Next Steps in Vehicle Electrification Technician Preparation Part I:

Advanced Skills Needed By Technicians Working With Current And Future Vehicles

January 29, 2020

Ken Mays, Central Oregon Community College,

Dr. Bruce Emerson, Central Oregon Community College

Ben Cruz, Principle Investigator of the NSF Center for Advanced Automotive Technology

Dr. Mark Quarto, Chief Technical Officer, Future Tech

Featured Speakers

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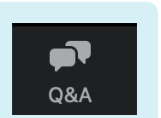
Please refer to Maddy Reznick, maddy@cwcleancities.org with any technical questions about this webinar.

Housekeeping

- Chat with other attendees in the chat box.
- Ask questions using the 

box.
- Feel free to log your question during the presentation- we'll answer these first during the Q&A section.
- Webinar recording & slide deck will be available to all attendees.

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Dr. Bruce Emerson,
Central Oregon
Community College

Bruce Emerson, COCC Engineering/Physics

Collaborator with Ken Mays

The changing need for education and training of Engineering Technicians.

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Engineering Technician

Engineer <=> Technician

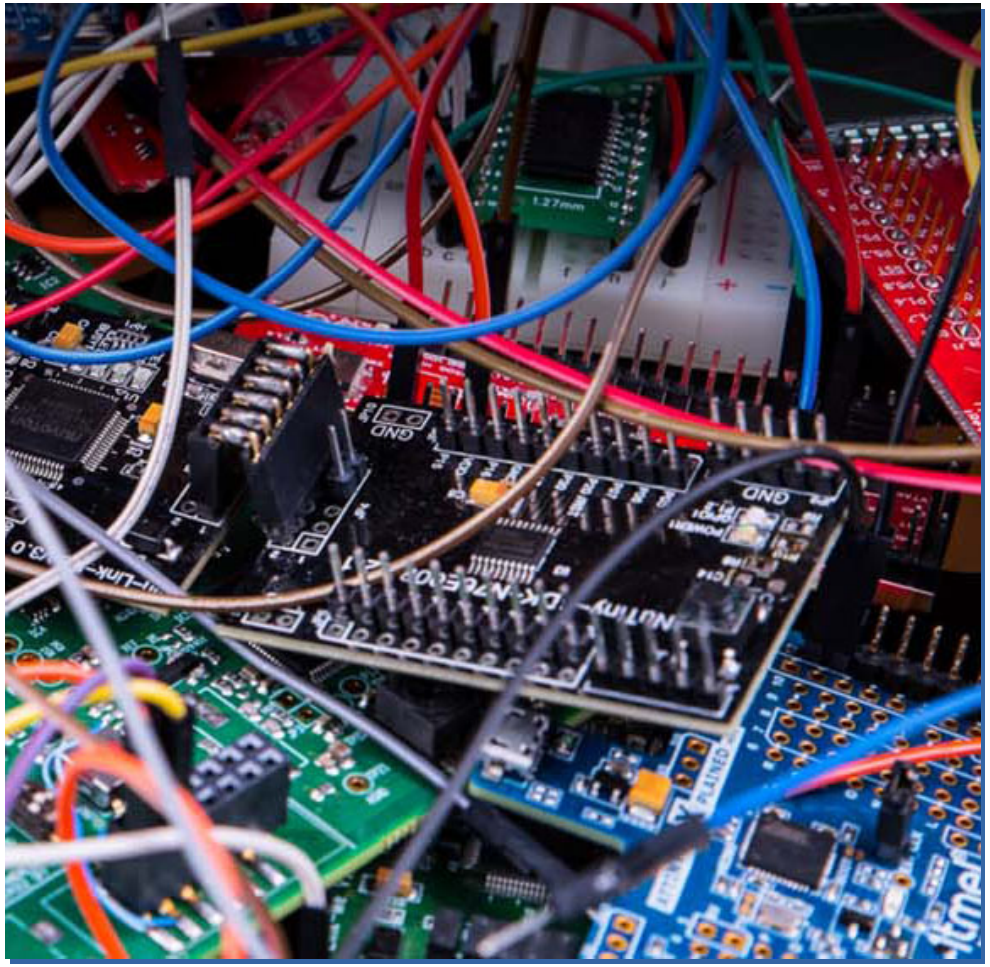
The Boundary is moving…

Engineers need practical skills
Technicians need academic skills

Engineering Technician

Microcontrollers

- ‘smart’ everything
- analog to microcontroller to computer
- not just realm of engineers
- coding skills
- sensor skills



Engineering Technician

Learning Models

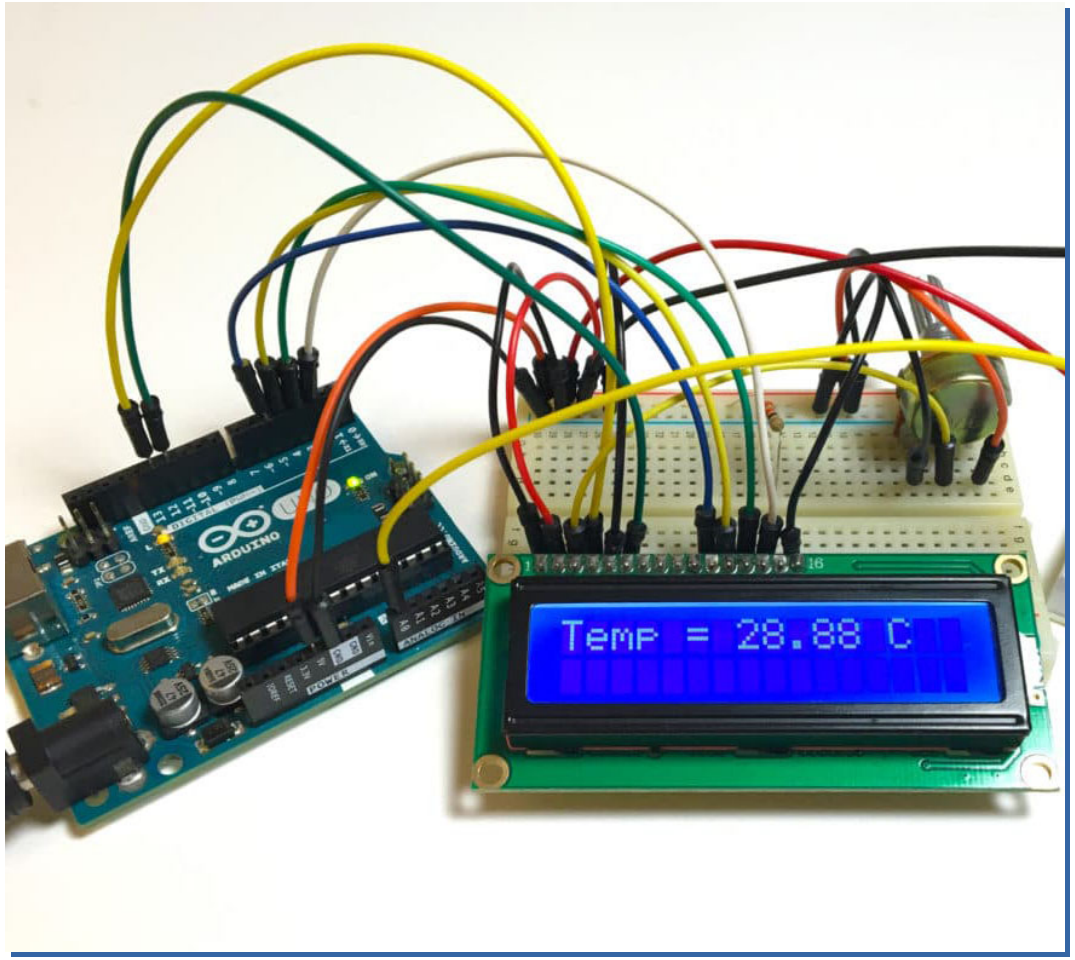
- Arduino and clones
- coding logic
- sensor management
- conditional behavior
- portable skills

```
int ThermistorPin = 0;
int Vo;
float R1 = 10000;
float logR2, R2, T;
float c1 = 1.009249522e-03, c2 = 2.378405444e-04, c3 = 2.019

void setup() {
Serial.begin(9600);
}

void loop() {

  Vo = analogRead(ThermistorPin);
  R2 = R1 * (1023.0 / (float)Vo - 1.0);
  logR2 = log(R2);
  T = (1.0 / (c1 + c2*logR2 + c3*logR2*logR2*logR2));
  T = T - 273.15;
  T = (T * 9.0)/ 5.0 + 32.0;

  Serial.print("Temperature: ");
  Serial.print(T);
  Serial.println(" F");
```

Engineering Technician

Troubleshooting/Diagnostics

- hands on experience
- understanding → prediction
- communication with engineers
- complex instrumentation/tools



Questions?

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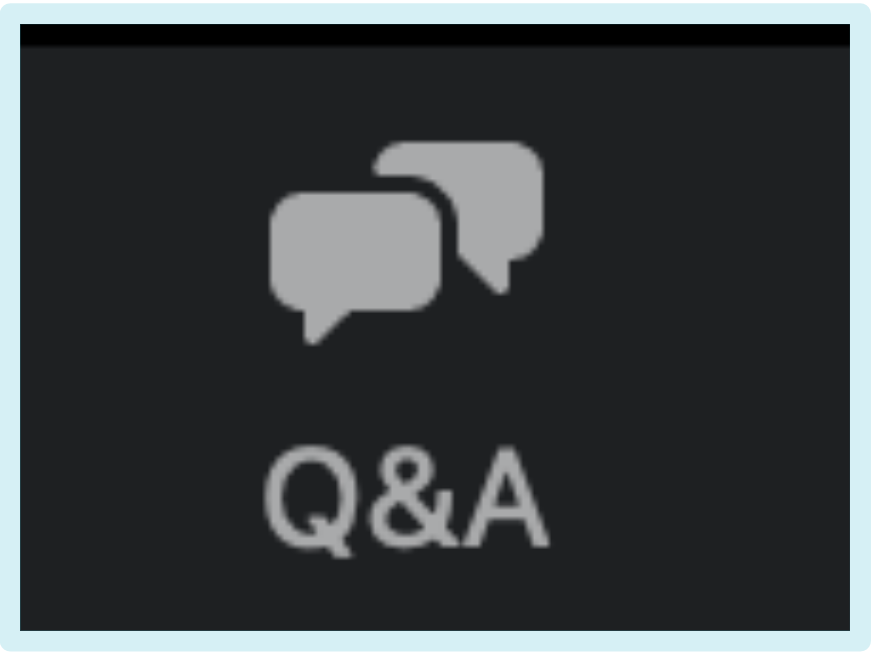


Ben Cruz,
Principle Investigator of the NSF Center for Advanced Automotive Technology

MACOMB COMMUNITY COLLEGE
WAYNE STATE UNIVERSITY

Emerging Automotive Technologies and Technicians

***January* 25, 2020**

Ben Cruz

Director- Center for Advanced Automotive Technology

CAAT

Macomb Community College

14500 East 12 Mile Road

Warren, MI 48088-3896

Center for Advanced Automotive Technology
C · A · A · T

Macomb Community College
Education • Enrichment • Economic Development
Discover. Connect. Advance.

New Automotive Trends Driving Change in the Auto Industry

- The emergence and advancement of Automated and Electric Vehicle Technologies is having a significant impact on the automotive industry.

Today's Main questions ?

- What are the Automotive emerging technologies?
- Where are the skill gaps
- What new educational materials are needed

Automotive Trends Driving Change

- The trends driving change are: Connectivity, autonomous and automated driving, mobility as a service, drivetrain electrification, and the need for high-performance computing.
- And all these systems must be light weight, and highly energy-efficient and power-conscious.

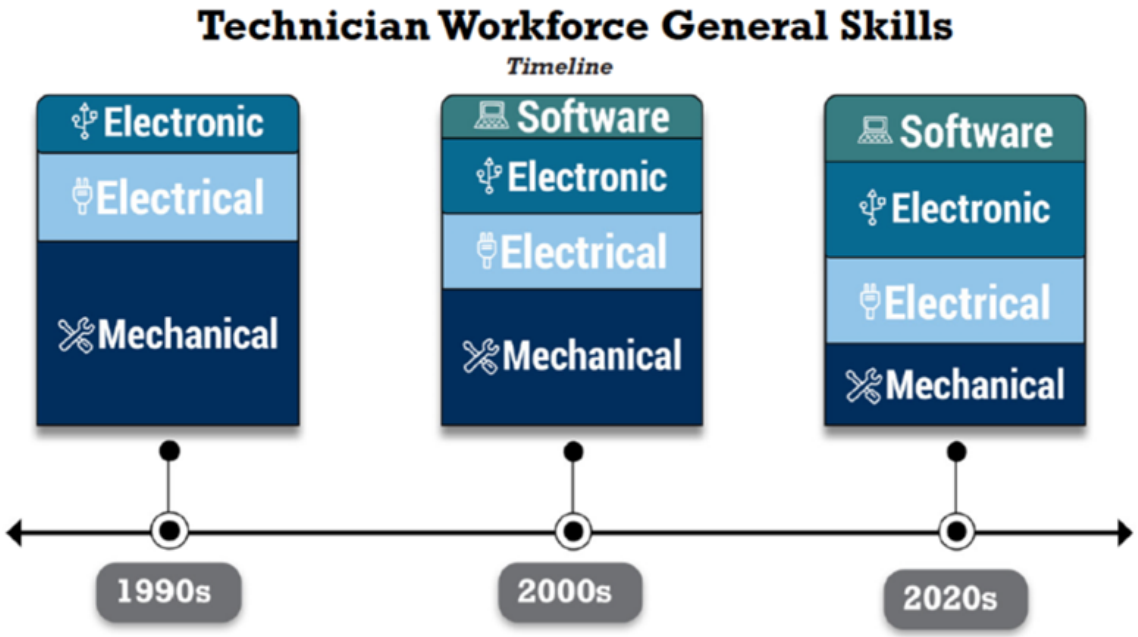
Digital Electronics and Electromechanical Controls

• 1980s	Microprocessors for electronic powertrain control, CAN and other busses, sensors (MAF, O_2, rpm), stoichiometric A/F ratio control, spark timing, algorithms and engine maps
• 1990s	OBD-II, cylinder deactivation, electromechanical systems for throttle, steering, and other applications
• 2000s	Digital Electronics; Adaptive cruise control, parking assist systems, Automatic braking, and vehicle electrification
• 2010s	Sensors: ultrasonic, radar, cameras, connectivity, advanced driver assistance systems And fully automated systems. Autopilot on Tesla - 2014 Super Cruise on GM - 2017

Connected and Automated Vehicles

CAV Middle Skill Jobs

Technicians comprise the majority

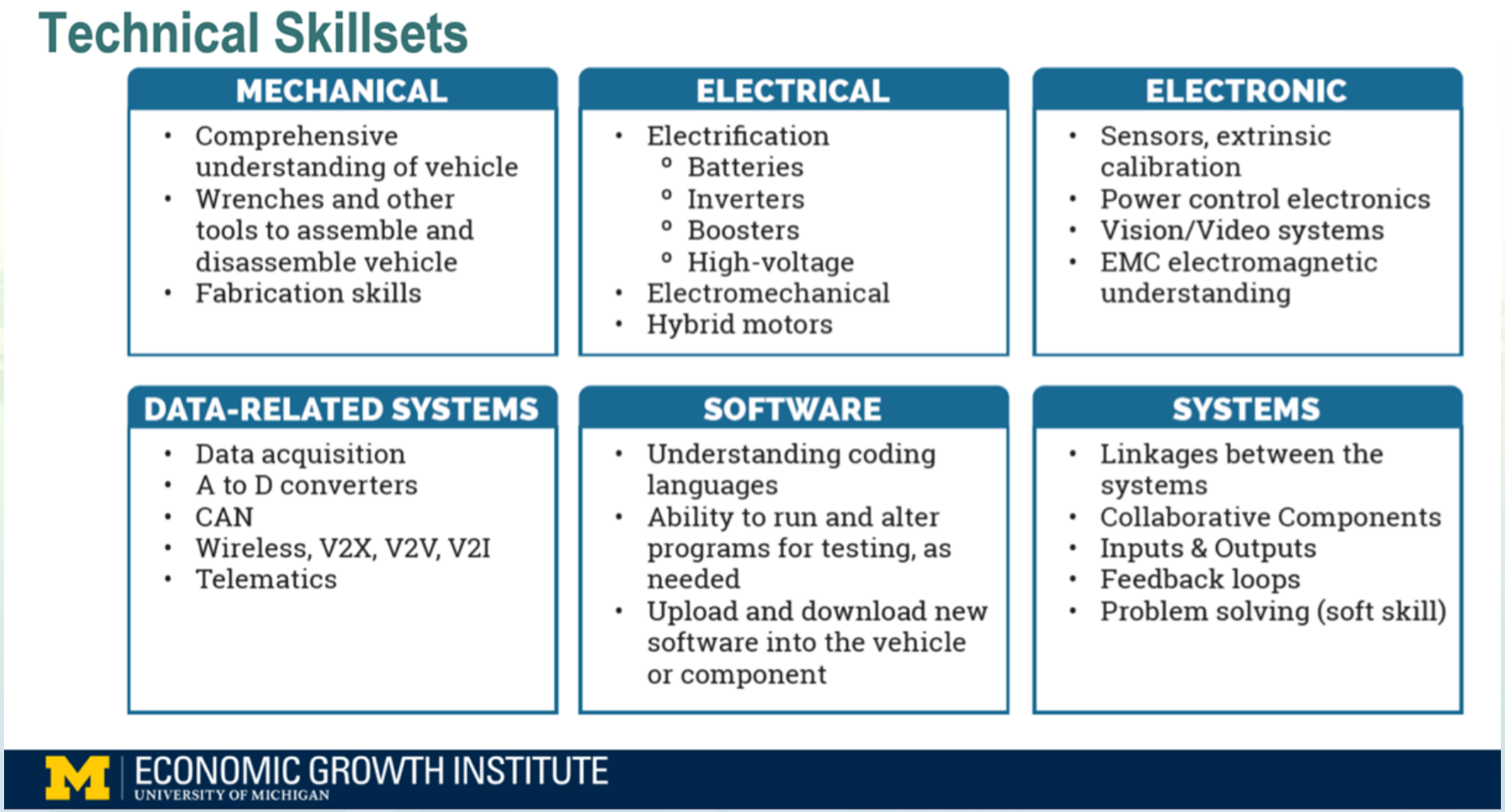


The complexity and number of skills are increasing

ECONOMIC GROWTH INSTITUTE
UNIVERSITY OF MICHIGAN

Sarah Crane Research Project Manager Economic Growth Institute University of Michigan
sarahrcr@umich.edu

Understanding the Technician Skills Gap



Sarah Crane Research Project Manager Economic Growth Institute University of Michigan
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Automotive Technicians Must Understand The New Vehicle Systems and Changing Technology

- High voltage batteries, power conversion, electric motors for electrification of powertrains & controls Software
- Advanced Driver Assistance Systems (ADAS)
- Lightweight materials and advanced joining and fasteners
- Manufacturing Automation
- Power electronics and Electromechanical control of everything in new vehicles with embedded software controls
- Automated and connected vehicles with electronic controls modules (ECU) to control radar, lidar, cameras, ultrasound and VTX communication.
- CAAT has responded by developing new educational materials to address some of the technician skills GAP

Auto Industry Message to CAAT

- We need higher skilled technicians
- We won't hire traditional service technicians
- We have hired your electronics technicians, but…. we have to train them on automotive and other skills
- We want you to educate a new type of automotive technician that we (OEMs and suppliers) can hire directly out of college
- Thus; the Idea for a new program.
  - Vehicle Engineering Technician Program

CAAT Has Developed Three Programs Aimed at Narrowing the Technician skills gap

- A two-year Automotive Manufacturing Associate of Applied Science

- A two-year Vehicle Engineering Technician Associate of Applied Science Degree

- Working on a Two-year Automation Tooling and Fixture Design Associates in Applied Science program

Vehicle Engineering Technician Program

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Automotive Technology-Vehicle Engineering Technician

The Vehicle Engineering Technician program is designed to provide students with the opportunity to develop the skills, knowledge and abilities required for entry level positions in the automotive industry. Students successfully completing this program will have the technical skills required to assist engineers in test, development, calibration and validation of sophisticated vehicles that have electrified powertrains, power electromechanical systems, advanced infotainment, driver assist systems, and connectivity in the next generation of safe, efficient, intelligent vehicles.

Career Opportunities:

Vehicle Engineering Technician-Associate of Applied Science: A job title such as Engineering Technician is attainable upon completion of this course of study. To learn more from a career specialist, visit the Office of Career Services at either campus or explore online at www.onetonline.org.

Vehicle Engineering Technician Program

Macomb Community College - Vehicle Engineering Technician Program 8/20/20					
Course	Course Title	Semester 1	Semester 2	Semester 3	Semester 4
AUTO-1000	Automotive Systems	3			
AUTO-1040	Automotive Electrical 1		3		
AUTO 2060	Automotive Electrical 3			3	
AUTO-2000	Connected, Automated & Intelligent Vehicles				4
AUTO-2600	Automotive Cybersecurity		3		
TMTH-1150	RCL Analysis - Applied Math	4			
ELEC-1161	Electronics Technology 1	3			
ELEC-1171	Electronics Technology 2		3		
ELEC-1211	Digital Electronics Basics		3		
ELEC-2150	LabVIEW Basics			3	
ELEC-2310	Vehicle Experimental Testing				4
ITCS-1140	Intro to Programing Design & Development			4	
ITNT-1500	Principles of Networking		4		
ITCS - 1300	Embedded C Programming for Automotive Systems			4	
PRDE-1250	Basic Blueprint Reading	2			
AAS/ABA	Gen Ed - English or Composition	3			
PHSA-150	Gen Ed - Physical Science 1050				4
AAS/ABA	Gen Ed - Economics or Sociology			3	
AAS/ABA	Gen Ed - Creative Writing				3
		15	16	17	15
				Total Credits	63

Articulation Agreements with Wayne State University

- For a Bachelor of Science Degree in Electrical or Mechanical Engineering Technology

- A graduate certificate in Electric-drive Vehicle Engineering

- A Master of Science Degree in Electric-drive Vehicle Engineering

Summary

- Vehicles are becoming electro-mechanical devices controlled by computers
- Automotive service technicians will need enhanced electronic, software, and troubleshooting skills to maintain, and repair future vehicles
- The Vehicle Engineering Technicians (VETs), with enhanced electronics, software, and laboratory testing skills are needed by OEMs and suppliers to assist engineers in the development of highly automated and highly electrified vehicles

Questions?

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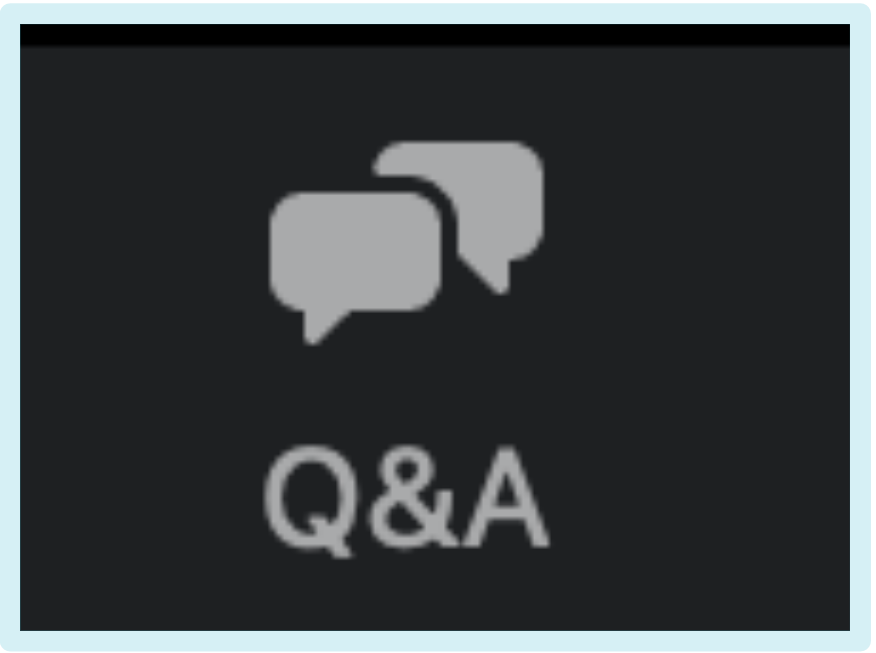


Dr. Mark Quarto, Chief Technical Officer, Future Tech

The Move to Vehicle Electrification

Barriers, Challenges, Gaps, Solutions

Presented by:

Dr. Mark L. Quarto

Quarto Technical Services & Consultant for FutureTech Auto

January 29, 2021

Bridging The Education, Training, & Skill Gaps

Legacy Skills

Bridge

New Skills

Abbreviated Problem Statement:

- Automotive Instructor and Technicians education & skills must be radically updated to accommodate VE technology
- Develop programs to bridge the gaps of mechanical centric skills to HV DC & AC power systems, electronic, and software centric skills
- Currently, minimal technician training & skills will transfer (bridge) from traditional to VE technology
- Time Horizon for transitioning from traditional to VE systems can be extensive (student dependent)
- Without careful development of “bridging” education and programs maintenance, servicing, and diagnostics will be severely impacted and impede fleet and retail service market
- Problem solution: Utilize existing NEVTEX Grant VE and Electronics curriculum design that will successfully bridge mechanical legacy knowledge and skills to HV power electronic, electronic, and software systems skills

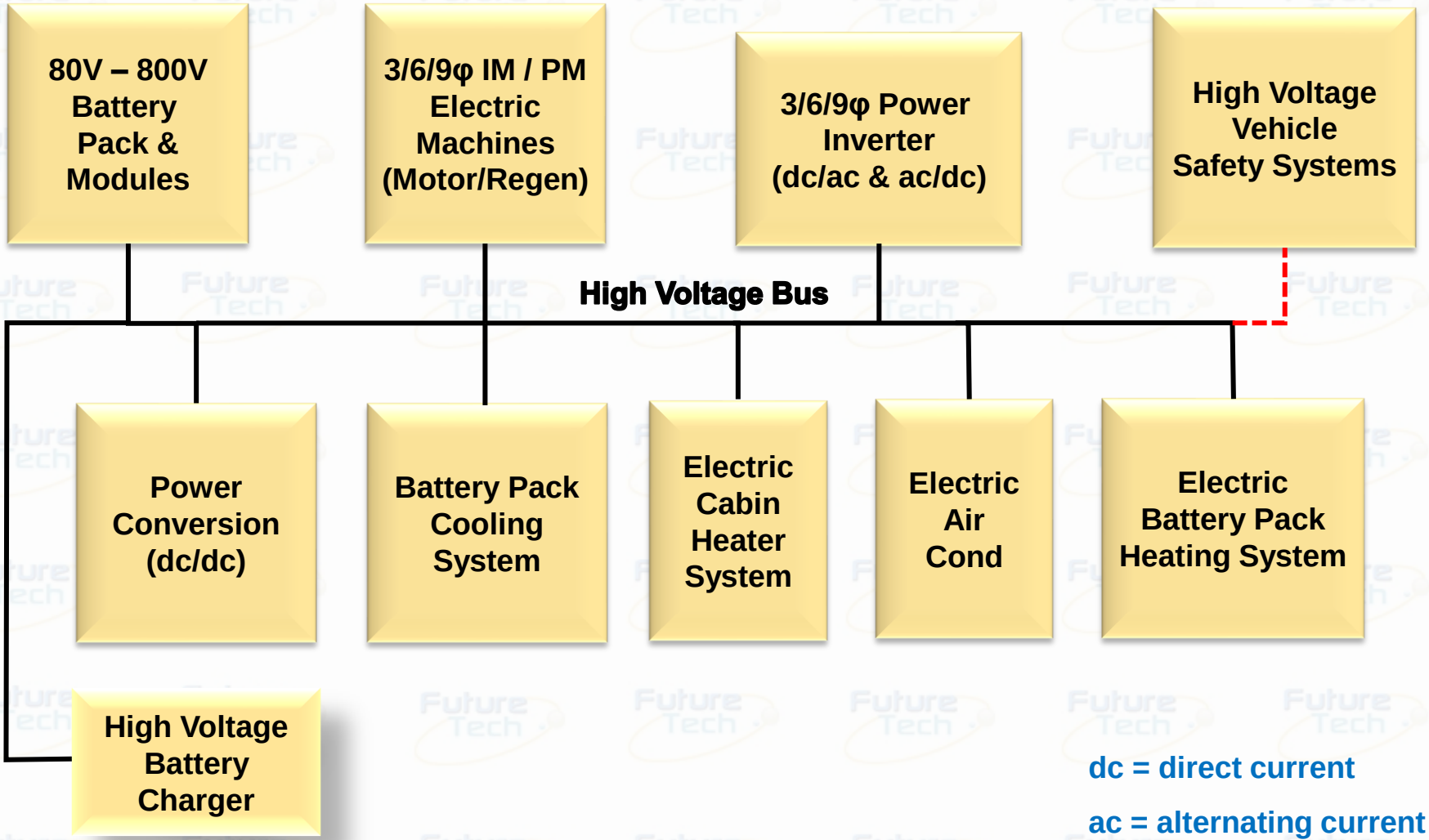
Challenges

Challenges

HV DC, AC, Electronics, & Software skills not in DNA of Automotive Instructors or Technician Populations

- HV DC Systems
- HV Multi-Phase Power Electronic & Machine Systems
- HV DC & AC Power Electronics and Control Systems
- Software (S/W) and Firmware (F/W) Systems:
  - Electronics Hardware Devices
  - Network Systems (CAN & Ethernet)
  - S/W – F/W Programming Skills (for systems manipulation)
- HV DC, AC, Network, and S/W-F/W Skills can no longer be considered “nice to know”…….it’s now a “need to know” market

Common BEV High Voltage Power Systems



dc = direct current

ac = alternating current

Gaps

Gaps

Legacy & Technical Skills

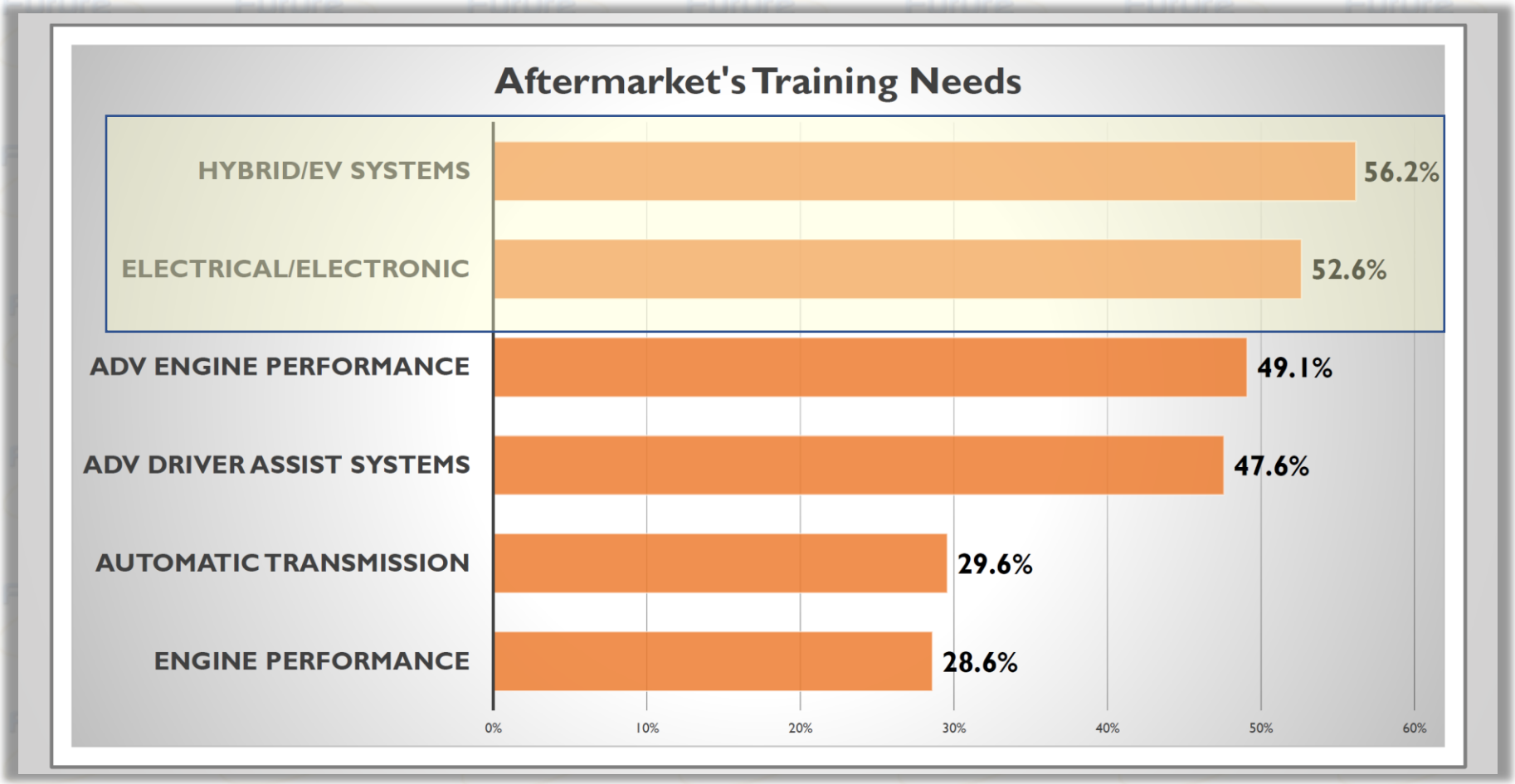
- Low Voltage Electrical Systems
- Mechanical Systems
- Hydraulic Systems
- Pneumatic Systems

Significant GAP

New Skills

- High Voltage Battery Pack Systems
- High Voltage Electric Drive (AC) Systems
- High Voltage Power Electronics Systems (DC & AC)
- CAN & Ethernet COMM Systems
- Electronic Devices, S/W – F/W Skills (for Systems Manipulation)

ASE ATMC 2018-2020 Training Benchmark Surveys



Courtesy ASE Training Managers Council

Barriers

Barriers

Barriers for Service Industry to transition Into VE technologies

- Minimal Population of "Qualified" Instructors to Instruct Technology, not OEM Product
- Automotive Education programs devote minimal time to VE technology
- Automotive Degree programs or tuition assistance not structured to add VE
- Automotive Service Industry "weak point" is electrical, electronic and S/W – F/W technologies

Solutions

Solutions

Legacy Skills

- Low Voltage Electrical Systems
- Mechanical Systems
- Hydraulic Systems
- Pneumatic Systems

Bridge

Develop Working Knowledge of Electronic H/W Devices, Software Structures, & Vehicle Network Education
&
Vehicle Electrification Technology Education

Build curriculum that connects Legacy "mechanical" experiences to New Skill Electronic, S/W – F/W, and Vehicle Electrification Systems

New Skills

- High Voltage Battery Pack Systems
- High Voltage Electric Drive (AC) Systems
- High Voltage Power Electronics Systems (DC & AC)
- CAN & Ethernet COMM Systems
- Electronic Devices, S/W – F/W Skills (for Systems Manipulation)

Possible Solutions

Solutions for Mainstreaming VE into Post Sec. and Private Institutions

- Electronics Industry transitions technicians into automotive diagnostics? (already in discussions)
- Private educational companies provide two year degree programs (meets state req's)
- Split Traditional Automotive Degree Programs and VE programs into a separate degree program
- Utilize private companies to augment traditional college programs with VE curriculum (meets state req's)

FutureTech Auto Solutions Examples

- *Need to Transition Instructors and Technicians into a "Working Knowledge" Level of Electrical concepts, Electronic Devices, and S/W - F/W*

- *Working Knowledge definition: A Level in between Engineers and Technicians*

- *Working Knowledge of these skills will help to "Future-Proof " a career in the transportation field – increase Technicians value*

FutureTech Auto Solutions

VE Technicians Need A *Working Knowledge*

Electronics & Networks Skill Acquisitions

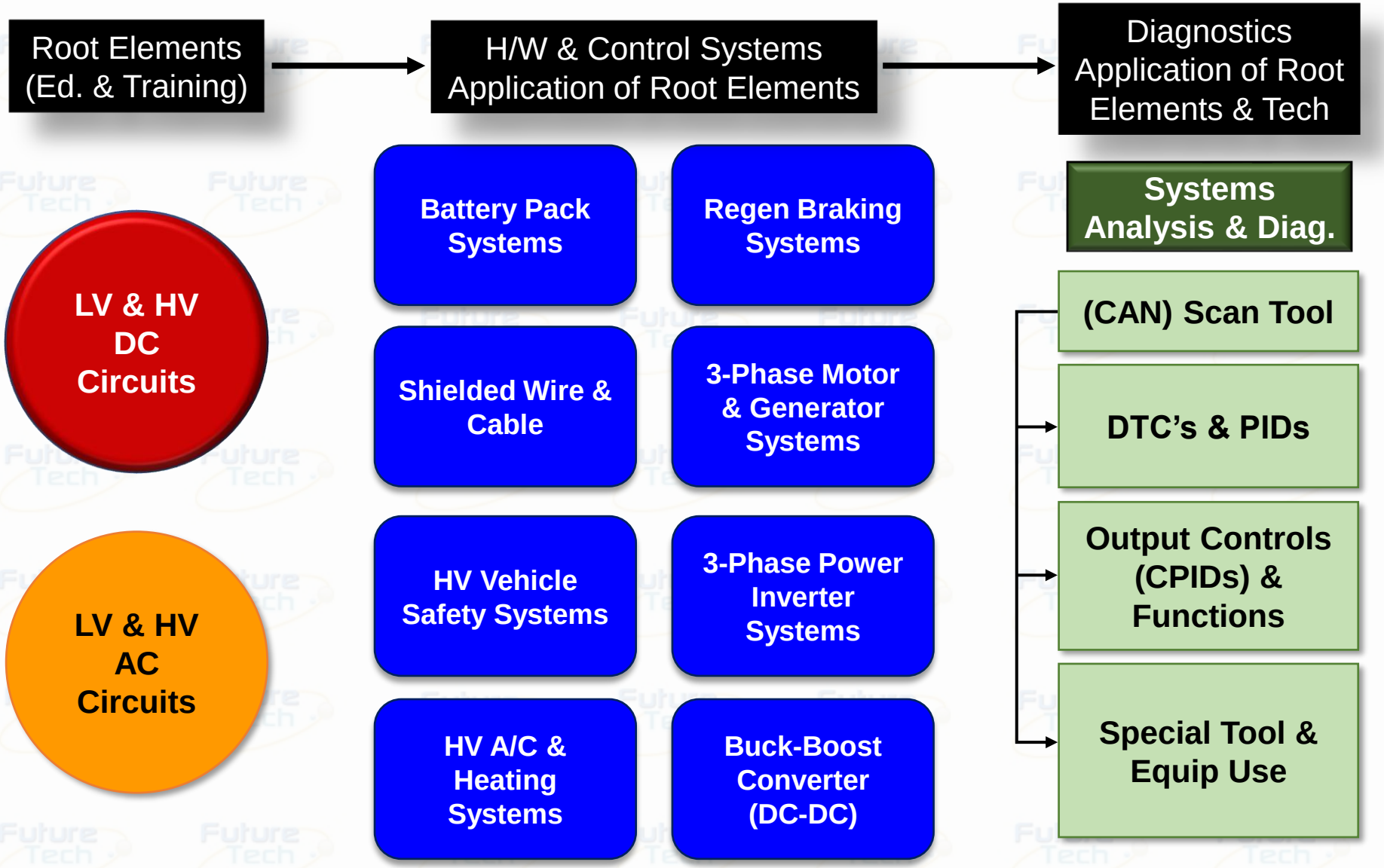
- Electronic Symbol Recognition
- Selection of Components
- Electronic Device Operation
- Component Failure Modes
- How To Read Device Spec Sheets
- Diagnostic Development by Device Type
- Circuit Operation Based on Device Type
- Circuit Manipulation

S/W – F/W & Networks Skill Acquisitions

- Focus
- Develop Logic
- Develops Creativity
- Systems Operational Flow
- Attention To Detail
- Diagnostic Processes
- How to Manipulate Circuits
- Construct Solutions

S/W = Software F/W = Firmware

FutureTech Auto Solutions



FutureTech S/W – F/W Education Elements

Advanced Systems require a Working Knowledge of Electronics & Software Systems

Thank You!

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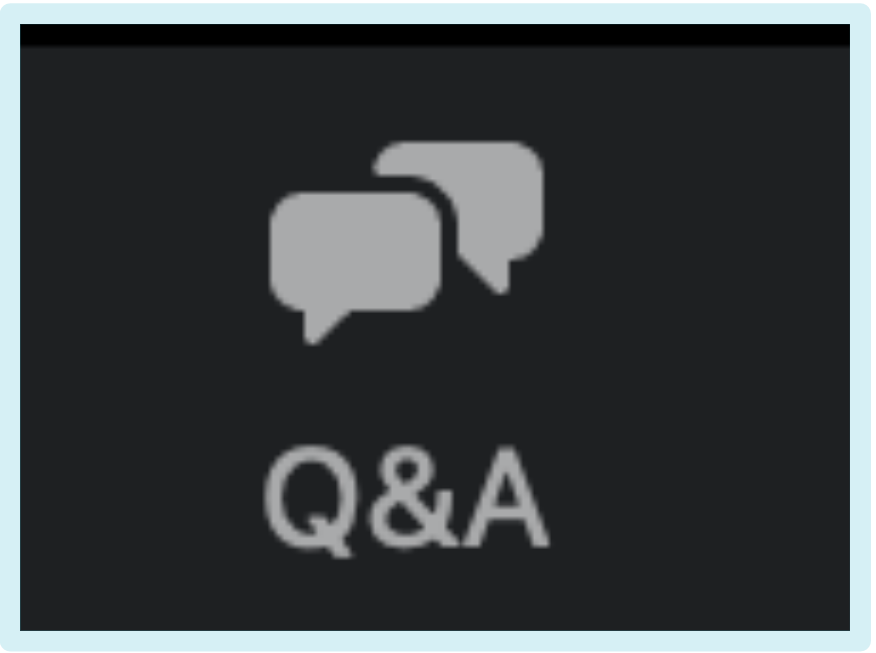

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Thank you


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