

MSc Thesis proposal Volvo Group Truck Technology: *Modelling heavy vehicle air systems in Modelica*

About us

Advanced Engineering & Vehicle Concepts is organized within Vehicle Engineering at Volvo Group Trucks Technology. We are responsible of preparing future trucks and transport solutions for all Volvo Group's brands and markets by managing and driving Advanced Engineering at Vehicle Engineering & Vehicle Technology. We develop the future competitive trucks to ensure the transport and energy efficiency for our customers and the society. We are open-minded and performance-oriented and honour to deliver tangible results.

Thesis Background

Environmental issues, consumers' expectations and the growing demand for freight transport have created a competitive environment in providing better transportation solutions. Conceptual and optimization-based vehicle design using mathematical models help finding cost- and energy-efficient solutions and eventually faster market adaptation. Therefore, mathematical models with acceptable levels of fidelity must be developed to facilitate the conceptual design and performing optimization, for example, to understand what vehicle components are suitable for US transport fleet market and how they are different from Asia and Europe applications.

Modelica language offers modular physical modelling. It is tool-independent and there are many open-source libraries which make building models with different levels of fidelity possible. In addition, models are open, so that the mathematical equations are visible to users, providing a good autonomy for updating the existing libraries and developing new models.

Problem motivating the project

Properties of the mathematical model such as modularity and flexibility in change of the model fidelity are necessary for vehicle conceptual design and optimization. The required system fidelity might be different depending on design targets, applications, optimization cost and constraints. The developed air system models should be easily replaceable within the overall vehicle model so that their performance and cost can be assessed and compared. In an optimization framework for sizing the components and replacing the pneumatic system with other solutions, the fidelity of models must be as lowest as possible and yet maintain the important physical behaviour, which is validated using high fidelity models or/and experimental data.

Envisioned solution

The envision solution is mathematical models in Modelica that can be used to simulate and compare the performance of air suspension system, pneumatic brake system, cabin, transmission, etc, together with their control and their energy usage. The models should be modular, i.e., it should be possible to change a low fidelity air suspension model or pneumatic brake system with a high fidelity one within the complete vehicle model to capture the physical phenomena needed for the given application. Developing the complete vehicle model is not part of the thesis.

Objective or Research Question

How to model the different air systems, e.g., suspension, brakes, cabin, transmission, etc in Modelica with the purpose of component sizing and cost and energy evaluation?

What are the important phenomena and physical behaviours that change or cannot be captured by altering the model fidelity?

What is the energy consumption of the specific subsystem in the air system?

How the parameter tuning can be done to fit the simulations with the available experimental data?

Deliverables (flexible)

- Mathematical models with different levels of fidelity of heavy vehicles' air systems, e.g., suspension, brakes, cabin, transmission, etc in Modelica, and if possible, using available open-source libraries.
- The Modelica model should be automatically parameterized reading a model-independent vehicle parameter file.
- Making the comparison of the simulation results with other available in-house tools as well as the available real-world test data, both in terms of energy consumption and performance.
- Some of the models should be exported as functional mock-up units to another environment (such as Matlab or Python) and re-parametrization and change of model fidelity should be tested in the new environment.

Requirement on student background:

Talented master students in Automotive, Mechanics, Mechatronics or Engineering Physics, with some knowledge of Modelica, programming and suspension systems. Please submit your CV and transcripts to toheed.ghandriz@volvo.com.

Supervision and examination:

Volvo Group Truck Technology, Advanced Vehicle Engineering.

Thesis Level: Master

Language: English

Starting date: January 2022

Number of students: 1 or 2

Physical location:

Mainly a university in Sweden, but students are welcome to sit also at VGTT occasionally.

Contacts:

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Supervisor(s) and examiner: will be decided based on where student(s) are studying.