**Co-supervised Master thesis, 2020**

# EVOLUTION – EffectiVeness Of Lorries and bUses using innovative TransmissION

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**Context –** Recently, the environment committee of the European parliament have decided, in 2018, on reductions in carbon dioxide (CO2) emissions for lorries and buses with a target of 35% by 2030. Hybridization of vehicles with internal combustion engine and battery is an interesting solution to reduce energy consumption and CO2 emissions of transportation systems. The use of several energy sources combines the advantages of each source to reduce the global energy consumption. However, the hybridization increases the complexity of Energy Management Strategies (EMS – distribution of energy within the vehicle), which depend on technologies and topologies of hybridization. The "series-parallel" topology is the most interesting for automotive applications. It is based on a simple planetary geartrain. This geartrain cannot, however, be considered for hybrid heavy-duty vehicles due to mechanical constraints, which induce a prohibitive sizing. New innovative transmissions are currently developed for heavy-duty vehicles, such as Electric and Continuous Variable Transmissions (EVT / CVT), and compound planetary geartrain. These new transmissions can improve Hybrid Electric Vehicles (HEV) allowing optimization of engine operation to save more energy. The development of EMS is a sensitive issue for these innovative transmissions.

Through the CE2I[1] project (Intelligent Integrated Energy Converter), the purpose of the EVOLUTION project is to study the effectiveness of innovative transmissions for lorries and buses. The University of Ghent (UGent) is developing EVT and CVT for HEV, and the University of Lille (ULille) is working on EMS of HEV using the EMR formalism (Energetic Macroscopic Representation). Last year, a first collaboration allowed to bring together the EMR approach developed at ULille and the expert knowledge on EVT from UGent. A scalable experimental setup of UGent's EVT was, moreover, developed.

**Objective –** For next year the EVOLUTION project will strengthen and structure cooperation by studying the effectiveness of variable transmissions for heavy-duty vehicles. The objective of this Master thesis is to compare innovative variable transmissions for lorries and buses. The Master student will first compare the innovation transmissions for lorry and bus applications. Two most appropriate transmissions will be selected from this comparison. Models and EMS will be then developed to study the effectiveness of the transmissions. According to the progression of the Master thesis, experimental tests will be planned at UGent.

**Student profile –** Master students or engineering students in their final year of study.

**Home institution –** University of Lille, France

**Starting date –** beginning of 2020 **Duration –** 4 to 6 months

**Payment –** from 500 € to 580 €/month according to the number of working days in a month

**Documents to send by email before January 31, 2020:**
**a CV, a cover letter, the transcripts of the last 3 years of study, a reference person who can be contacted**

[Druant 2017] J. Druant, H. Vansompel, F. De Belie, J. Melkebeek, P. Sergeant, "Torque analysis on a double rotor electrical variable transmission with hybrid excitation", IEEE Transactions on Industrial Electronics, vol. 64, pp. 60-68, 2017

[Druant 16] J. Druant, H. Vansompel, F. De Belie, P. Sergeant, J. Melkebeek, "Field-oriented control for an induction-machine-based electrical variable transmission", IEEE Transactions on Vehicular Technology, vol. 65, pp. 4230-4240, 2016

[Lhomme 17] W. Lhomme, A. Bouscayrol, A. Syed, S. Roy, F. Gailly, O. Pape, "Energy savings of a hybrid truck using a ravigneaux gear train", IEEE Transactions on Vehicular Technology, vol. 66, n° 10, pp. 8682-8692, 2017

[Vinot 14] E. Vinot, R. Trigui, Y. Cheng, C. Espanet, A. Bouscayrol, "Improvement of an EVT-based HEV using dynamic programming", IEEE transactions on Vehicular Technology , vol. 63, n°1, pp. 40-49, 2014

[Mayet 19] C. Mayet, J. Welles, A. Bouscayrol, T. Hofman, B. Lemaire-Semail, "Influence of a CVT on the fuel consumption of a parallel medium-duty electric hybrid truck", Mathematics and Computers in Simulation, April 2019, vol. 158,, pp. 120-129

[1] The goal of the CE2I project is to have "intelligent machines" that integrate electromechanical and electro-electric energy conversion as well as their control, while respecting constraints of size, emissions, functional reliability and structural and eco-efficiency.