Model-based conceptual design of a hybrid vehicle drivetrain

Summary of the internship:

The transportation sector is known to be one of the major sources of CO\textsubscript{2} and other pollutant emissions. Environmental awareness, limited oil resources and raising fuel prices have triggered car manufacturers, OEM’s and research institutes during the past decade to invest a lot of effort in improving the efficiency of future vehicles. Hybridization of the vehicle drivetrain is one of the technologies that enables to realize significant reduction of the fuel consumption and emissions. Compared to a conventional drivetrain in which only one power source – the combustion engine – is present, a hybrid drivetrain contains at least two power sources. There exist many different types of hybrid drivetrains, depending on the used type of energy storage devices: mechanical (e.g. flywheels), electrical (e.g. batteries, fuel cells, supercapacitors), etc. Another classification can be made based on the topology of the drivetrain, as illustrated by the figure below.

As the number of design variables grows significantly (drivetrain topology, size and type of combustion engine, transmission, type and size of the energy storage system, etc.), the conceptual design of a hybrid drivetrain becomes a cumbersome task. Moreover, the design is a trade-off between multiple objectives (e.g. fuel economy vs. cost) and several constraints (e.g. mass, size).

Flanders Make is currently developing a methodology to support the designer of mechatronic systems during the conceptual design phase. In contrast to the later phases of the mechatronic system design, we noticed that during the conceptual design phase one relies strongly on the knowledge and the creativity of the involved experts to generate and evaluate new concepts.

It is to be expected that the usage of computer power in the conceptual design phase could enable the generation of concepts that the experts might overlook and could allow to evaluate a much larger set of concepts. Consequently, the use of computational power will speed up this design phase and improve its effectiveness.
The approach builds upon 4 key elements:

- **Formal models to represent the design problem**,  
- **Automatic concept generation**,  
- **Model-based concept evaluation**,  
- **Multi-objective concept optimization**.

**Goal:**

The aim of this internship is to apply this systematic model-based design methodology to the conceptual design of a hybrid vehicle drivetrain.

**Profile student:**

- Bachelor degree in Mechanical, Electrical, Mechatronic or Computer engineering;  
- Knowledge of numeric optimization, scripting languages (Matlab, Python) and software for multi-physical modeling (f.i. Matlab/SimScape or LMS Imagine.Lab Amesim) is mandatory;  
- Experience with Sysml is a plus;  
- Passionate by research and new technologies with focus on applications for machines or mechatronic systems of the companies;  
- Result oriented, responsible and proactive;  
- A good communicator, able to communicate in English;  
- Eager to learn.

**Assignment data:**

The assignment is for 3 to 6 months and takes place at the offices of Flanders Make located in Leuven, Belgium.

**Additional information:**

All software and hardware needed for the execution of the project will be provided by Flanders Make.

**About Flanders Make:**

*Flanders Make* is the strategic research centre for the manufacturing industry. The mission of the centre is to strengthen the long-term international competitiveness of the Flemish manufacturing industry by performing industry-driven, pre-competitive,
excellent research in the technological domains of mechatronics, product development methods and advanced manufacturing technologies. This research will result in applications for machines, vehicles, vehicle components and high-tech production systems at the participating companies. To achieve this mission, Flanders Make conducts industry-driven joint projects and contract research assignments in the following research programs: Clean Energy-efficient Motion Systems, Smart Monitoring Systems, Autonomous Systems, Intelligent Product Design Methods, Design & Manufacturing of Smart and Lightweight Structures, Additive Manufacturing for Serial Production, Manufacturing for High Precision Components, Agile & Human-centered Production & Robotics Systems.

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