

With petrol-electric models offered in production form by many, **Jonathan Lawson** finds out how their test programs can aid traditional IC-engined vehicles

Hybrid hope

■ Future propulsion opinion seems to have developed into two main camps: one that states that developing hybrid technology is vital to reducing our reliance on fossil fuels, the other being that biofuels are a much better option.

Saab has attempted to combine the two with its 9-3 BioPower Hybrid Concept. The car – the world's first fossil-free hybrid, features a 2-liter engine, modified with hardened valves and stronger fuel hoses at

the company's Sodertälje facility in Sweden. Martin Elliot, Saab's manager of hybrid vehicle integration, (a division within Advanced Concept Engineering) says, "As far as engine management software goes, the base calibration is done for pure ethanol. It is definitely an E100 engine that can take gasoline, not the other round. We've changed the focus, and increased the compression ratio to limit the fuel consumption penalty."

Arguably the leader in the development of hybrid vehicles with its Prius, as well as Lexus RX400h, GS450h and the LS600h, Toyota recently unveiled its vision of cleaner future transportation with the Hybrid X concept vehicle.

Next to the engine sits the GM two-mode hybrid transmission, being developed alongside BMW and DaimlerChrysler. Inside the EVT are three sets of planetary gearsets, two electrical motors and four clutches. The control software and high/low voltage converters are housed above.

The rear axle is driven by a 38Kw electrical motor situated where the differential would normally live on a four-wheel-drive car. Elliot explains, "This motor is not used as the primary motive unit. It enhances the traction and gives an extra boost under acceleration. Also housed at the rear, under the floor in the trunk, is the Lithium ion battery.

Elliot continues: "An important aspect of the project is to see if it is practical to package all this technology in a smaller, front wheel drive architecture. GM will in North America put similar technology into production later this year, starting with large RWD applications like the Tahoe and Yukon." The first front wheel drive version will eventually be the Saturn Vue.

To date, the simulation work has concentrated on fuel economy, acceleration and top speed. Electrical loadings and crash performance have also been studied. As the hybrid design was already in existence, GM was able to provide useful input data which Saab use. The well-defined European driving cycle was used as a basis, with extra emphasis on the state of charge. Elliot notes: "We wanted to test for smaller engine sizes



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Micro climate

Ricardo has been testing various hybrid combinations over the last couple of years. The recent New York International Auto Show hosted a demonstration of a system that could be ideal for the stop-start motoring experienced by cabs. Dubbed a 'micro hybrid' due to the small increments added to the drive (small in cost as well as effect) the design could nevertheless cut emissions. Jeremy Holt, president of Ricardo US says, "If this technology were applied to all New York City taxis, Ricardo estimates that 40.9 million litres of gasoline a year could be saved, reducing greenhouse gas emissions

by 105,000 US tons (95,000 tonnes) of CO₂ a year." The standard alternator is replaced by an electric motor-generator. When the vehicle idles in traffic jams and at stoplights, the micro-hybrid system shuts the engine down. When the driver moves his or her foot from the brake to the accelerator pedal, the electric motor starts the engine instantly and silently. Also, energy generated during braking can be captured and used to power the vehicle, contributing to further efficiency gains.

The project is similar in approach to an earlier Ricardo research effort called

HyTrans, carried out two years ago in conjunction with Ford, Valeo SA and Gates Corporation. The physical test phases of the vehicle, based on a T280 Diesel Ford Transit, showed a close match to earlier simulations, with a door-to-door improvement in fuel consumption showing 21.3% under test, and 20.8% simulated. Ricardo's Marc Wiseman, US technology product group director says, "In developing the New York Taxi micro-hybrid powertrain concept we have applied the experience of a wide range of commercial programmes as well as joint research projects such as HyTrans. Despite its intended application in a gasoline powered sedan, the high starting torque requirement of the large capacity engines typically used in New York taxis coupled with the frequent stopping of a congested urban environment, means that we can transfer many elements of the hybrid architecture, which worked so successfully in the HyTrans diesel application. By selecting the appropriate mix of hybrid technologies for each application, our research has shown that potentially significant fuel efficiency improvements are achievable at modest incremental manufacturing or retro-fit cost"



X marks the spot

Although the company insists that the Hybrid-X is just a styling concept, Toyota's senior manager, powertrain engineering, Yutaka Iida has revealed a number of details about the specific powertrain to be used in any future petrol-electric offering from the Japanese automaker. "Future developments in our hybrid powertrains will be out in two years," he revealed. "Fuel economy will fall by 10 to 15%, through advanced batteries and packaging improvements needed for safety requirements.

to see if we could get further mileage benefits, but actually this engine turned out to be the best suited. By downsizing further we were just losing performance without big economy gains."

The next obstacle to be overcome was packaging. Elliot says: "We had to move the 12V battery to the rear which caused a few issues with cooling hoses, filters and master cylinders. We did a huge amount of clearance work in UniGraphics on screen before we put it together."

To date, in terms of physical hardware testing, the battery, battery management,



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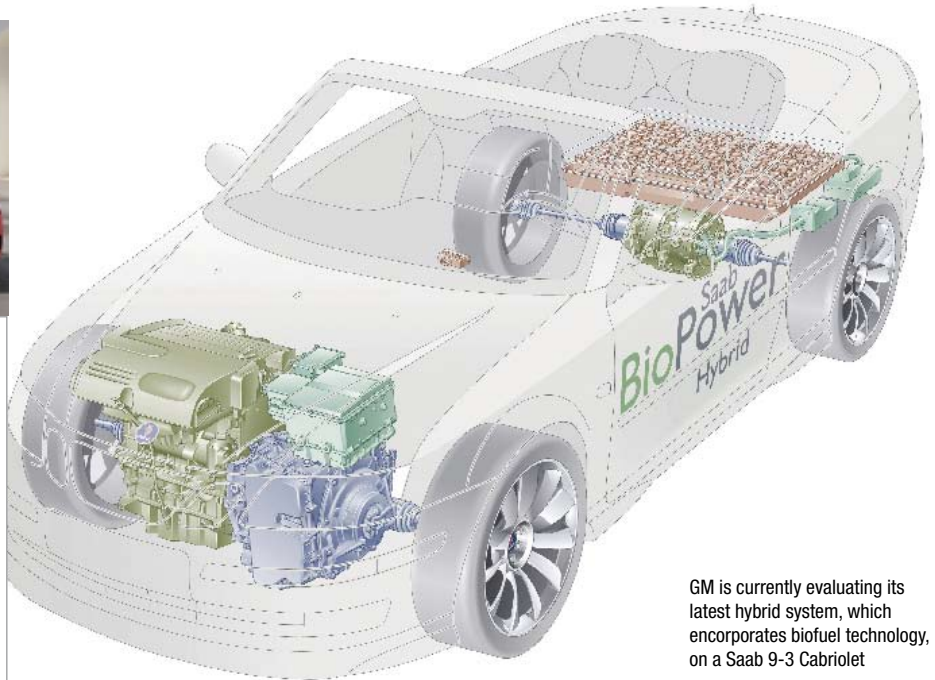




Joint effort

As well as collaborating with GM on the two-mode hybrid transmission, BMW and DaimlerChrysler have just announced that they will also work together on the development of an innovative hybrid module for rear-wheel-drive premium segment cars such as the M3 (above).

Both companies will bring a design to market within 3 years. A joint statement says: "The components will be individually adapted by the two companies to the different character of the two brands."



GM is currently evaluating its latest hybrid system, which incorporates biofuel technology, on a Saab 9-3 Cabriolet

charge utilization, drain and regeneration have all been scrutinized by strapping the prototype vehicle to a dyno.

EMC measurements have not been neglected. "We did some on the 12V system, just to be sure," reveals Elliot. "But the most in-depth testing was on the high-voltage stuff. Based on what we learned, we have introduced additional

shielding so now we meet the relevant standards. But more than this, it has triggered a discussion about EMC in general. In Sweden there is a very strong awareness of radiation, with much debate about mobile phone masts and so on. So the question has become should we just meet current legislation, or should we exceed it?

Saab's drivers are currently on the proving ground, measuring parameters such as real world brake performance and economy, as well as the subjective ride and handling tests. "We are progressing," says Elliot. "It is quite clear already that the control strategies are very important. We are fine tuning the balance between a smooth ride and optimised fuel

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consumption. If we are too aggressive on the fuel economy front, the drive quality suffers to some extent, because of the very abrupt start and stops, and very short transition times between different powertrain settings. We are working on the balance at the moment." To this end, the vehicle has been kitted out with accelerometers to measure vibrations, primarily during starting/stopping to gauge what happens when the IC engine kicks in or cuts out.

Also the way the engine is suspended is being examined. Larger engine mounts are being considered, as are different materials, hydrostatic mounts or active mounts which alter their stiffness to offset the rocking motion.

Physical testing is indicating economy improvements of around 25-30% over the original vehicle. After the testing phase is completed, results will be presented to Saab and GM, and a decision will then be made about the viability of mass production. ■



Supplier's view



The SGT-21 starter-generator tester from D&V

D&V Electronics Ltd from Ontario, Canada is right at the sharp end of hybrid testing. The company has grown from a background in developing test equipment for starter motors and alternators and their components to become a supplier of complete hybrid motor test systems.

Phillip Falk, strategic product development Coordinator says: "What we have done is develop a software platform and modular hardware system so we can pick and choose the components to quickly develop a turn key testing system. Behind the actual measuring application, we have introduced a powerful suite of development tools that we use internally to generate new software. So when we develop a new machine, we design the unique measuring application, backed up by a common, universal database with test specifications and an Excel output so reports can be generated." Falk reckons this dramatically speeds up the machine development process.

Increased interest in hybrids among the public has spurred OEMs to pour resources into new technology, and D&V Electronics has never been busier. "The segment that is growing fastest seems to be larger vehicles, SUVs and the like" says Falk. "Looking

forward, I think it's possible that in the next 1-2 years there will be some very interesting vehicles on the market. Based on what we know has been tested over the last five years, the power to weight ratio and the performance of some of these devices are just incredible. We can't say too much just yet, but there could be hybrid systems which add something like 100bhp to the vehicle, so these things will be much better than the conventionally powered equivalent."

Looking further ahead, Falk sees constant advances. "Look back to the 1960s, when we all drove cars with a generator. Then the alternator arrived in the early 1970s, which was a different approach to solving the same problem, operating at around 70A. Nowadays, an alternator can put out 200A without being much bigger. The rate of development is rapidly increasing now."

"The growth of hybrids could signal another cultural change. With high voltages present, the home mechanic will be positively discouraged from tinkering. What's more, when it comes to testing components such as combined starter/alternators the increased complexity will mean dealer service centers, garages and parts stores will need to invest in new test equipment."

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