Lear Delivers Quality Body Control Electronics Faster Using Model-Based Design

Lear automotive body electronic control unit.

The Challenge

Design, verify, and implement high-quality automotive body control electronics

The Solution

Use Model-Based Design to enable early and continuous verification via simulation and SIL and HIL testing

The Results

- Requirements validated early
- Development time cut by 40%
- Zero warranty issues reported

Automotive OEMs are pushing suppliers to deliver more functionality in ECU software. To reduce cost, suppliers often integrate many control functions for body electronics—from wipers, lights, windows, and antitheft systems to power distribution—on a single ECU, commonly known as a body control module (BCM) or smart junction box.

The rapid increase in system complexity has led to poorly defined requirements, missed deadlines, and quality issues across the industry. Engineers at Lear Corporation are addressing these challenges by using Model-Based Design to develop, verify, and implement body control electronics systems.

"With Model-Based Design we identify and resolve requirements issues before implementation," says Jason Bauman, supervisor, systems engineering at Lear. "Production code generation and continuous verification enable us to complete projects on time, within budget, and with high quality."

The Challenge

As vehicle electronics and electrical distribution systems become increasingly complex, requirements need to be clear, complete, and consistent. In traditional hand-coding workflows, ambiguous or conflicting requirements are often discovered late in the development process, leading to schedule or cost overruns.

Handwritten code for controllers with hundreds of inputs and outputs and sophisticated state logic is difficult to maintain and reuse. "In the past, as we implemented an engineering change request in one area, we had a difficult time predicting the types of issues we were introducing in the rest of the system," recalls Jinming Yang, principal engineer at Lear.

The Solution

Lear adopted Model-Based Design for the design, verification, and implementation of dozens of body electronics systems.

In one BCM project, Lear engineers analyzed customer requirements and partitioned the overall system into components such as interior and exterior lighting, battery management, and vehicle starting control.

The team used MATLAB®, Simulink®, and Stateflow® to develop fully functional behavioral models, including all required inputs and outputs, for each component.

To conduct early unit testing, the engineers used the Signal Builder block in Simulink to generate test stimuli and incorporate them into the models. The team also used Simulink to develop plant models for functional testing.

Using Simulink Verification and Validation™, the team analyzed model coverage and continued refining test cases, designs, and requirements until they reached satisfactory model coverage levels, including decision coverage and modified condition/decision coverage (MC/DC).

After verifying nearly 400 unit models, the team used Embedded Coder™ to generate C code. They verified this code via software-in-the-loop (SIL) tests that reused the test cases generated for the unit model tests.

MathWorks®

> *"We adopted Model-Based Design not only to deliver better-quality systems faster, but because we believe it is a smart choice. Recently we won a project that several of our competitors declined to bid on because of its tight time constraints. Using Model-Based Design, we met the original delivery date with no problem."* —Jason Bauman, Lear

Lear engineers integrated the generated code for each unit model into 20–30 feature-level components, which were in turn integrated into a complete system model. The team met with the customer and ran simulations of the components and the complete model to resolve ambiguities in the original design specification.

The group used MATLAB scripts to automate the conversion of test cases into test vectors for hardware-in-the-loop (HIL) and vehicle-based testing. They wrote additional MATLAB scripts to import and analyze the test results from the hardware.

The ability to share models enabled Lear to extend the workday across a distributed team. In some cases, design changes made by Lear engineers in North America were tested the same night by colleagues in Asia.

On a separate project for an international customer, issues with translating technical terminology made it challenging for Lear engineers to understand a particular requirement. "We used a Simulink model including a Signal Builder block to visualize different timing options, and the customer immediately selected the one they wanted," notes Bauman. "Opening that line of communication was vital to the project."

The Results

Requirements validated early. "For the BCM project, we used virtual integration and test with executable functional models in Simulink to identify more than 95% of requirements issues before implementation—compared with just 30% before we started using Model-Based Design," says Bauman. "We resolved issues much earlier too, often in as little as six weeks from the start of the project, instead of a year or more."

Development time cut by 40%. "We generated about 700,000 lines of code for the BCM project, and we reused test cases throughout the development cycle," says Yang. "This approach enabled us to reduce overall development time by about 40%."

Zero warranty issues reported. "Industry-wide, the number of warranty issues has grown with software complexity," says Bauman. "For the most recent products that we have completed using Model-Based Design, we've had no warranty issues related to application software after 12 months of production. That is a record that our current and future customers are happy to hear."

Industry

- Automotive

Application Areas

- Embedded code generation
- Verification, validation, and test
- Control systems

Products Used

- MATLAB®
- Simulink®
- Embedded Coder™
- MATLAB Coder™
- Simulink Coder™
- Simulink Verification and Validation™
- Stateflow®

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