

# Integrated Vehicle Thermal Management in Modelica: Overview and Applications

John Batteh<sup>1</sup>

Jesse Gohl<sup>1</sup>

Sureshkumar Chandrasekar<sup>2</sup>

<sup>1</sup>Modelon, Inc.

<sup>2</sup>Modelon, Inc.

Ann Arbor, MI, USA

Hartford, CT, USA

{john.batteh, jesse.gohl, chandrasekar.sureshkumar}@modelon.com

This paper highlights the use of a coordinated suite of Modelica libraries for vehicle thermal management (VTM) applications. The models are implemented using the Vehicle Dynamics Library, Liquid Cooling Library, and Heat Exchanger Library from Modelon. An integrated vehicle thermal management model is implemented, including the key physical and controls models. The model is used to demonstrate complex, multi-domain interactions between the physical and control systems over drive cycles for combined thermal and fuel efficiency studies. The model is also used to support controller development and optimization as an FMU integrated into Simulink. The flexibility of FMI-based workflows is also illustrated via batch and Monte Carlo simulations in Excel. A heat exchanger application coupling inputs from CFD illustrates the use of higher fidelity models from Heat Exchanger Library for calculation of performance degradation due to non-uniformity.

