# engine + POWERTRAIN technology international

JUNE 2021

## HYBRID FOCUS

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# McLAREN M630 V6 HYBRID

McLaren signals its electric intent – the manufacturer's first series-produced hybrid pairs a new V6 with axial flux tech

**HIGH FIVE**

Gilles Le Borgne, engineering head at Renault, discusses the fate of the ICE

**COMMON GROUND**

Is the future of powertrain development going to be increasingly collaborative?

**THINK BIG**

Koenigsegg pioneers camless valvetrain tech with its latest powerplant – the TFG

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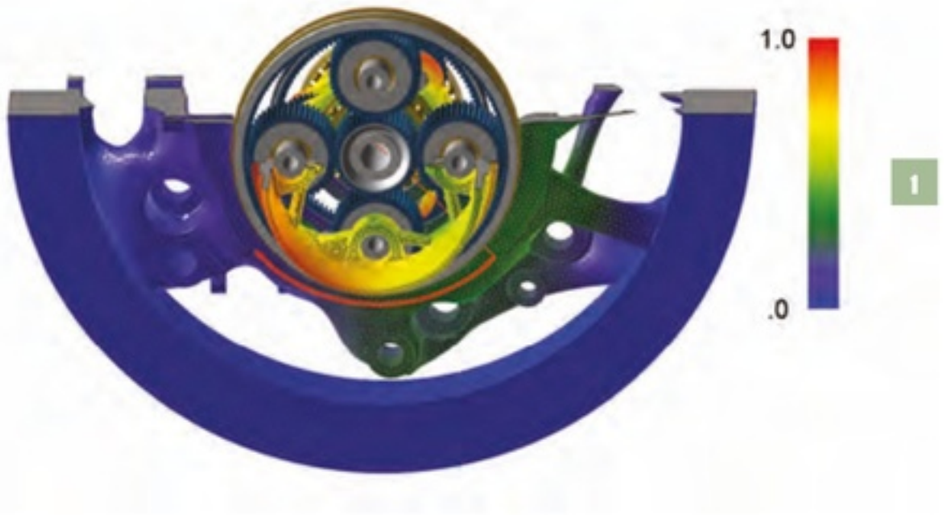


# Transmission design software

## A manufacturer-neutral software solution enables modeling, parameterization and calculation of transmission systems

In 2020, the KA-RaceIng team from the Karlsruhe Institute of Technology (KIT) dominated the Formula Student Germany international race car design competition, in which universities compete against each other with self-made formula racing cars. KA-RaceIng is one of the most successful teams in the history of the competition, winning in the overall category as well as almost every subcategory. The car is expected to be made even better for the 2021 event, with the main focus on further development of the drivetrain. To do this, the Karlsruhe team is relying on software developer FVA and its latest FVA-Workbench gearbox development software for assistance.

"To continue to be successful in the competition, we have to bring the gearbox design up to the current state-of-the-art level, season after season," explains Daniel Hartmann, KA-RaceIng's drivetrain team leader. "The FVA-Workbench enables us to integrate the latest research into our gear design, which makes it possible to design our car at a professional level."

**1.** FVA gearbox design software has enabled the KA-RaceIng team to design an in-wheel gearbox for its latest Formula Student car

**2.** The FVA-Workbench is equipped with a range of analysis features for transmission design

### GEARBOX DESIGN

Automotive drive technology development cycles are getting shorter and shorter. This makes fast, reliable gearbox modeling and calculations even more important. Many companies rely on the FVA-Workbench for efficient simulation and calculation of gearbox systems. The software's features can be highly automated and are easy to customize. Analytical approaches guarantee fast and reliable solutions to key drive technology issues. Any calculations for bodies that cannot be precisely described analytically are supplemented with suitable numerical methods. The FVA software's intuitive modeling techniques ensure consistent, valid, and manufacturable gear systems every time.

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KA-RaceIng's goal for this year's competition is to make the KIT21e race car notably lighter and more aerodynamic than its predecessors. To achieve this, the team is using the empty space in the wheels to house the new gearbox. This makes the monocoque narrower, allowing additional functional aerodynamic surfaces to be added. It also enables an increase in power density as the necessary torque is converted just before the wheel makes contact with the road. Upstream of the gearbox, the load on the shafts is reduced accordingly. This allows the use of very thin shafts, which greatly reduces the overall weight of the vehicle.

KA-RaceIng's drive concept features a two-stage planetary gear in the hub of each wheel. The drive is supplied by a custom-designed, flange-mounted electric motor. The two-stage planetary gear converts torque and speed from a maximum of 20,000rpm to around 1,500rpm in a compact space. Integrating the wheel bearings into the planet carrier of the second stage enables the wheel loads to be dissipated across the shortest possible path.

Cornering speeds in the competition generate high transverse forces, which lead to deformation of the wheel suspension and the planet carrier. In the worst case, these deformations can lead to uneven load distribution and ultimately to premature gearbox failure. For this design, it is essential to prove that the deformations do not have a negative influence on the gears.

### FINITE ELEMENT ANALYSIS

While developing the new KIT21e drive, the KA-RaceIng team was particularly impressed with the ability to consider the planet carriers as finite element components in FVA-Workbench. All components can be directly imported from CAD, positioned, and then considered with the software's one-click finite element modeling (FEM) design workflow. Additional calculations in external tools are no longer needed, and potential errors can be avoided.

All common CAD formats can be imported, and native Abaqus and Ansys meshing are also available. CAD geometries are directly meshed and qualified with the FVA-Workbench internal mesher. The qualification examines the mesh for critical or unsuitable elements that can negatively influence the solution. This provides users with real-time information about the quality of the mesh.

With one-click FEM, it is crucial to correctly position the FEM mesh relative to the gearbox model. An interactive dialog guides the user through the process to ensure that all bores are positioned correctly. Internally, the positioning corresponds to a transformation from the design coordinate system to the coordinate system of the FVA-Workbench. This potentially error-prone process is fully automated. Finally, the connecting nodes between the analytical components and FEM structures are located and selected in the FVA-Workbench.

Following the calculation, the results must be interpreted and documented. The reporting system in the FVA-Workbench simplifies this process. The results of the design are presented in interactive, easy-to-understand HTML reports, which can be customized and adapted to the current task. New graphics can be added or tables can be adapted to quickly and easily include additional information. Interactive HTML reports make it simple to share data. Recipients can open and edit the reports without any additional programs. ◉