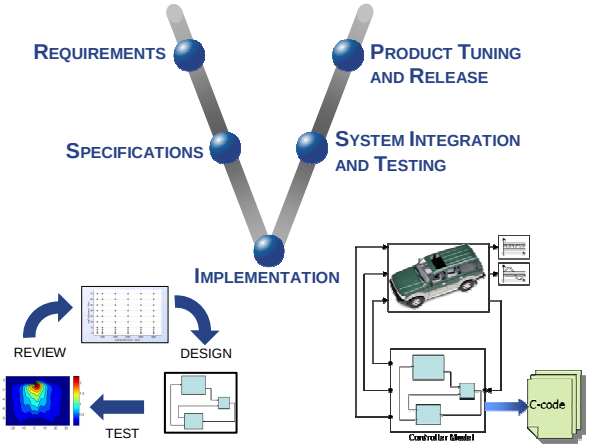
EMMESKAY
ADVANCED TECHNOLOGY SOLUTIONS

PLANT MODELING

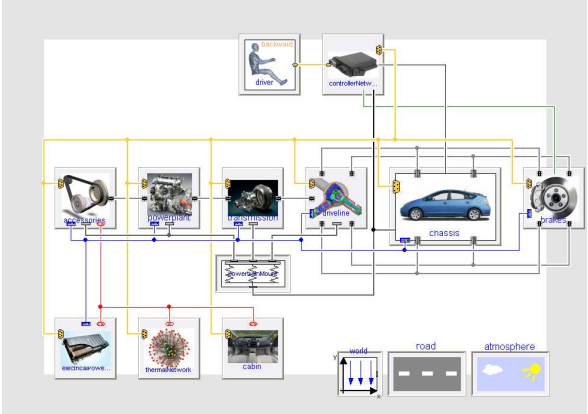


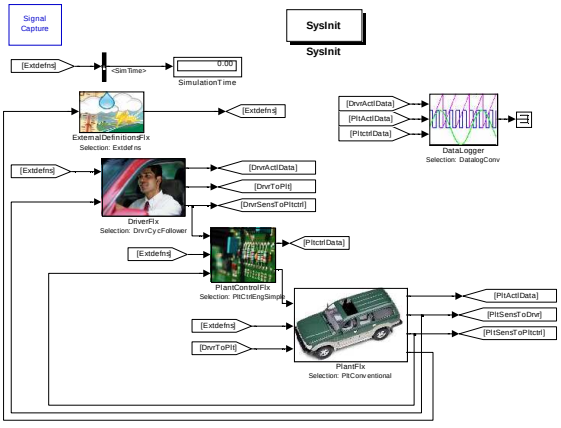
Systems Engineering

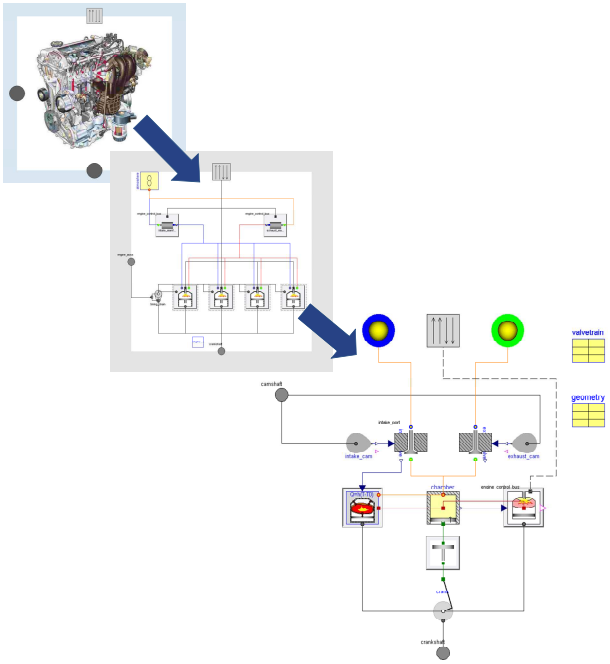
Emmeskay offers state-of-the-art plant modeling products and related consulting services to support Model-Based Systems Development (MBSD). Emmeskay provides a global resource base with diverse technical backgrounds. Our extensive experience across engineering domains, modeling approaches, tools, and advanced analysis methods enables us to deliver high quality technical solutions to challenging, multi-disciplinary problems. By leveraging fundamental domain expertise, practical modeling experience, and a structured, requirements-driven modeling process, Emmeskay offers a unique combination of skills to deliver high-value plant modeling solutions to customers in the mobility, defense, energy, medical, and environmental industries. This document highlights a few aspects from our plant modeling portfolio.

Vehicle Modeling: Emmeskay provides complete vehicle modeling environments suitable for simulation of conventional, hybrid, and other advanced concept vehicles. Emmeskay offers both a Modelica® based vehicle modeling architecture and the MoVE model in MATLAB®/Simulink® to support MBSD activities at the vehicle system level. The vehicle modeling architectures are flexible, modular, extensible, and reconfigurable to allow seamless plug-and-play simulation of system variants. Supported by formal configuration management technologies, these modular architectures give users the ability to rapidly integrate modifications of the plant and controller subsystems into the simulation to assess system-level vehicle response. The MoVE architecture is a convenient platform for real-time simulations and can support Model-in-the-Loop (MIL), Software-in-the-Loop (SIL), and Hardware-in-the-Loop (HIL) based controller testing and validation.

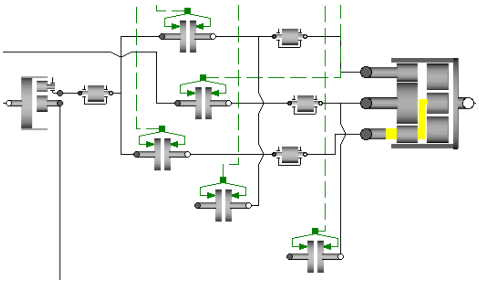
Each architecture enables the distributed development of large system models and is designed to support the integration of user-specific and Emmeskay-provided submodels of varying levels of complexity. Emmeskay offers a wide array of fully parameterized component models for use within the model architectures including representations for the engine, transmission, gearbox, driveline, electric machines, battery/electrical power network, and electrical and mechanical accessories. Integrated into the vehicle modeling architectures, these models support a wide array of drive cycle and maneuver-based simulations for performance, fuel economy, NVH, and thermal/energy management.





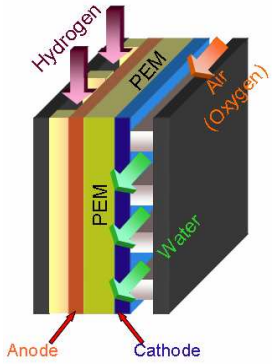


Engine Modeling: Dynamic models of engine behavior are required in a wide range of MBSD activities. Emmeskay offers dynamic engine models of both spark-ignited and diesel engines with varying levels of modeling detail to support both controls-oriented and design-oriented applications for key engine attributes such as performance, fuel economy, and NVH. The models are flexible, configurable, and fully parameterized for use in standalone applications or within the Modelica® based vehicle modeling architecture and the MoVE model architecture in MATLAB®/Simulink®. The models can be configured as mean value models for computationally demanding, real-time applications or with crank angle-resolved physics to support applications which require fluctuating engine torque dynamics. Models for sensor and actuator dynamics can be included to support ECU development activities. While typical component data is available for the parameterized models, custom parameterizations and calibrations can be developed to support modeling of specific engine hardware.



Custom Plant Model Development: Emmeskay has expertise in developing customized, dynamic models to support component design and MBSD activities such as trade-off analysis, control algorithm design, and closed-loop embedded software testing on a real-time platform. Using a structured model development process based on requirements, specifications, and validation data, high quality models can be developed which capture the behavior of the physical system. Customers benefit by having a re-usable platform from Emmeskay that captures the knowledge of the system.

Fuel Cell Stack Model (FC Stack): Emmeskay's FC Stack model is a MATLAB®/Simulink® based model of a Proton Exchange Membrane (PEM) Fuel Cell. Incorporating the physical, chemical, and thermal behaviors of the membrane, electrodes, and multiple component species in the process streams including coolant dynamics, the model simulates the critical physical phenomena occurring in the fuel cell and can be used for system analysis and design. The parameterized model captures the details of fuel cell performance over a range of design and operating parameters. The model architecture is reconfigurable thereby making it extremely easy to adapt FC Stack for application-specific requirements. Real-time compatibility enables hardware-in-the loop testing of stack controller.



Tools and Methods: Emmeskay works closely with customers to provide plant modeling solutions in a wide variety of tools. Emmeskay has vast experience in delivering models using the MathWorks® suite of tools including Simulink®, SimScape®, SimMechanics®, SimDriveline®, and SimHydraulics®. Emmeskay is one of the leading providers of plant models using the Modelica® modeling language and has deployed solutions using Dymola® and other commercial libraries including the PowerTrain library, AirConditioning Library, HyLib, and PneuLib. Emmeskay also has expertise in modeling with AMESim®, VHDL-AMS®, ASCET-SD®, and GT-POWER®. Beyond the native models, Emmeskay offers customer-specific services to support model calibration and validation, controller code integration, model process development, and advanced analysis methods such as system optimization, robustness analysis, and dynamic programming.

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