ALA.

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Exploring More of the DSG World

IN THE SECOND PART OF A LOOK AT THE DUAL CLUTCH GEARBOX, WE EXAMINE THE MOST COMMON ONE YOU WILL SEE HERE IN THE U.S.

BY **WAYNE COLONNA** | POWERTRAIN PRO PUBLISHER

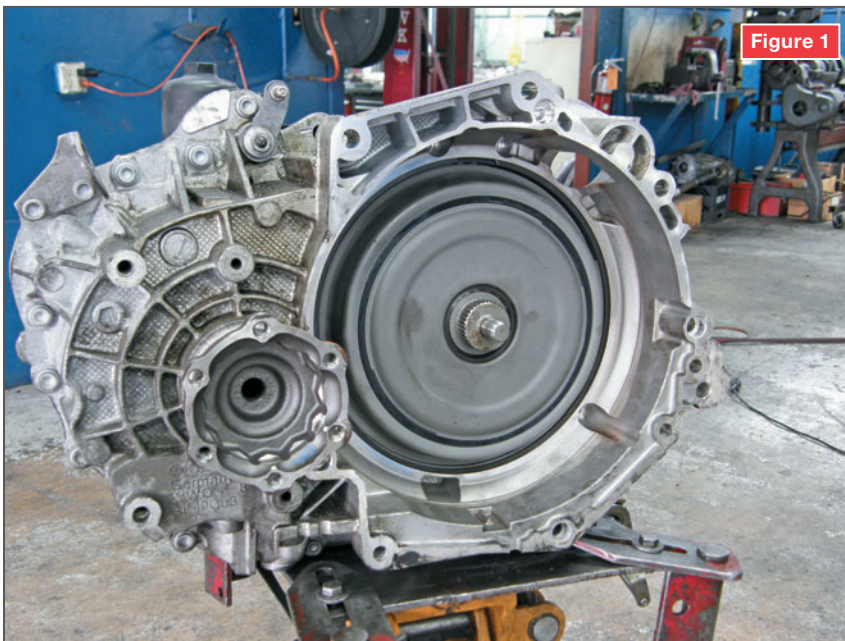
DSG World part one in July's POWERTRAIN PRO section of *Motor Age* took some time to discuss the DQ200 dual dry clutch unit covering typical failures encountered with this transmis-

sion, many of which were resolved with reprogramming the Mechatronic unit with modified software from TVS. Much of this information was dedicated to the online international readers of POWERTRAIN PRO.

In this article, attention is given to the DQ250 commonly known here in the United States as the DSG 02E gear box (Figure 1). TVS comments that of all the varieties of Volkswagens DSG gear boxes, this is the best one. But that doesn't mean its problem-free either. This too has programming in need of modifications, which will in part be covered in this article.

Before we do, aside from pulling codes and making fluid level and condition checks, it is always good to perform the following checks and procedures as a preliminary diagnostic routine.

1. Check wheel speed signals, as the ABS interacts with the Mechatronic unit and can contribute to a malfunction. (The Mechatronic unit is the



WAYNE COLONNA

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

MORE POWERTRAIN PRO

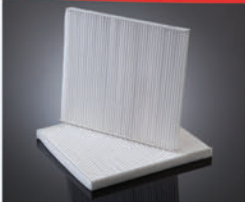
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computer and valve body combined – Figure 2).

2. Check engine load sensors and related filters (fuel, air, etc.). Skewed sensor information will affect the engine computer's ability to calculate engine torque. This info is then delivered to the Mechatronic unit to control clutch apply pressure. The Mechatronic unit also measures engine torque by how much pressure is required to maintain a 1 percent slip on the fully applied clutch. Wrong data can affect this operation.

3. The dual mass flywheel can cause noise and clunk complaints (Figure 3).

Listen for noise coming from between the engine and transmission. The clutch drum assembly also can cause clunk shifts. The clutch drum drive cover snap ring is known to pop out of its groove (Figure 4). This is not to be confused with the sealing cover (Figure 5). The drive cover is located behind the sealed cover. The actual double clutch drum is held in position by a small heavy snap ring. The drive cover indexes to the double clutch drum (Figures 6 and 7). When the drive cover snap ring pops out, this cover does not have too much room to travel, so it bounces

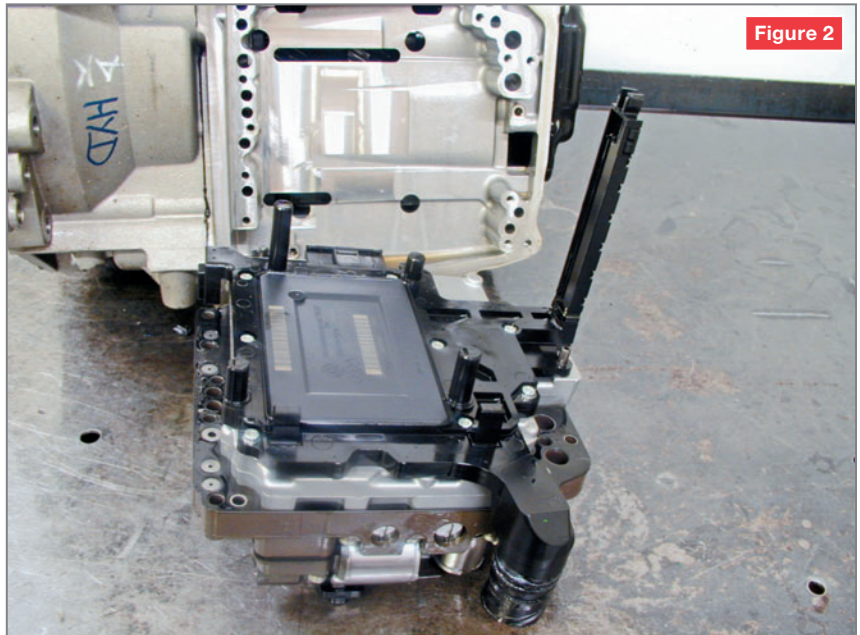


Figure 2



Figure 3



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between the sealed cover and the double clutch drum assembly causing the clunking sound on the shifts.

4. Perform basic settings with a capable scan tool or lap top based program. Software updates, basic settings and oil changes are useless in 96 percent of the cases when a gearbox has a real problem, unless the gearbox has had no new oil in 200,000 km.

With these preliminary diagnostic routines now discussed, the problems encountered with this box are:

1. The Mechatronic unit, the No. 1 problem area.

2. A failed clutch assembly would run second place.

3. Bearing failure is very rare. Although TVS hears from others that they see bearing problems, they themselves see only a few a year.

When these DSG units begin to fail, the shifts become very clunky. It can be due to programming issues,

Want more transmission tips and system tricks? Check out the special POWERTRAIN PRO supplement this month!

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clutch drum problems or something is wrong inside the transmission. TVS engineering feels it is better to replace what is needed rather than rebuilding it. From their experience, it is better to just change the Mechatronic assembly, or the clutch drum assembly, or the main gearbox with a new one.

It seems that once you disassemble these transmissions, after repairs and installation, the transmission never seems to shift right. In fact they partially disassembled a new transmission, reassembled it and installed it into a vehicle. The result was a noisy gearbox. After driving it approximately 620 miles (1,000 km), the noise did quiet down some but still remained very much noticeable. For this reason, TVS has concluded that opening up a DQ250 is not a very good idea, particularly so if you have a customer that complains about everything. There will be noise and it will not shift as smooth as it once did.

“Sometimes changing the Mechatronic assembly also can help, but the real problem has to do with programming. The clutch when fully applied is programmed to have a 1 percent slip.”

This is especially true with 4-wheel drive versions, as they already are inherently noisy and clunky, and unexplainably so. You can use all new parts, torque everything perfectly with all proper clearances and you still will have noise and clunk issues in many cases. TVS had a brand new 2-wheel drive transmission that was shifting smoothly and had no noise. They converted it to a 4-wheel drive set up with minimum necessary parts and it had

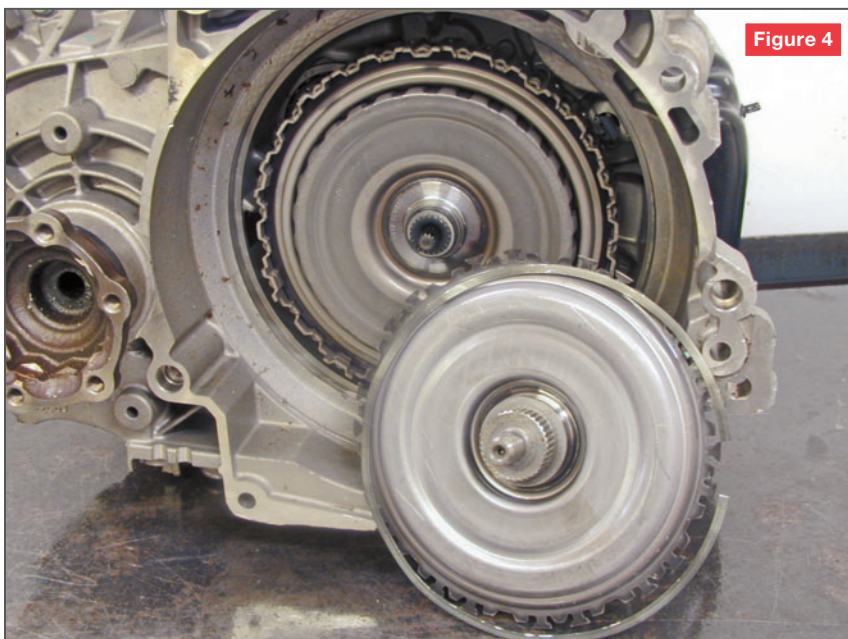


Figure 4

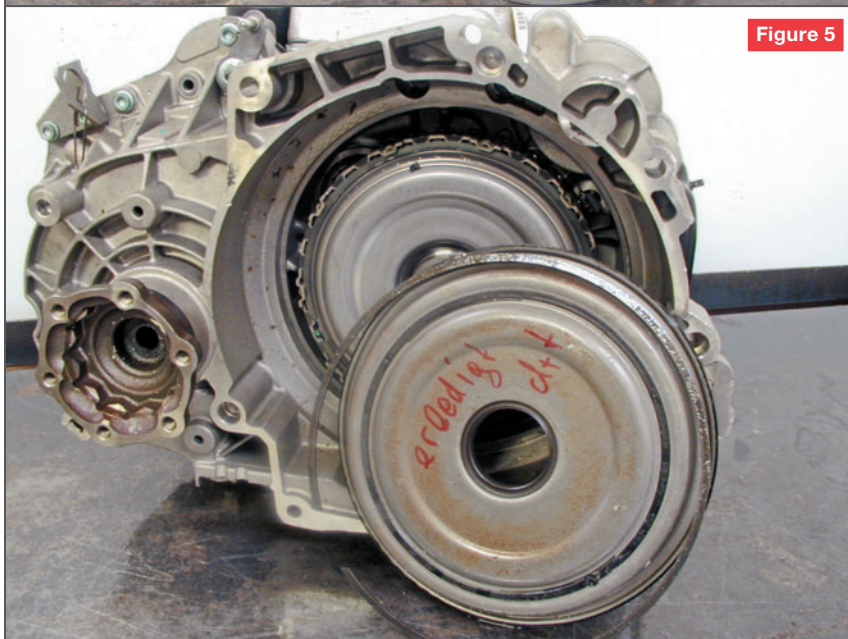
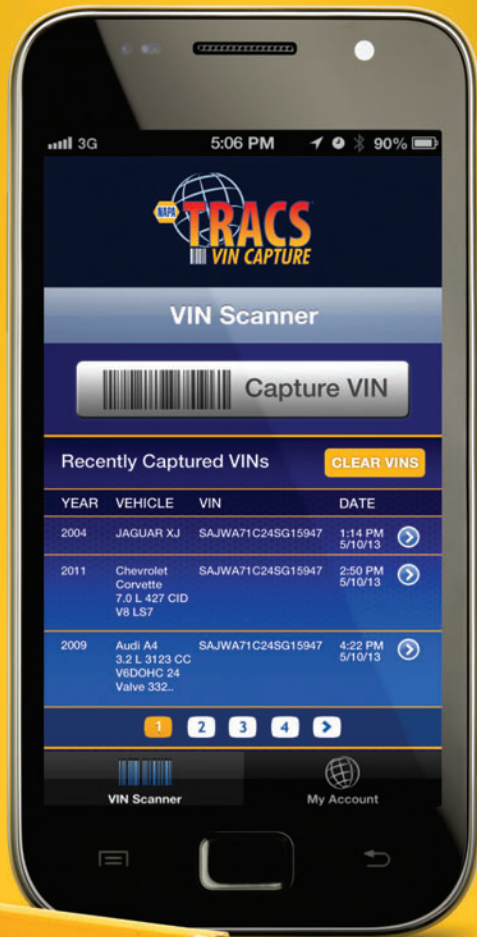


Figure 5

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noise. It also resulted in a very harsh engagement into drive or reverse.

Another problem that can be experienced occurs in vehicles using 2.0L TDI engines. The driver accelerates up to 4th gear at 2,000 rpm when the turbo kicks in hard and you feel a heavy vibration in the car. It feels like a bad fuel injector. Replacing the clutch assembly helps about 35 percent of the time. Besides clutch issues being the cause in some cases, these assemblies may have torsion spring problems as well.

Other times there may be fluid to friction issues, which changing the

fluid might help. It does not completely eliminate the problem, but it does help. If changing the clutch assembly eliminates the problem, it might come back again approximately 6,200 miles (10,000 km) later with the same complaint. The shudder complaint usually occurs after a highway run and the transmission is hot. Once you are back into city driving the shudder comes back again.

Sometimes changing the Mechatronic assembly also can help, but the real problem has to do with programming. The clutch when fully applied is programmed to have a 1 percent slip. If it



Figure 6

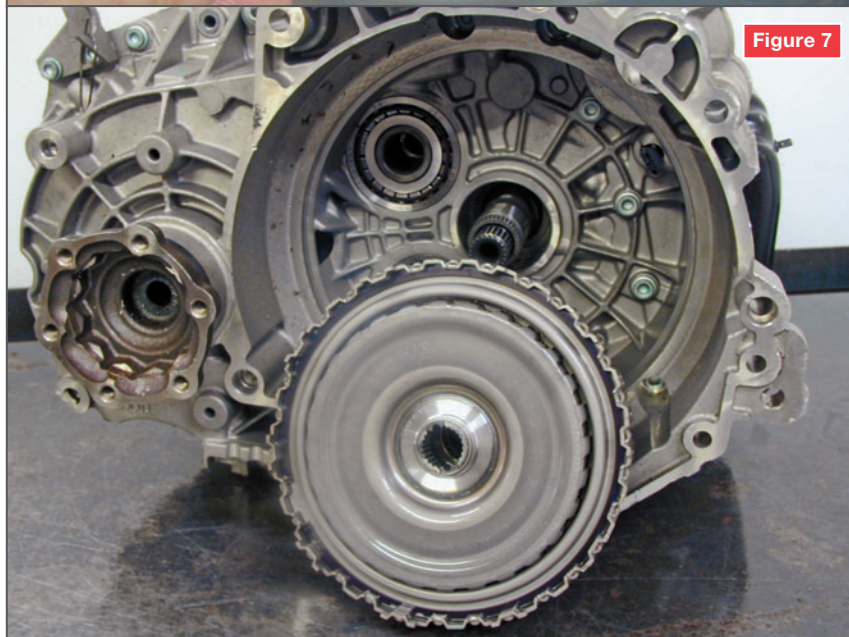


Figure 7

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doesn't see that slip, it will lessen the apply pressure. Then when it slips too much, it increases pressure. The cycling of the clutch in an attempt to maintain a 1 percent slip causes the heavy vibration throughout the vehicle. In time it causes damage to the friction plates and properties in the fluid break down as well. TVS reprograms the Mechatronic unit with a modified slip ratio to resolves this problem.

Finishing Up

Just a bit more on this closed loop system, using engine management software as an example — it has a fuel map targeted to obtain a 14.7 to 1 air fuel ratio. Through oxygen sensor input, the system constantly adjusts fuel delivery to maintain the ideal 14.7 air fuel ratio.

Similarly, the Mechatronic unit receives input that the engine controller is calling for 300Nm of torque. The Mechatronic unit calculates that 116 psi (8 bars) of pressure will be needed to maintain a 1 percent slip, i.e., when engine rpm is 2500, input shaft 1 or 2 rpm will be 2,475. By preset values such as this, the Mechatronic unit can quickly adjust clutch pressure to meet engine torque while constantly maintaining a 1 percent slip. If it notices a zero percent slip with 116 psi, it begins to drop pressure and sees that at 109 psi (7.5 bars) it sees the 1 percent slip. The Mechatronic is learning and then adapts to a new preset value of -7 psi (-0.5 bars) for the next time 300Nm of torque is required.

This adaptation value however is not presented in psi or bars, it is presented in amperage and frequency percent of

the clutch solenoid. The computer will decrease or increase amperage via frequency to raise or lower clutch pressure; so one might see a -0.15 amps as an adaptation value. Again, within the program there are tables which cross reference data of preset values to quickly respond to real time driving. This is done for acceleration, deceleration, high, medium and low loads as well as creep modes (when you are driving just a few miles per hour).

One complaint often times voiced by the driver is that acceleration from a stop seems slow. You can bury the pedal, yet the vehicle will accelerate slower than expected. The reason for this is to keep torque increase relative to clutch pressure. They both build up slowly so everything goes smoothly. This is considered normal.

There is an option for those who want a faster acceleration for racing and it is called a launch control. This is not a standard option in every vehicle here in the U.S. Launch control is when you select sport mode and deactivate stability control, then stand on both the brake and the throttle simultaneously; the engine will ramp up to about 3,000 rpm. As soon as you release the brake pedal, the computer will manage the torque to provide a maximum 0 to 60 performance.

But even this is slower than what is desired, and TVS developed a program to shorten the lag time without compromising the clutch. Its launch control operates from the manual shift mode. It removed the annoying half second delay time normally observed on launch, pumping 174 psi (12 bars) into the clutch. It becomes so strong that it wants to push the vehicle through the brakes.

Another software issue that occurs is during deceleration. Some newer software with added features affects the way it assists in slowing the vehicle through "engine braking." Some earlier versions lacking these added features allowed for smoother deceleration. When a new Mechatronic unit is installed, they now have a more pronounced engine braking occurring during deceleration, which they have not had before. Additionally, you can have two vehicles the same year, make and engine size yet this feature will act completely different between the two vehicles. The Mechatronic unit interacts with the engine's software of which there can be differences, thus causing a problem in one of the vehicles and not the other. Once again, reprogramming the Mechatronic unit will be required to eliminate the rough downshift feel the driver will complain about.

There are several other shifting complaints that are considered normal for this double clutch transmission. One of which is shifting from 5th to 6th and back to 5th. Under certain driving conditions it is difficult for the transmission to make this transition smoothly. The action it takes to make the shift is perceived as a slip.

Delayed Tiptronic down shift control is another. This too is considered normal operation as this requires multiple declutching. Certain synchronization speeds must be reached for declutching to take place, which can be as long as 1 second.

One other point to make relates to parking the vehicle. A contributing factor in causing premature failure of the transmission is to place the vehicle into Park before applying the power brake. We have seen parking pawls snap as a result of this incorrect procedure. The proper procedure is to apply the power brake first then place the selector lever into Park. *TLZ*



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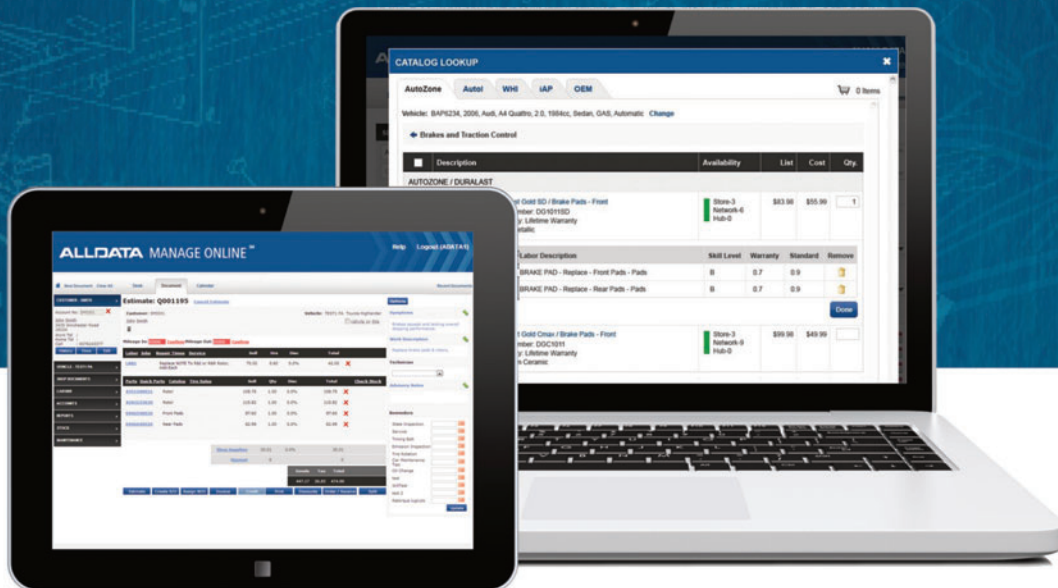


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SKYACTIV: KEEPING THE ZOOM IN ZOOM-ZOOM

The Red highlighted sections show the design of the support structure. This system gives Mazda vehicles an improved ride much like the ride of a heavier vehicle yet keeps it fuel efficient and gives it nimble handling. Energy from an impact is also dissipated throughout the vehicle's frame work.

MAZDA TAKES A TOTAL APPROACH TO DESIGN.

BY **TIM JANELLO** | CONTRIBUTING EDITOR

What is Mazda's SKYACTIV technology? Let's break it down. "SKY" is about preserving the environment by lowering CO₂ emissions. "ACTIV" is about preserving the excitement of driving by making the driver an active part of a system Mazda disguised as a car.

I am amazed at the new technology and the twists taken on some old ideas you see in Mazda's SKYACTIV technology. One of the ideas that really caught my eye was raising the compression ratio of the gasoline engine to 14:1 and the lowering of their diesel engines to 14:1 compression ratio. Looking into how they could do this and make it work was very interesting.

Background

Mazda launched its SKYACTIV technology for model year 2011. Mazda took on the challenge to promote driving pleasure while being environmentally friendly and providing outstanding safety for its vehicles' occupants. It began the redesign around 2008 with the idea that by 2015 it could increase fuel economy by 30 percent over 2008 models, without decreasing driving pleasure or safety.

Mazda believes the internal combustion engine still is going to be a major player in the future. It made the decision to position itself to seamlessly merge the internal combustion engine with present and future technologies such as electric drive, while keeping

the driving experience alive. Mazda believes in the concept of having the engine, transmission, body and chassis all work as a system, including the driver. Some of the problems its engineers faced were improving already highly efficient engines, improving both automatic and manual transmissions and giving the vehicle a rigid

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Motor Age Shines a Light on the Future of Auto

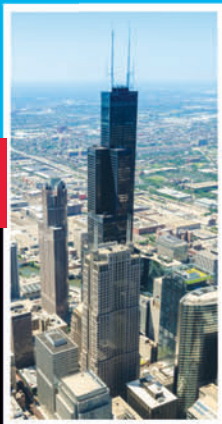


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body and chassis while maintaining safety from a lighter weight car for improved fuel economy.

We all know that an internal combustion engine is not efficient; somewhere in the neighborhood of 70 to 80 percent of the energy produced is actually lost either through heat or friction. First, Mazda took a hard look at both its gasoline and diesel engines. It went back to the drawing board to figure out how to pull more useful energy from the engines. One of first things it considered was gasoline direct injection (GDI) technology. That was just not good enough, though; Mazda wanted to improve it. All hot-rodders know that high compression engines typically put out more power, but the problem is that squeezing the air that tightly costs energy (pumping losses), just like the power it takes to run an air compressor. Mazda engineers also took aim at reducing internal engine friction and weight.

SKYACTIV-G (Gasoline Engine)

Engineers have been chasing Homogenous Controlled Combustion Ignition (HCCI) engines for a while. GDI is the newest step toward getting more energy from combustion. GDI is a gas engine designed much like a diesel. The gas is injected under higher pres-



The high-pressure fuel injectors are hiding behind the fuel rail and pressure sensors. Take note of how the intake runners are designed and tuned to take advantage of swirling the air as it enters the cylinders.

ures (500 to 3,000 psi) directly into the combustion chamber allowing for a more complete burn. The air in the cylinder is directed toward the spark plug located in the center of the cylinder head where gas is sprayed just before ignition.

Mazda asked the question, "How do you get more power with less fuel?" The answer is to increase combustion expansion ratio. This means a smaller combustion area, thus increasing down pressure on the piston. This is why Mazda increased the compression ratio to 14:1. As you know, engine knock robs power, increases emissions and causes engine damage, so engineers first went about lowering cylinder temps. Mazda decided to remove more residual exhaust gases from the cylinder.

As you know there is some exhaust back pressure with a major part being push-back (resonance) from the other cylinders. To overcome this problem, Mazda played on the idea of long tube tuned exhaust headers. Hot-rodders have used tuned headers to help extract the exhaust by making each tube length a specific length so one cylinder's exhaust pulse helps extract another's. They measured the timing of each exhaust pulse to determine the needed length to prevent push back at low to mid rpm range. The exhaust tubes needed to be 600 mm (about 23.5 inches) long between cylinders on opposite strokes to reduce exhaust gas push-back.

To fit the exhaust manifold in a reasonable space, they used a wrap-around Y-type tube design to get the needed length between two cylinders. Then the two tubes run into one pipe dumping into the catalytic converter, leading to the 4-2-1 design. This cut the residual cylinder gases from 8 to 4 percent, thus lowering the cylinder temps to help defeat engine knock.

Murphy's Law showed up with the 4-2-1 design. The engineers now faced a major issue with the catalytic converter's light-off time due to the distance from the exhaust ports. They adapted another old idea of retarding ignition timing to increase exhaust gas temps to heat the catalytic converter fast enough to prevent any increase in exhaust emissions. But this causes cold run misfires, so they made a deep cav-

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ity in the piston specifically shaped so the air and fuel are directed toward the spark plug creating a stratified charge (rich enough for combustion) around the spark plug. The specially shaped piston cavity had a benefit Mazda took advantage of, which prevented the combustion flame from coming in con-



The most noticeable change is the “well” in the center of the piston for mixing the high pressure injected gasoline and air. This well allows for a rich mixture to ignite around the spark plug then burns lean as the swirling air mixes from around the outside of the cylinders for a clean burn.



The deep “well” in the center of the pistons allow for the fuel spray to penetrate deeper into the cylinder’s air charge for improved mixing to lower soot. The 14 to 1 compression ratio allows Mazda to advance injection timing providing for a better air-fuel mixture. The exhaust gas recirculation system can also be seen at the back of the engine feeding into the intake just above the electronic throttle plate.

tact with the piston causing combustion cooling loss, that would prevent flame growth. Another trick Mazda used was to map the engine for the shortest time the air and fuel spend in the chamber before ignition and intensify air flow turbulence in the chamber for better mixing.

All of these combustion chamber changes allowed them to reduce the weight of the pistons by 20 percent, reduce connecting rod weight 15 percent and reduce piston ring drag 37 percent. The engineers didn’t stop there; valve train friction losses were next on the list. The engineers used another hot-rod trick of roller rockers in the form of roller followers on the cam. Mazda still was looking for more energy reduction, so it reduced the oil pumping losses 45 percent by electronically controlling the oil pump. All of the weight and friction reductions allowed Mazda engineers to increase fuel economy by 15 percent and add 15 percent low to mid range torque over previous models.

SKYACTIV- D (Diesel Engines)

Mazda’s engineers defied conventional wisdom by lowering their diesel engine to a 14:1 compression ratio. This lowered emissions enough to do away with expensive exhaust after-treatments like Selective Catalyst Reduction (SCR) or Lean NO_x Trap (LNT), but increased performance and fuel economy. This idea and some other improvements give the Mazda diesel 20 percent better fuel mileage while meeting Euro Stage 6, Japanese Long Term and U.S. Tier2 Bin5 emissions. Obviously, lowering compression ratio equals lower pumping losses, but this also allowed Mazda to optimize injection timing for better air/fuel mixture combustion while lowering engine weight and rotating mass.

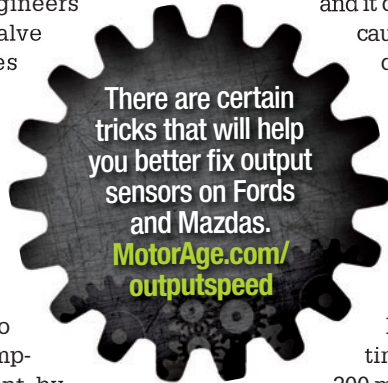
Lowering compression ratios reduces combustion heat thus lowering NO_x. This also allows more advanced injection timing giving the air and fuel molecules more time to better mix before combustion. This does two things.

First, it lowers combustion flash temperatures which lowers NO_x, and the better mixing gives a more complete burn greatly reducing particulate matter (PM or soot). Most diesels delay injection timing so the piston is starting down to lower emissions but Mazda knew combustion close to TDC makes for a more efficient engine.

It went after that expansion ratio, which is greater at top dead center (TDC). But again, if you change something usually other problems arise and it did. Lower compression causes lower heat, so how do you start and idle a cold diesel with low compression plus get any power for acceleration? The answer required several new ideas like using multi-hole piezo injectors capable of rapid response times (durations in the 300 micro-seconds) and nine injections per combustion stroke.

This allowed them to not only do the pre-, main and post-injection most diesels do, but also to modify the injection times per cycle for operating conditions and allow for precise high pressure injections for cold starts. The highly atomized fuel helps cold starts, but also Mazda adopted super-fast heating ceramic glow plugs to insure quick starts. To overcome cold run misfires, Mazda adopted Variable Valve Lift (VVL) on the exhaust. Knowing that only a single combustion cycle was needed to make exhaust temps rise, they open the exhaust valve on the intake cycle to pull exhaust back into the chamber for rapid cylinder heating. Most manufactures use the exhaust gas recirculation system for this, but that takes too much time for heating to occur. This technology is instant.

Most every diesel today has turbochargers, but Mazda went to new lengths again looking at performance engines that use a two-stage turbo charger design adapting these ideas to meet needed technology for clean/efficient operations under all conditions. Most diesels have some form of turbo lag, so the two-stage turbocharger enabled them to have smooth responsive torque output while decreasing emissions.



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A two-stage turbo is one small and one large turbo mounted together sharing the same exhaust and intake pipes. This allows for switching between turbo profiles giving the best air charge for the operating conditions. A small turbo will spool up using less exhaust to give good boost at low rpms, and the large turbo produces boost at higher engine speed giving a great torque curve over the entire driving range. This turbo design also gave Mazda better boost control helping to lower both NO_x and soot output.

Without the need for the expensive and fuel robbing regeneration of after-treatment systems Mazda is way ahead of the game. All of the advances Mazda did to their diesel engine allowed them to change to an all aluminum block and a thinner cylinder head, cutting a whopping 62 pounds (28 kg) of weight plus shaving the pistons' weight by 25 percent.

SKYACTIV-Drive (Automatic Transmission)

Mazda took aim at combining all the best advantages of each transmission type to make each one better. It looked at the advantages of a conventional (step shifting) automatic transmission, continuously variable transmission (CVT) and a dual clutch transmission (DCT). It improved fuel economy 4 to 7 percent by reducing slip, cutting

weight and reducing friction losses. It wanted a smoother shift, but also wanted to keep the fun in driving no matter which transmission choice the driver wants.

Everyone knows that a torque converter gives smooth starts and shifts but robs mpgs. Mazda wanted to get rid of slippage between shifts, so it improved the torque converter. To reduce the slippage, it locked the converter up just after takeoff. This required tighter electronic controls of both the engine and transmission plus better cooling of the multi-disc lock up clutch. The engineers controlled Noise, Vibration and Harshness (NVH) by providing a damper and compact torus (vane) in the torque converter, but also did a redesign of everything from the engine to the exhaust system.

To improve transmission oil pressure control they combined the hydraulic controls with the electronic controls into a Mechatronics module and located in the transmission. To get better shift quality, Mazda engineers came up with direct linear solenoids for quicker, more precise pressure control response giving better shifts.

SKYACTIV-MT (Manual Transmission)

Mazda came up with some different slants on manual transmission shifting and internal redesigns to lower weight

by 16 percent and reduce friction by 1 percent. Mazda wanted to develop two levels of manual transmissions, a large and mid-size to handle different types of power plants or combinations of. Space and weight were a major concern along with that driving experience theme.

It first looked to improve shift feel and shorten the shift stroke. This required redesigning the internal stroke by adding a small module spline to move the synchronizers. It adopted lock ball type synchronizers, shift load cancellers and ball bearing on the slides to give an easier but positive feeling shift. It rearranged the gears, moving first gear to the top shaft, using a common 2nd/3rd input gear and doing away with the reverse idler shaft. This allowed for a more compact and lighter weight yet tough, fun shifting transmission.

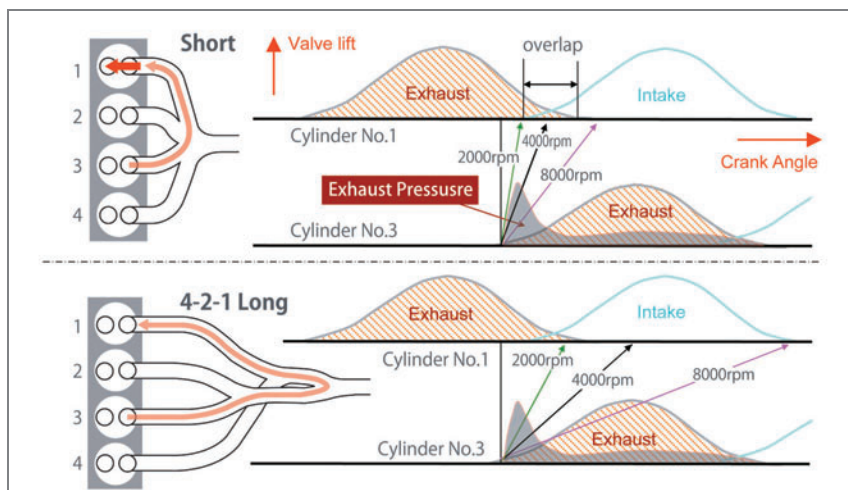
SKYACTIV Body

Mazda wanted to keep a crisp looking, aerodynamic body that would turn heads. It was determined to lower the weight by 8 percent, improve rigidity by 30 percent and still meet worldwide safety standards. Some of the ideas it went for were "straightening" and "continuous framework." Straightening refers to removing or decreasing underbody curves giving a straighter frame-like platform. Continuous framework means a completely bonded upper and lower structure combined into a dual brace configuration to spread any forces over the whole body. This gives the ride a tighter feel by absorbing impacts from bumps and improves crash safety.

In this body redesign, even the door hinges were improved. The redesign also included weld-bonding of the roof as an assembly before welding it to the body structure. Body materials were also changed to a higher tensile-strength steel material.

SKYACTIV Chassis

Last but certainly not least, Mazda engineers knew the chassis needed to be revisited with all the changes made to the powertrain and body. Remember they wanted to be able to adapt to any type of power plant and lighten the overall weight. If the engineers were to control the ride and keep the fun in driving, the suspension needed to be lighter, but offer more rebound control.



Mazda's drawing of how the 4-2-1 exhaust system (bottom of drawing) draws the exhaust out of the cylinders without allowing it to be pushed back into another cylinder when compared to traditional systems (top drawing). Keeping the exhaust from reentering a cylinder effectively lowers the cylinder temperature helping to prevent engine knock and lower emissions.


Mazda improved low to mid-speed agility and high speed stability by adding electric power steering to increase yaw gain. The steering ratio was increased for better low speed response and better road feel at highway speeds. Through the use of electronic controls the turning effort is speed adaptable. It also increased both caster angle and caster trail for a better straight ahead driving feel.

The rear suspension was reworked to increase road grip and reduce rear wheel bounce. The rear suspension dampeners were moved rearward giving a straighter line for rear wheel impact control. To add to this rebound control for absorbing road bumps and keeping the wheel in contact with the road, the rear trailing arm was moved upward above the wheel centerline. This allows the wheel to swing up to roll over a bump rather than the impact pushing backward on the wheel axle causing more energy to be absorbed by the body. The engineers incorporated the old idea of "box channel frame" construction for a more rigid cross member while lowering the weight 14 percent. The front member was extend-



Improvements to the torque converter can be seen in the cutaway. The torque converter lock-up clutch pack is shown close to the front, middle of the assembly. The upper rear of the converter shows the redesigned torus (vane) and dampener system. The fluid heat exchanger (located on this side of the transmission) has been added for improved fluid temperature control.


ed reducing the offset of the front lower control arms. The rear cross member was also given a bigger front to rear span to reduce the link offset for better wheel to body control.

Mazda engineers went back to the drawing boards to redesign their vehicles to blend with future technology while still keeping the fun in driving. They went against the normal thinking processes and made it work. Zoom on Mazda! 



TIM JANELLO
CONTRIBUTING
EDITOR

Tim Janello is an assistant professor for Southern Illinois University in Automotive Technology teaching baccalaureate students for the past seven years. He has 40 years of experience in the automotive repair field with Master ASE certification and L1.

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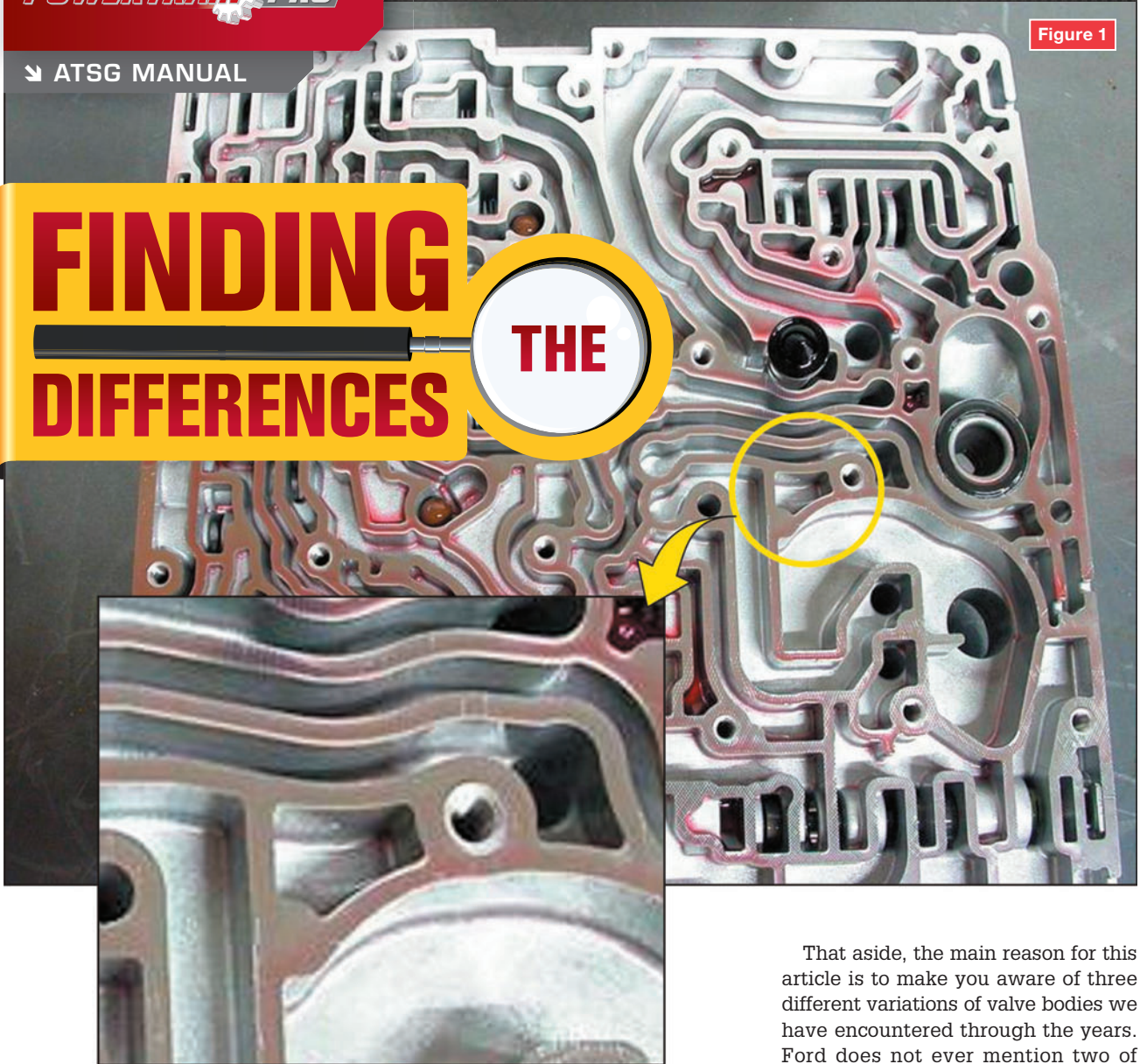
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Figure 1

FINDING DIFFERENCES

THE



EXAMINING 6R140 TORQSHIFT 6 VALVE BODY DIFFERENCES.

BY WAYNE COLONNA | POWERTRAIN PRO PUBLISHER

Whether you have a 2-wheel drive or 4-wheel drive vehicle equipped with a 6R140 (commonly referred to as the Torqshift 6), there is only one valve body listed for this transmission. This is a question that is often times asked on our technical hotline as the 2-wheel drive uses a lube pipe for the extension housing bushing while 4-wheel drives do not. The port opening at the solenoid end of the valve body where the lube pipe

is fitted remains open with the 4-wheel drive version. For this reason some have assumed that there is one valve body for a 2-wheel drive and another for 4-wheel drive applications. The lube is fed to this port through a .041-inch orifice in the spacer plate. If there is no pipe, it will simply dump into the sump. With 2-wheel drive applications the pipe is inserted and extends to the rear of the transmission where it is routed to the extension housing bushing.

That aside, the main reason for this article is to make you aware of three different variations of valve bodies we have encountered through the years. Ford does not ever mention two of them, but they are out there. Two of these valve bodies contain only two check balls, while the one Ford mentions has three.

The two types of valve bodies, which contain two check balls seem to be very early designs. Figure 1 shows what I believe to be the earliest design of all three-valve bodies. The critical area to be observed is displayed in the call out part of the photo. Figure 2 is the accompanying spacer plate. Notice there are two holes in the spacer plate that fits over the empty pocket shown in Figure 1.

Figure 3 shows the second type “two check ball only” valve body. But this one I believe shows a transitional phase to where a third check ball will be added. Figure 4 shows the accompa-

Photos: Wayne Colonna

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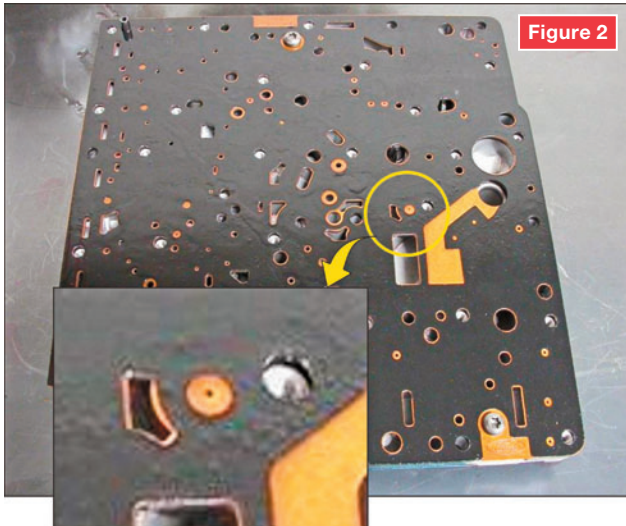


Figure 2

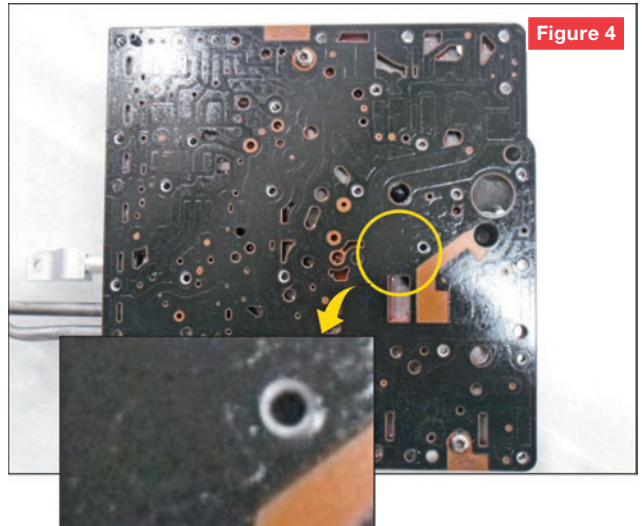


Figure 4

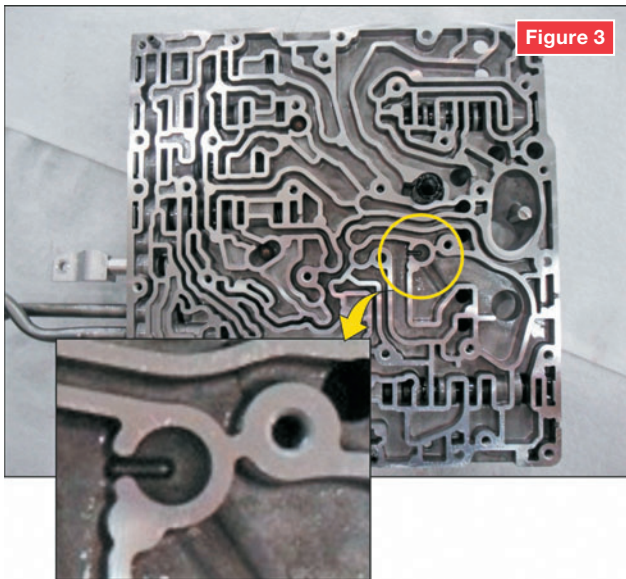


Figure 3

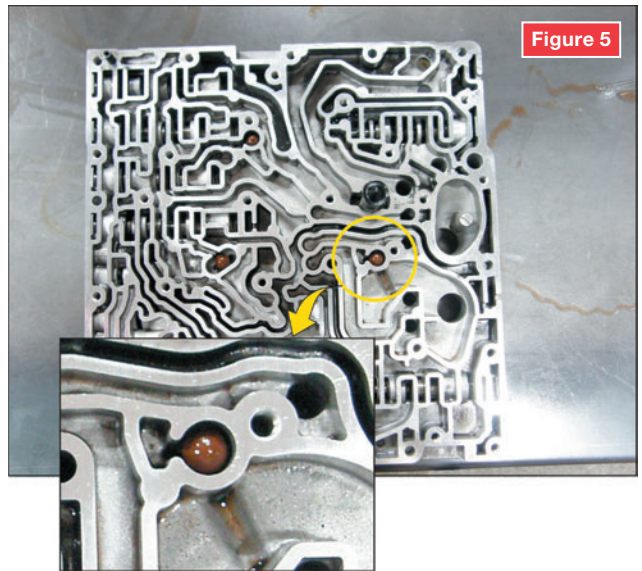


Figure 5

nying spacer plate. Notice it no longer has any holes over this area.

Figure 5 now shows the valve body, which does contain the third check ball. Figure 6 shows the accompanying spacer plate. Notice it now has two holes over the area of the check ball. If you look at the hydraulic schematic, you will notice it reflects the addition of this .375-inch diameter check ball. Regulated line pressure coming directly off the pump and Pressure Regulator Valve come in over the top of the check ball. This pressure is then forced through a

.041-inch orifice in the spacer plate and routed to the TCC Charge Control Valve. From there it becomes

Converter Charge Pressure.

With thinking there is only one valve body for this transmission when there are actually three that I am aware of, part interchange can and will cause converter charge issues.

Just by looking at the spacer plate shown in Figure 4, if it is used on the valve body with the third

check ball shown in Figure 5, regulated line pressure will be blocked from entering the check ball pocket. This means no converter charge pressure,

There is much more information on the problems you are encountering today in this month's special section. MotorAge.com/powertrainpro

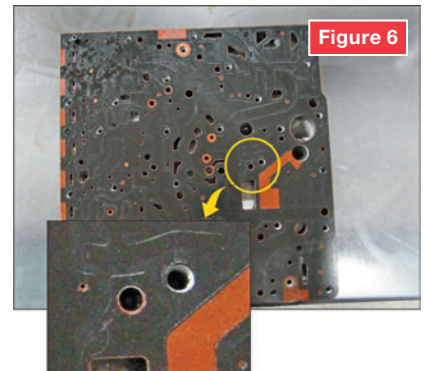


Figure 6

which means a no move condition. You may feel an engagement as the pump and PR valve is able to supply clutch pressure but there will be no turning of the input shaft with an empty converter. There will also be no cooler flow, which might be your clue to this unexpected mismatch of parts. *TLZ*

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TECHNOLOGY

THE NUTS AND BOLTS
OF AUTOMOTIVE REPAIR



IN THIS SECTION

- 68** Electrical
- 76** Underhood
- 82** Scope & Scan
- 84** Motor Age Garage

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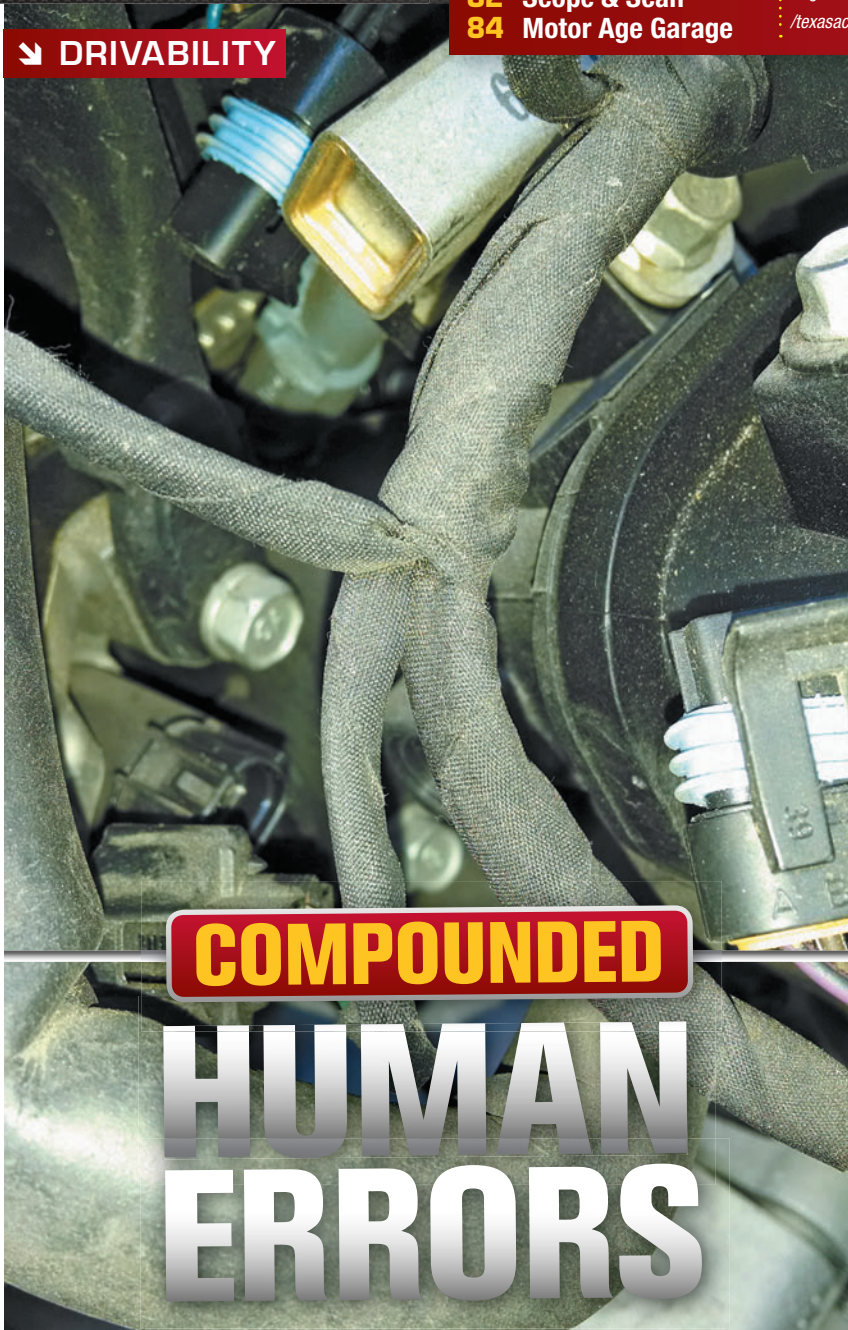
SOFTWARE SUBSCRIPTION

Snap-on software expanded back to 1992 models. /snapon1992

HONEYWELL SALE

Honeywell completes sale of friction materials side to Federal-Mogul. /honeywellsale

DRIVABILITY



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HUMAN ERRORS

Another drawback to mobile diagnostics work: finding and correcting the little things, like disconnected and damaged wiring.

**HOW MUCH EASIER WOULD IT MAKE OUR JOBS IF
IGNORANCE DIDN'T PLAY SUCH A MAJOR ROLE?**

BY **JAIME LAZARUS** | CONTRIBUTING EDITOR

There seems to be a prevailing attitude among a growing number of people employed in the automotive repair industry who must believe all automotive engineers are idiots. At least, that's the conclusion I've come to when I see how some (I refrain from referring to them as "techs") have attempted to resolve their customers' complaints.

What they do can't be called fixing cars. Some repairs I've witnessed have been attempted in the most interesting ways. I've been both entertained and disgusted by how some have re-engineered system designs, and I ponder the thought processes they must have gone through to develop their solutions.

I've also been embarrassed by the blemish such non-professional practices place on the industry as a whole. I wonder if the vehicle owner was charged for such a horribly botched job. I wonder how much time and materials, how much blood, sweat and tears, how much pain must have been suffered while doing these so-called "repairs." Let's define all that stuff by what it really is — waste.

A Professional Approach

A professional repair is done completely. Doing a repair completely means completely solving the problem, completely resolving the customer's concern and completely preventing it from ever happening again, if possible. It's the goal I strive for. I've found being a professional automotive technician to be rewarding in many ways including financially as well as emotionally, and don't imagine a "hack" feels anything like rewarded.



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“I CONTINUED TO PROD FOR MORE INFORMATION. ‘IS THE CONDITION REPEATABLE?’ ‘IS THERE A GEOGRAPHICAL REGION WHERE THE PROBLEM SHOWS UP?’ ‘MUST THE AMBIENT TEMPERATURE BE ABOVE A CERTAIN POINT?’ ‘DOES IT DO IT WITH A FOX?’”

JAIME LAZARUS [CONTRIBUTOR]

Those who know me most likely have heard me say, “I’m one of the laziest people on Earth. I don’t want to work any harder than I absolutely have to.” I am proud of my ability to imagine ways to perform repairs faster, better or longer lasting, but in the end, I perform the repairs as they should be done and strive to not create other problems in the process. Of course, I use creative methods to diagnose problems. After all, I want to get the most information in the shortest period of time possible. But I don’t even consider re-engineering a system, bypassing functionality or safety features, in order to affect a fix.

When called to diagnose a vehicle, I start by playing 20 Questions, the same way you should ask your customers when they present a diagnostic situation to you. I use the answers I’m given to narrow down what might cause the complaint and eliminate what I don’t need to test. Why look at the whole car if only a small part of it’s affected? That’s my kind of lazy.

Is there a way I can be lazy when I’m called to a shop that is now the third one to attempt to address the customer’s concern of “intermittent overheating” or will I have to actually (sorry for using a four-letter word here) work? What questions might you ask of the technicians who have run out of ideas how to resolve that complaint on a simple, non-exotic vehicle?

A Lazy Diagnosis

Let me share an example of a case I was called in to assist with to further differentiate one form of laziness from another. The vehicle owner complained her 1988 Nissan Sentra would overheat intermittently while in bank or fast food lines or stopped at traffic lights. Steam poured from under the hood and coolant would boil onto the ground, all classic symptoms. The electric fans worked every time the air conditioning was turned on, and thermostatically when the air conditioning was off.

My first question was directed to the shop owner, asking what repair

attempts had been made. He told me that a couple of thermostats, water pumps and radiators had been installed during previous repair attempts.

Let’s pause here and consider what information I’ve received so far. I can comprehend how a thermostat can act up every now and then, and a water pump impeller spinning on its shaft can pump fluid at times and not at other times. I personally have experienced both of these situations. But there was at least one shop/tech that believed a radiator would cause an intermittent problem, one that only occurred at idle.

I just have a hard time condemning a radiator for an intermittent problem. It scares me when I think of the reasoning (or lack thereof) used to condemn the radiator in this instance (twice at that). Do you agree with me here? If debris blocked the flow periodically, then a flush would remove it (and it wouldn’t be the fault of the radiator). If debris were present in the coolant, it would overheat under a variety of driving conditions. In any case, the odds



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that any of these items are faulty — yet produce the exact same symptoms as the vehicle owner originally described — are astronomical.

The current shop working on the vehicle thought possibly there was a blown head gasket or a cracked cylinder head. I've experienced only one vehicle that had a cracked cylinder head and exhibited symptoms that were intermittent in nature. That's one in possibly thousands of vehicles I've worked on, so it's not impossible though improbable. Can you think of any super-easy tests to confirm or to disprove the possibility?

I used a cooling system pressure tester on the one of these I saw. It passed the first two or three times the car was in for the same complaint. The last time, I checked it over and over throughout the day then I got distracted, forgot that I left the cooling system pressure tester on the car and went home for the night. The next morning I saw all the pressure had gone down but there were no external signs of leakage. I checked the oil level and saw it slightly over the full mark, but the oil filler cap showed no condensation or signs of coolant in the oil. I pulled all the spark



Considering everything else had been replaced without success, I thought a test of the cooling fan motor condition was in order.

plugs and noticed one had green coolant on the tip. The “a-ha” moment!

Once torn down, a crack could be seen on the port side of the exhaust valve seat on one cylinder but it was only leaking at certain temperatures.

Fast-forward a few decades to the Nissan. Because this was an overheating situation and not just a “coolant loss” complaint, I didn't need to leave any testers attached overnight. To quickly eliminate the same possibility of an intermittent combustion chamber coolant leak, I chose a 5-gas analyzer instead of a coolant pressure tester. I was confident everyone before me had pressure tested the system already. The 5-gas analyzer showed no hydrocarbons (HC) in the coolant reservoir.

Having quickly disproved the shop's suspicions of a combustion chamber coolant leak, I continued to prod for more information. “Is the condition repeatable?” “Is there a geographical region where the problem shows up?” “Must the ambient temperature be above a certain point?” “Does it do it with a fox?” (No, but this interrogation method reminds me of Dr. Seuss's “Green Eggs and Ham.”)

The problem was not repeatable, so I fell back on the old reliable culprit that I usually find to blame for most intermittent problems — the bad electrical ground. I tested each ground on the car, whether it had anything to do with the Engine Control Module (ECM), cooling fans or not, without any success. All had less than 50 mV drop to the battery negative terminal.

Considering everything I knew to this point, I felt sure it must be an electrical malfunction that caused the problem to be present intermittently. It might help you to follow my thinking if you consider this is an OBDI car. The ECM only has blink codes, and it passed every one of the five diagnostic modes. What would you want to do next?

I researched all kinds of service information as well as the other technical resources available to me at the time, but found no silver bullet that might help me get to the solution. I examined



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the wiring diagram intensely and decided to current ramp the fan circuits. I was able to immediately identify a fault in the cooling fan motor windings, but had to examine the waveform before I understood why this could cause the customer's complaint.

The Answer, My Friend

The single current pattern revealed a shorted armature segment in the fan motor. I figured if the shorted armature commutator stopped on one of the brushes, the fan might not start the next time it was needed. It might occasionally create a small magnetic field, depending where the armature came to rest, that might cause rotation. But if it was unable to and there was no vehicle movement, the engine could overheat. Once the vehicle began moving again, air flow through the radiator not only might keep the engine from overheating, but the air flowing through the radiator and fan might rotate it slightly allowing it to start next time.

“Initially, I figured a blown fuse or another ground was off, but neither was the case. It was then when I understood why the interior was partially disassembled.”

I had less than one hour invested. It's sometimes difficult for us to imagine things that might cause problems if we can't conceive things outside our own experiences. I think this is why the suggestion for a head gasket replacement was made.

It also might explain why identical conclusions were made about the parts previously installed. After all, because the fan always worked when expected, why would we suspect it? And I might tend to agree if the problem hadn't been specifically described as “inter-

mittent.” If someone who earns a living in the same business I do could consider a radiator as a potential source of an intermittent problem, why wouldn’t you consider the fan motor as a more likely candidate?

Lazy Has a Process

Here’s another example I’d like to share. I was called in to diagnose a “Cranks OK, won’t start” complaint on a 2004 Kia Sedona V-6 that was in a used car lot. I know, I know. Lots of flags went up right away when I got this call and I should have heeded the warnings. Used cars typically have little to no history, often have been “hacked” and (magically) must be fixed without the current owner spending much money. Unfortunately, this one was no exception. It was bought at an auction, was heard and seen running, was diagnosed with blown head

gaskets after it overheated (sound familiar?) and has not run since.

Someone deemed it necessary to replace the head gaskets, and during that process damaged electrical connectors, neglected to install all of the bolts (including the ECM ground eyelet bolt) and generally had done a slipshod job. This individual got fired and didn’t understand why. Now the job was passed on to the replacement. Working within the limitations of his own inexperience and those imposed by the used car lot owner (no tooling, no training, no money), he quickly exhausted all his capabilities and convinced the owner that I was the man who could fix this car. I felt challenged and wanted to live up to my reputation (ignoring my instincts). Once again I began by playing 20 Questions with the tech and the owner of the lot.

Upon arrival, I gathered as much information about the vehicle as I deemed necessary to perform an initial evaluation then headed to the car. I brought with me the factory scanner, a Power Probe, and my laptop only to find the vehicle had a dead battery, a partially disassembled interior and almost the entire engine electrically and mechanically intact. Oh, and it was outside and about to start raining. I silently reviewed all the questions I’d asked and didn’t remember asking the important ones that I obviously should have before heading their way. I made a mental note-to-self for the future.

After reassembling as much as we could see that was not right in the engine compartment and charging the battery, I began my analysis by scanning the ECM. “No communication with selected module” was the response. Initially, I figured a blown fuse or another ground was off, but neither was the case. It was then that I understood why the interior was partially disassembled.

I wanted to check power supplies and grounds at the ECM and found one with yellow tire crayon markings scribbled on it. Stuff like this is what I call the “Paul Harvey time,” or the time when you get the rest of the story.

“Oh that?” the tech told me. “We tried another ECM from the junkyard, It did the same thing, so we left it in there.” I identified this donor module and found it was from some other 2005

Korean-made vehicle, then entered the vehicle information as a “2005” to read the ECM. I researched enough to learn it could never work in this 2004. You already guessed it, didn’t you? The original was returned and no longer available, so I ordered a rebuilt unit that was appropriate for this vehicle.

I won’t bore you by going into further detail about each painful step of the diagnostic process; after all I’m sure most of you have experienced similar situations in your careers. I ultimately was able to determine the cause of the no-start. Once I confirmed the ECM was doing its job and all my basics were correct, I visually inspected the four camshafts that were reinstalled after the head gaskets were replaced.

For future reference, cams with an “I” stamped on their ends are for the intake valves and the cams stamped with an “E” are for the exhaust valves. Once the camshafts were oriented in their correct positions on each head and the timing components’ correct installations confirmed, it amazed the owner and technician how little cranking was required for this engine to come to life.

I did what I was called in to do, that is, get it running. I’m not sure if there still was an overheating condition afterward or not and really didn’t care.

In each of these instances, a lot more work was done than actually was necessary. Work that was caused by what I call “compounded human errors.” Had the correct diagnosis been performed initially, a huge amount of waste would have been avoided. Wasted energy, wasted time and wasted money.

I just shake my head sometimes. Compounded human errors also make me work harder than I should, and I’m too lazy for stuff like that. *ML*



JAIME LAZARUS
CONTRIBUTING
EDITOR

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

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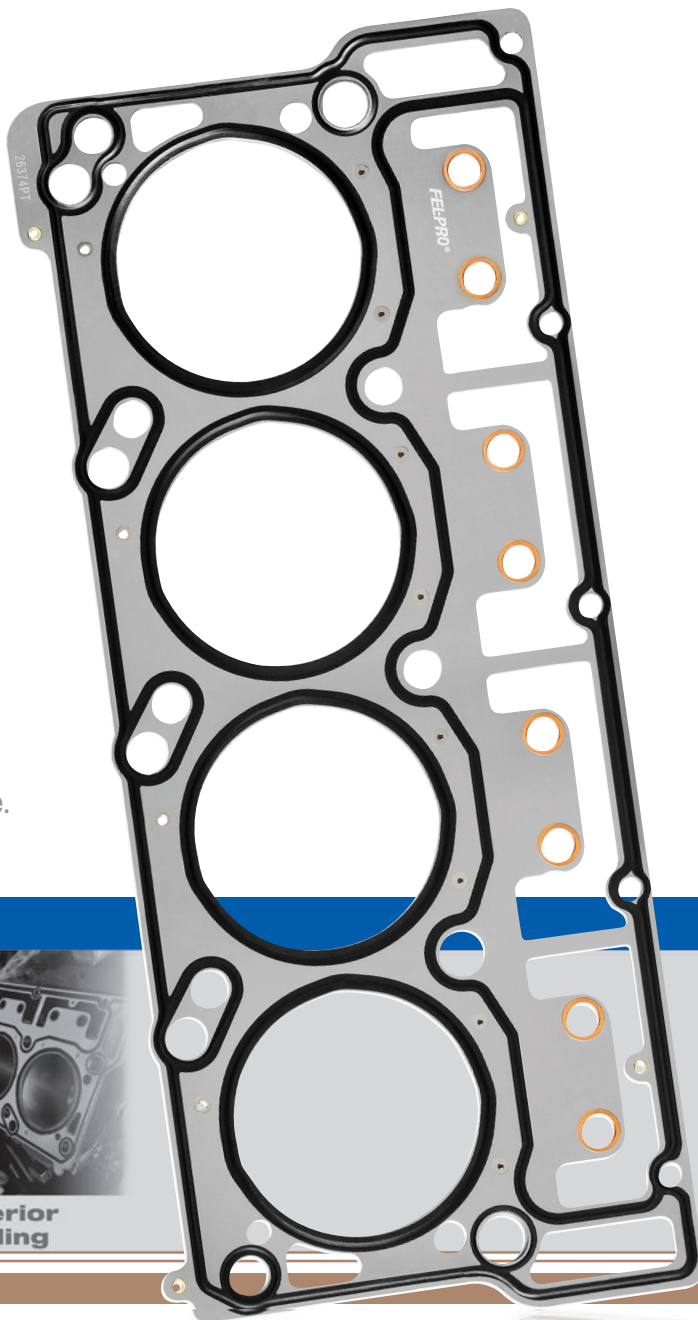
I now make a practice of comparing the VIN of the ECM to the actual vehicle VIN.



In the Kia’s case, it helped me uncover the first problem that required correction, the wrong ECM for the car.

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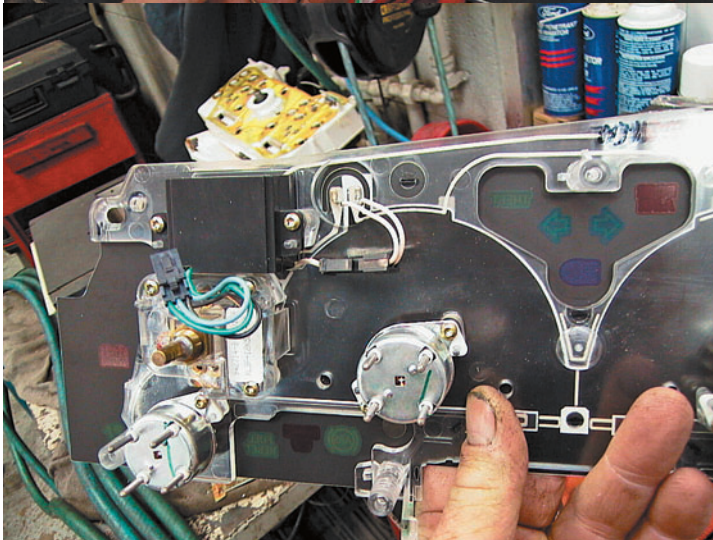
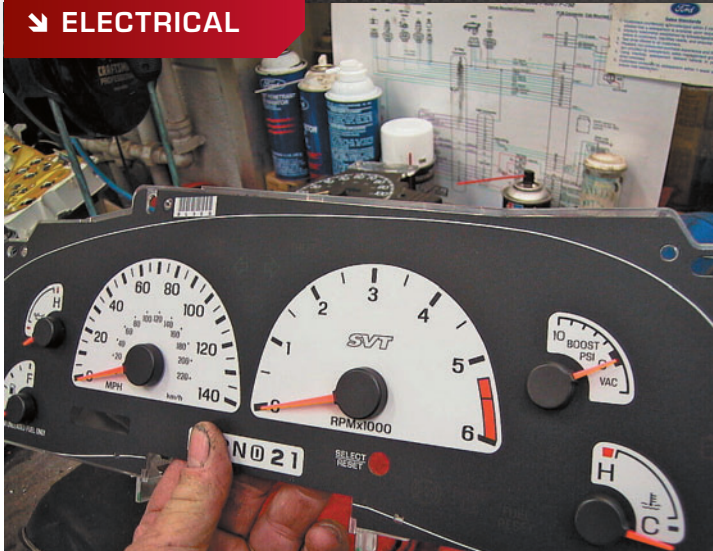
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This 1999 Ford Lightning cluster came in dark, and when I got it apart, I was kind of stunned that it had no bulbs and the cluster had to be replaced to get the illumination back.

NEEDS

AND

NUMBERS

THE EVOLUTION OF INSTRUMENTATION TAKES US FULLY INTO THE DIGITAL AGE. ARE YOUR SKILLS MOVING AT THE SAME PACE?

BY **RICHARD MCCUISTIAN** |
CONTRIBUTING EDITOR

In the same year the Titanic broke in half and sank to the bottom of the North Atlantic, George H. Townsend, president of Moto Meter Inc., obtained exclusive Boyce patent rights to manufacture radiator cap-mounted and dashboard-mounted engine temperature indicators. The year was 1912. Boyce Moto Meter instruments dominated the American automobile industry for about 20 years.

The most rudimentary clusters of old had nothing to show the driver except a speedometer, a fuel gauge and those simple warning lights that alert the driver when oil pressure is low, brake pressure is unbalanced or temperature is high. In the 1960s, some domestic platforms even had a blue or green warning light letting the customer

know the engine was still cold. Some instrument clusters included a strategically marked vacuum gauge that was intended to help the driver save fuel. The first vacuum gauge I ever saw was in the middle of the dash on a yellow 1965 Impala SS my friend Alan was driving back in the late 1960s. Some supercharged vehicles have a gauge that displays both vacuum and pressure.

Early speedometers had alarms that could be set to warn a driver if he or she was exceeding their desired top speed, and one 1963 Oldsmobile Super 88 I rode in had an indicator bar that would change colors from green to yellow to red, depending on the speed. The problem with that one is that some yo-yos (like the guy I was riding with that day) just loved watching that bar



turn red, which happened at 80 mph.

“Full Instrumentation” packages included gauges for temperature, fuel and oil pressure along with an ammeter for charging system status (replaced in the late 1970s by a voltmeter, which confused older ammeter-acustomed drivers). Some of today’s heavier duty light trucks boast a transmission temperature gauge along with

Photos: Richard McCuistian

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a built in hour meter function embedded with the odometer software. That measures the amount of time the engine has been running instead of recording only miles and oil life, because so many work trucks spend hours idling on the job and that time needs to be tracked for maintenance.



How to identify speed sensors in cars and testing them successfully.
MotorAge.com/speedsensordid

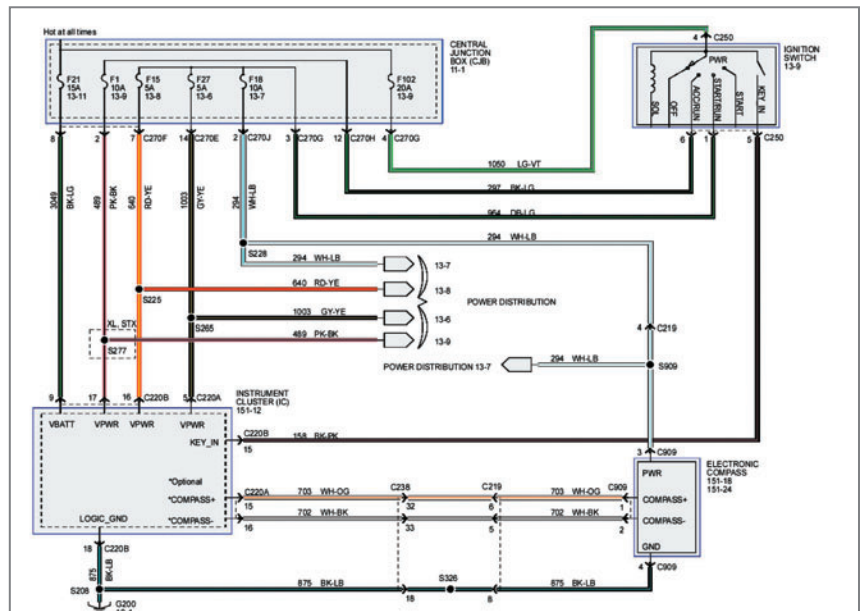
how to make the repair isn't sufficient without accurate troubleshooting procedures — how many times have we replaced a gauge or a sender and discovered that we had misfired on diagnosis? In today's world, you need a good scan tool and a pass through programmer, too.

Computerized instrument panels are the order of things now, with processing power that would have been considered science fiction when I was in high school. Anybody who drives a Ford Fusion is right at home with watching the instrument cluster boot up and fan out on each side of the speedometer with so many display options in those wings it's hard to keep track of all of them.

While there are still late model vehicles out there sporting the basic gauge package, sender-driven magnetic gauges are as archaic now as bimetal units were 20 years ago. Just about every instrument cluster is computerized, even on low-cost vehicles. And where there are instruments, needed repairs are inevitable, but knowing

Illumination & Warning Lights

Cluster illumination is probably the least common symptom we have to deal with, but it does happen, and on at least two vehicles I've serviced with illumination concerns, the cluster itself needed replacing when it went dark, those two being a late 1990s Ford Lightning (which has no bulbs that can be replaced) and a 2003 Jeep Wrangler I wrote about a few years back, where the instrument illumination circuitry inside the cluster is weaker than the 10 amp fuse the engineers placed in series to protect it. A short to ground anywhere on the orange instrument panel feed wire on one of those Jeeps can darken the cluster permanently without blowing the fuse.



This schematic illustrates the wiring so many new vehicle clusters are wired. Note that there are four fuses feeding the cluster, and one of them is a keep-alive. Sometimes F150s like mine have clusters that begin to kill the battery through that keep-alive wire, so watch for that.

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Inoperative indicator lights are another concern that isn't too common, but some of those lights are pretty important. For example, on some Fords the voltage passing through the battery light turns on the alternator voltage regulator, and if the wire leading from that bulb to the alternator gets shorted to ground or cut, the alternator won't work. If the wire is cut, the charge indicator light won't work, and neither will the charging system. If it's shorted, the light will be on all the time, but replacing the alternator won't fix the problem. Most newer cars have the Powertrain Control Module (PCM) between the battery light and the alternator turn-on terminal, but a wiring problem on that circuit can still drive an unwary tech to needlessly replace the alternator.

On mid-'90s Ford 4-wheel drive vehicles, the 4x4 low light can blow or lose its power feed, and that will confuse the PCM into remaining in 4x4 Low shift schedule, meaning the truck will shift all the way to its top gear at about 30 mph. I've seen at least one transmission rebuilt because of confusion related to a blown fuse feeding this indicator lamp.

I've also seen two inoperative Malfunction Indicator Lamp (MIL) lights over the past couple of months because of bad PCMs. Once I saw a high beam indicator blinking like a turn signal flasher on a brand new Aerostar, but placing my finger on that tiny bulb socket stopped the flashing, so I removed the bulb holder and tweaked the little contacts. On a Jeep Grand Cherokee, I saw a high beam indicator flashing a strange binary code and after the hotline had me replace the \$550 instrument cluster under warranty, I discovered that the \$125 Body Control Module (BCM) was really causing that concern.

Speedo Stuff

Back in the 1980s and '90s when cables drove speedometers and we had to replace an instrument cluster, at my shop we'd take the odometer drum out of the original speedometer and drop it into the new unit so those red tenth-mile numbers wouldn't lower the trade-in value of the vehicle. Granted, there was a sticker you could put in the door, but there's nothing to keep a driver from peeling the sticker off, and nobody wants to lose 25 percent of what their car is worth because of red tenth digits.

Cable driven speedometers were a pain sometimes, because they'd make cable-related noises while the cable was spinning and the needle would quiver, necessitating the removal of the speedometer, extraction of the cable from its tube and lubrication and reinstallation of the cable.

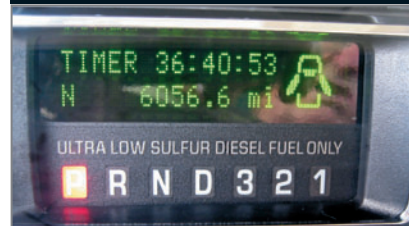
The speedometer needle can also be indexed wrong. Once I drew a ticket on a new Tempo that was reading 20 miles lower than accurate and the woman's complaint was that the car seemed noisy at road speed. It was no wonder, since she was driving between 80 and 90 mph everywhere she went, and who knows how she escaped getting a speeding ticket.

Speedometer needles on those older, cable driven units are mounted on a shaft that rides in a sintered bronze bushing in the center of the part of the speedometer that is spun by the cable. Also a part of the needle/shaft assembly is a copper coated drum and a tiny spiral spring. The needle fits on the shaft as an interference fit and can be popped off. The spinning part with the bronze bushing where the needle shaft rests has on it a bar-shaped magnet that spins inside the drum without touching it. As the magnet spins, the ferrous metal drum tries to follow the magnet, working

against the tiny calibrated spring and the attached needle indicates vehicle speed. The bronze bushing sometimes gets dry and tries to grab the needle shaft, bouncing the needle around all over the place. Whenever I ran into that concern on a Taurus or Windstar, I simply disassembled the speedo and lubed the bushing with a drop of motor



This 2006 Explorer cluster has a bevy of warning indicators in addition to the message center. When working on one of these that has malfunctioned, you have to find out where the signal is coming from that triggers the lamp – whether from the network or a hard-wired input. Keep your schematics handy.

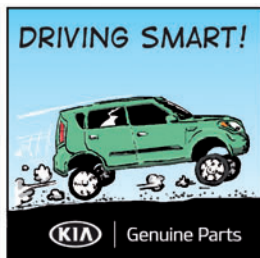


These hour meters are a relatively new feature and obviously get their information from the network and the PCM about engine run time.



When a gauge drifts into the danger zone, it's wise to check the datastream to see if the engine is truly running hot. If the same sender feeds the gauge and the PCM, it might be time to break out the Infrared Temp Gun for some strategic spot checks.

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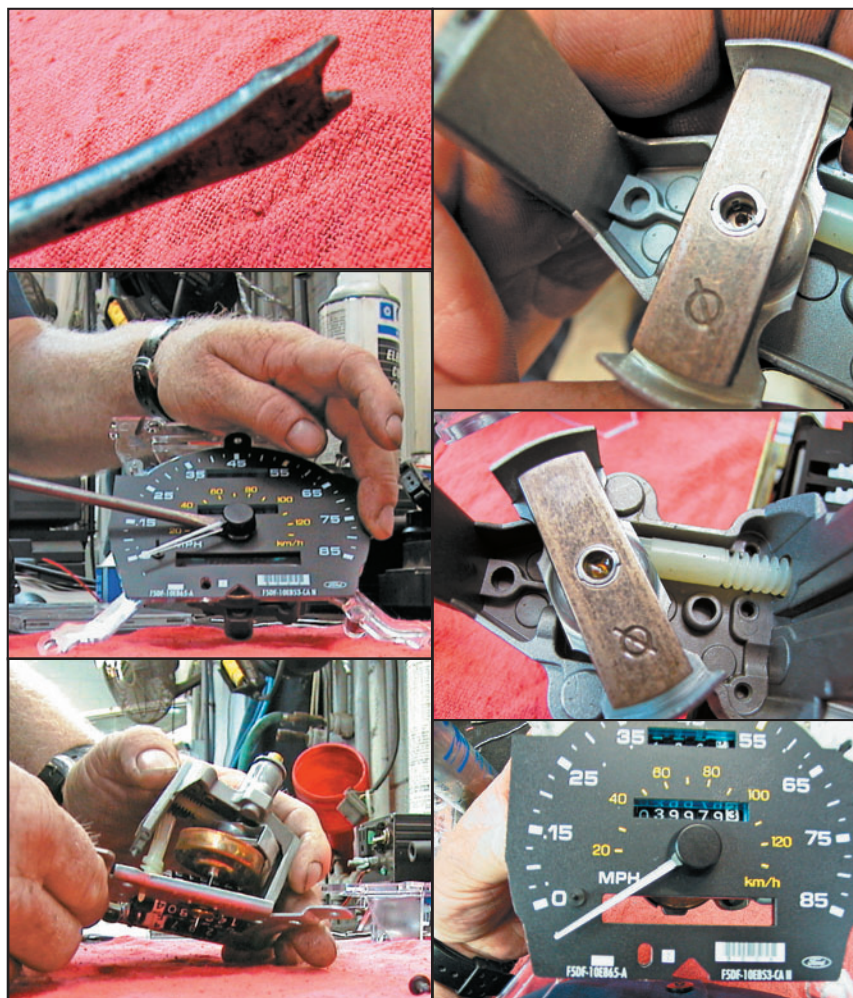


oil, and it was a permanent repair. Replacing the \$350 speedometer was only a temporary fix, because the new unit would fail the same way within a few thousand miles.

Electronic speedometers replaced the needle driven ones in the late 1990s, and speed sensors die, so watch for that, but make sure you replace the right sensor. That plastic output shaft speed sensor on the side of a Dodge RAM transmission doesn't feed the speedometer. That signal comes from the differential speed sensor, and on some Ford platforms that signal passes through the four wheel

Antilock Brake System (ABS) unit on the way to the cluster, and sometimes the ABS unit has to be replaced for an inoperative speedometer.

If something goes awry with the seat belt alarm module on vehicles equipped with one (and I've seen this happen), the speedometer can begin to read speed and then drop to zero when it reaches about 30 mph. I've also seen a bad junction box cause that problem. Sometimes when the speedometer goes dead on a computerized cluster, a simple reboot (battery disconnect) will bring it back online.



Working our way from top left down, photo one is a special tool I made to pop the speedometer needle off when working on the mid-'90s Taurus-Windstar speedometers. Photo two is removing the needle. Photo three is the drum and magnet assembly, and you can see the spiral spring. Photo four is the dry bushing, and photo five shows it with a drop of oil. Photo six illustrates proper indexing of the needle. With the shaft at rest, point the needle at the index mark, tap it back on and then lift the needle above the peg to put it back in place.



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Here's a tip: If the odometer works but the speedometer doesn't – or vice versa – the speedometer has to be the problem. It's as simple as that.

Other Needles

Among the other needles, fuel gauges are the most likely candidates for failure. Because the fuel tank sending unit is in the most hostile environment and has mechanical moving parts, it's the hardest working component. On some vehicles, the fuel gauge sender feeds its signal to an electronic module (like the Rear Electronics Module on some Ford minivans), which then forwards that information to the cluster. Personally, I don't like having a middleman between the sender and the cluster. When the sender fails, the gauge will continue to display whatever reading was there when the failure occurred.

On older magnetic gauge units, you can disconnect the tank sending unit and the gauge will go to full, but slosh dampening electronics typically keep it from happening quickly unless you switch the key off and back on between test steps. If you short the sender wire to ground, the gauge should go to empty. If you can find the ohm range of the sender, you can find ohm reading that corresponds with a half tank and use a potentiometer or special tool to send the half-tank signal and see what that does to the needle.

GM sending units from around the turn of the century wear out frequently, and you can buy just the sending unit from the dealer, but the parts store only sells the whole fuel pump module.

Oil pressure gauges are either transducer or contact switch driven, depending on the platform, and you need to find out what kind of sender you have and how the signal makes it to the cluster in order to troubleshoot those effectively. Using a scan tool can test the gauge whenever you can, but know how to test the sender too. Starting in 1987, Ford put magnetic gauges on most of their vehicles, but the transducer didn't work well with those gauges, so a 22 ohm resistor was placed in series with the gauge and the transducer was replaced by a switch that closed its contacts with oil pressure. These gauges read in the center and don't reflect true oil pressure, and Ford has continued to use

that system to this day.

Important note: When you're troubleshooting an oil pressure or temp gauge, it's wise to use your tools and know how to see what is actually going on in the engine's innards before assuming the problem is with the gauge.

Temp gauges nowadays frequently get their info from the Instrument Cluster electronics by way of a signal from the PCM, which is monitoring the ECT or Cylinder Head Temperature, and those sensors work very hard and are swimming in hot coolant, so they can fail and misreport the temperature. GM units can fail so as to make the temp needle swing all over the place while you watch.

Voltmeters, when present, are pretty solid and almost never give trouble. Some platforms have a "Check Gauges" light to get the driver's attention when he or she isn't watching the panel and something drifts into the danger zone. Chrysler has had that for decades, and now Nissans have a warning triangle that illuminates for the same reason.

With today's clusters, even the mildest oxidation on terminals can cause gauge anomalies. On some late-'90s/early-2000s Jeeps, we had to remove the instrument cluster and clean those tiny pins even though they didn't look dirty in order to get the cluster to stay alive.

There was a time when gauges could be replaced separately within the cluster, but those days are just about gone. Once again, you'd better have a pass through programmer if you plan to replace the cluster on most late model high end vehicle GM instrument clusters are some of the most notable that are prone to fail and they, like so many others nowadays, have to be flashed when installed. **ZZ**



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

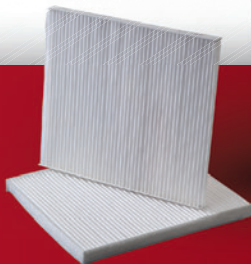
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MANAGING

Ever watch the spy movies where the good guy spots the laser triggers with smoke? You can spot smoke using a laser, too.

THE EVAP MAZE

SUCCESSFULLY SOLVING ONE OF THE TOP 10 MOST COMMON DTCS.

BY **DAVE HOBBS** | CONTRIBUTING EDITOR

Evaporative emissions (EVAP) systems have been around since the early 1970s. When an emission system has that much tenure on a vehicle, you would think diagnosing problems would be easy. Creating a great degree of frustration is the over proliferation of unique systems that work in various manners requiring a wide variety of diagnostic approaches. The names and types of systems boggle the mind: Intrusive, Non-Intrusive, ENOV, NVLD, DM-TL, LDP, EISM and on and on.

It all adds up to a frustrating path that reminds me of one of those hedge row or corn mazes that cause even the smartest explorers to get lost in their complex choice of paths to follow. But it doesn't have to be a maze of confusion.

Keeping It Simple (KIS)

There seem to be as many different types of EVAP systems as there are vehicle models on the road today. But it boils down to three things: knowing the system, knowing the EVAP (Diagnostic Trouble Codes (DTCs) and knowing your EVAP diagnostic equipment.

Knowing the system you are working on always is first and foremost to success in diagnosing anything on a vehicle. Pre-OBDII days saw a plastic canister of activated charcoal in place to perform the process of the adsorption of fuel vapors in the fuel tank. Adsorption of vapors is a process somewhat comparable to the more common term "absorption" of liquids. But remember the vapor adsorption process is limited (an EVAP canister can hold only so much) and creates heat.

Because a canister is not simply a plastic box filled with charcoal, it's easy to appreciate how potholes and off-road driving can take a toll on them. Internal fractions can allow the charcoal to escape into the purge line. If the spring gives up the ghost or breaks, charcoal particles will have too much space between them and will move around and become pulverized.



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Inside that more complex than you might have imagined canister also might be an enormous amount of dirt and sand if the fresh air filter has been neglected. This will cause the canister to be restricted for proper purge flow. One Asian OEM had a Technical Service Bulletin (TSB) that instructed technicians to remove the canister and weigh it on a scale as part of a diagnostic process. A canister too heavy (from dirt) meant it's time to replace.

Because the canister can hold only so many vapors, the Engine Control Module's (ECM) job is to control the EVAP purge solenoid. Part of the "maze" of EVAP diagnostics is the ever-changing terms that apply to various components that essentially do the same job. While GM calls the solenoid that controls purge operation a canister purge valve, Toyota might call it a VSV (Vacuum Switching Valve) and Ford may call it a VMV (Vapor

Management Valve). Thinking generically, just call it the "Front Door."

If there is a front door to allow vacuum into the canister, there must be a "back door" to allow fresh air to move through the canister in order for the canister to release the vapors it stores. Along with the fuel tank, filler neck and gas cap, we see that every EVAP system has all of these items in common somehow.

From the beginning of computer controlled engine management days in the 1980s, the ECM would apply a varied Pulse Width Modulated (PWM) duty cycle to the front door, and upon assumption that there were vapors in the canister to be burned in the engine, backed off the base pulse width in order to compensate for those burnable vapors and maintain a stoichiometric mixture. Early OBDII systems called "non-enhanced" went beyond this compensation to test for actual operation, with a purge vacuum switch and/or an ECM algorithm that allowed for O₂/Short Term Fuel Trim (STFT) to determine if the all components were doing their jobs.

Called a Loaded Canister Test, the typical ECM approach is to gradually ramp up the purge valve duty cycle while watching STFT for excessive shift due to the hydrocarbons (HC) being pulled from the canister. If the ramp up of purge is too fast (ECM not seeing much difference in trim numbers), the conclusion is an insufficiently loaded canister. Today's ECMs still might do this purge test, though it's unclear exactly which manufacturers (if any) still are running this test with enhanced systems.

On some vehicles today, if the canister no longer is effective, a DTC may or may not set. Some of the early OBDII non-enhanced systems such as those found on GM used a purge switch to give the ECM feedback that purge vacuum was being applied to the line running to the canister. So there was only the potential for flow codes, as these systems had no ability to detect leaks.

How And When

How EVAP system on board leak testing works can be broken down into two categories: pressure and vacuum. Pressure systems are mainly the Chrysler LDP (Leak Detection Pressure) and DMTL (Diagnosis Module Tank Leakage) systems used in BMW, Mazda, Land Rover and Kia. Vacuum systems are almost everything else.

Vacuum systems have been around since the beginning of enhanced EVAP systems and a front door (normally closed purge solenoid), a back door (normally opened vent solenoid) and a Fuel Tank Pressure (FTP) sensor are all that is required for leak detection operation. The FTP sensor on GM is biased at ambient pressure (sea level) at 1.5 volts with positive pressure pulling the sensor lower and negative pressure (vacuum) pulling the voltage above 1.5 volts.

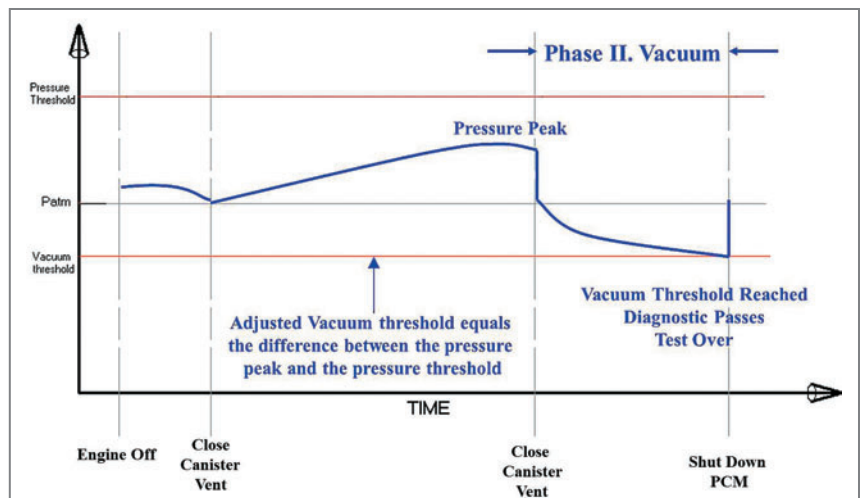
Ford's FTP is just the opposite, with pressure causing a move up the voltage scale from its 2.5 ambient pressure starting point and voltage running lower than 2.5 volts when vacuum is sensed in the system. Typical leak detection monitors require quite a bit of enabling criteria in hopes of avoiding



You can get better smoke and pressure flow by optionally removing the left-hand thread Schrader valve in the test port.



Smoke is emitted for a few minutes at a time on this machine before timing out. Be sure to follow OEM recommendations for using CO₂ or nitrogen for system testing to avoid fire/explosion hazards.



This chart shows the process used by GM's EONV system for leak detection.

Photo: General Motors

false codes. And being a two trip code, it's no wonder that EVAP monitors are the hardest monitors to run.

The leak test portion of the monitor requires an initial look at the voltage when the front door (purge) is opened along with the back door (vent) being open to determine flow problems. A slight vacuum is expected to occur. When vacuum is introduced into a system with normal restrictions such as the canister and vent filter, there should be a lowering of pressure. Too much means too large of a restriction through the canister and vent filter or something plugging the purge line or even a lack of purge valve operation.

This is followed by a gradually opened front door (purge) and closed back door (vent) to determine if the system can create a vacuum or drop in pressure within the system. If we can't pull the system down in the purge/system seal mode, then there must be a gross leak.

Finally the front door (purge solenoid) is closed to see if the vacuum we created with a sealed system during purge will hold for a bit. If there is a decay of

vacuum, then there is a leak, which again affords itself to the air conditioning vacuum leak test when the pump is turned off on your RRR machine.

Going forward to the 0.020-inch leak standard, those tests can be misleading (false codes) due to fuel sloshing and fuel temperature changes. This ushered in a host of key off systems during the mid-2000s. Toyota turns on a vacuum pump about five hours after the engine is turned off, first pulling the vacuum through a 0.020-inch orifice inside the vacuum pump and then pulling the vacuum against the closed system.

The whole idea with Toyota is to get the fuel cooled off and thereby stable for pressure testing. If the outside air temp is above 95°F, the wait time could be extended to seven to nine hours. GM's EONV system works with the key off like Toyota, but GM uses an immediate test to capture the pressure increase that occurs with hot fuel in the fuel tank from the previous trip. As the fuel cools, the tank pressure drops, creating a natural vacuum that can be watched for a decay which indicates a small leak.



The Smoke Wizard features a pressure/vacuum gauge, flow meter and flow control.

DTML Systems

DMTL pumps have a built-in DC motor the ECM triggers. The ECM monitors the pump's current draw to detect leaks. The DTML assembly also contains an ECM controlled change over valve the PCM normally opens and closes during a leak test.

The leak test process begins with the pump applying its output of air pressure against a 0.20-inch or 0.40-inch orifice to calibrate what an acceptable leak looks like with pump current. The change over solenoid valve (back door)

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then is energized, which seals the EVAP system and directs the pump output to pressurize the entire EVAP system. If there is a leak larger than the regulatory limit, it will take less current for the pump to run. Smaller leaks or no leaks mean higher current levels and no EVAP leak DTCs. Good connections seem to go a long way in ensuring accuracy and guarding against false codes.

Chrysler LDP Systems

This Chrysler LDP System has been around for many years but seems to be the most misunderstood. The pump uses a 12-volt solenoid that when pulsed by the PCM causes engine vacuum to be applied to a diaphragm inside the pump. As the vacuum is switched on, the diaphragm moves up and down creating a small amount of pressure against a spring that is calibrated to 7.5 in/H₂O. That's not much pressure — a tad more than 0.27 psi. It will expand a balloon a bit, but not inflate it. The LDP pump itself is the gateway to the back door of the system consisting of a remote canister vent air filter.

First the purge is ramped on to clear any pressure and then turns off. Next, the LDP solenoid is energized, allowing vacuum to be applied to the top of the diaphragm, compressing a spring, pulling the diaphragm up. The upward movement creates a slight pressure drop under the diaphragm. The inlet check valve opens, allowing in filtered fresh air.

Next the reed switch opens to tell the ECM the diaphragm is pulled up. The solenoid then is switched off. With pressure equal on both sides of the LDP diaphragm, the spring forces

the diaphragm down, physically closing the fresh air inlet valve and opening the outlet valve that allows the LDP's pressure into the tank/canister. The magnetic reed switch state changes and the solenoid is now re-energized. The diaphragm may only move ¼ inch and then stall out while the solenoid still runs. This is normal.

The ECM looks at the fuel level and figures out how long to run the LDP. The fuller the tank, the less time the pump has to run. Once the EVAP system reaches the spring pressure (7.5 inches of H₂O), the diaphragm simply will stay in the upward position. A timer in the ECM based on fuel tank level starts and switch status is monitored. The longer the diaphragm stays up, the better that EVAP system can seal. Leaks will cause the diaphragm to fall and the switch sense will change back to 12 volts again. The time between LDP solenoid turn off and LDP switch closure is called the pump period. This time period is inversely proportional to the size of the leak. The shorter the pump period, the larger the leak. The longer the pump period, the smaller the leak.

It's all about the tank's fuel level, though. Factory specs greatly vary with the fuel level. If the fuel level sending unit is inaccurate (I bent the float arm), you actually can have a leak DTC set.

Testing LDPs

When testing the system for leaks, you must either activate the LDP with vacuum and an electrical command or pull the hose from the remote vent filter and plug the fitting at the LDP prior to using a smoke machine to create a system seal and look for smoke/leaks. A word of caution should be applied here. Failure to connect your test leads with power and ground to the correct terminals can ruin the LDP's reed switch thereby ruining your diagnosis.

You can test your LDP with a method as simple as moving the diaphragm up with a constant ground applied to the solenoid (with a vacuum source applied to the LDP's manifold vacuum port) to see if you can change the reed switch status (from 12 volts to zero) or you can force the pump to run using the bi-directional controls of a capable scan tool and monitor the LDP solenoid and reed switch sense lines with a dual trace scope. Just don't smoke it and call

it a day. There is much more to this system than just leaks such as the ability to look for a pinched line for proper system flow during LDP operation.

Knowing Your DTCs

There are a wide variety of DTCs associated with EVAP systems and even when the second digit of the DTC is a zero, meaning non-OEM specific that doesn't mean there won't be a slight variation as to what can cause the DTC. Some DTCs are very specific — P0456 might very well be specific meaning a small leak but what about P0440 for an EVAP malfunction? Numerous OBDII tests may run in order to set a particular DTC. These tests are often displayed in Mode \$06 data and described in more detail in the manufacturer's Mode \$06 explanations.

This partial list of OBDII testing strategies for EVAP leaks and flow operation in the description section at the beginning of the appropriate DTC trouble tree are often similar to the following.

Power-up Vacuum Test: A passive test to detect restrictions or blockages in the vent path. When the ignition switch is turned on, the vent solenoid is opened and the purge solenoid closed. The test passes when fuel tank pressure sensor does not indicate a pressure or vacuum with the vent solenoid open.

Small Leak Test: An active test to detect minor leaks. The vent and purge solenoids are completely closed while a vacuum is present in the fuel tank. The system monitors the fuel tank pressure sensor for a vacuum decay rate that is too fast. The head space (area above the fuel) in the tank dictates who quickly vacuum (or pressure on some systems) will leak off. The more the head space (less fuel), the longer the tank should take to bleed off. As stated before, tank level accuracy is super important.

Purge Solenoid Leak Test: An active test to detect a vacuum leak through the purge solenoid. The vent and purge solenoids are commanded closed. If the pressure sensor indicates an increasing vacuum, the purge solenoid is leaking.

Knowing Your Equipment

Beginning with the smoke machine, it's important to remember to not tighten the gas cap prior to testing. You just may have ruined your evidence! If there isn't an EVAP test port, improvise an



Often, you'll need to check the filler neck seal from the cap side due to anti-rollover valves in the tank assembly that will otherwise seal this section off. Remember, most systems test using vacuum, not pressure!

entrance point for your smoke machine. Smoking from the front first can find leaks in the purge line, canister and vent solenoid, but you need to wait for the smoke to fill the tank before there is enough to come out the cap/filler neck.

Is your machine equipped with a flow meter only or pressure/vacuum gauge along with a flow meter? A flow meter is important to help you see how big the leak is. On full function machines with the flow meter and built-in calibration settings for .020 and .040 leak sizes, you will have the ability to induce pressure only into the system while watching the ball in the flow meter. If the ball is floating above the specified leak setting, it's time to add smoke. If the ball is below that setting, don't waste your smoke. The system isn't leaking right now.

Try operating the back door (vent solenoid) using an ammeter (if possible) for 10, 20 even 30 times to attempt to catch the all too common sticky vent solenoids. On machines with pressure/vacuum gauges, the gauge not only shows you how much smoke/pressure you are putting into the system (back door/vent closed of course) but also allows you to look at the vacuum from purge when the engine is running.

Partnering your smoke machine up with your scan tool makes all the sense in the world, especially if the smoke machine has a pressure/vacuum gauge. Commanding purge and while comparing the gauge to the FTP data PID on the scan tool can help confirm accuracy of the FTP sensor. The scanner also might be able to affect a system seal where the purge is turned on, vent closed to pull the EVAP system into a vacuum and then the purge turned off to watch for vacuum decay. If the scan tool PID for the FTP sensor is not available, you can use this gauge to watch for EVAP purge pressure drop and if you are doing a system seal you can watch the machine's gauge to observe vacuum decay on the smoke machine.

All but one brand of smoke machine incorporates a leak detection dye in the special oil used to make smoke, so don't pass up the opportunity to use an UV light and yellow glasses (that came with the machine) to help locate leaks.

Make sure you utilize the flow control knob on machines so equipped to customize the smoke volume to the leak.

Sometimes the leak is too small or too large to find with the full dose of smoke/pressure. Kinking the hose a little can work on machines that don't have the flow control feature. Finally, realize that although smoke will find the majority of leaks, very small leaks may not allow smoke molecules to escape. Combining that with knowing how to use tools you have to the fullest extent of their capabilities will be a great help in keeping us from getting lost in the EVAP maze. *TLZ*



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PLUGGING ALL THE LEAKS

THIS MONTH WE LOOK AT AVOIDING THE RETURN OF THE MIL LIGHT AND TIPS ON LEAK DETECTION.

BY G. JERRY TRUGLIA |
CONTRIBUTING EDITOR

New DTCs appearing after a repair is more common than you might think. The reasons why are several, but the most common are a failure to make sure all the OBDII test monitors are Ready, failure to address pending Diagnostic Trouble Codes (DTCs) and not investigating the cause of Mode \$06 failed test results. Let me provide you with a few examples that will shed some light, while helping you better understand why it's so important to perform a complete and thorough diagnostic procedure on an OBDII vehicle.

The screen captures (Figure 1) are from a 2006 LR3 with a 4.4 L V8 engine that came in the shop with a Mass Air Flow (MAF) sensor P0101 DTC. Along with the code, I found that not all of the monitors had run to completion. While performing my diagnostic procedure on this vehicle, it would have been easy to make the ultimate mistake of getting tunnel vision and just concentrating on the MAF DTC. But by looking at the monitor status, I could see that there were two monitors (the O₂ and Evaporative Emissions (EVAP)) that were listed as incomplete or Not Ready.

The one that I was really concerned with was the O₂ monitor, because the

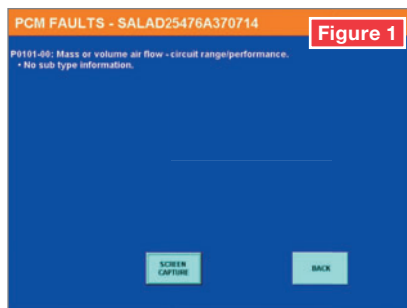


Figure 1

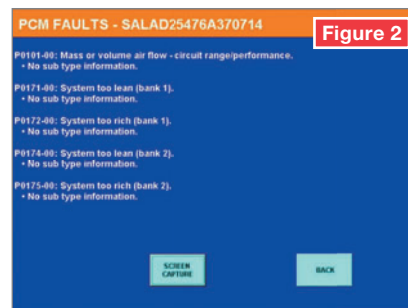


Figure 2

O₂ sensors are used to check other systems on the engine. I looked up the Drive Cycle criteria for the O₂ monitor and that seemed easy enough to run. Before checking or repairing the MAF circuit problem, I took the vehicle for a ride to see if I could get the O₂ monitor to complete.

Because the engine was hot, I knew that the EVAP monitor would not run until the vehicle cooled down, so there was no sense wasting time at this point to even try. The O₂ monitor status can affect the EVAP monitor. It always is a good idea to read up on how the system and components function and interact no matter how many times you may have worked on a particular manufacturer's product line.

We need to know how the Engine Control Module (ECM) is running the EVAP monitor. The O₂ sensors are used to check if the EVAP system is actually purging HC (hydrocarbon, or raw fuel) vapors. There always are checks and balances to ensure the systems function as designed. The EVAP purge valve (normally closed) is commanded open by the ECM, which is looking for a change in O₂ voltage to make sure the

EVAP system is working properly.

After driving the vehicle for 15 minutes and following the drive cycle requirements, the O₂ monitor did not complete. While performing my troubleshooting, I found a few problems that prevented that monitor from running, starting with a cooling system issue. The thermostat, coolant sensor and overflow bottle all need to be repaired or replaced. I installed a new thermostat, gasket, coolant sensor, coolant bottle, level sensor and bled the cooling system. I followed that repair with a check of the O₂ sensors using a labscope, confirming that they were working properly. Now that I knew the sensors were good and all the basics were good, I fully expected the monitor to run, and it did.



With the O₂ monitor Ready, I was able to test the system. Take a look at the DTCs that came up as a result (Figure 2). As you can see, the ECM now displayed five DTCs instead of the one that had been previously displayed. Not only did the monitor confirm the P0101 MAF sensor DTC, it was clear that the O₂ sensors were sensing failing conditions that were ultimately caused by a cheap aftermarket replacement MAF sensor.

Having monitors all run to completion is vital to confirming your repairs and avoiding comebacks caused by codes that appear after your initial fix.

Finding Tough A/C Leaks

A/C season can be a short window of opportunity for some, because not every one of us lives in a warm climate all year long. Most motorists expect their A/C system to keep them cold and comfortable when it's hot outside. So when their A/C system does not function, we get the job of diagnosing the problem. This is one repair that price does not seem to matter as much since the owner just wants to be cool.

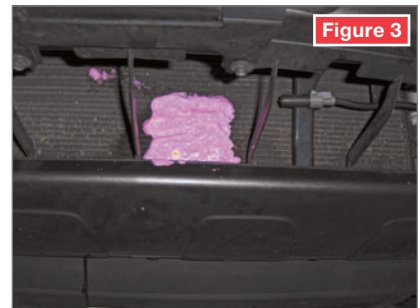
As you know from working on A/C systems, there can be numerous problems causing no cold air from the ducts. Low refrigerant, defective expansion valves or orifice tubes, defective compressors, leaks, contaminated refrigerant or sealant problems are just a few. Most of the time, if you have a good game plan on how to check and diagnosis the system, you can stay out of trouble. The first thing to do is use a sealant detector so you can make sure that your refrigerant identifier and A/C machine do not get contaminated. With that very real possibility out of the way, next check the refrigerant itself with an identifier for the same reasons.

How about A/C leaks? There are many methods for identifying system leaks with all of us familiar with the refrigerant leak detector, fluorescent dyes, ultrasound equipment and nitrogen testing. Even with these methods, finding the really small leaks always is a challenge. Considering how little modern systems hold, finding the little leaks is important to not only making sure our customers stay comfortable, but their system compressors live a long and happy life.

One solution is available from Automotive Test Solutions (ATS). The tester that ATS offers can find the smallest leak in the A/C system and is also useful for finding leaks in nearly any system on the car from EVAP systems to tires.

Here's a great example of a 2008 Acura RDX 2.3L Turbo I recently had with a complaint of poor cooling from the air condition system. The vehicle was brought to the dealer before coming to us because of a recall that matched the owner's complaint. The dealer recall (12-039) is for an A/C compressor extended warranty that addresses poor cooling caused by compressor performance. The vehicle owner was told that the compressor was replaced and fluorescent dye and refrigerant were added.

After the repair, the system was performing well for about a month before it went back to blowing warm air. The vehicle was returned to the dealer and rechecked for leaks but none were located. The system was recharged and returned to the customer. After another month, the owner experienced the same problem, but this time they brought the vehicle to us. We checked the system for the proper amount of R134a and found the system was free of sealant, was 100 percent pure R134a, but that the system charge was low. Our next step was to check the system using a new SAE J2791 leak detection sniffer able to detect leak rates of under ¼ ounce per year, but had no luck locating the leak. We tried checking for signs of the dye the dealer had installed using a black light that works on all dye spectrums, but still could not locate the leak.



We recovered and evacuated the system and used the ATS BullsEye system, pressuring the A/C system with CO₂. CO₂ is a smaller molecule and more easily passes through small holes, making it easier to detect. Using the special leak detector that comes with the kit, we located the area of the leak in the car's condenser. To confirm the small leak, we sprayed the BullsEye foam on the area where the BullsEye detector had triggered. As you can see (Figure 3), the pink foam (area of no leak) reacts with the CO₂ and turns yellow, confirming the leak. A new condenser and receiver drier (one complete unit) later, and this customer's problem was solved. *ZZZ*



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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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FIXING THE FIX

SOMETIMES THE HARDEST FAULTS TO FIND ARE THE MAN-MADE ONES.

BY MICHAEL MILLER | CONTRIBUTING EDITOR

For me, anyways, the hardest diagnostics are for the ones that another person created when fixing an original concern. I would be willing to bet that no one intentionally does something in a repair that will cause a different problem down the road, or even knowingly for that matter. However, it does reinforce the reason to gather information from a customer so we know what previous repairs have been done to a vehicle and keep an open mind. Even if the customer's concern appears completely unrelated to the previous work performed, it just might be correlative.

Now as for customers, it amazes me what lengths people will go to try to sneak by an emissions test instead



A RESETTING MIL

2005 MAZDA MPV

Vehicle Year/Make/Model

3.0L DOHC 24 VALVE

Engine

AUTOMATIC

Transmission

127,773

Mileage

THE MIL IS ON AND WHEN CLEARED, RESETS BEFORE THE CUSTOMER CAN SET ENOUGH MONITORS TO PASS AN EMISSIONS TEST

Vehicle complaint

of repairing a vehicle correctly. The vehicle in particular is a 2005 Mazda MPV that was due for its yearly smog test. According to the owner, for the past two years they have been driving around with the Malfunction Indicator Light (MIL) illuminated for most of the year and then having the code cleared a few days before getting the emission test done and driving about 30 miles to set all but the Evaporative Emission (EVAP) readiness monitor. To pass an emission test in our state requires that there be no more than one monitor incomplete on 2001 and newer vehicles under 8,500 GVRW. It does not matter which monitor is incomplete, unless the vehicle previously failed for a catalyst monitor, then the catalyst monitor must not be the one incomplete. Another point is that pending codes will not cause a failure. So if the code hasn't triggered the MIL on, it will still pass.

So as the customer explained it, for the past couple of years there was always a P0455 (Large Leak Detected) code that could not be repaired. When they would take the vehicle to an auto parts store for a free scan, they would end up being sold a gas cap. Another repair facility, which performed most of the customer's repairs, had looked at the vehicle but said they could not find any leak in the system and recom-

mended an OEM gas cap. The customer stated that there were no repairs other than normal maintenance done recently, but had an oil leak repaired a couple weeks before the MIL illuminated for the first time, more than two years ago.

However, the shop that performed the repairs convinced the customer that the MIL for the EVAP leak was not related to an oil leak repair. I can understand this from the shop's point of view, because the two are completely separate systems and we have all had the "ever since you" type of customers.

There were no records of diagnostics other repair facilities had performed on the vehicle, but the customer assured us that a Google search had shown that a gas cap was the cause for the code even though the first three gas caps proved them wrong. One thing that stood out in the customer interview was that the MIL now would return much sooner when the code was

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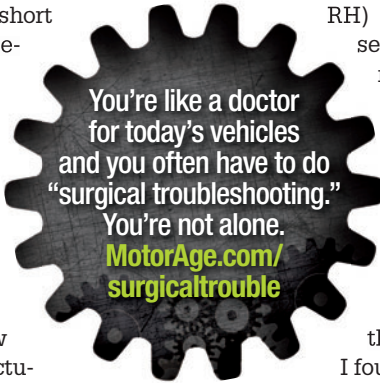
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cleared and driving a short distance, whereas previously, it took nearly two weeks.

Because there now was no chance to set enough monitors to pass an emission test before the MIL reilluminated, the customer knew they would have to actually get the vehicle fixed this time. When a MIL turns back on fairly quickly, it is very unlikely that the cause is an evaporative emissions system fault, especially in an area where summer temperatures rarely are below 100° Fahrenheit.

Starting at the Beginning

Looking at the vehicle code list, I found the P0455 (Large EVAP Leak), but also found a code P0037 (H02S Heater (Rear,



RH) Circuit Low). The O₂ sensor heater test also is not a one-trip failure, but the monitor does tend to run to completion much more frequently, so I started with a quick visual inspection. When I put the vehicle on the lift and inspected the rear oxygen sensor, I found the harness side of the oxygen sensor baking on

the exhaust manifold. It appears that the wiring harness retainer had not been correctly reinstalled and allowed the O₂ sensor wiring to drop down. Easy enough, there was the short to ground, so a new O₂ sensor was put on the repair order.

Now time to diagnose the EVAP system code. I have seen a lot of technicians start to diagnose an evaporative system leak by immediately putting

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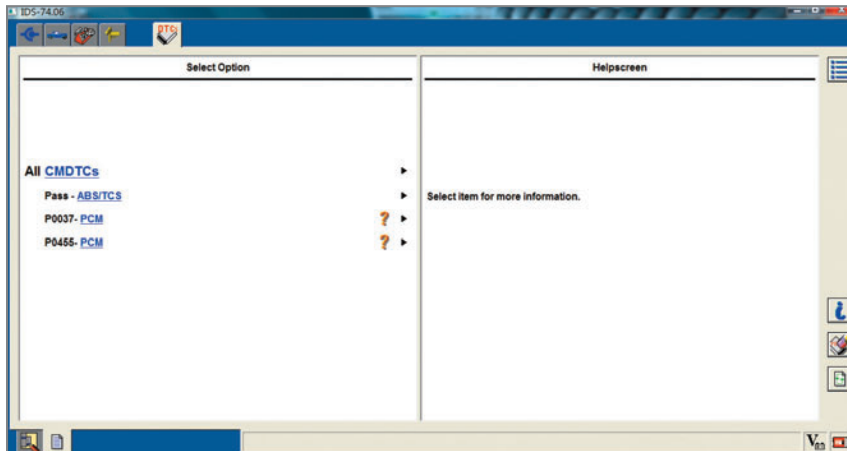


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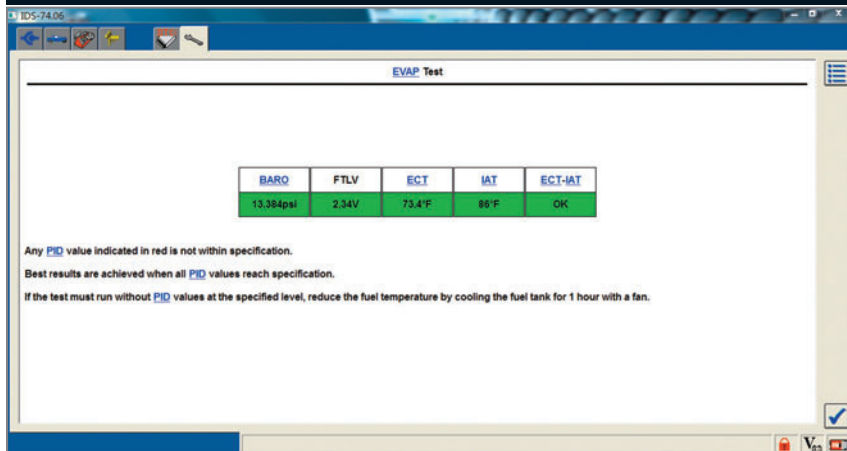
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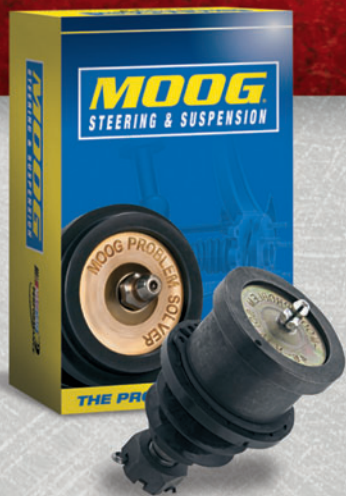


Codes present when vehicle was scanned.



All the relevant PIDs for the EVAP System Test are within specification.

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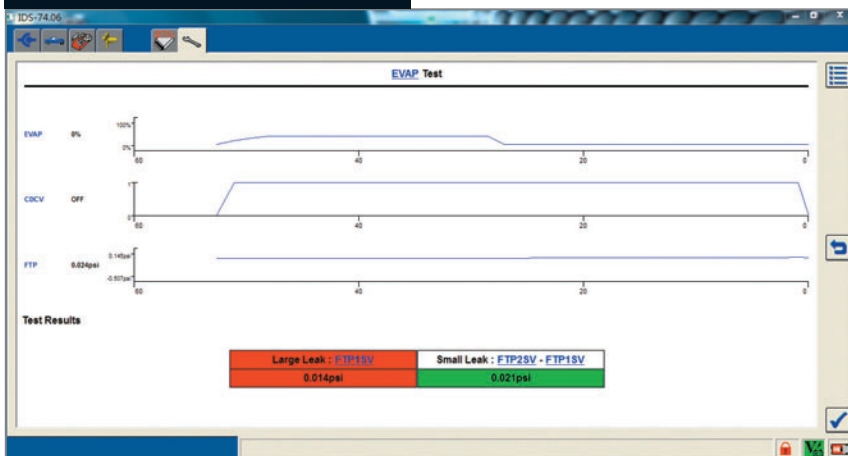


This was the cause of Code P0037 HO₂S Heater (Rear, RH) Circuit Low, the wires fell from the wiring harness retaining loom and melted on the exhaust.

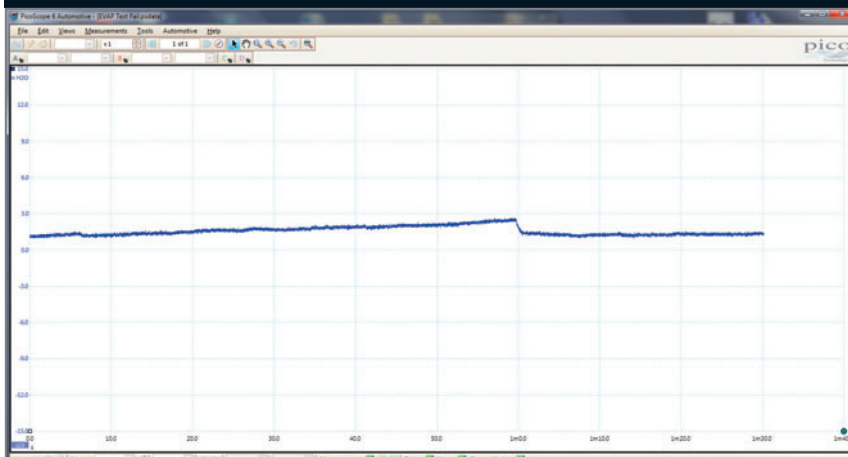
smoke in a system and looking for a leak. Being that this is a large leak, that might not be a terribly wrong thing to do, but I like to verify that I actually have a leak before smoking the system. In all cases though, the first step I take is to visually inspect the system. Sometimes you find a cracked hose or even one that is disconnected, but this vehicle appeared to have everything attached.

As always, it is a good idea to check for Technical Service Bulletins (TSBs) or possible reflashes for the code. Several hours and countless parts have been installed on vehicles when everything was functioning as designed, but an unpredicted variation in a parameter or calibration caused a test to fail.

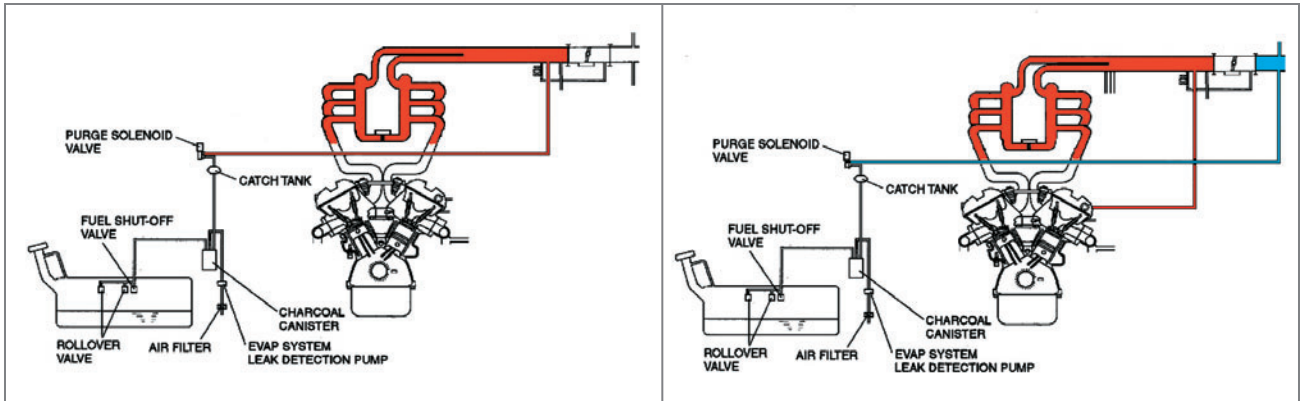
This vehicle uses a Leak Detection Pump (LDP), which, on most vehicles that use it, has a high failure rate. In fact,



The EVAP System Test results show the system does have a legitimate problem, but notice that the Fuel Tank Pressure PID value has very little change over the course of the test.



The pressure transducer image mirrors the fuel tank pressure PID of the IDS EVAP system test. The scaling is in inches of water pressure.



(Left) The EVAP system diagram from ALLDATA shows the correct vacuum routing for the purge valve. (Right) This was how the EVAP system and ventilation hoses were routed, which was causing the system to set a Large EVAP Leak code, even though there really were no leaks in the system.

some techs refer to the LDP as an acronym for "Likely Defective Part." Some manufacturers allow an EVAP system seal through use of a scan tool, which is what I try to use when available to verify both the integrity of the LDP and the command circuitry of the Powertrain Control Module (PCM). On this Mazda Leak Detection Pump, the changeover valve (which is part of the LDP itself) is what seals the vent to the atmosphere.

Because most of the newer EVAP systems are non-intrusive, meaning they do not have a test port, I like to test the system at the hose connection to the purge valve. While I am there, I also attach a MityVac vacuum pump to one side of the purge valve and confirm that it holds vacuum and does not leak down. I then use the bidirectional controls on the scan tool to cycle the purge valve to verify it works and is not restricted. This one passed the test. What I did find when I leak checked the system was that the flow meter ball dropped to the bottom of the gauge, indicating that the system was sealing.

Now what? The code states that I have a large leak, so that should be easy to verify since it sets every time the EVAP monitor is run. At this point I am trying to rationalize a replacement of the Leak Detection Pump, since maybe it is not sealing completely when the test is run. As for service information and theory of operation of the Mazda LDP, there isn't a lot. The only tests listed are an air resistance test, which is basically blowing from LDP port A to B and then from B to A to make sure there isn't anything blocking the component. Then there are electrical resistance tests. I'm thinking if there was an

electrical problem with the LDP a different code would have been set.

Failed Test, Sealed System?

My service information source listed several possible causes for this code:

- Loose or defective fuel cap
- LDP Malfunction
- Purge Valve Malfunction
- Fuel Tank Malfunction
- Charcoal Canister Malfunction

- Loose or disconnected vacuum hose
- PCM Malfunction

Time for a different diagnostic approach, probably the one I should have used from the beginning. This vehicle has the benefit of the EVAP system monitor test available as a functional test on its scan tool.

Starting the test, the scan tool verifies that certain parameters are in range, including the vehicle's fuel level



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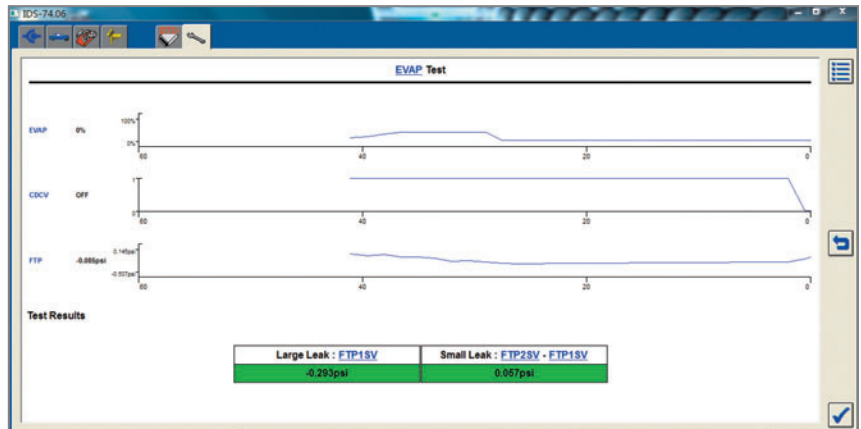


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(15 to 85 percent full) and a check to make sure the Intake Air Temperature (IAT) and Engine Coolant Temperature (ECT) difference is less than 15° F. The next step was to bring the vehicle up to operating temperature, the scan tool states to raise the engine rpm to 3,500 for three and a half minutes. Finally, the PCM takes over the EVAP system test by controlling the throttle opening to around 2,000 rpm while it performs the self-test.

The results of the EVAP system test verify the illumination of the MIL. The PCM believes there is a large EVAP leak somewhere in the system. However, one thing that I noticed was the Fuel Tank Pressure (FTP) Parameter Identifier (PID) was flat during the entire test. When the purge valve opened, engine vacuum should have been introduced to the evaporative system and I should have seen a negative pressure displayed on the Fuel Tank Pressure PID.

Could this be a defective Fuel Tank Pressure Sensor that is not correctly measuring the pressure change?



Running the EVAP system test after correcting the hose connections shows the system was now operating as designed.

Well, it's not the easiest component to get at for testing, so let's try another approach.

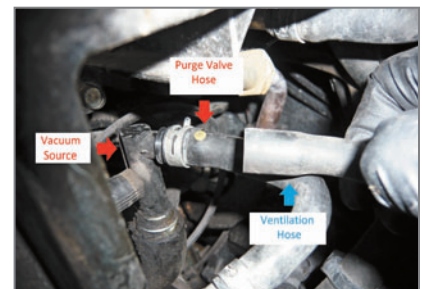
Someone's Lying

I attached a Pico WPS 500X Pressure Transducer to a fuel cap smoke adaptor to measure the true pressure in the fuel tank. Through the Custom Probes feature on the Pico Scope, I set up the

scaling to read in inches of water, the same pressure scale used by the PCM.

Running the EVAP system test again, I find a mirror image of what the FTP sensor displayed during the initial test. The test took a total of a minute and a half and showed virtually no change in the evaporative system pressure. The purge valve was opening and closing, so why would vacuum not reach the tank, unless there was no vacuum to begin with.

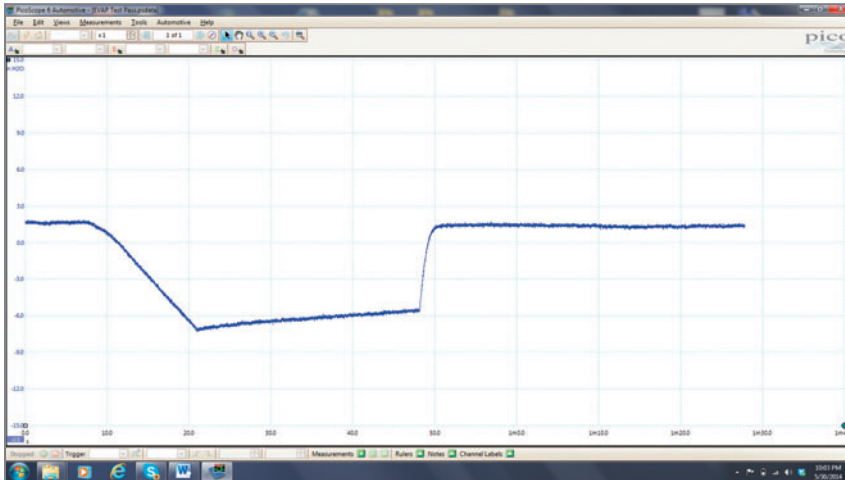
I tested the source of vacuum at the purge valve and found that vacuum read 0 in/Hg. I traced the vacuum line going to the purge valve and found that it actually came from the air intake boot on the atmospheric side of the throttle body. Well, that can't be right and certainly explains the lack of manifold vacuum to the purge valve. I used the EVAP Vapor and Vacuum Hose Diagrams in the service info and found that the hose with the vacuum source was supposed to be routed to the rear cylinder head cover. Apparently, when the hoses were disconnected to access



It was easy to see how the hoses could have gotten mixed up. They were both the same diameter and had the same length at the vacuum attachment.

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The scope capture of the Fuel Tank Pressure during the passing EVAP test shows the system reaches the target vacuum level quickly and also has very little change during the sealing portion of the test.

and replace the valve cover gasket on the rear cylinder head they were not reconnected to their correct locations. An afterthought of this had me wondering if the direct vacuum to the rear cylinder head cover ventilation port could have caused any engine running concerns. While I did not take notice of fuel trim readings on the scan data for this type of code, I did not notice any drivability issues of the vehicle while bringing it inside, nor had the customer mentioned any.

Looking at the two hoses, I can see where the mistake could have been made. They are the same size and also both line up easily with the position of the purge valve. It is hard to see exactly what I am referring to in the actual picture of the hoses on the vehicle, so I included the correct purge valve and ventilation system hose routing diagrams along with one that shows how the hoses were connected which was causing the failure. I swapped the hoses to their correct locations, cleared the codes and reran the EVAP system test.



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Michael Miller lives and works in Las Vegas. He is an ASE certified World Class Technician with more than 50 current certifications. He holds a degree in mechanical engineering and is currently completing a second degree in automotive technology.


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This time the system showed a pass on the large leak test. I also had the WPS500X attached during the test and noted the results. Notice that after the test starts, it takes only 20 seconds to reach the target vacuum of -7.5 in/H2O. I have found that when performing this test on newer vehicles, the scan

tool actually monitors target vacuum, so a fault like this one would have been more apparent. The next section is the Bleed Up portion of the test where the size of the leak is determined. This took approximately 30 seconds and the system lost less than 2 in/H₂O. Finally, the Leak Detection Pump released the vacuum and the PCM processed the results. One very nice feature of this test was that it gave results on the before and after repair that we can share with the customer.


While this was not a complicated repair, the diagnostics to find the problem were not found in any of my available information resources. Had I followed the diagnostic flow chart steps in order, I would have inspected the hoses for poor connections to the purge valve, but would have never checked the actual source vacuum at the purge valve. Too often we convince ourselves that a failure must be due to an electrical circuit or a component itself and we overlook items as simple as source vacuum. **ZZ**

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PIAA-USA has introduced two kits for mounting LP530 LED lights in 2014 and 2015 Toyota Tundra pickup trucks. These kits allow for the installation of PIAA's LP530 LED lights, and feature the Reflector Facing Technology (RFT). The LP530 lights come in either 20-degree driving pattern or 70-degree SAE-compliant fog pattern. Each kit includes all the parts needed to install a pair of PIAA's LP530 LED driving lamps (part No. 5362) or LP530 LED SAE fog lamps (part No. 5360). Each kit includes a pair of PIAA LP530 driving or fog lamps, two mounting brackets, wiring harness and mounting hardware, along with simple installation instructions, the company states. MSRP for each kit is just \$379. These kits from PIAA have been specifically engineered to replace the dim OEM lamps in the bumpers of the new Toyota Tundra. These new LED kits provide roughly three times the light output of the stock lights, and feature easy installation, which gives the front of the vehicle a premium LED look, the company states. They are also easily installed in trucks that were produced with no OE lamps in the bumper, requiring only the addition of factory bezels readily available from any Toyota dealer. Plus, these kits offer truck owners the choice of driving or fog lamps depending on the nature of their night-time driving.



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The video display starts right in the balance page, so no selection is necessary and all the required balance functions are on the main screen. In addition, the fast spin cycle provides accurate measurement with minimum cycles for fast results. Other unique features of the Hofmann geodyna 3900S include the Smart Sonar that simplifies parameter entry and the patented Virtual Plane Measurement (VPM) for precise measuring. The 2D SAPE inner data set arm automatically enters distance and diameter and a wheel guard sonar sensor automatically measures wheel width.

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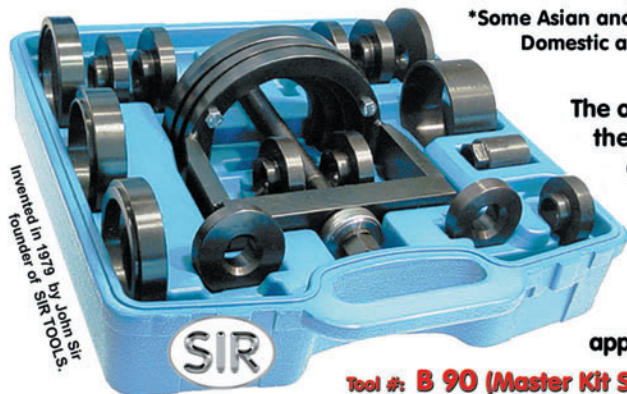
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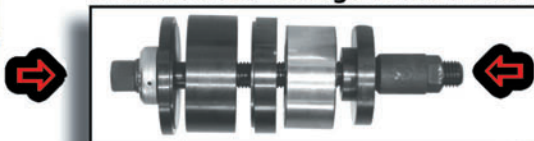
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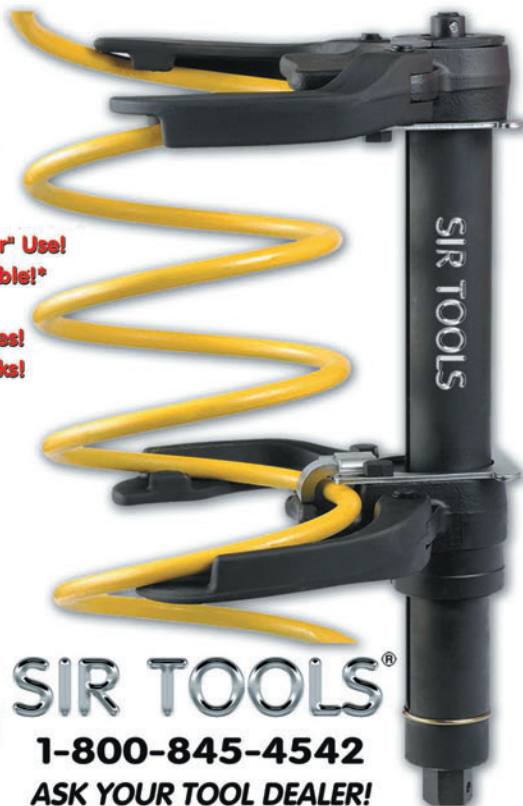
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ADVERTISING AND EDITORIAL PRODUCT INDEX

ADVERTISER INDEX.....PAGE

<input type="checkbox"/> ADVANCE AUTO PARTS.....	50, 51, 86, 70
<input type="checkbox"/> AFLAC INCORPORATED.....	23
<input type="checkbox"/> AIRTEX PRODUCTS.....	18-19
<input type="checkbox"/> ALLDATA LLC.....	45
<input type="checkbox"/> AUTOMECHANIKA.....	48, 49, 77
<input type="checkbox"/> AUTOMOTIVE MGMT. INSTITUTE.....	44
<input type="checkbox"/> AUTOMOTIVE TRAINING INSTITUTE.....	83
<input type="checkbox"/> AUTOZONE INC.....	30-31
<input type="checkbox"/> BENDPAK INC.....	33, 34, 63, 64
<input type="checkbox"/> BILSTEIN.....	10
<input type="checkbox"/> BOSCH AUTOMOTIVE SERVICE SOLUTIONS.....	21
<input type="checkbox"/> CARQUEST CORPORATION.....	3
<input type="checkbox"/> CARTER FUEL SYSTEMS LLC.....	7
<input type="checkbox"/> EASTERN MANUFACTURING/TRI D.....	85
<input type="checkbox"/> ENERSYS/ODYSSEY.....	55
<input type="checkbox"/> FEDERAL MOGUL CORP. - FEL PRO.....	8, 67
<input type="checkbox"/> FEDERAL MOGUL CORP. - MOOG.....	38, 39
<input type="checkbox"/> FEDERATED AUTO PARTS DIST.....	27
<input type="checkbox"/> FORD MOTOR MEDIA.....	61
<input type="checkbox"/> HENNESSY INDUSTRIES.....	57
<input type="checkbox"/> HOMAK MANUFACTURING.....	43
<input type="checkbox"/> IDEMITSU LUBRICANTS AMERICA CO.....	87
<input type="checkbox"/> INTERMOTOR/SMP.....	71
<input type="checkbox"/> INTUIT.....	17
<input type="checkbox"/> ITW GLOBAL BRANDS.....	CV2
<input type="checkbox"/> JS PRODUCTS.....	79
<input type="checkbox"/> KIA MOTORS AMERICA.....	37, 72, 75, OTR
<input type="checkbox"/> KYB AMERICAS CORP.....	29
<input type="checkbox"/> LAUNCH TECH USA INC.....	59
<input type="checkbox"/> MOVING TARGETS.....	25
<input type="checkbox"/> NAPA.....	15, 41, CVTIP
<input type="checkbox"/> NGK SPARK PLUGS (USA).INC.....	69
<input type="checkbox"/> NUCAP INDUSTRIES.....	88, 89
<input type="checkbox"/> O'REILLY AUTO PARTS.....	CV3
<input type="checkbox"/> PHILIPS AUTOMOTIVE LIGHTING.....	42
<input type="checkbox"/> RED KAP.....	53
<input type="checkbox"/> ROTARY LIFT.....	81
<input type="checkbox"/> STANDARD MOTOR PRODUCTS.....	47
<input type="checkbox"/> TECH SMART/SMP.....	11
<input type="checkbox"/> TENNECO AUTOMOTIVE BLDG-MONROE BRAKES.....	5, 73
<input type="checkbox"/> WD-40 CO.....	9
<input type="checkbox"/> WORLDPAC.....	CV4

EDITORIAL PRODUCTS.....PAGE

EnerSys Corp.....	90
CTEK Power.....	90
SuperSprings International.....	90
CRC Industries.....	90
Donaldson.....	90
PIAA-USA Corporation.....	91
ATP.....	91
Royal Purple.....	91
Snap-on.....	91

APG.....PAGE

Hunter Engineering.....	93
NAPA.....	93
BOLT ON TECHNOLOGY.....	94
Gumout.....	94
Ranger Products, a division of BendPak Inc.....	94
Advance Auto Parts Professional.....	94
Federated Auto Parts.....	94
Standard.....	94
Magneti Marelli.....	94
WORLDPAC.....	94

ARTICLES.....PAGE

iATN membership exceeds 80,000.....	6
Automotive Management Institute turns 25.....	6
Honest-1 introduces 'revolutionary' warranty.....	10
TST, ATSG, ATTS join Automechanika Chicago.....	10
Professional talk when it comes to today's techs.....	12
Best of the blogs, videos and discussions.....	12
Q&A with Mike Bailey, Oklahoma City shop owner.....	14
Management: Selling the value of service over price.....	16
Profit Matters: The secret to selling maintenance.....	22
Financial Figures: Searching out a coach.....	26
Shop Profile: Doing the right thing.....	32
POWERTRAIN PRO: Exploring more of the DSG world.....	36
Undercar: SKYACTIV: Keeping the zoom in Zoom-Zoom.....	46
ATSG Manual: Finding the differences.....	56
Drivability: Compounded human errors.....	60
Electrical: Needles and numbers.....	68
Underhood: Managing the EVAP maze.....	76
Scope & Scan: Plugging all the leaks.....	82
Motor Age Garage: Fixing the fix.....	84
The Trainer: Diagnostics and your senses.....	96

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DIAGNOSTICS AND YOUR SENSES

YOU WERE BORN WITH SOME OF THE BEST TOOLS YOU'LL EVER OWN.

BY **PETE MEIER**
Technical Editor

Who among us doesn't recognize that "rotten egg" smell from the exhaust as an indication of an overly rich mixture? Or that sickly sweet smell from the interior vents that surely means the heater core is leaking coolant? The senses we use in every day diagnostics are not limited to smell. We touch air conditioning lines and coolant hoses, we visually inspect for damaged components and we listen to distinguish which bearing is making all the commotion.

Of all the senses we use as technicians in every day diagnostics, hearing is one we tend to rely on the most for isolating the exact location of problem areas. We bend over the hood with cocked heads to pinpoint which lifter is ticking, which injector is not and I'm sure I can list several more examples. Learning what "bad" sounds like takes time and a little bit of mentoring from technicians who've already added the wayward noises to their internal libraries.

But even the most experienced of us sometimes need a little help in distinguishing the noise's ultimate source. Do you still use the extra long screwdriver held to your ear as one means to magnify the source? I do!

If I want to get an even cleaner audio signal to hone in on and identify, I grab a mechanic's stethoscope. Similar to the physicians stethoscope, the mechanic's version uses an aluminum rod connected to a diaphragm that in turn



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is connected to clear plastic tubing terminating in two ear pieces that help isolate outside noises while magnifying the noise being transmitted through the rod.

But what about those problems you can't identify using these old and tried methods? In this month's edition of The Trainer, we'll show you one of the latest ways to identify noises, their locations and causes using the new Steelman PRO SmartEar.

The Trainer is our monthly how-to video series. You can find more in the AutoPro Workshop. We aim to offer information technicians of all skill levels can use to better their services in the

bays. Let us know if you have a topic you'd like to see more information on. [TZ](#)

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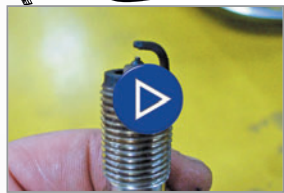
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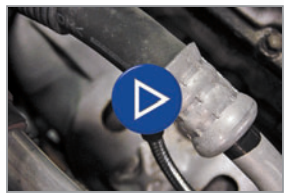
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