sys2WHEEL
co2 free city logistics

1st Newsletter Edition/May 2020

PROJECT MEETINGS

Kick-off Meeting, Graz
16 January 2019

Representatives of all 12 partners gathered in the premises of the Virtual Vehicle (Vif) to sharpen the vision of the project and to foster mutual understanding.

General Assembly, Regensburg
3-4 July 2019

Hosted by AVL Software, the meeting focused on system requirements for the two different system architectures, in-wheel and e-Axle.

General Assembly, Tel Aviv
28-29 January 2020

Hosted by SoftWheel, main topics are work package status, dissemination activities and challenges in 2020.

1 YEAR SYS2WHEEL – GOOD PROGRESS

The project SYS2WHEEL aims at developing sustainable city logistics and improving mobility, accessibility and quality of life of EU citizens. 12 international project partners are committed to achieve three main objectives:

1. Reducing cost in mass production by at least 20% through components becoming obsolete and through reduction of wiring costs.
2. Increasing powertrain efficiency by improved e-motor windings, advanced rare-earth magnets, reduced powertrain rotation parts, reduced losses, advanced control and weight reduction.
3. Increased affordability and user-friendliness by enhanced modularity and packaging. Space saving approaches in sys2wheel lead to more freedom for batteries, cargo and drivers.

To meet the ambitious targets of SYS2WHEEL, the project is divided into different types of activities, **2 horizontal and 2 vertical lines**, each representing one work package.

In the first year of the project, one **major achievement** was the development of requirements covering the wide range of different electric powertrains. It's the basis for the next steps, especially the basic simulation and tool development in Work Package 2, where development of controls and virtual validation of solutions is carried out.

Other highlights were the common dissemination activities together with the **E-VOLVE cluster** in Spain and Austria last year. The cluster is realizing synergies between six projects from the GV-01 Horizon 2020 call.

A major challenge for the upcoming months is the development of the different powertrains and its components, thermal management, NVH investigations and advanced control fulfilling the different requirements for our 2 main approaches for electric driving in a fleet application (e-axle and in-wheel motor).

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HIGHLIGHTS OF DISSEMINATION

GHOST and iModBatt workshop in San Sebastián, 18 Oct 2019, presentation of SYS2WHEEL as part of the E-VOLVE Cluster
A3PS Eco-Mobility 2019 in Vienna, 14-15 Nov 2019, conference paper by elaphe
2019 IEEE ICCVE in Graz, 4-8 Nov 2019, presentation of SYS2WHEEL as part of the E-VOLVE Cluster

UPCOMING EVENTS IN 2020

32nd International AVL Conference Engine and Environment in Graz, 25-29 May 2020, Zero-Impact Mobility: Emissions and Lifecycle Co2: No Longer a Conflict? Fully digital this time.
A3PS Eco-Mobility 2020 in Vienna, 18-19 Nov 2020

EVOLVE-Cluster representations:
2020 TEN-T Days exhibition to be held in Croatia, in Šibenik, 12-15 May 2020 ➔ cancelled due to COVID 19 (organizers are working on 10th edition of TEN-T days)
EUCAR Annual Reception in Brussels, November 2020
EARPA Form Forum in Brussels, October 13-14 2020
IEEE AEIT Automotive 2020 Annual Conference, November 18-20 2020, Turin

IN-WHEEL MOTOR TECHNOLOGY INCREASES PERFORMANCE OF VANS

In-wheel motors were introduced already 120 years ago by Porsche, however the motors had limited applications due to technology and power-supply limitations. As electric powertrain solutions developed more and more through the 20th century, there have also been examples of in-wheel motors in modern vehicles.

Today, in-wheel motors are already produced massively, in tens of millions of units per year, in low-requirement applications like two-wheelers. Thanks to technical developments that reach specific torques, in-wheel motor technology can now be adopted in the automotive industry.

City logistic is one of the most polluting segments of the transport sector and commercial vehicles generate much more noise than passenger cars. The ultimate goal of our project is to develop sustainable city logistics and improve mobility, accessibility and quality of life. One of the outcomes is a retrofitted **Fiat Doblo delivery van with in-wheel motors** from our project partner Elaphe Propulsion Technologies.

Having two Elaphe M700 in-wheel motors fitted between standard disc brake and rim in front wheels results in favorable performance for delivery van applications.

COST-BENEFIT-ANALYSIS FOR BASELINE AND DEMONSTRATION VEHICLES

SYS2WHEEL has very ambitious targets, like reduction of mass production costs by at least 20%, increase of powertrain efficiency and range as well as affordability and user-friendliness. To assess these targets, a cost-benefit-analysis (CBA) is done with a baseline and a demonstrator vehicle.

In a first step, the **total cost of ownership** (TCO) of both vehicles are collected, including base prices, fixed cost, workshop cost, operating cost and depreciation cost per month. Next, a list of all components is made that are newly installed, removed or modified between the baseline and demonstration vehicle. Project partner IESTA is now collecting these data from the industry partners.

Having collected all these data, the basis methodology can be applied:

1) Overall target categories (base/retail costs, efficiency, affordability…) are weighted relatively to each other, reflecting the importance for the customer.
2) Relative changes of costs and benefits for specific items in the demonstration vehicle to the one in the baseline vehicle are assessed.
3) Eventually, a **benefit-cost-ratio** is calculated for the demo vehicle relative to the baseline vehicle.

NEW TORQUE-VECTORING CONTROLLER

The University of Surrey will implement new torque-vectoring controller for the prototype SYS2WHEEL Fiat Tofas Doblo with front in-wheel motors. State-of-the-art implicit nonlinear model predictive control technology is being developed and compared with conventional stability controllers from equivalent production vehicles, based on the actuation of the friction brakes.

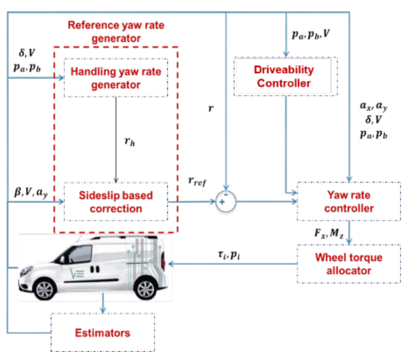

Figure 1: Simplified block diagram of the torque-vectoring control structure

The model predictive formulations (see the block diagram of the control structure in Figure 1) will include consideration of the electric powertrain power losses (Figure 2) as well as the longitudinal and lateral tire slip power losses. Such power loss contributions will be minimized in the objective function of the controller formulation. The reference cornering response, in the form of a desired yaw rate to be tracked by the controller, will be designed to be **energy-efficient through a model-based design approach**. As an example of the sensitivity of the power losses to the applied torque-vectoring control action, Figures 3 and 4 plot the variation of the total electric powertrain power loss as a function of the direct yaw moment of the torque-vectoring controller, for different values of the total wheel torque demand and vehicle speed. Finally, to enhance active safety when the commercial vehicle tows a trailer, **innovative hitch angle feedback control formulations** based on torque-vectoring actuation will be implemented and assessed against the performance of the conventional trailer sway mitigation algorithms included in production stability control systems.

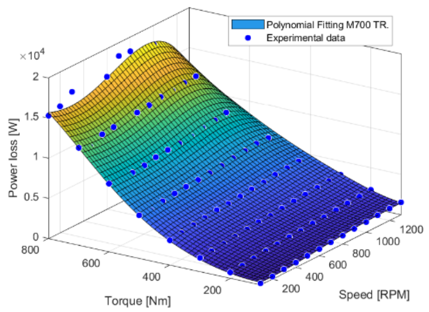

Figure 2: Electric powertrain power loss map

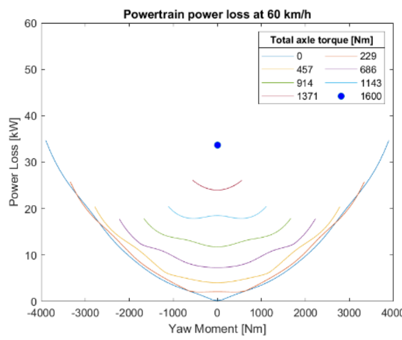

Figure 3: Powertrain power loss at 60 km/h as a function of the direct yaw moment

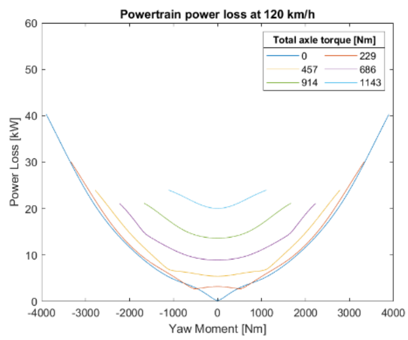

Figure 4: Powertrain power loss at 120 km/h as a function of the direct yaw moment