Impact of Model-Based Design in the Automotive Industry

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Simulink 6 for Model-Based Design
Inside Today’s Technology Explosion: Embedded Control and Signal Processing
Problems with Traditional Development

- **Requirements and Specifications**
  - Text-based
  - Prevents rapid iteration

- **Design**
  - Physical prototypes
  - Incomplete and expensive

- **Implementation**
  - Manual coding
  - Introduces human error

- **Test and Verification**
  - Traditional testing
  - Errors found too late in the process
Advantages of Model-Based Design

Requirements and Specifications

Design

Implementation

Test and Verification

- Executable models
  - unambiguous
  - only “one truth”

- Simulation
  - reduces “real” prototypes
  - systematic “what-if” analysis

- Automatic code generation
  - minimizes coding errors

- Test with Design
  - detects errors earlier

The MathWorks International Automotive Conference
Model-Based Design with Simulink
Nissan Develops Emission Reduction System for Mass-Production Vehicles Using MathWorks Tools

The Challenge

- To design an emission reduction system certified by the California Air Resources Board (CARB) for the Partial Zero Emission Vehicle (PZEV) Standard

The Solution

- Use MathWorks tools for model-based design to design an emission reduction system that was certified by CARB for the PZEV standard

The Results

- Development time reduced by 50%
- Environmental Protection Agency award received
- Number of sensors reduced

“Model-based design with MATLAB and Simulink is fully proven and indispensable to our engineering process, and gives us an edge over our competition.”

Shigeaki Kakizaki, Nissan Motor Co., LTD.
Table 2 shows ROM and RAM comparisons between hand code and auto code for a floating-point component in some typical powertrain software.

<table>
<thead>
<tr>
<th></th>
<th>Hand Code</th>
<th>Auto Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>6408</td>
<td>6192</td>
</tr>
<tr>
<td>RAM</td>
<td>132</td>
<td>112</td>
</tr>
</tbody>
</table>

The auto code has less size of ROM and RAM compared to that of hand code. The auto code is readable and peer reviewed, and checked with the QAC static analysis tool. Most importantly, the auto code is implemented in a real-world powertrain application.

CONCLUSION

A custom data class allowing data type and data scaling information to be incorporated into the model is...
Simulink and Model-Based Design Produces Results Across Industries

Standard for Powertrain Controls
Production Code Development

Advanced Flight Control Systems

FPGA-Based Radar System

AC’97 Audio Codec Chip
Yet, engineers are asking for…

- Modeling of ever larger systems
- Managing multi-team development projects
- Better integration with coding practices
- Exceed hand code performance
- Design more types of systems and components, including hardware
- Don’t forget that I use MATLAB, too!

These are the next set of challenges
Simulink 6

Large-scale projects and end-to-end development

New domains and applications

...driving the evolution and adoption of Model-Based Design
Simulink 6 for Large-Scale Projects and End-to-End Development

■ Large-scale modeling and teams
  ● Model Reference
  ● Model Explorer

■ End-to-end embedded system development
  ● Embedded MATLAB functions
  ● Fixed-point math
  ● Production code
  ● Test and verification
Simulink 6 for New Domains and Applications

- Signal Processing and Communications
  - RF Toolbox and RF Blockset
  - Video and Image Processing Blockset
  - Filter Design HDL Coder

- Control system modeling and design
  - SimDriveline
  - Control design and analysis in Simulink
Demonstrations of New Features in Simulink 6
Automotive Powertrain Control

■ Description
  ● Complete model of the vehicle powertrain
  ● Implements multiple complex controllers for automatic transmission powertrain

■ What you will see
  ● Model Reference for component-based modeling
  ● Modeling transmissions with SimDriveline
  ● Managing a data dictionary with Model Explorer
  ● Verification and validation of algorithms
Automotive Powertrain Control

- Drives modeled with SimDriveline
- Model Reference for component design and testing
- Package generated code for production deployment
- Data Dictionary in Model Explorer
New Products and Major Upgrades in Release 14 for Model-Based Design

### New Products
- Filter Design HDL Coder
- Fixed-Point Toolbox
- Link for ModelSim
- RF Blockset
- RF Toolbox
- SimDriveline (Aug ’04)
- Simulink Control Design
- Simulink Parameter Estimation
- Simulink Verification and Validation
- Video and Image Processing Blockset (July ’04)

### Major Upgrades
- Simulink
- Signal Processing Blockset
- Stateflow
- Communications Blockset
- Real-Time Workshop
- Embedded Coder
Summary

Simulink 6 brings:
- Model-Based Design to large-scale projects
- More comprehensive coverage of embedded system development
- New domains and applications

Simulink continues to drive the evolution and adoption of Model-Based Design

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www.mathworks.com/r14