

An aerial view of a white car with concentric blue circles representing sensor waves emanating from it. The car is positioned in the lower-left quadrant of the frame. The background is a light blue gradient with a faint grid pattern.

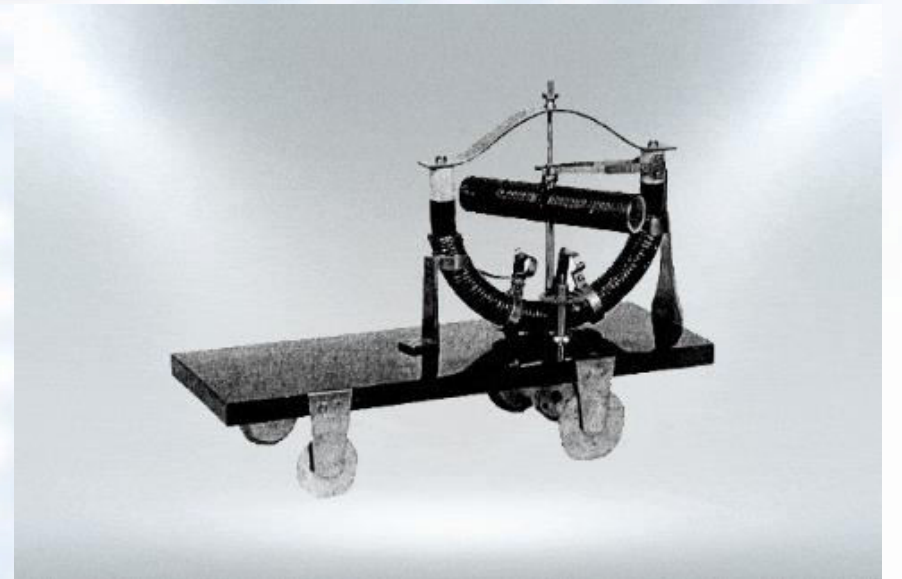
# Foundations for Autonomous Vehicles in Automotive Education

# My Background

- I have been in the automotive industry for over 35 years as a technician and educator
- Technician: Specialized on European cars at both the dealer and independent levels: Electrical, drivability and diagnostics
- Educator: High School Regional Occupational Program, Technical school, California Community College, and BMW Manufacture Training levels
- Certification & Education: ASE Master Technician with L1, California Bureau of Automotive Repair Certified Instructor and licensed Inspector and Repair Technician, B.S. from Florida Metropolitan University in Higher Education Management, A.A.S. Automotive Technology from Sequoia Institute, Diploma Wyoming Technical Institute, and manufacture training from multiple OEM's
- Curriculum: Development and implementation having completed curriculum work for multiple manufactures, State of California, regional grant projects, and various levels of educational programs
- Currently: Automotive / BMW faculty at Chabot College in Hayward, CA.

# Key Points for today's discussion

- Today's automotive education
- The "New" basics
- Autonomous Vehicles
- Advanced Drivers Assistance Systems (ADAS)
- Teaching ADAS
- Next Steps



# Current Automotive Education Foundations

- Technologies prior to year 2005
- Still applicable as core learning
- Easy to acquire vehicles, tools & equipment, faculty with experiential knowledge, industry related information
- Provides mostly non-electrical / electronics and is focused on individual systems based learning
- Brief introduction or awareness of vehicle technologies since 2005
- Hybrid and EV's have seen the most focus as "New Vehicle Technologies"

# The “New” Basics

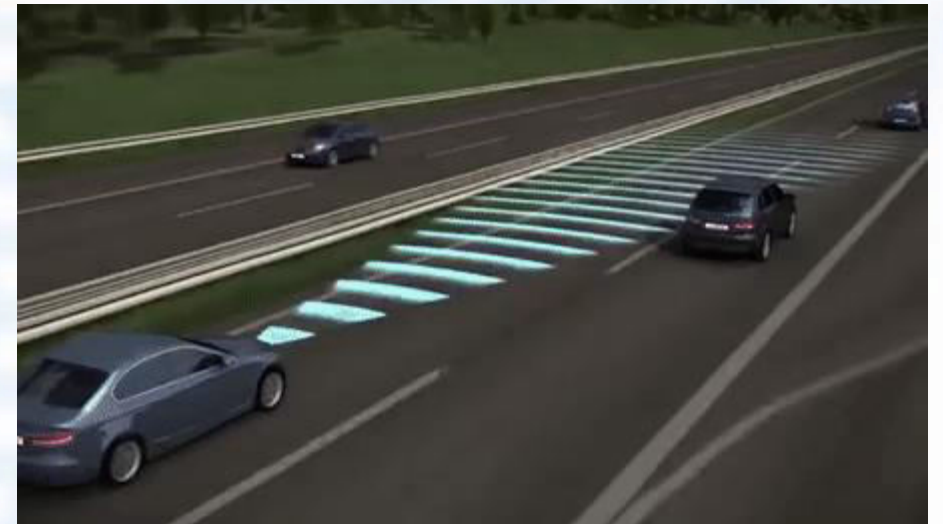
- Technologies since 2005 – More importantly, since 2010
- Applicable core learning (How much “rebuilding” is really necessary)
- More current MY vehicles, tools & equipment, faculty with current experiential knowledge, industry related information
- Increased focus on electrical / electronics and integrated systems based learning
- Brief introduction or awareness of vehicle technologies on current MY vehicles as applicable in “Core” subject

# What does the anticipated Autonomous Vehicle “*Revolution*” mean to automotive instruction?

- Decreases in the number of technicians due to lower vehicle sales and reduced vehicle service needs
- The need for technicians to have increased knowledge and experience on: EV’s, electrical, electronics, and integrated vehicle systems
- Cost increases to provide necessary instructional materials and qualified faculty
- Needed changes in education to recognize the complexity of vehicle systems and the type of students needed to enter into these careers

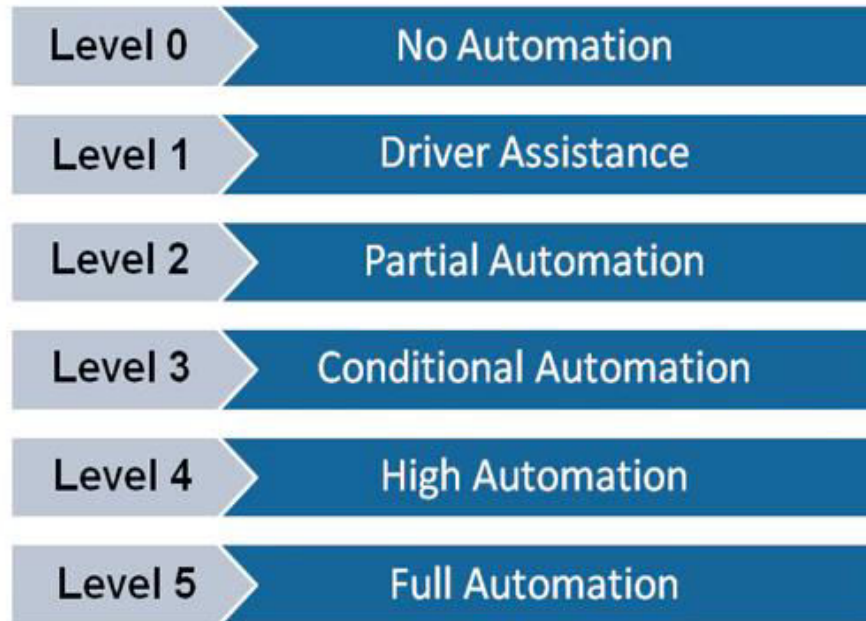
# Just how new are Autonomous Vehicles?

- First “Autonomous Vehicle” system: Adaptive Cruise Control, early 2000’s
- We have had various levels of “Drivers Assistance Systems” for many years
  - Adaptive Cruise Control
  - Park Assistance
  - Rear View Cameras
  - Lane Departure



# What defines an Autonomous Vehicle?

Levels of Automation for On-Road Vehicles: SAE International



Level 0: No automated systems (Traditional cruise control does not count).

Level 1: At least 1 assist system: Examples (Adaptive Cruise, Lane Keeping)

Level 2: At least 2 assist systems: Examples (Adaptive Cruise, lane keeping, auto emergency braking)

Level 3: Capable of taking full control during parts of the trip pending conditions being met (parallel parking or auto emergency braking)

Level 4: Capable of completing an entire journey without driver intervention. Still has driver controls available.

Level 5: Complete hands-off driving under all conditions. No driver controls available



# Should we be afraid of Autonomous Vehicles?

- No
- Air Bags in the mid-1980's experienced similar concerns: People could be injured or killed due to air bags, but how many were saved?
- There will be incidents, and they will receive huge press, but look long term and with a broad lens, and what would have happened even if a human was driving
- First "Auto Pilot" 1912 for aircraft



# What will most technicians do on Autonomous Vehicles?

- The majority of non-dealership technicians will have little “direct” interaction with the “Autonomous Related” systems

Why? Liability and access to information

- Technicians will be involved with the adjustment (Calibration), testing and replacement of sensors / cameras / etc.
- Technicians will not be writing code or making repairs on electronics
- Basic services, mechanical repairs, software installation, diagnostics, high-voltage repairs

# How will education prepare students?

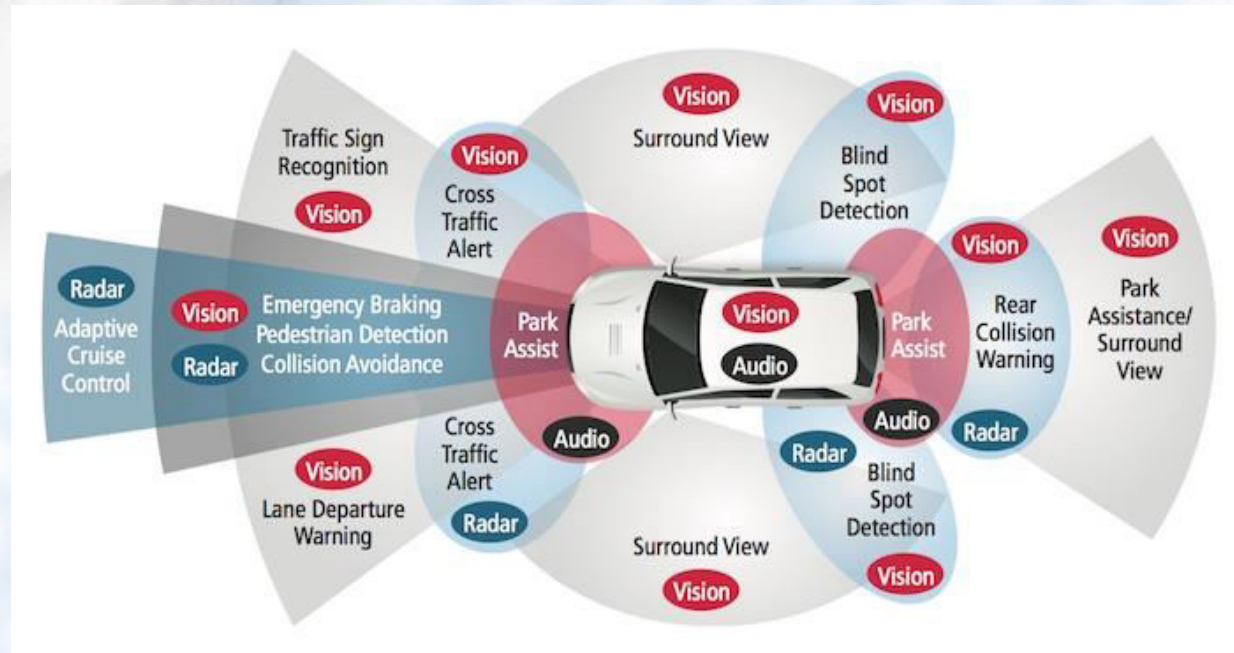
- The focus will need to be on existing basics, but with more focus on electrical, electronics, EV, and integrated systems
- Prepare the Automotive faculty
  - System operation: Theory and practical
  - Calibration and diagnostic techniques
  - Integrated systems understanding
  - \*Strong Work Force Regional projects already working on this
- Prepare the students
  - Focus on the Advanced Drivers Assistance Systems, they are the foundation of the Autonomous vehicle

# Advanced Drivers Assistance Systems (ADAS)

- Electronic systems / functions that support the driver to improve safety
- In some cases, may take temporary control of functions to prevent accident or improve drivers awareness
- Some of these systems as early as 2000's
- Some systems can be turned off, others active at all times

# What are Advanced Drivers Assistance Systems (ADAS)

- Lane Departure (LDW) / Lane Keep (LKA) / Lane Centering (LC)
- Active Cruise Control (ACC)
- Blind Spot Detection
- Parking Assist
- Autonomous Emergency Braking (AEB)
- Night Vision
- Traffic Sign Recognition (TSR)
- Intelligent High beam Assistant (IHC)
- Front Collision Warning System (FCWS)
- Front Vehicle Departure Warning (FVDW)
- Adaptive Lighting
- Driver Drowsiness Detection
- Rear Cross Traffic



# What is the relationship between ADAS and Autonomous Vehicles?

- ADAS share or provide many of the sensors for Autonomous systems
- Autonomous Vehicles are not “Stand alone systems” they utilize the existing vehicle systems
- Autonomous Vehicles are the utilization of various sensors and controls that are monitored, evaluated, and applied in lieu of a drivers input
- Autonomous Vehicles are the “Intelligence,” more than the hardware
- This allows education to focus on the sensors and actuators as the Artificial Intelligence (A.I.) is not something that technicians would be working on anyways
- ❖ Sensors and cameras provide awareness of surroundings, A.I. makes decisions (Eyes, ears, senses and brains)

# How can we use ADAS to prepare students?

- Description of system: Purpose and operation
- Description of all components associated with function and what part they play in operation
- Diagnostics: Fault codes, electrical testing
- Service and Repairs: Calibration

# ADAS System Lesson Example: Operation

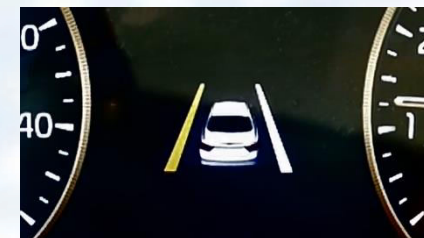
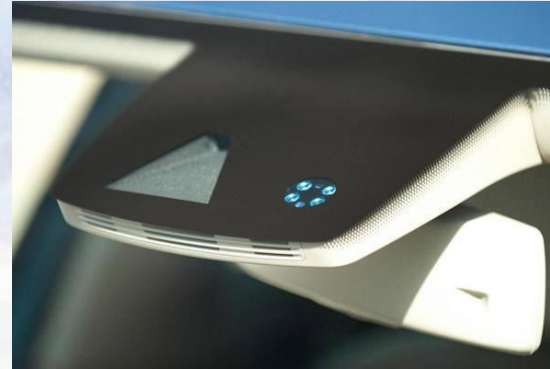
- **Lane Departure (LDW) / Lane Keep (LKA) / Lane Centering (LC)**
  - Operation
    - Camera(s) to see road stripes / markings
      - Some systems utilize only one camera, newer systems use two
    - Notify driver when leaving lane (LDW)
      - Turn signal activation key operational factor
      - May have correction capability
      - Audio, visual, haptic warning(s) to driver
    - To keep the vehicle in the lane (LKA)
      - Has correction capability
      - Audio, visual, haptic warning(s) to driver
    - To keep the vehicle centered in the lane (LC)
      - May have a “ping-pong” effect, weaving between the lines due to over corrections
      - Audio, visual, haptic warning(s) to driver





# ADAS System Lesson Example: Components

- Components
  - Camera(s)
  - Module(s)
    - LDW/LKA/LC
    - Electric Steering
  - Switches
    - Turn signal stalk
    - System on/off
  - Steering
    - Rack
  - Visual Indicators
  - Audio
  - Haptic feedback (Steering wheel shake)



# ADAS System Lesson Example: Diagnosis

- Diagnosis

- Visual inspection

- Damage to glass
    - Damage to camera(s)

- Fault codes

- OEM
    - SAE

- Electrical testing

- Power
    - Ground
    - Signals
    - BUS Communications

- External conditions

- Weather

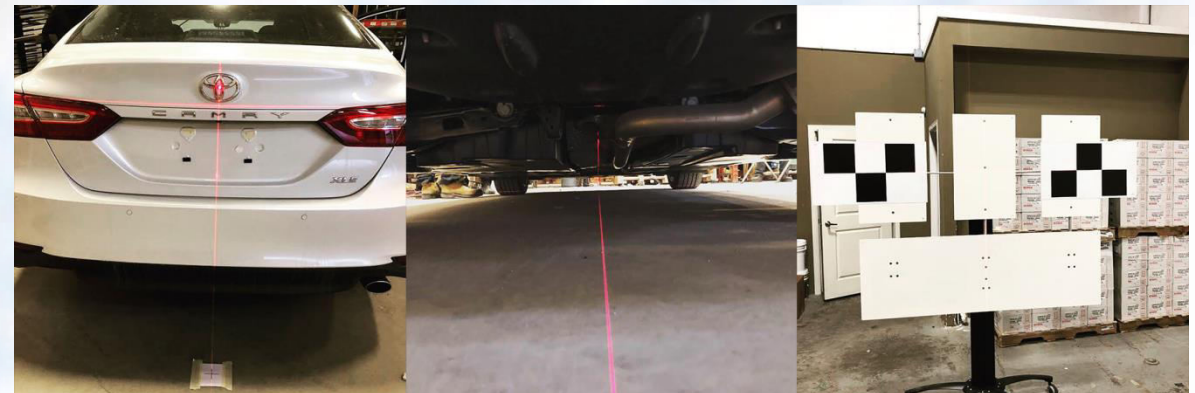
- Heavy rain
    - Snow / Sleet / Hail
    - Fog
    - Smoke / Dust
    - Direct Sun

- Clarity of road markings
    - Cleanliness of windshield



# ADAS System Lesson Example: Service / Calibration

- Mechanical
  - Targets
  - Some cameras hard mounted, some may be adjustable
  - Non-related repairs and services can require calibration
    - Windshield
    - **Alignment**
    - Collision
- Self / Auto Calibration
  - Driving
    - Calibration Mode
    - Road identification critical (markings)



# ADAS System Lesson Example: Lab Tasks

- Identify components and their location
- Describe system operation, compare with other vehicles
- Access scan tool tests and available information
- Vehicle Alignment (Thrust Angle is critical for calibration)
- Calibrate system
- Scope capture signals as applicable
- Perform visual inspection for damage
- Road test if possible

# ADAS Instructional Needs

- Vehicles like the Hyundai Elantra with Ultimate package have many of these systems and can be purchased for under \$30K, more brands are including many of these systems on all vehicles (Toyota Sense)
- Scan tools with ADAS capabilities: Bosch, Autel, others?
- Calibration targets: Full kit \$25k, individuals for specific calibration much less
- ❖ iCar (Collision) has similar needs, collision programs could partner with automotive programs for instruction and costs
- ❖ Municipal fleets will also be impacted and require technician training, potential to partner with cities / agencies / corporations
- ❖ Commercial Fleets will likely also incorporate moving forward

# Next Steps

1. Start the conversation / participate !!!
2. Educate our peers to the critical need for automotive education to evolve, the industry already has – technicians are behind
3. Review curriculum: Identify and prioritize what topics will receive more time and focus to meet current and future needs
4. Include “Awareness” of applicable technologies and link to existing systems when teaching “Core” content
5. Create: New content / courses / certificates / degrees / industry classes

# Next Steps

6. Train faculty: Utilize Tier 1 providers for “Generic” system instruction as OEM materials will be difficult due to liability concerns
7. Share: Info can be hard to come by, share with other schools, we are all in this together
8. Acquire: Vehicles, tools and equipment as necessary
9. Pressure ASE to adopt new technologies faster, how long did hybrid take to be recognized
10. Educate: School counselors and parents to the career opportunities and the technologies of today’s industry – this is a profession!

# Comments and Questions



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