Holistic Vehicle Simulation using Modelica – An Application on Thermal Management and Operation Strategy for Electrified Vehicles

Claude Bouvy
Forschungsgesellschaft Kraftfahrwesen mbH
Steinbachstraße 7, 52074 Aachen
bouvy@fka.de

S. Baltzer P. Jeck J. Gissing T. Lichius L. Eckstein
Institut für Kraftfahrzeuge – RWTH Aachen University, Aachen
Steinbachstraße 7, 52074 Aachen
baltzer@ika.rwth-aachen.de

The increasing electrification of the drive train in the automotive environment leads to higher requirements for automotive systems and their design. Furthermore, with the increased electrification of future car architectures the complexity and the interaction between the different physical levels (mechanical, electrical, thermal and chemical) will clearly be increased. Therefore, a computer based methodology to support the engineer in the design phase of car concepts, components and control algorithms is desirable. All relevant sections of a vehicle development process, e.g. longitudinal and lateral dynamics, thermal management or the power supply should be considered. Due to this necessity a new holistic vehicle library based on the modeling language Modelica is being developed at the Forschungsgesellschaft Kraftfahrwesen mbH Aachen (fka) and the Institute of Automotive Engineering (ika) of RWTH Aachen University.
The model library takes into consideration all energetic (mechanical, electrical, thermal and chemical) and logical (sensors, actors and control units) flows including dynamic boundary conditions (e.g. drive cycles, ambient conditions) of automotive concerns. It follows a layer based level approach and has four levels. At the lowest level (base level) generalized elements are implemented which can easily be adapted due to the object oriented modeling property of inheritance or instantiation. The second level, the components level combines a variable number of base elements to generate models to a chosen level of design. At the system level (third level) the interactions of energy and signal flow between all components are implemented. The top level, i.e. the vehicle level combines all vehicle sub models such as the power train, the respective cooling circuits, the power supply and the passenger cabin. Beside the global boundary conditions, such as the driving cycle, the route profile, ambient conditions or initial conditions a control block which consists of the driver and the ECU manages all concerns of control.

The introduced holistic method is applied exemplarily on an architecture with the traction battery used as a thermal storage to determine the potential of such a design on the overall efficiency and to analyse different operational strategies.