Hybrid Electric Vehicle

Information Kit

Contents

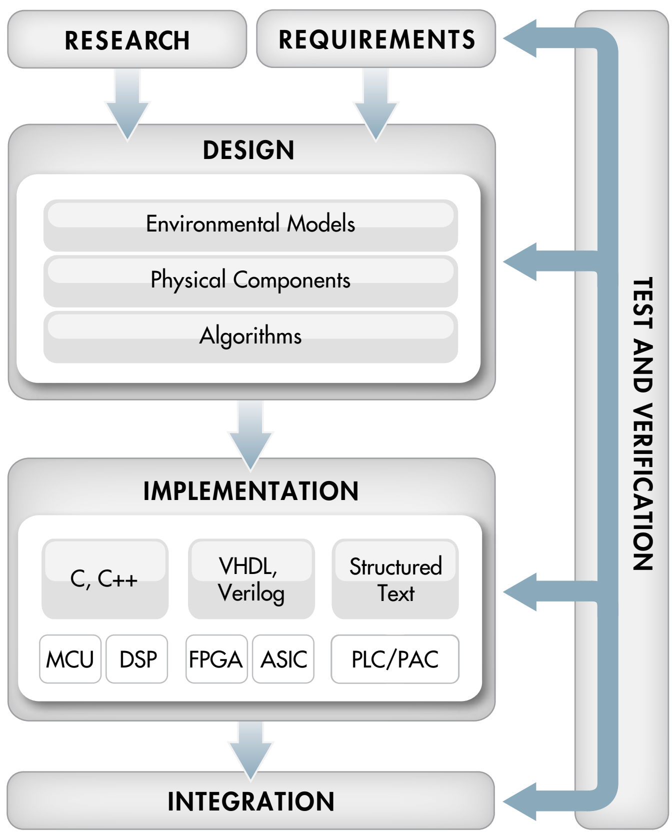
Workflow for Model-Based Design

Model-Based Design helps engineers meet the demand for green vehicles by facilitating the move from concept car to production-ready, fuel-efficient vehicle. Engineers quickly build conceptual system models, make design tradeoffs, and verify algorithms before prototype components or vehicles are available.

» Learn more

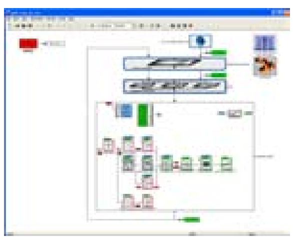
- System design and simulation
- Physical modeling
- Control system design

- Embedded code generation
- HDL code generation and verification



- Verification, validation, and test
- Rapid prototyping

User Stories



- Argonne National Laboratory Develops Powertrain System Analysis Toolkit with MathWorks Tools » Read Story

- Dongfeng Electric Vehicle Develops Battery Management System for Hybrid Electric Vehicles Using Model-Based Design » Read story

- Eaton Reduces Emissions by 90% for Leading Freight Carrier's Hybrid Test Delivery Vehicles » Read story

- GM Standardizes on Model-Based Design for Hybrid Powertrain Development » Read story

Technical Articles

- **Parameterization of a Battery Simulation Model Using Numerical Optimization Methods** » Read article

  Typically, battery models are complex and difficult to parameterize to match real-world data. Achieving a good generalized fit between measured and simulated results should be done using a variety of laboratory data. Numerical optimizations can ensure the best possible fit between a simulation model and measured data, given a set of constraints.

- **Analyzing Test Data from a Worldwide Fleet of Fuel Cell Vehicles at Daimler AG** » Read article

  More than 100 hydrogen fuel cell vehicles in the Daimler AG (formerly DaimlerChrysler) test fleet are operated by ordinary drivers in real-world driving conditions around the world. For development purposes only, each vehicle is equipped with a powerful telematics system that captures data on vehicle performance and driver usage patterns—from the vehicle's GPS coordinates, fuel tank fill level, and vehicle velocity to the position of the gas pedal beneath the driver's foot. MATLAB based algorithms were used to translate the millions of drive files accumulated by test vehicles into reports on vehicle performance and refueling infrastructure.

- **Using Model-Based Design to Build the Tesla Roadster** » Read article

  Tesla developed the 2008 Tesla Roadster, the world's first 100-percent electric production sports car, with a fraction of the budget of traditional vehicle development projects. They optimized engineering resources and the design process by using MathWorks tools to model the entire vehicle and its major subsystems, run detailed simulations, analyze performance, and evaluate design tradeoffs.

Technical Articles

- **A Verification and Validation Workflow for IEC 61508 Applications**

  » Read article

  Because of its ability to address software complexity and productivity challenges, Model-Based Design with production code generation has been extensively used throughout the automotive software engineering community. More recently, engineers have begun to focus on compliance with external standards such as IEC 61508 and the use of Model-Based Design.

- **Evaluating Plug-in Series Hybrid Designs for Postal Delivery Vehicles**

  » Read article

  The College of Engineering and Computer Science at the University of Michigan – Dearborn is helping to meet the growing need for more fuel-efficient vehicles with an interdisciplinary program leading to a master's degree in Automotive Systems Engineering. As part of this program, a study was conducted to determine the feasibility of using plug-in series hybrid technology to extend the range of electric vehicles used by the United States Postal Service. Using physical modeling tools from MathWorks, engineers modeled and simulated the vehicle, its powertrain, and its control systems.

On-Demand Webinars

- **Developing Accurate Battery Simulation Models** » View webinar

  An accurate battery model is essential to system-level design and analysis for many battery-based systems such as hybrid electric vehicles (HEVs) and uninterruptable power supplies (UPSs). However, battery models are complex and difficult to parameterize to match real-world data. In this webinar, MathWorks engineers will develop a battery model and use test data to automatically tune the model parameters.

- **Developing a Permanent Magnet Synchronous Motor Controller Using Model-Based Design** » View webinar

  Permanent magnet synchronous motors (PMSMs) play a vital role in automotive and industrial automation applications. However, the development of PMSM controllers remains a complex and often expensive engineering task. MathWorks engineers will show how you can reduce development time and cost with Model-Based Design. They will demonstrate the design flow of modeling the controller as part of an executable specification, designing with simulation, and implementing using automatic code generation.

- **Model-Based Design for Hybrid Electric Powertrain Systems** » View webinar

  Learn how to address the technical challenges of developing a hybrid electric powertrain system, including the power converter, motor, and battery subsystems, by using Model-Based Design. You'll also see how to develop complex control algorithms in parallel to the development of the mechanical and electrical hardware.

Demo Videos

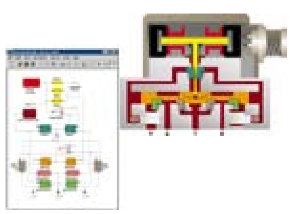
- **Modeling an Automatic Transmission Controller** » View video
  Model a controller for an automatic transmission. The control logic is modeled as a state machine using Stateflow.
- **Modeling a Vehicle Powertrain** » View video
  Build a model of a vehicle powertrain, including gears, tires, engine, and longitudinal vehicle dynamics.
- **Automotive Powertrain Control System** » View video
  Generate powertrain production code for automotive engine control units.

Key Products

- **Simulink** » Learn more

  Simulation and Model-Based Design

  Simulink® is an environment for multidomain simulation and Model-Based Design for dynamic and embedded systems. It provides an interactive graphical environment and a customizable set of block libraries that let you design, simulate, implement, and test a variety of time-varying systems, including communications, controls, signal processing, video processing, and image processing.



- **Simscape** » Learn more

  Model and simulate multidomain physical systems

  Simscape™ extends Simulink with tools for modeling systems spanning mechanical, electrical, hydraulic, and other physical domains as physical networks. It provides fundamental building blocks from these domains to let you create models of custom components. The MATLAB® based Simscape language enables text-based authoring of physical modeling components, domains, and libraries.

- **SimPowerSystems** » Learn more

  Model and simulate electrical power systems

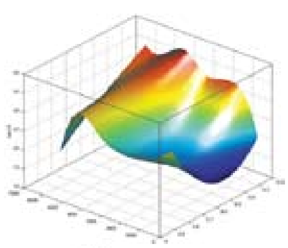
  SimPowerSystems™ extends Simulink with tools for modeling and simulating the generation, transmission, distribution, and consumption of electrical power. It provides models of many components used in these systems, including three-phase machines, electric drives, and libraries of application-specific models such as Flexible AC Transmission Systems (FACTS) and wind-power generation. Harmonic analysis, calculation of Total Harmonic Distortion (THD), load flow, and other key power system analyses are automated. SimPowerSystems models can be discretized to speed up simulations.

Key Products

- **Real-Time Workshop Embedded Coder** » Learn more

  Generate C and C++ code optimized for embedded systems

  Real-Time Workshop® Embedded Coder™ generates C code from Simulink and Stateflow® models that has the clarity and efficiency of professional handwritten code. The generated code is exceptionally compact and fast—essential requirements for embedded systems, on-target rapid prototyping boards, microprocessors used in mass production, and real-time simulators. Full support is provided for the integration of legacy applications, functions, and data.



- **Model-Based Calibration Toolbox** » Learn more

  Calibrate complex powertrain systems

  Model-Based Calibration Toolbox™ provides design tools for optimally calibrating complex powertrain systems using statistical modeling and numeric optimization. You can define test plans, develop statistical models, and generate calibrations and lookup tables for complex high-degree-of-freedom engines that would require exhaustive testing using traditional methods. By using the toolbox with MATLAB and Simulink, you can develop a process for systematically identifying the optimal balance of engine performance, emissions, and fuel economy, and reuse statistical models for control design, hardware-in-the-loop testing, or powertrain simulation.

- **Stateflow** » Learn more

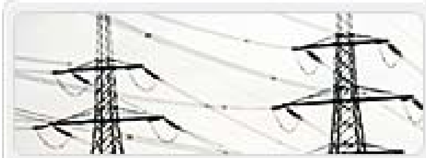
  Design and simulate state machines and control logic

  Stateflow® extends Simulink® with a design environment for developing state charts and flow diagrams. Stateflow software provides the language elements required to describe complex logic in a natural, readable, and understandable form. It is tightly integrated with MATLAB® and Simulink products, providing an efficient environment for designing embedded systems that contain control, supervisory, and mode logic.

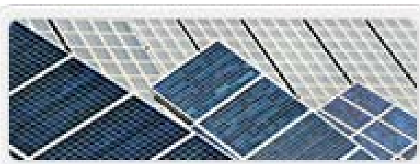
Additional Energy Segments

Engineers and scientists worldwide rely on MathWorks software to perform the challenging analysis, simulation, and product development tasks necessary to address the world's energy needs. You can use MATLAB and Simulink to evaluate energy resources, develop systems for power generation and distribution, model energy markets, and create products that consume less energy and are environmentally friendly.

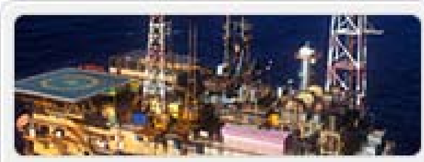
Electric Vehicles



Electric Utilities



Solar Power



Oil and Gas

Wind Power

Trading and Risk