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ARE CONNECTED ENGINES THE FUTURE?

Can the addition of GPS assistance to the ICE help increase efficiency, improve driveability and reduce consumption? Or is it nothing more than a clever marketing gimmick?

MAZDA REINVENTS THE ENGINE

A look at how Mazda is approaching the conundrum of the internal combustion engine with its own unique methodology

DIGITAL INTERFERENCE

We examine how one of the very last bastions of mechanical actuation, the valvetrain, is headed for a digital future

MOTORCYCLE TESTING

Motorcycles, by and large, have cars bested in terms of performance – but how do they hold up on emissions?

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BIG

brother

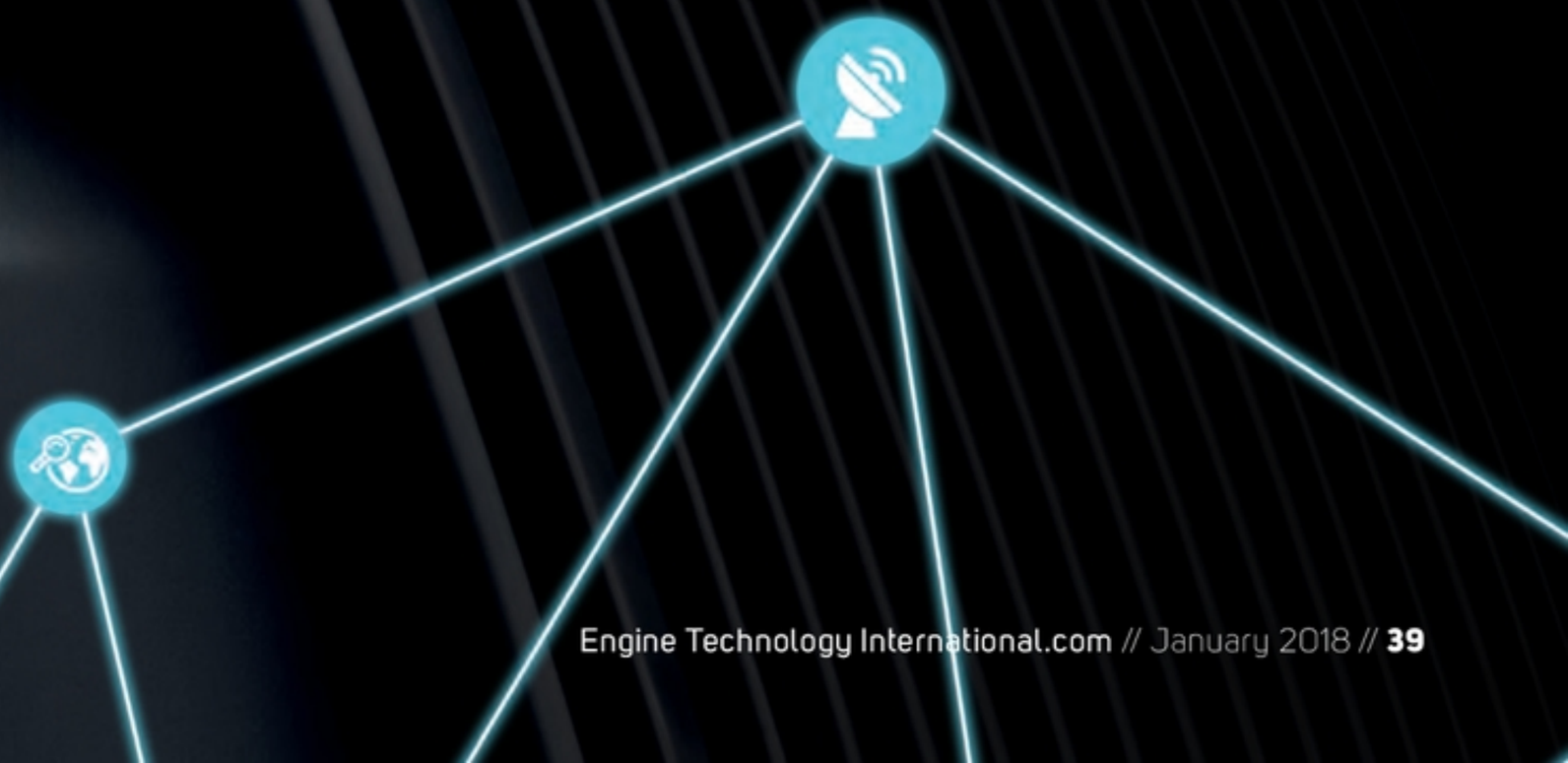
GPS-assistance has already been rolled out on a number of Rolls-Royce models, pre-selecting transmission ratios in anticipation of upcoming topography. But can it be applied to the IC engine to help increase efficiencies and overall driveability?

WORDS: **LEM BINGLEY**

As any fan of motorsport knows, location matters. Race teams of every caliber spend a great deal of time and effort setting up their vehicles to suit the particular geography of the track. Every setting that can be adjusted, from brakes to suspension to gearing to aerodynamics, will be tuned to gain a competitive edge. Improved adaptation to the geometry of corners and straights, elevation changes and surface qualities might put a car and driver on the podium.

Back when settings were tweaked with spanners, it was tricky to extend this kind of thinking to road cars. However, the advent of electronic control systems coupled with GPS-based location awareness has dramatically altered the situation. Today it's perfectly possible for a road car to set itself up on the approach to a tricky corner.

As well as honing performance, detailed knowledge of the road ahead can also improve smoothness or optimize fuel economy. This is an area that BMW has explored over the past few years, linking its GPS navigation unit to sophisticated software systems under the banner of Predictive Power Management.



First deployed with BMW's ActiveHybrid vehicles in mid-2012, software charts the course of the road ahead, including climbs, descents, speed limits and the radius of bends. The data gleaned triggers pre-emptive gear selection on the approach to hills, corners or junctions. It also enables safe high-speed coasting with the transmission disengaged, and helps manage hybrid battery reserves so that stored power can be deployed or regenerated at the most appropriate moments. A suitably equipped car can also prioritize different outcomes if the driver has selected Sport, Comfort or Eco driving modes.

A wide variety of factors have been tweaked under BMW's approach. Predictive thermal management in 7-Series cars, for example, forecasts the demands likely to be made on the engine. By adjusting fan speed and other variables such as intake shutter position and coolant volume, and taking account of driving style as well as the road ahead, BMW says dips and spikes in coolant temperature can be smoothed over and the engine kept closer to its ideal operating point.

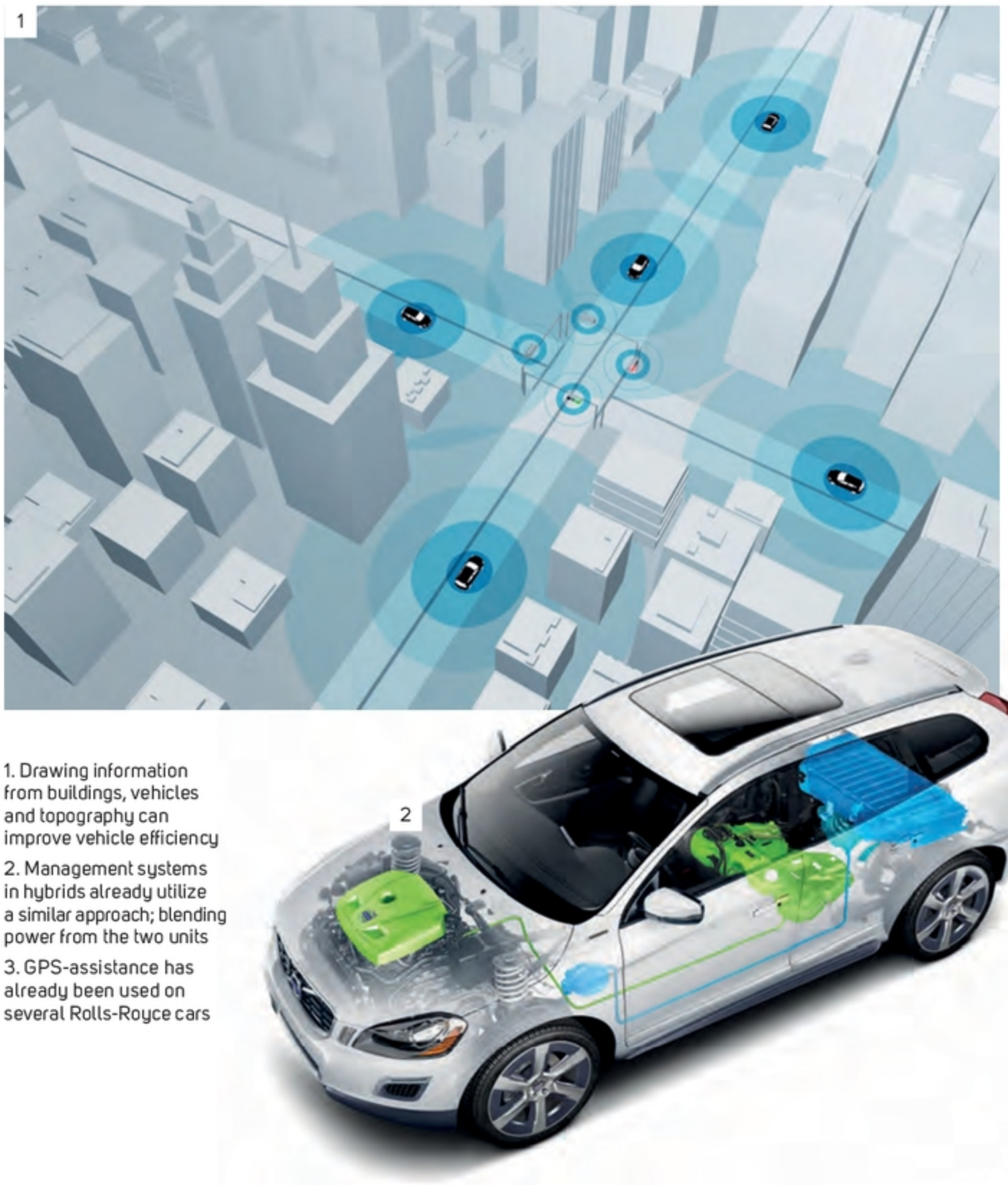
This kind of predictive technology has also been employed by BMW's Rolls-Royce brand, with satellite-aided transmission (SAT) a feature of both the Wraith and 2018 Phantom. By selecting the right gear at the right moment, SAT helps to provide the desired impression of seamless and unruffled progress.

At the time of the Wraith's launch in 2013, product manager Philip Harnett told *ETi* that the beauty of SAT was its use of existing hardware: "The navigation sensors are already there, as are the other car's features, so there's no added weight in integrating this system."

Volvo is another OEM that has deployed GPS-enabled predictive systems, starting with its first plug-in hybrid, the V60 PHEV. As early as 2011, Volvo predicted that fuel savings of 20-30% might be unlocked if a plug-in car's route was known in advance, allowing mains charge to be allocated in the most effective way across the journey.

Börje Grandin, director of electric propulsion systems at CEVT and former head of Volvo's electrification strategy, notes that GPS-based predictive strategies are most useful where there are plenty of variables to juggle. "With a pure electric vehicle, you are basically just pouring energy out of the battery and you can't affect it as much," he notes "In a hybrid we can really prolong electric range, but in a pure electric there's not much we can do."

Today's plug-in hybrids, which combine all the complexities of modern combustion engines and transmissions with electric motor-generators and mains-charged batteries, offer huge scope for improvement if the car knows where it's going.



1. Drawing information from buildings, vehicles and topography can improve vehicle efficiency
2. Management systems in hybrids already utilize a similar approach; blending power from the two units
3. GPS-assistance has already been used on several Rolls-Royce cars

"We can preselect gears, but also look at how much energy we have in the battery to go up slopes," says Grandin. "When should we charge the vehicle? We can decide this before we start driving and again when we are driving. This is an area we're exploring quite a lot because it really effects your fuel and energy consumption."

Forecasting beyond individual journeys is the next step for optimizing plug-in cars, says Grandin. "We know if it's Monday morning, statistically the user is going to go to work, because he does that every Monday morning. And we know how far the driving distance will be. So we could ask the customer, do you want us to charge in the most cost-effective way, with a suitable reserve, or just keep the battery full all the time?"

Internet-connected vehicles could take another step and tap into an owner's calendar to improve energy demand forecasts. "If the user allows us, we might know that next Monday he's going to the airport so we need

ENERGY STORAGE

It's not just large OEMs that are making efficiency gains through location awareness. GPS data is a key part of the plan for tiny British startup Riversimple, which is developing its Rasa vehicle, an ultra-lightweight two-seater powered by hydrogen fuel cells.

"We're trying to design a vehicle that will be as efficient as possible," says Dr Nico Sergent, Riversimple's powertrain architect. "A fuel cell provides the core power and it's sized for cruising, and we have a buffer of supercapacitors that provide the power to accelerate and get energy back under braking, and also to provide energy to go up hills."

The car's Hydrogenics fuel cell provides only 8.5kW of continuous power, while peak demands can hit 60kW. To maintain full performance, the Rasa's 0.5kWh bank of JSR supercapacitors need to be fully charged before tackling a sustained climb. "We use GPS altitude and speed to determine the ideal state of charge of the capacitors," Sergent says. "It's absolutely crucial."

As well as topping up the supercapacitors prior to climbing, the Rasa's control system also aims to empty them prior to a descent, to maximize the potential for energy recapture. "If we run out of space while going downhill we need to use the friction brakes instead, and whenever you transition from regeneration to brakes you have issues with brake feel. So it's not just a matter of pure efficiency, it has knock-on effects in lots of things," Sergent points out.

"If we didn't have GPS data, we'd have to pretty much double the size of our onboard energy store – double the size of the caps – just to make sure we've got enough energy for different scenarios," Sergent concludes. "It makes the car cheaper, lighter and more efficient."

The tactics employed by the Rasa could of course be used by any hybrid vehicle to maximize the contribution of its own transient energy store.

1

1. Using existing data from satnav systems means that assisted transmissions add no weight to a vehicle

2. The 2018 Phantom is the latest vehicle from BMW Group to use the assisted technology

to charge a little bit more," Grandin suggests. "These are the questions we're working with now, and that's really something that might affect the user of a pure electric vehicle too. It's about giving the user most value for money, so I think it's going to be an extremely hot area moving forward."

Sharing information between cars traveling on the same road is another possibility that could yield relevant data. While congestion hotspots are already flagged today, more detailed information might include warnings of slippery conditions, instant notification of accidents, or even locations where hard braking is going on. If you know where such incidents are occurring, you might skirt them to avoid a queue before it forms.

"I would love to get that information," says Grandin. "Currently, I'm not 100% sure I can get it because vehicle-to-vehicle communication requires standards and agreements between different OEMs. And when it comes to that, we're not there yet."

2