

Electric Vehicle Systems Lab

DISCUSSION DOCUMENT



Introduction:- The Modern Electric Vehicle Training Facility

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Overview

Since 1989, most vehicles have contained very sophisticated electronic systems, and by 2017, those electronic systems have controlled every aspect of the automotive system. The latest evolution of automotive technology is electric and hybrid technologies. As EV technology develops, the industry will need to ensure that their workforce is proficient enough to keep up with these changes.



Educators also hold a stake in the changing technologies. Engineering curricula should be adapted to account for developing EV skills, and educators will need to work with local employers to keep in touch with shifting demand. Educational programs will also need to be updated to create new learning opportunities for students, which can help students develop skills in a relevant context.

The demand for workers with EV skills is growing rapidly and is not expected to diminish anytime soon. And, as the need for workers continues to grow, so do the opportunities for those able to meet it.

Our latest range of trainers and associated lessons are designed to provide students with the skills and knowledge required to develop, integrate, maintain, and repair electric and hybrid vehicle technologies.

We Provide Instruction at Three Levels:

1. **Complete Vehicle Systems:** These are based on large panel trainers that illustrate the operation of complete EV and Hybrid Vehicle systems. Students can “operate” each type of vehicle, measure what is going on during the various modes of operation, and troubleshoot common problems.
2. **Common EV Sub-Systems:** Panel trainers provide each student with underpinning knowledge and troubleshooting experience with the most critical EV sub-systems such as Motors and Generators, and Batteries and Charging Systems.
3. **EV Electrical and Electronics Fundamentals:** A desktop training system provides very specific instruction and practice in fundamental and advanced electrical skills based around EV circuitry.

Workstations:

To understand the technology and gain the skills required for industry certifications, students need an understanding of complex electronic systems, and very sophisticated analysis and troubleshooting skills. In our EV Technology environment, students learn the most difficult skills by working independently through the lessons provided in our online curriculum.

When supported by high-quality lessons, there are many benefits to this type of independent instruction, including improved motivation, increased chances for creativity, and intellectual stimulation.

Each workstation contains a piece of training equipment and a computer, which may be connected to the trainer. For ease of connection, we recommend Windows-based computers.

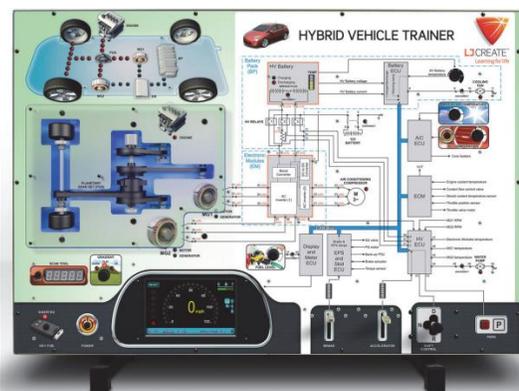
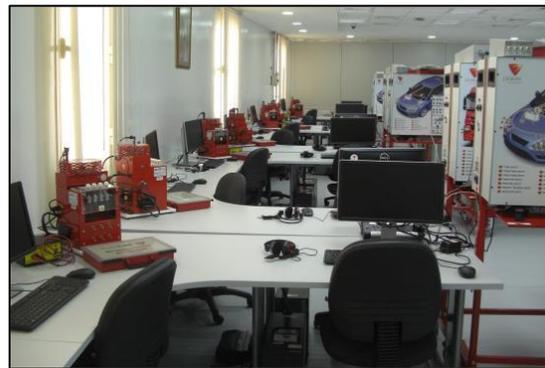
These workstations usually contain large panel trainers, and simulate some aspect of vehicle operation. Students work in pairs or singly at each station to complete the set of lessons.

Subjects included in this section include:

- Electric Vehicles
- High-Voltage Systems
- Batteries for BEV, HEV, and PHEV
- Electric Vehicle Systems
- EV Traction Motors
- Vehicle Charging Systems

Working through these stations gives students the opportunity to learn about the operation of the various systems that make up electric vehicles. They track the interaction of the various parts of each system and can troubleshoot the components within the systems. Since the student can easily follow the the instructions in the online lesson content, the instructor can be free to attend to other responsibilities, or the instructor can step the class through the lessons together. It also allows the students to study new and emerging technology with which, perhaps, the instructor has not had previous experience.

Example of on-screen simulator used with a Systems Panel



Whole-Class Training

There are certain underpinning skills that need to be learned by all students. It is most efficient to teach these to everybody at the same time. This way the instructor knows when students can progress to the next type of training experience, working on live vehicles. Increasingly, many of these skills are electrical troubleshooting, and our EV lessons provide instruction in the development of these skills. This section of the lab is intended as a place for all students to learn about core electrical circuitry and more advanced high-voltage electrical troubleshooting in a safe environment.



Topics covered include:

- Basic Electrical circuits
- Electronic Systems
- Electromagnetism
- Input Transducers
- Analog Integrated Circuits
- Pulse Width Modulation Signals



Classroom Training – Knowledge Lessons

The training in each of the previous categories has been all about developing and refining vocational skills. In a high-tech occupation like Electric Vehicle Technologies, each student also requires a great deal of knowledge to be able to properly apply those skills in the workplace.

For this reason, the EV Technology Systems lab contains hundreds of lessons covering all aspects of the technology. All of the lessons are available online, so instruction can be provided in the classroom, lab environment, or from any connected device for off-site training.



Every topic begins with a presentation that can be given by staff from the front of the class, and can also be watched by students on their own devices.

Following the presentation, students will be asked to complete some form of investigation – to show what they have learned from the presentation. Many of the knowledge investigations are based upon on-screen simulations of vehicle systems or service-related activities. Students use these simulations to complete virtual tasks, which again, can be run on-site or as assigned work off-site.



Finally, we provide a topic assessment to track the progress and performance of every student.

Alongside the technology-specific lessons, we have also included supporting instruction, which includes:

- Science
- Mathematics
- English Language
- Business Skills
- Workplace problem solving
- Workplace safety

Below you'll find a list of the library topics for EV Technology.

Electric Vehicle Digital Library – Contents Summary

Electric Vehicles

- Introduction to Hybrid and Electric Vehicles
- Definition of Electric Vehicles
- Example: The Nissan Leaf
- Features of Electric Vehicles
- Electric Motors
- Fuel Cells
- The Principle of the Fuel Cell
- Using Hydrogen as a Fuel
- Proton Exchange Membrane Fuel Cell
- Plug-in Electric Vehicles
- Range Extenders
- Principle of Regenerative Braking
- Choosing an Electric Vehicle
- Running an Electric Vehicle

High-Voltage Systems

- High-Voltage Vehicles
- Safety in High-Voltage Vehicles
- First Responders Safety
- Danger of Electric Current for Humans
- Safeguards Against Electric Shock
- Effect of Current on the Human Body
- Dealing with the Victim of an Electric Shock
- Qualifications for Working on High-Voltage Vehicles
- High-Voltage Wiring and Connectors
- Disabling Hybrid Vehicle Systems
- Disabling the High-Voltage System
- Legal Regulations
- Reasons for the Development of High-Voltage Vehicles

Batteries for BEV, HEV, and PHEV

- Introduction to Electrical Storage Devices
- Lithium-ion Batteries
- NiMH Batteries
- Lead Acid Batteries
- Nickel Metal Hydride Batteries
- Principles of Lithium-ion Batteries
- Principles of NiMH Batteries
- Safety with Batteries
- Battery Packs

- Battery Disconnection System
- Battery Lifetime vs Charging Rate
- Structure and Function of a Battery Pack
- Battery Modules
- Battery Cell Technology
- Effect of Temperature on Batteries
- Battery Thermal Management
- Battery Module Sensing Systems
- Battery Management System (BMS)
- Troubleshooting HV Battery Systems
- Advanced Battery Technology

Electric Vehicle Systems

- Introduction to EV Systems
- Electric Vehicle - Driver Display Panel
- EV Systems - Modes of Operation
- Operating an Electric Vehicle
- Troubleshooting EV Control Systems
- Cables and Connectors
- Cables, Connectors, and Protection Devices
- Electronic Circuits and Modules
- Contactors
- Construction of a Contactor
- Controlling Contactors
- Current Flow in Latching Circuits
- Selection of Contactors
- Single-Phase AC Voltage
- Three-Phase AC Voltage
- Three-Phase AC
- Generation of Three-Phase AC
- Representation of Three-Phase AC
- Voltage Converters
- The Inverter Principle
- DC to DC Converter
- Bridge Rectifiers
- Operation of a Bidirectional Inverter
- Pulse Width Modulation
- Troubleshooting a Frequency Motor Control Circuit
- In-Car Charging Circuits
- Troubleshooting the Charging Circuit
- Heating and Air Conditioning Fundamentals
- Air Conditioning Principles

- Air Conditioning Systems
- Refrigerant Leak Detection
- Refrigeration Cycle
- A/C Electrical System Fault Investigation
- Air Distribution Control System Investigation
- Blower Motor Fault Investigation
- Climate Control System Operation
- Compressor Fault Investigation
- Compressors
- Condensers
- HVAC Electrical Controls Investigation
- Lines and Hoses
- Networked Systems Data
- CAN Bus Data Processing
- CAN Bus Fault Diagnosis
- CAN Signal Response

EV Traction Motors

- AC Motors and Generators
- DC Motors
- Efficiency Formulas for Electric Motors
- Synchronous & Asynchronous Motors
- Frequency Motor Control
- Function of Frequency Converters
- EMC
- Frequency Converter Parameters
- Frequency Filters
- Motor Protection

- Interlock Systems
- Motor Installations and Safety
- Motor Protection
- Brake Systems
- Plug-in Hybrid Vehicles
- Motor Feedback & Sensors
- Position and Speed Feedback - Encoders
- Diagnose Equipotential Faults
- Diagnose Insulation Measurement Faults

Vehicle Charging Systems

- Electrical Installation in Buildings
- Components of an Electrical Installation
- Earthing Systems
- Circuit Breakers
- Consumer Units
- Re-Testing to Electrical Standards
- Production, Transmission, and Distribution of Electrical Energy
- Energy Distribution Calculations
- Line Surge Protection
- Introduction to Charging Systems
- Voltage, Current, and Power Calculations
- Charge Rate Measurement & Calculation
- Fast Rate Charging
- Ultra-Fast Charging
- SMART Charging Systems
- EV Charging Management Software

Implementing an EV Lab

Successful implementation of any high-tech training facility is based upon three pillars:

1. Curriculum: lessons/software/instructional guides
2. Resources: training equipment
3. Client services: planning/installation/training/technical support

Our consultants are happy to work with you on all three phases.