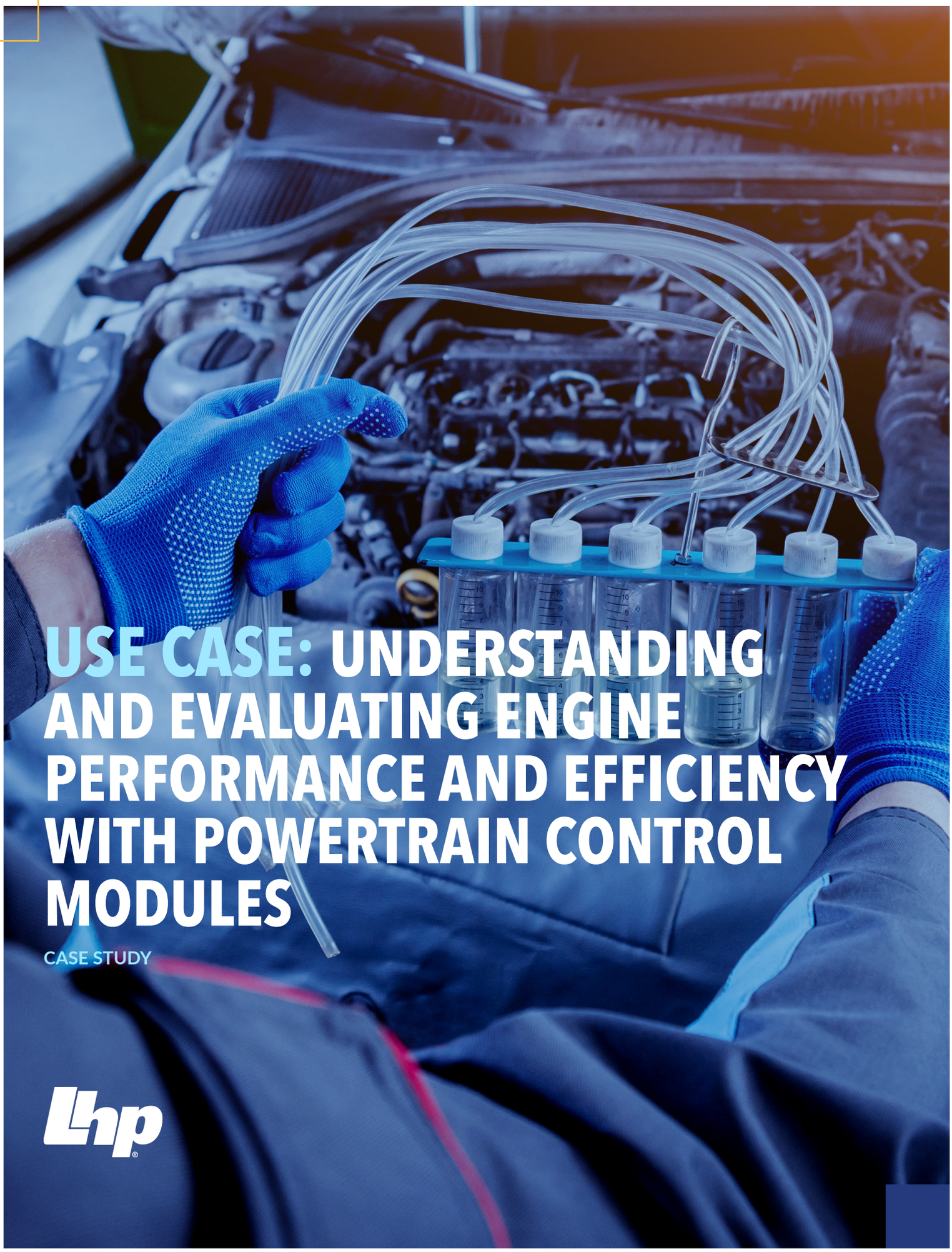


USE CASE: UNDERSTANDING AND EVALUATING ENGINE PERFORMANCE AND EFFICIENCY WITH POWERTRAIN CONTROL MODULES

CASE STUDY

INDUSTRY BACKGROUND

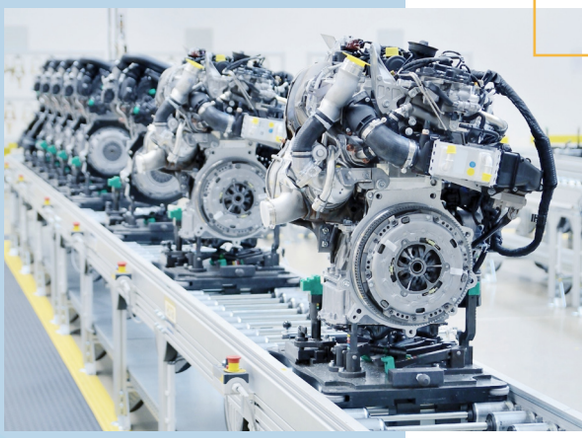
In the automotive industry, it is oftentimes more cost effective for one automobile manufacturer to license development of certain components to another manufacturer who already has a manufacturing presence in an area where they do not. When taking this approach, occasionally issues or inefficiencies with one organization's manufacturing process are revealed. This is exactly what happened recently when one large international automobile manufacturer licensed the U.S. manufacturing of one of its four-cylinder, gas, direct-injection turbo charged engines to another international automobile manufacturer with a large U.S. presence.

Because of complexities related to the advanced security features of the electronic control unit (ECU) for this particular engine, the original manufacturer performed all its testing once the engine was installed in a vehicle. Instead of taking this approach, to save time and money, the U.S. manufacturer wanted to test the engine before installing it in the vehicle. This presented a challenge because the original manufacturer felt that it would be a logistical nightmare and cost millions of dollars to use one of its ECUs to conduct testing outside of the vehicle.

Thus, the U.S. automotive manufacturer turned to the experts at LHP Technology Solutions (LHPTS) for help with this challenge. To adequately test the engine, they needed a test system that could start the engine, run the engine at a few different RPM levels, control the actuators and sensors simultaneously, and then read the sensors. Ultimately, they wanted to ensure everything was working properly before the engine was installed in the vehicle.

LHP SOLUTION

LHPTS engineers developed a comprehensive solution using the NI CompactRIO ecosystem, several Powertrain Control Modules, and NI LabVIEW software. To test the fuel injection



ABOUT THE PROJECT

Industy

- Automotive

Company Name

- US Manufacturer

Tools/ Technologies/ Skills

- NI CompactRIO
- NI LabVIEW
- NI 9751
- NI9757
- NI 9758
- NI 9759
- NI 9752 AD Combo

Goals of the Project

- ECU testing and Validation
- HIL Testing and Simluation
- Reduce costs, testing failures, and time to market

Application Area

- Testing and validation
- SIL/HIL Simulated Testing

system, we used the NI 9751 Direct Injector Driver Module to control the fuel injectors. We also used the NI 9758 Port Fuel Injector Driver Module to provide pulse-width modulation for the control valve solenoids to vary how much the valve is open during various points of the test. Using this module was advantageous compared to many other methods of testing that only test what occurs when the valve is either open or closed.

To test the fuel-to-air ratios in the engine, we used two additional modules. First, the NI 9759 Electronic Throttle Body Driver Module controls the throttle on the engine to regulate how air is let in. The NI 9757 Oxygen Sensor Interface Module monitors how much oxygen is in the exhaust flow. It also provides feedback on the fuel/ air mixture ratio. If it is lean or rich, adjustments can be made to the opening of the throttle to let in more or less air, or adjustments can be made to how much fuel is being metered into the combustion chamber.

We also used the NI 9752 AD Combo Module for multiple tests in the system. First, it tracks the position of the engine during a combustion cycle. Second, it takes a variety of measurements on the engine, with one of the main measurements for this system coming from the temperature and pressure sensors on the engine. These sensors measure the pressure and temperature of the air coming in and the temperature and pressure of the fuel in the fuel rail. There are also several points where the air pressure is measured, including before and after the turbo charger.

The final piece of hardware used in this system is the NI 9753 Differential Digital I/O Module, which is used to send digital commands to the smart coil to control ignition timing and dwell.

We built the control software for this system using soft- ware drivers for NI LabVIEW. Using this modular software structure also helps the manufacturer save money when engine variants are introduced. When this occurs, the end user, or LHPTS, can just tweak the software rather than swap out the hardware used in the system. For example, if a sensor is not present in a certain model, or if a different voltage range is needed for a test, the soft- ware can be quickly changed to modify the tests being performed.

This test system was installed in the manufactures hot test cell, and was designed to stay permanently with the test cell rather than an individual engine. The manufacturer's quality control department said it was much happier with this approach rather than using the original manufactures approach, because they want to be sure the engine is working properly before time and money is spent installing it in an actual vehicle.

Figure 1: NI-9751 Direct Injector Driver Module used to control the fuel Injectors