USER STORY

Instron Develops a Multiaxis Test Fixture Using SimMechanics

THE CHALLENGE

To design a test fixture and controller to test the design of a race car

THE SOLUTION

Use SimMechanics and Simulink to design a specialized digital controller together with the mechanics of the test fixture

THE RESULTS

- Simulation performed five times faster
- Models refined quickly and easily
- Design flaws detected and quality improved

To ensure a race car's optimal performance on the track, design engineers must thoroughly test every element of their design—including suspension dynamics, steering behavior, and aerodynamic loading—under strict laboratory conditions.

Instron Structural Testing recently designed a sophisticated new multiaxis test fixture that applies dynamic loads to a race car. The mechanical design team, based in Germany, worked closely with the company's control system specialists in the UK. The fixture can be used in the lab to test the vehicle's response to different steering, braking, and accelerating scenarios, providing data that would be difficult to acquire on a test track.

Instron used Simulink® to develop the controller and SimMechanics to develop the mechanical part of the test fixture. "Being able to model and simulate the entire system with a representative race car was critical to the success of the project," says Dr. Andrew Plummer, manager of control and analysis at Instron.

THE CHALLENGE

Instron set out to develop a test fixture that applied forces on the race car in multiple axes. Their customer could then measure and evaluate the performance of the car's suspension and entire handling dynamics.

Instron therefore needed to simulate a highly complex test environment comprising the controller, the test fixture, and the mechanics of the car, which itself had fifteen moving parts for each wheel. The test fixture integrated control systems and sophisticated mechanical components. These included 18 hydraulic actuators, each of which was connected to the car using mechanical linkages with rotating joints. Specialized parts needed to be designed and incorporated into the mechanical design to minimize friction in the joints.

Although Instron has produced many full vehicle test fixtures for passenger cars and race cars, this project required a higher system performance and greater control accuracy than ever before.

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>
> Dr. Andrew Plummer, Instron

In previous projects, Instron had used Simulink to model control systems and a mechanical modeling package to model mechanical parts. Using separate environments slowed down the design process, says Plummer, because it "required information to be passed back and forth between the two solvers at every time step."

THE SOLUTION

To improve efficiency, Instron used one integrated environment to model every component. They chose MATLAB®, Simulink, and SimMechanics to simulate the controller and the test fixture concurrently. They could then use simulation results from the controller and the test fixture to improve the design of each.

The Instron engineers developed the new controller in MATLAB and Simulink and used Simulink and SimMechanics to model the test fixture. Previously, they had developed a Simulink model of hydraulic components that simulated pressure differences across the pistons. They integrated this model into the SimMechanics actuator block, which enables a signal to be taken from Simulink and applied as a force to a SimMechanics body.

They incorporated the MATLAB and Simulink model of the controller into the SimMechanics model of the test fixture. They could then refine the SimMechanics model to enable them to test the performance of any test fixture or controller design.

To accelerate development, the engineers used Real-Time Workshop® to generate C code from the Simulink part of the control system. This code runs on a high-speed processing platform that is linked to Instron's standard digital controllers.

THE RESULTS

- **Simulation performed five times faster.** "Previously, when we were cosimulating between Simulink and the mechanical modeling package, information had to be passed back and forth between the two solvers at every time step," says Plummer. "Using SimMechanics, we are running simulations approximately five times faster than we were before."
- **Models refined quickly and easily.** "We've actually evolved the mechanical design so that we can test out any design idea using the SimMechanics model and refine it based on the results that we receive back from the simulation," Plummer explains.
- **Design flaws detected and quality improved.** "There's quite a range of areas that we've been able to understand using Simulink and SimMechanics," says Plummer. "We used SimMechanics to eliminate potential defects from the mechanical design. For example, we were able to examine the loads on a variety of mechanical joints to ensure that the components were durable."

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APPLICATION AREAS

- Automotive engineering
- Control design
- Mechanical modeling and analysis
- Modeling and simulation

PRODUCTS USED

- MATLAB
- Simulink
- SimMechanics
- Real-Time Workshop

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