

# MOTOR AGE

SEPTEMBER 2023

VOL. 142, NO. 7

VEHICLESERVICEPROS.COM



## TIRE SERVICE YOU CAN TRUST

RANGER® INTRODUCES ALL-IN-ONE TPMS SOLUTION

# TRU:SENSOR™

### ADAPTABLE AND COMPATIBLE

Extensive 98% vehicle coverage - including Domestic, Asian, and European

TS58R



**4** PROGRAMMING METHODS

**FREE** SOFTWARE UPDATES

**98%**



Silver Metal



Black Rubber

# TRUSENSOR™

RANGER® INTRODUCES

## ALL-IN-ONE TPMS SOLUTION

Ranger TruSensor™ TS58R TPMS diagnostic and programming tool has been designed to work on virtually all vehicles using wireless or OBD connectivity. TruSensors offers an extensive 98% vehicle coverage, and that includes Domestic, Asian, and European models. With the TS58R, technicians will see all critical information, such as Sensor Battery Life, Tire Pressure, Broadcast Frequency, Sensor ID, and tire location. Order now at [BendPak.com/trusensor](http://BendPak.com/trusensor)

### TS58R

UNIVERSAL TPMS DIAGNOSTIC  
& SERVICE TOOL KIT

Includes 8 Sensors  
SKU 5150035

**\$285\***



### TPMS Bundle 1

**\$720\***

TS58R TPMS Tool Kit + 24 Rubber Sensors  
SKU 5150100

### TPMS Bundle 2

**\$720\***

TS58R TPMS Tool Kit + 24 Metal Sensors  
SKU 5150101

### TPMS Bundle 3

**\$1,165\***

TS58R TPMS Tool Kit + 48 Sensors  
SKU 5150102



1-800-253-2363 ■ [www.BendPak.com/trusensor](http://www.BendPak.com/trusensor)

\*Price valid until September 30<sup>th</sup>, 2023. \*\*Free shipping to direct shipping points within the 48 contiguous United States only. © 2023 BendPak Inc. Ranger Products is a registered trademark of BendPak.

**Ranger**

A Division of BendPak

18

## ARE YOU CALIBRATING ADAS- EQUIPPED VEHICLES?

Add a new revenue stream for this essential service.



## 26 VIRTUAL REALITY AND THE AUTOMOTIVE TECHNICIAN

Could augmented reality (AR) become the new reality for training in the automotive industry?

## 36 FIXING 5V REFERENCE FAULTS

Diagnoses based on critical thinking provide an infallible scientific method.

10

## OPERATIONS THE POWER OF A STRUCTURED TRAINING PLAN

# MOTOVISUALS

SERVICE & REPAIR ANIMATIONS



## BRING SERVICE RECOMMENDATIONS TO LIFE

MotoVisuals® allows you to easily explain service recommendations and increase your close rate, with 400+ animations that illustrate all vehicle systems from normal to failure. Share with your customers in-person, by text or email.

Start a free trial at [my.advancepro.com/motovisuals](https://my.advancepro.com/motovisuals).



# MOTOR AGE

Talk Shop Anytime



**SEPTEMBER 2023**

VOL. 142, NO. 7 //

**VEHICLESERVICEPROS.COM**

## OPERATIONS

### 10 UNLOCK YOUR EMPLOYEES' POTENTIAL: THE POWER OF A STRUCTURED TRAINING PLAN

Running a successful business requires making significant investments in the training and development of your employees.

**OSCAR GOMEZ**

## TECHNICAL

COVER STORY

### 18 ARE YOU CALIBRATING ADAS-EQUIPPED VEHICLES?

Add a new revenue stream for this essential service.

**ROSS COLKET**

### 26 VIRTUAL REALITY AND THE AUTOMOTIVE TECHNICIAN

Could augmented reality (AR) become the new reality for training in the automotive industry?

**MICHEAL SMYTH**

### 36 DRAWING A BLANK

Diagnoses based on critical thinking provide an infallible scientific method, as shown by this 5V reference failure.

**RENE MEJIA**

TECH CORNER

### 43 HITTING THE BULL'S-EYE REPEATEDLY

Ignition analysis is not dead; in fact, it's often dead-on.

**BRANDON STECKLER**



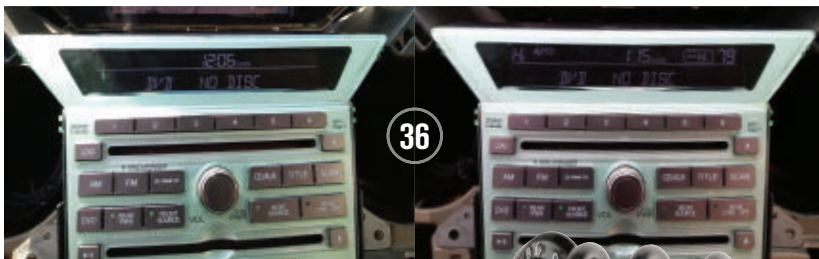
18



10



26



36



43



47

IN EVERY ISSUE



## 6 INDUSTRY NEWS

**AUTOMOTIVE TRAINING INSTITUTE NAMES NEW PRESIDENT**

**NORTHWOOD PARTNERS WITH AUTO-WARES FOR NEW SCHOLARSHIP PROGRAM**

**AACF RESPONDS TO MAUI FIRES, PROVIDES SUPPORT**

**TEKMETRIC AND APAC ATI PARTNER FOR SHOP MANAGEMENT SOFTWARE**

## 47 AUTOMOTIVE PRODUCT GUIDE

## 49 MARKETPLACE

## 49 AD INDEX



### VIDEO

#### MID-ATLANTIC AUTO CARE ALLIANCE'S SUPER SATURDAY 2023 TECHNICAL TRAINING EVENT AND EXPO

Motor Age Technical Editor Brandon Steckler talks about what to expect at this year's Super Saturday Technical Training Event and Expo. Use the QR code to view the video and get more information about the event, registration, and more.



## WEB EXCLUSIVES



### VIDEO: TOP 10 PRODUCTS OF JULY 2023

From an ultrasonic leak detector and exhaust pipe stretcher kit to industrial ceiling fans, check out the most clicked-on products of July.



See what other techs, shop owners, and mobile tool distributors were clicking on last month. Here are the top 10 most clicked-on products that were added to VehicleServicePros.com in July.

# MOTOR AGE

VEHICLESERVICEPROS.COM

Endeavor Business Media, LLC

30 Burton Hills Blvd, Ste. 185, Nashville, TN 37215. Phone: 800-547-7377

### EDITORIAL STAFF

**MATTHEW HUDSON**  
GROUP EDITORIAL DIRECTOR  
mHUDSON@endeavorb2b.com  
**JAY SIGHT**  
EDITOR-IN-CHIEF  
jsight@endeavorb2b.com  
**BRANDON STECKLER**  
TECHNICAL EDITOR  
bhsteckler@endeavorb2b.com  
**RHONDA COUSIN**  
ART DIRECTOR

### CONTRIBUTORS

**ROSS COLKET**  
**OSCAR GOMEZ**  
**RENE MEJIA**  
**MICHEAL SMYTH**

PRINTED IN U.S.A.

### SUBMISSIONS:

Motor Age welcomes unsolicited articles manuscripts, photographs, illustrations and other materials but cannot be held responsible for their safekeeping or return.

### ENDEAVOR BUSINESS MEDIA

CEO – **CHRIS FERRELL**  
PRESIDENT – **JUNE GRIFFIN**  
CFO – **MARK ZADELL**  
COO – **PATRICK RAINS**  
CRO – **REGGIE LAWRENCE**  
CHIEF DIGITAL OFFICER – **JACQUIE NIEMIEC**  
CHIEF ADMINISTRATIVE AND LEGAL OFFICER – **TRACY KANE**  
EVP - TRANSPORTATION – **KYLIE HIRKO**

### BUSINESS STAFF

**CHRIS MESSER**  
VP/GROUP PUBLISHER  
**MICHAEL WILLIAMS**  
BUSINESS DEVELOPMENT DIRECTOR,  
MOTOR AGE TRAINING  
**LESLIE BROWN**  
CUSTOMER MARKETING MANAGER  
**SHEILA WARD**  
PRODUCTION MANAGER  
**MELISSA MENG**  
AD SERVICES MANAGER  
**TRACY SKALLMAN**  
AUDIENCE DEVELOPMENT MANAGER  
**JILLEN WILLIAMS**  
SALES COORDINATOR

### SALES STAFF

**MATTIE GORMAN-GREUL**  
Associate Sales Director  
mgorman@endeavorb2b.com  
**CORTNI JONES**  
Director of Business Development  
cjones@endeavorb2b.com

### Account Executives:

**DIANE BRADEN**  
dbraden@endeavorb2b.com  
**MARIANNE DYAL**  
mdyal@endeavorb2b.com  
**CHAD HJELLMING**  
chjelling@endeavorb2b.com  
**BOB MARINEZ**  
rmarinez@endeavorb2b.com  
**LISA MEND**  
lmend@endeavorb2b.com  
**MICHAEL PARRA**  
mparra@endeavorb2b.com  
**MARTHA SEVERSON**  
mseverson@endeavorb2b.com  
**KYLE SHAW**  
kshaw@endeavorb2b.com  
**SEAN THORNTON**  
sthornton@endeavorb2b.com  
**JAMES HUWANG**  
Brand Manager,  
ASE Study Guides  
jhwang@endeavorb2b.com

### REPRINT SERVICES

reprints@endeavorb2b.com.

### CUSTOMER SERVICE

Subscription Customer Service  
877-382-9187; 847-559-7598  
MotorAge@omeda.com  
PO Box 3257  
Northbrook IL 60065-3257

**Connectiv**  
The Business Information  
Association, a division of SIA

MEMBER OF:



Motor Age (USPS Permit 925560), (ISSN 1520-9365 print, ISSN 1558-2892 online) is published 9 times yearly (February, March, April, May, June, July, September, October, December) by Endeavor Business Media, LLC, 1233 Janesville Ave., Fort Atkinson, WI 53538. Periodical postage paid at Fort Atkinson, WI, and additional mailing offices. POSTMASTER: Send address changes to Motor Age, PO Box 3257, Northbrook, IL 60065-3257. SUBSCRIPTIONS: Publisher reserves the right to reject non-qualified subscriptions. Subscription prices: U.S. (\$77.00 per year); Canada/Mexico (\$117.00 per year); All other countries (\$117.00 per year). All subscriptions payable in U.S. funds. Send subscription inquiries to Motor Age, PO Box 3257, Northbrook, IL 60065-3257. Customer service can be reached toll-free at 877-382-9187 or at MotorAge@omeda.com for magazine subscription assistance or questions.

Printed in the USA. Copyright 2023 Endeavor Business Media, LLC. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopies, recordings, or any information storage or retrieval system without permission from the publisher, Endeavor Business Media, LLC does not assume and hereby disclaims any liability to any person or company for any loss or damage caused by errors or omissions in the material herein, regardless of whether such errors result from negligence, accident, or any other cause whatsoever. The views and opinions in the articles herein are not to be taken as official expressions of the publishers, unless so stated. The publishers do not warrant either expressly or by implication, the factual accuracy of the articles herein, nor do they so warrant any views or opinions by the authors of said articles.

Endeavor Business Media provides certain customer contact data (such as customers' names, addresses, phone numbers, and e-mail addresses) to third parties who wish to promote relevant products, services, and other opportunities that may be of interest to you. If you do not want Endeavor Business Media to make your contact information available to third parties for marketing purposes, simply call toll-free 877-382-9187 or email MotorAge@omeda.com and a customer service representative will assist you in removing your name from Endeavor Business Media's lists.

Motor Age does not verify any claims or other information appearing in any of the advertisements contained in the publication, and cannot take responsibility for any losses or other damages incurred by readers in reliance of such content. While every precaution is taken to ensure the accuracy of the ad index, its correctness cannot be guaranteed, and the publisher waives all responsibility for errors and omissions.

AD DEADLINES: Insertion orders-1st of month preceding issue date. Ad materials-5th of month preceding issue date.

# BRING YOUR BAY TO THE MAX



**NEW** **ADAS BAY MAX LIFT**

Designed specially for ADAS calibration, while providing safer and more efficient mechanical repair and wheel alignment in a single standard bay space.

**Autel ADAS Bay Max 14K Lift**  
PART NO: AULS14ALOR1T

**Autel ADAS Bay Max 12K Lift**  
PART NO: AULS12ALOR1T



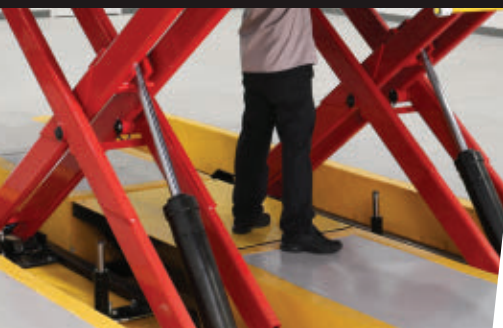
AULS14ALOR1T, AULS12ALOR1T

 ALL SYSTEMS  
ADAS CALIBRATION

 MECHANICAL  
REPAIR

 WHEEL  
ALIGNMENT

## TURN A SINGLE BAY INTO A MAXIMIZED PROFIT CENTER



### PREMIUM LIFT FEATURES

The innovative table riser, rolling jacking beams, stainless steel radius plates, runway air inflation, and LED undercarriage lighting are all standard.



### DRIVE ON/OFF AND IN ANY DIRECTION

Front and rear open runways paired with the unique flush-mount H shape configuration increases floor space, allowing for all systems ADAS calibration.



### IA900 + MSULTRA

A single system complete diagnostics, alignment, and ADAS workflow. One Maximized Bay.



### AUTEL ACADEMY TECHNICAL TRAINING

Visit [autel.com/us/academy](http://autel.com/us/academy) and register today for our onsite 2-day hands on ADAS Calibration Course.

**AUTEL**

AUTEL.COM | FOLLOW US @AUTELTOOLS



COMPANY NEWS

## AUTOMOTIVE TRAINING INSTITUTE NAMES NEW PRESIDENT

➔ Craig Montgomery has been appointed president of the Automotive Training Institute (ATI), according to a news release.

Montgomery has 15 years of experience working as an executive in the logistics and automotive technology fields. Most recently, he served as the chief revenue officer and general manager for Derive Systems.

An interest in the automotive industry began for Montgomery at a young age, with his grandfather being the owner of Hansson Automotive and Industrial Servicing in San Diego, California.

In his new role, Montgomery will help ATI in expanding its offerings to its membership, as well as supporting the launch of [www.drivenadvantage.com](http://www.drivenadvantage.com). 



CONTINUED EDUCATION

## NORTHWOOD PARTNERS WITH AUTO-WARES FOR NEW SCHOLARSHIP PROGRAM

*The scholarship program will provide financial assistance for those pursuing undergraduate and graduate degrees.*


➔ Northwood University and Auto-Wares Group of Companies have announced a new partnership to provide valuable opportunities for personal and professional growth to Auto-Wares employees, their spouses, and dependents.

“We are thrilled to join forces with Auto-Wares to empower their employees and families to pursue higher education at Northwood University,” stated Dr. Matthew L. Bennett, vice president of graduate enrollment and professional studies. “Northwood has a rich history of providing transformative educational experiences, and we look forward to offering our renowned programs to Auto-Wares’ dedicated workforce. This collaboration demonstrates our shared commitment to investing in individuals and equipping them with the tools for success in the rapidly evolving automotive aftermarket industry.”

The scholarship program will provide financial assistance for pursuing undergraduate and graduate degrees, creating a pathway for individuals to unlock their full potential and achieve their educational goals.

Auto-Wares says it has long recognized the importance of education.

“At Auto-Wares, we believe in investing in our employees and their families. Through this scholarship program, we strive to support their aspirations and contribute to long-term success in their chosen fields,” stated Aaron Roach, director of human resources at Auto-Wares. “By partnering with Northwood University, a university renowned for its comprehensive business and automotive aftermarket programs, we are confident that our employees and their loved ones will have access to top-tier educational programs that will enhance their skills and broaden their horizons.”

The scholarship program will cover a range of undergraduate and graduate programs offered by Northwood University, including business administration, automotive marketing and management, automotive aftermarket management, operations, and supply chain management, and more. Eligible Auto-Wares employees, their spouses, and dependents will have the opportunity to pursue their desired degrees while benefitting from Northwood University’s distinguished faculty, extensive industry connections, and experiential learning opportunities. 





**eXtra.**  
Rewarding loyalty



Earn double points from eXtra.  
Register now!

## Stock your shop. Earn rewards.

Upgrade your shop with the reliable performance of Bosch Filters. Built for hardworking professionals like you, our filters deliver high-efficiency filtration for oil, air, and cabin applications. Take advantage of our competitive pricing and unlock the benefits of our exclusive eXtra Rewards Program. Earn rewards points for the parts you're already purchasing!

Visit [BoschAutoParts.com/WorkshopFilters](https://BoschAutoParts.com/WorkshopFilters) today  
and discover a new level of excellence for your shop.



## INDUSTRY ASSISTANCE

## AACF RESPONDS TO MAUI FIRES, PROVIDES SUPPORT

*In response to the devastating Lahaina, Maui, fires, the Automotive Aftermarket Charitable Foundation (AACF) has established a dedicated relief fund to provide financial assistance to the families impacted.*

➔ In response to the devastating Lahaina, Maui, fires, the Automotive Aftermarket Charitable Foundation (AACF) announced it will be “providing much-needed support to the affected families.”

“During times of crisis, it is essential for the aftermarket indus-



try to come together and support one another,” said Joel Ayres, executive director of AACF, in a press release. “We understand the challenges that these families are facing, and our goal is to offer them a helping hand, reminding them that they are not alone in this journey toward recovery.”

The organization has established a dedicated relief fund to provide financial assistance to the families impacted by the fires.

“The Lahaina fires have been an unprecedented disaster, displacing families, disrupting businesses, and causing distress to our industry partners,” the press release stated, adding, “In light of these circumstances, the AACF has rallied its resources and expertise to extend a helping hand to the aftermarket industry families who have been hit hardest.” *TM*

## COMPANY NEWS

## TEKMETRIC AND APAC ATI PARTNER FOR SHOP MANAGEMENT SOFTWARE

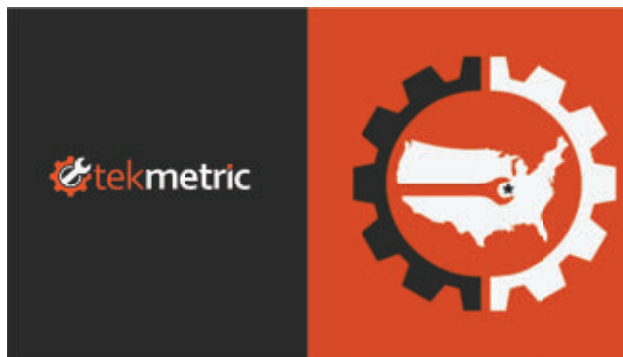
*The partnership aims to provide shop management software for its automotive repair training centers serving at-risk communities.*

➔ Automotive repair software company Tekmetric has partnered with California-based nonprofit APAC ATI (Automotive Professionals Advancement Center for Automotive Technical Instruction) to provide shop management software for its automotive repair training centers serving at-risk communities. APAC ATI is a nonprofit affiliate of Star Motors European Service that helps to provide access to quality jobs.

“The training we offer is about more than just turning a wrench; we are truly breaking down barriers to build a national network of skilled technicians,” said Chris Knuth, founder of APAC ATI. “We are elevating the industry and creating opportunity for those who are motivated to work hard and create a new life for themselves, strengthening local communities and the auto repair industry in the process.”

As the chosen software for APAC ATI, Tekmetric will provide its cloud-based, comprehensive shop management software to support trainees as they build their automotive skills. The technology will help trainees understand the importance of collaboration, efficiency, and customer transparency in a shop’s day-to-day operations.

“APAC ATI is meeting a critical need in our industry, empowering attendees with the knowledge and tools they need to advance in the auto industry,” said Sunil Patel, CEO of Tekmetric. “We are honored to work alongside Chris and his team to help prepare a



new generation of technicians for successful careers in the modern auto repair shop.”

Tekmetric will also support APAC ATI in providing shop owners with the tools and knowledge they need to offer a safe work environment, up-to-date tools and equipment, strong benefits, and continuing education opportunities.

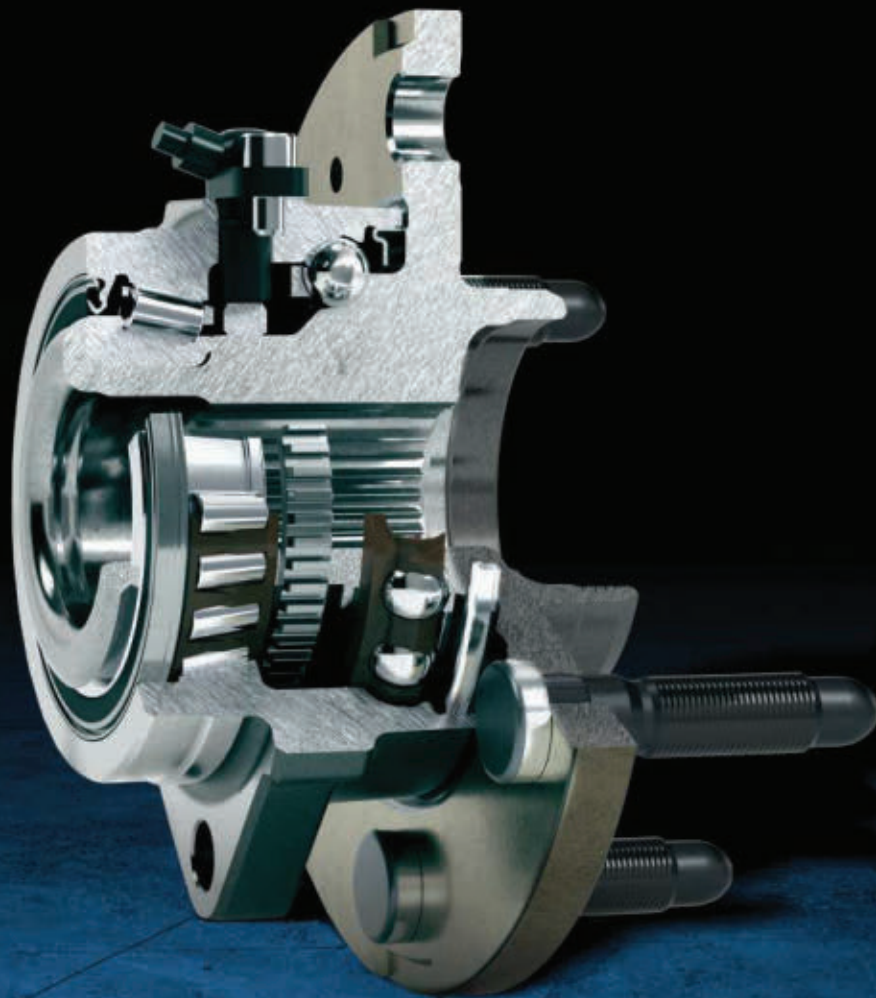
The training program is fully sponsored and requires no previous experience in auto care. Trainees are taught by experienced technicians nearing retirement, enabling them to share their knowledge with new generations of technicians.

In addition to auto repair skills, the program also teaches career development and personal growth skills to support graduates in building their careers after the program’s completion.

Following the program, APAC ATI partners with local auto repair shops to match graduates with stable roles to align with their new skills. *TM*

# X-Tracker Hybrid

A unique line of high performance hub units from SKF



For technical support and insights  
visit: [vehicleaftermarket.skf.com](https://vehicleaftermarket.skf.com)  
or scan the QR code to know more  
about the SKF products.

Unlock your employees' potential:

# the power of a structured training plan

Running a successful business requires making significant investments in the training and development of your employees.

BY OSCAR GOMEZ // Contributing Editor

**A** structured training plan is a crucial tool to maximize effectiveness, whether you're trying to upskill your technicians, offer professional advancement opportunities for your counter staff, or promote a culture of continuous learning and improvement.

With a structured training plan, you can define clear goals and objectives for your training activities, as well as make sure that your staff have the resources and support they need to be successful. Your staff will be aware of what has to be learned, how it will be learned, and when they may anticipate achieving their goals if you have a structured training strategy in place.

We'll discuss the value of a structured training program in this article, as well as the advantages it can provide to your technicians and counter staff. We'll also look at what makes a training program effective as well as how to design one that caters to the particular requirements of your staff. By the end of this article, you'll have a better idea of how a structured training program can enable you to tap into your employees' full potential and drive company success.

## Understanding the goals and objectives of the structured training plan

Understanding your desired goals and objectives is essential to creating an effective structured training strategy. Assessing the current expertise and knowledge of your technicians and counter staff is the first stage in this approach. By doing so, you'll have a general idea of what they already know and what they still need to learn.

### IN THE REALM OF ASSESSING AN INDIVIDUAL'S KNOWLEDGE AND ABILITIES, VARIOUS METHODS ARE EMPLOYED TO GATHER INFORMATION:

- Surveys and questionnaires can provide valuable insights into an individual's thoughts, feelings, and experiences on a particular subject.
- Performance evaluations offer a more objective assessment of how well someone performs specific tasks or responsibilities.
- Skills tests and exams are often used to evaluate a person's proficiency in a particular area, such as driving or writing.
- One-on-one interviews provide an opportunity for a more personal evaluation, allowing the evaluator to ask more in-depth questions and delve



PHOTO 9321292 © MAREK ULIASZ | DREAMSTIME.COM

deeper into the individual's knowledge and experience.

Each of these methods has its strengths and weaknesses, and often a combination of several of these approaches is used to gain a more comprehensive understanding of an individual's abilities.

The assessment process should be set up to find out what your employees do well and where they could improve, as well as how they like to learn and what drives them to do so. This information will help you make a training plan for your employees that is tailored to their needs.

## Setting clear and specific goals and objectives

Once you know what skills and knowledge your employees already have, the next step is to set clear goals and objectives for your training plan. These goals should be in line with your company's vision and mission, and they should show where your employees need to improve the most.

It's essential to set goals that are specific, measurable, achievable, relevant, and time-bound, also known as SMART goals. For instance, one SMART



# DEALER LEVEL DIAGNOSTICS

IDC 5

ADVANCED COVERAGE & REPAIR SOLUTIONS

## TEXA AXONE VOICE

Multi-Touch 13" Screen  
Military Grade / IP53 Rated

Windows 10 Open OS  
512gb SSD HD - 16gb RAM



- Interactive Maintenance Guides
- Component Replacement Guides
- Technical Information & Bulletins
- Interactive Wiring Diagrams
- Visual Live Data Dashboards
- System Diagnostic Reports
- Accurate ADAS Calibration
- Technician Remote Assist



RP1210, CanFD, DoIP, K-L,  
J2534, J1708, J1850, J1939  
Ethernet, WiFi, Bluetooth, USB

## TEXA **TXT** MULTIHUB MULTI-ENVIRONMENT COVERAGE DIAGNOSTICS FOR PROFESSIONAL TECHNICIANS

Single diagnostic interface able to scan cars, trucks, motorcycles, ATVs/UTVs, agricultural, construction and marine, while automatically using multiple protocol and connection options.



409 JOYCE KILMER AVENUE  
NEW BRUNSWICK, NJ 08901

[NORTHAMERICA@TEXA.COM](mailto:NORTHAMERICA@TEXA.COM)

[WWW.TEXAUSA.COM](http://WWW.TEXAUSA.COM)

MADE IN ITALY / OEM PARTNER



**TEXA USA**  
TECH SUPPORT  
855-200-8392

goal could be to enhance the technical skills of technicians in a specific area (such as troubleshooting), by the end of the quarter. Another goal could be to equip counter staff with the necessary knowledge and skills to upsell products and services, by the end of the year.

Encouraging continuous learning and professional development is also a vital aspect of training, and one way to achieve this is by offering regular training opportunities and rewarding employees who meet or exceed their training goals. By setting SMART goals for a training plan, employers can ensure that their employees receive targeted and effective training, resulting in improved performance and productivity in the workplace.

As an example, the SMART goal for counter staff could be to increase customer satisfaction ratings by 10 percent within the next six months. To achieve this goal, the counter staff will implement training programs and protocols for customer service, communication, and follow-up. They will set measurable targets for each team member and provide regular feedback and coaching.

Customer satisfaction ratings will be monitored weekly through customer feedback surveys and online reviews. The goal is relevant as customer satisfaction is a key performance indicator for the success of the auto repair shop. Satisfied customers are more likely to return for future services and refer others to the business. The goal is time-bound and will be achieved within the next six months. Weekly progress will be tracked and reviewed, and adjustments will be made as needed to ensure the target is met.

Continuing, SMART goal(s) for technicians could be to increase the efficiency of the repair process by 20 percent within the next six months. To achieve this goal, the technicians will research new tools and technologies that can improve the efficiency of the repair process. They will implement new procedures and provide training to technicians on the tools' use. The time it takes to complete repairs will be monitored, and areas for improvement will be identified. Feedback from technicians and the counter staff on the effectiveness of the new tools and procedures will be collected.

The goal is relevant, as improving the efficiency of the repair process will lead to faster turnaround times, increased customer satisfaction, and increased revenue. The goal is time-bound and will be achieved within the next six months. Weekly progress will be tracked, and adjustments will be made as needed to ensure the target is met.

The weekly progress review sheets for both counter staff and technicians will help to monitor progress and identify areas for improvement. The review sheet for counter staff includes tasks completed, challenges encountered, progress toward the goal, and an action plan for the next week. The



**Training Questionnaire Service Advisors & Techs**

1. Have you received any formal training education in automotive repair or maintenance? If yes, please specify the type of training and the date of completion. If no, would you be interested in receiving such training?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

2. Do you feel confident in your ability to diagnose and repair common automotive issues? If not, what areas do you feel you could use more training in?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. How familiar are you with the latest automotive technologies and diagnostic tools? Have you received any training on their use? If not, would you be interested in receiving such training?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. How comfortable are you communicating with customers about automotive issues? Have you received any training on effective customer communication? If not, would you be interested in receiving such training?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. Have you received any training on workplace safety, including handling hazardous materials, working with power tools, and preventing workplace accidents? If not, would you be interested in receiving such training?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

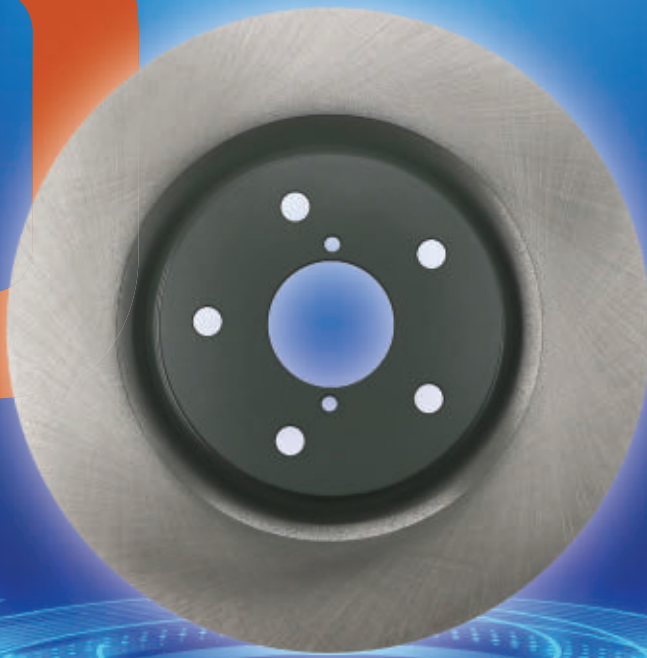
**A TRAINING QUESTIONNAIRE** allows shop owners to determine their staff's training starting point. This and other Master Automotive Training worksheets can be downloaded by scanning the QR code at the end of this article.

review sheet for technicians includes tasks completed, challenges encountered, progress towards the goal, and an action plan for the next week. Regular review and adjustment of goals and tasks are essential to achieving success.

Having clear and specific goals for your employees will help you focus your efforts and resources. This way, you can make sure that your staff receives the best possible training. Additionally, having clear goals will help you determine how effective your training plan is and allow you to make changes if necessary to achieve the results you want.

**Aligning your training plan with your company's vision and mission**

Your company's overall mission and vision should be reflected in your training plan. This means that your training should help your organization reach its strategic goals and show

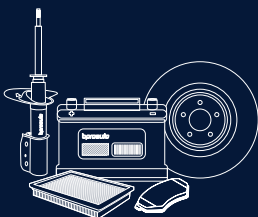


***Did it come through R&D?  
Or a wormhole to the future?***

**bproauto**  
Next-level parts.

***Right for today. Ready for tomorrow. Welcome to the new aftermarket.***

The O.E.-backed parts with the coverage you need today. The new technology you'll need for tomorrow. You'll wonder if some time travel was involved in the process.



Scan the code or visit  
[bproautoparts.com](https://bproautoparts.com)  
to learn more.



your employees how their work contributes to the success of the business.

For example, if your company's mission is to provide excellent customer service, then your training plan should focus on customer service skills like active listening, conflict resolution, and communication. If your company cares about the environment and wants to be sustainable, your training plan could include lessons on how to reduce waste and use products that are less harmful.

By aligning your training plan with your company's vision and mission, you will ensure that your training efforts are focused and effective, and that your employees are motivated and engaged in their learning experience.

**Developing a structured training plan**

Developing a structured training plan is crucial for the success of any auto repair shop. The first step in creating a training plan

is to determine the training needs of technicians and counter staff (Fig. 1). This can be achieved by conducting a skills assessment to identify areas where employees may require additional training or development. Once the training needs have been identified, the next step is to prioritize them based on the needs of the business and the employees.

The next step in developing a structured training plan is to identify the best training methods and techniques. This will depend on the nature of the training, the learning style of the employees, and the available resources. Some training methods that can be used include on-the-job training, classroom training, online training, and workshops. It's important to choose the method that will be most effective in achieving the desired learning outcomes. Additionally, the training plan should be designed to be interactive and engaging to maximize employee engagement and retention of knowledge.

Creating a timeline for the training plan is also an essential

**JUNG TYPOLOGY TEST™**

This free personality test is based on Carl Jung's and Isabel Briggs Myers' personality type theory.

Upon completion of the questionnaire, you will:

- ✓ Obtain your 4-letter type formula according to Carl Jung's and Isabel Briggs Myers' typology, along with the strengths of preferences and the description of your personality type
- ✓ Discover careers and occupations most suitable for your personality type along with examples of educational institutions where you can get a relevant degree or training
- ✓ Understand communication and learning styles of your type.
- ✓ See which famous personalities share your type
- ✓ Be able to use the results of this test as an input into the Jung Marriage Test™ to assess your compatibility with your long-term romantic partner

1. You are almost never late for your appointments

YES    yes    uncertain    no    NO

2. You like to be engaged in an active and fast-paced job

YES    yes    uncertain    no    NO

3. You enjoy having a wide circle of acquaintances

YES    yes    uncertain    no    NO

4. You feel involved when watching TV soaps

YES    yes    uncertain    no    NO

5. You are usually the first to react to a sudden event: the telephone ringing or unexpected question

YES    yes    uncertain    no    NO

6. You feel that the world is founded on compassion

YES    yes    uncertain    no    NO

7. You think that everything in the world is relative

YES    yes    uncertain    no    NO

**For Organizations and Professionals**

Organizations and specialists interested in personality assessments based on Jung's typology please visit [www.HRPersonality.com](http://www.HRPersonality.com) where we offer personality assessments for:

- candidate assessment and pre-employment screening
- leadership and staff development
- career counseling
- integrated solutions
- psychographics
- *New!* 1:1 Personality Compatibility Report

We offer team building and leadership workshops.

HUMANMETRICS INC.

**The 16 personality types**

ESTJ	ISTJ	ENTJ	INTJ
ESTP	ISTP	ENTP	INTP
ESFJ	ISFJ	ENFJ	INFJ
ESFP	ISFP	ENFP	INFP



**THIS PERSONALITY TEST** will help show owners better understand their type of personality and learning style for each team member. Find the test at <https://www.humanmetrics.com/personality/test>.



# REV UP YOUR SAVINGS!

Equipment | Tools | Shop Essentials



**ALL-IN-1 SHOPPING**



Call Now for a **FREE** catalog!

**1-800-261-7729**

Ask about our price promise guarantee.

**WE WILL NOT BE UNDERSOLD!**

**WRENCHERS.com**

© 2023 Wrenchers LLC. All Rights Reserved.

component. The timeline should be based on the prioritized training needs and the availability of resources. It should include milestones and deadlines to ensure that the training is delivered on time and within budget.

Finally, roles and responsibilities for training delivery and evaluation should be assigned to ensure that everyone involved in the training process understands their role and is accountable for the success of the training plan. This will help to ensure that the training plan is executed efficiently and effectively.

**Implementing a structured training plan**

Implementing a structured training plan is critical for the growth and development of an auto repair shop. To successfully implement a training plan, the shop owner must provide the necessary resources and support for training. This may include providing access to training materials, providing funding for training courses, and offering flexibility in scheduling to accommodate training sessions. Additionally, the shop owner should ensure that the employees have the necessary tools and equipment to apply their new skills and knowledge.

Monitoring progress and evaluating the effectiveness of the training is another crucial component of implementing a structured training plan. This can be achieved by setting specific goals and objectives and regularly checking progress against them. It's important to get feedback from employees on the effectiveness of the training and to make any necessary adjustments to improve the training plan.

By regularly monitoring progress and evaluating the effectiveness of the training, the shop owner can ensure that the employees are acquiring the necessary skills and knowledge to enhance their performance and the success of the shop.

Encouraging active participation and feedback from technicians and counter staff is also essential for the success of your training plan. Create a positive and supportive learning environment that encourages employees to ask questions and participate in training activities. Additionally, it's important to gather feedback from employees on their training experiences to identify areas where the training plan can be improved. By actively involving employees in the training process and encouraging their participation and feedback, the shop owner can ensure that the training plan is effective and meets the needs of the employees and the business.

**Maintaining and refining your training plan**

Just like car repairs are not a one-size-fits-all, refining your training plan is crucial for the continued success of my and your business. Regular review and evaluation of the training plan is essential to ensure that the training remains effective and relevant to the changing needs of the business and employees. By conducting regular assessments of the training

plan, It can identify areas where improvements can be made, and make necessary adjustments to improve the effectiveness of the training.

Updating your training plan to reflect changes in technology, industry standards, and company goals is another essential component of maintaining and refining a structured training plan. The automotive industry is constantly evolving, and it's important to keep up with the latest technologies and industry standards. By updating the training plan regularly, I can ensure that my employees have the necessary skills and knowledge to stay ahead of the competition. Additionally, by aligning the training plan with the company's goals, I can ensure that the training is focused on achieving the desired outcomes for the business.

Continuously encouraging learning and development among technicians and counter staff is critical for maintaining a culture of learning and growth within the business. By offering ongoing training opportunities and promoting a culture of continuous learning, I can ensure that my employees remain engaged, motivated, and committed to their professional development. This can lead to improved employee retention, increased productivity, and better overall business performance.

**Investing in employee development and learning for a skilled and motivated workforce**

In the end, a training plan is a useful tool for both organizations and people. It helps make sure that employees have the skills and knowledge they need to do their jobs well and help the company reach its goals. A training plan that is well thought out can bring many benefits, such as increased productivity, better job performance, and higher morale among staff.

I think it's important for every business to have a structured training plan for their techs and counter staff. This investment in employee development and learning can lead to a more knowledgeable, skilled, and motivated workforce, which is important for the success of any business. *TZ*



**OSCAR GOMEZ** is an ASE-certified Master Technician and the founder of Master Automotive Training in Rancho Cucamonga, California. He encourages both new and experienced technicians to keep learning and growing, both as people and as professionals to improve the auto industry one technician at a time.

**SCAN THE QR CODE TO READ THIS ARTICLE ONLINE AND TO DOWNLOAD A SET OF FIVE WORKSHEETS FROM MASTER AUTOMOTIVE TRAINING FOR YOUR USE!**



# DNJ®

ENGINE COMPONENTS

## CHEVROLET & GMC 4.3L OHV LV3 ENGINES WE GOT YOU COVERED!!!



YOUR ONE STOP SOURCE  
FOR ALL YOUR  
ENGINE PART NEEDS

[www.EngineComponents.com](http://www.EngineComponents.com)



# ARE YOU CALIBRATING ADAS- EQUIPPED VEHICLES?

Add a new revenue stream for this essential service.

BY ROSS COLKET // Contributing Editor

**W**hen it comes to today's vehicles, why wouldn't you plan on investing in your future? I recently attended a TechNet meeting representing approximately 60 to 80 shops. I sat on a panel with three other shop owners who are currently performing advanced driver assistance systems (ADAS) calibrations (Figure 1). To my surprise, of all those shops represented, not one of them performs ADAS calibrations.



PHOTO COURTESY OF SNAP-ON

**AUTEL IA900**  
performing a calibration

We have a unique business model in that we service a larger sized glass shop in the area and also eight body shops. The glass company is very progressive in that it does a lot of insurance work. As a result of this, the insurance companies will not compensate the shop without proof of a calibration and also proof that no trouble codes in any of the ADAS systems remain. I also find the chain body shops to be more progressive and understanding of ADAS because of their relationship with the training and education organization Inter-Industry Conference on Auto Collision Repair (I-CAR) and their training. Keep in mind, I deal directly with the body shops and not through the insurance company (much less stress and no runaround). As a result, this now accounts for one third of my business.



### **Some rewards aren't worth the risk**

Let's take a moment to reflect on the Honda Fit crash in Texas in 2013 (Figure 2). There was a 2010 Honda Fit that had its roof panel replaced in 2012 after it was damaged by hail. The collision shop chose to use panel bond adhesive instead of following Honda's OEM-recommended repair (which was to use some pretty specific types of welds to secure the roof panel). The plaintiffs bought the car used with no knowledge of the

prior repair. They were involved in a collision. The Fit's fuel tank ruptured in the crash, and it caught on fire. The couple now have lifelong debilitating injuries. The husband driving the car spent three years in the hospital and sees the doctor once a week, most likely for the rest of his life. The jury determined the roof panel collapsed because it was not welded, which weakened how the vehicle reacted in the crash, and awarded the plaintiffs a \$42M settlement, all because the body shop did not follow OEM procedures.

When I start an alignment with my Hunter alignment rack, many times it will tell me a calibration is required because of the wheel alignment being performed. So, if I didn't do that calibration, I would be liable for not following the OEM procedure. (Learn more about the case by going to <https://www.vehicleservicepros.com/21195017>, or scan the QR code at the end of this article to view the article and video.)

I encourage you to investigate becoming an ADAS-equipped shop. Keep in mind, early ADAS systems are now 23 years old. It is strange to think, but in another two years, ADAS vehicles will literally be classics. If you are equipped to service and repair/calibrate ADAS, you won't have to send your customers down the road. I have several shops in the area that send their customers to me either for programming, R1234yf, and ADAS. More than once, I have had those customers continue to come back to me because they knew our capabilities.

**Return on investment**

If cost is a concern for the equipment, think of it this way: most shops charge in the neighborhood \$100 for a wheel alignment and steering angle reset. How much did your alignment rack cost you? A brand-new Hunter setup is about \$90,000. A well-equipped Autel ADAS system goes for about \$40,000, a fraction of the cost of your alignment machine. An average calibration is anywhere from \$250 to \$500.

Also know that one of Audi's models requires all its ADAS features be calibrated as part of an alignment, which brings the total cost of that job to around \$2,800. I encourage you to

ask yourself which profit margin you would prefer. If you think you need a bunch of OEM equipment, you really don't. Autel is the only tool we use.

In terms of training, more and more sources are coming online to provide hands on training. Autel just built a training center in New York where they offer a two-day course. Once you get the basic concept of performing the calibrations, it really does become quite easy. Understand that you are either working with a distance sensor or a camera. Yes, there are different styles of distance sensors, but the reality is, any one is just a distance sensor.

Diagnosing a system is just like diagnosing an engine issue. The best part of working with ADAS systems is that most of the sensors are usually either four- or six-wire sensors: A voltage and ground supply, and two or four network wires. As long as you have an oscilloscope to check for communication, you are all set. Yes, you will also use your scanner to see if the sensor is reporting on the network and to check for any trouble codes.

The information sources of ALLDATA, Mitchell 1, I-CAR, and Direct-Hit have come a long way in making OEM information much more accessible. Mitchell 1 and ALLDATA have a special section devoted to ADAS. Yes, on the newer cars, you are sometimes going to have to log onto the OEM's website, but those instances are few and far between.

One of the things I have found interesting is that Audi will often list in the labor guide that calibration is required. Several of their models not only will require an alignment after replacing a clutch or transmission, but they will also need a forward-looking camera calibration. Autel has a great website for looking up targets and placement of the targets at <https://autel.com/us/adas-setup-reverse-lookup-guide/>. That site has a ton of good information on ADAS tooling as well as a return-on-investment calculator. Another good place to get information has been Facebook groups on ADAS. Most of the time, I sit back and watch the conversations and can distinguish which users are helpful and have good quality information to add.

**The best tools are the one that works for your shop**

When it does come time for you to purchase the equipment, I strongly encourage you to do your homework on who you purchase from. I am sure from the article that you can tell I am an Autel guy. They were one of the first to market with a complete solution and have been doing it the longest. Also keep in mind they are the factory tool for all the Stellantis divisions. I have found their technical support team for ADAS to be very helpful at times.

Another item you will want to take into consideration is you can buy the mobile equipment or equipment that uses cameras to get the correct frame placement. I am a strong be-



**2010 HONDA FIT** after the roof separated during a collision.

TRACY LAW FIRM



ELA320

# NEW ENERGY VEHICLE MAINTENANCE & DETECTION SOLUTIONS



ELP400



ELT500



ELB300



ES200

liever in the camera equipment. When you get a vehicle that won't calibrate after a repair, the first thing you are going to question is your measurements of where the target is placed. When I first started doing the calibrations, I had just such a car and I kept rechecking and rechecking. As it turned out, it was a distorted windshield. It had a "fisheye" in the camera view. With the camera system, we will run through the measurements one more time after the initial setup and also check our information sources for correct measurements, but then after that we know that the problem is with the vehicle.

**Causes of some common faults**

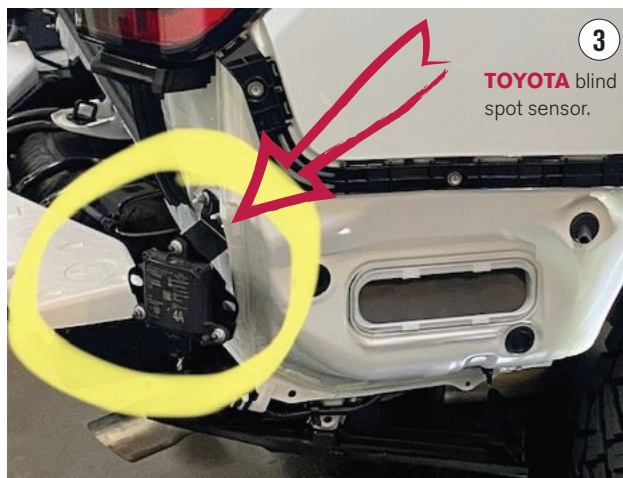
If you are unable to calibrate a vehicle, there are many things that can cause that. With blind spot monitors, the body can be damaged under the radar sensor; the bracket can be bent, or the sensor can be installed backwards. The sensor itself can be damaged from the impact, but typically, you will have no communication with the module. If the wiring is damaged, that is simple enough to repair. When you have a blind spot sensor that does not calibrate, the first thing you want to do is get the bumper off. I have had many guys tell me there was no damage around the blind spot sensor. Sure enough, as soon as the bumper comes off, I see it right away (Figure 3).

For a front radar sensor problem, make sure the correct emblem is installed. The emblems used with radar sensors are made of a different material and are very expensive as a result. Other typical radar sensor faults are similar to those of blind spot sensors. One difference that you will see with the radar sensor is that some are mechanically adjustable, and some are adjusted electronically during the calibration.

Forward-facing cameras can have a mount positioned incorrectly during manufacturing, or the glass can be distorted from when it was manufactured. We have seen the glass dusty in front of the camera, and the glass guys did not catch it. We did have one customer come in from the glass shop who wanted his windshield replaced, but the camera would not communicate. We offered to diagnose it for him, but he refused. He stated that he didn't use the systems, anyway, and that he was not prepared to put the money into the repair. I was impressed by the glass shop; they turned him away.

If you are concerned about replacing the sensors and needing to perform programming, don't be. We do all our GM and Ford programming in-house. For other vehicles, we utilize Autel's Remote Expert Service, which is remote programming through the internet. We have had great results with it, so I feel completely comfortable that we have a total solution. Also, some of the sensors are just plug-and-play.

If a car is not calibrated after windshield installation, and two years go by and the camera won't calibrate, it could have been a bad windshield all along. What do you think the



chances are of the customer mentioning to you that their car got a windshield two years ago?

We have had cars that would drive fine and not allow the camera to calibrate. Picture yourself getting that car for a repair. I am willing to bet that car would get a camera replaced and probably another windshield. If that vehicle had been calibrated two years ago when the windshield was replaced, it would have been a simple problem to identify that it was a bad windshield. By not calibrating, you are doing a disservice to your customer. In the long run, it may just cost them more money than if they had paid for the calibration.

By not moving forward with ADAS, you are setting a bad standard for the industry and opening yourself up to potential litigation. Really, if you want to think about it, you are doing a disservice to your customer. Even seemingly simple repairs can require calibration. For example, if you install a new radiator or condenser on a car equipped with a front radar sensor, if you touch that sensor, that vehicle needs to be calibrated.

Equipping the shop to handle ADAS repair and calibration solutions may seem like a big expensive undertaking, but the return on investment is huge. To gear up for ADAS doesn't cost...it pays! *ML*



**ROSS COLKET** is the owner of Colket Automotive Technical Services in Lansdale, Pennsylvania. He is an ASE Certified Master Technician with over 30 years of experience as both a technician and educator. As a former CTI instructor, he believes in the importance of training and giving back to the industry. Ross fully supports and believes in *Motor Age's* mission to "advance the automotive professional."

**SCAN THE QR CODE  
TO READ THIS AND RELATED  
ARTICLES ONLINE**





# DanAmAir®

## PROFESSIONAL ALUMINUM COMPRESSED AIR PIPING SYSTEM



Measure & Cut ►  
Push to Connect

*Use for new  
installation, or to  
expand or modify  
your current  
system*



Check out our  
DAA How-To  
YouTube videos

**EASY TO INSTALL YOURSELF  
OR HAVE PROFESSIONALLY INSTALLED**

- ENERGY EFFICIENT
- EASY TO INSTALL
- Modular design
- Corrosion Resistant
- Leak-free guarantee
- Removable and reusable
- Push-to-connect technology
- Immediate pressurization
- Full bore design
- 1/2" to 6" pipe sizes

**For a FREE quote call: 800-533-8016**

Dan-Am Co.® • One Sata Drive • Spring Valley, MN 55975



SEPTEMBER 1 - OCTOBER 31, 2023

WE'RE  
GIVING  
AWAY

**\$15,000+** IN PRIZES.

ENTER EVERY DAY FOR MORE CHANCES TO WIN AT  
**VEHICLESERVICEPROS.COM/GPG!**

VehicleServicePros.com, the official website of *PTEN*, *Motor Age*, and *ABRN* in partnership with the vendors that supply the vehicle service market with the latest products to improve your business, are pleased to introduce the ninth annual Great Prize Giveaway! Who doesn't love to win something? Better yet, you don't have to pay to play!

Vendors have partnered with VehicleServicePros.com to offer you a chance to win prizes. Vote for up to five products each day, increasing your chances for those particular prizes. Visit [VehicleServicePros.com/gpg](https://VehicleServicePros.com/gpg) to view all prizes and Enter to win Sept. 1 - Oct. 31, 2023. Winners will be notified by November 15th. *Good luck!*

## HOW TO ENTER

- Visit [VehicleServicePros.com/gpg](https://VehicleServicePros.com/gpg) to view all prize details and enter to win.
- To enter, check boxes on the entry page for your top five products.
- Be sure to stop back daily to improve your chances of winning.

BROUGHT TO YOU BY:

**PTEN**  
PROFESSIONAL TOOL & EQUIPMENT NEWS

**MOTOR AGE**

**ABRN**  
AUTO BODY REPAIR NETWORK

**VEHICLESERVICEPROS**.COM



**AirCat**  
2023 AirCat Giveaway  
**PRIZE VALUE: \$500.00**



**Autel**  
MaxiTPMS TS900  
**PRIZE VALUE: \$795.00**



**Bosch Diagnostics**  
TPA 300 TPMS Tool  
**PRIZE VALUE: \$882.00**



**Forney Industries**  
Easy Weld Bundle  
**PRIZE VALUE: \$504.98**



**Induction Innovations**  
Mini-Ductor Venom HP + Coil Kit  
**PRIZE VALUE: \$709.00**



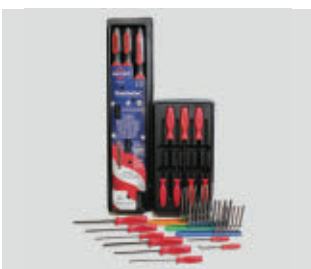
**K-Tool**  
Deluxe Mechanics Tool Set  
**PRIZE VALUE: \$3600.00**



**Lang Tools**  
Made in USA Specialty Tools  
**PRIZE VALUE: \$650.00**



**Launch Tech USA**  
Millennium Max  
**PRIZE VALUE: \$799.95**



**Mayhew Tools**  
Toolbox Set-Up  
**PRIZE VALUE: \$716.78**



**Opus IVS**  
CarDAQ-Pro™ 360  
**PRIZE VALUE: \$2995.00**



**OTC**  
Ball Joint Connected Adapter Kit  
**PRIZE VALUE: \$780.00**



**PowerProbe**  
PRO Tester Solder Combo  
**PRIZE VALUE: \$788.85**



**Streamlight**  
2023 Worklights Prize  
**PRIZE VALUE: \$850.00**



**Tool Aid**  
Pro-Pack  
**PRIZE VALUE: \$661.89**

**ENTER AT**  
**VEHICLESERVICEPROS**  
**.COM/GPG**

**Contest rules**

Entrants in the Great Prize Giveaway promotion must be a professional owner, manager or technician responsible for repairing and/or maintaining vehicles. Each entrant must be an employee of a fleet facility or vehicle service center as of August 31, 2023. Each entrant can register for up to five (5) products per day. Product registration entries may be submitted from 12:00 a.m. C.S.T. on September 1, 2023 through 11:59 p.m. C.S.T. on October 31, 2023 ("Entry Period") at VehicleServicePros.com. No other method of entry will be accepted. Endeavor Business Media, LLC's computer is the official time keeping device. Winners will be selected at random from all eligible entries received during the Entry Period. Odds of winning depend on the actual number of entries received for each product during the Entry Period. There is no limit on the number of products an entrant may win. Employees of Endeavor, Inc. or any Product Sponsor(s), their immediate family members (spouses and siblings, children and parents and their spouses, regardless of where they live), and members of their households (whether related or not) are not eligible to participate. Endeavor Business Media, LLC reserves the right to disqualify any entry. No purchase or subscription is necessary to win. Prize values may be rounded to the nearest dollar, or \$100. Purchase of or subscription to any Endeavor Business Media, LLC-related publications does not increase chances of winning. The Great Prize Giveaway promotion shall be governed exclusively by the laws of the State of Tennessee. Void in Florida and where prohibited or restricted by law. The full list of rules and regulations can be found at VehicleServicePros.com/gpg.



**1**  
**A TECHNICIAN USES**  
a tablet computer with  
Augmented Reality  
diagnostics software.

# VIRTUAL REALITY AND THE AUTOMOTIVE TECHNICIAN

**COULD AUGMENTED REALITY (AR) BECOME THE NEW REALITY FOR TRAINING IN THE AUTOMOTIVE INDUSTRY?**

**BY MICHEAL SMYTH //** Contributing Editor

**W**ith technological advancements sweeping the world, it comes as no surprise that virtual reality (VR) has made its way into our lives. A term that was only known to tech enthusiasts a few years ago is now becoming a household concept. But what exactly is virtual reality? Let's dive into the fascinating world of VR and explore its potential in the automotive diagnostic and repair industry.

Virtual reality is a computer-generated simulation of a three-dimensional environment that can be interacted with and explored by an individual. It immerses users into a virtual world, making them feel as if they are physically present in that environment. This is achieved through the use of a head-mounted display (HMD) that encompasses the user's vision, surrounding them with virtual surroundings. By wearing the device and through the help of motion-tracking sensors, users can look around and engage with

the virtual world just as they would in real life.

Although primarily used as a gaming environment, VR is not limited to gaming alone. Several industries have recognized the potential of this technology and have begun integrating it into their respective fields, including automotive diagnostics and repair.

## **VR vs. AR vs. MR: What's the difference?**

Virtual reality (VR), augmented reality (AR), and mixed reality (MR) are all

SCAN CODE



# CUT THROUGH THE RED TAPE

**YOUR TRUSTED PARTNER FOR AUTOMOTIVE  
PARTS, EQUIPMENT, AND SUPPLIES.**

We're a family owned and operated business, so we get it - your time is valuable. As your trusted partner for automotive parts, equipment, and supplies, FMP helps you cut through the red tape so you can focus your time on growing your business and profits, now and in the future. We understand, our success depends on yours.

Let us help supply your success. Visit [FactoryMotorParts.com/no-red-tape](https://www.factorymotorparts.com/no-red-tape).



**FACTORYMOTORPARTS™**

WE SUPPLY YOUR SUCCESS.

© 2023 Factory Motor Parts. All Rights Reserved.



SHUTTERSTOCK-ZAPP2PHOTO

**AUGMENTED REALITY GLASSES** being used to diagnose an internal combustion engine in the field.

related technologies with the common goal of altering our perception of reality. While they share some similarities, there are key differences that set them apart. Let's explore each of these technologies in more detail.

**Virtual reality (VR):** As mentioned in the previous paragraph, VR creates a completely immersive virtual environment that can be interacted with using specialized hardware, such as a head-mounted display (HMD) or gloves. When using VR, the user is transported to a digital world that is entirely separate from their physical surroundings. VR is often used in gaming, simulations, and training applications where users can engage with and manipulate virtual objects.

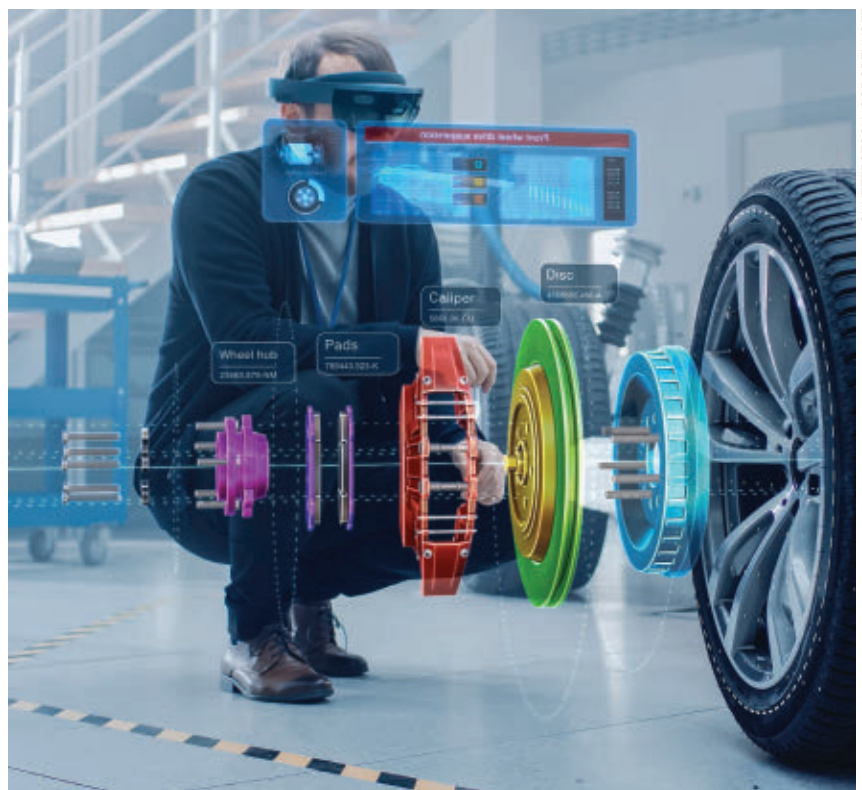
**Augmented reality (AR):** AR overlays virtual elements onto the real world, enhancing the user's perception of reality. It blends digital content with the real environment, allowing users to see and interact with virtual objects while still being aware of their physical surroundings. AR is typically experienced through a smartphone or tablet camera, smart glasses, or wear-

able technology. Popular examples of AR include "Pokémon Go," where virtual creatures are inserted into the real world, or furniture apps that let users visualize how different pieces would look in their own homes.

**Mixed reality (MR):** Mixed reality combines elements of both VR and AR, allowing users to interact with virtual objects that are seamlessly integrated into the real world. MR recognizes and responds to the user's environment in real-time, enabling virtual objects to interact with real-world surfaces and objects. This technology is often used in industrial design, architecture, and prototyping. Microsoft's HoloLens is one of the most notable examples of MR devices, as it overlays interactive holographic images onto the user's physical space.

As these technologies continue to evolve, their potential applications are expanding rapidly. Interactive training simulations to assist automotive technicians, VR, AR, and MR are transforming the way we perceive and interact with our environment. For simplicity, we will use VR as a generic term for AR and MR, as well as VR for the rest of this article.

**3 A TECHNICIAN** looking at a hub and brake exploded representation.



SHUTTERSTOCK-GORODENKOFF



## QUALITY, SELECTION, CONVENIENCE

From Headlights to HVAC to Electrical parts, TYC Americas has you covered. With a commitment to quality products and services, the assurance of a limited lifetime warranty, TYC Americas is the smart solution for premium replacement automotive parts.

### Your Partner in Mobility Solutions



**AUTOMOTIVE LIGHTS**



**MIRRORS**



**CONDENSERS**



**COOLING FAN ASSEMBLIES**



**CABIN AIR FILTERS**



**STARTERS**



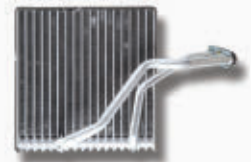
**ALTERNATORS**



**RADIATORS**



**BLOWER ASSEMBLIES**



**EVAPORATORS**



**WINDOW REGULATORS**



**FUEL PUMPS**



**HEATER CORES**



**TRANSMISSION OIL COOLERS**



**CHARGE AIR COOLERS**



## FIND YOUR ONE-STOP SHOP

For more information about TYC Americas replacement automotive parts, contact your local TYC Americas Account Executive or look up parts online at [www.tycamericas.com](http://www.tycamericas.com).



4  
SHUTTERSTOCK/SCHARFSINN

**VIRTUAL APPLICATION** for servicing a heavy-duty diesel tractor.

## Hardware requirements

Augmented reality (AR), virtual reality (VR), and mixed reality (MR) require different types of hardware to provide users with immersive experiences. Let's explore the hardware requirements for each of these technologies:

**Augmented reality (AR):** AR experiences can be accessed through various devices, depending on the level of immersion and interaction desired. Some common AR hardware includes:

**Smartphones and tablets:** Many AR applications are available for smartphones and tablets, leveraging their built-in cameras and sensors. These devices use AR software to overlay digital content onto the real-world view captured by the camera, providing users with an augmented experience.

**Smart glasses:** Dedicated AR glasses, such as Microsoft HoloLens, Magic Leap, or Google Glass Enterprise Edition, offer a hands-free AR experience. These glasses typically incorporate displays, sensors, and cameras that allow seam-

less integration of virtual objects into the user's field of view.

**Virtual reality (VR):** VR requires more specialized hardware to deliver fully immersive experiences. The main components for VR hardware include:

**Head-mounted display (HMD):** The HMD is worn on the head and typically consists of a high-resolution display for each eye, providing a stereoscopic 3D view. Examples of popular VR HMDs include Oculus Rift, HTC Vive, and Sony PlayStation VR. These devices block out the user's physical surroundings and present them with a virtual environment.

**Motion-tracking sensors:** To track the user's movements and provide a sense of presence, VR systems often include sensors. These sensors can be external (e.g., mounted on walls or placed around the room) or built into the HMD. They track the user's head, body, and sometimes hand movements to provide accurate and responsive interactions within the virtual environment.

**Mixed reality (MR):** Mixed reality combines elements of both AR and VR, requiring specific hardware capable of blending physical and virtual worlds. Some MR devices include:

**Headsets:** Mixed reality headsets, like Microsoft HoloLens or Magic Leap One, are designed to overlay interactive virtual objects onto the user's real-world view. These headsets incorporate cameras, sensors, and displays to enable users to see and interact with virtual objects that are seamlessly integrated into their surroundings.

**Handheld controllers:** MR often involves gesture-based interactions, requiring handheld controllers or input devices. These controllers allow users to interact with and manipulate virtual objects in the mixed reality environment, enhancing the level of immersion and providing more intuitive interactions.

It's important to note that the hardware requirements for AR, VR, and MR can vary depending on the specific application or platform. Advancements in technology continue to improve the capabilities and accessibility of these devices, making them more user-friendly and affordable over time.

## VR and the automotive technician

In an era where technological advancement is taking over various industries, virtual reality (VR) has emerged as a groundbreaking tool with the potential to transform the way we learn and work. While VR applications have already made headlines in gaming and entertainment, its potential impact is expanding to new realms. One such sector that stands to benefit greatly from VR is the field of auto repair, and there are signs that it can revolutionize the automotive repair profession.

**Enhanced training and education:** One of the key applications of VR in auto repair is in training and education. Traditionally, technicians have



# RAISING THE STANDARDS OF EXCELLENCE

**AP** SERIES™

*NEW 360-Degree Automatic Swing Arm Restraint System  
Provides the Ultimate In Safety and Vehicle Fall Protection*

**NEW  
ARRIVAL**  
SHOP NOW



Model: **10AP**  
10K lb. Capacity  
Two-Post Lift

LEARN MORE 



**Bi-Metric Swing Arms**



Certified to meet the  
standards of ANSI/ALI  
ALCTV: 2017

Our 10AP Series offers the convenience of wide or narrow installation wrapped up into one configurable package. This durable, safe, and reliable car lift features an expandable top beam and BI-METRIC™ arms to suit virtually every vehicle lifting requirement – symmetric or asymmetric. The 2-in-1 design gives operators the option of loading vehicles either symmetrically (centerline of vehicle at column) or asymmetrically (centerline of vehicle behind column). The simple, yet highly sophisticated is sure to keep operating costs low and productivity high. Check out the full line of 10AP lift series at [bendpak.com/10AP](https://bendpak.com/10AP) or call us at **1-800-253-2363**.

**1-800-253-2363 • BENDPAK.COM**

©2023 BendPak Inc. All rights reserved.

**BendPak**®



**AUGMENTED REALITY** being used as an overlay to a client's vehicle for diagnostics.

relied on hands-on experience and physical demonstrations for learning the intricacies of repairing vehicles. However, with VR technology, trainees can now immerse themselves in virtual environments that simulate real-life repair scenarios. This allows aspiring technicians to gain practical skills and experience without the need for expensive equipment or risking costly mistakes on actual vehicles.

**Simulation-based practice:** VR provides a safe and controlled environment for technicians to practice their skills before working on real vehicles. This reduces the risk of damaging customer vehicles and ensures that technicians are thoroughly trained and confident in their abilities. Whether it's disassembling an engine, diagnosing complex electrical issues, or performing routine maintenance tasks, VR simulations enable technicians to practice without any associated risks or monetary losses.

**Advanced diagnostics and troubleshooting:** VR can significantly improve the efficiency and accuracy of diagnostics and troubleshooting. With virtual reality, technicians can visualize complex vehicle systems in

three-dimensional space, allowing them to identify potential issues more effectively. VR-based diagnostic tools can provide real-time data, allowing technicians to monitor vital signs, simulate various scenarios, and access digital repair manuals right in front of their eyes. This integration of VR with automotive diagnostics will save time, streamline repairs, and increase customer satisfaction.

**Remote assistance and collaboration:** With VR, technicians can now receive remote assistance from experts across the globe. By wearing VR headsets, technicians can share their live view of a vehicle, enabling remote experts to guide them through complex repairs, offer advice, and even draw annotations in the technician's field of view. This collaborative approach saves time, reduces costly travel expenses, and enhances the overall quality of repairs.

**Engaging customer experience:** Finally, VR has the potential to elevate the customer experience in the automotive repair industry. Some auto shops are already utilizing VR to provide interactive and informative experiences for customers. Imagine

being able to virtually walk through the repair process, understanding the mechanical intricacies of your vehicle, and gaining insights into the necessary repairs. VR can bridge the gap between technicians and customers, fostering trust, understanding, and satisfaction.

### How To Get Started

Acquire the necessary equipment: To get started with VR and auto technician training, it is essential to have the right equipment. You will need a VR headset capable of rendering immersive visuals and providing motion tracking. There are various options available in the market, ranging from high-end devices like the Oculus Rift or HTC Vive to more affordable options like the Oculus Quest. Additionally, you will need a compatible computer system capable of running the VR software smoothly. Make sure to check the VR headset's requirements and ensure your computer meets or exceeds them for optimal performance. Having a dedicated training space with proper lighting and minimal distractions is also advisable.

**Choose a suitable VR training program:** Once you have set up your VR equipment, it is time to select a suitable VR training program. There are several options available that cater specifically to auto technician training. Research different programs and choose one that aligns with your learning objectives and preferences. There are quite a few independent options available, and more OEMs are developing or have developed VR systems for use by their dealerships and licensed repair facilities.

Consider factors like the program's content, level of interactivity, and availability of real-time feedback. The ideal VR training program should provide comprehensive modules covering various automotive systems and components, along with guided instructions and assessment tools.

# EVAP COOLERS & HUGE CEILING FANS COOLING SOLUTIONS THAT GO THE EXTRA MILE!

Summer Savings June 1 – September 30, 2023

**SUMMER  
SAVINGS**  
GOING ON NOW!

BendPak's Cool Boss Division Keeps  
Temperatures and Energy Costs Low

**THESE FANS ARE  
GINORMOUS**

AVAILABLE NOW AT

**AutoZone**

Contact Your Local AutoZone® Commercial Sales Rep!

AutoZone® offers industry-leading coverage and fast delivery on all Cool Boss evaporative coolers and HVLS fans.\*

Offer is good on purchases made through your AutoZone Commercial Managers between June 1 and September 30, 2023. \*Free shipping to direct shipping points within the 48 contiguous United States only. Customer is responsible for offloading equipment upon arrival. All rights reserved. ©2023 CoolBoss, LLC, a subsidiary of BendPak Inc. CoolBoss products are protected by one or more patents in the United States, China, Europe, and other countries. BendPak reserves the right to set, change, modify or discontinue any product, or MRP condition at any time, without notice and without liability. AutoZone, AutoZone & Design, are registered marks of AutoZone IP LLC.



SCAN TO LEARN MORE  
or visit [www.coolboss.com](http://www.coolboss.com)

**COOL BOSS™**

A Division of BendPak Inc.

**Start your VR training journey:**

With everything in place, it is time to dive into your VR training. Begin by familiarizing yourself with the interface and controls of the VR program. Take your time to explore the virtual environment and understand how different tools and car parts can be interacted with.

Follow the program's modules systematically, starting from the basics and gradually progressing to more advanced topics. Make sure to pay attention to details and practice tasks repeatedly to reinforce your learning. Additionally, don't hesitate to seek help or guidance from instructors or fellow trainees if you encounter any difficulties.

**Supplement with hands-on experience:** While VR training offers an excellent foundation, it is crucial to supplement it with real-world hands-on

experience. Joining an apprenticeship or finding a mentor who can provide practical guidance will allow you to apply the skills you have learned in the virtual environment to real vehicles. This practical experience will solidify your knowledge and help you become a competent auto technician.

**AN EXAMPLE OF** Mixed Reality (MR) glasses combining both the VR and AR environments.



6

SHUTTERSTOCK-ELLARIA

**Is VR the right choice for your training program?**

Virtual reality is redefining the boundaries of auto technicians, offering exciting possibilities that were once unimaginable. From immersive training experiences to advanced diagnostics and troubleshooting, VR

# Defining the standard.

Hunter equipment is trusted in thousands of facilities around the world.

Take advantage of the fastest and most accurate alignment systems in the business.



Scan or visit

[hunter.com/align](https://hunter.com/align)

**HUNTER**  
Engineering Company



**MADE IN USA**  
USING THE FINEST US & GLOBAL MATERIALS

**SEMA**  
SHOW  
2023

Visit us at the show!  
Booth #42017

SHUTTERSTOCK-ALEXEY BOLDIN



7

**VIRTUAL REALITY (VR)** headsets are popular with consumers for gaming but are becoming the choice of the automotive industry due to their ease of use and low cost.



**MICHEAL SMYTH** is a founding partner and director of training for AFV Educate, a not-for-profit 401(c)(3) training

organization specializing in alternative fuel curriculum development and educational presentation for first and second responders and automotive technicians. His previous positions included director of West Virginia University's National Alternative Fuels Training Consortium and director of training at Automotive Video Innovations. Smyth has over 12 years of experience working with and presenting information on AFVs.

is transforming the way technicians learn, work, and interact with customers. As technology continues to evolve, we can expect further advancements that will reshape the future of auto repairs. Embracing VR in the automotive industry will undoubtedly lead to improved efficiency, increased accuracy, and enhanced customer satisfaction.

While the potential of VR is exciting,

there are still challenges to overcome. The cost of entry into the VR world can be a barrier for many, as high-end VR systems require a significant investment. Additionally, issues related to motion sickness and discomfort are still being addressed, as some individuals may experience discomfort when using VR for extended periods. *TL*

**SCAN THE QR CODE TO READ THIS AND RELATED ARTICLES ONLINE**



POWERED BY

Get Fixes.  
Repair Tips.  
Share Reports.

Scan.  
Diagnose.  
Succeed.

**SDS** SMART DIAGNOSTIC SYSTEM

A new era of professional diagnostic solutions designed to help you accurately fix cars faster.



- Instant boot times = faster scanning
- OBD2 & OEM Diagnostics: Comprehensive full-system diagnosis
- OE-Level Functions: Services, Routines, Calibrations
- Full EV/HEV/PHEV Coverage
- RepairSolutionsPRO™: Take charge of scans and reporting with ease
- Plus, more features for advanced vehicle diagnostics



SCAN FOR MORE INFORMATION

**INNOVA.COM**

# DRAWING A BLANK

DIAGNOSES BASED ON CRITICAL THINKING PROVIDE AN INFALLIBLE SCIENTIFIC METHOD, AS SHOWN BY THIS 5V REFERENCE FAILURE.

BY RENE MEJIA // Contributing Editor



PHOTO: RENE MEJIA

I was called to a shop and faced a 2011 Honda Pilot boasting about 180,000 miles on the odometer. The customer complaint was no control over the HVAC temperature (In either the front or rear of the car). An accompanying complaint was the temperature displays being blank on both the front and rear HVAC units (**Figures 1+2**). Upon my arrival and before confirming the complaint, the shop informed me they replaced the front and rear HVAC control units with used units, to no avail.

## First impressions

Upon entering the vehicle to confirm the complaint, I saw it was dismantled, yet all of the components were still plugged in (**Figure 3**). When computers have been replaced and the same concern is still present, I like to reinstall the originals if it's not too time consuming. My main focus is speed and accuracy with every single movement and second of thought I put into diagnosis. Time is money! So when it comes to used, remanufactured, repaired, or even new modules, we have

all seen our fair share of lost time due to faulty units right out of the box. I recently diagnosed a Mercedes-Benz with a faulty ECM sourced from the dealer. After three visits to this car, I considered the possibility of the ECM being defective only by verifying the operation and integrity of literally every other related component. After replacing the ECM again, the vehicle was fixed. Anything (including my equipment) can be faulty and needs to be verified.



PHOTO: RENE MEJIA



PHOTO: RENE MEJIA

**VIEW OF THE FRONT HVAC MODULE** and controls during the initial fault (Temp displays are blank for driver and passenger front).

**VIEW OF THE REAR CLIMATE CONTROL PANEL** during the initial fault (Display is totally blank).

# WORK MEETS COMFORT



## ROLLING CREEPER SEAT CONVERTS FROM HIGH TO LOW

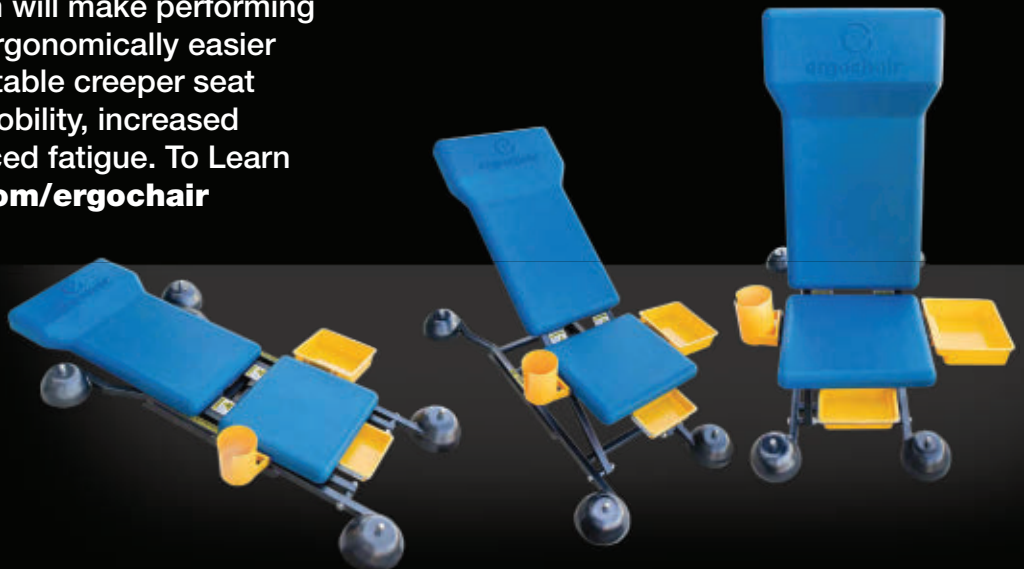
The **ergochair™** is the adjustable height rolling work seat which will make performing awkward work tasks ergonomically easier and safer. This comfortable creeper seat offers a full range of mobility, increased productivity, and reduced fatigue. To Learn more visit [bendpak.com/ergochair](https://bendpak.com/ergochair)

UP TO **5** LOCKING HEIGHTS



TRANSFORMS COMFORTABLY FROM CREEPER TO UPRIGHT SEAT

LEARN MORE 



1-800-253-2363 • [BENDPAK.COM](https://BENDPAK.COM)

©2023 BendPak Inc. All rights reserved.

 **ergochair™**



PHOTO: RENE MEJIA

**3** **VIEW OF THE INSIDE** of the subject vehicle upon my arrival.

fault codes in this article, I figured it would be better to take the time to expand on my process at this point. The 55 stored fault codes in the first scan showed a nice buffet of faults that could have easily caused me to fall down a rabbit hole, including but not limited to a DTC pertaining to no communication with the HVAC module. As I mentioned earlier, if time and accuracy are important, so is **KEEPING IT SIMPLE** and following the scientific method without fail.

I try to shy away from starting out by clearing faults, as it could definitely affect diagnosis. But it must be looked at in a case-by-case basis. Thankfully, modern scan tools have the ability to capture and save the old faults, so I then decided to clear them and only found the reappearing fault for the rear air mix door motor control circuit.

**A fork in the road**

Is it possible the main complaint of no temperature control is associated with the fault I found? Or could there be an additional problem with the vehicle? This is where the analysis of data becomes paramount. The scientific method tells us that we must look at the data before drawing a conclusion. I must say in all honesty that following this process is not something I was able to do overnight, nor did I stay with it consistently in the beginning of getting into diagnostics.

Yet after time, trial and error, and, as a great man once said, “not giving up,” I have been able to use this very method all day and every day. And not only does it feed my family, I get to live out a once distant dream of doing mobile diagnostics.

Direction? Well the problem has directly affected the module and its ability to function, and the fault code is reported by the same module. If the module is functioning properly, the 5V reference circuit to the door motor po-

**Starting with a clean slate**

So, after reinstalling the original HVAC control units and confirming the complaint I performed a vehicle system scan of all the modules and found fault codes stored in five modules (**Figure 4**). After saving the scan PDF to my

scan tool, I cleared all faults out of all the modules. Then a second system scan (after a key cycle) yielded me a total of 55 codes (**Figure 5**). Both scan reports had one DTC in common in multiple modules (**Figure 6**).

Rather than including a list of 55

8. Multiplex Integrated Control Unit	1	Fault
9. Hands Free Link	1	Fault
10. Power Tailgate	1	Fault
11. Power Seat/Power Mirror	1	Fault
12. HVAC/Climate Control	1	Fault

8. Multiplex Integrated Control Unit	11	Fault
9. Hands Free Link	11	Fault
10. Power Tailgate	11	Fault
11. Power Seat/Power Mirror	11	Fault
12. HVAC/Climate Control	11	Fault

**4** **A CONDENSED VIEW** of the initial system's fault scan that shows only the modules with the fault code that piqued my interest.

**5** **AFTER CLEARING THE FAULTS** and performing a key cycle (same condensed view as Fig #4).

1. Multiplex Integrated Control Unit (1 DTC)		
Codes	Description	Status
B1244	An open in the rear air mix control motor circuit	Permanent DTC

2. Hands Free Link (1 DTC)		
Codes	Description	Status
B1244	An open in the rear air mix control motor circuit	Permanent DTC

3. Power Tailgate (1 DTC)		
Codes	Description	Status
B1244	An open in the rear air mix control motor circuit	Permanent DTC

4. Power Seat/Power Mirror (1 DTC)		
Codes	Description	Status
B1244	An open in the rear air mix control motor circuit	Permanent DTC

5. HVAC/Climate Control (1 DTC)		
Codes	Description	Status
B1244	An open in the rear air mix control motor circuit	Permanent DTC

**6** **CONDENSED VEHICLE SYSTEM SCAN** showing the same fault being reported by five modules.

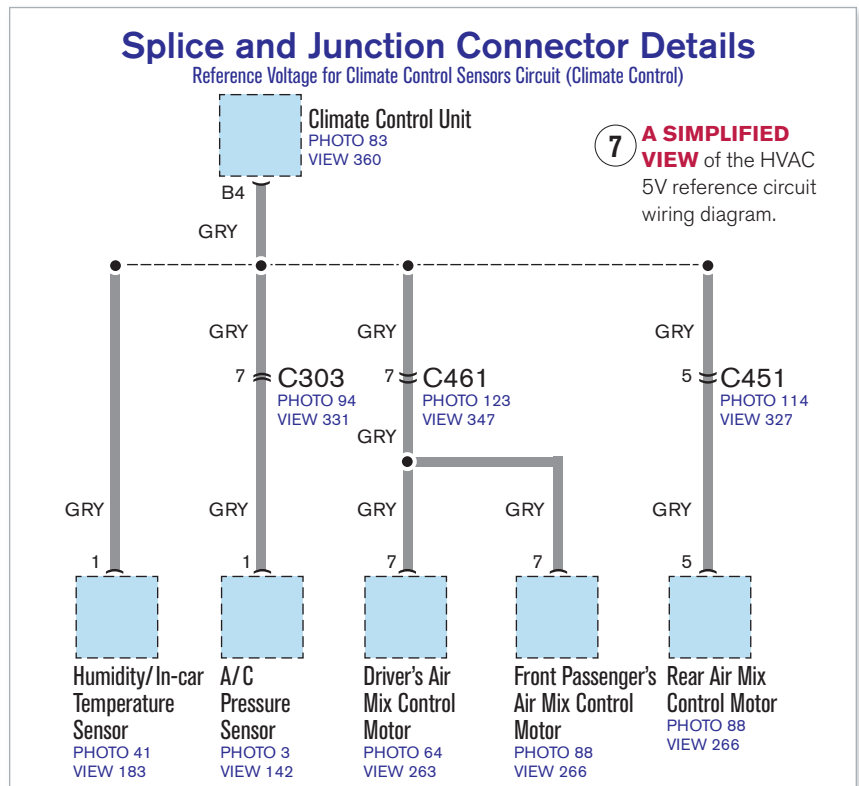


sition sensors should be present and accounted for.

This is also a great technique for driveability diagnostics (As if there is a no-communication concern with a PCM, for example). It will help you determine that unit or module is alive and working properly. If the reference circuit is shorted versus not present, it can help tell you if you need to check for an input problem or an output problem.

So before going crazy with checking voltage and ground supply, etc., my next test was on the 5V reference circuit in the HVAC control unit, knowing that it will tell me a lot about a module and it's inputs and outputs.

After viewing the wiring diagram for the 5V reference circuit, I was then able to see which components it supplied, including the rear air mix door (**Figure 7**). I connected my scope ground to the battery negative terminal and



# Your engines deserve nothing less.

## Dayco® Direct-Fit OE Replacement Timing Chain Kits

- Available for early and late model pushrod engines and all late model OHC engines
- Everything you need in one part number
- OE quality chains prevent stretch for the life of the kit
- 2-year/60,000-mile parts & labor warranty





Learn more here!



@dayconorthamerica | na.daycoaftermarket.com





MOVE FORWARD. ALWAYS.™

tested the connection by going to battery positive terminal with the other test lead (As I stated before, I suspect everything to be a potential problem). I have had to repeat quite a number of tests in the past because my equipment was not properly grounded.

After proving the scope's functionality, I then connected my scope up to the gray wire at cavity B4 of the HVAC module (**Figure 8**). Right away, I noticed a problem, as the reference circuit was down to 0V (**Figure 9**). My next thought was... is this 5V reference circuit shorted to ground, or is it open/no output from the HVAC module?

Now, I could be thinking at this point that the 5V reference circuit is simply open/no output from the HVAC module. I knew the actuator is where I was headed. Why? If the reference circuit were open, we would certainly

have a multitude of open circuit/circuit low faults. The wiring diagram showed that the reference voltage supplied a few players in the HVAC system. It has been my experience that in some — but not all — cases where there is a shorted reference, it will most definitely affect the module emitting it, especially with its DTC logic. And in others, as I mentioned earlier, it is common for a shorted reference to put a Chrysler PCM to sleep and not allow communication (among others). At this point, I truly couldn't tell if the circuit was shorted or open. However, there is a very easy and logical way to tell.

So, I figured the rear air mix door actuator position sensor (internal to the actuator assembly) would be the likeliest suspect for this problem (**Figure 10**). After unplugging the actuator, the 5V reference returned and the HVAC

temperature displays came back to life (**Figures 11, 12 + 13**). Also, the temperature settings are now controllable from the front and rear HVAC displays.

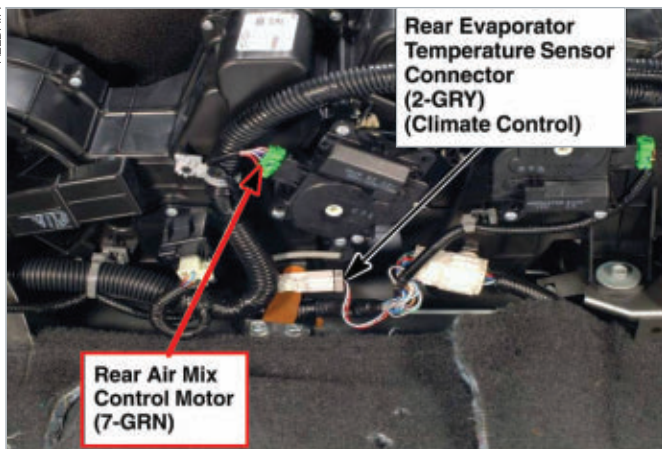
I cannot stress enough how important it is for me to follow a laid out process for my diagnosis. As it is very easy to become frustrated and confused with troubleshooting. Especially in a case as this one where a multitude of possible faults can be the culprit of the same symptom. A faulty HVAC control unit? A faulty front display, or temperature sensor? Perhaps even a faulty BCM? These are components that come to mind when I think about this case without the use of the scientific method.

I have spent a lot of time in years past "lost in the weeds" due to the shotgun approach of troubleshooting. Especially when we have been servicing



PHOTO: RENE MEJIA  
ALL DATA

**CHANNEL 1 OF MY SCOPE** connected to the gray 5V reference wire at the HVAC control unit.



**10 COMPONENT LOCATION VIEW**, left side of the center console.

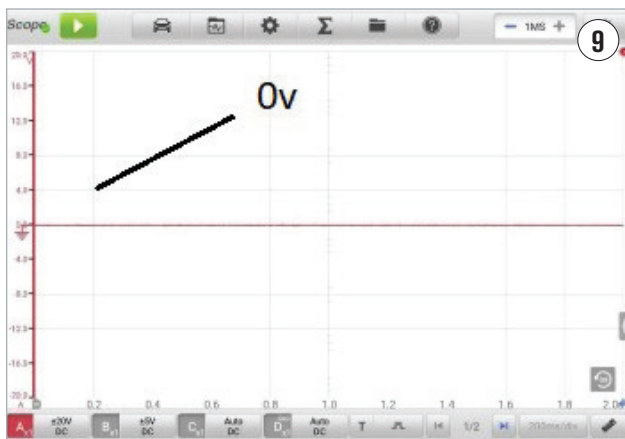


PHOTO: RENE MEJIA

**MY FIRST SCOPE CAPTURE** of the 5V reference measurement, which displays 0V.

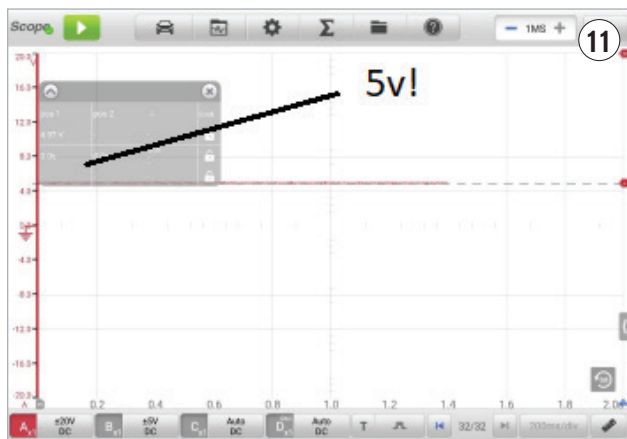


PHOTO: RENE MEJIA

**AFTER DISCONNECTING** the rear air mix motor, the 5V reference voltage returned.



PHOTO: REINE MEIJA

**VIEW OF FRONT HVAC MODULE** and controls with 5V reference restored (temp displays are now active for driver and passenger front).



PHOTO: REINE MEIJA

**VIEW OF REAR CLIMATE CONTROL** with 5V reference restored (display is active).

cars long enough that we can see common problems, we may say to ourselves “that sounds like its the...” Many of us (including myself) have gotten along by firing the parts cannon.

What about the times when the problem is not the usual suspect? My

experience, more often than not, hasn't been the usual suspect. One thing I can say for sure is that it was the frustration that made me get further into honing my skills as a diagnostician. The solution for me has been the use of this scientific method. There is no pro-

cess on Earth like this one. It is something that is learned by all parts of the mind and body.

Diagnosis begins with the aquistation of data and using that data to ask a question. And that data and those questions are different for each problem I

*Where Quality Meets Knowledge*



# QUALITY-BUILT™

**STARTERS & ALTERNATORS**

powered by: **mpa**



Unlock the potential of your repairs with our Quality-Built Starters and Alternators. Embrace the **Part Smart Knowledge Library** to stay ahead in the ever-evolving automotive world.

**Learn More Here!**





PHOTO: RENE MEJIA

**“COLLECT DATA,’ ‘ASK THE RIGHT QUESTIONS,’ ‘TRUST YOUR EQUIPMENT,’ ‘REMAIN TEACHABLE,’ AND ‘LOVE WHAT YOU DO’ ARE MY LIFE MOTTOS.”**

However this car was a “hard” fault. And like a game of wack-a-mole, the rear actuator was sticking its head up. It was a quick, simple diagnosis thanks to the process I mentioned. The faults stored in memory led me to the cause of the problem, yet I’ve seen cases where fault codes do not lead you to the problem.

**My secret to success**

The process ALWAYS stays the same, even though the problems change. The HVAC displays may have been drawing a blank, but that didn’t mean I had to. ‘Collect data,’ ‘ask the right questions,’ ‘trust your equipment,’ ‘remain teachable,’ and ‘love what you do’ are my life mottos. Thank you for reading. *TM*



**RENE MEJIA** began his journey working on cars at the age of 15. He attended and graduated from the automotive program at Morris County School of Technology in Denville, NJ. He continued working as a mechanic until 2011 when he began operating a busy repair garage in Hackensack, NJ.

In December of 2022, Rene established “Final Stop Mobile Auto Tech, LLC,” beginning the next chapter in life. His motivation to help others in his pursuit of his dream, of conducting mobile automotive diagnostics.

face. In this instance, What can cause the temperature displays to be blank? A list of things comes to mind, but while asking that question and looking at the data my equipment is giving me, I start to get answers.

A list of potential answers to that question come at this juncture. Most of them come from simply sitting in the driver’s seat right from my scan tool. But we have to ask the right questions to follow the first. Is this problem constant? If so, then what are the faults stored in memory? Again, we had a multitude of faults stored in various modules. Clearing them and rescanning the car showed one clear fault.

Let’s say if this problem was not consistent and we cleared the faults and none came back (which happens quite often). We would be most likely stopping and attempting to get the fault to return crossing our fingers it did. It would be at that point, I would have to leave and return when the problem is consistent.

In the past, I have lost time chasing an intermittent fault (that was not present at the time), only to find I was better off walking away. If I cannot locate the issue in a timely manner, I am doing a disservice to the shop and customer. I have learned to return to the car when the concern is there.

**SCAN THE QR CODE TO READ THIS AND RELATED ARTICLES ONLINE**

# HITTING THE BULL'S-EYE REPEATEDLY

SO OFTEN, I HEAR THE CHANTS OF MANY A TECHNICIAN SAYING, "IGNITION ANALYSIS IS DEAD." ON THE CONTRARY, I FIND IT TO BE DEAD-ON!

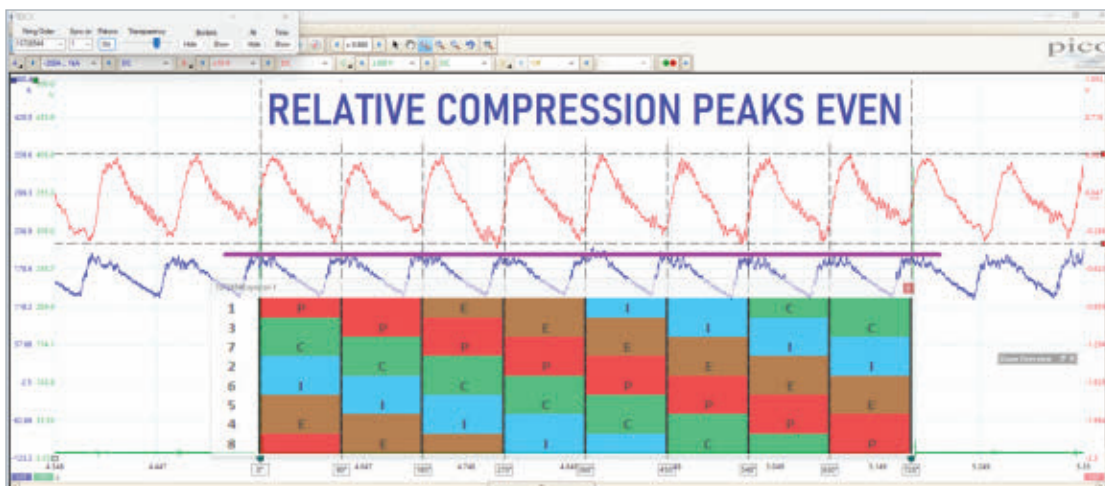
BY BRANDON STECKLER // Technical Editor

**M**y good friend Rick was faced with a challenging 2017 5.4L Ford F-150. The truck exhibited a single-cylinder misfire that only reared its ugly head at throttle tip-in during the 1-2 gear shift. It never oc-

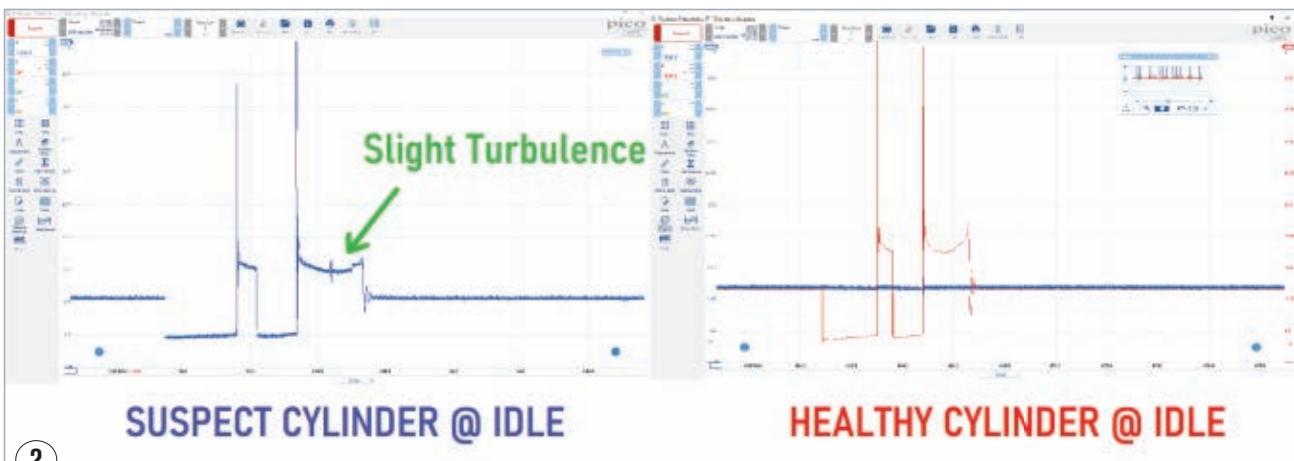
curred under heavy load. Through experimentation, Rick could replicate the symptom in the work bay. In "park" and at 1,700 RPM, he could occasionally reproduce the misfire, giving him the opportunity to view some basic scan tool data. The data showed the misfiring cylinder to be cylinder No. 1.



WELCOME BACK TO ANOTHER EDITION OF "THE DATA DOESN'T LIE," A REGULAR FEATURE IN WHICH I POSE A PUZZLING CASE STUDY, FOLLOWED BY THE ANSWERS TO THE PREVIOUS ISSUE'S PUZZLE.



**1**  
**THE BLUE RELATIVE COMPRESSION TRACE** represents almost no variation in starter load, meaning almost no difference in compression from cylinder to cylinder.



**2**

**SECONDARY IGNITION WAS CAPTURED** at idle speed from both a known-good cylinder and that of the suspect cylinder, although the misfire symptom is not present at this time, slight turbulence can still be seen in the blue ignition trace of the suspect cylinder.

**Preliminary data**

A fan of an easy and fast approach (considering the elusive fault) Rick thought it was best to swap both the fuel injector and ignition coil for cylinder No. 1 with those of a non-suspected cylinder. Reanalyzing the scan data after the swap of each component individually revealed the misfire remained with cylinder No. 1. This led Rick to go with his gut feeling about the fault being a mechanical one.

Using his **Pico scope and amp probe**, Rick proceeded with a relative compression test, on Channel A (shown as the blue trace in Figure 1). The result of the test didn't readily display an obvious mechanical fault re-

lating to a compression loss for cylinder No. 1, or any cylinder for that matter. This was the point where Rick reached out for my input.

After hearing what experiments had already been performed, I had a few important questions for Rick, as I was on the road and couldn't perform my own research at the time. The first piece of data I requested was the underhood Vehicle Emission Control Information (VECI) label. The information on this label let me know if the engine had an EGR valve and what type of heated exhaust gas oxygen sensors (HEGOs) were utilized. Considering the fault was present at 1,700 RPM, I suspected a density misfire in which the introduc-

tion of EGR may disrupt the combustion process.

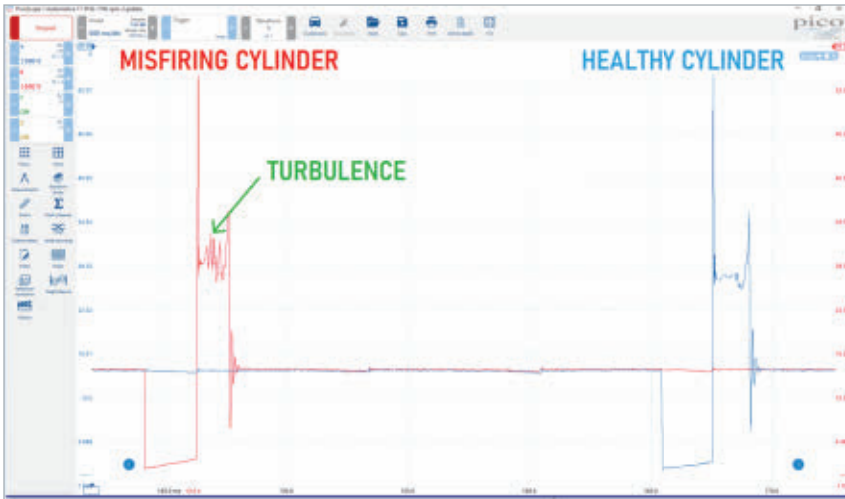
**Just the facts, please**

Because this vehicle does not rely on an EGR valve, it uses valve overlap to accomplish the same goal. It achieves this with variable valve timing (VVT). I asked John to view the desired and actual camshaft position PIDs, because I was interested in any error that may have been occurring. The results showed the desired and actual camshaft positions to match, indicating no existing VVT faults. I then asked John for the total fuel trim for each bank at the time of the misfire.

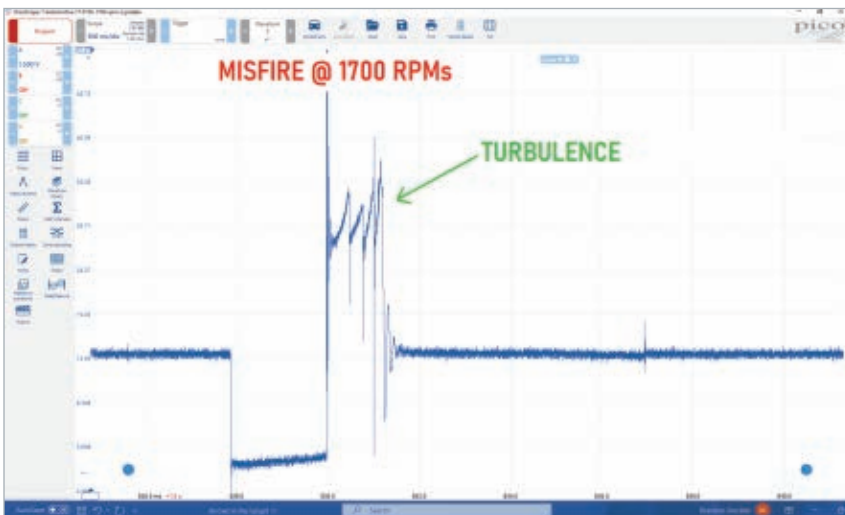
**Bank 1**= -13 percent

**Bank 2**= -7 percent

Although the two values deviated from each other a bit, this finding didn't



**3** **UNDER ELEVATED RPM**, the turbulence is exhibited, and a slight misfire occurs at a correlating time. The turbulence represents a variation in conductivity within the cylinder and can be caused by even a minor compression leak.



**4** **A ZOOM OF** the same turbulence.

offer a “home run.” But the fuel trim values do offer a clue that we were not dealing with a fuel- or ignition-based misfire, leading us closer to a cylinder #1 mechanical fault.

The next logical test I suggested, due to the ease of access, was an analysis of an ignition capture at idle. Although the fault wasn’t present at idle, the ignition waveform reports the conditions within the combustion chamber at the time of spark discharge. If there was any type of cylinder leakage, we would surely see it here.

The results of the test were evident. The variation in conductivity within the combustion chamber was present. The horizontal line, known as the burn line, should be relatively flat at idle, representing little variation in conductivity. That indicates a dense air/fuel charge and a cylinder that can harness its contents properly. The one obtained from cylinder 1 (misfiring cylinder) was not flat (**Figure 2**). Keep in mind, the capture was taken without a misfire occurring, which worsened under elevated rpm (**Figure 3+4**).

**POWER PROBE®**



## Power Probe’s PWM Adaptor

Used with any Power Probe to send a PWM signal to automotive components!



**CATEGORY:**  
*Diagnostic Equipment*

[www.powerprobe.com](http://www.powerprobe.com)

**The data doesn't lie**


With all the information in front of us, we are faced with deciding how to proceed. Here are some bullet points of what we know to be factual, and I will ask all of you, diligent readers, for your input:

- Vehicle misfires only under light load conditions
- Relative compression testing reveals no significant loss from the misfiring cylinder
- Fuel trim doesn't indicate a bank-to-bank trim issue for a single-cylinder misfire

- Ignition analysis for the suspect cylinder reveals a variation in conductivity

**Given this information, what would you do next?**

- Replace spark plug for cylinder No. 1
- Perform induction cleaning service
- Clean VVT oil control valve No. 1
- Perform cranking pressure waveform analysis on intake and/or exhaust system

**Be sure to read next month's Motor Age issue for the answer to this month's challenge and what was discovered!** 



**BRANDON STECKLER**

is the technical editor of *Motor Age* magazine. He holds multiple ASE certifications. He is an active

instructor and provides telephone and live technical support, as well as private training, for technicians all across the world.

**SCAN THE QR CODE TO READ THIS AND RELATED ARTICLES ONLINE**



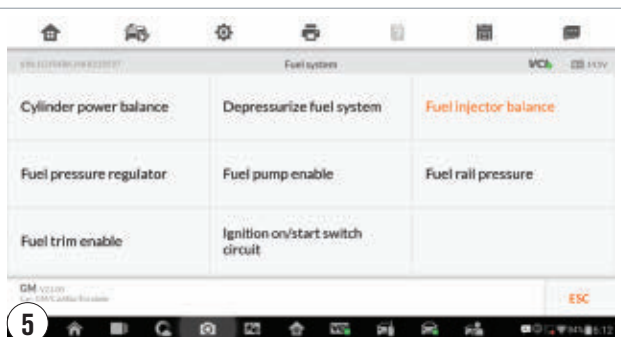
**SOLVED: (July 2023 Motor Age) 2019 Honda Fit, P0172 - rich condition**

**What would you recommend doing next, given the data bullet points in last month's challenge?**

- 1) Replace skewed primary WRAF sensor
- 2) Perform available direct injector automated scan tool test
- 3) Replace all four direct injectors
- 4) Replace skewed-high fuel rail pressure sensor

For those of you who chose answer #2, congratulations! (Figure 5). Although the replacement of the direct fuel injectors was required (due to imbalanced fuel delivery), replacing the injectors without first testing them may have been proven to be a costly mistake. Like any electrical device, the direct injectors require healthy circuitry and injector-driver control to deliver fuel appropriately. So, choosing answer #3 is not the most appropriate answer.

Answer #1 is incorrect. Although a skewed primary WRAF sensor could indeed shift fuel trim negatively, the rear HO2S was similarly reporting a rich condition, indicating that the primary



**THE INJECTOR BALANCE TEST** is a great way to discover injector spray issues with little effort, right from the driver's seat.

sensor was likely reporting correctly.

Answer #4 is incorrect. If the fuel rail pressure sensor were skewed high, less actual pressure would be created and the direct injectors would underdeliver fuel. This would result in a lean condition and elevated fuel trims and possibly even a lean DTC. The most appropriate answer is answer #2.

**APG // AUTOMOTIVE PRODUCT GUIDE**



**GENERATES THREE TYPES OF REPORTS**

The RepairSolutionsPRO from Innova Electronics is an app that can be downloaded for the SDS43 and SDS50 tablets in order to access all possible features and functions, including the most comprehensive automotive repair databases with verified fixes, repair tips, TSBs, parts/tools, schedule maintenance, and predictive repairs from ASE Certified master technicians. In addition, the app enables the user to generate three different

types of reports, including a diagnostic report focused on helping technicians solve problems, a collision industry report, and a service writer/service manager customer facing report to ease communications with the customer, upsell maintenance, obtain authorization, and provide collision shops with pre- and post-scan capabilities.

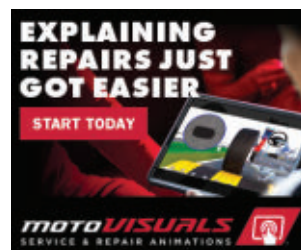
[VEHICLESERVICEPROS.COM/53066968](http://VEHICLESERVICEPROS.COM/53066968)

**BOOST YOUR SHOP'S CLOSE RATE**

Today's demanding customers require clear and concise information before spending money on their vehicle services and repairs. MotoVisuals allows you to easily explain services to increase customer confidence and your shop's close rate.

Access more than 400 service and repair animations that show how each part of the car works and what can happen when that part fails. Share animations in-person, online, by email, or text. You'll talk less and sell more with MotoVisuals.

[VEHICLESERVICEPROS.COM/53069169](http://VEHICLESERVICEPROS.COM/53069169)



SPONSORED



## UPGRADE YOUR SHOP, UPGRADE YOUR AIR

DanAmAir is a fast, flexible, and easy-to-modify aluminum pipe system for compressed air in any shop or garage with optimum flow rate performance. The Press-to-Connect fittings feature a full-bore design for turbulence-free air delivery. This quick, instant connection eliminates the need to thread, solder or glue, for far less installation times than traditional copper or black pipe and allows you to do-it-yourself.

[VEHICLESERVICEPROS.COM/21256438](http://VEHICLESERVICEPROS.COM/21256438)

SPONSORED



## CAN BE USED WITH AC AND DC CURRENTS

HinderRUST Electrical Corrosion Protection is engineered by Fluoramics to prevent corrosion and oxidization on electrical terminals and hardware. It has a high dielectric constant and can be used with AC and DC currents. Designed to spread and soak into hard-to-reach areas, its

penetrating protection fights oxidization on copper, aluminum, brass, and steel, and will not attack plastics. It's a rust-stopper that is moisture-displacing, solvent-free, and

non-flammable (liquid). It is not electrically conductive and may be applied on both new installations and on existing rust without any prep. Available in an 8 fl. oz. refillable Brush-It Bottle, 11.7 fl. oz. aerosol spray can, 1 qt jug, and 1 gallon jug.

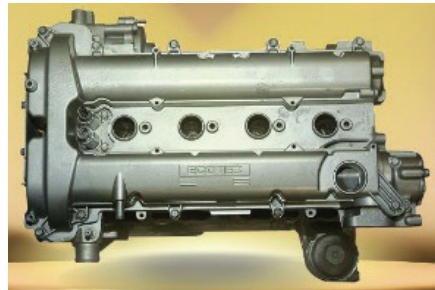
[VEHICLESERVICEPROS.COM/53068436](http://VEHICLESERVICEPROS.COM/53068436)



## AVAILABLE IN TWO CONFIGURATIONS

The Autel ADAS Bay Max Lift is a flush-mount hydraulic scissor lift designed to enable mechanical repairs, wheel alignments, and ADAS calibrations to be done within a single bay space. Compatible with passenger cars and light trucks, the lift is available in 12,000 and 14,000-lb capacity versions, both with front and rear opening runways, flip-down wheel stops, and low-angle approach ramps for easier access. The lifts are ALL certified and feature stainless steel front radius plates, and rear slip plates with turn plate pocket protectors for paint protection. Lifts come standard with built-in runway air tire inflation kits at each wheel and shatterproof 24" LED kit with automatic shut off.

[VEHICLESERVICEPROS.COM/53064558](http://VEHICLESERVICEPROS.COM/53064558)



## AVAILABILITY FOR 13.2 MILLION VIO

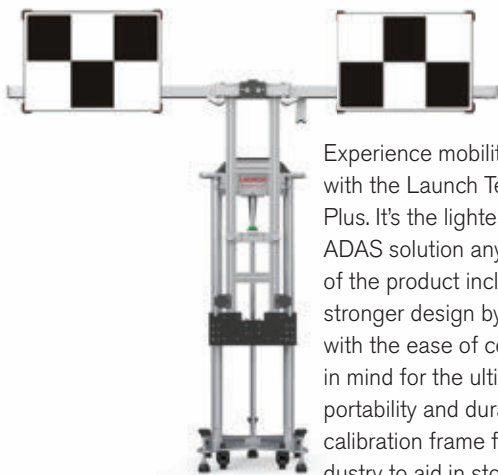
We're not shy about our extensive offerings of remanufactured transmissions. Now it's time for our engines to share some of that spotlight! ETE REMAN offers 53 engine part numbers with approximately 13.2 million VIO, making sure we are there when you need us.

Not only have we continuously added more remanufactured engines, we make sure quality is still No.1.

- Designed to deliver optimal performance and reliability
- High-quality components used during remanufacturing to enhance engine efficiency and power
- All units disassembled, cleaned, inspected, and machined
- Shipped in a reusable container for core return and Mahle gasket kit included for installation
- And more!

[VEHICLESERVICEPROS.COM/53068543](http://VEHICLESERVICEPROS.COM/53068543)

SPONSORED



## LIGHTWEIGHT, PORTABLE ADAS SOLUTION

Experience mobility and efficiency with the Launch Tech ADAS Mobile Plus. It's the lightest, most portable ADAS solution anywhere. Key features of the product include a lighter yet stronger design by nearly 50 percent with the ease of constant transport in mind for the ultimate solution in portability and durability, the smallest calibration frame footprint in the industry to aid in storage and transport,

leveling adjusters independent from the caster wheels to reduce accidental shifting after placement, and fast setup. Travel-friendly protective case included.

[VEHICLESERVICEPROS.COM/53061414](http://VEHICLESERVICEPROS.COM/53061414)



## PREMIUM STRUT ASSEMBLIES CAN SAVE YOU TIME

- Pro-STRUT™ strut assemblies are designed with the professional service provider in mind. A completely loaded, direct-fit strut design allows for quick installation, saving you time and resources. Bolt-on technology allows installation without specialized tools.
- Pro-STRUT provides excellent coverage and premium quality for your customers' vehicles. Coverage includes popular Asian, European and domestic light vehicle applications.
- Pro-STRUT strut assemblies are engineered for driving response and consistent control. They are built for operation in a wide range of temperatures and to withstand harsh road conditions. Pro-STRUT strut assemblies are backed by a limited lifetime warranty. Distributed exclusively by Autopart International and Worldpac.

[VEHICLESERVICEPROS.COM/53067836](http://VEHICLESERVICEPROS.COM/53067836)

SPONSORED



## FULLY FOLDABLE TO SAVE ON SPACE

The TOPDON Phoenix ADAS Mobile is designed to make one-stop ADAS calibration service ideal for repair businesses, glass repair shops, and mobile calibration use. The foldable ADAS calibration frame is space-saving to minimize setup time, easily assembled to speed up setup procedure and calibrate in various locations indoors. The ADAS calibration package supports LDW, RCW, AVM, NV, BSD, and ACC safety systems and includes the TOPDON Phoenix tablet for a wide range of OE-level vehicle coverage. The foldable calibration arms and base collapse for easy storage. Sturdy construction provides quick setup and reliable calibration accuracy. Included targets and patterns attach securely to the frame.

[VEHICLESERVICEPROS.COM/21225700](http://VEHICLESERVICEPROS.COM/21225700)



## FEATURES A 12" TOUCHSCREEN

The Thinkcar Platinum S12 includes features such as dynamic ADAS calibration, multimeter, oscilloscope, TPMS communication, 12" touchscreen, and guided diagnostic processes for select vehicles at no extra charge. The Android-based scan tool is also compatible with Thinkcar static calibration systems and includes step-by-step instructions with illustrations. It supports CAN FD and offers 34 maintenance functions, auto VIN scan, topology mapping, and bidirectional communication. Includes THINKDIAG 3 VCI and two years of software updates.

[VEHICLESERVICEPROS.COM/53042719](http://VEHICLESERVICEPROS.COM/53042719)

## INCLUDES AIR-HAMMER-POWERED PUNCH ROD

The PowerPull Fuel Injector Puller Kit from ProMAXX Tool by Milton features two versions, a Base Kit and ProKit Plus version. Both include an air-hammer-powered punch rod to pop injectors free. They also feature a 6" slide hammer that produces power by attaching directly to the fuel line port, and an 8mm dimple in the lift kit fork to accommodate an included air-hammered-powered punch.

The punch concentrates the force and vibration of the air hammer to vibrate and shock the fuel injector out.

[VEHICLESERVICEPROS.COM/53068889](http://VEHICLESERVICEPROS.COM/53068889)



## IDEAL FOR TIRE SHOPS

The BendPak 12AP-SRT 12AP-SRT Short-Column Two-Post Tire Shop Lift cost-effectively improves tire shop productivity and efficiency while mitigating risk. With 12,000 lbs rated capacity,

massive wingspan that reaches most OEM lifting points, and the versatility of both symmetric and asymmetric lifting, the 12AP-SRT can raise 99 percent of cars, SUVs, and trucks to a comfortable working height much faster and easier than a set of jacks. Its single-point safety lock system, super-strong automatic arm restraints, and limited maximum lifting height of 47" deliver superior peace of mind. The short 93.5" columns offer lower product, installation, and maintenance costs, plus a cleaner floorplan.

[VEHICLESERVICEPROS.COM/53068887](http://VEHICLESERVICEPROS.COM/53068887)





**SIMULATES OUTPUT SIGNAL FROM AUTOMOTIVE SENSORS**

The ANSED Diagnostic Solutions HU31035 Automotive Sensor Simulator is designed to simulate and actuate the output signal from automotive sensors such as frequency, voltage, and test sequences.

It's especially useful for wiring tests. It can simulate the signal and compare it to the scan tool reading. The Sensor Simulator allows users to eliminate the need to replace sensors that work. Users can simulate most sensors, injectors or actuators, including ABS, lambda, EGR, CKP, knock, and MAP sensors. Simulator functions include simulated resistance, voltage, sine wave, square wave, and simulated temperature coefficient sensors, throttle and pedal sensor sequences, as well as testing mode and simulated mode of oxygen sensors.

[VEHICLESERVICEPROS.COM/21211667](http://VEHICLESERVICEPROS.COM/21211667)

**INCLUDES NEW FEATURES AND IMPROVEMENTS**

The John Bean Tru-Point ADAS Calibration System Software Update 1.8.0 includes new procedures, features, and improvements. New features include initial remote scanner vendor integration, target subscription expiration message on the home page, activation on first boot and network connection, ability to send messages and promotions to the home page, add pointer target measurements to manual mode, and customer information is now available on the menu after selecting a vehicle.

[VEHICLESERVICEPROS.COM/53062435](http://VEHICLESERVICEPROS.COM/53062435)



**TURN YOUR TOOL IDEA INTO MONEY**

**LISLE CORPORATION CURRENTLY PAYS ROYALTIES TO OVER 100 INDIVIDUALS.**

Lisle has been in business for over 115 years and for over 50 years has been working with individuals on an award or royalty basis. If you have an original tool idea which others may need, we have a procedure to evaluate your idea.



Respond now to request an idea disclosure packet, or fill out a form online: [www.lislecorp.com/idea-program](http://www.lislecorp.com/idea-program)

P.O. Box 89 • Clarinda, IA 51632-0089  
712-542-5101 • Fax 712-542-6591

**HIT THE FAST LANE OF THE AUTOMOTIVE INDUSTRY**

For Web Exclusives and Advertising Opportunities

Go to our Website

[www.VehicleServicePros.com](http://www.VehicleServicePros.com)

**AD INDEX**

**AD INDEX**

ADVERTISER	PAGE #	ADVERTISER	PAGE #	ADVERTISER	PAGE #
AAPEX	51	HUNTER ENGINEERING	34	SATA / DANAM AIR	23
ADVANCE AUTO PARTS	2	INNOVA ELECTRONICS	35	SKF USA	9
AUTEL US	5	LAUNCH TECH (USA)	21	STELLANTIS	13
BENDPAK	31, 33, 37	LISLE CORPORATION	49	TEXA USA	11
DAYCO	39	MOTORCAR PARTS OF AMERICA	41	TYC	29
DNJ ENGINE COMPONENTS	17	POWER PROBE GROUP	45	WORLDPAK	52
FACTORY MOTOR PARTS	27	ROBERT BOSCH LLC	7	WRENCHERS	15



# THE TRAINER #140: CAPITALIZING ON DSO ZOOM CAPABILITIES FOR EFFICIENT DIAGNOSTICS

SELECTING THE APPROPRIATE TIME BASE FOR YOUR DSO'S CAPTURE IS ONE OF THE KEYS TO DIAGNOSTIC SUCCESS.

BY BRANDON STECKLER // Technical Editor

Ask any diagnostician, and they'll tell you that capturing the correct information for analysis is key to making sound diagnostic decisions. But viewing the data appropriately is what it takes to make those decisions efficiently and without oversight.

Just because the vehicle symptom is present when a capture was acquired, it doesn't necessarily mean the cause of the symptom will be visible when reviewing the acquisitions. Setting your scope up for success means proper data acquisition.

Today's episode will focus on the time base of the digital storage oscilloscope and the role it plays in capturing data appropriately for diagnostic decision-making. Using a multiple-channel scope allows for multiple signals to be acquired simultaneously, and that data should tell a story. However, just like a book, if you are too close or too far away, it becomes very difficult, if not impossible, to read that story.

The adjustable time base will allow for either a bird's-eye view or a zoomed-in view of the captured data. Both of these are necessary in the diagnostic process and will offer either a trend view to see repetitive patterns or a more detailed view to see the nature of



the fault occurring. This allows for that story to be told in a clear and concise manner. Stick with *Motor Age* magazine's Technical Editor Brandon Steck-

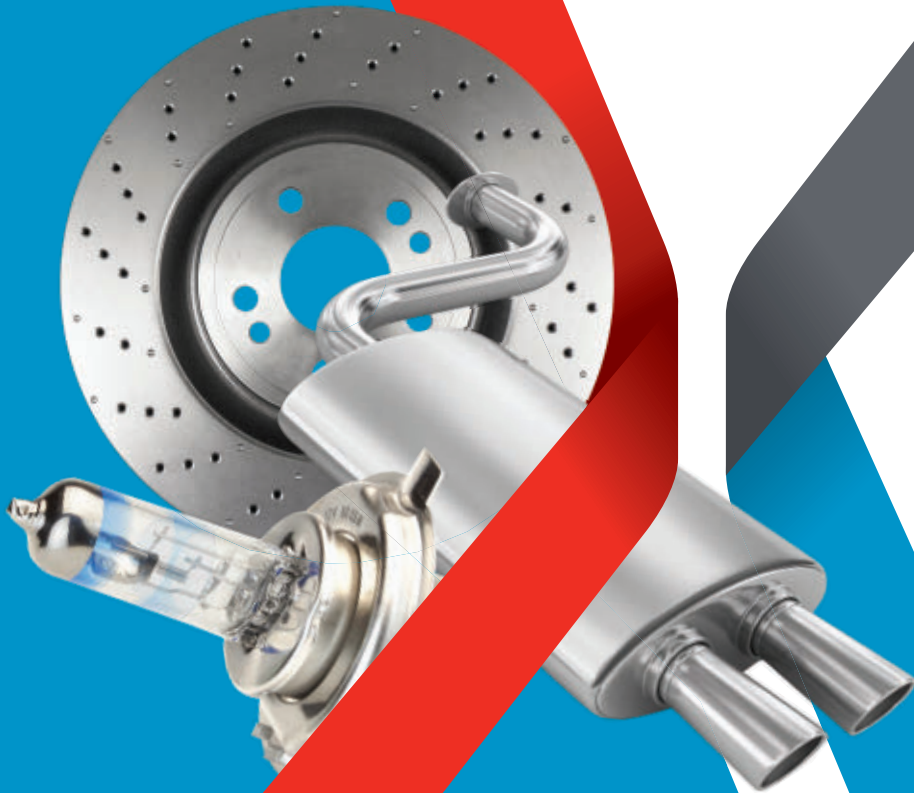
ler as he walks you through the scope time base, how to properly set it up for success, and see what today's episode of the Trainer is all about. **ZZ**

SPONSORED BY

# AUTEL®



SIGN UP FOR YOUR SUBSCRIPTION TODAY AT [CONNECT.MOTORAGETRaining.COM](https://connect.motoragetraining.com)



# WHERE SERVICE MEETS SUPPLY CHAIN

**OCTOBER 31–NOVEMBER 2**

**LAS VEGAS, NV | THE VENETIAN EXPO | #AAPEX23**

Nothing brings the automotive aftermarket community together like AAPEX. It's the only event where hands-on training meets expert-led business education. Where professionals and industry leaders from around the world gather to make connections, catch the latest demos, and find the perfect products. And it's where you belong. Secure your spot today.

**REGISTRATION IS NOW OPEN. | [AAPEXSHOW.COM](http://AAPEXSHOW.COM)**

**aaapex**  
*ahead of the curve*



# YOU'RE COVERED

Worldpac has the quality OEM brands you trust.



**WORLD PAC** 

[worldpac.com](http://worldpac.com) | [worldpac.ca](http://worldpac.ca)  
Access quality brands, technical training  
and business solutions all in one place.

