Track Tests in Laboratory

- Coupling of MTS test rig and dSPACE Simulator
- Real and simulated components in the loop
- ASM replaces nonexistent components and environment

A new proof-of-concept test bench for developing and validating mechatronic chassis systems was presented at Automotive Testing Expo Europe 2006 by MTS Systems Corporation. The Mechatronic Development and Validation (MDV) test bench – jointly developed by MTS and dSPACE – consists of a mechanical rig for testing semi-active suspensions and a dSPACE Simulator for real-time vehicle dynamics simulation. This combination of a real test rig and real-time simulation shifts test tasks from the track to the laboratory. Beside track test savings it provides new test capabilities in early development phases.

Demo System at Automotive Testing Expo Europe 2006

The proof-of-concept system presented at Automotive Testing Expo Europe 2006 is an integration of an MTS hydromechanical rig with a dSPACE Simulator. It demonstrates how the two test systems can be synchronized in real time and how a large amount of real-time data can be managed and exchanged. The test bench simulates rough road inputs on the tire side of a suspension and force inputs on the body side. It consists of one quarter of a suspension with a variable rate damper, its ECU, a hydromechanical MTS test rig, an MTS rig controller, and a dSPACE Simulator Full-Size. The MTS test rig contains the suspension's road and body actuator (in the demo z-axis only), both controlled in real time by the MTS rig controller.

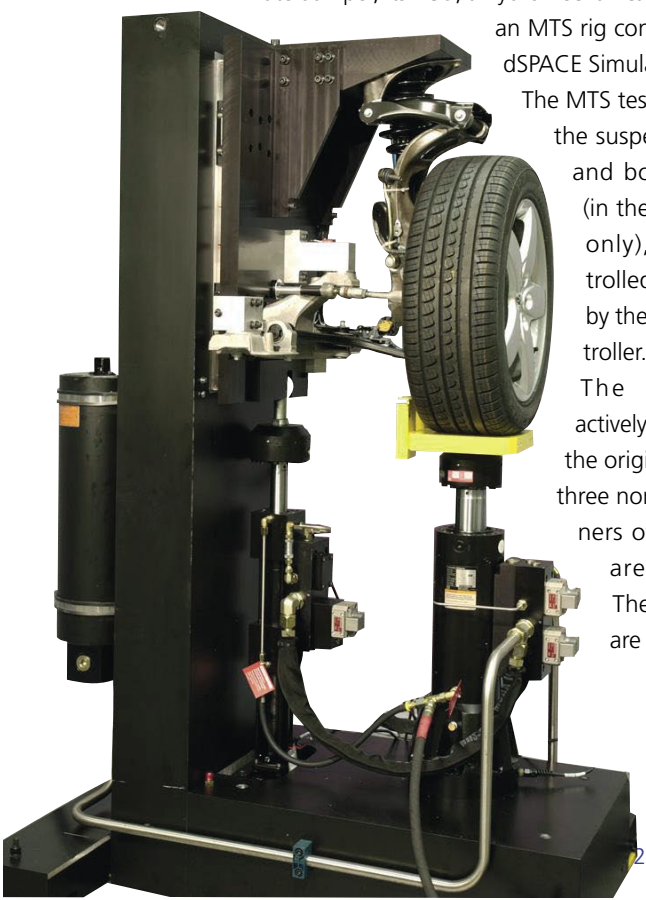
The damper is actively controlled by the original ECU. The three nonexistent corners of the vehicle are simulated. Their ECU ports are connected to the I/O of the simulator, and the corresponding wheel positions are calculated by the ASM vehicle dynamics model (ASM = Automotive Simulation Models). All signals simulated and generated in the vehicle dynamics model are available to the I/O of the simulator. The ECU receives inputs from the real suspension and the model through the simulator. In contrast to closed simulation models, ASM's open and modular model structure enables real parts and simulated parts to be combined in this way.

dSPACE Simulator and ASM also provide the environment (road, driver, maneuvers), which is communicated to the MTS rig controller in real time at 2048 Hz via two SCRAMNet+ connections. Using the powerful DS1006 Processor Board for model and I/O processing guarantees the low latencies which are essential for real-time communication.

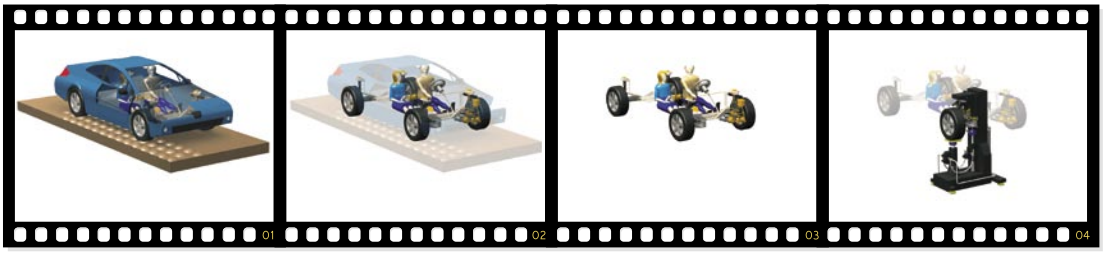
The main components of the dSPACE Simulator Full-Size are the DS1006 Processor Board, a DS2211 HIL I/O Board, and a SCRAMNet+ Interface. The host tools are AutomationDesk for test automation, ControlDesk for instrumentation, MotionDesk for animation, and ModelDesk for model parameterization.

Benefits of MDV Test Benches

Early test studies can be done with an MDV test bench, if test tracks are too expensive and pure HIL simulation is not sufficient or not applicable. MDV test benches are an efficient alternative to track and road testing, performing repeatable, highly accurate



Demo test bench at Automotive Testing Expo Europe 2006 in Stuttgart (Germany).



▲ *From the track to the laboratory with test rigs that physically simulate the road.*

simulations for improved vehicle performance and safety characteristics.

The combination of real-time simulation and real test rigs allows closed-loop operation with real ECUs. MDV test benches can be used for failure simulations and safety-critical tests that cannot be done on a test track. MDV test benches can be used throughout the development and validation phases of a vehicle product development cycle to support system identification, algorithm development, and calibration.

Using dSPACE Automotive Simulation Models in the loop with real components makes mechanical testing more realistic. The mathematical models which make the tested component operate under realistic conditions can be modified easily, so compared to track testing, more can be tested in less time. By relying less on the proving ground and more on the test lab, especially for validation and calibration tasks, mechatronic system engineers will achieve the time and cost savings necessary to support a greater volume and variety of mechatronics-related test scenarios.

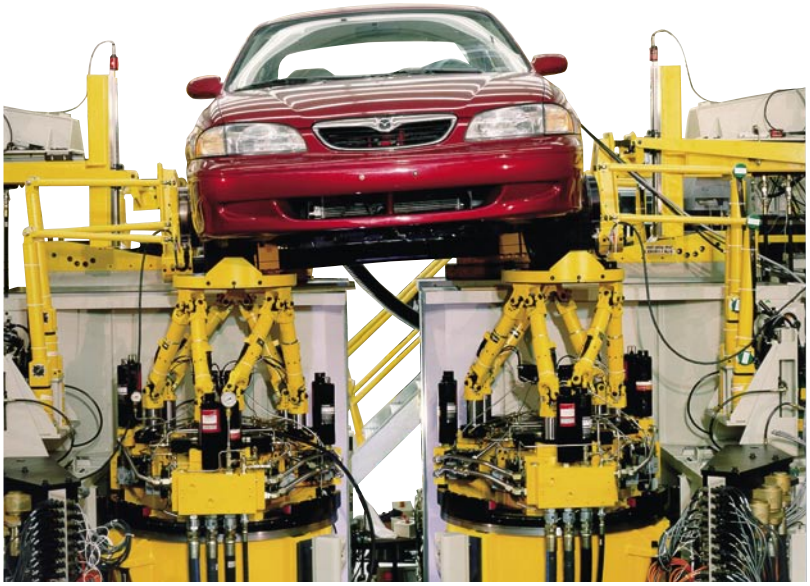
Application Examples

MDV benches can be used for virtually any active chassis or drivetrain system, allowing original equipment manufacturers (OEMs) and suppliers to develop and validate mechatronic ground vehicle systems in a lab setting more efficiently. In many cases, MDV bench functionality can be added to an existing physical test bench. Two areas where this can be done are drivetrain and suspension test systems:

Dynamometer-based (measuring torque and rotational speed) drivetrain test systems for transmissions and all-wheel drives are two types of benches to wich MDV functionality from dSPACE and MTS can be added. In these applications, the test bench simulates realistic loads and tractions on the drivetrain components, with the relevant electronics in the loop.

Suspension test systems, such as seven posters and kinematics and compliance systems, can likewise be developed or upgraded to include MDV functionality. In these applications, the model represents portions of the vehicle and the environment that are not present in the lab to reproduce driving events for the purpose of algorithm development, validation, or evaluation.

Further information on the MDV test systems can be obtained from MTS at info@mts.com



▲ *The mechatronics development and validation concepts demonstrated with the proof of concept apply to other MTS test benches, such as the Dynamic K&C.*

In both cases, the goal is to increase development and validation productivity and prepare the system for more focused track and road evaluation.

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