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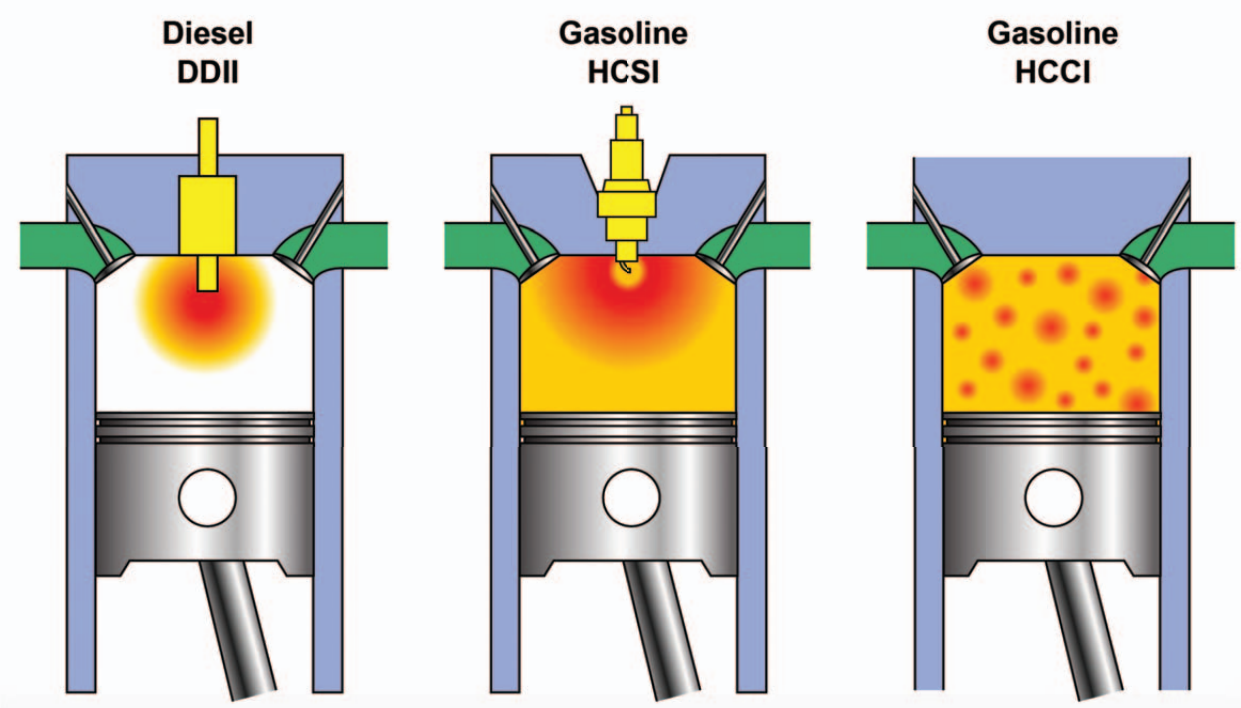
Take a look inside HCCI

INSIDE: SHOP MANAGEMENT SYSTEM POWERED BY AI



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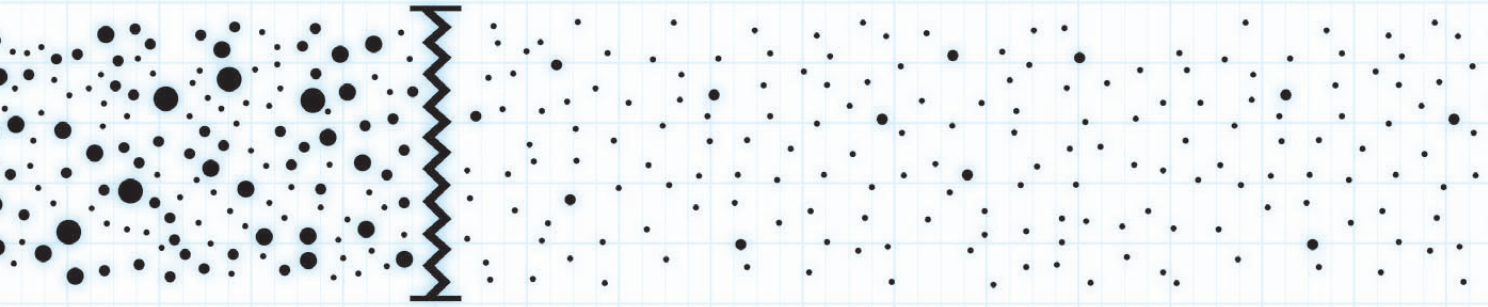

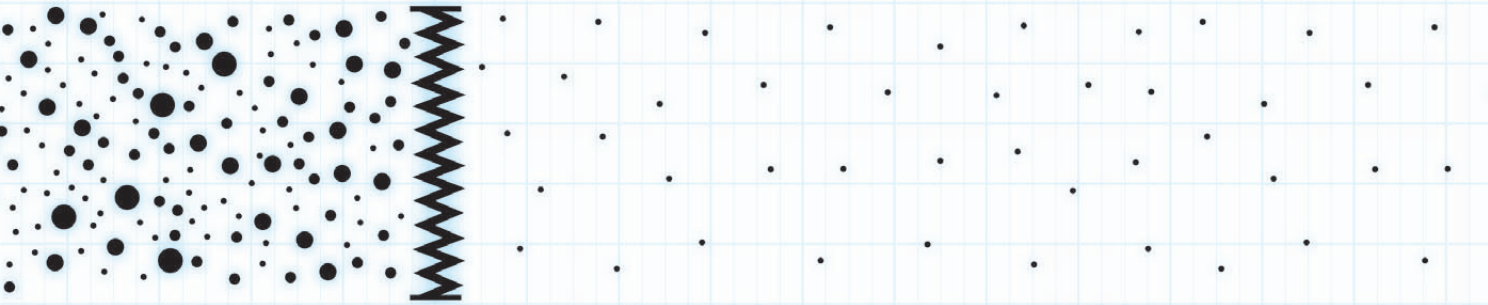

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MOTORAGE.COM/DISC

EVAP SYSTEMS — OPERATIONS AND TROUBLESHOOTING

Do EVAP leak codes frustrate you? In this webinar, Pete and G. review EVAP system designs and demonstrate the testing of the various components. We'll cover system operation, valves, lines, the charcoal canister, gas tank and more. We'll also show you a number of leak-detection techniques.

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ARTIFICIAL INTELLIGENCE

NEW SHOP MANAGEMENT SYSTEM UTILIZES AI

CHELSEA FREY // Senior Associate Editor

Artificial Intelligence (AI) has been innovating countless aspects of our day-to-day life for years — from apps that can determine the best route based on the current speed of traffic to Facebook's algorithm that personalizes your newsfeed to the spam filters of your email. Now, AI is innovating the day-to-day of independent repair shops by helping them run their businesses more effectively.

Shop4D, a technology company founded in 2018 by the founders of Auto Profit Masters and the RPM ToolKit, has launched a new cloud-based shop management system that integrates every aspect of the repair into a single tool. The system's AI then learns from every inspection, advisement and communication and proactively shows the owner how to run the shop more efficiently.

>> AI CONTINUES ON PAGE 5

BREAKING NEWS

ASA OPENING

ASA SEEKS NEW EXECUTIVE DIRECTOR

The Automotive Service Association (ASA) is seeking a new executive director.

Between now and Oct. 1, 2018, ASA is inviting interested and qualified candidates to submit their applications to lead the 67-year-old association.

Roy Schnepper, ASA chairman of the board, will be heading the Nominating Committee efforts to find a new leader.

"Associations are undergoing enormous challenges due to generational shifts, social changes and technology," said Schnepper. "It's crucial that we find the right person who can be an industry leader and provide our association with a clear vision for our future."

ASA has a vacancy in its executive director role due to the departure of Dan Risley, its former president/executive, who left to pursue an opportunity in his home state of Illinois. Beth Risch, the association's current CPA, has been appointed

>> ASA CONTINUES ON PAGE 5

TRENDING

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DENSO FOUNDATION AWARDS STEM GRANTS

DENSO will donate nearly $1 million in overall funding to 25 institutions of higher learning across North America to support science, technology, engineering and math education programs.

MOTORAGE.COM/STEM

AAPEX FORUM TO DISCUSS IMPORTANCE OF ADAS RETROFITS

The new ADAS Forum — Saving Lives Through Retrofitting ADAS on Existing Cars will be held on Nov. 1 from 10-11:30 a.m. during AAPEX 2018.

MOTORAGE.COM/ADAS

ASSOCIATIONS URGE TO MODERNIZE NAFTA

Automotive industry associations representing parts and vehicle manufacturers are urging a renewed focus on trade negotiations with the U.S., Canada and Mexico to modernize NAFTA.

MOTORAGE.COM/MODERN

TARIFFS A THREAT TO INDUSTRY, SAYS MACS

After 25 percent tariffs went into effect on a list of Chinese goods, many MACS members have voiced concerns on the impacts these will have on all sectors of the auotmotive industry.

MOTORAGE.COM/TARIFF

PHOTO: SHOP4D

>> AI CONTINUED FROM PAGE 4

The need for AI in auto repair presented itself when the creators of Shop4D, David Rogers and Terry Keller, realized that the most difficult aspect of turning a struggling repair shop around is getting the owner and staff to truly act on the metrics of the business. AI can also help with another daunting challenge for shops — the technician shortage. Rogers explains, "There are far fewer technicians coming into the industry, so we had to come up with a way to make the entire repair process much faster and more efficient — even the diagnostics — so that a shop can move those vehicles through faster while relying more on facts and data."

The process of Shop4D looks like this: When a vehicle arrives at the shop, the shop's tablet or cell phone camera reads the VIN and starts the check-in process. By the time the vehicle is dispatched, the technician already has access to recall and TSB information, and the AI is already working to diagnose the vehicle. As the tech is doing an inspection, Shop4D will source parts and begin to build the invoice. You may be wondering where the vehicle-specific information is sourced — Shop4D has partnered with Epicor and Motor to provide integrated parts and labor time lookup, service intervals and more.

Aside from vehicle inspections and parts ordering, AI is also incorporated into the shop's point of sale, customer communication and marketing, credit card processing, and management and measurement.

The true innovativeness of AI lies in its ability to constantly learn and fine tune the data processing as more information is added. Shop4D takes that ability of AI and expands it exponentially — once a shop has switched to Shop4D on the shop's existing devices, they're connected to an AI that is constantly learning from each shop on the system. Every repair and interaction thus makes the program smarter for all businesses connected to it.

Chris Morgan, manager of Keller Bros. Auto Repair in Littleton, Colo., has implemented the technology in his shop and has seen improvements for the business and his employees. He shares, "Every team member — myself, the techs, the service writers — has more time to focus on their primary job because they are spending less time diagnosing a problem, doing research or dealing with busy work. With nearly every step automated from the moment a car comes into the shop, we have more time to focus on providing excellent customer service and fixing the vehicle, so we're able to bill more hours and spend more time growing our customer base."

As this system shows, AI could provide independent repair shops the edge they need to compete with larger repair centers and dealerships. One thing is certain: the shop of the future is no longer an idea in our imagination — it's here.

To learn more about Shop4D, visit www.shop4d.com.

>> ASA CONTINUED FROM PAGE 4

as interim chief operating officer. Risley remains as a consultant to the association to provide continuity during the transition.

The Automotive Service Association is the largest not-for-profit trade association of its kind dedicated to and governed by independent automotive service and collision repair professionals. ASA serves an international membership base that includes numerous state affiliate and chapter groups.

ASA advances professionalism and excellence in the automotive repair industry through education, representation and member services. To take advantage of the many benefits of membership in ASA, please visit ASAshop.org or call (817) 514-2900, ext. 2.

MITCHELL 1 OFFERS TRAINING WEBINARS

MOTOR AGE WIRE REPORTS //

Starting in the fall, Mitchell 1 will offer Manager SE shop management software workshops via free online webinars, covering the most popular topics from the workshop curriculum, including customizing the software to your business; recommendations, revisions and technician worksheets; canned jobs, part kits, packages and discounts; inventory, purchase orders and parts catalogs; scheduler configuration and appointment tools; and recent features added to the software.

"Over the years, we've had many requests to make our popular Manager SE training workshop material available to a broader audience than we can accommodate in a traditional classroom setting," said Tim McDonnell, senior market manager for Mitchell 1 shop management. "So, we're excited to deliver the high-value content online, giving more people the opportunity to attend and benefit from training."

Look for updates on course titles, dates and other details using the interactive Manager Forum toolbar button or visit http://www.managerforum.net.

SHOP MARKETING FOR ARTIFICIAL INTELLINGENCE

"Good data" in AI leads to successful marketing

DAVID ROGERS // Contributing Editor

What makes automotive repair shop marketing effective?

That might seem like a strange way to open an article on artificial intelligence (AI) and marketing. After all, can't we just ask a computer to tell us what makes marketing effective? But the truth, as we'll see in a moment, is that computers are only as smart as the data they're given to learn.

Which is why this is such a critical question to ask, and why I want to answer it up front. Effective marketing — the kind that leads to sustainable growth for a repair shop — is marketing that attracts and retains quality customers. It builds trusting relationships

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Effective marketing isn't measured by ROI or car count (no matter what some marketing companies tell you) or by how busy you feel (no matter how much stress it takes away), but rather by looking at the long-term health of the business and loyalty of your customers.

And when it comes to AI, that difference in the definition of effective marketing is like a chasm. Here's why.

First, let's remove some of the mystery. AI isn't sorcery. You can't just turn on a computer and wait for it to become self-aware. You must teach it, and it learns a little, and then you test it and teach it some more.

Think about self-driving cars and a simple stop sign. When a human is behind the wheel, they can recognize a stop sign easily. It's got eight sides, it's red, it says stop. If there's graffiti or a sticker on the sign, it's still easy to identify it as a stop sign. But if you're a computer, and you expect a sign to be red and octagonal, say 'stop' in white and now there's other writing on the sign — does it still mean stop?

What if it's dark and it's hard to tell if it's red? What if it's partially behind a bush? Is half a stop sign still a stop sign?

AI is the long, drawn out process of showing a computer enough pictures of stop signs — big, small, clean, dirty, easy-to-see, partially hidden, and on and on — that the computer can recognize that simple stop sign and obey basic traffic laws.

But what happens if you teach your self-driving car that stop signs aren't red and octagonal, but yellow, upside-down triangles? Just because the computer thinks that yield signs are stop signs doesn't make it real. It will now make decisions based on bad data.

Which is why it's so critical to be clear on the definitions of marketing and AI. If you teach a computer that effective marketing is based on car count, then you're likely to get results that lead to more car count at the expense of the size of your average ticket and customer loyalty and long-term success.

We hear about the dangers of AI and how we need to be fearful of it, and this is why. In the wrong hands — trained with the wrong data or trained to look for the wrong solution — AI can destroy. If a marketing company doesn't know how to measure the long-term effect of marketing on a business, but wants to train AI to support their marketing strategies, it will end up being deadly for the shops that take that advice.

In other words, AI isn't a magic elixir. Indeed, there's plenty to be wary of.

Not least of all because "Artificial Intelligence" is a marketing buzzword right now, and can be twisted to mean something as simple and basic as "we use spreadsheets and graph the data." Real machine learning — the kind that leads to better marketing — cannot happen overnight. You must spend the time measuring marketing so you can teach the computer what effective marketing is and how it works.

Even more importantly, and to hammer this point home, it also takes an understanding of what makes marketing effective.

In other words, beware of anybody who promises AI-driven marketing that doesn't have the history (and therefore the data) to make that claim possible. There's a reason why people get degrees in statistics and mathematics to start a career in teaching a computer how to learn — it all starts with a lot of measurement.

With all these warnings out of the way, AI does mean incredible new possibilities for marketing in automotive repair shops.

Better marketing messages

We are not yet to a point where computers can start crafting marketing messages. There's a reason why the internet is full of hilariously terrible attempts by AI to write marketing messages, movie scripts and songs: the technology is not there yet.

By measuring the effect of a marketing piece on the health, trust and loyalty of your customer base, a computer can recognize what marketing messages work best with particular types of customers. Imagine being able to target great customers with the messages that are most likely to work on them, every time.

But that big warning light is flashing again. You can train a computer to tell you which marketing is most effective, but if you don't know yourself, the results the computer provides will be ineffective. If you train a computer that customer loyalty is less important than an immediate spike in car count, AI will give you the tools to destroy your customer base more effectively than ever.

Better marketing budget

We all know auto repair is seasonal. You can mitigate it through your marketing, but summer is always busier than the holiday season.

What we're finding is AI can help plan for that seasonality.

There aren't shortcuts, of course. It takes looking at years of past performance, and years of marketing budgets, and again, understanding how to attract and retain quality customers, but AI can use all that measurement to help plan for the future.

Combined with the computer's findings on best marketing messages, shops are suddenly looking at a future where their marketing budgets are fine-tuned for reaching great customers and driving them all year long

so that those car count peaks and valleys are flattened out.

Better marketing results

When you target the right customer with the right marketing at the right time, you can sustainably grow your shop. But, just as AI doesn't happen in a vacuum — it must be taught the real results of effective marketing to predict how to increase those results — your marketing doesn't happen in a vacuum either.

You can send the perfect message to the perfect potential customer, but if your customer service breaks down at the shop, you'll lose that customer forever. Unless you're also measuring your team and your shop, unless you are fixing production bottlenecks and perfecting your service advising processes, unless you've got your profit margins dialed in, your incentive pay plans in place, and your team trained and accountable, marketing can and will fail.

There's a common trap that shop owners fall into when it comes to marketing: "If only I had more cars, all of my problems would be solved." It leads to owners switching marketing companies once a month to try something new and/or less expensive. That means havoc for marketing, of course. If no campaign can ever be maximized because it doesn't run long enough to be measured and adjusted, then a significant portion of those marketing dollars end up wasted.

But more than that, it ignores the problems that led to low car count in the first place. Yes, sometimes, more cars are all that's needed. But more often than not, car count dropped off for a reason. Poor customer service, incomplete inspections, broken production pipeline, uncommitted team — these things must be measured (even analyzed by AI) and improved if your marketing is going to be truly effective and sustainable.

In other words, AI can lead to a marketing renaissance for auto repair shops, but it can't replace doing the important things that lead to a shop being successful: measuring your team, training them and holding them accountable, every day.

This is an exciting time to be a shop owner. AI is starting to give us control over every aspect of our shops — from accountability to training to marketing. If you understand who is behind the AI — and how they're training it — the coming months and years will change the industry for the better!

DAVID ROGERS is chief operating officer of Keller Bros. Inc., president of Auto Profit Masters and president of Shop 4D, the industry's first Artificial Intelligence (AI) -enabled, self-learning system for proactively managing repairs, customers, marketing, profits and employees. Reach David via email at *contact@shop4d.com,* toll-free at 1-866-826-7911, or *online at https://shop4d.com/.*

A PROCESS OF TRIAL AND ERROR

Strategies to help make your next advertising program a success

TIM ROSS // Contributing Editor

Have you ever overcooked a steak or planted a garden that didn't bloom? Chances are, you didn't give up cooking or gardening afterward. Yet, when it comes to advertising, shop owners are often ready to quit marketing altogether after one failed campaign.

If you don't advertise, you're limiting your shop's growth. If your past efforts didn't produce the results you expected, you owe it to your business to investigate what went wrong, so you can make improvements for the future. In other words, practice – just like in cooking or gardening – makes perfect. Now, marketing may not be as much of a science as those two pastimes, but there are strategies you can follow that will increase the likelihood of success.

Here are some steps to consider when implementing a successful advertising campaign. While I'm focusing on direct mail, these tactics should prove useful no matter what type of medium you choose to employ.

Determine your full market potential

Too many shop owners choose their target customers randomly, or worse, cast too wide a net with their marketing. Before launching any campaign, it's important to figure out what the size of the market is for your services. One way to attack this problem is to review your current customer database. Look at where your customers are coming from and how much they are spending per visit. Those numbers can help guide your targeting efforts. If you don't have that data readily available, another option is to consider the income levels of the households located closest to your shop. We typically recommend that our customers target middle-to-high income households within one to three miles of the shop. Shops in rural areas can stretch much further out, since the density levels will be lower and they'll need to extend the distance of their campaigns to reach their full market potential.

Prioritize consistency over quantity

Hitting your full market potential every month is great, but some shops may not be able to afford sending postcards to that many homes. In that case, it might make sense to split your mailings, so you can reach them more frequently, rather than trying to send to your entire list just once or twice a year because that's all your budget allows. Consider a shop that has a market potential of 13,000 homes, but doesn't have the resources to mail to all of those homes each month. That shop can break that 13,000-piece mailing into two drops of 6,500 and mail those households twice a month to stay front of mind. Alternatively, the database could be broken down to three drops of 4,300 that are mailed three times a month. Even though the number of customers the shop is reaching is smaller, by staying active, they are reducing the risk of being out of sight and out of mind when a customer needs a repair or service. For some shops, a smaller mailing might make sense, particularly if they don't have the staff to support a large campaign. If a shop mails to all 13,000 at once and is inundated with calls, but has to turn customers away, they've likely wasted their money.

Be smart about your offers

You can mail the right people consistently and still not attract the response you

PHOTO: GETTYIMAGES / SAPFIRR

want if you don't give those folks a compelling reason to visit your shop. Because you can't predict what one household might need versus another, the trick is to provide a range of offers. We always suggest including an oil change on your postcard because it's the most frequent service customers typically have done. Putting an oil change offer on your postcard also indicates to customers that you are open to doing small maintenance jobs and accepting new customers. It also makes sense to feature a coupon with a tiered dollar or percentage off of a repair or maintenance job. For example, $50 off any repair or maintenance service of $250 or more. This may push people in the door who had been holding off on having a repair addressed. Finally, be sure to include a seasonal offer — such as a free A/C check – that will remind customers about service that may be coming due because of weather or time of year. A free check engine light scan is another great way to move the needle. This gives potential customers a good reason to sample your shop without a lot of risk.

Be realistic when measuring ROI

Keep in mind that a range of factors will impact your response rates, including your location, online reviews, the timing of your campaign, hours of operation and how well your front desk staff handles leads. You can't do much about your location, but extending your hours or ensuring your staff is well trained on converting leads might improve the outcome of your campaigns. You'll also want to consider more than just sales when measuring success, as it might not tell the whole story. For example, a sales spike that coincides with a late spring campaign might be due to drivers gearing up for road trips, not your advertising. We suggest that our clients look at the addresses of customers who came into their shop during the campaign and compare them to the addresses that were mailed to during that same period. That will give you a better gauge of how effective your advertising was in reaching your target market. We also recommend looking deeper at the customers who come in once your campaign has been activated to see if they are first-time customers, regulars, or those who were in your database, but haven't visited in a year or more. That information will help you determine how well your campaign succeeded at achieving goals beyond just driving sales, such as winning back former customers and retaining existing ones.

Like anything, advertising requires a certain amount of trial and error to get right. But investing the time and money into better understanding the process can help you achieve the results you want.

TIM ROSS is president of Mudlick Mail, a provider of direct mail services for the automotive service industry. He has been with Mudlick Mail since 2008. *info@mudlick.com*

The fastest way to fail as a shop owner

Do not focus solely on changing your employees — change yourself as well

When I started coaching and training shop owners decades ago, I learned a valuable lesson about something that was slowing down my effectiveness in driving profits and dreams home to these owners. I would teach them all the same techniques and strategies, but I never understood why some just wouldn't drink the water.

I was recently listening to one of our ATI Senior Coaches, Eric Twiggs, tell a story to one of his 20 groups; and I thought you might like to hear what he told them.

Changing your perspective

The story is told of an eight-year-old boy named Mitch who was out of control. He would do the opposite of whatever his mother, Molly, told him to do.

When she said "sit down," he would stand up. When she said "be quiet," he would talk louder. When she said "stop running," he would run even faster.

Molly knew that Mitch liked to work with puzzles, so as a last-ditch effort to settle him down, she gave him a puzzle of the world globe to put together.

She gave him this advanced, adult-level puzzle, figuring that it would occupy his time and give her some much needed peace and quiet. To her surprise, Mitch returned to her side five minutes later having solved the puzzle.

YOU WON'T BE MOTIVATED TO FIX SOMETHING THAT YOU DON'T BELIEVE IS YOUR FAULT. THE STARTING POINT OF YOUR SUCCESS IS TAKING OWNERSHIP OF YOUR FAILURES.

"How did you put that together so fast?" Molly asked.

Mitch responded, "It was easy. On the other side of the globe puzzle pieces was the picture of a man. I turned the pieces over and focused on fixing the man. Once I put the man together, I could put the world together!"

Most shop owners are seeking an external solution to an internal problem. The fastest way to fail as a shop owner is to blame everything and everyone except yourself for your problems.

Are you like most shop owners? Stay with me to learn how to change your world, so you can avoid the fastest way to fail.

Start with yourself

The best way to change your world is to assume that everything that happens is your fault!

If there is a puzzling problem like low car count, the natural impulse for the average shop owner is to point the finger at the customers, the economy, the weather and the employees.

The top shops on the other hand start by focusing on themselves. When you encounter a problem in your world, ask yourself the following questions:

1. What is my desired outcome? (Be specific!)
2. What are my actual results?
3. What role did I play in the actual results?
4. What can I do differently to achieve the desired outcome?

Applying it to life

Let's use car count as the example as

we apply the previously mentioned questions. I will play the role of the shop owner.

1. My desired car count outcome is 45 cars per week.

2. My actual weekly car count result is 37 cars per week.

3. I contributed to the actual result by not listening to and coaching incoming phone calls, failing to do my Google Plus and Google My Business posts, and by not holding my writers accountable for scheduling exit appointments.

4. Starting this week, I will coach incoming phone calls, post on Google + and Google My Business, and hold my writers accountable for scheduling exit appointments.

The bottom line is that you won't be motivated to fix something that you don't believe to be your fault! For example, why would you listen to incoming calls if you believe the weather is your real problem? Why would you bother posting on Google if you believe that your customers are all broke and not able to repair their cars because of the local economy?

The starting point of your success is taking ownership of your failures. When you start with yourself, you will be motivated to take the actions that produce a successful outcome.

Find the right "birds"

When I was growing up, there was this kid in my fifth-grade class named Matt. He was cool and popular. My mother would always warn me to stay away from him. She would always say, "Birds of a feather flock together."

My teacher would pull me to the side and warn me to stay away from Matt. When I met with the school's guidance counselor, her only advice was to "stay away from Matt."

My response to all of this guidance was to continue to hang out with him. Our friendship abruptly ended the following semester, as he transferred to another school. Recently, while watching the news, I learned that my old friend Matt is currently in prison serving a life sentence.

My mother, teacher and guidance counselor knew the following truth: Birds that flock together end up flying to the same destination.

MOST ARE SEEKING AN EXTERNAL SOLUTION TO AN INTERNAL PROBLEM. THE FASTEST WAY TO FAIL AS A SHOP OWNER IS TO BLAME EVERYTHING AND EVERYONE ELSE FOR YOUR PROBLEMS.

In order to change your world, it's critical that you "fly" with world changers. There's a "bird" in an upcoming ATI shop owner's class at a location near you who is changing his car count world in spite of the vendors saying "everybody in the area is slow!"

There's a bird among your acquaintances who has changed her hiring world by hiring her replacement even though "it's hard to find good people in her town."

There's a bird with a shop in your area who has high margins in a low-income market.

Keep in mind the fact that you won't be motivated to find the right bird until you take the first step of owning the problem. I challenge you to assume full ownership so you can fly into action!

Now, fix your world!

As I conclude, I'm reminded of the following poem, written by an unknown monk, that ties everything together:

When I was a young man, I wanted to change the world.

I found it was difficult to change the world, so I tried to change my nation.

When I found I couldn't change the nation, I began to focus on my town. I couldn't change the town and as an older man, I tried to change my family.

Now, as an old man, I realize the only thing I can change is myself, and suddenly I realize that if long ago I had changed myself, I could have made an impact on my family.

My family and I could have made an impact on our town. Their impact could have changed the nation and I could indeed have changed the world.

If you start with yourself, and find the right birds, you can change your world and avoid the fastest way to fail!

Still need more car count?

Looking to take ownership of your car count problem, but don't know where to start? Simply go to *www.ationlinetraining.com/2018-08* for your own copy of "More Cars From Google Checklist." If you can score a 10 on this quiz it's worth four cars a week for most shop owners. If you're already doing all 10 techniques then at least you know them all!

CHRIS "CHUBBY" FREDERICK is the CEO and founder of the Automotive Training Institute. ATI's 130 full-time associates train and coach more than 1,500 shop owners every week across North America to drive profits and dreams home to their families. Our full-time coaches have helped our members earn over 1 BILLION DOLLARS in a return on their coaching investment since ATI was founded. This month's article was written with the help of ATI Coach Eric Twiggs. *chubby@autotraining.net*

Assess your shop's productivity

Complete this assignment to see if your internal processes can be improved

Many shop owners have difficulty making their office time productive, so I developed an assignment for you to undertake.

Remember that "office time" is uninterrupted time, and the purpose is to work ON the business to see where you can improve it.

What can I do to improve NET income of the business?

Here's the assignment:

- Pick out three random, long-term (minimum three years) clients.
- Print out the work that should have been done over the past two years as suggested by the manufacturer for the same mileage driven during this period.
- Calculate how many labor hours per visit should have been produced.
- Retrieve the past two years' vehicle history for these same clients.
- Make a list of the work that was missed for the same time period. Calculate how many labor hours this represented.

THIS EXERCISE WILL FORCE YOU TO LOOK AT YOUR INTERNAL PROCESSES AND HOW YOU HANDLE EVERY CLIENT.

- Based on the historical mileage driven per year, and the number of miles currently on the vehicle, what maintenance is required for the next two-year period based on the manufacturer's recommendations?
- How many labor hours per visit does this represent, when the client must come in every 5,000 miles for an oil change?
- Make a list of the changes required in the "processes" of your shop for handling your client to ensure you can maximize productivity and serve your client professionally.

This type of exercise will force you to look at your internal processes and how you handle every client. The two conclusions you will most likely discover are: 1.) your internal vehicle inspection process must be clearly defined; and 2.) the

6 TIPS TO CREATE SUPERSTAR SERVICE ADVISORS

BOB COOPER // Contributing Editor

1. Make sure you have the right people on your team. Look for attitude, aptitude, ethics and a natural talent to sell. With training and guidance, they can take your business to the top.

2. Set clear expectations. Break down clearly defined monthly performance goals into weekly and daily sales and car count goals so your advisors know exactly what they need to accomplish every day.

3. Have a clearly defined inspection process. These processes should include vehicle inspection procedures and the documentation of all discoveries. our advisors should also be required to accurately estimate all of the discovered services and fully disclose all discoveries to your customers.

4. Provide your advisors with the right tools. They need a robust shop management program, feature-rich warranties, point-of-sale items to get customers visually involved (such as fluid samples), and third-party financing options. They also need techs who can produce, daily goal sheets to track their performance and digital voice recorders so they can critique their own sales presentations. They need quick-reference guides that list the benefits of your most common services.

5. They need to have their performances monitored and measured, and they need consistent feedback. We recommend that owners or managers perform a repair order review with their advisors at least once a week to analyze sales and have a dialogue about what could have been done differently to close the sales. Also use this time to reinforce your commitment to ethics and customer satisfaction.

6. Advisors need ongoing training. They should be sharpening their skills with a sales course at least once a year.

As a shop owner (or manager), you need to make a point of feeding the hearts of your service advisors. By catching them doing things right and providing them with the appropriate praise and recognition, you will be creating happier advisors who are more determined to help you and your company reach your goals.

front counter must have the time to have a proper discussion with the client as to what is recommended and why based on how the client uses the vehicle, their expectations with the vehicle and what is necessary to ensure safety, reliability and efficiency of the vehicle.

In North America, there is no definitive definition of a "comprehensive inspection." This is a discussion to have with your technicians to establish a definition and standard in your shop. The purpose of a comprehensive inspection is to create a complete file on the vehicle so you can then manage the vehicle for safety, reliability and efficiency by recommending when service should be performed. You manage each vehicle as you prioritize the repairs and maintenance on behalf of the client. This also allows you to give the client a budget for maintaining their vehicle. A comprehensive inspection should be performed once a year for consumers and twice a year for commercial vehicles. It is a paid inspection and will most likely take 1.0 to 1.5 hours on a basic consumer vehicle charged out at a diagnostic rate.

Keep in mind your service advisor requires the proper amount of time to spend with each and every client on their visit. Seriously look at the front counter processes. They are not there to "sell" the job; they are there to connect with the client to build a trustworthy relationship and to properly counsel the client on what is required for their vehicle. Too many service advisors do not have the proper time to spend with the client. When the service advisor is rushed, billed hours are missed. I recommend one service advisor for every two technicians. Remember the service advisor also has to spend time with the technician to ensure all details of the technician's recommendations are clearly understood before he or she talks with the client.

Doing this basic office assignment quarterly will confirm if you are truly moving forward in the right direction. It is not about sales, which measure activity; it is about billed hours, which measure productivity. Productivity creates NET income and it is NET income that allows the business to grow and expand.

How are you spending your time? Do you work "IN" or "ON" the business?

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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European success

Training, enthusiasm help specialized shop stand out in D.C. metro area

ROBERT BRAVENDER // Contributing Editor

Drive European. You've got to admire a name that not only states a shop's specialty, but proclaims a lifestyle. There's certainly no shortage of BMWs, Mercedes and Audis cruising around the Washington D.C. metro area — but that doesn't make it any easier for Proprietor and General Manager Sam Dawood.

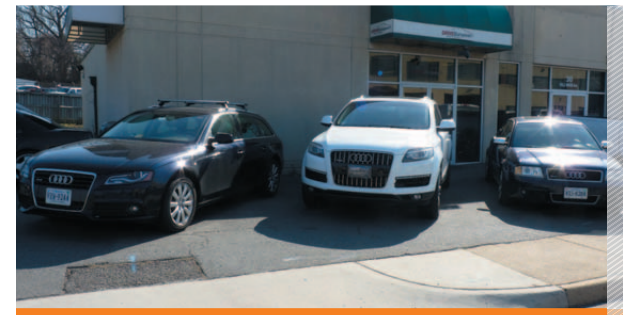
"You can draw a 15-mile radius from here and you will have three BMW dealerships, same with Mercedes, same with Audi, almost the same with Porsche, plus a ton of independents," he says of his crowded market. "Frankly, I'm advertising heavily, spending a ton of money [on web presence]. It starts with my customer relations software, which I use to market to people day in and day out. I use Demand Force for this, as well as Google Adwords, Yelp advertising, and quite a bit on search engine optimization."

For this Dawood utilizes a local web firm, but remains heavily involved with the feedback, which is crucial for customer relations. "It's very much the old fashioned 'treat people as you want to be treated,'" he states. "If something doesn't need to be done to a car, it doesn't need to be done. I call it technical ethics; sometimes it's a gray area, but you try to make it as black and white as possible. Just be transparent and honest.

"If need be, I spend a lot of time explaining," he ironically explains. "By the same token, the world has changed and people are moving really fast. Last year I went to digital inspections and have gotten heavily into texting for communication. I'm working really hard on getting emails; even if someone doesn't want to give me their address, I tell them it's for stuff that will make their experience so much easier."

As a result of all this, Drive European has developed very close relationships with a lot of their clients. "As one of them has noted, 'Sam, you've outlasted three of my marriages,'" Dawood laughs. "Maybe that's not so much a testament to me, but we're friendly, we take of them, and they're also enthusiasts; some of them have unique cars that they're madly in love with, and we honor that love for the automobile."

Accordingly, an entire page on the shop's website is dedicated to 'Our Customers,' featuring testimonials and handsome pictures of clients' cherished rides, some taken by Dawood himself. "Over the years we have developed special relationships built on trust, respect and most importantly a shared passion for cars," the page declares.



DRIVE EUROPEAN
Falls Church, Va. //

Sam Dawood
Owner

1
No. of shops

19
Years in business

4
No. of employees

3
No. of techs

5
No. of bays

3,500
Total square footage of shops

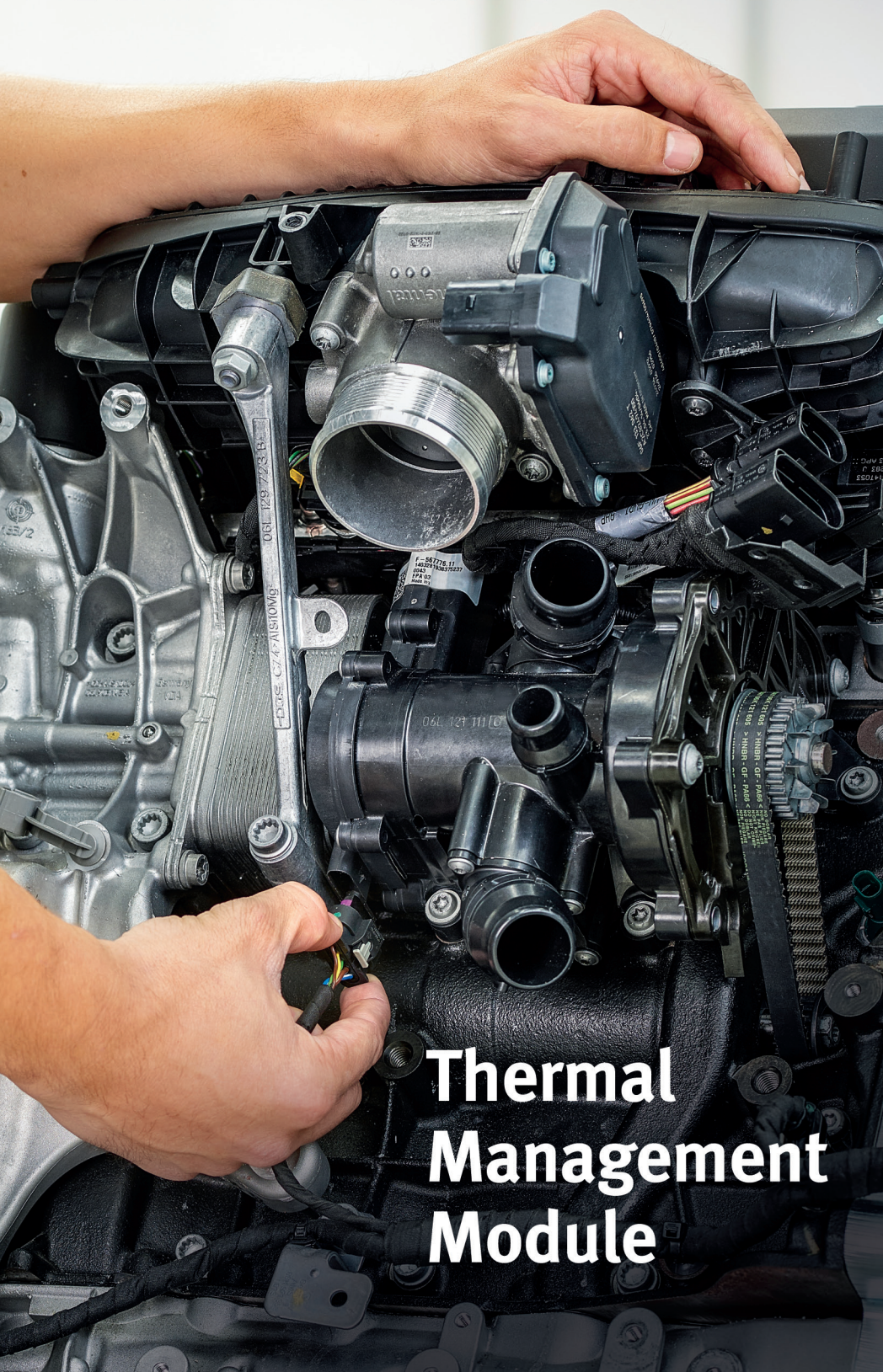
ASE, BMW, Mercedes-Benz
Training and certification

You can sense Dawood's own passion for cars — he's cultivated a career since high school. "At that time I had a Datsun 280Z that I was in love with, but no one could fix it," he relates. "I'd pull in to shops with exotics and chat with the mechanics — I was probably a nuisance because I didn't have a lot of money, but I wanted the knowledge."

He still does, which helps explain why Dawood signed up along with one of his technicians for *Motor Age* Training CONNECT, an online portal for hundreds of training modules. "Frankly, I should be signing up for business and marketing classes," he laughs, "but I personally have a love for this.

"I can argue that I need this knowledge because I also like to know what's going on in the shop," Dawood rationalizes. "With the size of our shop and the volume we do, there's usually just one master technician, and two brains are better than one. I find it fantastic that you continue after passing a test (for

PHOTOS: DRIVE EUROPEAN



Thermal Management Module

INA...the original Schaeffler brand.

For decades, INA has been the pioneer of automotive technology. As each model year rolls out, vehicle manufacturers continue to rely on INA's quality, reliability and unparalleled innovation. Schaeffler is the engine expert. That's why our products are in every car in the world.

100
Years of
system competence

OE quality
products

For top performance in every driving situation: Intelligently-controlled cooling systems from INA.

Government emissions requirements are a tough challenge for the automotive industry. New water-pump generations are making an important contribution here – but at the same time this means new requirements for installers. That's why INA offers its automotive service professionals and distribution partners not only the latest engine cooling system technology, but the necessary specialized expertise to go along with it.

INA Thermal Management Module (TMM) with water pump.

Thermal management controls engine temperature **appropriately, right from the start.** Depending on operating conditions and the driving situation, it controls the amount of coolant flowing through the engine's coolant circuits and increases cooling efficiency. To ensure easy installation, the INA TMM is sold as a complete module to the independent aftermarket. It includes all mounting parts needed for replacement and is exclusively available from Schaeffler.

Benefits and Solutions:

- Reduces CO_2 emissions
- Improves fuel economy
- Heats car cabin faster
- All parts in one box
- Expert training
- Installation guide with video

Count on INA for innovative solutions that make cars run like new.

Removal

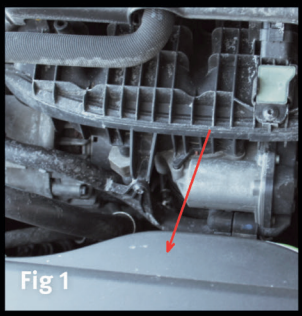


Fig 1


Fig 2


Fig 3

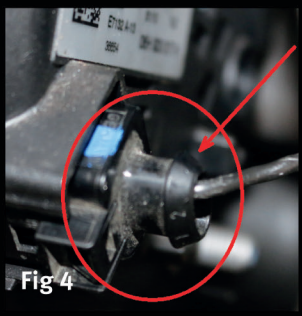

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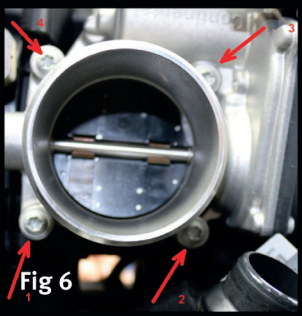
Fig 5



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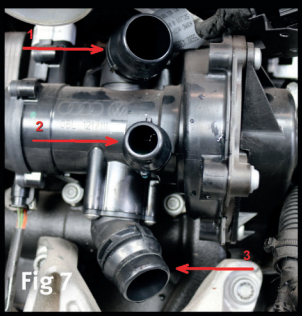

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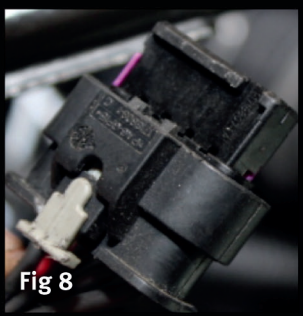


Fig 8

Fig 9

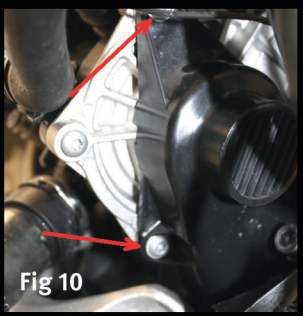


Fig 10


Fig 11

INSTALLATION GUIDE

Schaeffler Thermal Management/ 538 0360 10
For VW 1.8/2.0 TFSI, engine code EA888 with longitudinal and transverse engines.

Removal

1 (Transverse engine only) Remove the engine cover by removing the three mounting screws and lifting the front section. (Fig. 1) When the cover comes loose, carefully remove it.

2 (Transverse engine only) Carefully remove the coolant hose by undoing the hose clamp and sliding the end of the hose off.

3 Remove the lower sound insulation and drain the used coolant into a container. (Fig. 2)

4 (Transverse engine only) Take the air charge hose off of the intercooler and unplug the charge air sensor. Remove the air duct hose mount. Loosen the hose clamp on the throttle body. Pull the air duct hose down and push it out of the way. (Fig. 3)

5 (Longitudinal engine only) Slide the charge air hose off the throttle body. (Fig. 3)

6 Disconnect the charge control plug at the back of the alternator. (Fig. 4)

7 Disconnect the electric plug connector on the throttle valve control unit. (Fig. 5)

8 Take out the screws of the throttle body and remove it.
Note: Loosen the rear screws first. (Fig. 6)

9 (Transverse engine only) Unscrew the coolant tube from the intake manifold.

10 Carefully remove the coolant hoses from the thermal management module (TMM) by raising the retaining clips on the hoses. (Fig.7)

11 Disconnect the electric connector of the TMM by pulling out the lock tab, then pushing in the connector lock on the release tab. (Fig. 8)

12 Unscrew the plug holder below the inlet manifold.
Note: Loosen rear screws first. (Fig. 9)

13 Remove the timing belt guard at the back of the TMM by loosening its two screws. (Fig. 10)

14 Disconnect the oil pressure switch connector by pulling out the lock tab, then pushing in the connector lock on the release tab.

15 Completely remove the TMM drive belt. Loosen mounting screws on the balancer shaft by turning them three times.
Note: Left hand threads. Make sure the engine does NOT turn with the coolant pump wheel. (Fig. 11)

16 Remove the screws of the TMM with a T30 Torx bit. Then slide the TMM off of the oil cooler and lift it carefully out of the engine compartment.

Installation


Fig 12

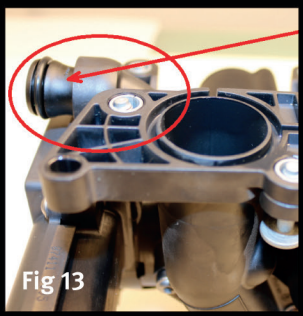


Fig 13

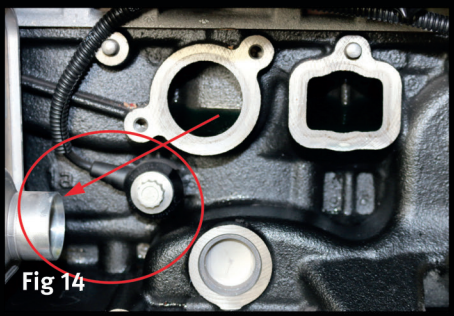


Fig 14

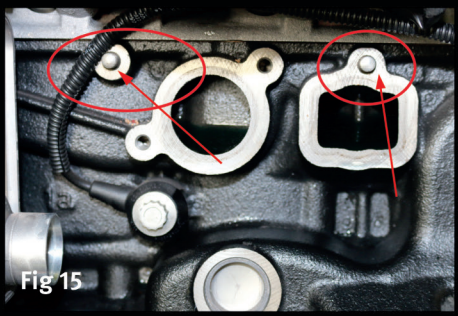


Fig 15

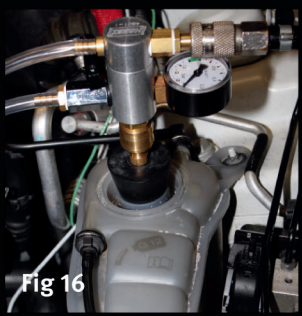


Fig 16

INSTALLATION GUIDE

Schaeffler Thermal Management/ 538 0360 10
For VW 1.8/2.0 TFSI, engine code EA888 with longitudinal and transverse engines.

Installation

17 Replace the timing belt and mounting screws. These are included with the 538 0360 10 set. Tighten the screws to 9 Nm + 90°. (Fig. 12)

18 Carefully place the completed assembled TMM (538 0360 10) into the engine compartment. Mount the connecting tube back onto the TMM (Fig. 13), and then reconnect the oil cooler hose. (Fig. 14)

19 Align the TMM onto the two guide pins on the engine block (Fig. 15) and tighten the TMM mounting screws to 9 Nm.

20 Reinstall the drive belt onto the TMM and balance shaft. Tighten the balance shaft cone to 9 Nm. + 90°.

21 Remount the drive belt guard at the back of the TMM and tighten both screws to 9 Nm.

22 Remount all components that have been removed in reverse order.

23 Fill cooling system to manufacturer's specification with either g12 or g13 coolant. System must be filled with a flush and fill machine that uses between 6-10 bars of pressure. (Fig. 16)

24 (Longitudinal engine only) To vent the system, open the valves of the cooling circuit using a vehicle diagnostic tester's "cooling circuit venting" routine.

25 When the expansion reservoir is filled to max, secure the cap. Start the engine and set HVAC temperature to high and turn off the air conditioning compressor. Run the engine at 2,000 RPM for 3 minutes.

26 Let the engine idle until both of the large coolant hoses are warm to the touch, then run the engine at 2,000 RPM for an additional 2 minutes.

27 Turn the engine off and allow it to cool back down. Once the engine is cool, check the coolant level in the expansion reservoir and correct if necessary.

28 Reinstall the lower sound insulation.

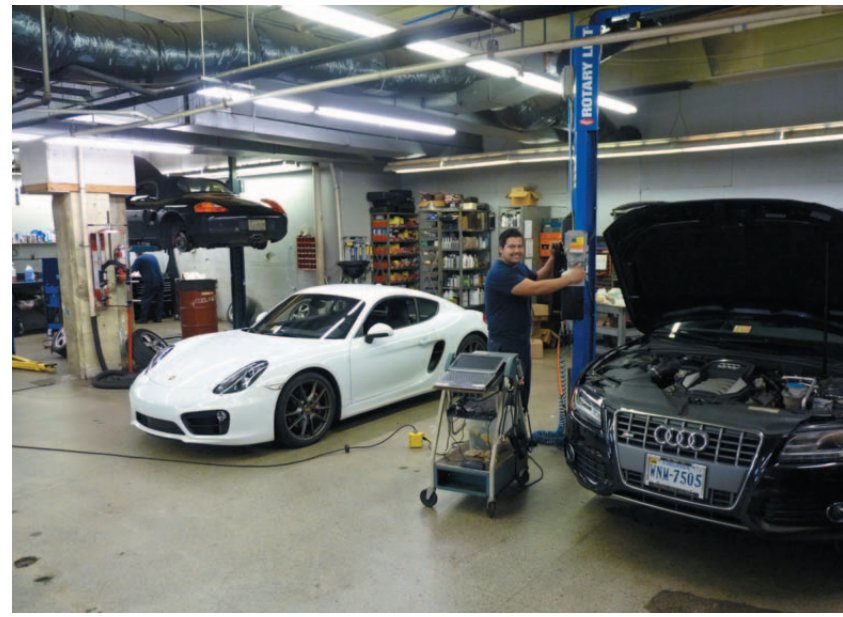
each Master Tech class); I can monitor that for my guys, see what they've done, when they've finished it, and they get paid for it. I love it.

"The pay plans are linked to ASE and education," he continues, "and I've found that CONNECT content is very good; they're delivered in a very nice way with short modules so they're not going to overload you. You can watch them as many times as you want, and you can learn something really valuable in 20 minutes. It's very beneficial."

Another appeal of the program is having the info come directly to his technicians, rather than chasing seminars across the country. "I buy my parts from WORLDPAC, and they have one of the biggest training programs that I'm aware of and they're very good," says Dawood. "However, they don't bring classes here. Frankly, it's difficult to hop to New Jersey for a class on BMW body electronics or to Colorado for something else. It's difficult enough for my guys to leave early to go to the local community college."

Easy access to training might have other benefits in the future; Dawood is considering expanding into a market most independent European repair shops don't venture: German econoboxes. "It's a thought that I've had," Dawood explains. "While there aren't a lot of Smart Cars [Mercedes] in this area, there are a lot of Mini Coopers [BMW], and I'm advertising to try to gain these. But there might be this preconceived notion that they have to take them to the dealer. As many as there are, my hunch is that I'll have to talk harder at the Mini customer to bring them in here, or maybe it's sheer numbers."

At the other end of the scale, Dawood says the most exotic car they've ever worked on was a Pebble Beach-winning 1937 Alvis. According to Wikipedia, this British luxury touring car is widely considered one of the finest automobiles



produced in the 1930s. "But it's not our business model, and we don't advertise for (exotics)," he notes.

"At one time we used to say yes, but they're so specialized," he continues, "plus we really have no place to store them… Still, quite a few have rolled in over the years: Rolls-Royces, Ferraris, Bentleys." Meanwhile Dawood keeps his own passion for classic cars and technology stoked with an old Jaguar V-12 E-Type. "I converted it from carburetion to fuel injection," he says. "It was a lot of work…but a nice learning experience."

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.
rbravender@comcast.net

Change the conversation for vehicle safety inspections

Repairers, consumers have to engage with new messaging to stop current trends

Vehicle repairers have watched a slow hemorrhage of state vehicle safety inspection programs for a number of years. These programs go back to 1926 and increased to 31 states plus the District of Columbia in 1975. In addition to voluntary programs and mandatory state programs, the federal government, through the Highway Safety Act of 1966, mandated that the U.S. Department of Transportation prescribe uniform standards for state highway safety programs.

The 1990 Clean Air Amendments encouraged states to establish emissions inspection and maintenance programs to improve air quality. These programs were regularly attacked by the media, political pundits and even some in the auto industry. Unfortunately, a number of policymakers in safety inspection states took advantage of this movement and compared safety inspection to problems with emissions inspection and maintenance. Arguments against vehicle safety inspection programs included costs to the consumer, inconvenience of the inspection, little evidence that inspection prevented accidents, injuries and deaths, just another tax, etc.

Although some state programs survived frequent attacks, the industry saw inspection programs in other states eliminated. As of this writing, we have 15 state programs.

The Automotive Service Association (ASA), along with the American Association of Motor Vehicle Administrators and other members of the automotive aftermarket held numerous conferences during CARS each year in Las Vegas. Of late, ASA held Vehicle Safety Inspection Forums in Pennsylvania and Missouri. Although well attended with excellent program content, these forums have not prevented the onslaught of attacks on state inspection programs in those states.

This past legislative session in Texas, the inspection program came close to ending after an aggressive legislative push. It is anticipated that we will see legislation to terminate the Texas program again in this next session. In Missouri, the authorizing committee approved legislation to end the inspection program. Missouri's program has been the template offered to states to demonstrate how a successful program is structured. ASA testified against the bill and initiated a grassroots effort to stop it. Other aftermarket associations joined the fight to protect Missouri's program. The Legislature adjourned without passing the legislation and the bill is dead for the year.

So how can we change the conversation about vehicle safety inspection? As repairers, we have to work closer with the aftermarket and other industry colleagues to educate members of the industry, consumers and policymakers about the value of these programs. The last sessions' industry efforts in Texas and Missouri demonstrate that we can stop these very harmful bills when we join together.

In addition, we have to make a better case as to why these programs should be in all 50 states. The National Highway Traffic Safety Administration (NHTSA) has not been an encourager of these programs despite the U.S. Government Accountability Office (GAO) report references to the need for more NHTSA involvement. At a minimum, NHTSA should pursue data relative to programs protecting the motoring public from accidents, injuries and deaths.

Whether it's providing consumers with important information about recall efforts or becoming part of the vehicle safety firewall as new technologies are deployed (i.e. autonomous vehicles), the arguments for these programs need updating. NHTSA has an opportunity to be part of this movement. It's not too late.

Unless we take a more aggressive stance as to the importance of these programs, they will continue to be at risk and will likely not be part of the revolution in automotive technology.

ROBERT REDDING is the Automotive Service Association's Washington, D.C. representative. He has served as a member of several federal and state advisory committees involved in the automotive industry. *rlredding@reddingfirm.com*

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WE NEED TO FOCUS ON COMPETENCY AND SKILL MASTERY, RATHER THAN OUTCOMES

CHRIS CHESNEY //
Contributing Editor

Earlier this spring, I attended the annual ASE Training Managers Council (ATMC) conference in Atlanta. This is where a group of automotive training leaders from both the OEM and aftermarket meet to share best practices in automotive education. This year, one of the presentations solidified my views on what every technician needs to learn and know. The presenter, a principal at Electude named Koen Berends, shared his vision on how diagnostics and automotive education need to transition from a traditional outcome-based model to a competency-based model.

The challenges facing the service bay are changing at an ever-increasing rate, yet our education model has not changed in years. Our current education model is a two-year vocational program, and the outcome was typically a young technician entering the workplace and becoming a productive employee that provides value to the shop owner. It worked…for a while.

Fast forward to today and we see the most complex data networks on the planet come into our shops that carry over 100 million lines of code in order to operate. Yet, we still only invest the same two years in our young technicians. So, what's the answer? Using our current outcome-based model of education, it could possibly take eight or more years to achieve the levels of post-vocational competency that we once had. I believe the answer is to modernize education by focusing on competency and the mastery of skills rather than basing our education on outcomes.

Traditional or outcome-based learning puts all students through the same program for a fixed period of time, no matter if they learn or can apply the knowledge or skills. A competency-based program is where students work on a concept and are supported until they learn and can apply it in context with their career. Once mastered, they move to the next step. Traditional education focuses on tasks or skills on systems students are studying, while competency programs focus on core skills, not the specifics of the system. For example, in current education programs a student might learn to test and diagnose a particular Ford system that contains certain core technologies, followed by learning to test and diagnose a Toyota system that contains some of the same technologies. The student has now learned the Ford way and the Toyota way, but when faced with an Audi, how do they react? In most cases they'll say they need Audi training. In a competency-based model, the student learns how to test and diagnose the technology no matter the badge on the fender. As Koen so brilliantly put it, "Specific system knowledge cannot be a learning objective. Being able to follow diagnostic procedures is the learning objective."

In other words, become competent in testing and diagnosing the technology, not the nameplate. Today, we have complex networks that contain simple wiring or data busses with many nodes on the network that require a different set of skills both in the way we test, and in the logic we use to solve problems. To apply the outcome model to these systems creates so many variables that if a technician hasn't mastered the competencies, the amount of time needed to solve the problem negatively impacts the shop's bottom line and is not fair to the motorist.

As Koen said, today's students and technicians need to focus on generic skills independent of the OEM specifics. This does not mean you should not learn the OEM strategies and process; it means if you've mastered the competencies for each technology, when you approach OEM service information that asks you to pick up a tool or points you to a test, you'll know exactly why and will have a clear expectation of the expected test results.

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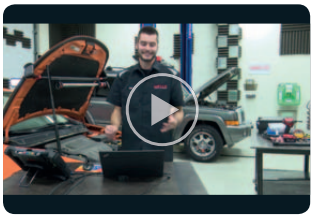

Diagnosing with the lab scope

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The importance of sharing knowledge

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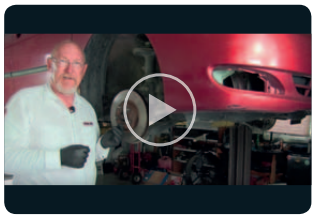

The right way to prep a brake rotor

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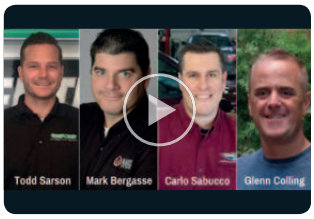

Friendship first, competitor second

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MECHANICAL MOMENT

SERVICE REPAIR PROBLEMS AND SOLUTIONS THAT JUST MIGHT BENEFIT YOUR SHOP TECHNICIANS

NEW HEADLAMP ON MERCEDES-BENZ NEEDS PROGRAMMING

VEHICLE: 2010 Mercedes-Benz C 300, 4MATIC, V6-3.0L

MILEAGE: 98,2201

PROBLEM: The customer complained that the right low-beam headlight was burnt out. He replaced it, but the headlamp is still inoperative.

DETAILS: The tech verified the fuses were OK and replaced the right headlamp bulb again, but the headlamp is still inoperative.

CONFIRMED REPAIR: After talking with the Tech-Assist consultant, the tech used a scan tool to reprogram the SAM module for the new bulb replacement. The headlamps worked normally again.

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This tech tip and others come from ALLDATA Tech-Assist, a diagnostic hotline of ASE-certified Master Technicians.

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TRAINING EVENTS

AUGUST 8
The Advanced Technology & Diagnostic Repair Forum
Georgia World Congress Center
Atlanta, Georgia

AUGUST 8-10
NACE Automechanika 2018
Georgia World Congress Center
Atlanta, Georgia

AUGUST 25
ATI: Eight Essential Skills for Auto Repair Shop Success
Hotel to be determined
Valley Forge, Pennsylvania

SEPTEMBER 6
ASA-Midwest Lawrence/Topeka Chapter meeting: Six Month Goals
Comfort Inn & Suites, Jayhawk Room
Lawrence, Kansas

OCTOBER 13
ASA-Midwest Des Moines: Hands-on Hybrid Training
Williamson's Repair & Tire
Bondurant, Iowa

OCTOBER 30-NOVEMBER 1
AAPEX 2018
Sands Expo
Las Vegas, Nevada

PROTECTING YOUR DIGITAL DIAGNOSTICS

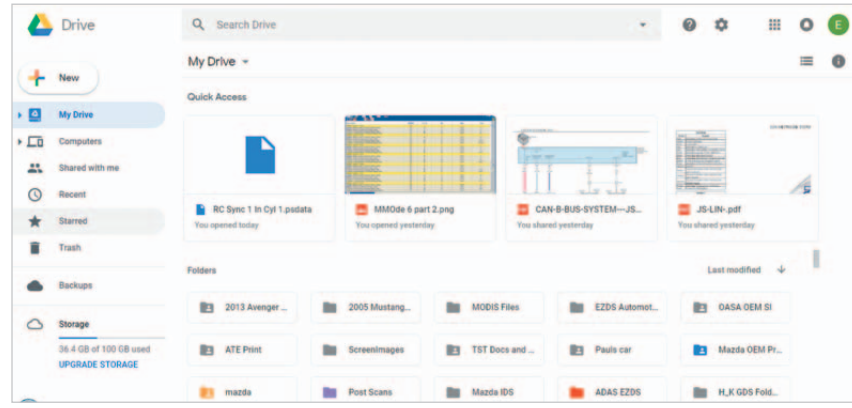
EVERY CAR YOU CONNECT A SCAN TOOL OR SCOPE TO MAY BE THE KEY THAT HELPS YOU FIX ANOTHER. LEARN HOW TO MANAGE ALL THAT DATA!

ERIC ZIEGLER // Contributing Editor

We live in the information age. We have smart phones, smart homes and smart cars. Some new cars have just as many and sometimes more lines of code than a modern jet fighter! Diagnostics have become more intuitive due to all the enhancements in information systems and scan tools. We now can do all module scans for DTCs, view log files of all the module part numbers and calibrations, view time stamp code information, record movies or snapshots while doing test drives and perform tests of components electrically using a digital storage oscilloscope or DSO. But what do we do with all this data after we record it? Hopefully we are saving some, if not all, of it. In this article we are going to investigate the archival of our precious diagnostic data so we can easily access it later. We will also investigate some programs and apps that will aid us in that ability.

Save your hard work

Most diagnostic techs who have been to any class I have taught know one of my pet peeves is doing a diagnostic test drive without a scan tool hooked up to the DLC. My second pet peeve is having the scan tool hooked up and NOT recording a snapshot or movie of the test drive or capturing the failure. The information recorded gives the tech vital diagnostic information that can be reviewed safely when the tech returns to the shop. But what do we do with data when we are done with it? Do we store it solely on the tool? Do we share it with the front desk or customer? Do we share in forums or social media? I remember, years ago, Jorge Menchu of AESwave.com had the forward vision to create a software program that was years ahead of its time. The program was called Annowave® and it was was my first exposure to a systematic way of archiving data for later use.



GOOGLE DRIVE OFFERS a free 15 GB cloud storage service to anyone with a Google account. This allows you to access your files wherever you have internet service.

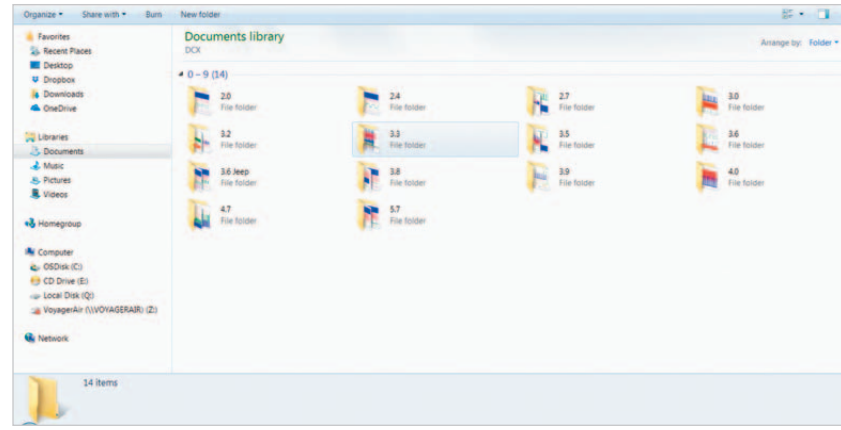
The good news is all this information is digital and can easily be archived on a scan tool, a thumb drive, a hard drive or in the "cloud." Digital storage and cloud drive storage has never been more affordable. Often, there is a lot of information that goes into diagnosing a modern vehicle; vehicle DTC scans, freeze frame info, scan data snapshots, service information (SI), technical service bulletins (TSBs), wiring diagrams, scope captures etc. But what do you do with all of it? Moreover, how do you manage it?

I like to create a folder on my computer's desktop named specifically with year, make and model (YMM) and the nature of the problem — 2010 Silverado 5.3 P0171 rough idle, for example. I drop all my digital data in there and sort it out after the vehicle is fixed and retain the folder for later viewing. This gives a centralized location for my data and simplifies accessing it whether on my laptop, another computer I "push" the folder to or if I upload the folder to a cloud for remote viewing elsewhere.

"Pushing" a folder or file refers to the process where a digital file is trans-

PHOTOS: ERIC ZIEGLER

ferred through the ether via an app. Think of this as emailing an attachment to yourself without having to go through all the steps — open your email account, compose an email, attach the file and send – then open the email and download the attachment to the second device. Pushing the document is seamless – you simply click on the file and "push" it to another device using an app such as Pushbullet®, Google Keep® or something similar. Practically any digital file or image can be "pushed" or shared between devices. Devices can include laptops, computers, tablets and phones. Examples of data that one could push include a photo of a grooved rotor taken by a tech's cell phone and pushed to the service writer's computer, a TSB sent from the service writer's computer to a tech's tablet or a wiring diagram sent from a tech's laptop to a second tablet.



THE KEY IS TAKING THE TIME to organize the data in a way you can find it later. For example, I have a parent folder for CKP/CMP captures, then subfolders by OEM, and finally by engine.

YOU DON'T HAVE TO OWN A PICO to view Pico data files. The software is free to download on their website.

Saving Snap-on files

Most tool manufacturers use a specific file extension and have their own programming for viewing and storing their data. Snap-on scan tools, for example, save their movies and scope captures on the drive inside the tool. They have file extensions like ".scm" or ".vsm." If you tried to open this file by itself, you would receive the "Windows cannot open this type of file" prompt. Snap-on has a solution for viewing files separate from your diagnostic tool. They offer a little known free downloadable program called Shopstream Connect.® It is available for download at their website: www.snapon.com/diagnostics/us/SSC.

Shopstream Connect provides the user "a practical in-shop software tool to transfer, save, manage, review, annotate, email and print files that were saved or recorded on your Snap-on diagnostic platform," per Snap-on. In a nutshell, you download this program for free and keep your diagnostic information in one place on a device other than your tool.

The trick as I see it is the same in every platform – label or name your files in a way that will allow you to quickly find them later. The tool may ask you the year, make and model when you save the file on the tool. When Shopstream Connect transfers the file from the diagnostic tool, I want to name it something that I can easily search out and find quickly for later viewing. Often the default name may be "User" and the date. Hovering the mouse over the file and right-clicking will give you the ability to rename the file. Moreover, if multiple files are from the same vehicle, you may want to create a folder and name it after the YMM of the vehicle and the issue, say, "2003 F150 5.4 Misfire P0300." Another consideration is to label your file whether it is a "known good," "known bad" or "undetermined" capture. This is extremely helpful in archiving files for later use.

Perhaps, during some research or a play day with your scope you capture a CKP/CMP waveform from a vehicle with no codes or no driveability issues, you need to label the file something that lets you know it comes from a vehicle with no faults. I like to use "KG" or "KB" in the file name such as, "2003 Ford F150 5.4 CKP CMP KG." This will allow me to quickly access this file later using a folder setup like CMP_CKP>Ford>F150>5.4 etc. or by simply using the Windows search feature in the start menu.

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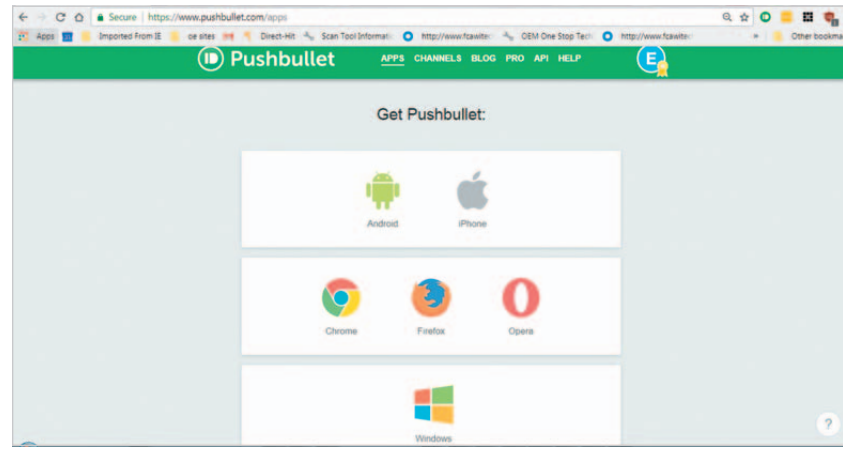
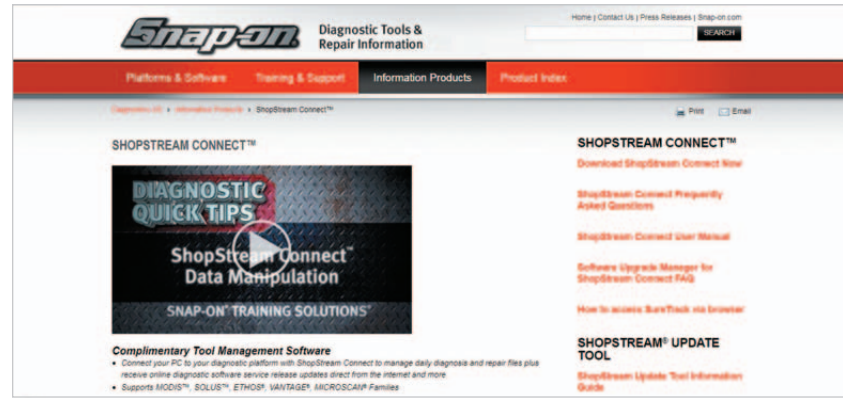
OUR STARTERS GOT

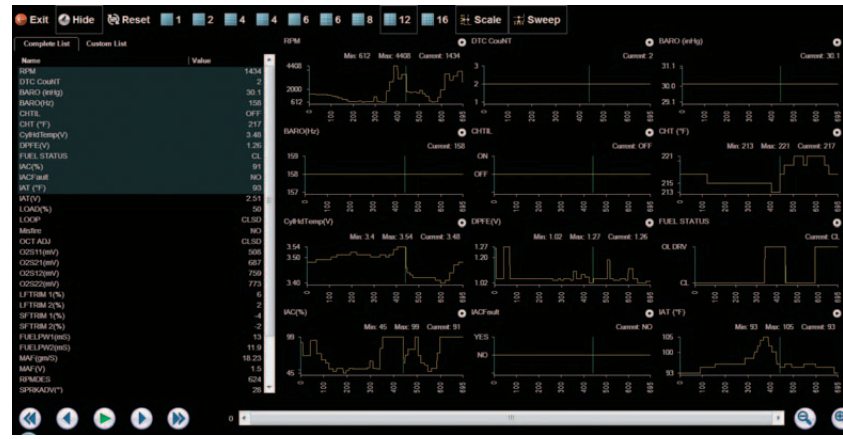
In Shopstream Connect, you can change the way you view data. You can pick how many scan tool PIDS are on the screen, pick the background and line colors and thickness, zoom in and out. This allows the user to customize their viewing experience. The other thing that makes this program very helpful is that it backs up the diagnostic tool and has a centralized location for your files. This also allows the user to be able to share these files via internet or a jump drive with other Snap-on Shop Stream Connect users. Networking and "diagnostic share sites" like iATN or Diag.net are a great resource for techs to gain knowledge and share knowledge during this paradigm shift in technology of the modern automobile market. Once the diagnostic tool's information has been transferred to a computer (non-internet tool platforms IE Vantage Pro, Solus, Solus Pro, etc.) one can attach the file from SSC to an email or upload to a site such as iATN or Diag.net to share with others or network with industry peers to gain a second opinion.



WANT AN EFFICIENT WAY TO TRANSFER FILES from one device to another? Need to share a photo or DTC record with your service writer? Try the app Pushbullet.



SNAP-ON DATA FILES USE DEDICATED FILE EXTENSIONS, meaning you can't view them on your laptop without help. This is the help – Snap-on's Shopstream Connect – and it's free to download.



THE SHOPSTREAM CONNECT SOFTWARE allows you to manipulate the recorded scan tool data on your device.

Share and network

Skype is another internet venue where people can communicate and share files across great distances. Groups can be formed and "rooms" created for the ability to share knowledge to network with other industry professionals. These rooms could be within your company, say a company that has multiple shops, or a group could be created from like-minded folks you had the privilege of connecting with at national training conferences such as NACE Automechanika or Vision. I am fortunate to be a member of such rooms and daily communicate across this great country with some of the most talented techs I have ever met. I find it to be a great resource for peer-to-peer connectivity.

Another helpful way of storing, sharing and remotely accessing your files is to leverage the technology of a cloud drive for your benefit. A cloud drive is an online storage drive that you can upload files and folders of data to for access anywhere you can connect to the internet. Cloud drive files can be shared with others and you can also control who has

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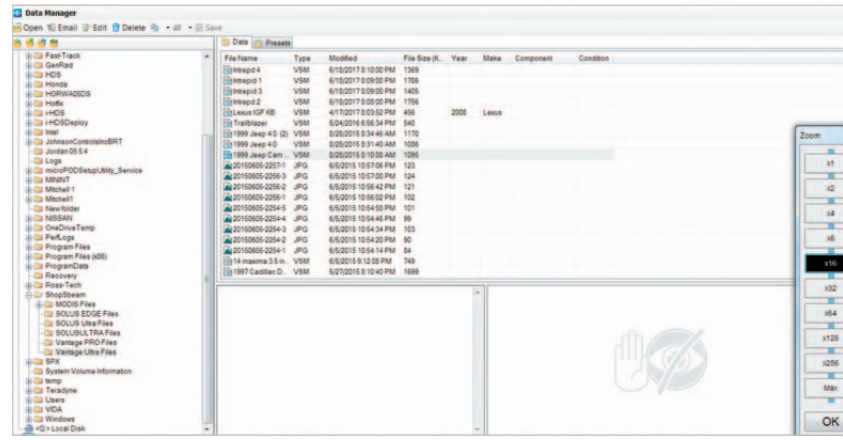
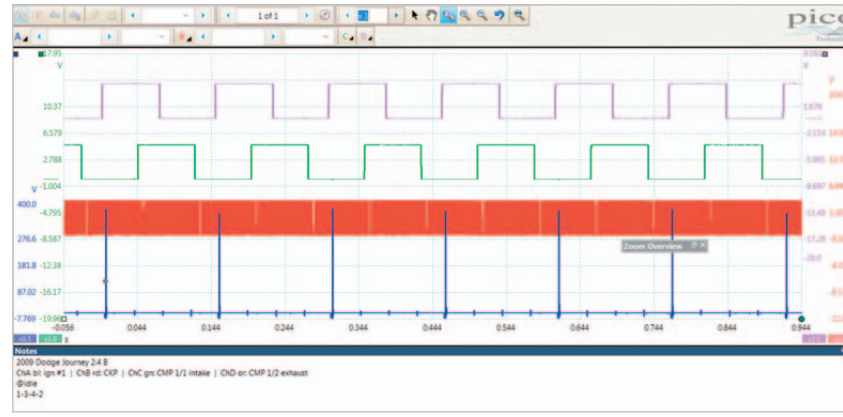
access to them. For example, you have a cloud drive and a folder for a CKP/CMP correlation capture that you want to share among all the employees of a company. You can send an invitation to access these files to whomever you wish, and you can also select who has access to modify the folder or contribute to it. Google Drive is one of the more popular cloud storage apps. If you have a Gmail address you have availability to 15 GBs of G-drive cloud storage for free. You can purchase additional storage extremely reasonably, up to 1 Tb for under $10 a month. Be sure to label your folders and files with as much information in the file name as you can, so you can retrieve them quickly for sharing and downloading using the Google Drive search feature. Google Drive is a secure place to store other files and images other than diagnostic tool data like photos, PDFs of service information (SI) procedures, TSBs or software. The price and availability of cloud drive storage has never been more available and affordable with other options like Microsoft OneDrive and Dropbox apps.



NOTE THE FILE EXTENSION ".VSM" — this is a dedicated extension.



NAME YOUR FILES WITH A STANDARD FORMAT – like year, make, model, engine – along with a capture descriptor and whether it was Known Good (KG) or Known Bad (KB). Use the notes section to detail what channel was tracing what and any other info relevant to the test.

Scope captures

One of the most powerful tools in many diagnostic techs' arsenal is the laptop based PicoScope®. I have been a big fan of this extremely powerful lab scope since John Thornton introduced me to it and Matt Fanslow put one in my hand. PicoScope captures or files are saved with a unique file extension ".psdata". This means PicoScope software is required to open them.

The cool thing is you do not have to own a Pico or have a software subscription to have this software on your computer. PicoScope software is downloadable for free at their website, www.picotech.com. The files being digital in nature allows me to save, store and share these images across the internet via an email attachment, Skype, cloud drive, or to upload to websites like Diag.net, iATN.net or social media sites like Facebook.

Because the Pico software is free to download without any purchase, anyone can download it, open and view the ".psdata" files. iATN has a waveform database that has, in recent years, allowed the Pico ".psdata" and Snap-on ".vsm" scope waveform images. This is very useful because subscribers can download, open, view and manipulate the captured waveforms, as well as create a database of their own making. That can be something super handy to have!

Again, what is key is good record keeping skills! Use the notes function of the software to label your channels so a viewer can easily tell what they are looking at. I like to create a folder for the vehicle where the YMM and the nature of the problem is in the title. Inside the folder, I label and store all my subsequent waveforms. Name your capture files accurately with detailed information of what is in the capture. I also like to start the file name with the number of the order in which the files were captured; that is, the first captured file number might be "1 CKP CMP sync 1" and the next capture "2 IC primary current sync 1" if this was my second capture, and so on. I do this because while the files are time stamped, the Pico software will alphabetize the files based on the file names, which could mix up the chronological order of the files.

A lot of my folders have several captures. For example, if I have pre- and

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post-repair captures of the same type of waveform, let's say, CKP CMP waveform post-CKP replacement, that I forgot to annotate in the file name, I can look at the number and quickly determine which is which via the order the waveforms were captured. This may sound silly, but over the years you will accumulate hundreds, if not thousands, of Pico waveforms! I also like to make a habit of ending my file name with the suffix of "KG" or "KB" when possible. This lets me search out and recognize "known good" and "known bad" captures at a quick glance. For example, "3 2005 Grand Caravan 3.8 CKP CMP sync 1 KG" would be the third waveform I captured of this vehicle, and it is a "known good."

In addition to capturing and storing waveforms in a manner that we can quickly identify and access, having a known good that we can reference is crucial. Perhaps we do not have the correct waveform in our stored database; there are resources available to us that do. I have been a member of iATN.net for many years, and one of its most useful resources is the waveform database available to subscribing members. Pico has also allowed users to integrate their waveform database provided we have registered with them and created a forum user ID and are online with the Picoscope software opened and a Picoscope connected.

Build your database

The amount of diagnostic information we gather to successfully diagnose a modern vehicle can be surprisingly large. This is not going to change. Having a systematic way of gathering and storing to a centralized location is a huge time saver for me personally. Also remember to have a system of filing that works for you. Naming your files and folders appropriately so you can quickly identify and locate them is mission critical to this process. Remember it could be months or even years later that you may want to revisit the data. Look into free programs like Snap-on Shopstream Connect and Pico's waveform reference library if you own that equipment. It is simply foolish not to take advantage of something that can help you, especially if it is free. If you have a Gmail address, I would sign up and use the free 15 GB Google Drive® storage and add more if you need it. Remember to back up your files in several locations in the event of an HDD or a tool RAM failure. You worked hard to collect this data — work equally as hard at saving and archiving in a way that you can quickly source and interpret it later.

ERIC ZIEGLER is an ASE Certified Master Tech who specializes in module programming, drivability, electrical and network systems diagnostics. He owns and operates EZ Diagnostic Solutions Inc. and is a trainer for Automotive Seminars and The Driveability Guys.
eric@diagnosticsolutions.com

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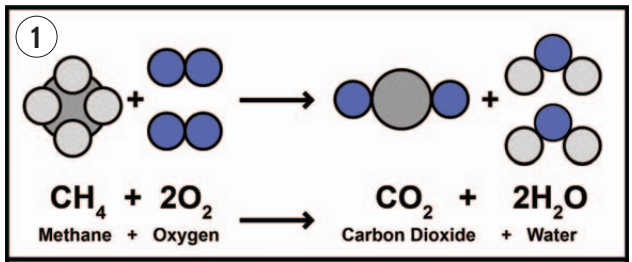
BERNIE THOMPSON // Contributing Editor

It's hard to believe that the internal combustion engine has been around for more than 200 years. The design of such an engine is a combination of work from many different individuals, but basically we attribute the modern engine to Nikolaus Otto. Nikolaus was a German engineer who developed the compression charge internal combustion engine that ran on liquid petroleum gas. This basic design is what the modern engine is based from. Over the years, many individuals have put their twist on Nikolaus's engine design in order to enhance the reliability and performance — and it's getting ready to be twisted again!

Introducing HCCI

As you already know, the modern internal combustion engine has seen a few twists. These twists are based on technological advancements in order to produce better performance and emission production. But perhaps you are not aware of one advancement the modern engine has seen — the Homogenous Charge Compression Ignition (HCCI) engine. Homogenous Charge (HC) refers to the charge state prior to ignition. A substance is homogeneous if its composition is identical wherever you sample it. This means that the charge mixture (fuel and air) has a uniform composition throughout the cylinder. Compression Ignition (CI) refers to the method that is used to drive the fuel past its autoignition point. When air is compressed rapidly, the molecules are accelerated off of the moving piston where they hit one another. The kinetic energy from the piston is turned into vibrational energy of the atoms, causing a heating effect. This process is called Adiabatic Compression. The Adiabatic processes are characterized by zero heat transfer with the surroundings. In the case of rapid compression, the process occurs too fast for any heat transfer to occur. Heat transfer is a slow process. This rapid compression of the air creates a rapid heat increase that is used to drive the fuel well past its autoignition point.



A stoichiometric diagram of the combustion reaction of methane

There are multiple ways used to combust fuel in the internal combustion engine. The fuel stock that is selected will set the method that will be used. In the automotive industry, the fuels that we are most familiar with are gasoline and diesel. These fuel stocks have been around for many years and are used around the world. When using these fuel stocks, the ignition point is obtained with different methods. Gasoline will use the method of spark ignition, while diesel will use the method of compression ignition.

Spark ignition

In the spark ignition method, the charge prior to ignition is that of a homogenous charge. This means that the fuel/air charge is evenly mixed throughout the cylinder volume. In order to completely burn an evenly distributed mixture within the cylinder, the air/fuel ratio must be very close to that of stoichiometry. Stoichiometry refers to the weights of the chemicals that will react. In an internal combustion engine, the fuel is the reactant and the air is the oxidant. Air is comprised of 79 percent nitro-

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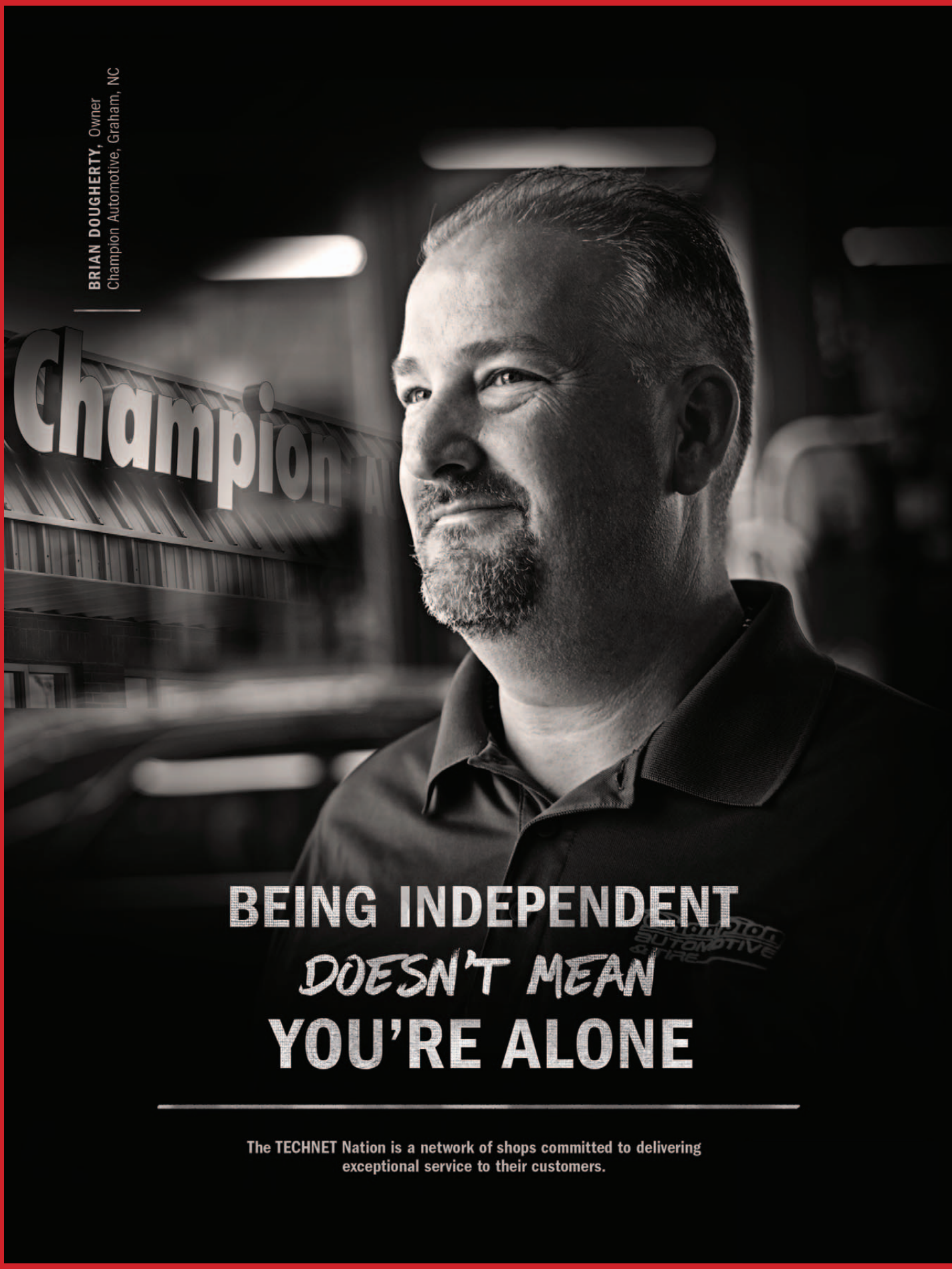
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gen, which is used as the working fluid, and 21 percent oxygen, which is used as the oxidant. The reaction will occur between the fuel, which is hydrocarbon based, and the oxygen. The stoichiometric ratio between the fuel and air is one where the hydrocarbons and oxygen are at a weight ratio that once they react with one another neither chemical will be present. This means that the hydrocarbons break apart, becoming hydrogen and carbon. In the presence of oxygen, the hydrogen combines with the oxygen forming a new chemical — dihydrogen monoxide (H_2O — water). The carbon attaches to the oxygen forming a new chemical — carbon dioxide (CO_2).

If the hydrocarbons and oxygen are at a stoichiometric ratio and react with one another, then neither of these chemicals will remain present within the combustion gases (Figure 1). The chemical weight will be the same, but the new chemicals formed during a complete reaction will be water and carbon dioxide. Although the mixture is at a stoichiometric ratio, in the real world there will not be a complete reaction between all of the chemicals so there will always be some hydrocarbons and oxygen left after the combustion process. This is due to the flame front being unable to get into the crevices around the spark plug, valve pockets and piston rings.

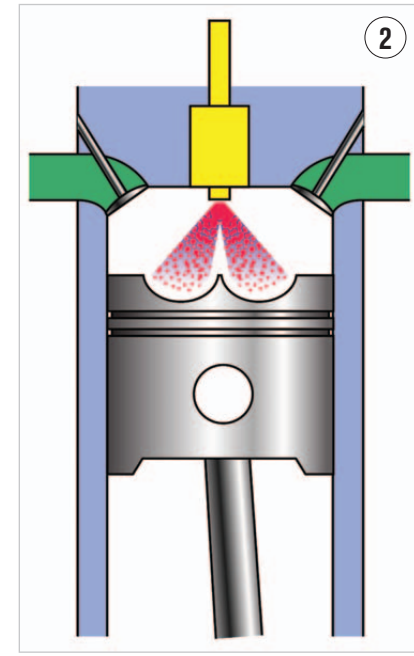
In a spark ignition system, the spark provides the heat that will push the temperature above the autoignition temperature of the fuel. The fuel/air mixture is homogeneous and is kept very close to stoichiometry. As previously discussed, this is the exact amount of fuel and air necessary for complete combustion of the fuel. The spark provides the point of ignition within the cylinder. This is the point where the fuel stock is driven past the autoignition temperature in a localized area around the spark event. This point can be controlled as the start of combustion; however, the combustion phenomena itself is much harder to control.

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 and is driven by the transfer of heat. When the flame front is propagating across the combustion chamber, the fuel and air, being a homogenous charge, allows this flame front to move without being hindered. This allows for a stable combustion event of the fuel. Any attempt to improve fuel economy by running a lean mixture with a homogeneous charge will result in unstable combustion. This is due to the propagation of the flame front being impeded. This will impact the power production and emissions of the engine.

Compression Ignition

In the compression ignition method, the charge prior to ignition is that of a stratified charge. A stratified charge refers to the state of charge as having gradients or layers. This is where the fuel/air charge is not mixed, but is separated. The cylinder is charged with air, and the fuel is injected directly into the cylinder as a fuel-rich aerosol concentration (as seen in Figure 2).

This is usually a mixture with a lean stoichiometric ratio. The air volume within the cylinder, having been compressed, is heated well above the autoignition point of the fuel stock. When the fuel is injected into the hot air within the cylinder the fuel changes states from a liquid to a vapor. The heat continues to be driven into the fuel within the cylinder, thus establishing the point of ignition. This is the point where the fuel stock is driven past the autoignition temperature in a localized area around the injection event. This injection point



can be controlled as the start of combustion; however, the combustion phenomena itself is much harder to control. The injected fuel plume has gradients of fuel mixture, as well as gradients of temperature and pressure. The fuel plume, being a rich vapor mixture, will only burn at the surface. In order for the chemical reaction to occur, the air concentration surrounding the fuel plume must interact with the fuel at a surface level. The surface level of the fuel plume is at a stoichiometric ratio, which allows the chemical reaction to take place.

During the combustion event, the air on the surface of the fuel plume and the fuel on the surface of the fuel plume are combusted or burned. This combustion process is accomplished in layers. As the outer layer is burned, the flame front is then driven into the next layer of the fuel plume. Burning in layers allows the fuel to burn more slowly, releasing its energy over more degrees of crankshaft rotation and thus producing more torque from the crankshaft. This combustion process continues until all of the fuel has been consumed within the reaction. If the fuel plume is

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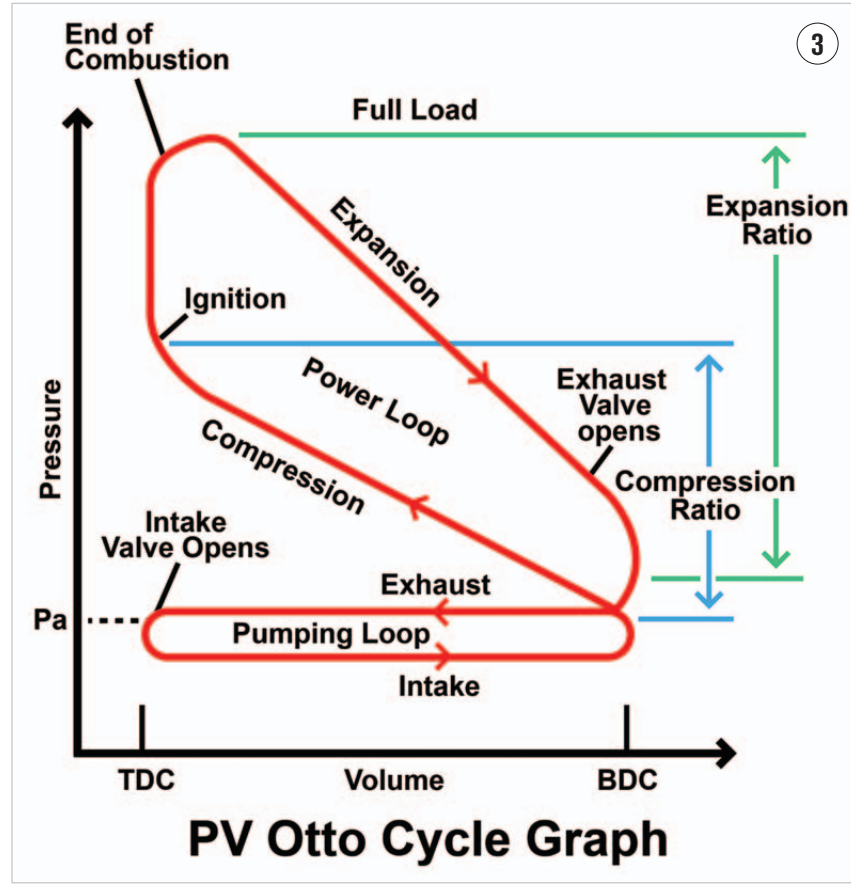
too rich, then the fuel in the center of the plume will not have enough oxygen to burn. This will create black smoke with heavy particular matter expelled from the exhaust system.

A stratified charge can allow higher compression ratios to be run without creating pre-ignition. There cannot be pre-ignition without fuel in the cylinder. Stratification allows the fuel to be injected only when the piston is close to the Top Dead Center (TDC) position. This late injection timing will set up the fuel/air charge for ignition. Additionally, with the way in which the fuel is burned on the boundary layer of the fuel plume, the engine can run at a much leaner air/fuel ratio than that of a homogenous charge engine.



HCCI

HCCI is not a new development; it has been around for many years. What is new is the way that the HCCI system is implemented and the electronic control of the HCCI system. HCCI uses the Otto combustion cycle (4-stroke engine) and was popular before the introduction of spark ignition. Since the internal combustion engine is a heat engine, the fundamental operation of the device is the production and use of heat. The Otto cycle describes the idealized thermodynamic operation of the 4-stroke engine (shown in Figure 3).

In these engines, everything that is done prior to the combustion of the fuel type is to set up the fuel/air in the cylinder so the charge can be ignited, burned and combusted. The conversion of chemical potential to thermal energy is important. The way in which this conversion takes place can change the engine's thermodynamic efficiency. The engine's thermodynamic efficiency is a measure of how effectively the engine converts heat into mechanical power. As we have seen, the way in which the fuel/air charge is set up and ignited is quite different and will change the thermodynamic efficiency of the engine. What is needed is a way to best extract the energy from the fuel stock. This is where HCCI comes into play. The HCCI engine provides a different way in which the fuel/air charge is set up and combusted.

The basis for the HCCI operation is the Homogenous Charge (HC). This is where the fuel/air charge is that of a uniformed composition throughout the cylinder. In a gasoline-based engine, the most popular method is to deliver the fuel with a port-style fuel injector and mix the fuel and air prior to the entrance into the combustion chamber.

Yet another way to fuel the engine is to use direct injection (DI). With DI, the fuel is injected with fine liquid fuel droplets directly into the combustion chamber. This method has less time to mix the fuel and air, so it is much harder to obtain a mixture that is completely homogenous. However, recent advancements have been made that allow the DI to obtain a better mixture within the cylinder.

The port-style fuel injector delivers a gaseous suspension of fine liquid fuel droplets that can be suspended in the air flow moving through the engine's induction system and into the cylinder. As this mixture moves into the cylinder, the mixing can be increased by a tumble and swirl effect, which creates a fuel/air mixture that is nearly homogeneous throughout the cylinder prior to ignition. This aerosol mixture is in a liquid format that, once injected and moved into the cylinder, is heated with adiabatic compression. This heat will change the liquid gasoline into a gasoline vapor that can be combusted. If the compression of the air is high enough, the heat will continue to be driven into

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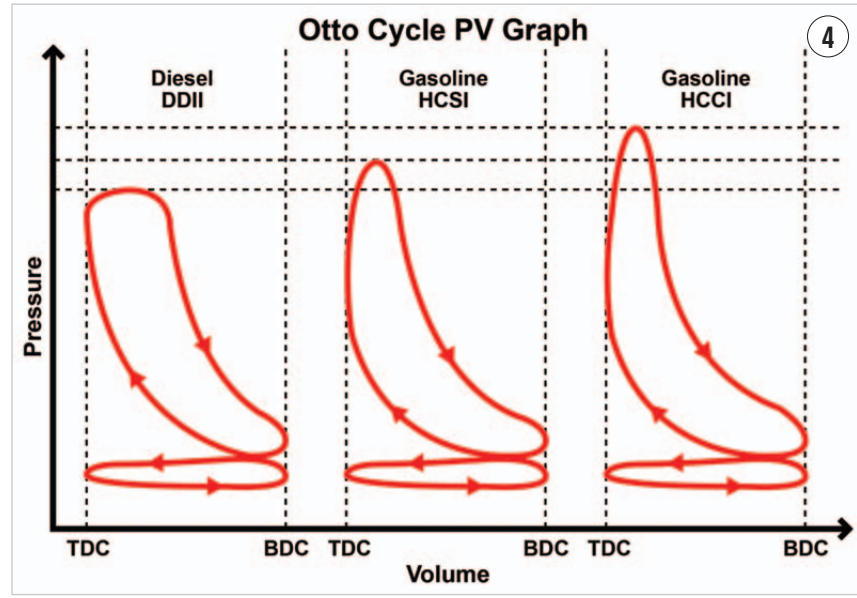
the fuel — this in turn will drive the gasoline past its autoignition temperature and will start the combustion process.

The HCCI combustion process is different from a spark ignition gasoline engine. In a spark ignition gasoline engine the point source of the ignition event causes a non-uniformity within the combustion chamber as a function of the fuel burn process. During the combustion process in an HCCI engine, the fuel throughout the cylinder is heated and ignited near simultaneously. This is not an explosion, but instead a somewhat controlled energy release of the fuel. This near-simultaneous ignition event provides for a more rapid heat release from the combustion event that increases the peak pressure within the cylinder (as seen in Figure 4). This in turn increases the engine's thermodynamic efficiency.

The HCCI Combustion event has benefits over Homogenous Charge Spark Ignition HCSI) and Diesel Direct Injection Ignition (DDII). With spark ignition combustion, in order to achieve a complete burn the fuel/air mixture needs to be close to that of stoichiometric. With HCCI combustion, the mixture can be lean of stoichiometric and still achieve a complete burn with low nitrogen oxide (NOx) production.

Diesel can also achieve a complete burn lean of stoichiometric; however, due to the way the fuel plume is burned, particular matter (soot) is formed with high NOx emissions. Only the HCCI combustion process provides multiple ignition points throughout the cylinder (as seen in Figure 5). Unlike conventional combustion in the spark ignition or diesel ignition process, HCCI does not rely on a flame front to propagate combustion but instead combustion occurs as spontaneous ignition everywhere in the charge volume when the required conditions are met.



Making it work with gasoline

Gasoline's autoignition temperature is much higher than that of diesel fuel. Gasoline has a flash point of -45°F, and an autoignition point of 536°F, whereas diesel fuel has a flash point of 126°F, and an autoignition point of 256°F. In order to autoignite gasoline, the compression will need to be higher than what is needed for diesel fuel. To autoignite diesel fuel you need a compression ratio of 11.0:1. In order to start a cold diesel engine, the compression ratio will need to be much higher. To ensure a cold diesel engine can start, the compression ratio on the direct injection diesel engine is usually 18:1 to 24:1. In order to autoignite gasoline, the compression ratio will need to be 15:1 or higher. At part load, the compression ratio to autoignite the gasoline will need to be at least 17:1.

With a need for a higher compression ratio to enable the HCCI combustion event, the engine will need a way in which this can be obtained. One way is to use an engine with a Variable Compression Ratio (see "VCR: A future technology applied today," April 2018). This is where the compression can be controlled through changing the static compression ratio of the engine. Another way to control the compression charge rate would be the use of forced air induction. One method would be the use of a supercharger with a constant variable control pulley drive system. With this system the supercharger can spin at speeds that are different from that of the crankshaft speed. This allows the cylinder charge volume to be controlled, an increase in volume raises the compression ratio, whereas a decrease in the volume lowers the compression ratio.

Yet another way to heat the cylinder volume is through exhaust gas dilution. This can be done by rebreathing or by recompression. In rebreathing, the cylinder charge temperature is controlled by exhaust gases being cycled back into the combustion chamber after exiting the exhaust port. In recompression, the cylinder charge temperature is controlled by trapping hot residual gas from the previous engine cycle by closing the exhaust valve early during the exhaust stroke. In either method the charge temperature can be controlled.

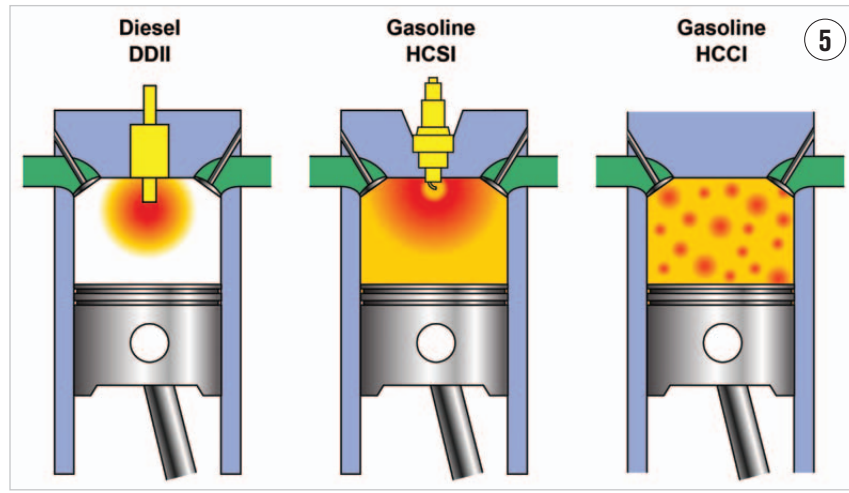
Now that the charge temperature can be controlled for the autoignition of the fuel, the fuel itself can be a problem for this process. Gasoline is a mixture of hydrocarbon (HC) components. These

HC base chemicals have different hydrogen carbon bonds with different chain configurations and lengths. This allows some of the HC chemicals to vaporize at low temperature, while other HC chemicals vaporize at higher temperatures. Additionally, the flash points and autoignition points of these HC chemicals will vary widely with temperature.

One would think that there would be a standard recipe used when blending gasoline; however, this is not true. Basically any hydrocarbon that burns can be utilized in the gasoline blend. There are laws that the gasoline will be required to meet for the pump rating of the fuel and the volatility of the fuel. The pump number is how the fuel is rated to control engine knock and the Reid vapor pressure is a rating of how much of the liquid fuel vaporizes at a given temperature. Both of these ratings are important for the performance and emissions of the engine.

Since there is no prescribed way to blend the fuel base, each gas station will have different hydrocarbons in their fuel blend. This becomes a problem with the HCCI combustion event. Since there is not a given start of the combustion event, the heat within the cylinder is what will dictate the point of ignition. Therefore, the heat within the cylinder will have to be managed very carefully. Different hydrocarbons will vaporize and ignite at different temperatures, thus each gas station will have fuel that will have different autoignition points. If the autoignition points of the fuel are too low, detonation can occur. Detonation within these engines will have to be avoided at all costs. Detonation is a supersonic shockwave that occurs throughout the combustion chamber, creating a near stepwise change in pressure. This is where the charge is ignited instantly. Detonation can cause catastrophic damage to the engine.

These fuel differences will make the operation of the HCCI engine very difficult. In order to have better control over the entire operating range of the engine, a dual mode can be used. This will allow the spark ignition on gasoline based engines, or diesel direct injection ignition on diesel based engines, to remain operational under some conditions. For example, a gasoline based engine will idle with spark ignition combustion. Then under light to moderate load, the engine will operate with HCCI combustion and at heavy load the engine will operate with spark ignition.



However, there are problems when using dual-mode ignition. For instance, when transitioning to and from homogenous charge spark ignition (HCSI) and homogenous charge compression ignition (HCCI) modes of engine operation. HCCI under part load requires a compression ratio of 17:1. When transitioning from HCCI to HCSI the compression ratio will need to change almost instantaneously to 12:1. This will be difficult to accomplish with just a variable compression ratio engine. So the variable compression ratio will only be used for part of the heating of the air charge. Boost pressure form force air induction and exhaust dilution will be used in conjunction with the variable compression ratio. The results are far better when using multiple systems to control the temperature of the air charge.

The use of HCCI has many practical benefits. These engines operate close to the maximum thermal conditions for the engine. Higher compression ratios provide greater performance with better emission and fuel economy. HCCI improves the conversion efficiency which improves the thermodynamic efficiency of the engine. HCCI provides for faster la minar flame front temperatures, thus higher combustion chamber peak pressures without the production of NOx. Faster combustion rates increase engine response. Additionally, running less ignition advance lowers parasitic losses. HCCI can also run lean of stoichiometric while still providing a complete burn of the fuel. As you can see these benefits of the HCCI combustion process are significant. This means that these engine will soon be in production and in your service bays.

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20 YEARS OF THE TOYOTA PRIUS

THE PRIUS IS THE LEADER IN HYBRID SALES, AND ITS DESIGN WAS REVOLUTIONARY

JOHN D. KELLY // Contributing Editor

Has it really been 20 years since the first Toyota Prius was released? Yes, it was launched in Japan in December 1997 as a 1998 model. The Prius was launched in the U.S. in the summer of 2000 as a 2001 model. The Prius is now in its fourth generation. Whether or not you like the Prius, almost every other hybrid vehicle on the market today contains parts that were obviously patterned after the first Toyota Hybrid System (THS) in the first Prius. This was the world's first mass produced hybrid vehicle, and it shocked the entire automotive industry upon its launch.

The development of the first Prius is an incredible story that is detailed in a 387-page book called *The Prius that Shook the World* by Hideshi Itazaki, published in 1999. Unfortunately, that book is out of print. I found a used one on Amazon several months ago, and I was able to get permission from Mr. Itazaki to share some of the information from his book with you. I will also share additional information I have collected over the years.

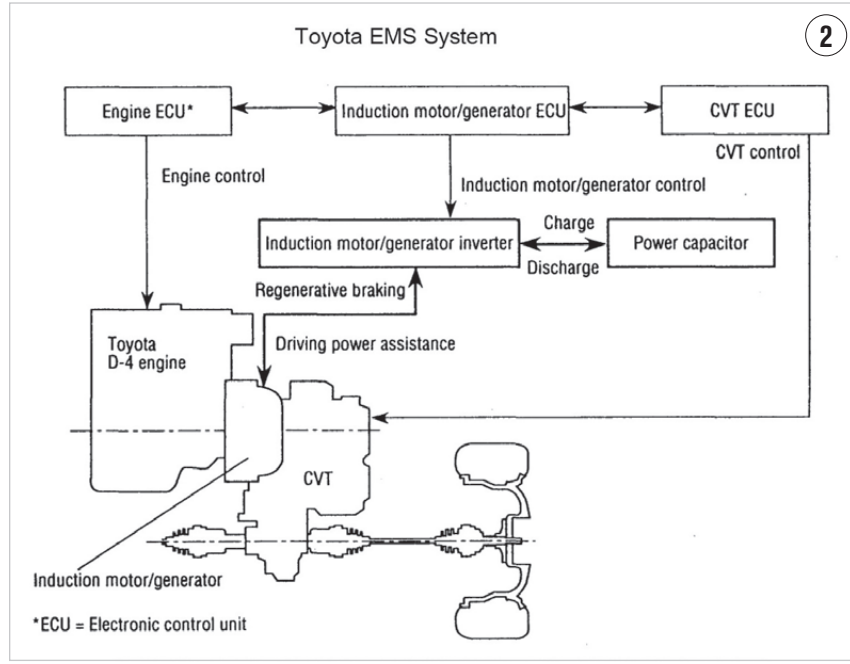
Why did Toyota build the Prius? According to my research, a combination of four factors inspired the development of the Prius.

EPA Laws: In 1990, amendments were made to the U.S. Environmental Protection Agency's (EPA) Clean Air Act of 1970. The automotive industry was directly impacted by new rules to reduce acid rain, reduce urban air pollution, and reduce toxic air emissions.

CARB Laws: Also, in 1990, the California Air Resources Board (CARB) adopted the Zero Emission Vehicle (ZEV) mandate. Both of these changes in laws affected the ability of an automobile manufacturer to sell cars in California without meeting the new regulations by 1998-2003.

Inequality: Further inspiration to build the Prius came from inequality of enforcement of U.S. laws. Toyota had already experienced situations where U.S. fuel economy and emissions laws were enforced on Japanese auto makers, while granting extra time to the Big 3 from Detroit to find ways for their cars to meet the requirements. Toyota Motor Corporation took these new regulations seriously.

THE 1995 TOYOTA PRIUS CONCEPT CAR.



THE 1995 PRIUS CONCEPT CAR Toyota-EMS (Energy Management System)

PHOTOS: TOYOTA GLOBAL NEWSROOM

Pride: Because of inequality and probably some personal pride, Toyota engineers decided they wanted to show people in the U.S. that a car can be practical, attractive, clean and fuel efficient. They wanted to beat the Big 3 from Detroit to market with such a car.

G21 Project: In September of 1993, Toyota formed the Globe 21st Century (G21) project to research what the car of the future would look like, how it would operate, and how polluting it would be. The following ideas for a concept car resulted from the project: (1) It would have a roomy cabin with a high seat position; (2) Use an aerodynamic body design; (3) Achieve 20 km/L (47 mpg) fuel economy (50 percent better than the car of the day); (4) Use a horizontally mounted efficient engine with direct fuel injection; (5) Use an efficient Continuously Variable Transmission (CVT); and (6) It would be a vehicle with no increased infrastructure requirements (unlike electric and Compressed Natural Gas (CNG) vehicles).

To make a long story short, the G21 project went through several phases as progress towards the development of a concept car from scratch proceeded. In late 1994, Toyota management decided that a 50 percent increase in fuel economy was not enough for a car of the 21st century; they directed the G21 group to double the fuel economy instead.

A concept car (Figure 1) was built for the October 1995 Tokyo Motor Show. The car was built with an electric induction motor/generator sandwiched between a direct injected 1.5L gasoline engine and a push-belt CVT transmission. A capacitor was used to store, and release, energy as required. This system was described as the Toyota-EMS (Energy Management System – Figure 2), rather than a hybrid. Toyota wanted it kept secret that they were developing a hybrid vehicle.

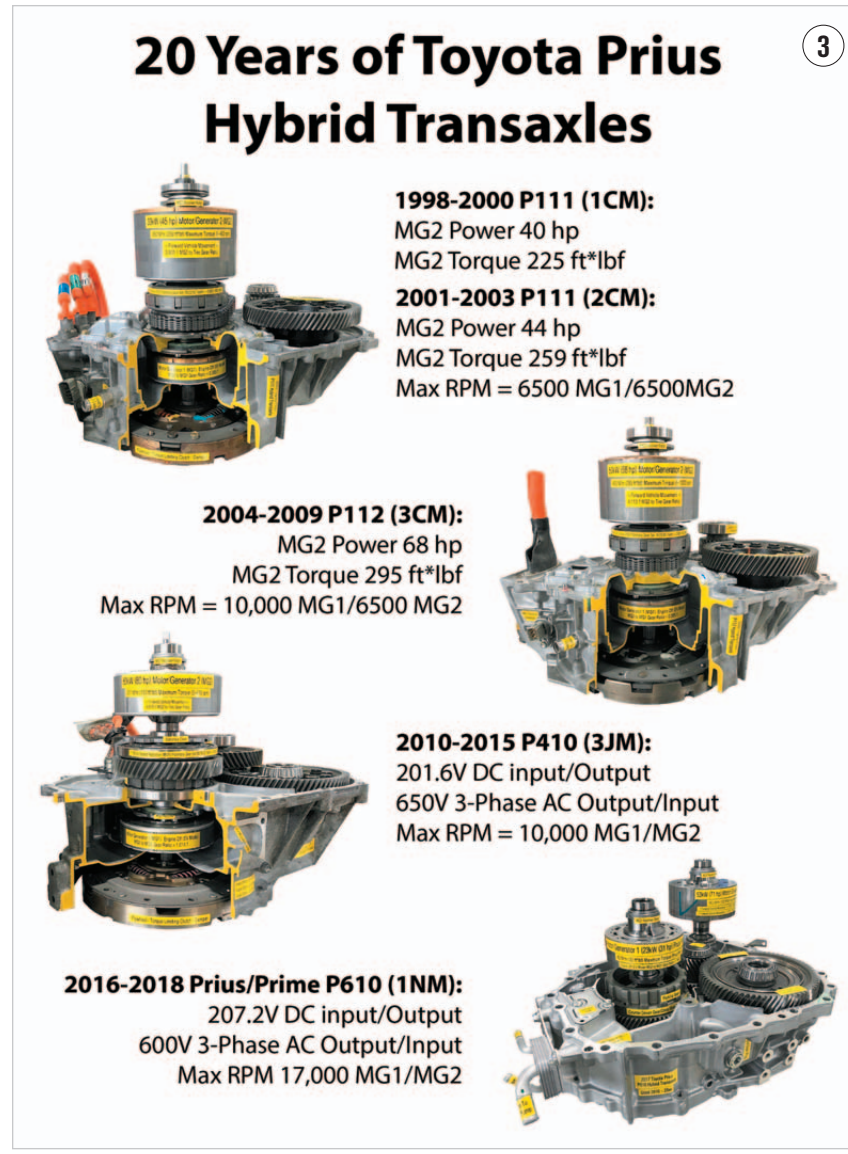


PHOTO: JOHN D. KELLY

THE 1998-2018 TOYOTA PRIUS E-CVT TRANSAXLES

Toyota Hybrid System: As a result of the directive to double fuel economy, the G21 project group had to change everything; a new powertrain design had to be developed. In June of 1995, at the final meeting of the G21, development of a hybrid vehicle was officially approved at the meeting and a code name "890T" was assigned to the Prius. Toyota was determined to keep the development of their hybrid vehicle a secret. The hybrid system was named "Toyota Hybrid System (THS). Development of the new THS system presented many challenges. Most of the following challenges had never been accomplished in the automotive industry. Toyota had to pioneer the design of each of these from scratch.

Atkinson Cycle Engine: Rather than using the direct injected gasoline engine (Otto Cycle), it was decided to develop an Atkinson Cycle gasoline engine because of its high efficiency and low exhaust emissions. The Atkinson cycle engine was better suited to work with the new transaxle design. As you may know, the Atkinson cycle engine

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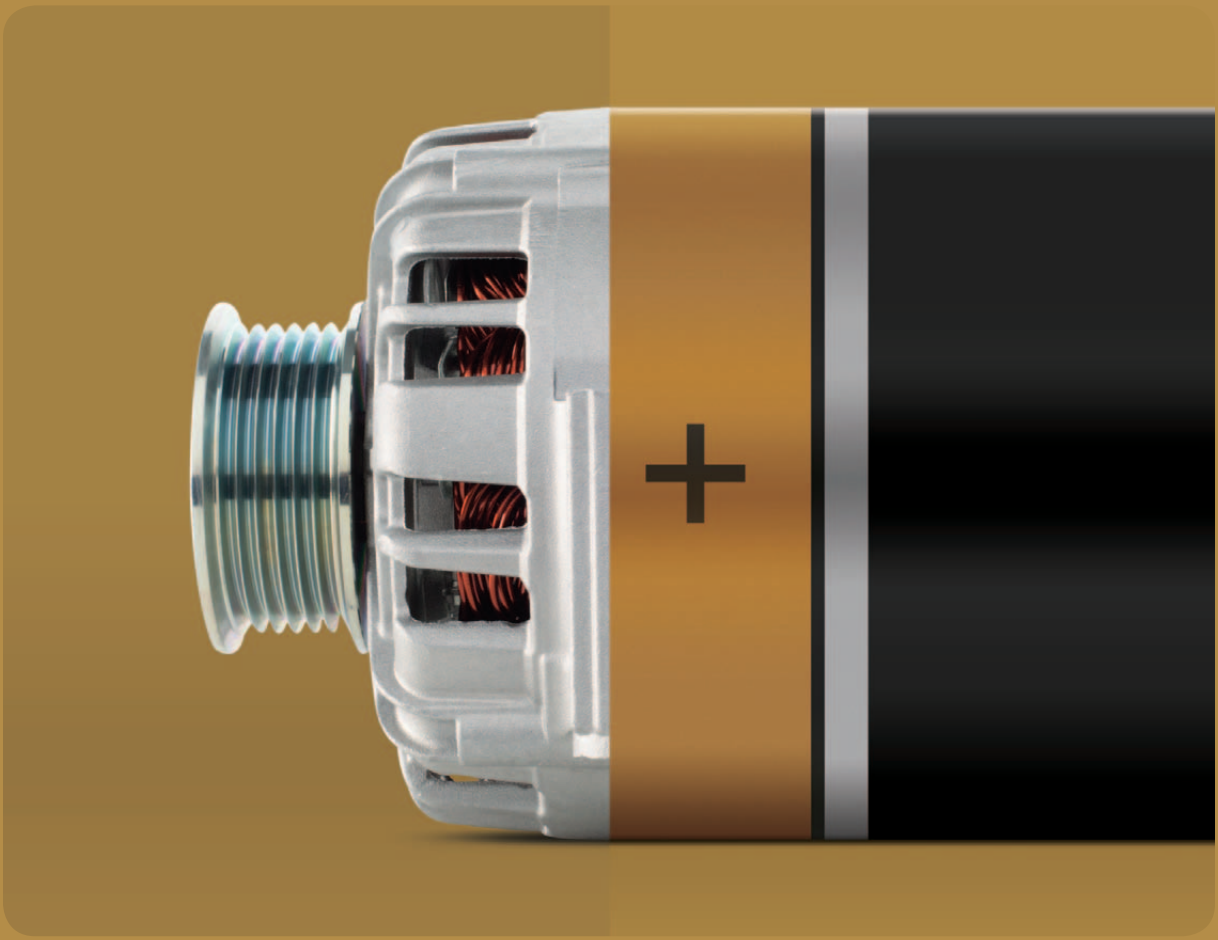

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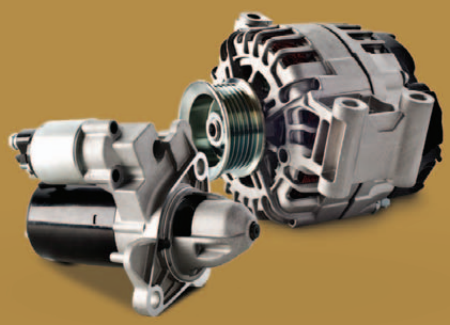

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leaves the intake valve open for a short period of time during the compression stroke. This action effectively reduces the compression ratio in the cylinder.

The Atkinson cycle engine had two unique problems when used with the hybrid system. Both problems were solved by adding Variable Valve Timing with Intelligence (VVT-i), but not for the traditional reasons of improved performance. The first problem was the jolt of starting and stopping the engine while the car was moving. The jolt was reduced by using the VVT-i to leave the intake valves open for a longer period of time than usual to decrease cylinder pressures under those conditions.

The second problem involved starting the engine when cold. Remember, a non-Atkinson cycle engine always has lower compression ratios, which makes cold starting difficult. The addition of the VVT-i system allowed the intake valve to be temporarily closed early, causing higher cylinder compression and easier cold starting. This engine would eventually become known as the Toyota 1NZ-FXE.

Transaxle (Figure 3): The push belt CVT transaxle was dropped as an option because it was more difficult to start and stop the engine when the car is in motion. They decided to develop a Power Split Twin Electric Motor/Generator Electronic CVT (E-CVT) transaxle instead. If you recall, the power split design uses a single planetary gear set. The planet carrier is connected to the engine's crankshaft, the sun gear is connected to Motor Generator 1 (MG1), and ring gear is connected to the traction motor (MG2). The power split design allows the engine to contribute torque to the traction motor to help propel the vehicle. This transaxle would eventually become known as the Toyota P111.

P111: The P111 (1CM model) and P111 (2CM Model) transaxles had a single Power-Split Device (PSD) Planetary Gear Set and a chain-driven final drive.

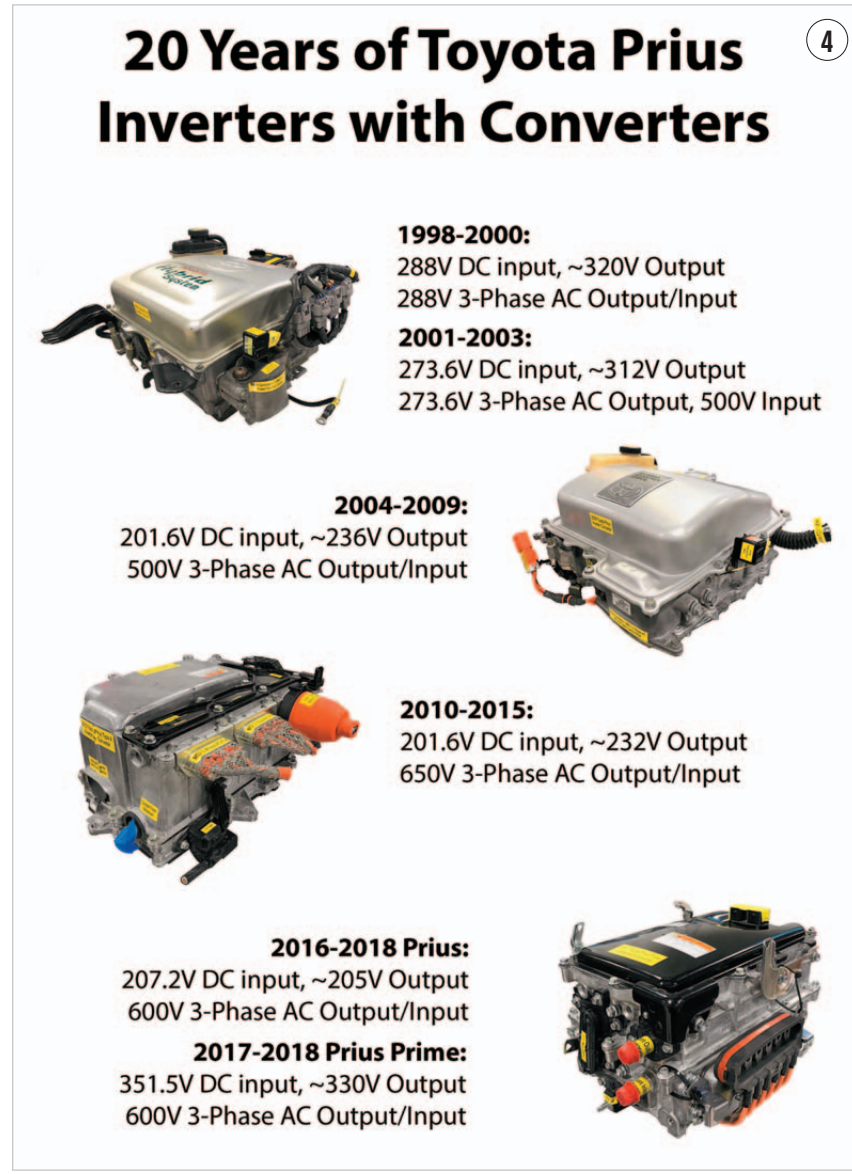

PHOTO: TOYOTA GLOBAL NEWSROOM

THE 1998-2018 TOYOTA PRIUS INVERTERS WITH CONVERTERS

P112: The P112 (3CM model) transaxle was almost identical to the P111 (2CM); however, a change to the design of MG2 resulted in 9 percent more motor torque.

P410: The P410 (3JM) transaxle has two planetary gear sets: A (PSD) set and a new Motor Speed Reduction (MSR) set. The MSR increased the MG2 motor torque 2.63 times through gear reduction. As a result, MG2 motor speed increased to a maximum of 10,000 RPM. A gear drive replaced the chain driven final drive of the previous models.

P610: The P610 (1NM) transaxle was a new efficient design, but it operates identically to the P410 with a (PSD) planetary gear set and a (MSR) gear set and a maximum of 17,000 RPM.

Inverter/Converter (Figure 4): As you may know, the inverter uses power from the high voltage DC battery to drive each of the 3-phase AC electric motors in the transaxle through six

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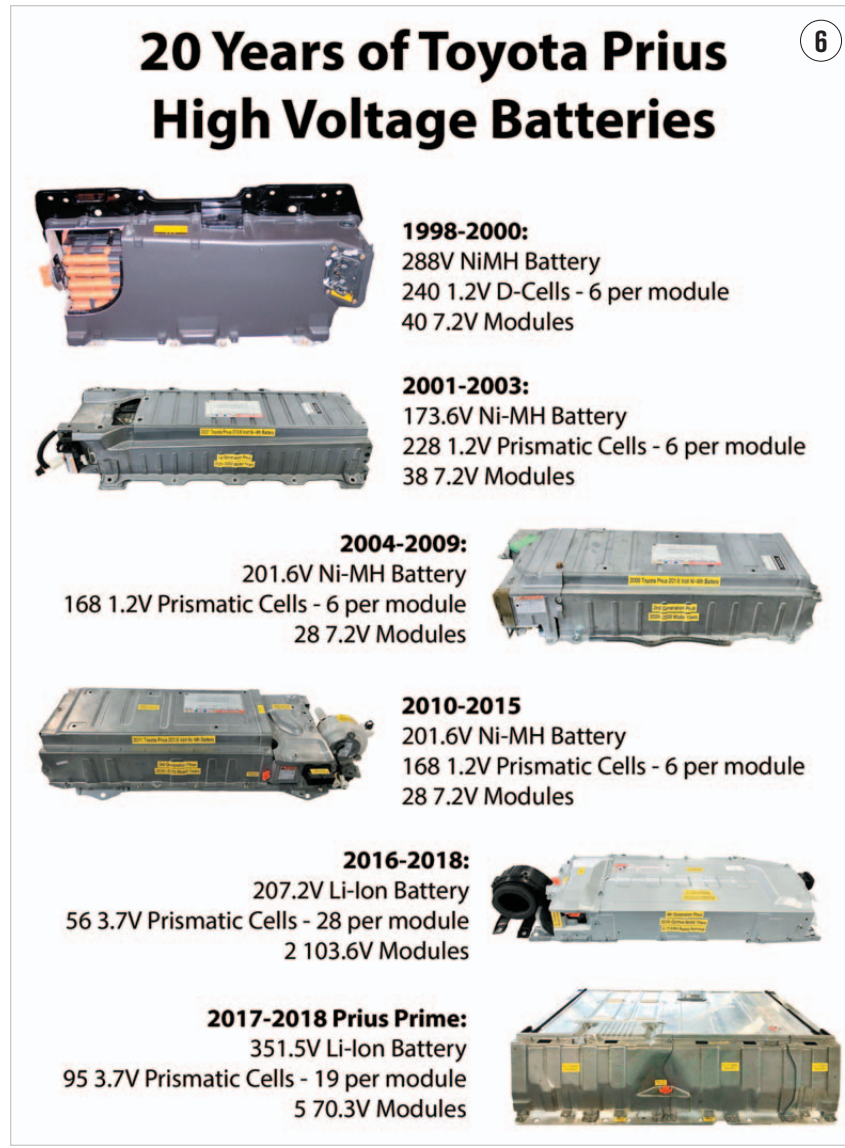
PANASONIC EV ENERGY PRODUCED THE PRIUS BATTERIES

Insulated Gate Bi-polar Transistors (IGBT). The IGBTs also contain a diode, which is used to help rectify 3-phase high voltage back to DC voltage during deceleration and while the engine is running. IGBTs had never been developed for this power level and high operating temperature. Toyota had to design their own IGBTs in-house. The high underhood temperatures caused by the engine running made the design more difficult. It was a very long and frustrating process, but Toyota set the benchmark for IGBTs and inverters that others use to this very day.

If you have ever heard that the Prius does not have any power, it came from the 1998-2003 Prius. The 1998-2003 THS inverters did not use a boost converter to increase system voltage above battery voltage. These models were not well suited for mountainous driving. At times, customers would complain of a lack of power driving up a long uphill grade with a fully loaded vehicle. There was actually a "Turtle Light" that would come on to indicate the battery energy was depleted and to drive less aggressively to let it recover.

Beginning with the 2004 model year, to remedy the lack of power complaints, a boost converter was added to the inverter. This would more than double the voltage applied to the transaxle MG2 motor to drive the vehicle. The combination of the boost converter, transaxle modifications and better aerodynamics was called the Toyota Hybrid Synergy Drive (HSD). These vehicles do not lack power; they are very fun to drive.

Further enhancements in 2010 and above were named the Toyota Hybrid Synergy Drive-II (HSD-II).



THE 1998-2018 PRIUS BATTERIES

2001-2003 PRIUS AND THE 1998-2000 ARE SIMILAR

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High Voltage Battery (Figure 5): It is hard to imagine this today, but the Nickel-Metal Hydride (Ni-MH) battery was a relatively new technology in the early 1990s: Toyota had already co-developed an Ni-MH battery with Matsushita Battery Co. for the 1994 RAV4 EV, but developing the Prius battery was going to be more challenging.

There were two big problems with the Prius battery development: **1. Excessive heat:** They tried placing the battery under the car (like the Rav4 EV), but the battery got too hot from the additional heat produced by the engine and from the road. Finally, they decided to put the battery in the trunk behind the back seat to solve the overheating problems using air cooling. **2. Power output:** The Prius battery was supposed to supply 288 Volts and 20 kW of power. The early designs of the battery did not have the capacity output needed for the Prius to meet the directive to double fuel economy. The first battery was also about twice the size allowed for the space in the Prius.

In December of 1996, after failing to produce a satisfactory battery for the Prius, Toyota partnered with Matsushita Electric and Matsushita Battery in a joint venture to form Panasonic EV Energy company (Figure 6). The battery for the first Prius was made of 240 round D-Cell 1.2V Ni-MH cells all connected in series in a box behind the back seat. There were many production problems resulting from tiny specs of lint contaminating the battery cells internally. Poor connections between each of the 240 cells was also an early concern. These issues were solved just in time for the December 1997 launch of the 1998 Prius.

The 2001 model and later Prius battery designs used flat prismatic battery modules in place of the older D-cell designs. Panasonic EV Energy is the supplier of Ni-MH batteries for all four generations of the Prius as well as some Honda and General Motors hybrids.

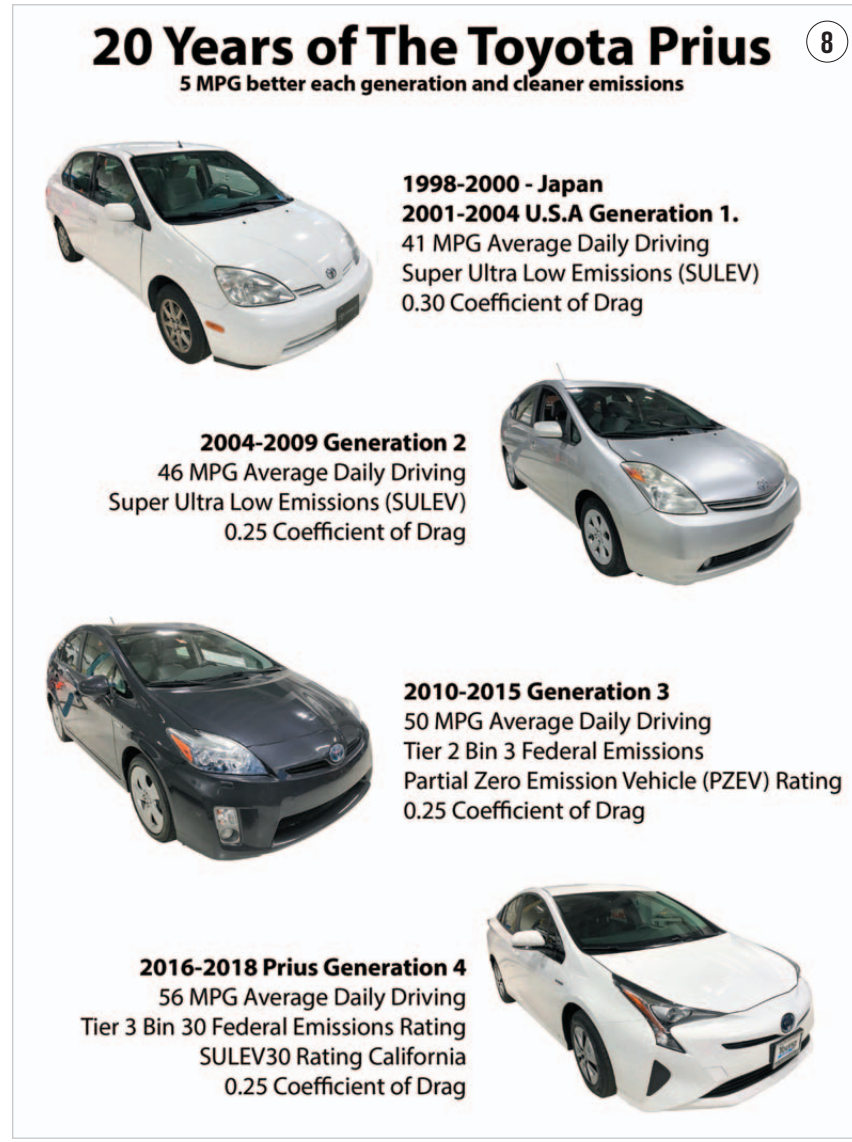

PHOTO: JOHN D. KELLY

THE 1998-2018 TOYOTA PRIUS GENERATIONS

The 2016 and later Prius 207.2V battery used two stacks of 28 3.7V Li-ion cells in place of the older Ni-MH modules. The 2017 and later Prius Prime 351.5V battery used five stacks of 19 3.7V Li-ion cells for electric-only driving and then the vehicle switches to hybrid mode.

Four Separate Cooling Systems: The 1998 Prius hybrid required four separate cooling systems: One for the engine, one for the combination of the inverter and the transaxle, one for the air conditioning, and one for the high voltage battery. That meant that three radiators were needed to fit where two would have normally been placed. It was decided to combine two radiators (the engine and the inverter) into one unit. This style of radiator system is still used in the latest Prius today.

Regenerative Braking System: Stopping a hybrid vehicle under all possible conditions presented many new challenges. Toyota engineers had to figure out how, and when, to blend

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hydraulic braking and regenerative braking from the motor/generators. They had to make this brake system feel like any other vehicle's braking system would. They had to simulate how the brake pedal felt while it was being depressed. They even engineered a creep forward feeling when the brake pedal was released to simulate what a car with an automatic transmission does. All of these systems had to be developed from scratch.

Introduce it to the world: After only 2.5 years of development time using 1,000 engineers, the 1998 Prius is shown to the world press in October and finally offered for sale at Japan Toyota dealerships on December 10, 1997. This real-life hybrid vehicle shocked the press and the automotive industry, especially the Detroit Big 3. Toyota showcased the Prius at the January 1998 Detroit Auto Show. The Big 3 automakers displayed non-functional concept cars and announced that they would have superior hybrids and fuel cell vehicles on the road in 2-3 years (which has never happened in the last 20 years).

The 1998 Prius looked almost identical to the 2001-2003 Prius (Figure 7). It had right-hand drive, no rear spoiler, and six spoke wheels. It looks nothing like the later models of the Prius.

Initial sales orders of the 1998 hybrid Prius were three times what were predicted in Japan over the next three years. Toyota decided to release The Prius to the rest of the world in 2000, but only after several modifications were made to give it more power and make it more reliable.

Today the Toyota Hybrid System and its variations have found their way into 40 other Toyota and Lexus vehicles over the last 20 years. It has become the best-selling and most efficient hybrid system in the market with over 10.4 million hybrid vehicle sales worldwide. The Prius of today would shock the original G21 group. The Prius has exceeded all of the G21 goals established in 1993 except for the use of gasoline direct fuel injection (GDI), but Toyota just announced a new GDI hybrid engine earlier this year, so more changes are on their way.

After 20 years of the Toyota Prius, are you familiar with how they work, how to diagnose and repair them, how to service them? If not, it has been 20 years! It is time to get started before you fall behind in the ever-changing world of hybrid and electric vehicle technology. Best wishes!

JOHN D. KELLY is a professor of automotive technology at Weber State University in Ogden, Utah, and a former technician. He specializes in automatic and manual drivetrain and NVH diagnosis and hybrid and electric vehicle technology.
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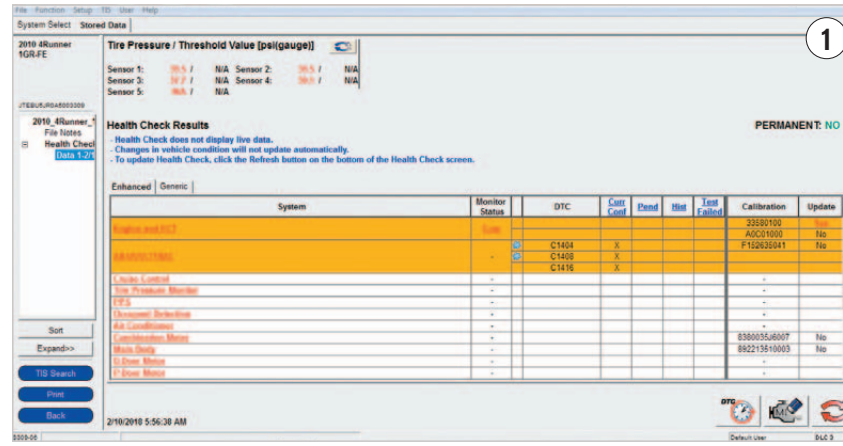
G. JERRY TRUGLIA //
Contributing Editor

Don't fear Asian vehicles! Since many companies already share parts and technology, you will notice that Asian vehicle are not that much different than domestic vehicles. Just like any other vehicle that comes into your shop with a problem, you need a game plan on how you're going to address the issue.



2014 Toyota 4Runner

Our first vehicle is a 2010 Toyota 4Runner 1GR-FE with 128,000 miles on the odometer that came in with the ABS light illuminated and the owner complaint of a braking issue. We started our diagnosis with a Q&A of the owner, followed by a short test drive and a visual inspection before connecting our scan tool.

After we connected the Toyota TechStream scan tool (Figure 1) we found the following DTCs: C1404 (Open or Short in Rear Speed Sensor LH Circuit), C1408 (Open or Short in Rear Speed Sensor LH Circuit) and C1416 (Open in the Sensor Signal Circuit of a Malfunction area occur 255 times or more). Our next step was to take a look at the DTC supporting information — Freeze Frame. As you can see from the Freeze Frame data (Figure 2), the Left Rear wheel speed was recorded moving at 0 mph, while the other wheels were displaying 26 to 27 mph.

The source of the DTC could be caused by the rear speed sensor, skid control sensor wire, speed sensor circuit, speed sensor rotor and/or the master cylinder solenoid skid control ECU. Common problems with theses sensors include debris, a sensor that has moved from its normal position and defective sensors. We took the vehicle for a test drive with the scan tool connected, making sure we drove it in a straight line at 28 mph to see if the DTC would reappear. The DTC returned right away, so there was no need to drive the vehicle in reverse at 2 mph as recommended by Toyota.

With the test drive confirming that the circuit had a problem, my lead technician (Bill) checked the wiring to make sure there were no connection problems. After the wiring checked out, the next step was to call the 4Runner owner and recommend that both rear wheel speed sensors be replaced. Take notice that we did not use a labscope on this problem since Toyota service information had specific testing of the circuit that would confirm the problem without using any other tool besides the Toyota Techstream. Why take out the backhoe when a shovel will do the job? We need to remember that we sell our time to the customer, so we need to diagnose the problem in the easiest and most efficient way.

2005 Toyota Tacoma

A 2005 Toyota Tacoma with a 1GR-FE V6 4.0L came in with an overheating issue and the MIL on. This vehicle had 123,938 miles on the clock and has served our customer very well over the years. After we connected our scan tool, we discovered that the MIL was illuminated due to a misfire in number 6 cylinder.

As Bill began his diagnostic game plan, he came upon a low coolant level as part of his preliminary checks. He also found that the scan data displayed a P0306 DTC that could be caused by a mechanical, ignition or fuel issue. He proceeded to check all the easy stuff first, performing a relative compression test, ignition and fuel system test. After performing a basic cooling system pressure test that failed to hold pressure, his next step was to check for a head gasket problem since this is a common issue on this Toyota V6 en-

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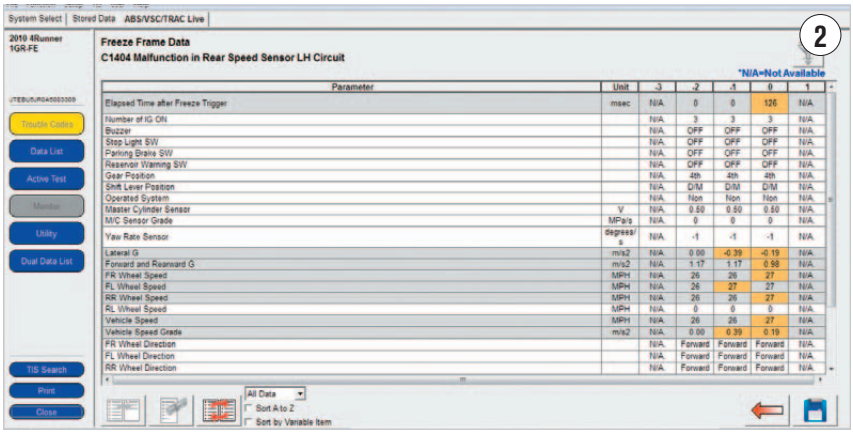


Parameter	Unit	-3	-2	-1	0	1
Elapsed Time after Freeze Trigger	msec	N/A	0	0	126	N/A
Number of IG ON		N/A	3	3	3	N/A
Buzzer		N/A	OFF	OFF	OFF	N/A
Stop Light SW		N/A	OFF	OFF	OFF	N/A
Parking Brake SW		N/A	OFF	OFF	OFF	N/A
Reservoir Warning SW		N/A	OFF	OFF	OFF	N/A
Gear Position		N/A	4th	4th	4th	N/A
Shift Lever Position		N/A	D/M	D/M	D/M	N/A
Operated System		N/A	Non	Non	Non	N/A
Master Cylinder Sensor	V	N/A	0.50	0.50	0.50	N/A
M/C Sensor Grade	MPa/s	N/A	0	0	0	N/A
Yaw Rate Sensor	degrees/s	N/A	-1	-1	-1	N/A
Lateral G	m/s2	N/A	0.00	-0.39	-0.19	N/A
Forward and Rearward G	m/s2	N/A	1.17	1.17	0.98	N/A
FR Wheel Speed	MPH	N/A	26	26	27	N/A
FL Wheel Speed	MPH	N/A	26	27	27	N/A
RR Wheel Speed	MPH	N/A	26	26	27	N/A
RL Wheel Speed	MPH	N/A	0	0	0	N/A
Vehicle Speed	MPH	N/A	26	26	27	N/A
Vehicle Speed Grade	m/s2	N/A	0.00	0.39	0.19	N/A
FR Wheel Direction		N/A	Forward	Forward	Forward	N/A
FL Wheel Direction		N/A	Forward	Forward	Forward	N/A
RR Wheel Direction		N/A	Forward	Forward	Forward	N/A

gine. Bill's decision to proceed in this direction was based on the test results from the relative compression test that indicated normal results, while the cooling system pressure test failed.

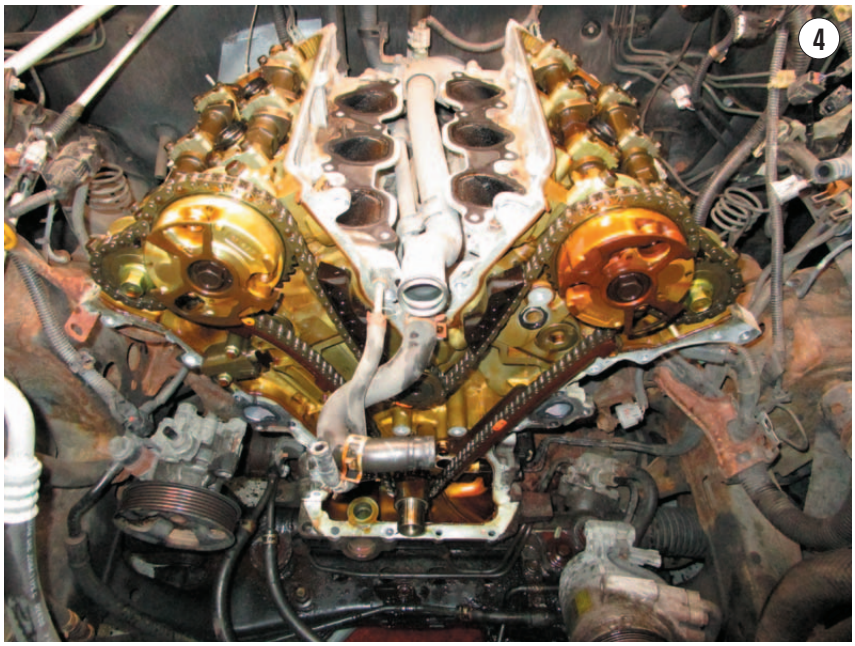
His next logical step was to check for CO_2 in the cooling system using the ATS Bullseye CO_2 tester. In our shop, we have had excellent results while using the BullsEye tester to uncover head gasket or cylinder head issues. On this vehicle, the test results indicated CO_2 levels that could be the result of a cylinder head gasket, head or engine block problem. You may be thinking that we should have used the engine block tester that uses the liquid blue dye and changes color when there is a compression leak issue. Our experience with the block test has not always been good or accurate enough at detecting problems.

While using the ATS Bullseye CO_2 leak detector (Figure 3), we uncovered a CO_2 leak that was displayed by the tool's led bar illuminating along with an audible alert. The confirmation provided by the Bullseye tester was what we needed to inform the vehicle owner that we would need extra diagnostic time. Our next step in the confirmation process was to perform a cylinder leak down test in order to complete the diagnosis of this engine. Notice, we did not perform a compression test since we already confirmed that the engine's relative compression was within range, the cooling system had already failed the pressure test, and now the leak detector was indicating high CO_2 levels in the coolant.

Since this engine had an issue with overheating, we explained to the owner that we had to remove the cylinder heads and send them to the machine shop to be pressure tested. When we removed the cylinder heads, we noticed a difference in the head gasket near cylinder number 6. We checked the engine block with a straight edge and feeler gauge to make sure that it did not warp. Since it checked out, we just needed to wait to hear back from the machine shop. We received a call from the machine shop informing us

that the heads were in good shape except for cylinder number 6. The valves in cylinder number 6 were not sealing properly, most likely due to the head gasket failure that was causing coolant to leak into the cylinder.

This Toyota 4.0L V6 engine utilizes three timing chains and tensioners (Figure 4) along with VVT (Variable Valve Timing) only for the intake cams. There are two small chains that go from the exhaust gears that are just run-of-the mill plain gears that are connected to the intake VVT gear on each bank of the engine. The long, big chain goes from the crank pulley to the VVT intake gears to the center idler gear. One of the most important components is the Camshaft Timing Oil Control Valve, aka the solenoid that controls the oil flow to the camshaft phaser. We made sure that the solenoid screens were clear of debris and that the resistance and current readings were good before we reinstalled them. After we installed the reconditioned cylinder heads, new timing chains, tensioners, chain guides, thermostat, Toyota engine coolant/antifreeze, full synthetic Pennzoil oil and a NAPA oil filter, the engine was now ready to be started up. Once the engine started up, it ran fine with no misfires or any signs of a coolant issues. The Tacoma was test driven to make sure there were no issues before we returned it to the owner.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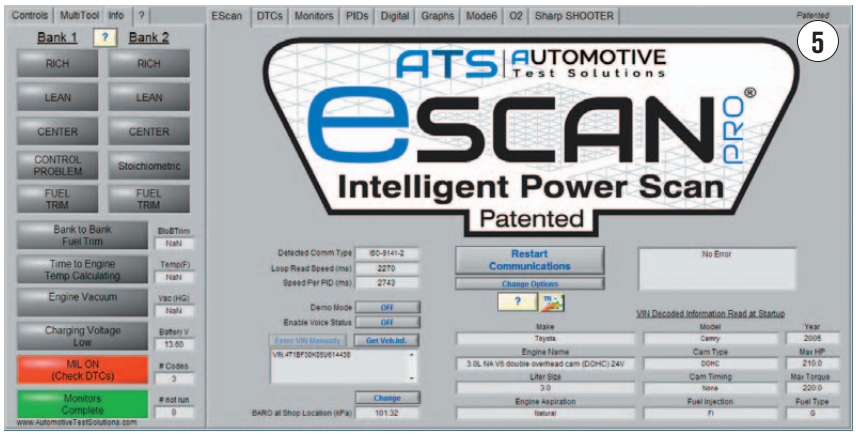

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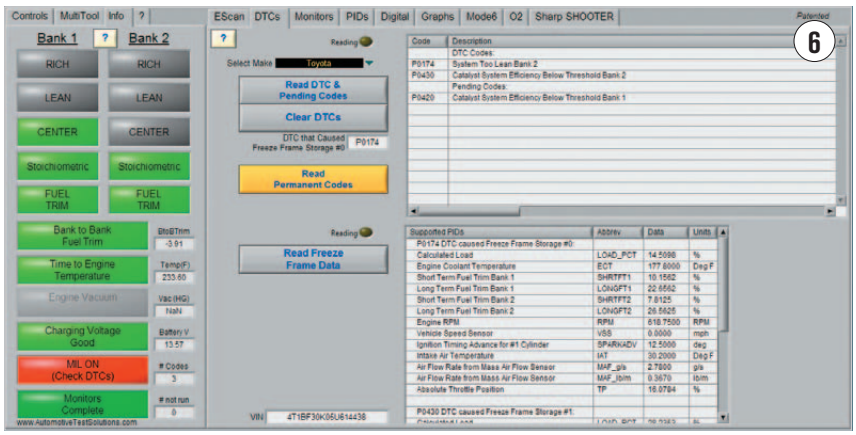

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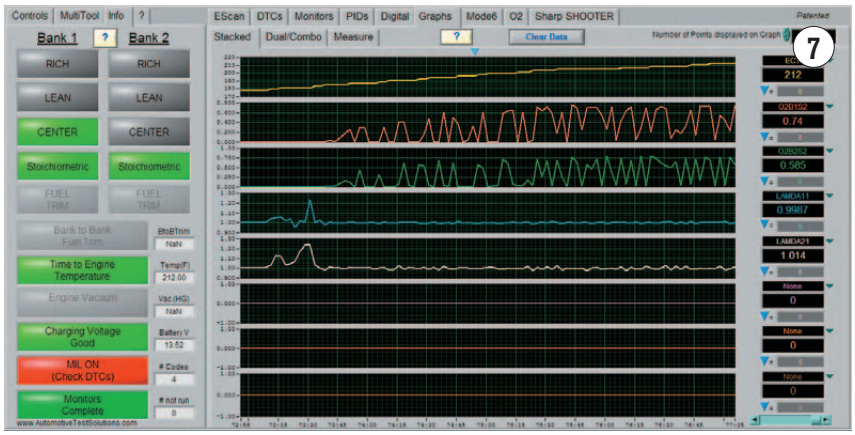
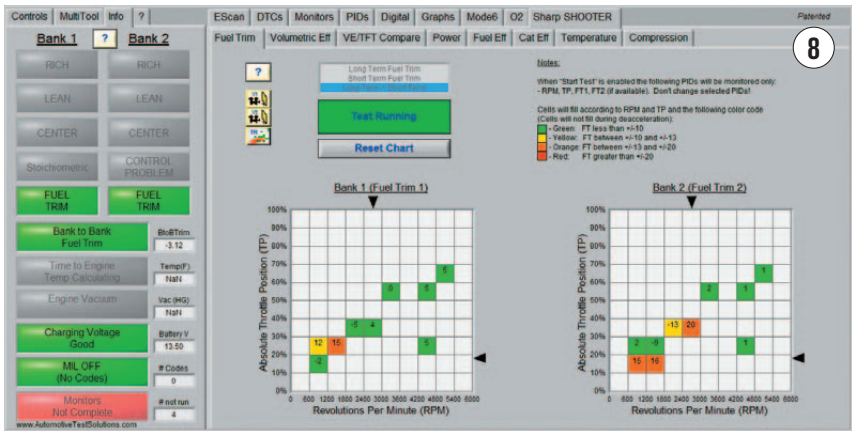
2002 Lexus GS 430

A 2002 Lexus Model GS 430 V8-4.3L with 184,733 miles on it came in with a complaint of a Check Engine light on and a loss of power. Our first step was to perform a visual inspection followed by connecting our scan tool. We checked Identifix to see if there were any common problems and found that there were a few issues with the Knock sensor. With our scan tool connected, the data revealed a P0325 Knock sensor (left bank circuit problem) DTC. The next step was to check the circuit, so we disconnected the EC1 connector and followed the information described in ALLDATA.

With a labscope connected to KNK1 and chassis ground we raised the rpms to the described amount and viewed the data. With the other channel connected, we were able to compare the





left bank (the side throwing the code) to the right bank. What we noticed was the waveform voltage amplitude was different between the two. The left bank did not display the same voltage height or frequency as the right bank. We called the vehicle owner and provided him with the information about the job that we would need to perform to solve his problem. We suggested, since the engine had high mileage on it and the intake manifold was going to be removed, it would be a good idea to replace both Knock sensors along with the starter motor. The vehicle owner only gave us the approval on both knock sensors, so the old starter remained in the engine. With the two new sensors installed and the cooling system refilled and bled, the DTC was cleared and the car was test driven. The vehicle was now back to the proper operating condition and the Lexus owner was happy.

2005 Toyota Camry

Our next vehicle was a 2005 Toyota Camry 3.0L V6 that came in with the Check Engine light on (Figure 5) and three DTCs. Since it's a drivability issue, we figured we'd get the most information in the shortest amount of time using a good Global OBD II scan tool rather than connecting an enhanced scan tool. The EScan Pro allows us to check relative compression, MAF, fuel trim and catalyst efficiency as well as DTCs in a matter of minutes.

The EScan provided us with a direct path in diagnosing our problem vehicle. The scan tool data (Figure 6) uncovered these DTCs: P0174 (Bank 2 System Lean) and P0430 (Catalyst System Efficiency Below Threshold Bank 2). There was a pending DTC P0420 (Catalyst System Efficiency Below Threshold Bank 1). Looking at the Freeze Frame data, we noticed that the LTFT (Long Term Fuel

Trim) on Bank 2 was at 26 percent while Bank 1 was 22 percent. Take notice that the Freeze Frame was captured a 618 rpms and at 0 mph. The engine temperature was not fully warmed up since the temperature was only at 177 degrees F. The Freeze Frame for the P0430 was captured at 210 degrees F and the vehicle speed was 55 mph. The LTFT on Bank 2 was much lower at 3 percent while Bank 1 was only at 0.7 percent. What most likely was occurring was that the engine was being command to go rich at idle, dumping too much fuel and taking out the Bank 2 catalytic converter.

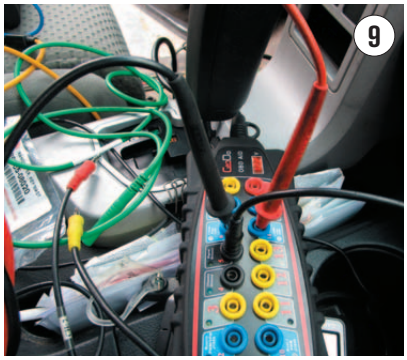
As we graphed the Bank 1 and 2 rear O_2 sensors (Figure 7), we noticed heavy frequency indicating that the efficiency of the converters was not normal. This led us to our next step to check the Fuel Trim chart (Figure 8) that you can see has a high fuel trim command at the lower end of the chart. This usually indicates that there is a lean condition only at idle since the number greatly reduces as the chart is filled up. Notice once we get past the 30 percent range of throttle the numbers go into the normal range, indicating that it's not a fuel delivery problem due to a clogged fuel filter, voltage drop at the fuel pump or for that matter a bad fuel pump. The results also indicated that the fuel trim issue is not a load sensor issue since the fuel trim numbers do not rise throughout the full range of the chart. It's a good idea to see if Fuel Trim goes down as we raise the rpms up. If the Fuel Trims do head south, it indicated that the problem is a vacuum leak issue. This Camry needed some work from an intake gasket, fuel system cleaning, spark plugs, air filter and most likely catalytic converters. The owner decided not to repair the vehicle but rather lease a new vehicle.

2007 Toyota Tundra

Our final case study is on a 2007 Toyota Tundra that was towed in from another shop with the complaint of a no start condition. The shop stated that the vehicle just stopped running, so their customer had the vehicle towed to their shop. They confirmed the no start condition then connected their scan tool only to find that there was no scan tool communication with the Tundra. Their next step was to install a remanufactured PCM only to come up with the same results.

They call us and asked if we could program the truck, thinking that would get the Toyota running. Once the Tundra arrived, Bill checked it out only to find that the PCM was not communicating with any of our scan tools. Bill called the shop and explained that he could not program the vehicle since there was no communication. He suggested we diagnose the problem and asked for two hours of diagnostic time to check the vehicle out further.

Bill started by installing a breakout box (also known as a "BOB") at the DLC (Figure 9) then measuring the CAN line resistance using the ohm meter. As you can see from the picture (Figure 10) of the meter, the ohm resistance reading was 63.3 ohm — within specifications. Now it was time for Bill to leave the shovel behind and get the backhoe out. He now connected the EScope Elite to pins 6 and 14, CAN high and low. Remember "KISS" (Keep It Simple Stupid!), always start with the easiest test first, as Bill did by checking the resistance with the ohm meter before moving up to using a labscope.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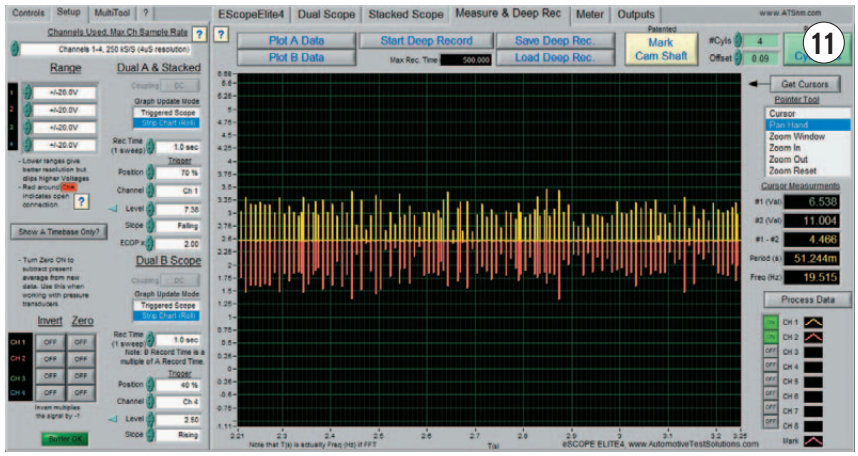

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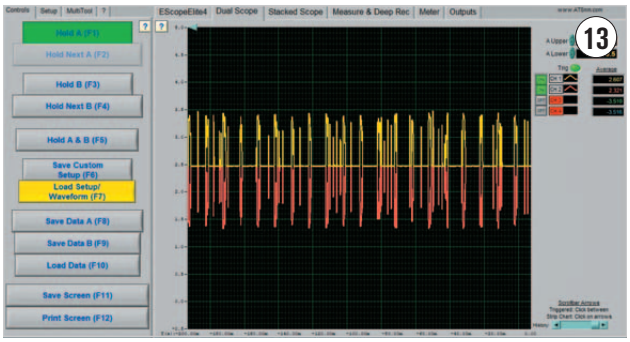

Take a look at the scope communication screen (Figure 11) and see if you can diagnosis the problem. It looks like both CAN high Pin 6 and low Pin 14 are producing a 1v voltage signal. The voltage of CAN high signal is going from 2.5 volts to 3.5 volts while CAN low was producing a signal that was 1.5 volts to 2.5 volts. Your first thought may be that there is something on the vehicle pulling down the voltage signal. Well if that is what you think is causing our no communication/no start problem, you would be dead wrong. There is nothing wrong with the voltage levels, but rather with the frequency of the signal. The one volt level is normal, so don't expect a 5 or 12 volt CAN signal on this CAN system.

The proper diagnosis and repair of this vehicle was attributed to the training that my lead tech recently attended. This past March Bill attended our 15th annual TST Big Event where we had three good instructors, with two of them covering CAN. At the end of the first seminar that was taught by Snap-on's Jim Mortiz, CAN was covered from the ground up. This was followed after lunch by the other CAN presentation by Automotive Test Solution's (ATS) Bernie Thompson. If you ever had the experience of being in Bernie's seminars you know you must buckle up. He started off like a rocket on a launching pad taking off into space. Bernie proceeded to explain the CAN system and following it up with real world problem vehicles he had diagnosed and repaired. Bill listened carefully to Bernie's presentation and that provided him with the information he would need to repair this Tundra.

Bill asked me to take a look at the scope screen capture that he had taken to confirm if there was a problem. I suggested that he locate the CAN disconnect if this vehicle had one and start removing components from the BUS. Unfortunately, this vehicle did not have a CAN disconnect comb that allows systems to be removed from the BUS. Bill proceeded to disconnect the component that we have seen to be biggest problem on other Toyota Tacoma's. The problem component that was preventing the CAN system from properly delivering packets was caused by the AIR (air injection reaction system) that had a shorted solenoid. Once Bill disconnected (Figure 12) the air pump connector, the CAN packets returned to normal, now having a proper frequency that allowed the engine to start. The scope capture (Figure 13) of the CAN pins 6 and 14 as you can see now looked different that resulted in the engine starting.

Knowing how to use a labscope is a very important step in diagnosing a CAN system issue. The labscope provides an inside picture into the electrical system that it is connected to. It's a good idea to get yourself a good labscope and know how to use it. As in this case study, we had the Escope Elite 4 along with the proper training on how to use a scope. In fact, the training that Bill had recently gone through was one of the biggest factors in resolving the CAN issue on this vehicle. Bill attributes his success in diagnosing and repairing this CAN problem vehicle to the seminar he attended taught by Bernie Thompson. Remember we need to attend seminars and hands-on training classes to be updated so we don't evaporate.

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YOU NEVER KNOW WHO'S WATCHING

WHILE I TEND TO DO MOST OF MY OWN MAINTENANCE AND REPAIRS, THERE ARE STILL JOBS WHERE I HAVE TO TAKE IT TO ONE OF THE LOCAL SHOPS. TODAY, IT WAS TIRES AND ALIGNMENT. HAVE I GOT A STORY FOR YOU!

PETE MEIER // Technical Editor

It's no secret that most consumers have a guarded view of us. In a recent survey, 86 percent of the respondents thought that the cost they paid for their repair was outrageously high, and 40 percent of the consumers asked were certain they were being overcharged for the repair. Additionally, it is estimated that consumers are being charged tens of billions of dollars every year for unnecessary or ineffective repairs.

Are these studies accurate? Do they truly represent our industry?

I try very hard to remain optimistic about our profession. I have been fortunate to meet hundreds of talented, honest and hard-working people from every corner of the country. These men and women work hard every day to do the right thing by their customers and, for the most part, their businesses are booming as a result.

But I have also met just as many who are, in my opinion, the reason behind these consumer opinions. Let me share a story of my own experience — one that, I'm afraid, is not an isolated one.

Time for some new shoes

I am fortunate enough to have a fairly well-equipped shop at home. This is the "garage" I use to film our training video series, "The Trainer," and other projects. It is also my "man cave" of sorts, where I tinker with my own little projects, help out friends with their repair needs and maintain my own vehicles.

Sometimes, though, I don't have the equipment to perform the repairs. Then, like most consumers, I have to find a shop to perform the work for me. In this case, it was as simple as it gets. I needed new tires for my RAM pickup.

Just like any other consumer, I did my homework and got a few quotes. My wife found a coupon for Goodyear tires through the official corporate website that promised as much as 35 percent off on my purchase. The truck originally came fitted with Wrangler SR-As, and I was happy with them. At nearly $150 a pop, saving 35 percent was rather attractive.

THE MAJORITY OF TECHNICIANS I MEET are hard-working men and women who want to be the best they can be.

Making the purchase was very easy. Select the tires, apply the promo code for the discount and complete the entire transaction (including mount, balance, disposal fees and tax) online. Then select your closest Goodyear store and make the appointment to get the tires installed. I entered my credit card info, completed the transaction, and selected a shop about 30 minutes from the house. Within minutes, I got a confirmation that my appointment was scheduled and I was all set! So far, so good.

First one in

I was at the shop at 6:45 a.m. for a 7 a.m. appointment. I made the appointment for the first available time they had so I could minimize my time away from work as much as possible. I was preparing for some vacation time and was pressed to get all my normal duties taken care of before I left.

The bay doors were closed but the lights were on. Even so,

PHOTOS: U.S. AIR FORCE

I stayed in the truck until a few minutes before 7. I remember all too well all the little things I needed to do to open a shop in the morning and how much it irritated me to have those early birds that arrived before dawn and then stared at me through the door, waiting for me to unlock it. I figured I'd leave the guys alone until it was officially time for them to open their doors to the public.

I walked into the reception area to an empty room. It only took a few minutes, though, for the service writer to walk up to the counter. I would like to report that I was met with a smile, but quite the opposite was true. The greeting I got was cold and distant, as if I were a problem to be disposed of quickly so he could get back to his coffee.

After confirming my appointment and printing out the paperwork, he asked for my keys. Now remember, I'm buying brand new tires from a business that specializes in tires. If you were in his shoes, what would you have done next?

I have been in his shoes, on numerous occasions, and I always walked out to the vehicle with the customer in tow. I would take a TPMS tool with me and check the operation of all the sensors prior to bringing it into the shop, explaining to the customer what the system did as I did so. I would also check the tire wear patterns and would recommend an alignment check, at the least, to make sure that the new tires would have a chance at lasting as long as possible. Last, I would get the vehicle mileage and check for the oil sticker left behind by the last service facility to see if there were any routine maintenance items I could discuss with them before any work began.

Didn't happen here — not one little bit.

I had to bring up the request for the alignment. In fact, I know I needed an alignment and I was more than prepared to pay for one. Unfortunately, the service writer person said his alignment tech wasn't in yet. Fortunately, I said, I had brought my work with me and was prepared to wait. Not a problem!

All done

Less than two hours later, the service writer came out from the shop with my keys in hand. Note here that I didn't spend the entire two hours peering through the glass into the shop, watching the work being done. Nor did I stand at the bay door behind the plastic yellow safety chain. I've had customers who've done just that, watching my every move to make sure I did the work I was being paid for and didn't steal anything from their car in the process. (At least, I guess that's why they stood there!) No, I was perfectly content to drink my coffee and get some work done.

I wasn't quite prepared for the avalanche of BS I was about to hear.

"Mr. Meier, your truck is ready", he began. "The alignment was only off a little bit so we made a few minor adjustments. I'm not going to charge you for it."

Awesome, I thought! Since the truck had recently been in an accident, I was curious as to what adjustments had to be made, so I asked to see the printout.

The service writer passed over a form that looked like most alignment machine printouts with the "before" column on one side, the specifications in the center, and the "after" on the other side. Both the "before" and "after" columns were filled with dashed lines — no numbers.

"The left front and right rear were a little off but not much," he said, pointing at the sheet.

"But there are no numbers here," I said. "What angles, exactly, were off?" I don't think he was prepared to respond to someone who knew that there were different angles involved with an alignment.

After a moment's hesitation, he answered, "The caster on the front and the toe on the rear," actually referring to another printout he wasn't showing me.

"Interesting. How did you adjust the

toe on a rear-wheel drive truck with no toe adjustment?"

You could see the color drain out of his face when he began to realize he was dealing with an informed consumer. "Well, that came into the green after we made the front adjustment. But we're out of green ink. That's why you don't see the numbers on the printout I gave you."

Now I'm thinking I should hop across the street to the local Walmart and buy some waders. It was really starting to get deep in here.

I wanted to ask him why he would spend the time to make a caster adjustment on the truck and not charge me for it. After all, I'm more used to service writers coming back and looking for more money to start moving the control arm around. I, as a tech, sure as heck wasn't going to do it for free! But it was obvious that I was being fed a load of you-know-what and didn't feel like pursuing it any further.

Besides, I was thankful that he had supplied me with the topic for this month's column!

Another alignment story for you

Speaking of alignments, I had a similar experience with another tire specialty store when looking for tires with my youngest son. The service manager offered to perform an alignment check for free to help us make sure we wouldn't wear out the new tires prematurely.

Great! Go for it!

A half hour or so later, he comes up front with the printout. Both front wheels are in the "red," he tells us, indicating the need to perform an alignment. He recommends a 4-wheel alignment on my son's Toyota Corolla, and I don't disagree, even though the rear wheels are showing "green" on his form.

Taking the printout from his hand, I look at the numbers and quickly see that there is nothing wrong with the alignment, regardless of the "red" numbers. Total toe is right where it should be, as are caster and camber. The reason for the red? The steering wheel was turned to the left when the readings were printed out.

This one I called him on. Either he, or his tech, was trying to pull a fast one and collect over $100 for doing nothing more than returning the wheel to center and printing out the actual measurements. I asked the manager to join us and judging by the look on the service manager's face, he was none too happy about my request to speak to him.

THE GUY WHO HUNG THE TIRES on my RAM wasn't this young man – wasn't even a Firestone store. But he did an equally efficient job. I don't think he had any role in the BS his coworker was about to feed me.

I asked the manager point-blank if he was in the business of fleecing his customers and went on to explain what had just happened. Of course, he assured me they ran an honest shop but he would investigate my complaint. He even offered my son a free oil change, but I asked him if he really thought I would trust anyone in that shop to perform any kind of work on any of our vehicles ever again? To his credit, a few days later he informed me that both the technician and service manager had been terminated. He had found evidence of similar disparities. And that news didn't bother me a bit.

How many others?

I really wish I could tell you that my experiences here were the exceptions, but they aren't. I'd honestly have to say the odds of my running into a great shop are about even with my running into one that needs help. I will say that I believe that most negative experiences are caused by lack of training or experience, rather than by any willful aim to cheat someone out of their money — and that leaves me with some hope for our ability to improve our overall reputation.

What kind of shop do you work for? If you're fortunate to be in a great shop, stay there! If not, then consider what you can do to help make it a great shop — or move on. The talent pool is getting shallow and there is no shortage of great shops looking for great people.

If you're the shop owner or manager, and not sure of what kind of shop you have, try having someone you know (and your employees don't) come in and put them to the test. Are they delivering a quality customer experience or are they treating customers as an annoying interruption of their day? Invest in your business by investing in your employees' training — both at the counter and in the shop. Let them know that delivering anything less than an exceptional job is not acceptable and reward those who rise to the expectations.

The time is right for us to reinvent ourselves as an industry and as a profession. How high will you raise your bar?

PETE MEIER is an ASE certified Master Technician with over 35 years of practical experience as a technician and educator, covering a wide variety of makes and models. He began writing for *Motor Age* as a contributor in 2006 and joined the magazine fulltime as Technical Editor in 2010. Pete believes in the mission of the magazine to "advance the automotive professional" and provides resources to working techs around the country through print, social media and YouTube.
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INCURRING COMPLICATIONS

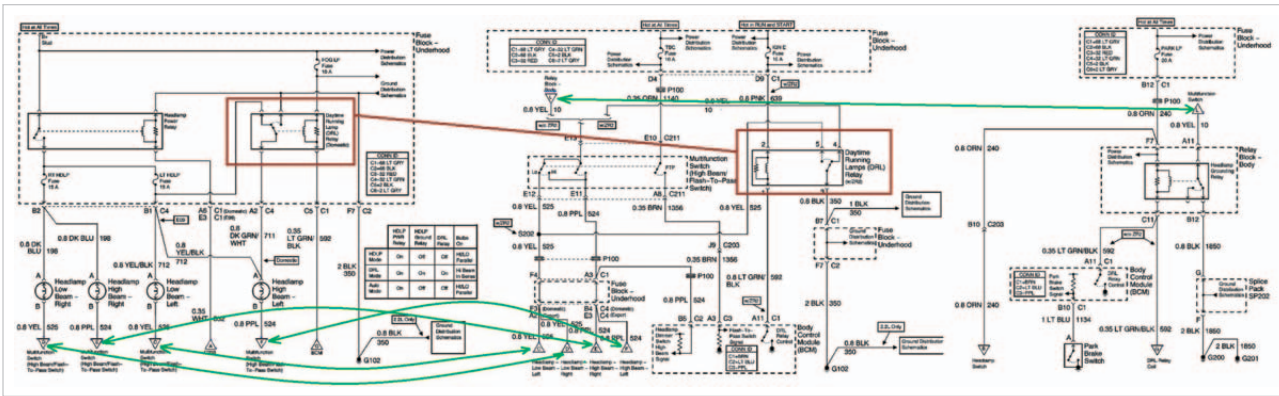
A HEADLIGHT REPAIR THAT SEEMS SIMPLE INSTEAD OFFERS SOME WIRE-RELATED SURPRISES

RICHARD MCCUISTIAN //
Contributing Editor

I've been in this business since the early '70s, and the guys who are my age and older know that there was a time when the most complicated electrical issue we might encounter on a vehicle would be turn signals or power windows. Even back then things happened that didn't seem to make sense. I once encountered a '78 Dodge pickup with an inoperative left-hand turn signal. After checking bulbs, wiring, grounds, etc. I discovered that simply replacing the flasher brought both sides back online. Never quite understood that one.

Then there was the '66 Cadillac convertible with a driver side power

DASH-DIGGING AND GROUND-CHECKING, we finally managed to find a bad multifunction switch by checking the ground feed that was supposed to pass through the switch but didn't.



THIS SCHEMATIC IS CONFUSING ON SEVERAL LEVELS — note that there are two daytime running lamp relays shown — and one of them parenthetically mentions an RPO code, but the other one simply says "domestic." The headlight grounds exit the first page going down and enter the next page going up. The ground that passes through the headlight grounding relay begins on the bottom and goes north through the relay and then enters the page in the middle headed south through the Multifunction switch. Complicate that by shoving the grounding relay into a panel way up under the dash and you've got a recipe for frustration. Rather than trying to contain all this on one schematic, they should have provided a different one for non-domestic vehicles. This is ridiculous.

PHOTOS: RICHARD MCCUISTIAN

window issue that would come and go, and as I dug into that one I found a pushed back pin in a connector at the left kick panel — and from the condition of the harness and the connector it appeared that it had been that way since the car was brand new.

Once my brother's '78 Cadillac developed road-speed radio static that he only noticed after the tires were rotated. Back in those days you weren't supposed to cross-rotate radial tires, and while I was digging in the dash for issues with the antenna and whatnot, he noticed from looking at his spoke rims that the tires had indeed been cross-rotated. When we put them back like they were supposed to be, the while-driving radio static evaporated.

Then there was the '80 model Lincoln that would buck and skip exactly five minutes after a morning cold start but would never do it again while the car was warm — and that turned out to be a pushed-back wire in the crank sensor connector pigtail. I can't explain the five-minute deal, but when I seated that connector the problem was gone.

I knew of one six-volt vehicle from the '50s that wouldn't spin and wouldn't start with the key but would instantly fire up if you put it in gear, pushed it, and popped the clutch. That one turned out to be a bad engine-to-frame ground.

THIS TRANSFER CASE had lost all its oil and had destroyed itself internally, but the one we got from the salvage yard (which came empty and dry on the outside) started leaking as soon as we drove it after filling it with Dexron II. We don't charge labor, but in a shop situation, who do you charge for the labor to re-seal it or replace it a second time? This is a dirty deal no matter how you color it.

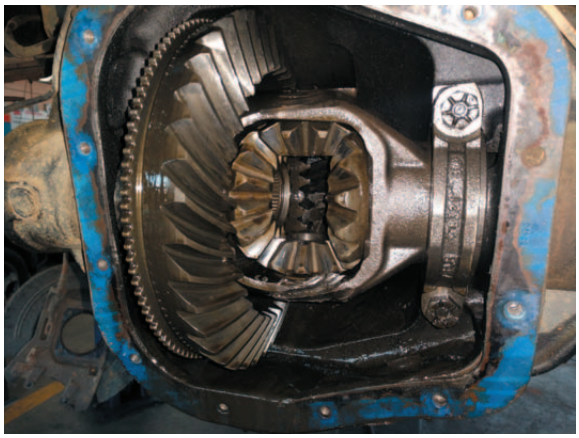
Headlight issue

This little old 2003 Chevy S10, 2.24 L, 4-cylinder with 214,894 miles on the odometer had a lot of other issues that had been ignored until it developed a headlight issue, and if somebody's planning to drive at night or in the rain,

the headlights are a must-have. Initially, I was thinking this would be a slam dunk. How hard could it be to figure out a headlight problem on a 15-year-old domestic? Well, we hadn't tackled one of these S10 headlight issues before, and this one was a wakeup call.

The initial concern was that the headlights tended to only illuminate on flash-to-pass. Occasionally they would work normally, but usually they wouldn't. Heck, the Daytime Running Lights wouldn't even work. The owner of the truck couldn't care less about the DRL, which isn't required in these parts — he just wanted to turn on the light switch and see where he was going at night.

To begin with, I like to see if power and ground are available at the bulbs with the circuit energized, and as we traveled that path, we got side-tracked when we found that we only had ground at the right front headlamp. With the bulbs unplugged, there was no ground at the left front lamp, but with the right front bulb connected, we had a ground. This tended to confuse the student I had doing the work, and so we waded into the wiring schematic — which became even more confusing. Folks who are familiar with this platform are already smiling, I expect.



THE PINION GEARS IN THIS DIFFERENTIAL had died and it had been driven enough to mark the carrier pretty heavily. Rather than buying the parts to rebuild this one we just got a replacement. That repair went smoothly.

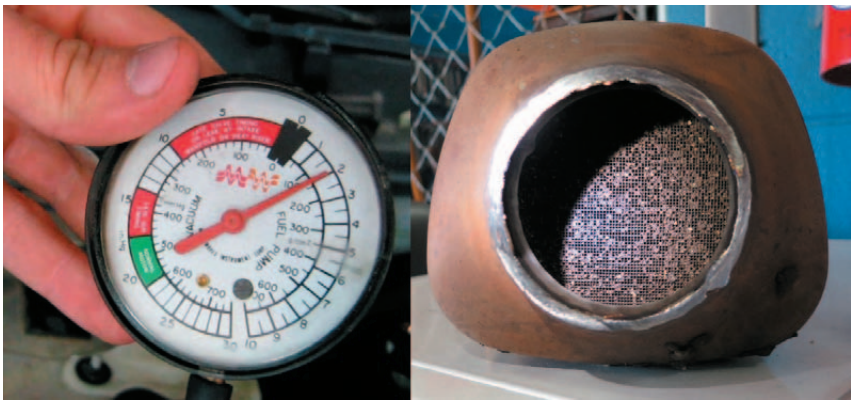
USING THIS METHOD, we found the Suzuki engine skip (right) within 30 seconds, never having even connected a scan tool. This provides a much higher resolution peek at the ignition system than simply yanking the P030x code and was a LOT faster.

One of the maddening things about so many of today's schematics is how they move from page to page with those funky arrows. Granted, the shop manual folks sometimes give us link boxes on those arrows so we can jump right to the page where the circuit continues, and that's a good thing. Gone are the days when the entire vehicle schematic could be found on just one page (of course, that was in the 1960s). This schematic was light years away from that one-page utopia, and besides all that, it broke some key rules.

I teach my people that, in most cases, on a schematic, power comes in from the top and ground comes up from the bottom of the diagram. And that's usually the case, although I've seen it violated a few times on isolated schematics for one reason or another. Well, this S10 schematic shatters that rule and inserts some other curve balls in the process.

The origin for the ground was G200, which is under the dash in front of the driver and attached to the bulkhead. That ground feed makes its way through a splice pack to feed a lot of other stuff, but for our purposes, it feeds the headlamp grounding relay through the common and normally closed terminals in that relay. The ground then departs that relay, makes its way to the multifunction switch (from the top of the diagram, no less), and the MF switch feeds it to the headlight bulbs, which are powered by the headlight relay. As the ground feed departs the MF switch, the ground passes through the underhood fuse block (no fuses in this ground circuit,

though) and then exits and splits into four different feeds, all of which exit the page headed south — i.e., toward the bottom of the page — which no ground circuit should be allowed to do (my opinion). When these grounds reappear feeding the headlamp bulbs, they enter the page from the bottom (as grounds are wont to do). Since they exit the previous page headed south and enter this page headed north, the student wound up in a tailspin, effectively auguring her troubleshooting plane down into the slough of no understanding. It was a nasty thing to watch and even nastier to experience, since I was in the copilot's seat trying to teach her to fly.



THIS WAS ANOTHER ONE where a higher-than-scan tool resolution diagnosis was needed – a scan tool is useful, but nothing says "clogged cat" like a few pounds of exhaust backpressure.

Honing in on the target

Understanding the circuit and being able to locate and access the various connector and components is of obvious importance. In this case, the components consisted of the headlight switch, the BCM, the headlight relay, the headlight grounding relay, and the Daytime Running Lamp relay. The BCM is a major player here, receiving a Headlights OFF signal from the headlamp switch, which, through another part of its ganged array, sends Headlamp Relay Coil power to the BCM so that the BCM can operate the Headlamp Power Relay at its discretion with the switch in the ON position. So, the Headlamp switch, through two different circuits, sends power AND ground to the BCM.

The BCM is monitoring ambient light by way of an electric eye on the right side of the dash for DRL activation when the other conditions are met. Both the DRL and the Headlamp grounding relays are feeding the lamps through their normally closed terminals so that when the headlamp power relay is energized, the left headlight is forced to get its ground through the right-hand headlight bulb's filament. In a word, the headlights are illuminated in series during DRL operation and are only half as bright, rather like the cooling fans that are fed in series when they're spinning on low. The schematic shows an alternate wiring of the DRL relay if the vehicle isn't "domestic," and that doesn't help a new schematic reader either.

Flash-to-Pass is a separate switch within the MF switch that triggers the BCM to energize both the DRL relay and the Headlamp Grounding Relay. The Headlamp Grounding Relay then breaks the circuit to ground and the DRL relay grounds the left headlamp directly, bringing both headlights into a parallel circuit situation for a bright Flash-to-Pass. This is also supposed to happen when the regular headlights are on at night. This wasn't happening except on Flash-to-Pass, and that was the concern we were pursuing.

So we decided to back up and take another run at it. I always teach that circuit checks are best made at the easiest accessible point, no matter where it may be in the circuit, and to work from there. The annoying thing about this truck is that the Headlamp Grounding Relay is in a relay center that

is mounted in a very tight spot under the dash on the left hand side, which makes the relay no fun to access. So we began at an easier spot.

Noting that the normally closed Headlamp Grounding Relay contacts feed the ground circuit to the MF switch pin E13 by a yellow wire, we determined that there was indeed a ground at the MF switch but that it wasn't passing through the switch to the lights. Ground in — no ground out, not on pins E12 OR E11. That was something of a breakthrough, and when we bypassed the switch, we had lights. And so I had Kayla replace the Multifunction Switch. The lights then worked, and everybody was happy. It was a wild ride, though.

Transfer case complications

This was a 1997 Tahoe that came in with a rumbling drive-line noise, which turned out to be a leaky transfer case that had gone dry and had destroyed itself internally. They had driven the vehicle like this for a while, opting not to do anything about it until the noise became more troubling. The initial complication came from the salvage yard; the first transfer case to arrive was the wrong one. We had already removed the old transfer case, which was quite a job, since the torsion bars and their crossmember had to be removed and not much of anything had been disassembled on this one for years. But we made it happen. And when the correct transfer case came in, it looked clean and dry and was the right part. So we popped it in, put everything back together, and pumped the requisite amount of Dexron II in there. We also replaced the output shaft seal on general principle. And then came the complication. We drove the vehicle and heard no noise, but when we looked underneath, the replacement transfer case seemed to be leaking the same way the original one had — between the case halves. So that one will have to come back out for a re-sealing. I guess we need to devise a method of pressure-testing it before we put it back in there.

This one kind of reminds me of a transmission swap we did on a four-wheel-drive Expedition a couple of years back that did famously for about a month and then came back with a cracked flywheel. It was like having to do the whole job all over again.

On another note, a 1999 F150 came in with a ruined rear end due to failed pinion bearings (it had been driven that way for quite a while) and we snagged a replacement rear axle from the same salvage yard for five Ben Franklins. The brake backing plates were banged up on the salvage yard rear axle, and we had to swap and replace a lot of the brake parts to get the rear disk stoppers done right, but that job went like a song.

Ignition quickies — and a complication

There are two of these I'd like to share. One was a 2003 Suzuki XL-7 that came in for an exhaust leak. We found that somebody had started trying to cut the exhaust (to steal the cat, maybe?) but had decided to stop only partway through. After I fired up the torch and coat-hanger welded the exhaust leak shut (we don't have a wire welder, although we should have, I guess), it became evident that the engine was skipping to beat the band. The driver hadn't even noticed the skip! Rather than busting out the scan tool, I grabbed the GTC505 and rested its wand on the top of the coils until I found a high-firing voltage on one coil. The plug was new but greasy, and we popped a new plug in its place. It took about 30 seconds to locate a bad spark plug and another five minutes to replace it — and that skip was history. We also checked the compression on that cylinder and rechecked the spark pattern after replacing the plug. We cleared the codes with the Autel.

The second ignition quickie was on a 2009 Camry that had developed an engine skip on #1 and had tossed a primary ignition fault code for coil A. The problem was that, while

the skip had been dead and present for many a mile, it stopped happening about the time the Camry made it to the shop, which is, as we say, par for the course.

Since the GTC 505 was just lying there in its open box after the other job, I grabbed it to see what the pattern looked like and found that the erstwhile misfiring coil's pattern didn't look out of line — of course, the engine was running smooth, too. Nevertheless, I ordered an aftermarket replacement coil from the parts store and installed it, along with a new set of plugs, because this one hadn't had any and it was only a few miles early according to the maintenance schedule. It still ran smooth, but when I checked the new coil with the 505 I saw an astonishingly high voltage —about 90,000 volts.

I reinstalled the original coil and saw less than 20k, which was what the other three coils were reading. I called the parts store and had them send a different brand of coil, and when we installed that one the pattern was normal. Then the parts store manager told me that the manufacturer of the first coil had said that Japanese cars require a higher voltage coil and that we had possibly wound up with one of those — not sure what to make of that information, but oh well.

The lesson I gleaned from that Camry experience was that it's wise to double-check after installing the new part — you know, trust but verify? It was a satisfying element of "verifying the repair" that went beyond a simple test drive. After replacing the coil the first time, the Camry was running so well that I would have had no reason to suspect foul play had I not done an after-check with the 505 just for grins. Both ignition jobs went a lot smoother and a lot quicker than they would have if we had used only a scan tool.

Then there was the Pontiac Power Loss issue — after we had exhausted scan tool diagnostics on that one, we screwed my homemade pressure test fitting into an upstream O_2 sensor hole and found enough backpressure to condemn the cat. We replaced it with a Walker bolt-on replacement. It was a fitting end to a satisfying week.

RICHARD MCCUISTIAN is an ASE-certified Master Auto Technician and was a professional mechanic for more than 25 years. Richard is now an auto mechanics instructor at LBW Community College/ MacArthur Campus in Opp, Ala.
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THERMAL IMAGING CAMERAS HAVE BECOME MORE AFFORDABLE OVER THE LAST FEW YEARS. IF YOU'RE CONSIDERING ADDING ONE TO YOUR TOOLBOX, WATCH THIS MONTH'S TRAINER FIRST!

PETE MEIER // Technical Editor

I remember buying my first IR (Infrared) temperature gun. I've used it to identify misfiring cylinders, clogged condensers and a whole lot more. And when I first saw a thermal imager applied to some common automotive troubleshooting challenges, all I could think of was, "This is an IR gun on steroids!"

At that time, though, the sources for thermal imaging cameras was limited to a few manufacturers and the cost of even a bargain-priced unit was way out of my reach. But now, there are a number of thermal imagers on the market and the price point has dropped significantly. Is it time to add one to your toolbox?

Whenever I considered adding a new tool to mine, I always asked myself if I really needed one. The rule of thumb I used was simple – if I had to borrow a tool from another tech more than three times over a month or so, I needed to add it to my own collection. Well, that didn't happen here since no one else in the shop owned an imager! The second test was based on whether or not the tool would make me money. Would it make a job easier, and therefore faster, to perform? Would it make diagnosing common problems faster? Would it be a tool that I used on a more or less regular basis?

I think a thermal imager meets the second set of criteria.

Thermal imagers can be used to identify a variety of problems like misfiring cylinders, restricted cooling system or air conditioning components, failed or failing bearings, and all of the other problems we used to use the IR gun for. But it can do more. It can also be used to identify the cause of parasitic drains, help locate electrical shorts or sources of voltage drop in a circuit. It makes testing heated components quick and easy, from checking a heated seat grid to a defroster grid in the rear glass.

And it can do a lot more, limited only by your own imagination.

In this edition of The Trainer, I'll share some tips on the tool's use and limitations and show you a variety of applications for which the tool can be utilized. After you've seen it, you may feel like I did — adding a thermal imager to your toolbox can be a solid investment. MA

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SUMMER 2018 VOL. 13 | NO. 2

HERE COMES THE SUN

This repair will help correct a slow closing and/or noisy sunroof

CALMING CHAIN CHATTER

Timing chain tensioner replacement may be needed for CVVT assembly

WHEN A HYDRAULIC RACK WON'T TRACK

A needed alignment or something more serious?

KIA | Genuine Parts

A partnership for safety

We team up again with B.R.A.K.E.S. to provide driver training

With driver safety as the goal, Kia Motors America (KMA) recently announced a multi-year renewal of its partnership with B.R.A.K.E.S. (Be Responsible and Keep Everyone Safe). Through classroom instruction and hands-on defensive driver training, Kia aims to reduce injuries and save lives by providing teens and their parents with the tools they need to be responsible behind the wheel.

In 2018, B.R.A.K.E.S. is hosting training in cities around the country. A sampling includes Atlanta, Ga.; Cleveland, Ohio; Chicago, Ill.; Charlotte, N.C; Memphis, Tenn.; Orlando, Fla.; San Diego, Calif.; St. Louis, Mo.; Scottsdale, Ariz.; and many more.

"Car crashes are the number-one cause of death among teens, but with Kia's help, we know we're making a difference," said multi-time-Top-Fuel-drag-racing-champion-turned-road-safety-advocate Doug Herbert. "It's impossible to know exactly how many lives our schools have saved over the last 10 years – we have trained nearly 30,000 teens plus their parents – but even if it was only one life, it would all be worth it. We're grateful for the ongoing commitment and support from Kia, which enables us to continue making America's roads safer for everyone."

Kia serves as the Official Vehicle and a presenting sponsor of B.R.A.K.E.S. Kia's support helps B.R.A.K.E.S. offer free training for all attendees by offsetting costs through a financial donation and a 44-vehicle fleet, including Soul, Rio and Forte models.

"Kia Motors is committed to vehicle and road safety, and our partnership with B.R.A.K.E.S. is an important way for us to convert that commitment into action," said Saad Chehab, Vice President, Marketing Communications, KMA. "We congratulate the B.R.A.K.E.S. organization on a decade of saving lives and look forward to continuing our collaboration for years to come."

Advanced driver training

B.R.A.K.E.S. provides participating teens and their parents with free hands-on, advanced driver training program taught by professional instructors, including current and former members of law enforcement, professional racers and stunt drivers. Each school includes four hours of training, starting with a short, 45-minute classroom presentation followed by nearly three hours behind the wheel of new Kia vehicles. The program includes distracted driving awareness, panic braking, drop-wheel/off-road recovery, crash avoidance and car control/skid recovery – all among the biggest causes of crashes for new drivers.

A fleet of Kia vehicles are used for hands-on driver training events across the U.S.

For safety's sake, please encourage your customers and their family members, as well as your family members, to attend one of the classes. Anyone wanting to register for a class or see the upcoming schedule can visit www.putonthebrakes.org/2018-notification-list.

Kia Motors America, Inc.

All trademarks and tradenames are the property of their respective owners. 2019 Optima shown with optional features. Not all optional features available on all trims. Some features may vary. Expected availability fall 2018.

IN THIS ISSUE

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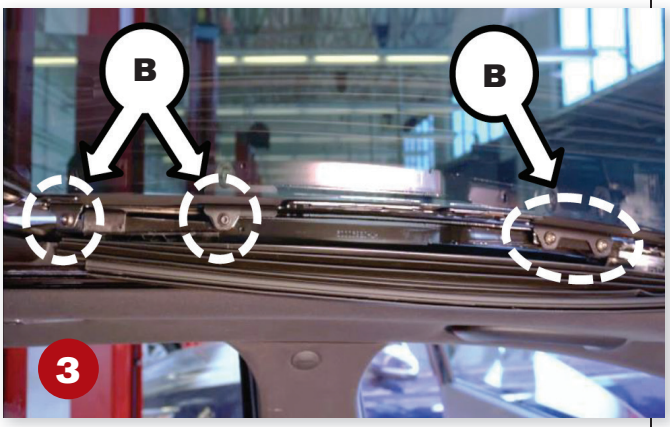
Here comes the sun

This repair will correct a slow closing and/or noisy sunroof

AFFECTED VEHICLE PRODUCTION RANGE

Model	Production Range
Sorento (UMa)	October 27, 2014 to January 23, 2016

You may encounter some 2016MY Sorento (UMa) vehicles produced from October 27, 2014 through January 23, 2016 that exhibit a slow-to-close panoramic sunroof and/or an abnormal noise when closing it. To help remedy either occurrence, follow the procedure in this article to clean, lubricate and replace the rear tilt levers.



Service Procedure

1. Inspect the operation of the panoramic sunroof and confirm the customer's concern before conducting this repair.

Notice: If the sunroof is inoperative, proceed to normal diagnosis, and once corrected, inspect for the "slow-to-close" and/or "abnormal noise when closing" concern, and apply the information in this article as necessary.

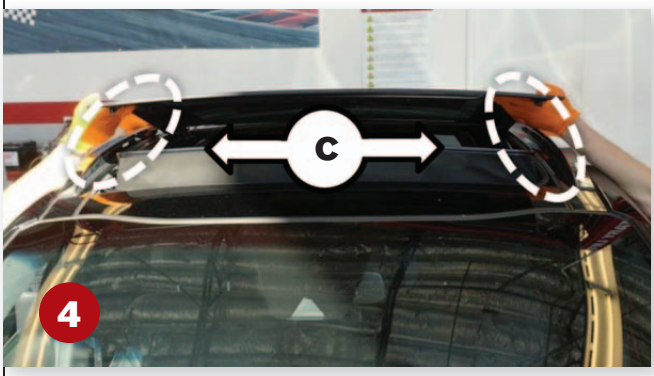
2. With the panoramic sunroof roller blind retracted, carefully remove the accordion covers (A) on the right and left side.

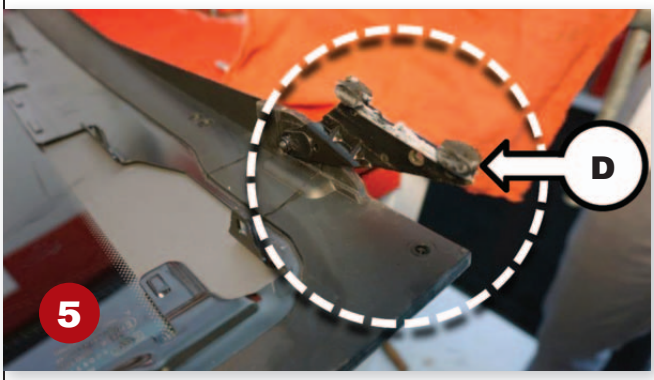
3. Using a T25 Torx® socket, remove the four screws (B) on the right and left side.

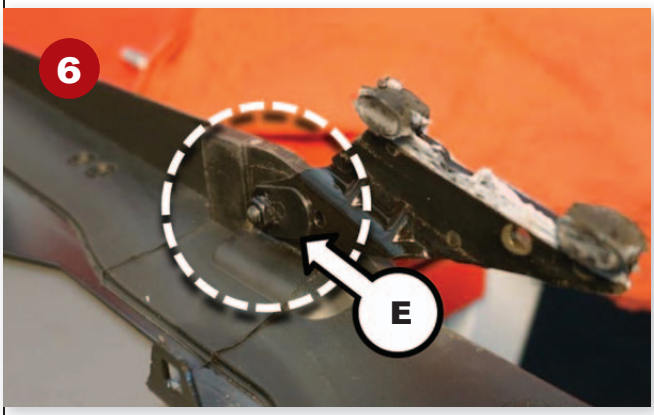
Caution: Use caution not to scratch or damage the glass during removal of the screws.

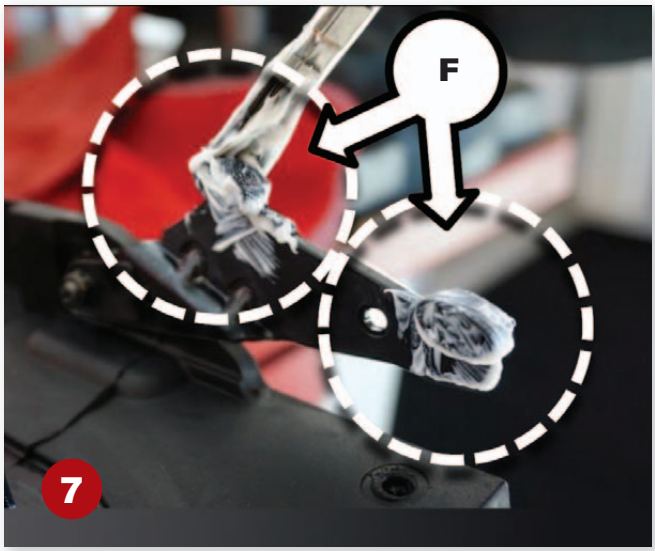
REQUIRED PARTS

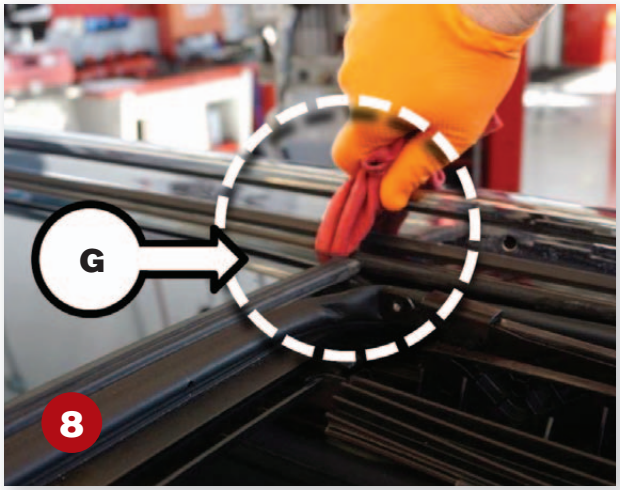
Part Name	Part Number	Quantity	Figure	Comments
Lubricant	81685 C5000FFF	1		This specific lubricant must be used. One container covers 30 vehicles.
Acid Brush	N/A	1		Sourced locally
Tilt Lever	81651 C5000 (LH)	1		N/A
	81652 C5000 (RH)	1		











4. With the assistance of another person, remove the panoramic sunroof glass by sliding the glass towards the front of the vehicle until the sliders are out of the tracks (C).

Caution: Use caution not to scratch, dent or damage the glass during removal.

5. Lay the glass on a soft, flat, protected surface with the tilt levers (D) facing up.

6. Using an 8mm socket, remove the nuts securing the tilt levers on both sides (E). Replace the tilt levers with new parts and tighten the nuts to the specified torque.

Tightening torque:
35.4 ~ 53.1 in.ft (4 ~ 6 N.m)

7. Lightly coat the tilt lever shoes (F) using the lubricant specified in the "Required Parts Chart" on page 9.

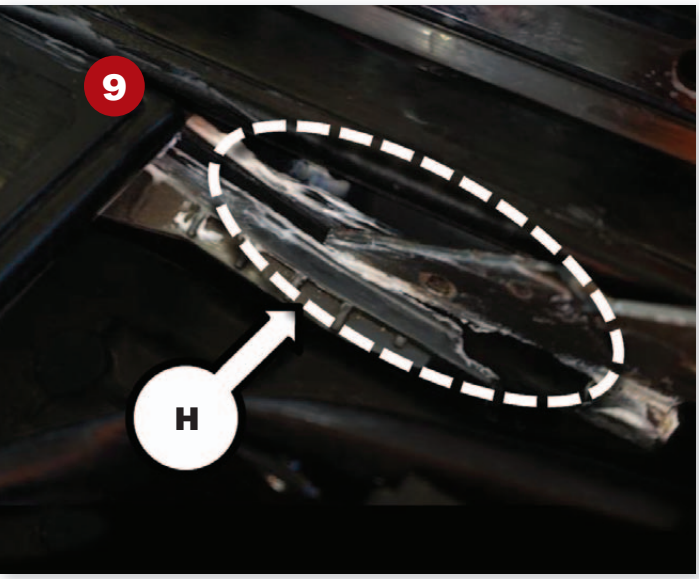
Caution: Failure to use the lubricant specified in the "Required Part" chart may result in an ineffective or repeat repair.

Do not use Kia Dampening Grease (P/N UM011-CHA052), as it is not compatible with the grease used by the factory.

8. Using a non-marring trim panel tool and a clean shop towel, clean the rear guide rails (G) on both sides until there are no foreign materials present on the rag.

Caution: Use a non-marring trim removal tool (Such as Snap-on® Part Number PBN5 or equivalent) to avoid damaging roof seals.

Failure to thoroughly remove any old grease or foreign material from the guides may result in an ineffective or repeat repair.



9. Using a clean brush, apply a sufficient amount of the specified lubricant to the entire length of both rear tracks (H). (Approx.15 grams of lubricant per track)

10. With the assistance of another person, carefully reinstall the panoramic sunroof glass by inserting the tilt levers into the guide rail (I). Thoroughly clean the excess lubricant from the panoramic sunroof.

Notice: Ensure the glass and all other components contacted while performing this procedure are clean.

11 Function-test the operation of the panoramic sunroof, confirming the customer's concern is corrected, and that the one-touch open/close is functioning.

Notice: If the one-touch open/close is not functioning, follow the reset procedure found in the next column under the "Panoramic Sunroof Reset Procedure."

Panoramic Sunroof Reset Procedure

1. Turn the ignition key to the ON position, and then close the panoramic sunroof completely and release the switch.

2. Press and hold the CLOSE button (J) for 10-15 seconds until the sunroof fully closes then retracts slightly. The sunroof operates as follows:

BLIND OPEN → GLASS TILT

Release the switch.

Perform step 3 within 5 seconds.

3. Press and hold the CLOSE button until the sunroof glass operates as follows:

GLASS CLOSE → OPEN → CLOSE

Release the switch.

4. Verify operation of the sunroof to confirm reset procedure is successful.

» TSBs may be updated from time to time. Please refer to TSB BOD125 at www.kiatechinfo.com for the latest procedures.

» All images are for illustration purposes only.

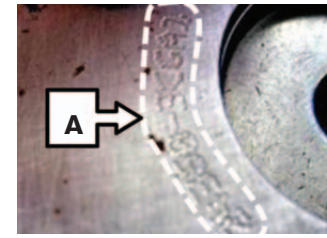
Calming chain chatter

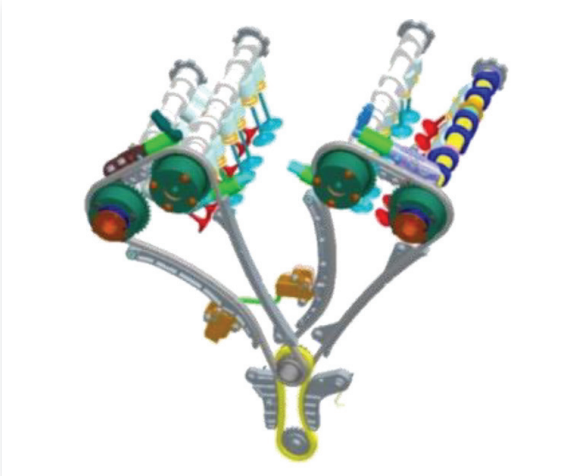
Timing chain tensioner replacement may be needed for CVVT assembly

A brief chattering or rattling noise from the engine on start-up — after a cold soak — may be evident for some 2014~16MY Cadenza (VG), produced from February 1, 2013 through January 7, 2016, and some 2014~2015MY Sorento (XMa) vehicles, produced from December 17, 2012 through December 11, 2014. If so, the timing chain tensioner may need to be replaced. This article addresses the replacement process.

Model	Production Date Range
Cadenza (VG)	From February 1, 2013 through January 7, 2016
Sorento (XMa)	From December 17, 2012 through December 11, 2014

REQUIRED PARTS

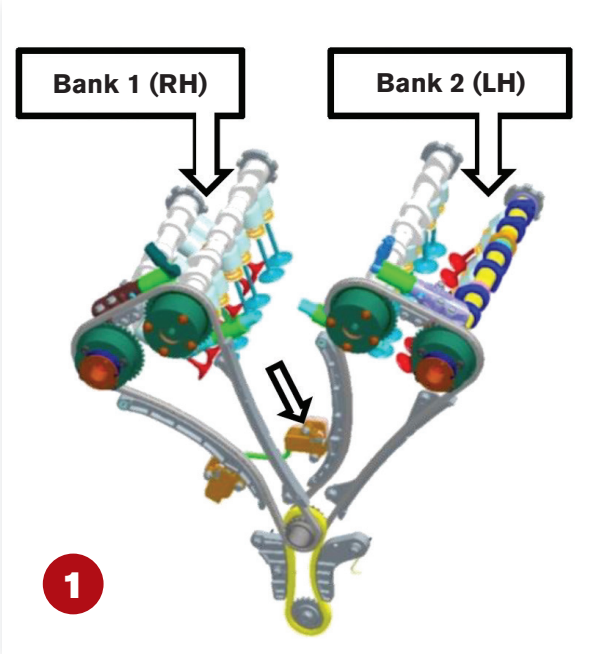
Model	Part Name	Part Number	Figure	
Cadenza (VG)	Timing Chain Tensioner	24410 3CGA2		
Sorento (XMa)	Timing Chain Tensioner	24410 3CGA2		
	Intake CVVT	**Previous Part Number** 24350 3CGA0		
		New Part Number 24350 3CGA1		Check the part number (A) engraved in the metal to identify the previous type and new one.

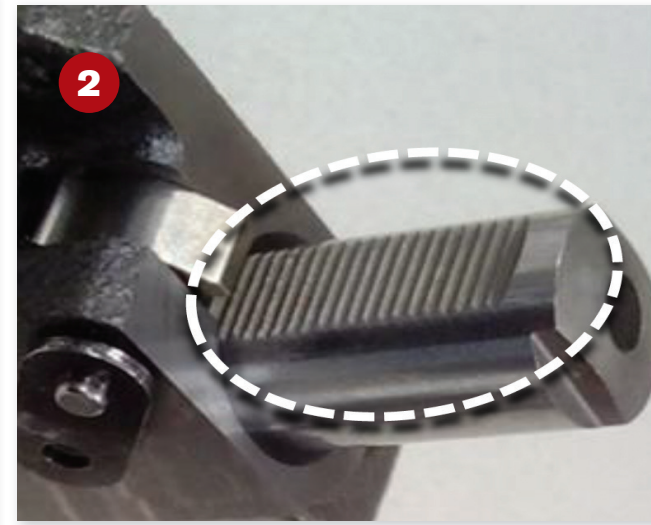


Related Parts	Part Name	Comments
Gasket - Rocker Cover	Refer to your local Kia dealer	
Gasket - Rocker Cover		
Gasket - Outlet, LH		
Gasket - Outlet, RH		
Gasket -ETC Actuator		
Gasket - Water Pump, RH		Metal
Gasket - Water Pump, LH		Rubber
Gasket - Surge Tank		

» TSBs may be updated from time to time. Please refer to TSB ENG148 at www.kiatechinfo.com for the latest procedures.

» All images are for illustration purposes only.





Service Procedure

Notice: This Service procedure should only be performed on engine bank 2 (LH), as shown.

1. Refer to the "Engine Mechanical System → Timing System → Timing Chain" section in the applicable Workshop Manual at KiaTechInfo.com, to install the improved timing chain tensioner.

2. For XMa vehicles, confirm that the latest intake CVVT is installed by referencing the part number.

Refer to the "Engine Mechanical System → Cylinder Head Assembly → CVVT & Camshaft" section in the applicable Workshop Manual at KiaTechInfo.com, to replace the intake CVVT.

Notice: Torque the intake CVVT retaining bolt with hand tools and a torque wrench. Do not use power/air tools.

Tightening torque:
47.4 - 56.4 lb·ft (64.7 - 76.5 Nm)

3. Once proper tensioner installation has been completed, reinstall all removed components by reversing the order of removal.

4. After confirming proper engine oil and coolant levels, start the engine and verify the rattle concern has been resolved.

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*Genuine Kia replacement parts (except battery) sold by Authorized Kia Dealer under warranty are covered for the greater of (1) the duration of the New Vehicle Limited Warranty or (2) the first 12 months from the date of installation or 12,000 miles, whichever comes first. Labor charges not included when not installed by an Authorized Kia Dealer. Warranty is limited. See Kia's Replacement Parts and Accessories Limited Warranty for further details.

When a hydraulic rack won't track

Your customers may tell you they think they need an alignment because their vehicles wander and won't "stay on track." Could be. But if their vehicles also have some other symptoms, the problem might be a worn-out steering rack.

Besides the tracking issue, look for a dead spot in the steering, low or discolored power steering fluid, a power steering fluid leak under the vehicle, a burning smell or a grinding noise.

Finding some of — or all of — these issues may lead you to recommend replacing the steering rack. If so, we have you and your customers covered with Genuine Kia rack-and-pinion unit replacements, their complementary components and fluids, all of which are specifically engineered for Kia vehicles.

Now that's truly getting your customers back on track.

KIA

Genuine Parts

Contact your local Kia dealer today for assistance and delivery of your parts.

Kia Genuine replacement parts (except battery) sold by an Authorized Kia Dealer under warranty are covered for the greater of (1) the duration of the New Vehicle Limited Warranty or (2) the first 12 months from the date of installation of the Kia Genuine replacement parts or 12,000 miles, whichever comes first. Labor charges not included when not installed by an Authorized Kia Dealer. Warranty is limited. See Kia's Replacement Parts and Accessories Limited Warranty for further details.