

electric & hybrid

vehicle technology international

ICON REBORN

It's taken eight years and the program has been rebooted countless times, but the NSX is back – and it's a plug-in hybrid tour de force



HACKED

As powertrains go from mechanical to electric, should the industry be worried about cybersecurity?

January 2016

LIQUID ASSET

It might only be a development mule, but BMW's hydrogen i8 promises a lot

RANGE FINDER

Will lithium really put EVs in the same league as IC engine cars?

AUTONOMOUS JOURNEY

The technology is here, so when will we see driverless EVs out on the road?

Pass the test

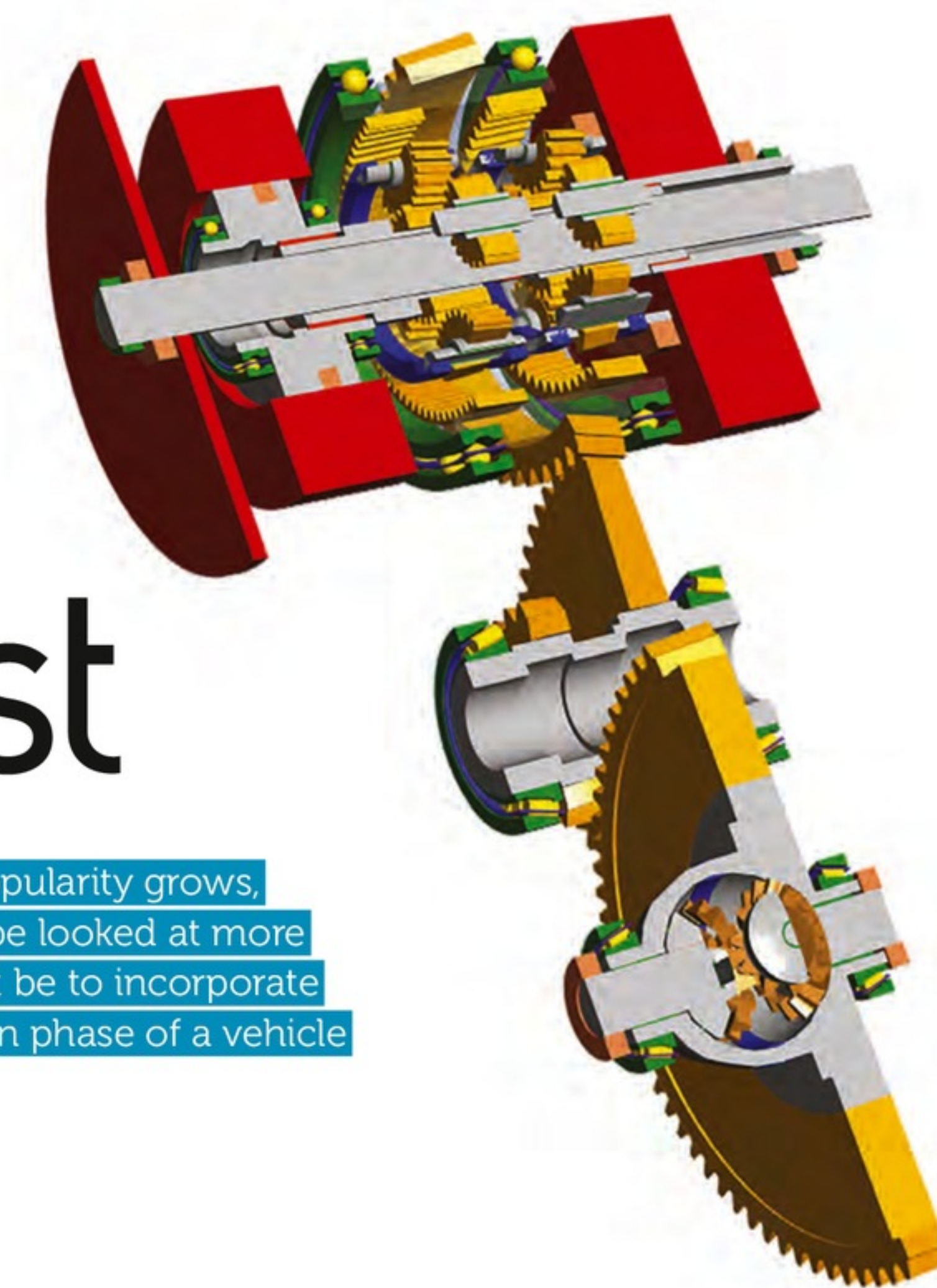
As hybrid and electric vehicle popularity grows, the impact of NVH will need to be looked at more carefully. The solution just might be to incorporate NVH testing into the initial design phase of a vehicle

WORDS: KARL VADASZFFY

Smart Manufacturing Technology (SMT), an engineering services and software development specialist that serves all sectors of transmission and driveline development, has a truly global reach, with offices in the UK, USA, China, Portugal and Korea.

Gareth Cooper, senior transmission engineer, reveals that over the past year, the industry's interest in electric vehicles has intensified, with a natural increase in the attention being given to the testing of NVH. "With electric vehicles," he says, "noise is becoming a major issue because electric motors don't generate the same noise as traditional combustion engines, which drivers are used to. When it comes to electric, the noise of the gearbox comes through into the car a lot more prominently. And it's a high-pitched whining noise, which can be very irritating."

He suggests the solution to such a problem can be found by simulating NVH performance during an electric vehicle's design phase. To this end, SMT offers MASTA, a complete suite of CAE software



Hybrid transmission designed in MASTA

"Noise is becoming a major issue because electric motors don't generate the same noise as traditional combustion engines"

Gareth Cooper, senior transmission engineer, SMT



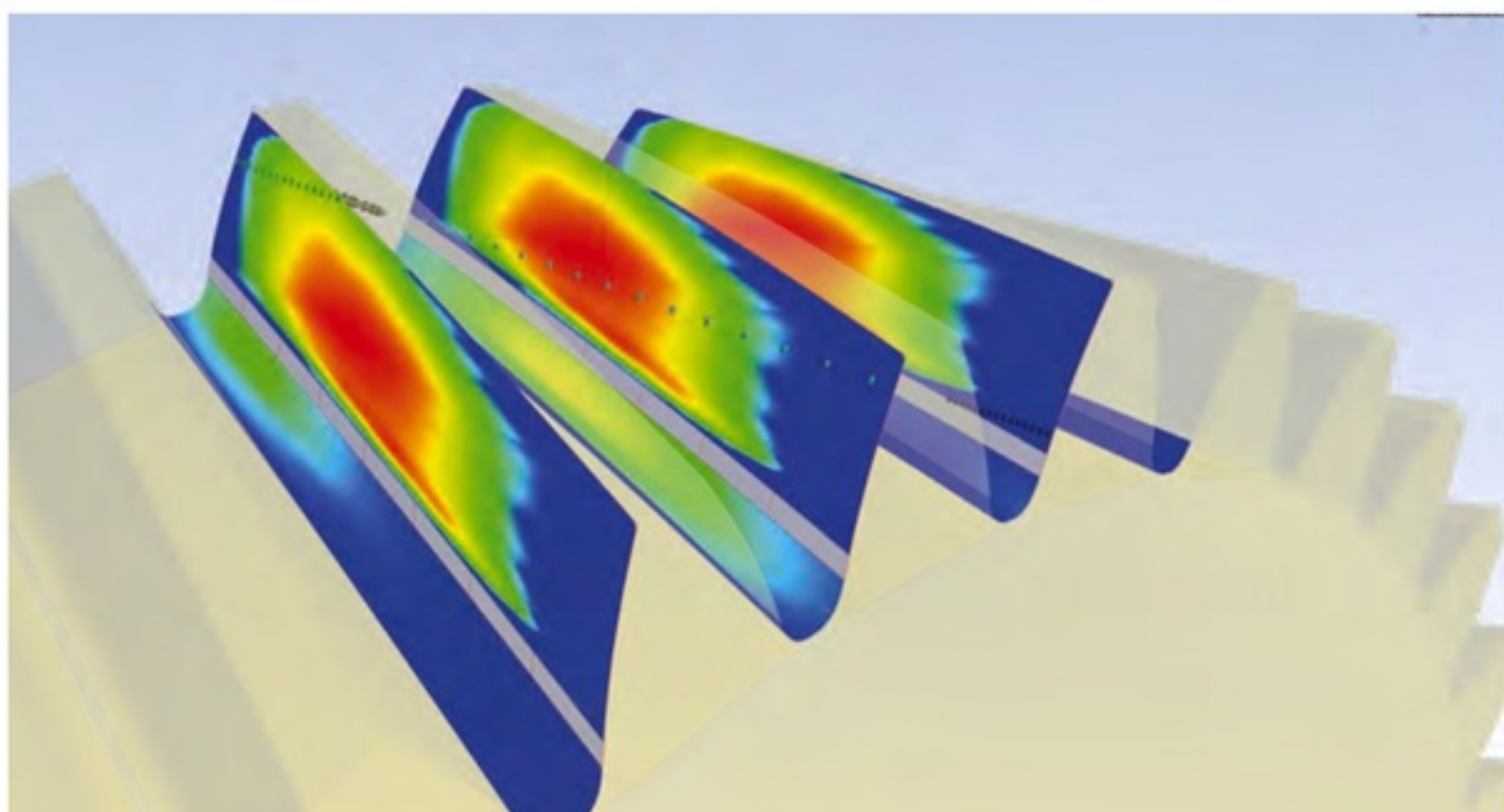
for the design, simulation and analysis of advanced transmission systems. Engineers can use MASTA to predict key transmission performance characteristics and identify design faults or weaknesses before manufacturing commences, resulting in time and cost savings.

Cooper says, "It's possible to design gears to be quieter, but getting it right from the start saves a lot of time in the development cycle. The aim should be to design low NVH from the start and have it as one of the design criteria."

But many electric vehicles are already on the market and many are past the initial design stages, and MASTA can also be used in such instances, as Cooper explains: "It can be used to troubleshoot existing designs, identifying the source of a noise and optimizing the design to reduce it. For instance, a customer might have a gearbox that is noisy, but by using MASTA we can identify the source of

"A customer might have a gearbox that is noisy, but by using MASTA we can identify the source of the noise and improve the design"

Gareth Cooper, senior transmission engineer, SMT



Above: Loaded tooth contact analysis image from the MASTA software suite

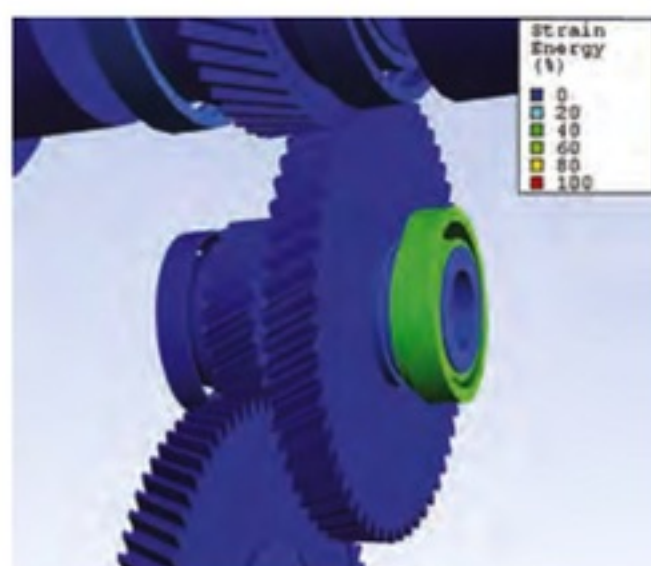
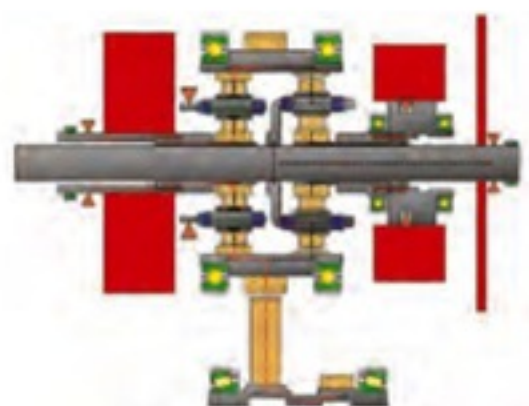
the noise and improve the design." However, he points out that turning to NVH testing at a later stage is more costly because it involves using prototypes.

MEASA is the company's data acquisition software that is capable of performing precise measurements and complex analysis of NVH and TE data. Its seamless data exchange with MASTA enables engineers to gather real-world test data, and feed expected orders from CAE models to identify the main contributors to excitations within a system.

Cooper says it is possible to reduce noise by optimizing the gear geometry, the microgeometry of the gears, the stiffness of the system to reduce gear misalignment in operation, and by optimizing the casings so that they don't resonate and respond to the frequency generated by gears in an operating range in which a gearbox will be running.

Other capabilities of MASTA – users of which include more than 100 blue chip companies – are explained by Cooper: "Users can build up a model of a gearbox quickly as it uses all standard components – gears, bearings and shafts – and then they can do system-level analysis, initially using MASTA to rate gears and calculate stresses. In addition, it can calculate the deformation and stress in a casing, of the shafts, and it can figure out how misaligned gears are, and the effect this has on the strength of the gears."

Below: Images from the MASTA software suite, which offers engineers detailed virtual analysis of designs before manufacturing even begins



Another key area of development Cooper highlights is the move toward higher speeds in electric vehicles. He explains that while motors might traditionally go up to 7,000rpm, manufacturers want to reach 20,000rpm. He says, "This offers more efficiency, so there's interest in using higher-speed, lower-torque motors, which will take the operating range of standard components, such as bearings and gears, beyond what they were originally designed for.

"Standard off-the-shelf bearings, for example, are used to going up to 6,000rpm, so to compensate for this we're looking at solutions like hybrid bearings that include ceramic elements. These offer less resistance and are more lightweight, so there's less centrifugal load from the high speed. They also offer insulation from electrical discharge, which can damage bearings." But, he states, at the moment they're a high-cost solution.

"So, to optimize whatever choice is made, MASTA offers detailed analyses of the bearings and looks at the distortion of the bearings under load, exploring the running conditions of the bearings so that we might be able to take a standard bearing and push it beyond its design capabilities. Ultimately, it's analysis and simulation that will prove what a bearing can do."

In the future, Cooper predicts a big push toward achieving greater efficiency from the transmission, "because with an electric vehicle, efficiency directly correlates to the range of a vehicle". Lubrication and sealing are key areas that are being explored to achieve this greater efficiency.

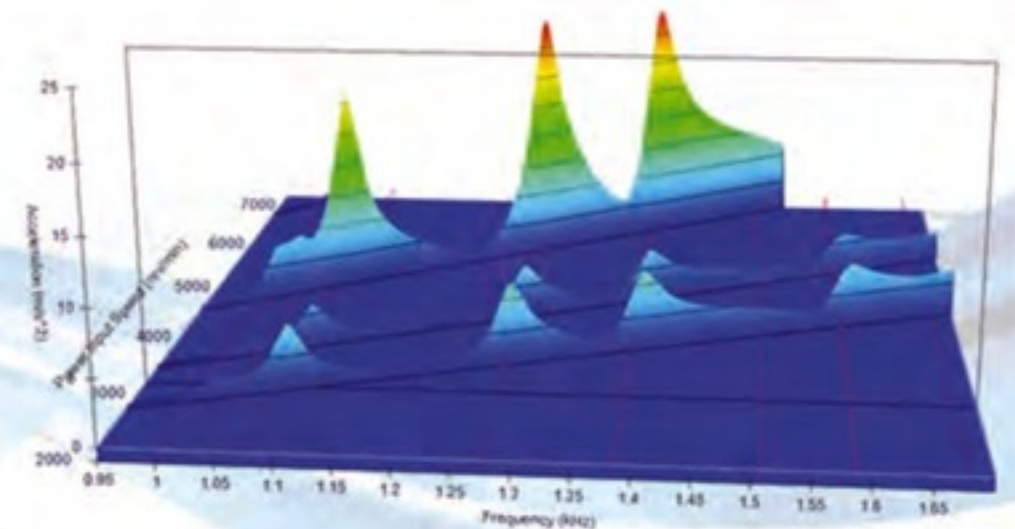
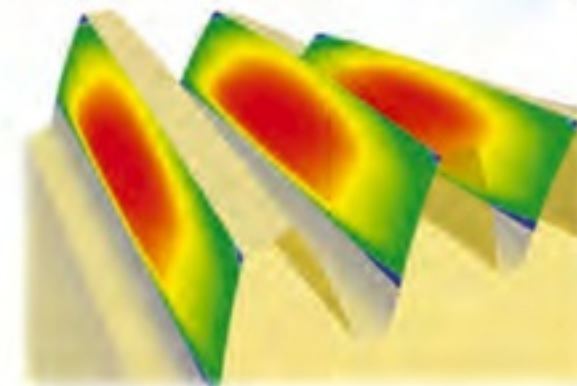
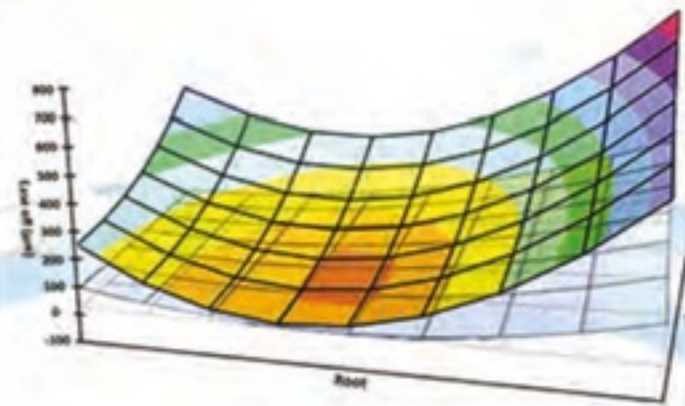
"We're also looking at fully integrated systems with an electric motor and transmission within one casing so that we don't have to seal a 20,000rpm rotating shaft," he adds. "And there's a move toward hub drives, which is an electric motor and gearbox built into the hub, directly driving the wheels."

Also available from SMT is DRIVA, its solution for simulating flexible multibody dynamic events within the time domain. The company has applied this technology successfully to a number of applications, including engine drivetrain dynamics projects. Cooper argues that it will become more widely used with hybrids, where "it can be used to simulate the switchover between the combustion engine and electric motor in the time domain of the electric motor taking up drive and the combustion engine switching on. Then taking some of the drive, you might get dynamic effects through the drivetrain, which would be felt through the gearbox". □

MASTA

CAE solutions for the design, analysis and optimisation of complex transmission systems trusted by the world's leading engineers.

AUTOMOTIVE | ENERGY | AEROSPACE | MARINE | RAIL | INDUSTRIAL | DEFENCE



Of all the decisions I've made over the 40 years working for Joy Global, picking MASTA as our gearbox design software is without doubt the best one!

MARK L ZIEGLER, PE. - PRINCIPAL ENGINEER

- Accurately and rapidly design transmission systems from scratch or imported concepts
- Comprehensively understand the life of a mechanical part over the customer duty cycle
- Identify potential failure modes early in the product development cycle
- Rapidly predict key performance characteristics at the design stage
- Easily explore changes in transmission layout, component selection and/or design, materials and manufacturing processes in the convenience of a virtual environment
- Perform full system simulations for any transmission or driveline configuration
- Incorporate manufacturing simulation at the design stage to reduce process development time & cost

Evaluate our software and discover for yourself
Call +44 (0)115 941 9839
or visit **masta.smartmt.com**

SMT 
SMART MANUFACTURING TECHNOLOGY