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Optimising the parts others cannot reach

A powerful simulation tool facilitated a project to investigate the benefits of ancillary hybridisation on LMP1-H cars. By **William Kimberley**

WITH the new LMP1-H regulations that were introduced into the World Endurance Championship and the wider use of Energy Recovery Systems, it became apparent that one of the key limitations of the internal combustion engine was its thermal efficiency.

One of the common ways to improve internal combustion engine efficiency is to reduce both parasitic and drag losses within components like gears, bearings and ancillary loads so that the useful power at the flywheel is maximised. This in turn led to work on optimising every single component that comprises the power unit.

Recently UK systems engineering company Claytex collaborated with Oxford Brookes University in a project that investigated the benefits of ancillary hybridisation on LMP1-H cars. The study focused on two particular benefits of ancillary hybridisation: to improve performance; and reduce fuel consumption.

The engine ancillaries modelled were the oil pump, the oil scavenge pump, the water pump and the fuel pump. These ancillaries supply the engine with fluid – cooling, hydraulic, lubrication and fuelling – power and are all "useful energy" losses for the engine, but they are also essential for the engine operation.

The idea of hybridising the drives to the engine ancillaries is to choose the most efficient way to drive the ancillaries, hence reduce energy losses during vehicle operation. The reduction in losses leads to less fuel used in the internal combustion engine and reduces the amount of fuel stops during the span of a race, thus improving vehicle competitiveness. To assess the ancillary hybridisation effectiveness, the whole vehicle model is simulated, including the powertrain, and then virtually run round a lap of Le Mans using a combination of electrical and mechanical ancillary drive propulsion strategies – electric motor or internal combustion engine-driven.

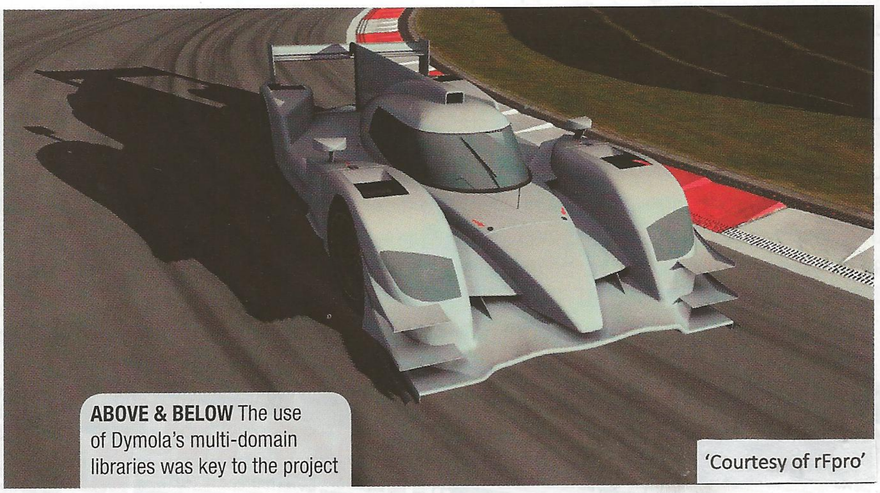
In order to be able to simulate this multi-physics model, Dymola, a physical modelling and simulation tool for model-based design of complex engineering systems, was used to simulate and integrate all aspects of the vehicle. The program is used by companies operating in many industries including automotive, aerospace, motorsport, energy and high tech.

Multi-domain libraries covering the mechanical, electrical, control, thermal, pneumatic, hydraulic, powertrain, thermodynamics, vehicle dynamics and air conditioning domains can be coupled together to form a single complete model of the system.

The Modelica modelling language used to define models provides the user with open access to the language. This means that users are free to create their own model libraries or extend from the existing ones to accelerate development times, reduce maintenance efforts and improve the level of reuse across projects. This allows customisation of existing components and the creation of new ones where required. It's also one of the reasons why Dymola is already widely used within Formula 1 and NASCAR for desktop, trackside and driver-in-the-loop simulator use.

The benefits of the hybridisation of the engine ancillaries were reduced fuel consumption and increased acceleration performance leading to a possibility of reducing the number of stops during the race and, in terms of vehicle performance, allowing quicker acceleration to reach the top speed.

The simulation and analysis of the complete vehicle by means of integration of all vehicle subsystems would not have been possible if not for the multi-domain capabilities of the simulation tool used in this study. It saved not only track time and costs but also engineering and prototyping costs for development of multiple design iterations of the hybrid drives. RT



ABOVE & BELOW The use of Dymola's multi-domain libraries was key to the project

'Courtesy of rFpro'