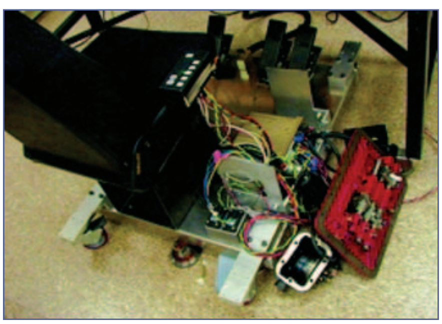
MATLAB in the World

Innovative applications of MathWorks tools across the sciences and industry

AUTOMOTIVE

Automotive engineers responsible for powertrain, chassis, suspension, and other systems must reduce development time while continuing to satisfy market demands for safe, high-performance, fuel-efficient cars and trucks. This requires the development of new technology and systems, particularly electronics and software in the vehicle. It also requires improved collaboration among carmakers and their suppliers to produce clearer specifications, faster design iterations, and verifiable implementations. Automotive companies are meeting these challenges by using development and testing processes based on model-based design, technical computing, and test-and-verification tools from The MathWorks. Here are some examples.

Hardware-in-the-Loop Testing of a Transmission Controller



Eaton Corporation tests the controller for its Fuller AutoShift line of automated mechanical transmissions using a hardware-in-the-loop (HIL) vehicle simulator built using Simulink®, Real-Time Workshop®, and xPC Target. The simulator enables Eaton to test the controller hundreds of times in varying terrains (such as highways, mineshafts, mountains, and flat ground) and environmental conditions (such as rain, snow, and ice), without incurring the time, expense, and safety hazards associated with road testing. The simulated vehicle can be "driven," tested, and run repeatedly in an environmental chamber where road conditions are quickly created. It provides all the electrical signals that the transmission controller "sees" in a real vehicle. xPC Target enabled Eaton to use standard ISA, PCI, and PC/104 I/O hardware, significantly reducing development costs and time. www.eaton.com

Using Design of Experiments to Test Transmissions and ECUs

IAV GmbH in Germany has reduced development times for transmissions and electronic control units (ECUs) by introducing process innovations in two areas of testing: design of experiments (DoE) and HIL. They designed an automated DoE-based process for engine and transmission testing using MATLAB® and the Model-Based Calibration Toolbox. This process uses advanced analytical techniques to produce an optimized test plan, enabling IAV to reduce the scale and cost of bench testing while obtaining a detailed, reliable analysis of engine behavior. The performance of an HIL testing system is often compromised by the slow execution of the complex models running on the system. IAV addressed this problem by developing a Simulink library that is both comprehensive enough to model the dynamic behavior of the complete drivetrain and optimized for speed of execution on HIL systems. www.iav.de

Testing Engine Control Software

BMW tests complex new engine control software by using engine models, developed in MATLAB and Simulink, running on dSPACE Simulator. Because Simulink is an open environment, BMW can incorporate pre-existing engine models from various modeling tools into their Simulink models, using test bench measurements to parameterize them. Code is generated from the engine models using Real-Time Workshop, then deployed onto dSPACE Simulator, where BMW tests the controller software using HIL simulation. This approach enables BMW to test ignition, injection timing, and other features of engine performance safely and cost-effectively. www.bmw.com

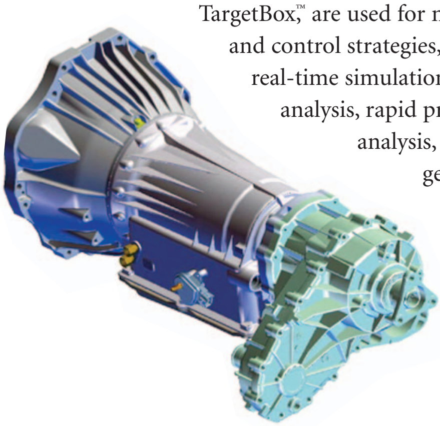
Source: dSPACE News, 1/2003

Modeling and Testing Hydraulics and Gear Shifts for Transmissions

Ion Transmission Systems (formerly BTR Automotive) manufactures transmissions for rear-wheel drive, four-wheel drive, and all-wheel drive vehicles throughout the world. BTR must ensure that each new transmission is working to its maximum efficiency and, at the same time, minimize overhead and development time. MathWorks tools enable BTR to conduct sophisticated testing while reducing the time spent out on a test track. BTR uses MATLAB, Simulink, and other MathWorks products to simulate and check the hydraulic stability and shift calibration of their transmissions. Simulink provides a common modeling and simulation environment, enabling teams working independently on the hydraulic and mechanical aspects of a transmission to integrate their models and avoid duplication of effort. Simulink Performance Tools accelerates the simulations, reducing many to just five minutes. This approach has reduced overall testing time by three to four months, saving up to $200,000 per program.
www.ionlimited.com.au

Customizing Control Software for Heavy Equipment

CAT Electronics develops electrical and electronic monitoring and control systems for a wide range of products, including diesel engines, electric power generators, marine vessels, and earthmoving, construction, and road building machines. These systems are used in Caterpillar Inc. and OEM customers' products. The relatively low volume of many of these products makes traditional approaches to control system development unfeasible. CAT therefore uses mathematical models of control strategies and the mechanisms being controlled as the basis of all development activities. MathWorks products, including MATLAB, Simulink, Stateflow, Real-Time Workshop, and xPC TargetBox,™ are used for modeling mechanisms and control strategies, real-time and non-real-time simulation, control system analysis, rapid prototyping, data analysis, and production code generation. This approach enables CAT to develop customized software in a cost-effective and timely manner.
www.caterpillar.com



In-Vehicle Prototyping and Implementation of Control Strategies

To meet demands for increasingly complex new vehicles while continuing to reduce costs, Jaguar Cars in the UK takes every opportunity to develop and test new functionality using existing production vehicles instead of creating expensive prototypes. This approach usually involves adding a special-purpose ECU with a Motorola® MPC555 microcontroller to the vehicle to ensure compatibility of the various electrical systems. This additional ECU can then be utilized to develop new features within a complete vehicle environment. Jaguar uses MathWorks products to design, simulate, and test control algorithms and then to generate code that can be downloaded to general-purpose ECU hardware. This approach enables Jaguar to cut several weeks or, in some cases, months from the traditional design process by performing many design iterations early in a vehicle program, resulting in more robust system requirements and a reduced, more focused validation effort. **www.jaguar.com/uk**

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