CUSTOMER CASE STUDY:

TITAN optimizes D&F and NVH Testing for Ford Motor Company

OPTIMIZED D&F AND NVH TESTING

Mars Labs, in collaboration with Ford Motor Company engineers, optimized their demanding Durability & Fatigue (D&F) and Noise, Vibration, and Harshness (NVH) testing using Titan.

BACKGROUND

Durability and fatigue (D&F) testing is a testing methodology applied to systems, components, and materials to establish expected life and identify potential points of failure. It is typically performed early in the product development cycle to assess and validate product design objectives, the results of which provide critical information that can translate to improved quality, reduced costs, and accelerated development.

As applied to motor vehicles, durability and fatigue testing typically requires both static and dynamic frequency measurements, ranging from static conditions to bandwidths up to 50 Hz. For reasons of control and repeatability, it is not uncommon for such testing to be executed via simulation-based systems. For proper operation, these systems require a feedback control loop, which means incorporating an analog output from the data acquisition system. If the data acquisition system does not provide an analog output, that capability must be implemented by 3rd party hardware, and this can result in additional setup time and frustration to configure and calibrate a complete control system.

Noise, vibration, and harshness (NVH) involves the analysis and modification of the noise and vibration characteristics of vehicles. Sources of noise can include the engine, drivetrain, tires, brakes, road surface and wind, as well as cabin cooling fans and engine accessories. Once a source of noise is identified, corrective measures such as barrier isolation, acoustic absorption, and other methods can be implemented to remove or reduce undesirable NVH characteristics.

For D&F and NVH testing, increasingly aggressive development schedules dictate the need to conduct testing as efficiently as possible, and ideally, using the same equipment to minimize reconfiguration activities. This is one of the challenges faced by Ford Motor Company (FMC), as they sought to upgrade their aging data acquisition equipment and update their test labs.

CUSTOMER CHALLENGE

For years, Ford had been using equipment from multiple system types to support separate data acquisition and simulation systems. This arrangement resulted in a time-consuming setup and system calibration for the simulator. This was particularly problematic for the analog output equipment supporting the simulator, as that equipment did not have the ability to balance or monitor the data while running. Additionally, NVH test requirements dictated the need for larger channel counts, which were beginning to exceed the ability of the existing DAQ system. Furthermore, Ford was looking to reduce the amount of training and support for many different pieces of equipment by procuring a single system that could support both D&F (simulation) and NVH testing, while providing for expandability, higher channel counts, and portability to easily transfer between in-vehicle testing and the lab environment.

A Ford Mustang on a four-poster tire-coupled road simulator

What Ford desired in a replacement data acquisition system:
- A common system that could unify all aspects of testing
- Expandability – the ability to add channels as needed
- Increased channel function density – the ability to support multiple sensor types
- Support for commonly-used D&F and NVH scan rates
- Integrated Analog Output support
- Portability – a compact form factor to fit into tight spaces
- Compatibility with the existing setup in the test cells
- Ease of use – simplicity in setup, configuration, and monitoring
- Minimal system retraining

TITAN SOLUTION

Leveraging an established working relationship with Ford, Mars Labs, a specialist in data acquisition systems for automotive R&D, began collaborating with Ford engineers to refine an existing DAQ product (Mars Labs' "Titan"™ Input Module) into a fully integrated system that would be suitable for both D&F and NVH testing.

Based on an existing universal input design that provided multi-sensor connectivity, plus innovative design features such as AutoBalance and built-in Calibration functions, the Titan immediately improved efficiency in test configuration, troubleshooting, and system verification.

Titan's modular design was well-matched to meet Ford's requirement of both portability and expandability, as the module's compact size and light weight allowed the device to fit into tight spaces, and permitted multiple modules to be efficiently combined into larger channel-count systems when needed with the addition of a Titan CPU Channel Multiplexer. Using a Titan CPU Channel Multiplexer, up to eight Titan Input Modules support up to 128 channels, providing Ford with ready expansion capability as test requirements change.

A 32-channel Titan DAQ system for standard seat and instrument panel NVH data collection

A standard Titan Input Module uses a 9-pin D-sub connector (type DB9F) for each input channel. Ford's test infrastructure is based on industry-standard Bendix connectors. To smoothly integrate the Titan system into Ford's existing infrastructure, Mars Labs designed rack-mounted interface adapter panels with Western Regional-wired Bendix connectors, allowing Ford to fully utilize the Titan system in their test labs without changing existing cabling and interconnections.

Custom designed Bendix Interface Adapter panel based on a Titan Input Module

The development of a dedicated Analog Output module provided the support required for closed loop D&F simulations. Developed in the same form-factor as other Titan modules, the design of the Titan DAC Analog Output module allowed it to be separated from Input Modules for optimum flexibility and placement in simulator configurations. The bandwidth of the module was optimized for D&F testing, and an innovative interconnection design combined power and communication over a single connector, eliminating the need for additional power sources, and simplifying connections between equipment.

The Titan DAC Analog Output Module

While new hardware was being developed and existing hardware refined, enhancements to the Titan Control Software (TCS) package were undertaken. Foremost was support added for commonly-used sample rates for D&F and NVH testing. Additional enhancements, such as improved monitoring, triggering, and export functions, further expanded the versatility and ease of use of the Titan system, ultimately providing Ford with a unified D&F and NVH testing solution suitable for both in-vehicle and laboratory environments.

CUSTOMER ROI

Now three years after the initial development activity, the Titan system has proven to be a huge benefit to Ford, demonstrating exceptional versatility and excellent reliability in all phases of D&F and NVH testing. The modular design of the system allows Ford to easily reconfigure in-vehicle tests as needed, and seamlessly translate those acquisitions into the test lab. The modular design also facilitates the replacement, servicing, and repair of individual modules, minimizing system downtime and maximizing productivity.

Using Titan, Ford reports a time savings of 5-6 days for test configuration and troubleshooting over the previous system, and with a 50% increase in the channel count. They report that Titan provides excellent reliability and performance, along with lower support costs, and improved efficiency.

MOVING FORWARD

Mars Labs continues to work with Ford providing training, technical support, and feature enhancements in an ongoing collaborative effort that benefits both companies. As an extension of this collaboration, Mars Labs is currently working in partnership with Ford on techniques for performing D&F testing using ICP sensors; this test unification effort will be detailed in a later case study.

ADDITIONAL RESOURCES

For more information and details on the setup and usage of Titan with MTS Simulators refer to the following Application Notes:

- APN-1001 - DAC Analog IO Applications
- APN-1010 - Interfacing the Titan Data Acquisition System
         with MTS Road Simulation Equipment