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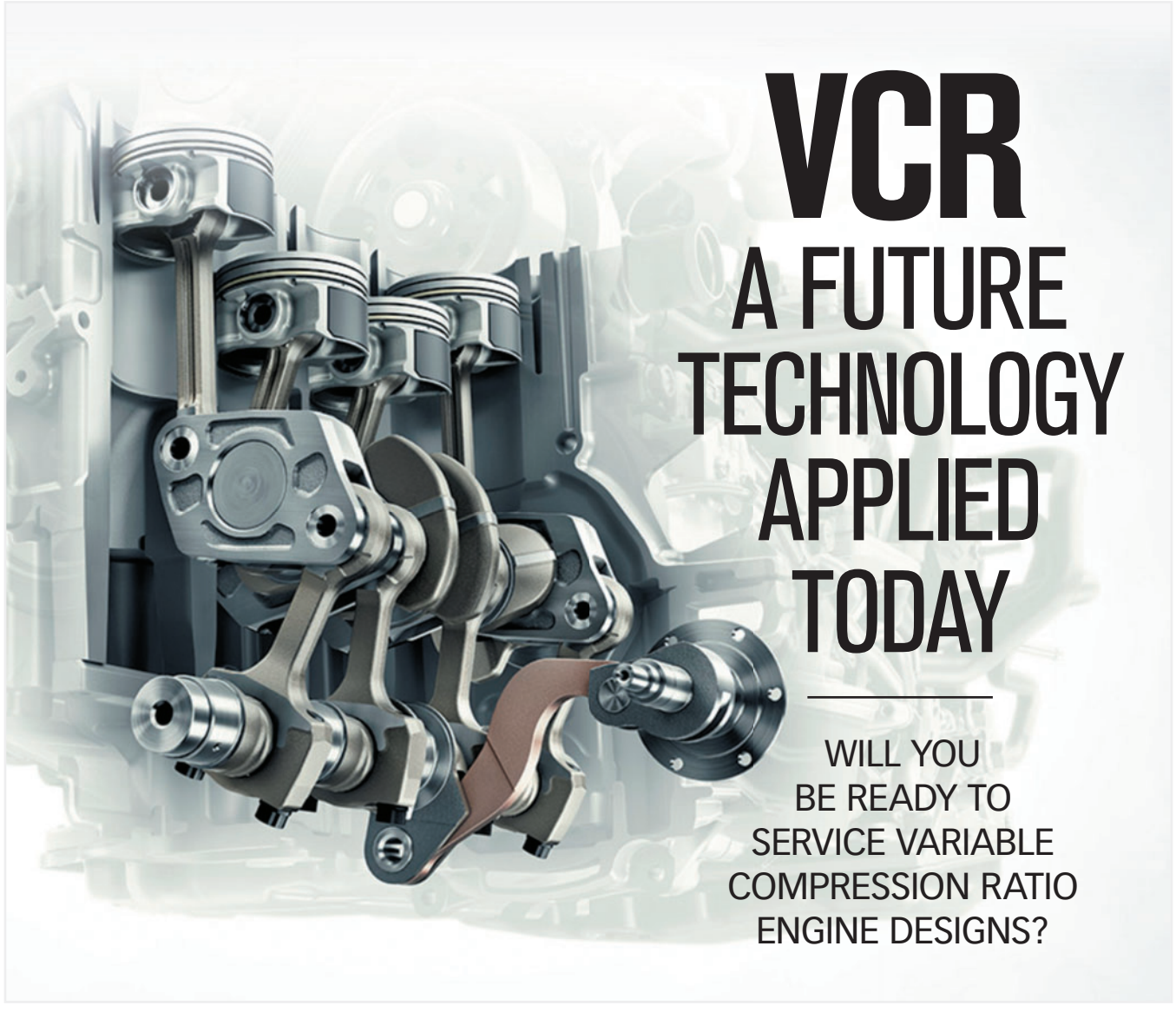

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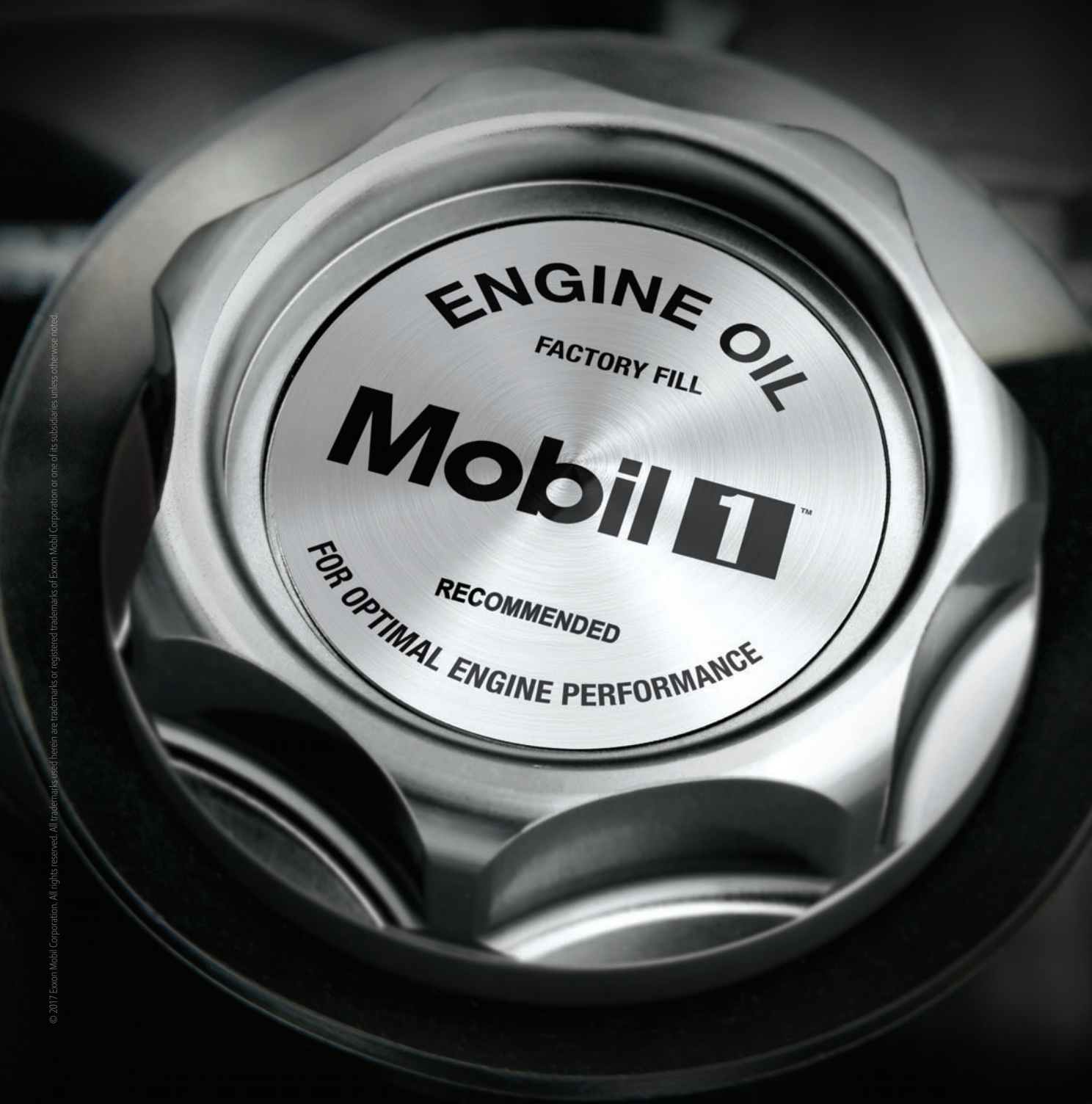

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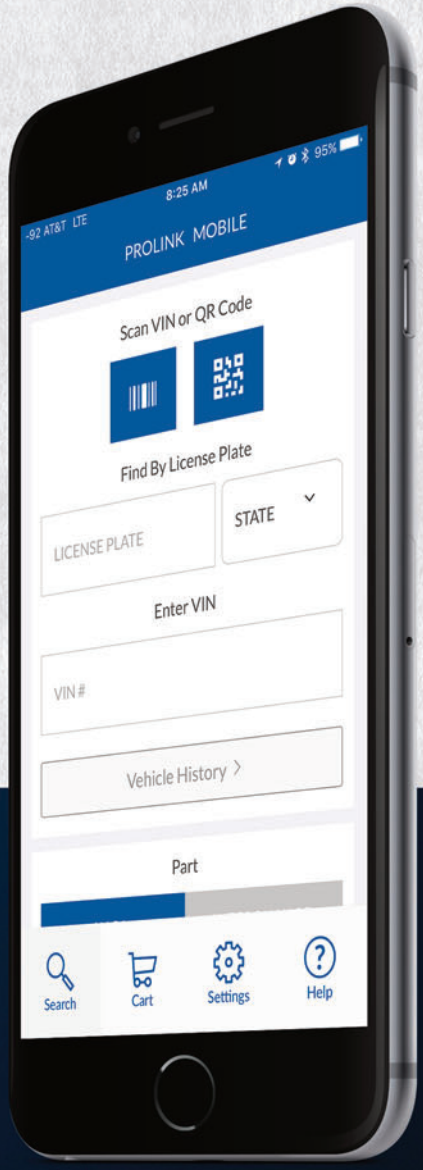

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EDUCATION

CONSUMER PURCHASES PUSH MORE EV TRAINING OFFERINGS

JAMES E. GUYETTE //
Contributing Editor

Mindful of a steadily growing influx of hybrid and plug-in electric vehicles, governmental and private-sector educators are expanding the amount of available industry EV training to meet the demand for knowledgeable parts and repair personnel.

Numerous courses already are available, and new programs continue to be developed as EVs become more prevalent and previously new cars come off warranty.

Backed by the Bill & Melinda Gates Foundation's OPEN+ Platform (Open Professionals Education Network) and

>> EVS CONTINUES ON PAGE 6

BREAKING NEWS

INDUSTRY TRAINING

ASA OFFERS SESSIONS AT ANNUAL MEETING

The Automotive Service Association (ASA) has announced its lineup of instructors for the May 3 training sessions at the 2018 Annual Business Meeting.

Scheduled for May 2-4, at the Walt Disney World Swan & Dolphin Resort Hotel in Orlando, the Business Meeting will feature two half-day sessions on Thursday, taking place simultaneously from 2-5 p.m. The classes are approved by the Automotive Management Institute (AMi), and students can earn six credits per class. The Thursday sessions include:

- "New for 2018: 6 Tips for Making Better Decisions," by Maylan Newton, CEO of ESI, which is designed to teach shop owners and their staff the techniques of developing better decision-making skills.
- "Embracing Change: Take the Fear Out of Change and Establish a Mindset of

>> ASA CONTINUES ON PAGE 6

TRENDING

HOW MOBILE DIAGNOSTICS CAN IMPROVE BUSINESS

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Faith Eberhardt, office manager at Carport Automotive, is the winner of a 2017 Buick Enclave through the ACDelco Ride, Race, Rewards Sweepstakes.

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>> EVS CONTINUED FROM PAGE 4

the U.S. Department of Labor's Trade Adjustment Assistance Community College & Career Training (TAACCCT) program, the National STEM Consortium (NSC) is a collaborative effort among 10 colleges in nine states to create a series of curriculum offerings that include comprehensive EV training.

With funding from the National Science Foundation, the Center for Advanced Automotive Technology (CAAT) — a partnership between Michigan's Macomb Community College and Wayne State University — is among more than 40 Advanced Technological Education Centers located throughout the country.

In California, where EVs currently comprise about 5 percent of the state's car parc (No. 1 in the U.S. with ambitious future growth goals promulgated by the governor's office), the Cleanetch Institute's 16-week Certified Electric Vehicle Technician Training Program (CEVT) has extensive instruction offerings.

The process of converting classic internal combustion vehicle models into EVs has proven to be particularly popular among the students.

"We are on the cusp of massive changes," says Michael Bream, owner of EV West in San Marcos, Calif. The company has 12 employees, including a staff of six engineers who design vehicle-specific EV conversion procedures, a shop area where conversions are conducted, and a wholesale/retail lineup of EV parts & accessories along with charging station components.

"We adjust along the way," says Bream of his EV SKUs. Originally aimed at outside-of-the-box do-it-yourselfer enthusiasts, "as we've moved along we've realized that this is a business-to-business thing" patronized by professional repairers and EV conversion shops.

His clientele includes David Benardo, the proprietor of Zelectric Motors in San Diego who converts vintage Volkswagens and Porsches into EVs. Benardo's shop handles the exterior and exterior restoration aspects and then facilitates and subcontracts the powertrain portion in cooperation with EV West.

"We have a lot of people who are fascinated by our business model," according to Bream, who encourages ICE aftermarket entrepreneurs to embrace the EV evolution — especially as it pertains to executing EV conversions.

"It's future-proofing for your business," he says, offering free advice with the goal of fulfilling your need for parts. "If someone opens a shop just like mine, I will help them. I have a four-year wait at my shop, with deposits already made, to have a car converted. The most important thing is there's no competition" as these types of do-it-for-me jobs remain a rarity and you'd be entering a field that bodes well for a heightened level of acceptance.

Overcoming the trepidation of entering into a new marketplace can be achieved by obtaining education and experience. "There was fear and anxiety when fuel injection came out," Bream recounts. "If you can make the leap from carburetors to fuel injection, the leap to EV conversions is like a small step."

Just do it

Colleges and vocational schools are certainly acceptable resources, but Bream is fonder of on-the-job experimentation and refinement. "Education is education, but the best education is just doing a seat-of-your-pants conversion," he suggests.

"I'm a hot rod tuner, and I cruise around with a laptop. My dad is a hot rod tuner, and he cruises around with a timing gun."

As part of an engineering college project, Bream and his classmates were tasked with inventing an electrically powered boat. He took to the assignment like a duck to water, so-to-speak, and upon graduation he constructed an EV land-racer. "I bought components and built a race car; that's how I got into it. I had no clue — I just did it."

Thus for "absolutely, positively car guys," venturing into serving the EV segment is quite a doable endeavor for you and your staff. "I will not hire a computer guy," Bream declares. "I'll hire a car guy who knows computers. It's easier to teach a car guy about electronics than it is to teach an electronics guy about cars."

Although there may be some customers interested in a conversion "because his wife can't stand the smell" of ICE exhaust fumes, the best prospects for implementing a viable EV bay is in an upscale neighborhood with a progressive-leaning, environmentally friendly population.

"You're not going to have a lot of (financially strapped) college students doing this, and you probably won't have many customers for this in the Texas oilfields."

>> ASA CONTINUED FROM PAGE 4

Improvement," by Richard Flint, chairman and CEO of Flint Inc., which will explore the four-phase timetable a shop goes through toward self-destruction if it is not willing to implement change. The course also will offer specific steps shop owners must take to open their mind to improvement.

Registration is now open for ASA's 2018 Annual Business Meeting. To register or learn about additional activities planned for the meeting, go to www.asashop.org/annualmeeting.

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CALCULATING LEADERSHIP IN TODAY'S MARKET

New school artificial intelligence + old school measurement = modern shop management

DAVID ROGERS // Contributing Editor

In mid-2017, Audi announced its new A8 would be fully self-driving up to 40 miles per hour. Nissan is following suit with a full range of driverless vehicles by 2020.

Meanwhile, robots are performing surgery, computers are diagnosing cancer, and in late 2017 the news media began running articles and commentary on the ability of machines to replace teachers in the classroom.

Welcome to a world driven by Artificial Intelligence, commonly known as AI, where computers can learn and do problem solving. The technology that helped a computer beat a Grand Master at chess in 1997 is now helping drivers automatically parallel park their cars and avoid accidents, and will soon help drivers get around town without touching the steering wheel.

Being able to service this technology is critical for technicians, of course, and continuing training and education will be critical for survival in this industry.

But that's not the point of this article.

Embracing change

Change has always been a way of life for technicians. Bluetooth is replacing cables and hoses just like sensors and

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computers replaced the carburetor. Technicians already know they need to keep learning.

The real change is coming for owners. For every early technology adopter, there are two more owners still doing tickets by hand, relying on word of mouth and comfortable with just getting by.

In this new world, teachers, drivers and surgeons are slowly being replaced by algorithms, and shop owners are unlikely to be the exception to the rule. If we don't hurry up and use the tools and technology available to us to run our shops, somebody else will use that same technology to take our shops.

The mountain in front of us

A 2017 industry-wide survey conducted by a national automotive industry resource found that a full 32 percent of shops do not regularly track their important benchmarks. Of those that are regularly tracking, a full quarter of shop owners aren't measuring the efficiency of technicians — a basic metric of measuring a team.

And, these numbers are worse than 2015! The industry could see and smell the smoke back in 2015, and rather than extinguish the problem, we decided to wait for the fire to burn itself out.

Even on the surface, this is a monumental problem. It is not less expensive now to operate a shop than it was two years ago, and will not be less expensive two years from now. Ignoring business metrics even in the best of times is suicide.

But this is far from the best of times for the independent shop owner.

I started off this article by talking about AI. Let me use it to bring this point straight to home.

In late 2017, an article I read on a blog called "Medium" shined a light on a program that major cell phone companies created. Those companies are selling real-time data about you — your number, your provider, your address, plan type, type of phone and even current location — to purchasers.

Granted, your cell phone plan may not reveal a lot about you. But when it's combined with information about the vehicle you drive and your online purchase history, this metadata builds a picture of you. Who you are, what you like, how you buy.

This isn't a warning about your digital privacy, though. I'm telling you that if a large company — say, a car manufacturer — wants to build a profile of a perfect customer, they only need to purchase the data and use AI to identify trends.

They have purchasing power that independent shops do not: to buy massive amounts of data and AI programmers who can turn that data into actions.

We are staring down the barrel of manufacturers being able to target and steal your customers with laser-like precision — and half of the owners in our industry don't even measure how their employees are performing each day.

How to adapt successfully

First and foremost, you must close the knowledge gap.

Our industry is still dominated by poorly-focused, activity-driven marketing. We still allow marketing companies to cherry pick numbers like return on investment without looking at the actual behavior and trust of the customer base they drive.

In an age of machine learning, that's unacceptable. If a campaign makes you busy, but ends up replacing your customer base with no-value coupon chasers, it's wasted money. Doing so when we can quickly measure the effect of marketing is wrong. Doing so when a computer can quickly learn where your best customers are and target them with the right message is conceding that we want the dealerships and chains to win.

You can probably not afford the data or the payroll needed to do that in-house, so step one must be to switch to a marketing company that is data-driven and results focused.

That knowledge gap extends to shop measurement.

We already know that half of shops aren't measuring their employees regularly. Of those that are measuring, only a fraction are doing so daily.

The fact of the matter is that we cannot hope to survive long as independent shops if we're not willing to do the basics. Too many of us are content to look back at the previous month to try to measure going forward.

Setting aside AI for a moment, this can't keep happening. If you don't know how you're doing until the month is past, it's too late to fix anything. You can make changes, sure, but the money you lost last month is gone.

Unless you make the change today, you can't save this month either.

The picture is even more clear with AI. Consider what the dealerships and chains can learn with their resources. They can know their most efficient employees, how to effectively dispatch and can manage inventory based on data from locations coast to coast.

And half of us won't even do basic measurement.

The truth is, shop owners are about to face a reckoning. Unless you think techs will be easier to find in the future, or that costs will go down, or that you'll face less competition, the only answer is to take a giant step forward. We must do better marketing, we must manage smarter, and we must start measuring our business like the future is already here.

If you want to know how we're using AI daily in our auto repair shop to measure and market, visit autoprofitmasters.com.

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FEELING IS BELIEVING

MARCH-APRIL

Your next technician is working for a competitor

Does your shop have what it takes to lure them away?

We are all aware of the technician shortage in our industry. There are likely more shops out there looking for a tech than not. One thing we need to realize is that the tech we are looking for is currently working for someone else. So how do we attract them to come to us, and away from where they are? Let's listen to veteran ATI coach Steve Privette explain how it is done.

In many cases, if a tech is looking to leave his current job it is usually for one of these five reasons: money, time, convenience, environment or relocation.

Your ads need to touch on all of these areas to give you the best chance of finding your next technician.

Money

If we don't pay them well, someone else surely will. In our search, we do not want to use words like "competitive pay" in our postings, as this equates to average. How about this instead: "Industry top pay for the right individual." That will pique the interest of a tech searching for more money. Another idea is to offer a hiring/signing bonus, which can be paid over service time.

Think you cannot afford to pay more? Realistically you can't afford not to. You may have to adjust your labor rate to compensate for paying more, which is what every industry does. As costs go up in any business, this gets passed along to the consumer. If you view yourself as the best shop in town, you should be able to pay the best and charge the best.

Time

Many techs are currently working five or more days per week, some including weekends. These days it appears many employees value their time just as much as — or more than— money. One of my members was getting very minimal response to his tech search, so we decided to modify his listing to say "four- or five-day work week, your choice." His responses increased a good bit, as he was getting interest in the four-day work week option. We decided that getting a good tech four days per week was better than zero days a week. That shop owner ended up doing four-day work weeks for all of his techs, and added another tech for full weekly coverage. He hasn't experienced a work force issue since. A potential tech who is on the fence about working for you due to distance might be swayed by commuting one less day weekly.

IN MANY CASES, IF A TECH IS LOOKING TO LEAVE HIS CURRENT JOB, IT IS USUALLY FOR ONE OF FIVE REASONS.

Convenience

This is the one we have the least control over. Some techs are searching for a change due to a long commute. We cannot move our shop to where the tech is, but we can offer to assist with the costs related to his/her commute by helping with fuel expense and/or even offering a car to drive for the right individual. These can be worked into a pay plan. Again, you can also offer a four-day work week to help compensate for the commute.

Environment

There's nothing worse than spending the majority of your waking hours in a negative environment. This can wear on you and become toxic. There are techs out there who make good money, the hours are fine, and the shop is convenient, but

the negative environment drives them out. When posting ads, project the opposite. Things like, "Come be part of the family" or "We BBQ/grill for lunch every week." Is your shop an enjoyable environment to work in? Do you focus on recognizing and rewarding your employees? Another environment category is a dirty shop with outdated and/or nonworking equipment. This too can drive a tech out. Is your shop clean and with updated working equipment? If so, let's list that in our posting. Something like, "State-of-the-art equipment," and/or "Clean, organized shop." If not, let's get it clean with updated equipment to attract techs.

Relocation

When searching for a tech, use sources that will attract from all over the country and not just locally. Consider a statement like: "Relocation assistance available for the right individual." This can work similar to a hiring bonus where you would pay their moving expenses over time after they have been employed with you for a while.

Finding technicians is getting harder every day as our seasoned techs are slowly retiring, and the number of people entering our industry is dwindling. The shops that are willing to adapt to the needs of technicians are the ones that will have technicians. The shops that say they won't pay the most, won't offer four-day work weeks, won't be convenient, or won't create a positive, clean environment also won't have technicians.

Chubby and many economists are predicting a slowdown in the general economy starting in the third quarter of 2018 and into 2019. When this happens, your customers will slow down buying new cars, and the automotive repair business will grow quickly. Everyone will be looking for more techs, but the smart shop owners will have them on board before it happens.

If you are like many shop owners and are unsure of what are the best interview questions that you need to ask, we have them for you. Simply go to www.ationlinetraining.com/2018-04 for a limited time and we will give you the interview questions that can make the difference between hiring the next superstar or someone who just sounds like one!

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 115 associates train and coach more than 1,400 shop owners every week across North America to drive profits and dreams home to their families. This month's article was written with the help of Coach Steve Privette. *chubby@autotraining.net*

Will your shop fit into the mold of the future?

A look at how state-of-the-art shops operate and how you must prepare

If you're a progressive shop owner today, your future looks very bright indeed. New opportunities are about to open up for you if you continue to maintain a positive attitude and a focused commitment to your business.

Your prospects are bright in comparison to those who fail to prepare for advancing vehicle technology, the growing shortage of technicians and a new generation of educated and plugged-in consumers. Owners who do not keep up with the times will pay a steep price as the business landscape changes.

Thousands of independent shops will disappear in the next few years, but those left will be terrific businesses to be a part of.

These thriving shops will typically have eight hoists and two "diagnostic only" bays in a meticulously clean facility.

Vehicle calibration services will impact bay design. We'll see bays as wide as 35 feet that give adequate room for this specialized service. Vehicle software platforms will become the new training models as many high-end technicians transition to the role, essentially, of software analysts.

Shops will have secure high-quality connections to the internet. Tablets will replace clipboards and paper. And accessing technical information, vehicle service histories and management information will all be done online. Parts ordering will be done with the touch of a button instead of a phone line.

Shop websites will be managed by outside firms and used not only for marketing, but as a tool for clients seeking information on their vehicles. Making service appointments will be streamlined, with calendars automatically synced and updated.

And as your shop evolves, so will your workforce. Your well-paid and highly trained staff will be committed and fully engaged, with a clear understanding of your vision for the business as a whole and their role within it.

WE DON'T GET PAID FOR WHAT WE DO. WE GET PAID FOR WHAT WE KNOW. THIS IS THE NEW AFTERMARKET REALITY. DOES THIS SOUND TOO FARFETCHED? IT'S ALREADY HAPPENING.

Management and staff will establish a close, professional relationship. This will be a "career" — not just a "job" — for everyone in the shop. The business will offer unique opportunities for personal growth and job satisfaction. Challenges will be met with enthusiasm and rewarded with handsome compensation and financial stability.

Professionalism is going to be even more necessary in tomorrow's shop environment than it is today. The emphasis will be on developing highly-tuned management skills and ethical relationships with coworkers, clients and affiliate companies. Only suppliers that are committed to the success of the shop will have the privilege of interacting with it.

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everyone has each other's back.

The result of this "team" approach will be greater trust and loyalty from clients, as they see how their vehicle maintenance is being managed for safety and reliability. High-functioning shops will earn permissions from their clients to access the full range of vehicle information available through telematics. This will allow a level of vehicle management that exceeds the highest client expectations.

The impact on you and your staff will be dramatic. You'll become a fully operational team, enjoying a professional wage based on the talents you bring to the operation. The most progressive and successful facilities will take a profit-sharing approach, where everyone benefits from the shop's success. The days of offering a simple bonus are rapidly coming to a close. Individual bonuses tend to be a divisive force in a business. Profit sharing creates a unified team.

As I've discussed before, shops will have a minimum of three labor rates. Some will have as many as five different labor rates to handle the challenges of advanced technology. These rates will no longer be set around multiples of an hourly wage, but will reflect the need for operational efficiencies, which affect the true cost per billed hour. This new reality will reward the shops that "get it" because achieving efficiencies will be key to remaining competitive in the market. You have to attract those top-performing techs and compensate them fairly. Inefficient shops will price themselves out of the market.

The tension and animosity between the independent sector of the aftermarket and OE dealer will start to subside. Both sides will need each other more than ever. With future vehicles working their way up to 500 million lines of software code, the potential for more vehicle recalls is very real. High-end independents are very likely to be solicited by dealerships to give them a hand making sure consumers are taken care of in a timely manner.

The best technicians — the ones reaching analytic specialist status — will see each other more frequently at high-end training sessions and industry conferences. This will allow them to share information more easily and build stronger relationships. These professionals will embrace a culture of continuous learning — something that is already happening in other industries and is long overdue in ours.

Independent shop owners will also start to work more closely together, as the need to specialize in specific vehicle models emerges. The days of working on all makes and models will come to an end. The amount of information, training and tooling will be probative, forcing shops to start working together to meet market demands. This potentially is one of the most exciting changes coming to our industry. Professionalism and cooperation will reach a whole new level within the aftermarket.

We don't get paid for what we do. We get paid for what we know. This is the new aftermarket reality. Does this sound too farfetched for you? Well, watch out. It's already starting to happen.

I'm confident you'll see — or read — about businesses that have embraced the new aftermarket within the next 18 months. Will you be one of the shops that excels in this new reality? Or will you be one of the unfortunate statistics? The alarm is being sounded. Are you hearing it loud and clear?

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

Shop forgoes profits and relies on volunteers to provide repairs for those in need

ROBERT BRAVENDER // Contributing Editor

Full disclosure: this shop doesn't make any money. Not one red cent. Not due to any mismanagement— quite the opposite — but because it's a non-profit, faith-based endeavor called God's Garage.

Located in the Houston suburb of Conroe, Texas, it only "repairs vehicles for single mothers, widows and wives of deployed military with no labor costs," explains Chris "PC" Williams, founder of this philanthropy. "We also give vehicles away to qualified recipients. Through donated cars and parts, we are able to bridge troubled times in so many people's lives."

Since no one actually owns the garage, Williams is the president, just as there are no employees, only volunteers. "Our group consists of lead technicians through those just learning the automotive trade," he explains. "I actually started this thing about six years ago, just a group of guys who got together once every couple of months to help people out."

Automotive service and assisting those in need have long been linked in Williams' family, starting with his dad. "My father was a helper," he says. "We would be all dressed up to go somewhere and if he saw someone stuck on the side of the road, we would pull over and help them out.

"My dad was always into cars, motorcycles, boats, basically anything that had a motor and could go fast," laughs Williams. "He even went to tech school to become a mechanic. He ended up becoming a pastor, but was still wrenching on cars and helping people whenever he could."

While Williams eventually followed his father into the ministry as a youth pastor (PC = Pastor Chris), he didn't pick up his father's aptitude for mechanics. "I can't stand working on cars," he confides. "I wasn't the best student, but he taught me the basics of car care."

His father's lessons dramatically came together one rainy night when Williams was driving home from church. "I could barely make out in my headlights a couple people walking on the side of the road. I pulled over, and I didn't know if they'd get in the truck with me, but it turned out it was a lady from my church and her little girl."

Taking them home, Williams learned that for three months this single mom had been begging or borrowing rides to get to work and church, sometimes even hitchhiking, since her truck was in the shop and she couldn't afford to pay for it.

GOD'S GARAGE
Conroe, Texas // godsgaragecar.com

Chris "PC" Williams
President

1
No. of shops

6
Years in business

3,500
Total square footage of shop

"That night I went home to my wife, and I cried," says Williams. "I told her this can't happen when I can do something about it. I've got friends who've got a couple extra dollars, friends who can work on cars; we've got to do something, we can't just let this happen."

After helping this woman out of her predicament, Williams began calling people in earnest. "I'm a networker and I've been blessed to know a lot of people," he declares. "I just started spreading the word around to my friends, and before you know it we had a dozen guys showing up, and it grew from there."

For his part, Williams built a small shop on his property, but since there's no shortage of clientele, the work quickly eclipsed this 40'x40' facility. "We really needed to go three to four nights a week, and I couldn't do that in my neighborhood," Williams relates. "I found a 3,500 square foot building with some stor-

PHOTOS: GOD'S GARAGE

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age in the back, but it was a pretty large lease so I told the guy I couldn't do it."

But it turned out the owner had heard of God's Garage and planned to volunteer. He offered the building to Williams at the cost of the mortgage note. "It was over $1,000 less a month, so we jumped in." God's Garage now had an official address.

"We've built the place out," Williams proudly notes. "We've got three lifts right now, looking forward to getting an alignment rack when we get enough pennies saved. We've got five or six guys during the day every day, a dozen more two or three nights a week. We've got retirees, shift workers, firemen, airline pilots; three of my mechanics are full-time master techs, and they bring their scanners with them as well.

"(The volunteers) just come in, grab a work order, pick what they want to do and get after it," Williams continues. "It's amazing to me; I'm in awe. Just about every day I look around at the people everywhere, and these guys don't just give time, they all give financially: $10, $20, $100 a month to go towards doing what we're doing so we can buy more parts."

Then there are the giveaway cars. "If we have a donated car with the potential of being a giveaway, we want to make sure that it's safe and reliable," reports Williams. "They usually have mileage of 180,000-200,000 and up, but they're going to be a good solid runner, and our goal is to get them a year to two years down the road so that the families who get them are in a better place."

Applications for these cars can be filled out on their website, Williams explains. "I get 30 or more applications a day right now, and the waiting list is getting longer. We have a vetting team that will call them, spend some time with them. They check their references to try to make sure that the need is real. Some people think that this is a giant organization, but we don't have money; we're paying to do this."

One requirement is that recipients take a budgeting class. "Our teachers push hard to give them skills that they need not only to budget, but to overcome obstacles," Williams says. "Listen, I don't care what church you go to, I don't care if you go to church or don't go to church; we just want to hang out, have some fun, and do some good for other people. (Because) it's not just giving a car to somebody, it's a life-changing event, and that's so humbling and so amazing to be a part of."

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.
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Looking for more pigs than chickens in today's market

INDUSTRY MEMBERS MUST BE MORE THAN JUST INVOLVED; WE NEED TOTAL COMMITMENT

CHRIS CHESNEY // Contributing Editor

You've most likely heard the story about the chicken and the pig. Both lived on a farm and were raised by a farmer who made sure they had everything they needed. One day the chicken thought it would be great to do something nice for the farmer. The chicken approached the pig with his idea. The pig asked, "What do you suggest we do?" to which the chicken replied, "Well, the farmer really likes a good breakfast. Wouldn't it be great if we made him breakfast since he has little time to do so?"

The pig replied, "What should we make for his breakfast?" The chicken thought for a moment and said "Well, I know he likes eggs. I would be happy to provide a couple." The pig then asked "What else would the farmer like for breakfast?" The chicken again gave it some thought and replied, "He really likes bacon! It would be great if you provided some bacon." To which the pig replied, "Well that's just great. Your contribution requires your involvement while mine requires a total commitment!"

This story illustrates the current issues we face in the automotive service industry. There are some who are involved, yet few who are fully committed. The issues we face as an industry are many; the technician shortage and the never-ending onslaught of new technologies are just two examples. Everyone is concerned because these issues threaten our livelihood and the way we do business, and they signify change in how we support our teams.

Let's look at a couple examples that need our attention. First, there is industry concern that vocational schools are not producing what you need in the way of skilled technicians. Many shop owners complain that the graduates they hire simply can't perform the services offered without further investment or training, so they hire them and put them on the lube rack and hope they learn the skills they need there. Yet, they complain the young techs can't do an inspection correctly, or that they don't seem to have the desire to learn or the enthusiasm to grow. Or, they complain that the OE dealers are cherry picking the best talent and leaving the rest to the aftermarket.

These are all concerns, but the solution is staring us right in the mirror. Vocational schools are limited in time and resources to grow new talent. In the last 20-plus years, the complexity of the automobile and the services you provide have increased tenfold, but schools are still dealing with the same or less resources as they attempt to provide you with talent. Couple this with the fact that vocational instructors are usually one or two-man teams that spend more time at their craft than most of you, and get paid less than half what you pay your top technicians. For those schools that have achieved ASE Education Foundation credentials, they must meet all the record keeping standards and must decide what topics and skills to focus on each semester. Quite frankly, they can't do it successfully without your help.

As a requirement of their accreditation, vocational schools must form an advisory council. This advisory council is charged with providing the instructor with direction regarding the focus of their program and the skills they want to see as a result. If you are concerned that the OE dealer is getting access to the best students, it is likely because the dealer is involved and committed to supporting the local vocational program and you aren't.

It is easy to get involved. First, it takes a phone call. Don't wait for the vocational instructor to call you. Be-

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>> CONTINUES FROM PAGE 24

come a part of their advisory council. Review what they are teaching and how they are teaching it. Partner with them by reviewing their curriculum. Observe the way they teach a skill. Ensure they are building what you want by getting involved. But better yet, make the commitment to support them by getting your peers in the community to join you. These efforts need to be a "we" project rather than a "me" project.

I often hear this comment from shop owners: "I only visit the school or get involved when I need a new technician." This is the equivalent of being on a deserted island with vegetable seeds and waiting until you're hungry before you plant the seeds. In order for you to ensure you have the talent you need when you need it, you must have a program in place where you are sowing, watering and growing new talent. If you happen to have someone in the pipeline who is ready to work on their own as a productive technician but you don't have a spot open for them, if you have the involvement of your peers, then you can find them a home easily. It is critical to always have someone in the process of growing their skills so you always have that resource to draw from when the need arises.

Lastly, there is the old perception that if I bring someone onboard and put a mentor with them, I'm going to lose money because the tech that is mentoring is producing less, and the apprentice won't make up for it. If this is your perception, you are approaching the mentor/apprentice opportunity with the wrong plan. First you must choose the right mentor. The best mentor is someone who is still gaining experience but is passionate about doing the job right and sharing what they know. Believe it or not, you might be choosing a 25 to 35-year-old technician as your mentor. More on that topic in the next edition.

So, the question is, are you coming to breakfast? If you are, which element of breakfast are you — the chicken or the pig? It isn't hard to get involved. Start by finding the school in your area. Visit www.asealliance.org and click on the 'Find a School' link near the bottom of the page. Come to breakfast because it's the most important meal of the day. Better yet, get involved. But my challenge to you is to make a commitment to your business, your customers and your industry. Be the bacon!

CHRIS CHESNEY is the Senior Director of Customer Training for Carquest Technical Institute (CTI) and Advance Professional.
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OIL LOSS AND WHAT TO DO ABOUT IT

OIL CONSUMPTION COMPLAINTS? ODDS ARE YOUR CUSTOMERS DON'T EVEN KNOW THEY HAVE ONE. YOU MAY NOT EITHER UNLESS YOU KNOW THE INVISIBLE SIGNS!

G. JERRY TRUGLIA //
Contributing Editor

Have you noticed lately that some of your customers' engine oil levels are low even though the mileage interval has not been met? Well, you're not alone, since many OEs have been using thinner viscosity oil for their new engine designs to meet the CAFÉ (Corporate Average Fuel Economy) standards.

Before we go too deep into this subject, we need an understanding of the oil that is required in today's modern engine. For years, we looked at an oil bottle, only taking notice of the name brand and oil weight to maybe decide on whether to use it in the engine we are working on. Those days are over; now there are recommendations called service ratings that classify passenger and commercial vehicle motor oils by the American Petroleum Institute (API). You're most likely familiar with the API donut that is on every oil bottle that has the two-letter rating of the oil. The letters that you need to look for currently are either SM or SN, which supersede the previous ratings. The donut also has the Society of Automotive Engineers (SAE) viscosity grade that has the common numbers on the bottle, such as 0W-20 or 5W-30 and so on.

By the way, the "W" after the first number does not stand for weight, but rather for a "winter" designed oil. A 5-30 is not the same as a 5W-30 oil, so be careful to use the specific recommended oil. Manufacturer requirements and specifications are listed in all the popular service information systems.

Another important thing to remember is the difference between gasoline and diesel engine requirements. The specification for the engines are different, and it is vital that the correct oil be used. Rather than the SN-rated oil, diesel engines require the use of a CJ-4 oil. The C stands for commercial engines (diesel engines) and J is the current performance level, while the 4 in a J-4 oil indicates a 4-stroke diesel engine. Believe it or not, there is still more to understand before we move on to some problem vehicles. The OEs require the correct oil, and in some cases the oil

PHOTOS: G. JERRY TRUGLIA

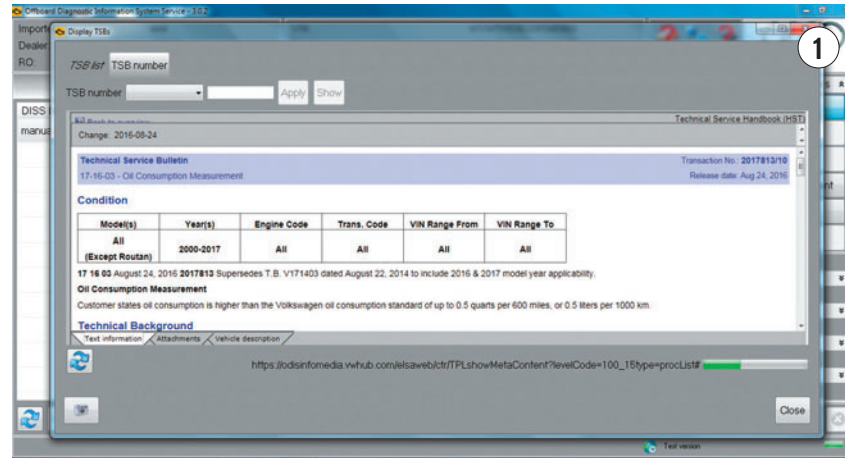
filter, to be installed in the engine before they will even think about running their oil consumption test. More on the test later in the article, but for now let's move on with a few more bits of important information. There is another bunch of letters that are on the oil bottle, such as ILSAC (International Lubricant Standardization and Approval Committee) that is common on oils that are used in Asian vehicles, such as GF-5 that is now recommended. The next standard, ACEA (Association des Constructeurs Européens d'Automobiles), is a specification that must be used if you are changing oil on any European engine. The ACEA is a performance/quality classification, such as A3/A5 tests that are used in Europe. This standard for European engines is more stringent than the API and ILSAC standards. Be aware if there is an engine issue due to lubrication — the OE will take an oil sample and send it to a lab for testing. When the lab results come back, it must indicate the correct viscosity along with the approved rated oil for the engine was used or no warranty bucks will be paid out. Don't be left on the hook for an expensive engine repair job due to improper oil usage. It's always better to purchase a good quality oil that has the correct specifications to prevent damage to today's very expensive engines.

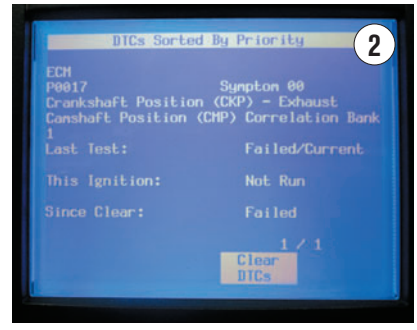
Consumption causes

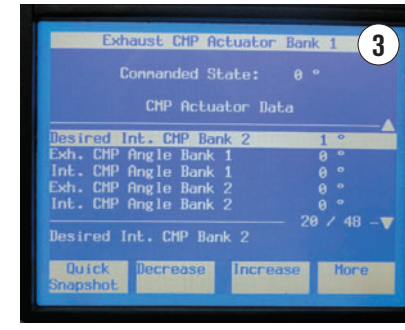
There are many issues with oil consumption on today's engine, whether it's a leak due to poor engine breathing or sealing. Consumption can also be caused by poor engine design, such as piston ring, piston or engine block design issues. Since the engines we are working on are not our father's Oldsmobile design, the amount of oil usage is different than years ago. The amount of normal oil usage has drastically changed in the past five to 10 years. For many years, the normal amount of oil consumption was considered to be a quart of oil every 3,000 to 4,000 miles after completing the engine break-in period.

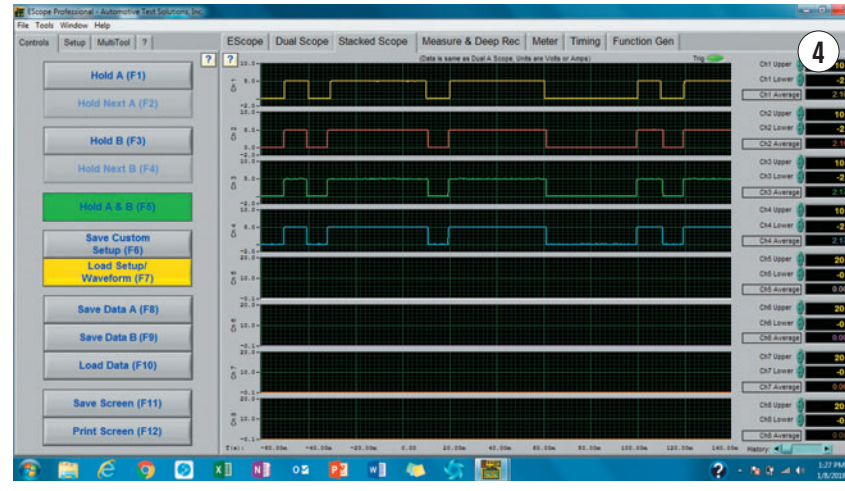
This is not the case today, as you can see by the ODIS VW factory scan tool screen shot (Figure 1) that states that up to 0.5 quarts of oil in 600 miles is normal on VWs built from 2000 to 2017! Anyway, VW is not the only OE that has an oil consumption issue. GM, Toyota, Subaru and Honda are just a few that also have problems. We had one of our customers with a Subaru return to the dealer due to a high consumption and had a new motor installed for free under warranty. Many Camry hybrid owners, including one of ours, have received the complete engine assembly replacement along with catalytic converters for free. A Toyota TSB (Technical Service Bulletin) states that some 2006 to 2011 model year vehicles equipped with the 2AZ-FE engine may exhibit engine oil consumption issues and a P0300 DTC. The fix for this issue is the replacement of an updated piston assembly that has been changed to minimize

oil consumption. Some other issues that I will cover in this article related to oil are the high failure rates of timing chains and related components. There have been studies conducted into the abnormal wear of timing chains, gears and the other components that has been linked to poor oil quality. The oil quality is a big factor in the accelerated wear of the previously mentioned components. Besides low oil quality, oil level, volume, pressure, viscosity and the use of oils that don't meet specifications, there are oil additives that can accelerate timing chain and component wear. The goal in this article is not to provide you with all the TSBs on oil consumption or timing chain problems, since that would be redundant to give you information you can find in your shop's service information system. With that said, you might want to search "oil consumption" next time you're logged in!









Case study time

A 2009 Chevy Traverse 3.6L came in with a check engine light on, along with the following DTCs: P0017 (crankshaft position exhaust correlation Bank 1, Figure 2), P0300, P0301, P0303 and P0306. Since this engine is known for engine-related DTCs that are caused by timing chain issues, we know what we have to check. Rather than spending time diagnosing ignition or fuel issues, we are going to concentrate on the mechanical side. The 3.6L engine that is in our problem vehicle has known issues related to timing chain, gear and timing chain guides. In fact, GM will replace the damaged components at no charge up to 120K.

The GM dealer will replace the timing chains, inspect and only replace the gears and timing chain guides if there is extreme wear. Their research has uncovered a problem with timing chain stretch as being the main issue, so they no longer change all the components as they have done in the past. But hold on, the reason this engine has timing chain issues is due to oil and oil change intervals. GM had previously recommended a semi-synthetic DEXOS 5W-30 oil be used in the engine and changed at 7,500 miles. Their new specification for oil is a full synthetic DEXOS 5W-30 that now has a shorter recommend oil change interval of 5,000 miles. As you are surfing through service information, you will find that GM has a few TSBs that have references to timing chains and oil change requirements. Another tidbit of information on this 3.6L engine is that one quart of oil in 2,000 miles is classified as normal oil consumption.

The first thing that you should always check besides the oil level is the often overlooked PCV (Positive Crankcase

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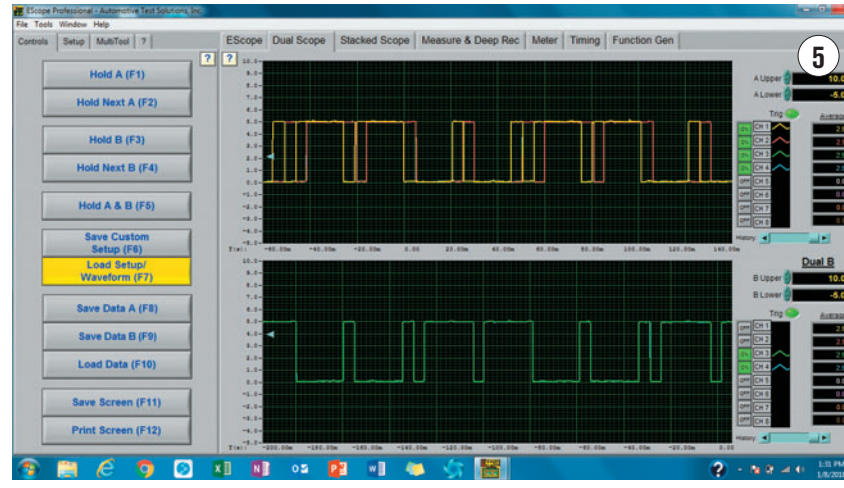
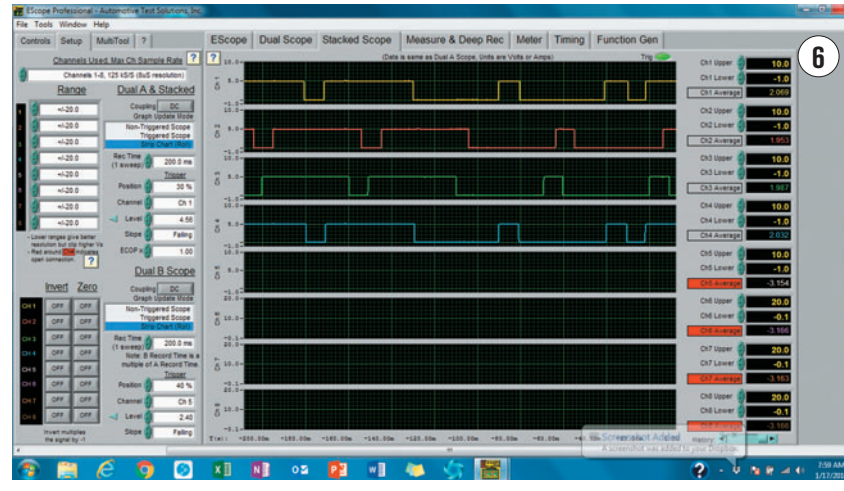
Ventilation) system. Many times, the No. 1 problem of oil consumption is oil being pulled through the PCV system. Make sure that the PCV valve and all the passages are clear of obstructions, along with using the OE PCV valve to avoid oil consumption problems. Any PCV restriction can cause oil consumption issues along with oil leaks from gaskets and seals.

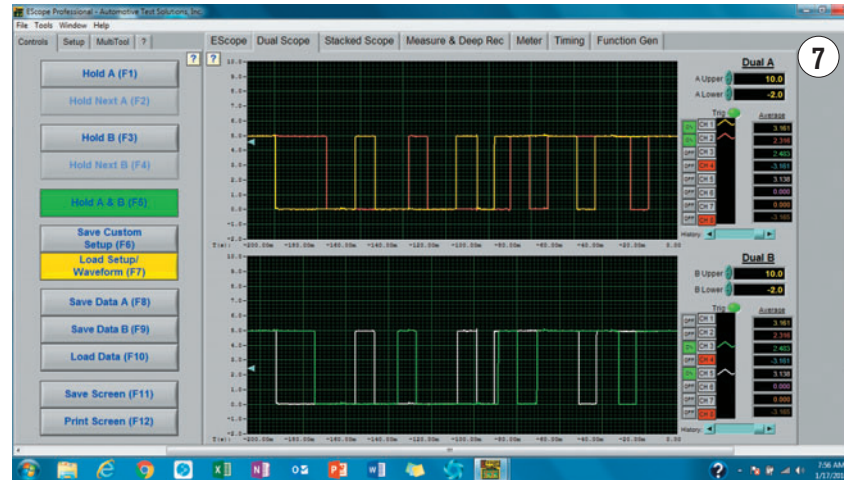
Since the PCV and the passages were operating as designed, our first step in diagnosing the DTCs was to check the PID for camshaft degrees. We used the scan tool data to compare actual cam degrees compared to the desired (Figure 3) of both Bank 1 and Bank 2. Notice from the screen shot in Figure 2 that Bank 1 was OK at the time, while Bank 2 was displaying 1 degree. Since Bank 2 was currently only displaying a small amount off the desired PID, there must be an issue at different times related to engine speed and load. The same had to be true of the reading on Bank 1, since it was showing the exact degree of the desired PID. Obviously there had to be a bigger degree difference from actual to desired to set the DTCs, but the scan tool was not currently displaying the difference. With Bank 2 one degree off, it most likely did not go far enough out of specifications or it would have set a P0018 or P0019 Bank 2 Intake and Exhaust Correlation DTC. The scan tool data indicates an issue that leads to the random and cylinder number 6 misfire DTCs.

To uncover the root cause of the DTCs, we decided to use the scan tool's bidirectional control to check the cam phaser solenoids. As we were commanding the phasers, we observed the actual to desired readings to see if oil had the ability to flow to the cam phasers. Since we did not see the expected difference in the actual to desired readings, it was time to connect our labscope to check the cam to crank sync. We needed to use four channels of the labscope so we could connect to the intake and exhaust cam sensors. Knowing where to put it is an important step, so Bill, my lead tech, located the PCM that was right up front on the left side of the radiator support. After looking at the wiring diagrams, Bill found both intake and exhaust camshaft position sensors and back probed them.

With the labscope connected, we





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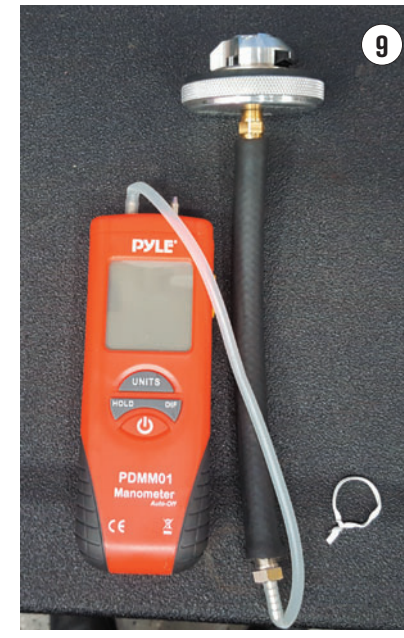
were able to view the waveforms (Figures 4, 5) to see if the timing was off. Without a known good reference, it was difficult to tell if the waveforms were good or bad. We checked iATN and other internet sites for a good reference only to come up empty handed. Bill proceeded to do a bit more research and found a group of techs on Facebook that have a wavefile forum. The techs on the forum had a reference on what should be normal. We continued to check the camshaft waveforms as we commanded the phasers to check for proper movement and reference point. Our conclusion was that the timing chains were stretched, or the gears and guides were worn and needed replacement. Credit to Bill for doing good research, finding that GM would perform the repair for free up to 120K. With the information that Bill uncovered, it spurred me to call the GM dealer that I have purchased a few vehicles from. I asked if they could check the vehicle out and get the job done within the next few weeks. Since this is a big dealership with more than 40-plus bays and technicians, they had my customer drop his vehicle off the next day. The dealership told me that they have one technician who just does these timing chain jobs and that he had just finished one and was ready for another. We were surprised the job was completed that quickly since this is not an easy job. The only way to properly perform this repair is to drop the subframe along with the complete powertrain.

After the vehicle was repaired, the Traverse owner dropped by saying that the engine was running great, but the steering did not feel right. He said he called the dealership and was told he needed struts and a wheel alignment. We checked the vehicle out and found that his struts were all good and not leaking, and while it was in we checked the camshaft signals (Figures 6, 7) so we could have a known good signal.

They were correct on one of the two repairs they recommended. It did need a wheel alignment since the engine subframe was taken down and moved from its original position. After the wheel alignment was completed, the problem was resolved and the vehicle was back to the way it was designed. Needless to say, the owner was happy that we were able to resolve his steering and suspension problem, along with helping him with the timing chain replacement. The Traverse owner did have one concern about the dealership even though they completed all the work for free. He wondered why the dealer told him that he needed struts and a wheel alignment when there was nothing wrong with the struts. On the owner's behalf, I contacted the dealership and asked if GM could reimburse him for the wheel alignment since it should have been performed along with the timing chain job, in my opinion. The last I heard, the dealer is considering the issue and will get back to me.

A Honda next

Our next oil-related problem vehicle is a 2010 Honda CR-V with a 2.4L engine and 70k miles on it. We have been servicing this vehicle since it was new and changed the oil using 0W-20 SN/GF5-rated full synthetic Idemitsu, then Eneos Japanese's oil before switching to Pennzoil Platinum oil with no change of oil consumption. We researched the oil consumption problem for our customer since the engine was using a quart of oil in less than 600 miles. This CR-V is not driven hard — a mother uses it for normal transportation around town and on the highway. We explained to the customer that the local Honda dealer would perform an engine oil consumption test on the motor to see if it passes or fails the test. The first step the dealer will perform will be to



drain the oil and change the filter, using the OEM-required oil and filter. If it fails the consumption test, Honda will refund the cost of the oil and filter change along with replacing the pistons, piston rings and possibly the complete motor for free if it is less than 8 years old or has been driven less than 150k miles (whatever comes first).

We made sure before telling her about this information that we checked and replaced the PCV components to rule out any problem in the PCV system, along with making sure there were no existing oil leaks. The CR-V owner is busy being a mom and has not yet had Honda perform the test. You can't fix what you can't control.

BMW in the bay

BMWs have an oil consumption problem mostly due to poor engine breathing issues. It is recommended that you use a manometer along with checking the specification for the BMW engine you're working on to check if it is in specification. We normally encounter many BMWs, as well as Benz owners, who buy more car than they can afford and they don't follow the proper main-

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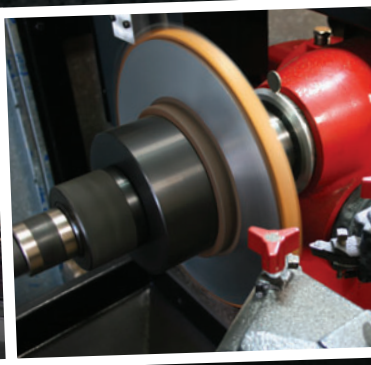

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tenance schedules or the recommended services. The problem with BMW, Benz and Audi are neglected breather systems, but it is not totally the fault of their owners. As I stated, most of the owners who come to our shop can't really afford to maintain the vehicle properly, so they look for the cheapest way out. Going the cheap way causes the Euro owners to spend a lot more bucks on their vehicles as a result of their poor maintenance.

One popular vehicle in our area is the BMW 328xi E90 with 3.0L N52K package that often has oil issues. The oil issues are mostly from leaks due to the breather/PCV system (Figure 8) that is not properly flowing oil vapors. We use our digital manometer with a special oil cap (Figure 9) from AGA Tools, since most of the Euro engines we work on do not have oil dip sticks. Using the BMW recommendation for the engine of 33 mBar with a 10 percent variation, but not more than 5 mBar difference, will reveal a problem or not. More than a few BMW owners have come in with issues of poor running, performance, MIL illuminated or oil leaking that they could not get resolved on their neglected Beemers.

After performing a breather test that fails, we recommend the replacement of the breather components with the BMW cold weather package that includes the pressure regulator valve, separator, backpressure valve and hoses. We ask the vehicle owner to return in 1,000 miles so we can check for leaks and see if the engine is consuming oil. BMW oil requirements are a 5w30 ACEA approved oil only. One quart of oil in 750 miles is what BMW states as acceptable. Wow, that bucks!

In ending this article, I want to remind you to always check the oil level in every vehicle that comes into your shop, making sure it is at the proper level. If the oil is found to be low, adjust the level until it's full or change it if it's overdue for service. Always check the OE requirements of oil and the specification that is recommended, along with a good quality filter. Don't forget to check engine TSBs that may include oil information and oil consumption test procedures. Happy motoring!

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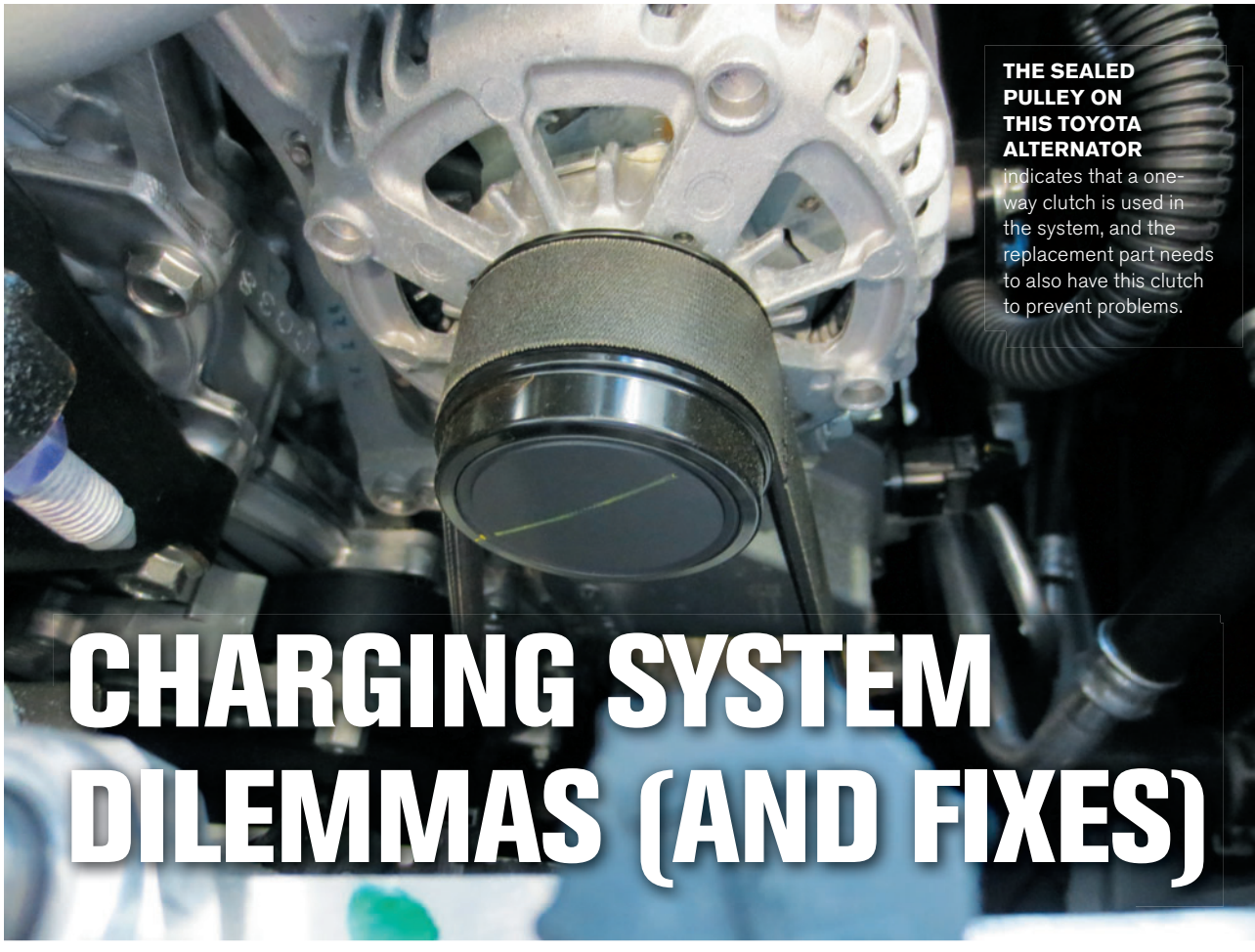
gtruglia@tstseminars.org



THE SEALED PULLEY ON THIS TOYOTA ALTERNATOR indicates that a one-way clutch is used in the system, and the replacement part needs to also have this clutch to prevent problems.

CHARGING SYSTEM DILEMMAS (AND FIXES)

CHARGING SYSTEMS TODAY ARE MUCH LESS TOLERANT, SO IT'S IMPORTANT TO UNDERSTAND HOW TO PROPERLY DIAGNOSE AND REPAIR THEM WHEN THEY MALFUNCTION

VANESSA ATWELL //
Contributing Editor

It's difficult to name a system on a newer vehicle that isn't electronically regulated or controlled. That means, more than ever, that a malfunctioning charging system can affect the entire vehicle and not just the initial start-up. So when they do go wrong, customers tend to notice and bring the vehicles in right away for repairs — great, but diagnosing and repairing those newer charging systems can be quite a challenge.

In fact, on newer vehicles, a faulty charging system can cause problems ranging from no-start conditions to MIL lights coming on intermittently and can even cause accessories to occasionally stop working.

Additionally, charging systems on newer vehicles are much less tolerant of any problems than they ever used to be, and diagnosing them successfully means being aware of how seemingly small variations between measurements and specifications can actually mean the difference between normal vehicle operation and a drivability nightmare — even on vehicles designed for severe-duty conditions and very rough service. The basics are still there — battery, generator, connections and control — but how each system is diagnosed has definitely changed. And it's important to know how to figure out what's wrong.

No worries. Here are a few examples and solutions to common and uncommon problems to make diagnosis as straightforward and problem-free as possible.

Getting started

As ever, successfully diagnosing charging system problems begins by inspecting the battery — because if the battery isn't within manufacturer specifications,

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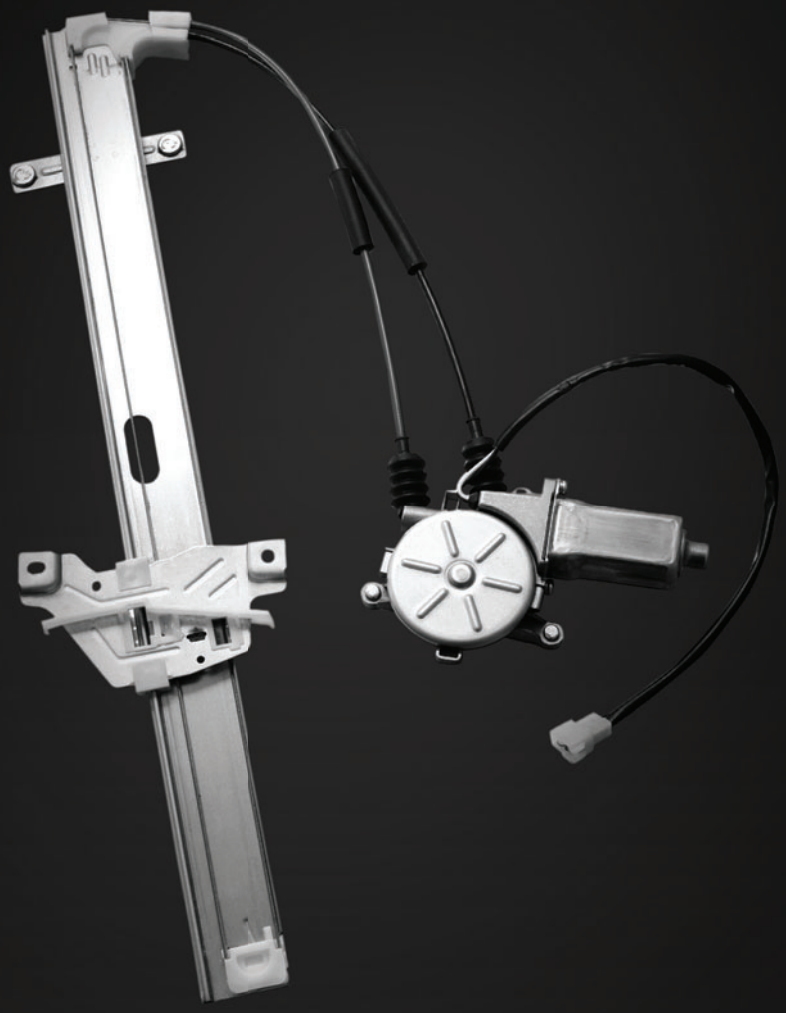

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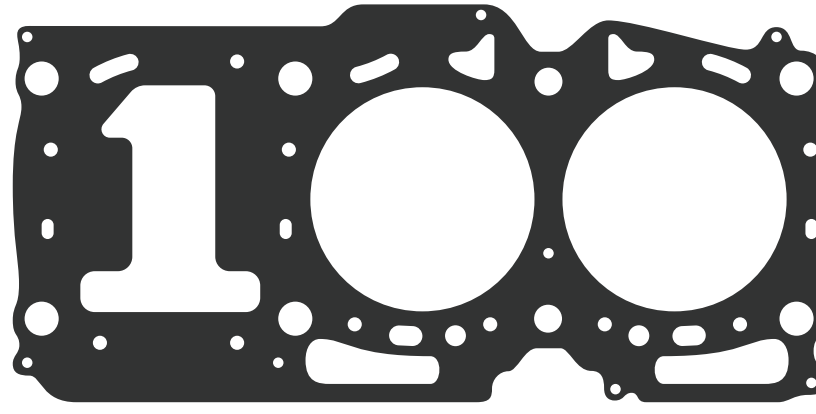

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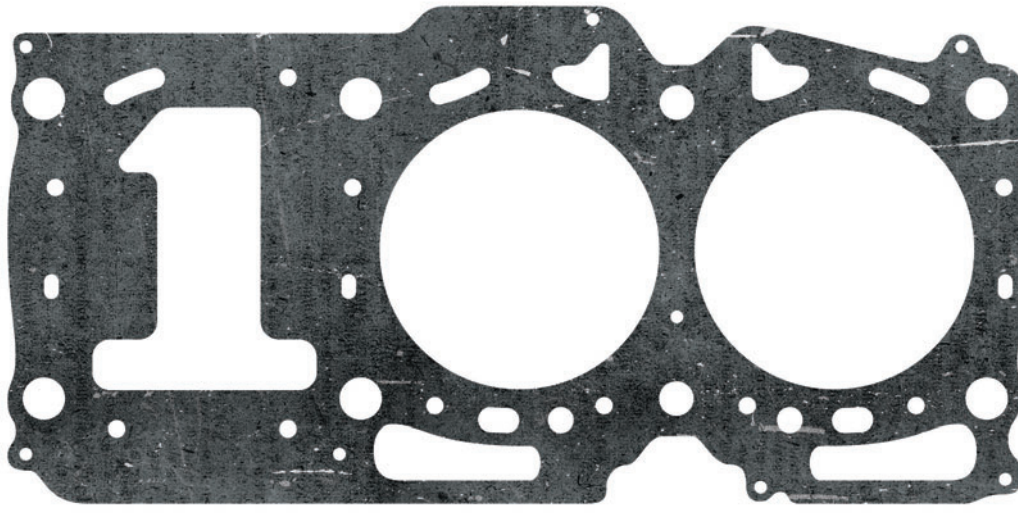

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the rest of the charging system cannot be reliably tested (which can be a challenge when a vehicle is towed to the shop with a dead or drained battery).

If there's ever a question, inspect and charge the battery according to service information — including reviewing tech tips and service bulletins — and then when the battery is known to be good and within specifications, proceed to test the rest of the charging system. This is so important that even if the battery looks new or has been recently replaced, it's still critical to ensure that the battery is OK before proceeding further with any diagnosis — charge it according to specifications if needed, check quickly for things that would likely drain the battery like the block heater or cord not working, a missing serpentine belt, or even that something was left on and only then continue with charging system diagnosis.

This step is important and not to be skipped for two reasons.

The first reason is that battery problems can easily be mistaken for drivability concerns — and often are — and there's just no point wasting time chasing something that can easily be repaired.

For example, one of our clients recently texted us because their Chevrolet 4x4 truck needed to be boosted after the door was left ajar and the MIL light then came on while driving. Replacing the battery fixed both the no-crank concern and the MIL problems, which took him completely by surprise because he couldn't make the connection between the truck's older, weak battery finally failing and the MIL coming on while driving. (I told him he was free to replace more parts if he wanted to.)

In another recent instance, a customer's six-year-old Toyota Corolla was boosted in an underground parking space and then driven to the shop for further service (to save the cost of an expensive tow). The vehicle drove well for about 15 minutes after being boosted, and then the charging light came on and it stalled in the middle of an intersection (so much for saving the customer money). A new battery (and tow) fixed that problem as well.

In other words, any time the charging system shows signs of a problem, it's critical to ensure the battery is within specification before beginning diagnosis, and if it isn't, it must be successfully charged or replaced before any further diagnosis can take place. Time-consuming indeed, but it needs to be done — the charging system can't function properly with a bad battery, and unfortunately, it wastes time and money to proceed otherwise.

The second reason ensuring that the battery is within specifications before beginning any charging system diagnosis is so critical is because the tolerances used for modern charging systems are so exacting that even a slightly discharged battery can cause serious problems — and in the real world of freezing temperatures and harsh operating conditions, it's fairly easy for a battery to discharge slightly.

In other words, "Close enough to 12.0 volts... " or, "One battery at 12.0 volts but the other a bit lower... " is not the same as, "More than 12.0 volts...," which is usually the specification required for testing to proceed (but always check to be sure). From experience, the voltage of a fully charged battery actually isn't 12.0 volts — it's usually 12.6 volts or slightly higher, so a reading of 12.0 volts is already indicative of a severely discharged battery and worth investigating further.

For example, newer Ford trucks with slightly discharged batteries that still measure 12.0 volts at the battery posts cannot start, and they can make a frightening clanking noise — even though their batteries measure at 12.0 volts. (Charging the battery for a few minutes can make all the difference, as can plugging in the block heater — the truck starts and there's no noise, something to keep in mind if you encounter this problem during the colder weather).

THIS WAS AN EASY FIX FOR AN MIL ON CONDITION, and replacing this battery in a 2000 Chevrolet truck was fairly straightforward — but it's critical to avoid over-torqueing the bolt to the battery post so that is doesn't crack, leak or just plain seize up (something to maybe share with any apprentices or students before they install any batteries).

TOP POST BATTERIES, LIKE THE ONES IN THE FORD 4X4 TRUCK are fairly easy to inspect and check for damage, loose connections and cables, and general signs that something's wrong. That's a good thing, too, because the system is incredibly sensitive and malfunctions, and no-starts can occur even if the battery indicates "12.0 volts."

It's also worth mentioning that the battery cables should be clean and make secure contact with the posts, and that if they're loosened — for cleaning during diagnosis or to replace the battery — they should be re-secured without over-torqueing them. This is especially important for side-post batteries, and it's worth mentioning

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to any apprentices or helpers who install batteries. Over-torqueing side-post batteries can actually crack the case and cause a messy, corrosive leak or simply cause the post and bolt to seize together, which creates a future nightmare for the next tech who has to undo the bolt when there's very little clearance. Torqueing fasteners and components correctly certainly hasn't changed even though so many other things about the charging system have.

Also, as ever, identifying and repairing a charging system problem early, before a no-crank or no-start condition develops, is much easier and more profitable than fixing it afterwards. If your shop has a small, handheld battery tester, using it to test vehicle batteries during routine oil changes or service is time well spent indeed since it can quickly identify batteries on the verge of failing (OK, it's not foolproof, but it's pretty good) and faulty parts can then be replaced while it's easy and convenient to do so (in the service bay surrounded by tools), rather than when it's a much more difficult and inconvenient job (such as in underground parking spaces).

This is especially good practice before the winter weather arrives and also before summer road trip season starts. It can help pay for the tool and also keep customers happy — win, win indeed.

Bad batteries causing problems is nothing new, but what is relatively new is the extremely strict adherence to manufacturer specifications. It's essential to understanding that the small fluctuations that were acceptable even a few years ago can now cause major problems and can indicate where the problem lies. Keeping this in mind while taking measurements for diagnosis is critical because, as one excellent tech recently told me, "Close enough actually isn't."

Pulleys

Another important thing to be aware of is that many manufacturers use one-way clutches and pulleys on many of their alternators, and not checking for this can result in an embarrassing and costly come-back.

The one-way clutches are used for various reasons, notably so that the serpentine belt needs less tension and is therefore easier on everything in the system that is driven by the belt (or drives the belt), and also so that there are fewer noises and vibrations from the system. This is indeed quite a difference from the days of getting as much tension on a belt as possible to eliminate noisy chirps under high load

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(I remember techs using shims under the A/C compressor mounts of a 2000-era GMC truck used for racing to raise the pulley up slightly, increase tension on the belt, and thus get rid of a brief squealing noise at very high rpm).

It's certainly easy enough to check if an alternator pulley has a one-way clutch or not — with the belt off, check if the pulley rotates freely in one direction but not the other. Not hard at all.

However, if you're still unsure, check service information and find out because it's important to verify that the replacement part being used also has a one-way clutch installed, and not just to prevent noise and vibration, but also to prevent the vehicle from coming back with the charging light on.

This is important to do even if the replacement part came from the dealer and is handed to you still sealed in the box.

One dealer tech I worked with was in a rush on a Saturday morning, and he didn't check. He just installed the component the parts department handed to him and sure enough the replacement part didn't have the one-way clutch on the pulley (even though it looked the same and fit perfectly).

The vehicle road tested OK, and the customer drove away, but unfortunately the vehicle returned less than a week later with the charging system light on. And this particular alternator was downright ugly to replace once, let alone twice — it was way down in the engine compartment and underneath everything, and the engine had to be raised and various components removed to access it. However, difficult as it was to get the alternator on and off, installing an alternator with the clutch in the pulley did indeed fix the problem. (And of course, ensuring that the spacer bushing was pushed back enough so that the new alternator easily fit on to the mount made it a bit easier, though it still wasn't a fun task at all.)

And if you're thinking you could just quickly swap over the pulleys if you're faced with this problem, think again. Removing the pulley is not just a matter of undoing the nut, popping it off and then removing and swapping it out. Pulley removal and installation requires a special tool and is not a simple task at all — trying to do it isn't recommended. Perhaps save a headache by ensuring that the replacement pulley is the correct style and size and that the one-way clutch on the new unit is indeed operating correctly before installing it (if you're not sure, check service information and find out for sure). If the pulley isn't correct, think twice before

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installing it anyway — the one-way clutch is important; leaving it out is not a good choice.

Finally, it's not uncommon to re-use the belt after replacing the alternator, but it is important to note the direction of rotation and to reinstall the belt so that it continues to rotate in that same direction to prevent underhood chirps and other noises from developing. Never use belt dressing or the like to eliminate a noise, as it can ruin the belt and make a mess on every pulley in the system. A little bit of care can prevent problems from developing and returning.

Checking pulley condition has always been a good idea, especially if there's belt noise, but now there's just a bit more to inspect — that the one-way clutch is working OK and that the replacement unit does indeed come with the clutch installed — and that it works. All quite simple once you get in the habit.

ECM control

Finally, since the alternator's output is so carefully monitored and controlled, it's also critical to ensure that the control module isn't reducing alternator output for any reason and that the actual connections, cables, fuses and connectors are in excellent condition before replacing the component – it doesn't take much to cause a problem, and alternators are often wrongly accused of failing when the actual problem is in the control system.

QUICKLY INSPECTING the condition of connections, fuses and fusible links can save headaches later on.

Even a fraction of a volt or a tiny bit of resistance makes a big difference on newer vehicles and shouldn't be dismissed as "close enough." Those tiny variations that were acceptable before are now the difference between the system working correctly and malfunctioning horribly.

To prevent problems and save time, it's wise to look up the specifications in service information and verify voltage at the control module with a scan tool, not just by placing a multimeter across the battery terminals before and after the vehicle starts and checking that the voltage is 12.0 and goes up to 14.0 when it's running. It's important to verify that the control module sees correct battery voltage and isn't commanding loads be shed or reduced.

It's also still important to check voltage drop across the heavy cables and also pin grip at the smaller terminals in the system when diagnosing charging system faults — female connectors can lose grip after being disconnected and reconnected as few as three times. In other words, it doesn't take much to cause a problem and paying careful attention to detail is the best way to quickly and accurately find the cause. It's that attention to detail that makes the difference now.

Also be sure to check fuses and fusible links for problems if something seems strange — all of them. We had a Honda Civic towed to the shop completely unresponsive, and it wouldn't be boosted or power up. Turns out the main fusible link was blown. The customer tried to boost the vehicle themselves — backwards, which they didn't mention — and the vehicle needed not only a battery but the fusible link replaced as well (the fusible link did its job and did indeed protect the rest of the system from damage). Sadly, customer behavior just doesn't seem to change even though their vehicles do.

Conclusion

Despite what's currently posted online, the days of removing the negative battery cable while the vehicle is running to diagnose a faulty alternator have been over for a very long while (and let's be honest, that was never a good test or a good idea to start with) and the days of accepting 12 volts across the battery terminals before cranking and 14 volts at the battery with the vehicle is running (measured with a voltmeter) as proof that the charging system was problem-free are gone as well. Diagnosing charging system problems on newer vehicles requires service information and the proper diagnostic tools — and a bit of experience knowing what to look for and where. But if you're ready for it, diagnosing and repairing charging systems can help those diagnostic tools pay for themselves quickly.

It's definitely worth learning about what's new with charging systems over the past few years to prevent headaches and reduce diagnostic time — and maybe even prevent some embarrassing situations from ever occurring. Charging systems are more critical than ever, and there's certainly money to be made repairing them, which is still important, indeed. MA

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

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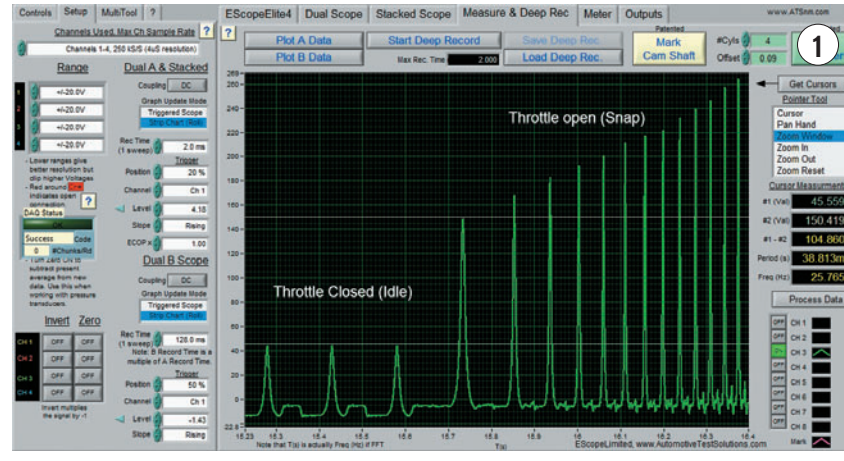
VCR — A FUTURE TECHNOLOGY APPLIED TODAY

VCR, OR VARIABLE COMPRESSION RATIO, ENGINE DESIGNS ARE NOW IN PRODUCTION. WILL YOU BE READY TO SERVICE THESE SYSTEMS?

BERNIE THOMPSON //
Contributing Editor

The engine was equipped with 12:1 pop-up forged pistons." We who have been around awhile have all heard this statement and immediately know that this engine was built for performance. It has always been known that a higher compression ratio (CR) provides the internal combustion engine with better performance and economy. If this statement is true, why do the OEs not incorporate higher compression ratios in their engine designs? With modern improvements to the internal combustion engine in systems, such as Variable Cam Timing (VCT), Variable Valve Timing (VVT), Direct Gasoline Injection (GDI), Induction Charge Valves (ICV), Forced Air Induction (FAI) (to name just a few), it is clear that the manufacturers are looking for every ounce of performance they can obtain. So why not high compression ratios? In order to understand why the OEs do not use higher compression ratios, it will be necessary to understand what is involved when changes are made to the compression within the engine.

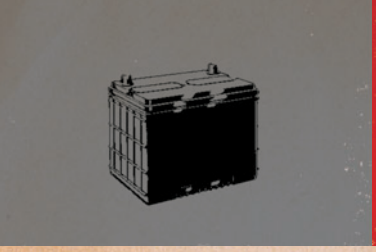


What is compression really?

Compression is based on a cylinder volume change that occurs over one of the strokes of the internal combustion engine. When the piston is at the Bottom Dead Center (BDC) point after the intake stroke has occurred, and then moves to the Top Dead Center (TDC) point, the volume change that occurs within the cylinder is the percent that the volume ratio changed. This volume ratio change is referred to as the static compression ratio of the engine. This static compression ratio does not change. The volume contained within the cylinder does, however.

It is important to understand that this volume change within the cylinder of the spark ignition engine will not be constant; therefore, the compression within the cylinder will be changing as well. This is because the throttle plate is varied. The throttle plate restricts the air volume into the engine, thus the air volume within the cylinder changes in correlation to the throttle plate movement. This volume change can be seen in Figure 1, which shows an in-cylinder pressure waveform using an oscilloscope and a 300PSI pressure transducer. At idle, the volume within the cylinder is low due to the throttle plate being closed, restricting the air flow into the engine. When the throttle plate

PHOTOS: BERNIE THOMPSON



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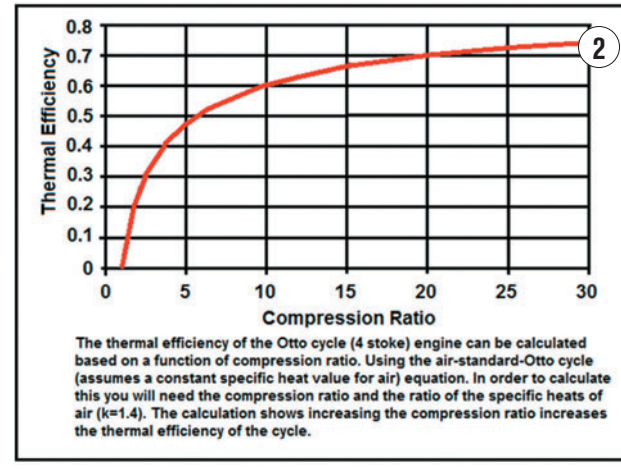
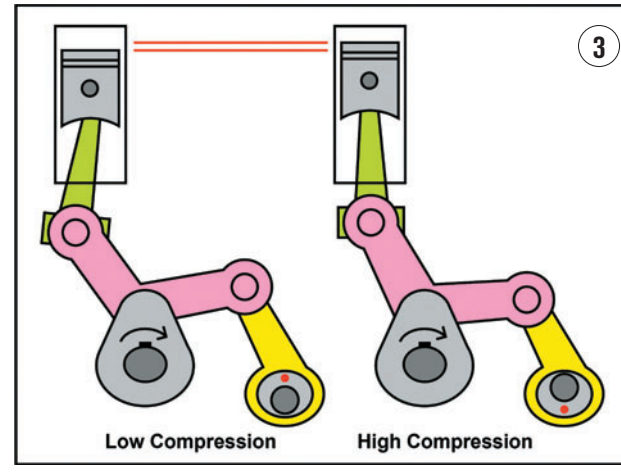
is snapped open, the in-rush of air increases the volume of air within the cylinder, therefore increasing the compression.

When the manufacturer designs the engine, they are aware of this pressure change within the cylinder. The engineer then calculates the piston movement from BDC to TDC (the swept volume) and the clearance volume that is remaining in the combustion chamber at TDC. This sets the engine's static compression ratio based at 100 percent fill volume within the cylinder. As we now understand, this fill volume in a running engine is constantly changing, so in a naturally aspirated engine, the 100 percent fill volume that sets the static compression ratio will not be reached except, possibly, at Wide Open Throttle (WOT). A passenger vehicle runs at less than 40 percent throttle opening for greater than 90 percent of the time the engine is running. Therefore, the majority of the time the engine is running, the compression of the engine is much lower than the engineer's set point for the compression ratio. The question then would be: how is this ratio set? The data is based on the worst-case scenario that the engine could operate in, so the setting may be in Death Valley on a 125°F degree day, at WOT, with pump-grade gasoline. The engine's compression ratio is then set in these conditions so that the engine does not have detonation or overheating conditions. It would be clear that the average vehicle may never be operated in these extreme conditions, but the engine design must account for possibility.

Since the internal combustion engine is a heat engine, the fundamental operation of the device is the production and use of heat. In these engines, everything that is done prior to the combustion of the fuel type is to set up the air/fuel in the cylinder so the charge can be ignited, burned and combusted. The compression stroke of the engine takes a large volume and rapidly changes the volume state to a small volume. During these conditions the air molecules, which are comprised of approximately 79 percent nitrogen and 21 percent oxygen, hit or strike one another, creating heat. The more molecule strikes that occur, the hotter the air will become. This heat is put into the working fluid — the nitrogen and the oxidant — which is the oxygen. This heat is used to heat the fuel so that it turns from a liquid to a vapor and excites the molecules so they are vibrating. These vibrating molecules will set up the charge so that it is easier to ignite and burn. In a spark ignition engine, once the point of ignition takes place, the spark ionizes the spark plug electrodes, producing a state of plasma, which takes the fuel well past the autoignition temperature of the fuel. This sets up the ignition phase of the fuel. The combustion phase of the charge is where the chemical energy is changed to thermal energy. The heat released is then driven into the next layer of the charge, thus igniting it. This is referred to as deflagration. Deflagration is the combustion that propagates at subsonic speeds through the gas that is driven by the transfer of heat. This is much different than detonation, which is the supersonic shockwave that occurs throughout the combustion chamber creating a near stepwise change in pressure; this is where the charge is ignited instantly.



The thermal efficiency of the Otto cycle (4 stoke) engine can be calculated based on a function of compression ratio. Using the air-standard-Otto cycle (assumes a constant specific heat value for air) equation. In order to calculate this you will need the compression ratio and the ratio of the specific heats of air (k=1.4). The calculation shows increasing the compression ratio increases the thermal efficiency of the cycle.



Once the fuel reacts with the oxidant, the thermal energy released heats the working fluid, which causes the nitrogen to expand and push down on the piston surface area. This, in turn, uses the three-bar linkage to produce torque from the crankshaft. So, chemical energy is turned into heat energy, which is turned into mechanical energy.

Increasing efficiency

Compression is the volume change that occurs within the cylinder; the higher the compression, the greater the heat that is put into the cylinder. Since the internal combustion engine is a heat engine, this additional heat will create more output from the engine. Let us be clear here: the air/fuel charge only burns at one rate producing one value. The additional power does not come from the fuel burn, but rather the additional pressure that is produced from a higher compression within the cylinder.

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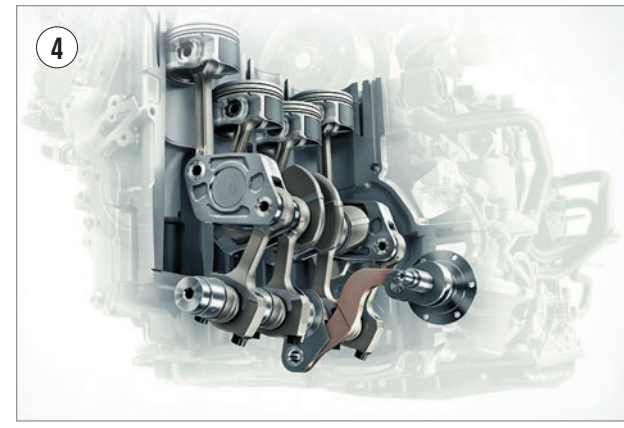
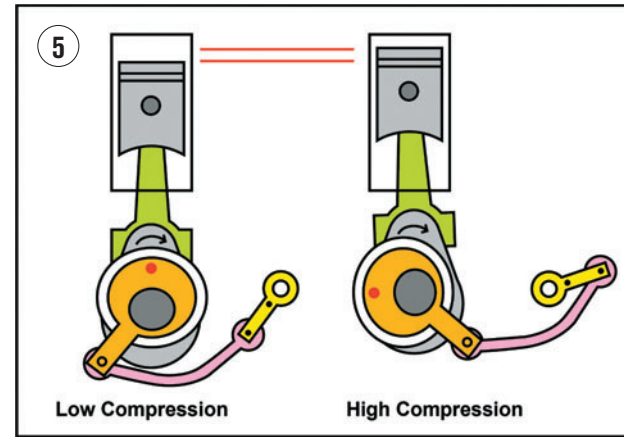
With the piston coming physically closer to the head there is less area, which will produce a higher peak pressure. This higher peak pressure will increase the engine's thermodynamic efficiency, which is a measure of how effectively the engine converts heat into mechanical power. In Figure 2, a chart is shown that demonstrates the theoretic thermodynamic efficiency gains as a product of compression ratio.

To understand how this occurs it is necessary to look at the engine's expansion ratio. The expansion ratio explains what occurs as the piston is moving downward while the fuel is burning, creating pressure within the combustion chamber. Since the piston came physically closer to the head, there is less area within the combustion chamber. As the fuel releases its thermal energy, it heats the working fluid, which creates pressure within the combustion chamber. Pressure is the force multiplied by the area. Pressure per square inch (PSI) or, more accurately, pound-force per square inch, is the force of one pound-force applied to an area of one square inch. So the pressure within the combustion chamber is multiplied by the area of the piston. Thus the higher the pressure the more force is created to push down on the piston. The rule of thumb for a gasoline-based engine is that the compression ratio is about 100 times the combustion pressure. So a CR of 8:1 would produce approximately 800 PSI of peak combustion pressure, whereas a higher CR of 12:1 would produce approximately 1200 PSI of peak combustion pressure. For example, if a 3 inch diameter piston were used; 3 inches/2 = 1.5 radius; 1.5 radius x 1.5 radius = 2.25 radius squared; 2.25 radius squared x 3.14 pi = 7.065 area of a 3 inch piston. Now that we have the area of the piston, multiply this by the force, 7.065 x 800 PSI = 5652 pounds of peak force; and 7.065 x 1200 PSI = 8478 pounds of peak force. It is now clear that the compression ratio produces a higher force to rotate the crankshaft with, thus producing greater performance.

Additionally, with a higher compression ratio the volume ratio change within the combustion chamber has a greater change over the power stroke as well. With a higher compression ratio, the area at TDC is smaller, so the area, or volume, will have a greater change as the piston moves away from the head. This area will change the way the peak pressure in the cylinder decays. An increased area allows the burning fuel to expand with a greater force over more degrees of crankshaft rotation, thus more energy is extracted from the original high-pressure charge. This in turn helps the engine's thermal efficiency.

Higher compression ratios produce higher peak pressures, therefore the design of the engine components will be heavier in order to withstand this greater force. However, there will be a penalty for carrying this additional weight for the life of the vehicle, so the gain from a heavier engine must be offset by better performance produced from the higher compression ratio. Additionally, there will be a limit to how high the compression can go. The physical properties of the materials used in the engine, as well as the fuel stock, will have limits. Ultimately the engine cannot have detonation, as detonation will create severe engine damage, so the compression ratio must be set to eliminate detonation within the combustion chamber.





The answer — VCR

Now that the problems of setting the static compression ratio in an engine are obvious, what is needed is a way to alter the compression ratio of the engine. We are all aware of one such static compression ratio change in the engine, known as the cold start enrichment. When the additional fuel is added to the combustion chamber on a cold engine, the fuel stays in a liquid format. Liquid, being virtually incompressible, takes up some of the clearance volume in the combustion chamber. This lowers the clearance volume within the combustion chamber, thus increasing the compression ratio of the engine. The additional pressure that is produced from a higher compression ratio increases the temperature of the working fluid; thus, with more heat the lighter aromatics of the fuel stock flash into a vapor. Remember only a vapor can burn; liquids and solids do not burn. Additionally,

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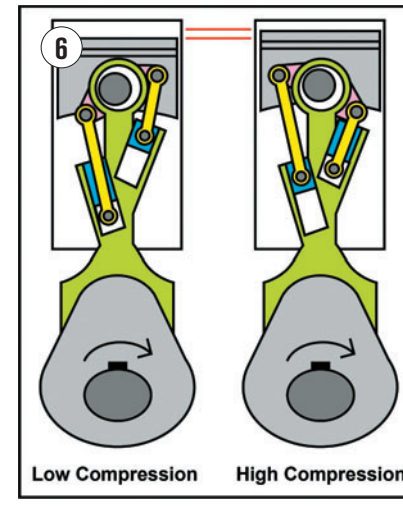
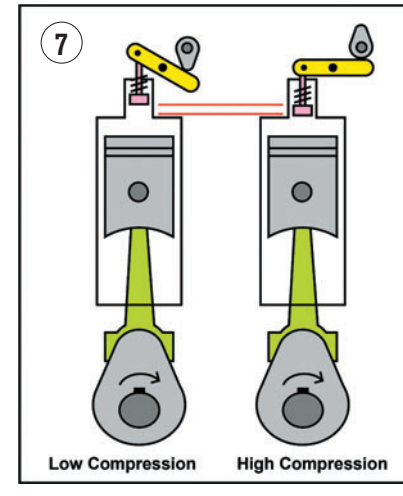
only an air/fuel mixture being stoichiometric can burn. If the air/fuel mixture is rich, once the oxygen is consumed, the fuel will no longer burn, leaving fuel in the combustion chamber. If the air/fuel mixture is lean, once the fuel is consumed there will be oxygen left in the combustion chamber. Once enough of the cold start enrichment fuel vaporizes, then the air/fuel mixture is combustible and the engine can be started. This is a temporary compression ratio change. What is needed is a way to accomplish this clearance volume change on a permanent basis.

The best way in which to utilize the engine's compression ratio is to dynamically change the compression ratio as the engine is running. The Variable Compression Ratio (VCR) engine does just that. The VCR engine changes the volume within the cylinder so that the compression is changed on the fly. There are many ways in which this can be accomplished; however, in the few VCR system examples shown in Figures 3-7, the change of the clearance volume at TDC is how this will be accomplished. When the compression ratio can be changed dynamically, the best compression ratio for the conditions that the engine is operating under can be utilized. This means that under light load the static compression can be much higher than the static compression under heavy load. This increase of the static compression ratio under light engine load conditions increases the thermodynamic efficiency of the engine. Under light load the cylinder fill volume is far less than 100 percent. This is due to the throttle plate and the air flow velocity moving through the engine. With less volume fill within the cylinder, the compression pressure is much lower than the static compression set point. So if the static compression ratio is raised, with less volume contained in the cylinder, the pressure within the cylinder goes up, creating high fuel efficiency. Under heavy engine load where the throttle plate is at WOT, the volume contained within the cylinder is high so the static compression ratio is lowered to provide the best power output while controlling detonation and overheating of the cylinder. The VCR engine can continuously vary the compression ratio, so the thermodynamic benefits appear throughout the engine load range. Thus the VCR engine provides the best of both worlds — fuel efficiency with lower emissions, while providing maximum power output from the engine. All internal combustion engine aspirations, Naturally Aspirated (NA), Turbo Charged (TC), and Super Charged (SC), can benefit from VCR technology. Additionally, VCR engine technology will be needed in order to enable the Homogeneous Charge Compression Ignition (HCCI) engine. HCCI is a form of internal combustion in which a well-mixed air/fuel ratio is compressed to the point where the fuel autoignites. This autoignition is much like a diesel engine except it uses gasoline as the fuel stock.

Not just a theory — in production!

Let's look at the first production VCR engine in use. This engine was designed by the Nissan motor group. It uses a Multi-Link Rod-Crank style VCR system as seen in Figure 3. The first observation is that the connecting rod is no longer directly connected to the crankshaft, but instead is connected to a multilink assembly. This linkage assembly is connected to a control rod that is connected to an eccentric shaft. When this eccentric shaft is rotated with a computer-controlled gear reduction electric motor, the control rod changes the geometry of the multilink assembly. In one position, the eccentric shaft rotates so the control rod is raised, allowing the multilink assembly to move downward on the opposite end so the piston height within the cylinder is lower, lowering the compression ratio. In another position, the eccentric shaft rotates so the control rod is lowered, allowing the multilink assembly to move upward on the opposite end, so the piston height within the cylinder is higher, raising the compression ratio. This linkage system changes the piston height approximately 6 mm, changing the static compression ratio from 8:1 to 14:1 in about 100 ms of time.





This system is used on the 2018 Infiniti QX50, and is shown in Figure 4. The engine is a 2.0 liter turbocharged four-cylinder VCR engine that produces 268 hp (200 kW) @ 5,600 rpm and 280 lb ft (380 Nm) @ 4,400 rpm. The result of this is an engine that gets 27 percent

better fuel economy than Nissan's 3.5-liter V6, at roughly the same HP and torque, but is smaller and lighter. Perhaps this Multi-Link Rod-Crank style VCR system is the best design from the viewpoint of mass production.

More VCR concepts

In Figure 5, an Eccentric Bearing style VCR engine is shown. This VCR engine has the main bearing bore designed so that this bore is off center. The main bearings are then supported by an additional bearing set so that the main bearing assembly floats in the engine block. A control lever is attached to the floating main bearing, which is connected to a control link that in turn is connected to a control lever arm assembly. This control lever arm assembly can be rotated by a computer-controlled electric motor with gear reduction. In one position the main bearing is rotated so the piston height is lowered in the cylinder bore, lowering the compression ratio. In another position, the main bearings are rotated so the piston height is raised in the cylinder bore, raising the compression ratio.

In Figure 6, a Hydraulic Connecting Rod VCR-style engine is shown. This VCR engine has a more conventional look where the connecting rod attaches to the crankshaft and piston. However, the piston end of the connecting rod is much bigger due to the hydraulic control pistons and articulating piston pin assembly. The articulating piston pin assembly has the piston pin hole offset. When the hydraulic pressure is applied by the computer control valve to one of the control pistons, this assembly moves the position of the piston pin so that the piston is moved downward, lowering the compression ratio. When the hydraulic pressure is applied to the other hydraulic control piston, the piston pin assembly is rotated so as the piston is moved upward, increasing the compression ratio.

Figure 7 shows an additional piston volume change VCR-style engine. This style VRC engine was the first VCR engine that was built, and was used for rating the octane of gasoline. It was designed by Harry Ricardo in the 1920s. This engine design has a much more conventional look to it. The main difference is the volume piston contained in the cylinder head. With the volume control piston in the upward position the clearance volume is increased, lowering the compression ratio. When the control volume piston is moved in the downward position, the clearance volume is decreased, increasing the compression ratio.

Testing a VCR engine

Now that you understand the inner workings of the VCR engine, it will be quite easy to test. You will need a scan tool, oscilloscope and a pressure transducer. Install the pressure transducer in the cylinder head in place of the spark plug. Now start the engine and, without changing the throttle or RPM (which would change the volume), use the scan tool to command the VCR system to change the compression ratio. The pressure should increase or decrease with the VCR-commanded ratio change. The pressure change will be directly related to the static compression ratio that the engine can obtain. If the engine has a compression sensor in the combustion chamber, you can match the sensor output reading against the pressure transducer reading. Now you will be ready for these high-tech engines when they roll into your service bay.

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DIAGNOSING VARIABLE CAMSHAFT TIMING SYSTEMS

VCT IS NOW A COMMON ENGINE SYSTEM ACROSS A VARIETY OF MAKES. HERE'S HOW TO DIAGNOSE VCT CONCERNS EFFECTIVELY AND EFFICIENTLY.

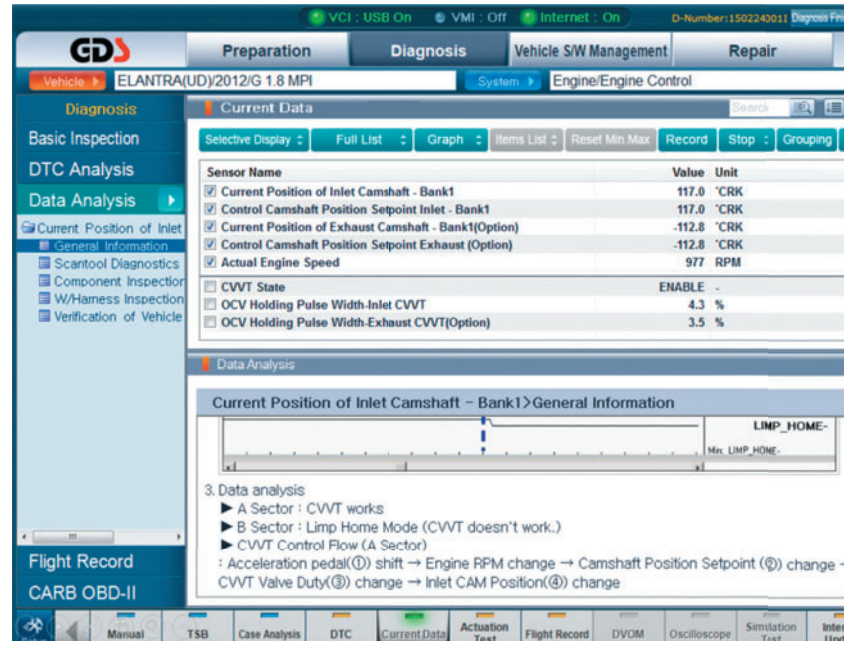
SCOT MANNA // Contributing Editor

Today almost every engine produced has some type of variable valve timing system installed to take advantage of the improvements in power and efficiency that adjusting valve timing affords. VCT, or Variable Camshaft Timing, has been around for quite some time now, so every working technician has dealt with these systems in one form or another. Let's go over some general guidelines before we delve more deeply into the diagnostics of these engines. VCT systems only change valve timing events; they do not change valve lift or duration. There are variable lift and duration systems on the market, such as Chrysler/Fiat Multi-air or BMW Valvetronic, but we will be discussing camshaft phasing systems only in this article.

The foundational knowledge you need

There are three basic designs in use today. The first is the single independent system where either the intake or exhaust camshaft is moved. Second is the dual equal where both the intake and exhaust are moved the same (think single camshaft designs like cam in-block camshafts on a V8). The third and most common today is the dual independent, where the intake and exhaust camshafts are moved independently from one another. Within these general layouts are vehicle-specific systems that actually do the work of moving the camshafts with the two most common being spline drive cam adjusters or vane-style cam adjusters (or as I commonly refer to them — "phasers.")

Spline drive systems are being replaced by vane phasers, which offer greater range of movement and faster response times. The two most com-



THIS HYUNDAI GDS SCAN TOOL DISPLAY SHOWS the current intake cam position as 117 degrees (home position) and the current exhaust cam position as -112.8 (home position).

PHOTOS: SCOT MANNA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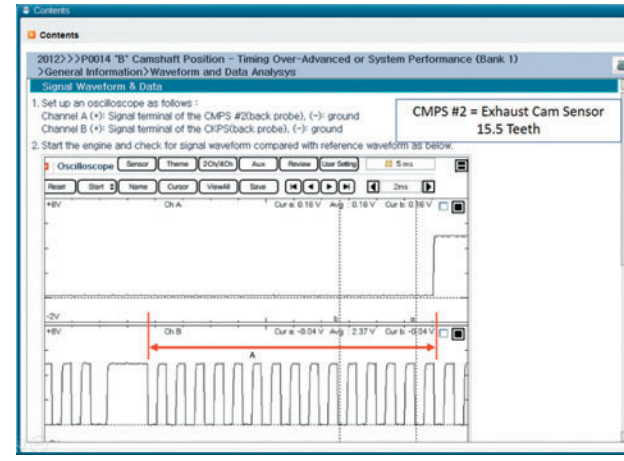
mon types of vane phasers in use today are oil pressure actuated phasers and cam torque actuated (CTA) phasers, which use the force of the valve springs to move the camshaft and not direct oil pressure. CTA phasers built by Borg Warner are used on some Ford engines and the Chrysler Pentastar 3.6 V6 engine. The most unique part of these cam torque actuated phasers is their ability to move the cam without the need for engine oil pressure so they can move the cam its full range during cranking! While this is not a strategy employed by the manufacturer, it is important to know this capability. Many oil pressure actuated phaser engines cannot move the cams at engine idle due to the low oil pressure present under idle conditions.

While knowing that camshafts are adjusted is important, it is more important to understand why camshafts are "phased" or moved in relation to the crankshaft. One of the main benefits of variable cam timing is the reduction of oxides of nitrogen through in-cylinder exhaust gas recirculation resulting from increasing valve overlap when the camshaft is phased. This allows the powertrain engineer to remove the troublesome exhaust gas recirculation hardware from the engine. To increase valve overlap, you must either advance the intake camshaft or retard the exhaust camshaft. Several domestic engines, such as the GM 4200 in the Chevy/GMC Trailblazer and Envoy SUVs, use the exhaust cam to accomplish this task. Many Asian-produced vehicles like to phase the intake camshaft to accomplish this task, so you will see many Nissan and Toyota engines that phase the intake cam. Of course, phasing both cams allows more benefits to be realized, such as improving torque output by advancing the intake cam or reducing pumping losses by moving both cams and lowering engine vacuum. The theory behind camshaft phasing can fill a decent sized textbook, so we'll wrap this up and move onto diagnosis.

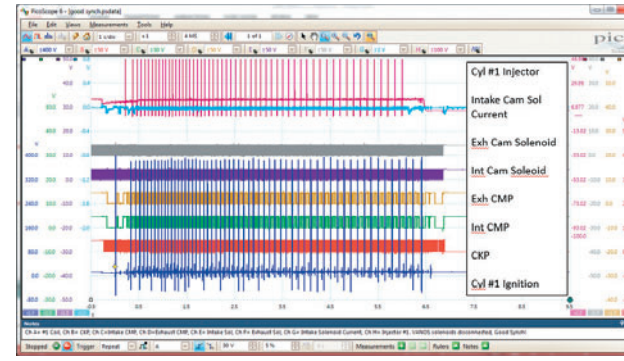
VCT diagnostics

VCT diagnosis should begin with an understanding of what the potential problem areas are. VCT problems can be grouped into three classifications: mechanical, electrical or hydraulic. Mechanical problems would be considered as stuck vane or spline actuators, stuck oil control solenoids and jumped or stretched timing chains. Electrical problems include failed camshaft position sensors, failed oil control solenoids or any wiring problems to these items. Hydraulic problems can be low oil level or pressure, wrong oil viscosity or restricted oil supply passages. Each of these areas must be tested to determine the root cause of a failure and will require different tools to complete the testing.

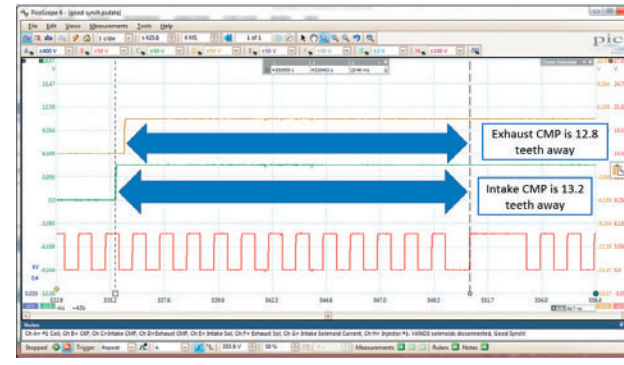
The first tool used in almost every VCT diagnosis is the scan tool. This tool at the very least will provide any codes that have set if a problem develops and depending on the vehicle being serviced, may deliver enough information to make a complete diagnosis of the problem. Some manufac-



THIS SERVICE INFORMATION ILLUSTRATION is from a 2012 Hyundai Elantra 1.8 engine, code P0014 diagnosis chart. It shows the correct exhaust cam sensor to crankshaft sensor relationship scope waveform, or sync. This is very useful for performing VCT testing and diagnosis.



THIS KNOWN GOOD SYNC waveform from a BMW 3.0 N52 engine will be zoomed into in order to take a look at CKP/CMP correlation.



HERE YOU CAN SEE THE RELATIONSHIP between the CKP missing tooth region and the leading edges of the intake and exhaust CMP sensors. The oil control solenoids were not connected.

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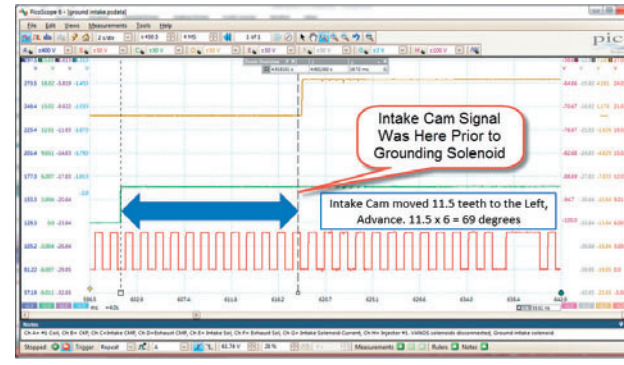
turers (such as Ford) give so much data and bi-directional controls that you may need nothing more than a good scan tool. Other manufacturers provide very little VCT system information beyond codes and will require a technician to do more thorough testing with meters and scopes.

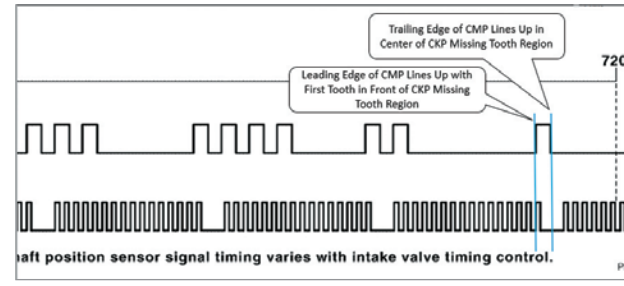
There are some need-to-know items for a technician before he or she begins a VCT diagnosis on any vehicle. You'll need to know how the engine control computer displays cam timing data on the scan tool; the range of motion or phase angle of each phaser; cam timing specifications if performing in-cylinder analysis with a pressure transducer; oil pressure specifications; known good cam/crank synch waveform; and how the oil control solenoid is controlled. Some manufacturers display cam timing data as a zero value when the camshaft is at its locked or home position and then the number of degrees of advance or retard are shown when the cam moves. A GM vehicle showing 18 degrees for the intake camshaft means the cam has advanced 18 degrees from its home position, pretty simple. Other manufacturers such as Chrysler, Hyundai or BMW may use the camshaft lobe centerline data to display cam timing. This means the cam timing PIDs can be different for the intake and exhaust cams and the numbers won't start from zero. The BMW cam timing chart shows the intake cam centerline position with the cam in the home position is 120 degrees and the fully phased position is 50 degrees, so the phaser range is 70 crankshaft degrees. If the lobe centerline is after TDC, such as is the case with the intake cam, the displayed numbers are positive and as the cam advances the lobe centerline moves closer to TDC, so the number counts down. If the scan tool displays 100 degrees on this engine for the intake cam, the cam has phased, or advanced, 20 degrees from its home position. The exhaust lobe centerline is before TDC, so the scan tool numbers will be negative. As seen on this diagram, the home position for the exhaust cam is -115 degrees and the cam can retard to -60 degrees for a range of 55 crankshaft degrees. Again, like the intake, the numbers are counting down because the exhaust cam retards and the lobe centerline moves closer to TDC. Hyundai displays cam timing data in the same fashion.

When a scan tool doesn't help

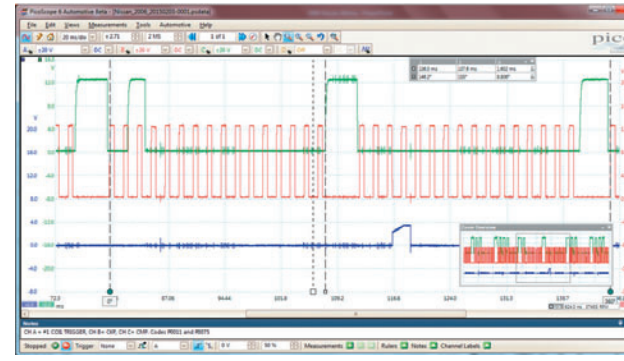
The next item to discuss is scope testing VCT systems and the issue of known good cam/crank sync relationships. This type of testing is critical in diagnosing problems, such as stretched timing chains, and will also be needed to test system operation if there is little cam timing data provided by the manufacturer, such as some BMWs or early Toyota systems.



GROUNDING THE INTAKE CAM VANOS SOLENOID moved the cam to the fully phased position. The scope measures 69 degrees; service information states a 70-degree range for intake cam travel.



NISSAN TRAINING BOOK DEPICTION of correct CKP/CMP signal relationship. I have added the callouts shown.



THE SLIGHTLY RETARDED CMP single pulse can be seen in the middle of the captured waveform.

A KNOWN GOOD CKP/CMP SIGNAL from a 2004 2.5 Nissan saved with a Snap-on scope.

Some, but not many, manufacturers provide known good scope patterns in their service or training materials. This problem of finding "known good" means there is an abundant amount of homework needed by techs in the field to scope vehicles before wear sets in and capture and save known good cam/crank sync waveforms and build their own database. This takes some considerable work but will pay big dividends later when confronted with making a decision of whether or not an engine is in sync without pulling off the timing cover to check camshaft alignment when diagnosing a camshaft timing correlation code.

I prefer to set up my scope the same way whenever I am testing VCT systems regardless of the vehicle I'm working on. If using a four-channel scope, I connect channel A to the #1-cylinder ignition signal so I can quickly identify the four-stroke cycle, channel B to the crankshaft position sensor signal, channel C to the intake camshaft sensor signal and channel D to the exhaust camshaft sensor signal. If you only have a four-channel scope and are working on a dual-bank engine, you must test one bank at a time. My eight-channel scope allows me to test both banks simultaneously, thus saving me some time moving scope leads. Once I connect to the vehicle, I start the car and capture a waveform.

It is crucial to point out at this point that if you are going to capture a "known good" sync waveform, there must be no cam phasing occurring when the pattern is saved. There are vehicles that can phase their camshafts at idle and if you are not familiar with the cam phasing strategy of the vehicle you are working on, you would need to verify with a scan tool that the cams are in the home position, or better yet just unplug the cam timing oil control solenoids before you capture a sync waveform. It would be a serious mistake to decide to tear down a motor to replace a timing chain that you think is off because you compared a waveform you captured to an incorrectly captured waveform uploaded to the internet by a tech not aware that the supposedly known good waveform he was posting had the cams moved 8 or 10 degrees from the base position. The best "known good" waveforms are the ones you capture yourself and you know exactly what the conditions were when you saved the waveform.

There are a few items you need to know when analyzing a VCT system waveform, the most important being the design of the crankshaft sensor trigger wheel. Scopes that have rotation rulers make it easy to determine how many degrees of engine rotation each tooth on a trigger wheel is valued at. For instance, many engines use a 60 minus 2 tooth trigger wheel for the CKP. This means there is room for 60 teeth, but 2 are removed to create a sync for the PCM to identify. If you divide 360 by 60 you get 6, which means each trigger wheel tooth is displaying 6 degrees of engine rotation. You can now line up a CMP waveform signal edge to the CKP signal and determine very accurately how far off an engine is from correct valve timing. I simply pick a point in the waveform where the two signals have a transition and start counting teeth.

Once you determine the correct CKP/CMP relationship, you can continue testing the system by applying power or ground to the oil control solenoid with the engine speed raised so the engine does not stall and capture a waveform of the cam sensor with the cam phased to its maximum travel. Count the number of teeth the CMP sensor has moved from its sync position and multiply by the number of degrees per CKP tooth to see if the

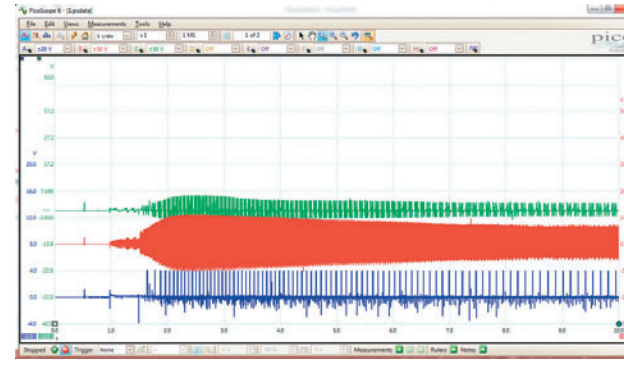
camshaft moved its full published range. Remember while viewing the signals on a scope, the exhaust cam signal will move to the right because it retards, and the intake cam signal will move to the left because the cam advances. This testing routine can be employed on any engine and can be used when the vehicle does not supply scan data PIDs for cam timing.

A real-world example

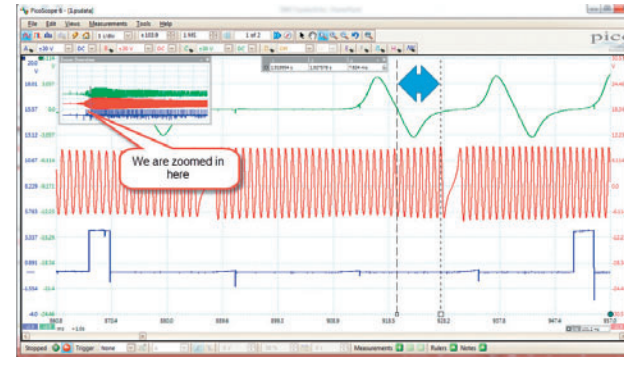
Putting this testing technique to use in the shop is straightforward, yet many techs are intimidated by scope diagnostics or are unwilling to spend the time to capture these waveforms. A shop called concerning a problem they were having with a 2006 Nissan Altima with a 2.5 engine. A code P0011 was setting. Their scanner read the intake valve timing PID as -26 degrees, and they were not sure what that meant. Some scan tools read Nissan cam timing data incorrectly, and this was one of those cases. The shop had replaced the cam and crank sensors, but the code returned quickly. I mentioned they should scope the cam and crank sensors along with the ignition trigger, but they decided to send the vehicle to me for a diagnosis. Having seen these vehicles before, I have a known good sync waveform, but I decided to look at service information to see if the data was available to the other shop to make an accurate diagnosis. Upon looking at code repair information for a P0335, I found a hand drawing of the correct CKP/CMP relationship from Nissan training information.

Armed with this data and my scope, the rest was fairly easy. The code chart diagram shows the single pulse CMP signal rising edge lining up with the first CKP tooth before the missing tooth area on the CKP signal, and the CMP trailing edge lining up directly in the center of the missing tooth gap. The waveform captured from Nissan with the cam timing solenoid unplugged shows there is misalignment. The CMP pulse is shifted to the right a little over 1 tooth. My Nissan factory scan tool read -13 degrees for the intake cam position, exactly half of what the other shop's scan tool read. This slightly retarded signal means the timing chain has stretched and will need replacement. This example clearly illustrates the need for known good waveforms when testing VCT systems.

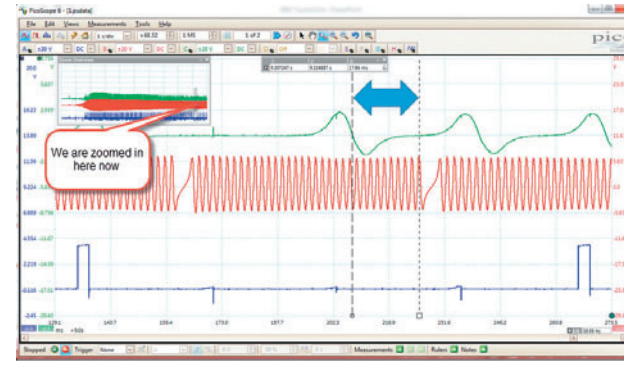
This next car came to the shop with an MIL on and a rough idle complaint. This 2002 Toyota Echo has the 1.4 1NZ-FE motor and is setting a code P1394, which is defined as a VVT system malfunction — timing does not change. This vehicle does not display cam timing data on the scan tool, and the code charts lists the first step in diagnosis as checking for correct cam timing alignment. I would prefer



WAVEFORM CAPTURE OF 2002 TOYOTA Echo testing VCT operation. This engine should not move the cam at idle. Advancing the cam at idle will cause rough running due to increased valve overlap.



CHECKING CKP/CMP RELATIONSHIP before the engine builds oil pressure.



CHECKING CKP/CMP RELATIONSHIP waveform capture showing the intake cam advanced after the engine ran a short time from a stuck open oil control valve.

not to pull the timing cover off as my first step in diagnosis, and there is certainly an easier way. I connect the scope to the #1 coil trigger signal, the CKP signal and the CMP signal. The CKP trigger wheel is a 36 minus 2 tooth wheel with each tooth representing 10 degrees of crankshaft rotation. I set the time base on the scope to 1 second per division and start the engine and capture 2 screens. I will zoom in on the waveform just after the engine begins to start and then again

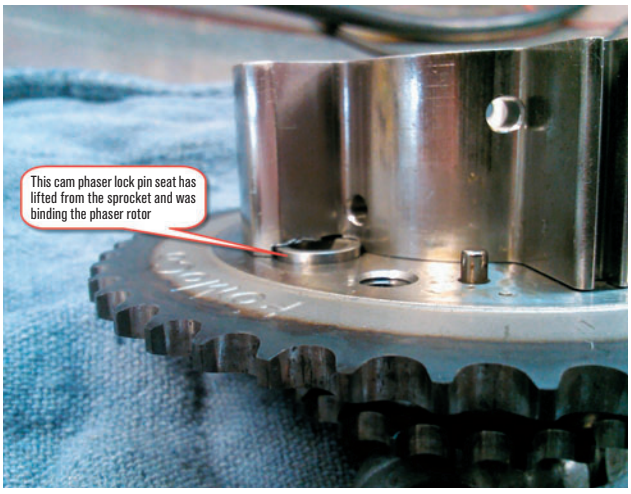
after about 9 seconds of run time.

The first zoomed-in capture shows the transition across the zero line of the CMP sensor to be about 8 teeth ahead of the CKP missing tooth region. Remember there is not enough oil pressure built up to move the camshaft yet.

The next capture shows the waveform zoomed in after the engine has been running and the oil pressure has built up. As can be determined with the scope, the CMP signal has shifted to the left and advanced — about 3 teeth or 30 degrees of cam advance. The cam should not phase at idle because advancing the intake cam increases valve overlap and will cause rough running, like opening an EGR valve at idle. The same thing happens with the oil control valve unplugged, so the problem is not an electrical issue like a shorted to power solenoid. The oil control solenoid is stuck open, and replacing it cured the problem. These stuck-open solenoids on older Toyota V6 engines are fairly common and if you see an entire bank of the engine begin to misfire after raising the engine RPM and returning to idle, you should inspect these solenoids first.

Don't forget the basics

While the scope can be a very useful tool to aid in VCT diagnosis, do not forget the basics because they can really bite you when you ignore them. Simple items like the correct oil viscosity or ensuring the engine has correct oil pressure will cause many techs to waste time testing these systems and then doubling back to check something that should be verified early on. VCT systems are tested by the engine computer for two distinct concerns: did the camshaft reach its target position and how fast the camshaft responds. Most cam phasing systems can move the camshaft its full range in less than 300 milliseconds. Even if a cam moves to its target position, it may still code for over or under advance if it moves too slowly. Correct oil pressure is a necessity when it comes to VCT response rates. Remember to inspect any filter screens that can be found on oil control solenoids or in hydraulic passages in the engine if VCT codes keep returning. Many spline drive cam phaser performance codes have been repaired simply by using chemical cleaners added to the oil and then performing an oil change. This simple step allows the gear movement to free up and allows the cam to move to the commanded position faster. VCT systems are here to stay. A systematic troubleshooting plan will help you diagnose these systems with confidence. Hopefully the testing strategies outlined in this article will provide a good foundation for successful VCT system repairs.



THIS PHASER WAS REMOVED FROM A 2008 MERCURY SABLE with a 3.5 V6. The phaser lock pin seat that is pressed into the sprocket has lifted and is cutting a groove into the phaser rotor. The unit would bind intermittently and set a code P0022 for over-retarded cam timing.

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BEAM ME UP, SCOTTY!

THE SYSTEM TECHNOLOGIES THAT WERE ONCE ONLY A FIGMENT OF AN ENGINEER'S IMAGINATION ARE THE SYSTEMS WE ARE SEEING ON PRODUCTION CARS TODAY. ARE YOU READY FOR WHAT TOMORROW MAY BRING?

PETE MEIER // Technical Editor

It seems like this is a question we've been asking ourselves for a very long time now. I think it all started when the first computer was used to manage emissions nearly 40 years ago. Now, you younger techs have to bear with me here. I'm an old-timer and the first cars I worked on were carbureted beasts, and the most complicated electronics they had were the AM radios on the dash. I've watched the entire era of computer-controlled systems evolve from the first throttle body injection systems to the technologies we have today. And, to be honest, it's taken some effort to keep up with it all. Many of my peers didn't and have fallen by the wayside as a result.

And I got news for all of you just entering the field. With what is on the market today and what is coming down the road, I'm betting you'll be making similar comments when your hair starts to turn gray!

Just 10 years ago

One example of the changing technology is discussed elsewhere in this issue in an article by Bernie Thompson entitled "VCR – A future technology applied today." No, VCR does not stand for "Video Cassette Recorder" — it stands for "Variable Compression Ratio," and it's a topic I actually wrote about nearly 10 years ago. At that time, though, the engineering was only in prototype. Today, at least one design is scheduled for use on a production vehicle, slated to debut on the 2019 Infiniti QX50.

PHOTO: INFINITI

THE 2019 INFINITI QX50 will be the first production model equipped with a VCR engine.

As with most of the "new" technologies surrounding engine management, the idea of variable compression ratios is a result of old concepts revisited with the capabilities engineers have at their disposal today. The basic four-stroke cycle remains the same. It's just being fine-tuned for maximum efficiency across the entire operating range by providing a variety of means of changing the engine's operating modes. Of course, the resulting increases in efficiency mean more power and better fuel economy. It also means additional training to fully understand how the system works and how to fix it when it doesn't!

Another challenging technology you're going to soon face (if you haven't already) are the ADAS (Advanced Driver Assist Systems) in use. These are the blind-spot monitoring systems, the anti-collision systems, even the parking assist systems — and that just names a few. Most of these systems rely on radar, cameras or a combination of the

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two as primary inputs. Some routine services you're used to performing can cause these systems to malfunction if the proper procedures aren't followed.

One example is something as simple as replacing a damaged windshield. If the new glass doesn't meet the OEM specification, the forward-facing camera assembly (many are incorporated into the rearview mirror assembly) may get a distorted view of the road ahead and pass that misinformation along to the controller. The now-confused controller may think the vehicle is drifting right or left, and continuously "buzz" the driver's backside in warning (passive systems) or activate the brakes accordingly to correct (active systems). In reality, you now have a "pull" in one direction or the other that no amount of alignment corrections are going to fix.

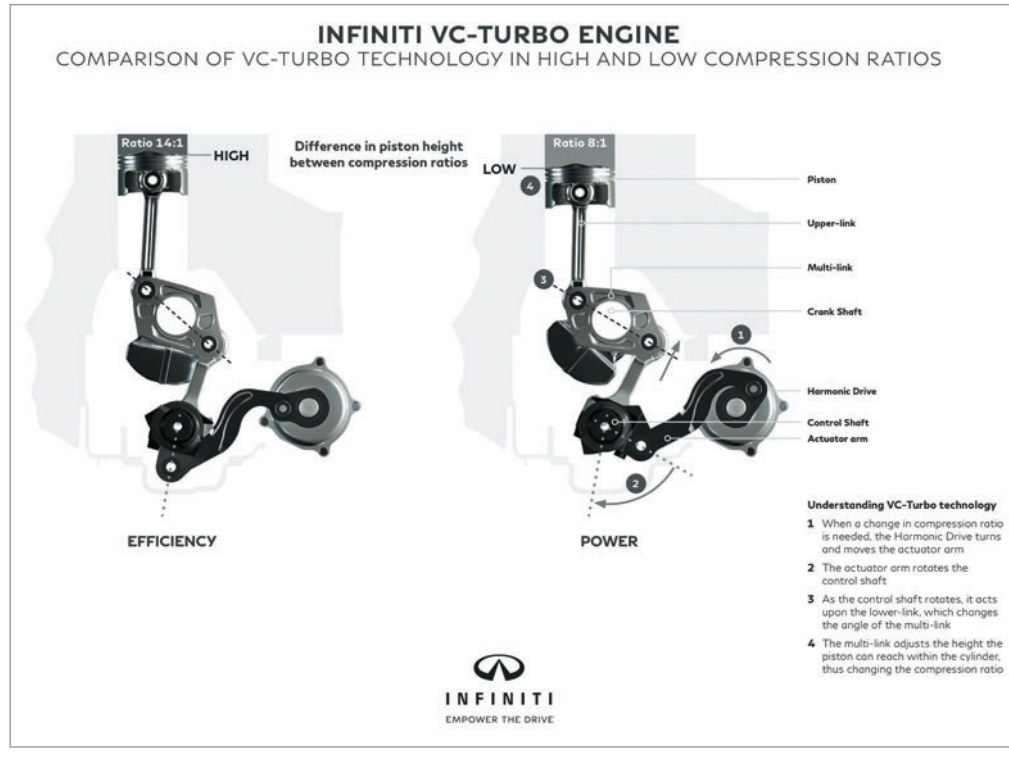

PHOTO: INFINITI

THE VCR DESIGN USED BY NISSAN allows for continuously changing piston position, allowing for maximum charge compression without detonation.

Another challenge related to ADAS is the recalibration of the camera and/or radar components after a unit is replaced. Reminiscent of the early days of On Board Diagnostics, there is no "standard" practice in place. What that means is a potentially high investment cost of the targets and tooling you'll need to perform these recalibrations, and that doesn't even take into account the often massive shop floor space some OEM procedures require. Can you shortcut these processes? You probably can (as more than a few YouTube "gurus" have demonstrated) but do you really want to? These are safety systems, after all, and if you try to shortcut a recalibration process to save money, you may find yourself spending a lot more when that vehicle is involved in an accident and the family's lawyer comes calling.

Here's another take from the "oldies, but goodies" file: It's been almost 30 years since the first hybrid was introduced in the U.S. How many of you have embraced hybrid and EV technologies? How many of you have gotten formal training on how to properly (and safely) service, troubleshoot and repair the High Voltage (HV) systems?

Hybrid and EV sales are on the rise, albeit slowly. But in a recent article, I read where many experts feel that the 2030 MY will be the tipping point among consumers. That's only a decade away! Some automakers have announced that they are increasing their number of hybrid and EV offerings and one has even stated it will cease making gasoline-only powered models in the very near future. Heck, even the iconic motorcycle brand, Harley-Davidson,

PHOTO: HARLEY-DAVIDSON

EVEN HARLEY IS GETTING IN ON THE EV TREND, offering the Project LiveWire to consumers in the 2020 MY (forecast).

has joined in on the EV trend announcing the addition of an EV-powered model in the 2020 MY. Imagine, Peter Fonda and Dennis Hoffman cruising across the country on a pair of those!

Now consider just how fast the last 10 years have passed. These technologies, the new and the not so new, are going to overtake the industry within the lifetimes of many of you reading this article today. And just as I'm sharing the memories of the early days of my career, imagine yourself sharing with your grandchildren what it felt to actually "drive" a car or what it sounded

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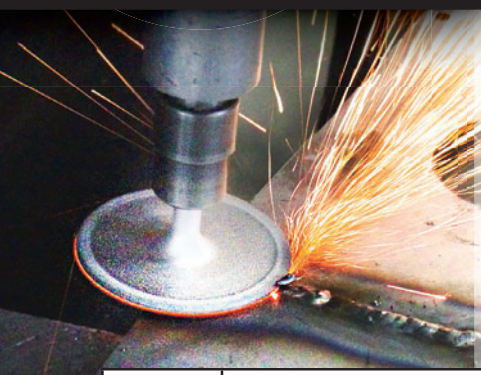

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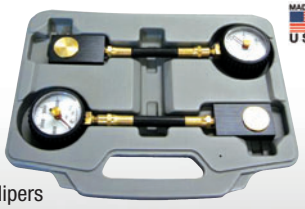

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like to hit WOT on a 400hp V-8!

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In only a few more months, NACE Automechanika will be opening its doors in Atlanta! The event is being held Aug. 8-10. This year's training event is focused on the topics you've wanted most and features the top instructors in the nation. Nearly every independent instructor presenting at Automechanika is doing what you do every day — working on cars and solving problems — and they will be bringing their hard-won lessons to the event. Don't miss out!

Another program we have for you is *Motor Age Training* CONNECT, an online video-based training platform that you can use as a supplement to your current training plan. With over 350 titles in the library today, and more being added every month (including a few featuring yours truly!), you'll be sure to find content that fits your needs. You can also start a track program that takes you from newbie to Master in a more structured approach. That's the one I'm on and I've already learned a lot, even in the early segments of the program.

PHOTO: PETE MEIER

YES, I AM A *MOTOR AGE TRAINING* CONNECT STUDENT.
This is the first certificate I earned, back in January.

It's a small monthly subscription, and you can cancel at any time — no long-term contracts or any of that nonsense. Between these two training opportunities, *Motor Age* has you covered!

Remember the Scion?

Last month, I shared the frustration of trying to solve a cold weather shudder my wife was experiencing on her Scion tC. I'd like to report that I've found the problem, but I can only share that I found the source of the noise only — and not the underlying cause.

The noise turned out to be the hood rattling, or more precisely "buzzing" when all the right conditions were met. I made a slight adjustment to the hood bumpers, located at each side of the engine compartment, to apply a bit more tension on the latch. That took care of the noise, but not the issue that allowed the vibration in the first place. And, of course, now the weather is warm and I can no longer duplicate the symptoms. Guess I'll have to wait until the next few weeks of winter to come along!

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

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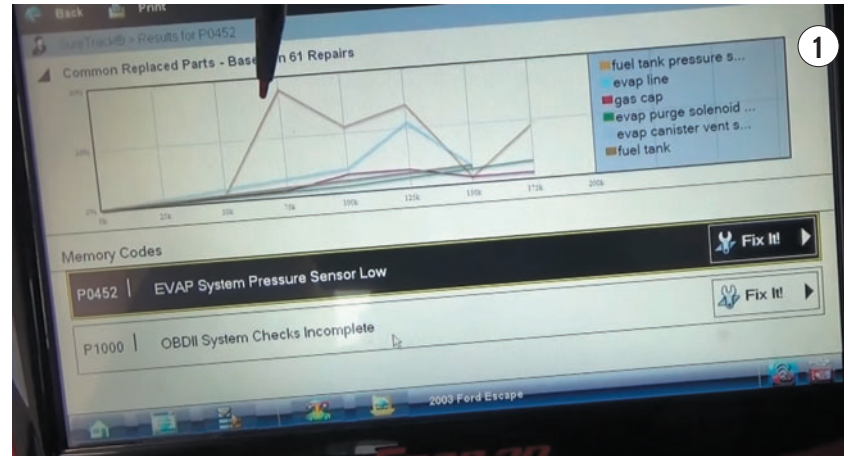
EVAP CODE P0452 — SIMPLE, RIGHT?

THIS MONTH, WE WELCOME A NEW CONTRIBUTOR – ERIC "O," SHOP OWNER AND HOST OF THE "SOUTH MAIN AUTO REPAIR" CHANNEL ON YOUTUBE. WE'RE SURE YOU'LL ENJOY HIS FIRST TALE!

ERIC OBROCHTA // Contributing Editor

I started out my diagnosis on a 2003 Ford Escape with an automatic 3.0 VIN 1 24 Valve V-6 just like I would any other vehicle that I bring in the bay. First, the customer interview to gather the information and the complaint — with just shy of 200K on the odometer, the MIL light is on — then gather some codes and data, come up with a plan, repair and verify and then move onto the next one. Little did I know my plans were about to be derailed!

The customer had no complaints other than a glowing MIL light. A quick scan revealed a P0452 "EVAP System Pressure Low" both pending and current (Figure 1). It's nothing new for us in the rust belt to see EVAP codes on a day-to-day basis — that's for sure! While sitting in the driver's seat, I decided to have a quick look at the Fuel Tank Pressure (FTP) data PID and quickly discovered it was at 2.6v KOER, which is normal for a Ford EVAP pressure sensor sitting at atmospheric pressure. Wanting to see if the FTP sensor would respond to vacuum, I opened the vapor management valve (purge solenoid) with the scan tool and saw the voltage drop was around 2.19v (Figure 2). That is about what I would expect to see considering the canister vent was still open. OK, so what is going on here? I don't recall at the time what possessed me to increase the rpms, but I did. Perhaps it was in an effort to gain a bit more vacuum on the decel while



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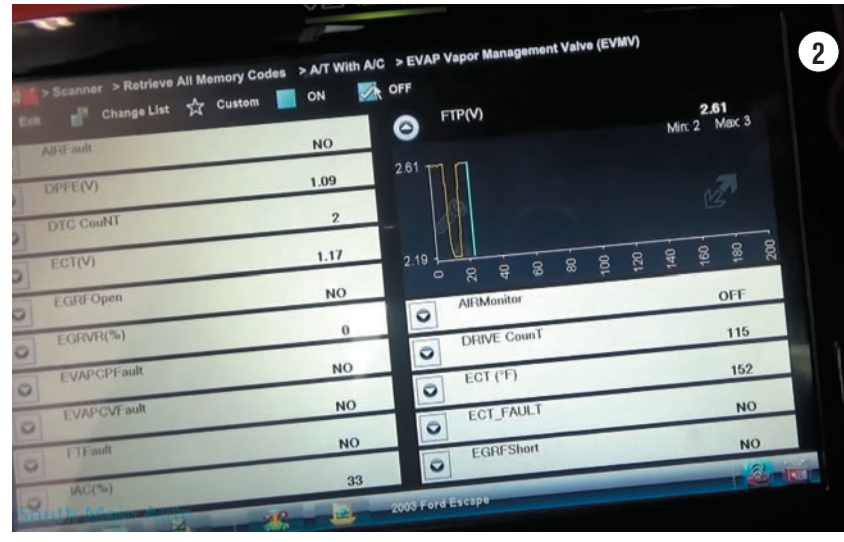

2

PHOTOS: ERIC OBROCHTA

watching the FTP data PID with the vapor management valve still open. Whatever the thought was, it turned out well because it revealed the problem! At EXACTLY 3,000 rpms, the FTP data PID would drop straight to zero volts (Figure 3)! OK, you have my attention, I thought.

I now knew what the ECM was looking at and why it flagged the code. After all, it met the code-setting criteria. I pulled up a wiring diagram to see what I could gather from it and to verify what I already knew (Figure 4). It is a standard three-wire 5v pressure transducer that was easily accessible under the driver side rear seat — a ground wire, signal wire and a 5v reference. It also shared the same 5v reference as the Differential Pressure Feedback EGR (DPFE) and the Throttle Position Sensor (TPS). Thinking to myself that if the sensor shares the 5v reference and it was losing it, and it happened to be at or before that splice S105 that I saw in the diagram, certainly we could see that in scan data because it should affect the other sensors sharing the same 5v reference, right?

Time to test a theory

After a moment of recreating the conditions and monitoring the TPS and DPFE PIDs, they appeared to be unaffected. I knew it could not be losing the ground side because if that were the case, the voltage should go high. I verified this by simply unplugging the sensor and indeed it did go high (Figure 5). While I still had the sensor unplugged, I recreated the conditions of the fault and the signal stayed nice and steady. However, after plugging it back in, the condition was still present (Figure 6). We did not correct the condition by unplugging it or messing with the harness.

Now that I had grabbed what data I could, I decided to use a graphing DVOM to look at the wires right at the FTP

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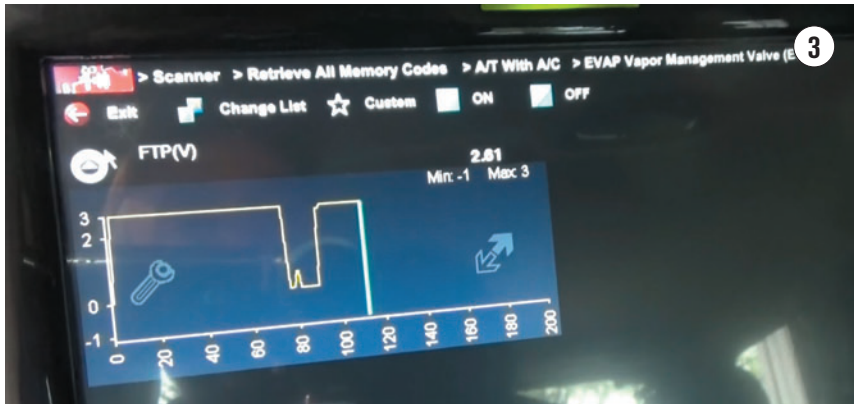
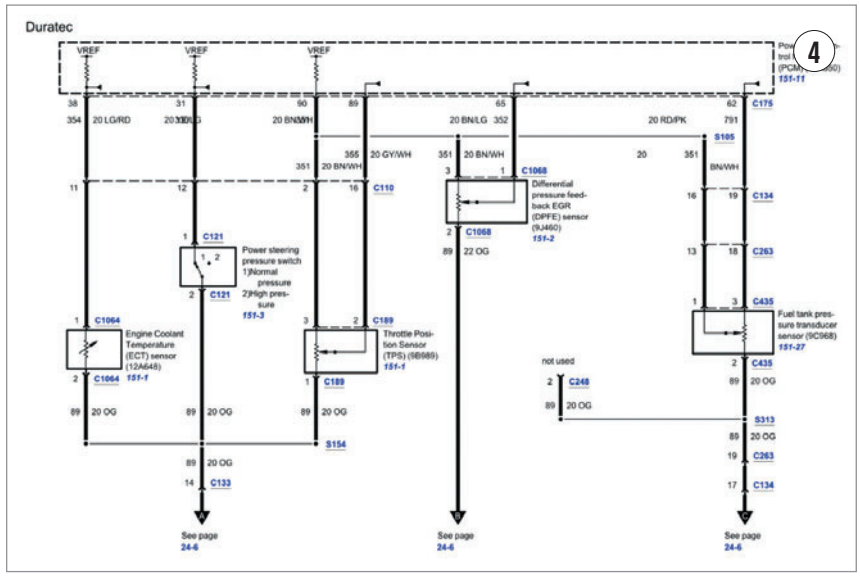
sensor in hopes to get an idea as to what was going on. It is a two-channel meter, so I monitored the 5v ref, signal wire and ground all at the same time and it revealed exactly what the scan tool was showing. When the signal wire dropped to 0v at 3,000 rpm, the ground and 5v ref stayed perfect. Or so they seemed. Not really knowing where to go next, I decided to just double check the circuit integrity of the signal wire from the ECM to the FTP sensor. I unplugged the FTP sensor and the ECM, supplied battery voltage on the signal wire and with a 780mA test light on the other end and it seems to carry current just fine (Figure 8).

At this point, I really just don't know. With a parking lot full of other work, it was getting hard to concentrate. Part of me is thinking the ECM is gone wonky, but the fact that it is so predictable and it only does it at 3,000 rpm is still weighing in my mind. I decided to substitute a known good (used) FTP sensor (Figure 9). With the used sensor installed it did the same exact thing! I decided to gather a bit more data on a test drive, and it revealed that driving it made no difference and it still drops out at 3,000 rpm. Engine torque, bumps, forward, reverse, hot or cold — nothing made a difference.



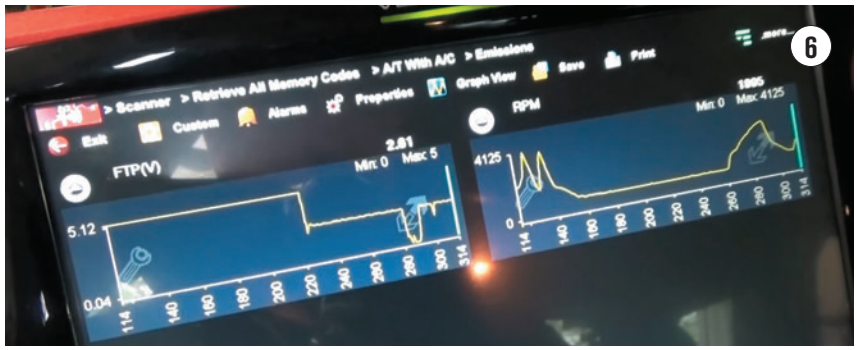


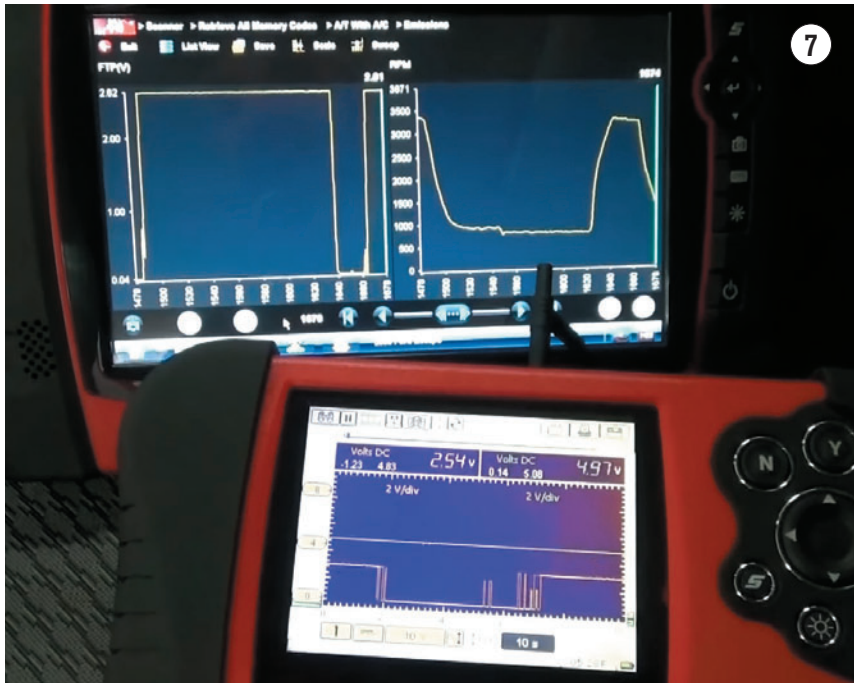
Not beaten yet!

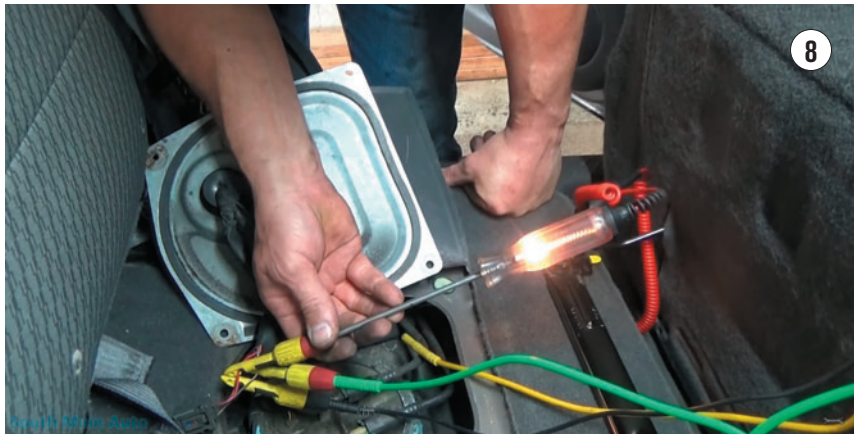
Feeling out of ideas, I called my friend and mobile tech Keith DeFazio from New Level Auto Diagnostics in Staten Island, NY. We discussed what tests had been performed and what the possible causes were and tried several things such as unplugging DPFE, TPS and re-testing.

Unplugging either the DPFE or the TPS sensors caused the problem to disappear! WHY?! Was something happening on the 5v reference? It was time to have a closer look, using the scope feature on my DVOM. With the scope hooked back up, there it was staring me in the face. At 3,000 rpm, the 5v reference would go into a high frequency hysteria (Figure 10). Seeing this, however, only brought about more questions. The main one: where is all this noise coming from and why is it affecting the signal wire and making it drop right to zero volts?

While I was still contemplating ideas, I needed to know if the signal was being "sent" by the ECM or "received." The easiest way to do that was to just cut the wire near the ECM and scope both ends of it, and I discovered it was coming from the FTP sensor to the ECM. I still had no idea why, though. However, it did lead me away from thinking it was the ECM at the time. All I knew was something was changing at 3,000 rpms.







At this point I have tried unplugging the coils, the alternator and various other components, just to try and get an idea of where this noise is coming from and was not making any progress. I decided to study scan data some more to try to gather some clues as to what could be changing. I thought to myself: is the alternator duty cycle changing?; is there a device or output turning on at the same

time?; ANYTHING? Still nothing.

Deciding to call it a night, I figured it is best to go home and sleep on it. I woke up at 3 a.m. and rushed back down to the shop to fix this mind-bender. On my way out the door, it dawned on me that I never saw a Power Steering Pressure (PSP) switch input on the scan tool. Could that be changing? I clearly remember thinking to myself, "that is a 5v switch, right?" I walked back in the shop, fired the scan tool back up and unplugged the PSP switch. I GOT IT!!! The problem was gone! But why?!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I grabbed the scope, back probed the connector, and there it was (Figure 11). The PSP switch at 3,000 rpm was opening and closing like a mad man. I also discovered I was wrong; it is not a 5v switch — it is indeed a 12v switch. Good thing I was tired and did not give it a second thought. Had I known it ran off a 12 circuit, would I have gone back in and checked it?

A new PSP switch was fitted the following morning. The EVAP code was repaired, drive cycle was completed and the symptoms were corrected. As a mechanic who grew up in this field and learns from self-study and by getting my butt kicked from time to time, this one humbled me and taught me a few things. The first thing was to use my scope feature from the get-go even if it seems unnecessary. You never know what it might show you. It also reminds us that sometimes we do need to walk away, clear our heads and not give up! I also learned the value of having a great friend in the industry who shares the same passion for repairing vehicles as I have and is always willing to bounce ideas around.

I tend to chuckle every time I have a vehicle come in now with an EVAP code tripping the MIL, because you just never know. It may just need a new power steering pressure switch! Who would have thought?

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AD INDEX

AD INDEX

PRODUCTS

TRACKING DOWN BELT NOISE

NOTHING IS MORE ANNOYING THAN A SQUEALING BELT. BUT WHAT DO YOU DO WHEN YOU REPLACE THE BELT WITH A NEW ONE — AND THE NOISE REMAINS?

PETE MEIER // Technical Editor

Squealing belts are kind of like fingernails on a chalkboard. (If you're old enough to remember that reference!) It's a noise that just penetrates to the bone and is, at the least, annoying.

On cars still equipped with adjustable belts, usually the noise is easily corrected by a readjustment of the belt tension. Of course, any good tech is going to inspect the belts for signs of wear: cracking, frayed edges, contamination, just to name a few.

But what about cars equipped with non-adjustable serpentine belts? Many techs still rely on the visual inspection method to determine the condition of the belt. But with most now being made with EPDM (Ethylene Propylene Diene Monomer — a synthetic rubber), a visual inspection alone may not reveal a belt that has reached the end of its serviceable life.

And what if the noise doesn't go away when you install the new belt?

Other factors that come into play when tracking down a noise concern include the condition of the accessory pulleys, the condition of the tensioner, the alignment of all the pulleys, and even the quality of the belt itself. Anyone remember the Chrysler minivan TSB requiring the fitting of an updated belt to their models to address a noise issue?

In this edition of The Trainer, we'll

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demonstrate how to inspect the condition of these EPDM belts and then dive into troubleshooting the more common causes of belt noise. When we're all done, you'll be prepared to solve those annoying concerns for your customers quickly — and permanently!

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