

# THE FUTURE OF THE CAR

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## Visions of mobility in the megacity

The expanding global urban population is driving the industry towards greener, safer, connected vehicles, writes **John Reed**

To each age its car. At the dawn of the motoring era, automobiles were “horseless carriages”, designed to ferry their passengers in padded comfort along muddy, rutted roads.

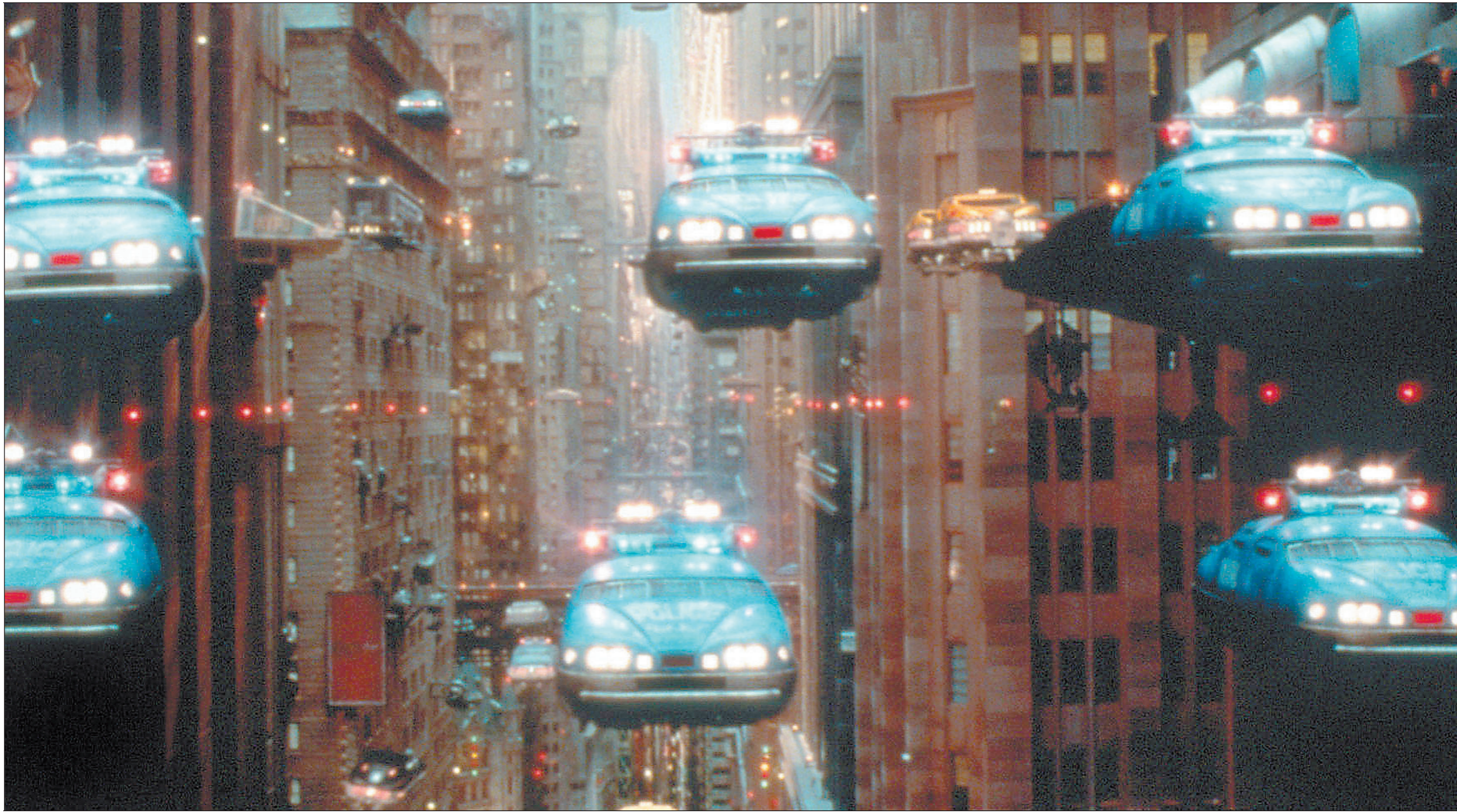
In prosperous, optimistic mid-20th century America, cars were big, exuberant-looking vessels that took design cues from rocket-ships. In the 1970s, recession and the oil shock brought cars back down to earth with the rise of the frugally priced, no-frills, small “econobox”.

At this week's Frankfurt motor show, carmakers will display an array of new and experimental vehicles that offer a window into our vertiginous, uncertain, breathlessly paced times.

While some of the more fanciful features displayed on manufacturers' concept cars will never see the light of day, a few big themes on the future of driving will be vividly clear in Frankfurt: cars are becoming radically cleaner, increasingly networked to their surroundings and endlessly adaptable to the driver's needs.

One of the industry's two biggest buzzwords right now (they both begin with ‘M’) is “megacity” – the other is “mobility”. By one estimate, there will be 3bn passenger cars in use worldwide by 2050, more than four times that on the roads now. As more people go to live in cities – and often large and congested ones at that – we will be spending much more time in our cars, often travelling at low speeds.

Regulators, with a zeal undiminished by the credit crunch, are pressing the industry to make its cars cleaner and safer. The hand of the state, in the form of national and local government subsidies for electric



Motoring in the 23rd century as visualised in the 1997 film 'The Fifth Element': the state and consumers are demanding ever greater innovation in automotive technology

Alamy

and hybrid cars and their batteries and infrastructure, has now definitively tipped the whole industry into developing plug-in cars.

Cars, the crowning aspirational consumer goods of the 20th century, are also converging with the defining technological device of our time: mobile phones. With more time behind the wheel, more drivers are demanding from their cars the same connectivity as they have in the office or at home.

Enter the connected, semi-autonomous, super-safe car. Here are some of the things cars on the road today can do: brake and accelerate to prevent acci-

dents; tighten the seat belts when collisions are unavoidable; park themselves at the push of a button; recognise road signs; and read out and reply to e-mails.

Here is a very partial list of what they will be able to do soon: drive semi-autonomously in cities; allow you to pay bills on the move; tailor your trip and the environment in the cabin after downloading cloud-based information on the weather, traffic and your preferences; and guide you there using a three-dimensional head-up display.

According to Microsoft, cars are now the third fastest-grow-

ing connected device after mobile phones and tablet personal computers. Continental, the automotive supplier group, speaks of the “vehicle as companion” in the future, equipped not only to get you from A to B but to learn your quirks and anticipate your whims.

For carmakers, the continuing rise of the “connected car” offers significant opportunities. To name just one: longer and more lucrative dealer relationships, thanks to vehicle diagnostic systems that will inform drivers of maintenance and upgrades available for their cars.

As cars become rolling mobile

devices, though, carmakers are contending with some thorny challenges, notably their industry's longer product cycles and higher customer expectations. Unlike a mobile device, a car must be built to be driven for many years and must hold its value when it is sold.

There is also the danger of overloading drivers with visual or aural distractions – an issue increasingly in regulators' sights under the catchphrase “driver distraction”. In this respect, carmakers face a direct conflict between safety priorities and the demands of passengers who want to multi-task from behind the wheel.

This is not a new problem – carmakers say that taking a call on even the most rudimentary hands-free device can, depending on the situation, be dangerously distracting.

They are responding by developing radically simplified visual displays and voice-activated communications systems that allow drivers to focus on the road. Some are introducing systems that enable the car to delay incoming calls if the driver is executing a demanding task.

With the rise of networked, rechargeable cars, the industry

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### ADVERTISEMENT



Mazda's stylish compact SUV - the Mazda CX-5, is the first car to benefit from not only the new 'Kodo' design direction, but also the brand's next-generation SKYACTIV TECHNOLOGY.



Kiyoshi Fujiwara

## WHY IS ONE CAR COMPANY NOT FOLLOWING THE OTHERS?

Conventional thinking dictates if you fancy a new car you have to make a trade-off between performance and fuel economy.

But not if you're considering Mazda's next-generation cars, says Executive Officer Kiyoshi Fujiwara, who is a true believer in the company's ethos of defying convention.

When talking about his firm's all-new, cleaner, and much more efficient range of vehicles, he says: “The most important thing is that the car should be always fun to drive.”

“Our benchmark was the Mazda MX-5 roadster for the way it drives,” says Fujiwara. “The oneness between the car and driver is our goal.”

#### The revolution begins here

Tomorrow at the Frankfurt Motor Show, the drapes come off Mazda's stylish compact SUV - the Mazda CX-5. It is the first car to

benefit from not only the new 'Kodo' design direction, but also the brand's next-generation SKYACTIV TECHNOLOGY.

This signals a radical way of thinking – one that not only delivers major fuel savings and reduced running costs, but maintains Mazda's famous fun-to-drive mantra.

You may not think this relatively small company from Hiroshima is capable of delivering on such a promise. But remember, this is the only Japanese brand to have ever won Le Mans. They also commercialized the rotary engine, most recently in the Mazda RX-8.

#### Sky's the limit

Compared with existing engineering approaches, Mazda's use of smart materials like high-tensile steel and innovative new chassis design have shaved off 100kg in weight, whilst maximizing safety.

But why no hybrid or pure electric alternative?

“Every study shows that, by 2020, 90 per cent of all cars (including hybrids) will still use internal combustion engines,” says Fujiwara. “Cutting emissions and fuel consumption on

high-volume engines will have a greater impact on greenhouse gases than selling smaller volume electric cars.”

#### Capturing lost energy

Traditionally, only 30 per cent of the energy created in a combustion engine reaches the wheels of the car. In what Fujiwara calls “a total rethink” his team focused on ideal combustion to improve on this ratio.

The result, a SKYACTIV-G petrol engine that uses 15 per cent less fuel while delivering 15 per cent more performance. And achieves an extraordinary 14:1 compression ratio (equal to levels of current high-performance race cars).

The diesel is even more astounding. Economy has been improved by 20 per cent and maximum torque can be delivered at 1800 RPM. The engine boasts two turbos – one big, one small – and the lower compression ratio of 14:1 is the lowest compression ratio in any production diesel engine, allowing the engineers to cast lightweight engines out of aluminium.

#### Automatic choice

Channelling the power to the wheels is either the SKYACTIV-MT manual six-speed or the new SKYACTIV-Drive automatic transmission. During the drive, Mazda's automatic transmission has a torque converter that locks up instantly, reducing slippage by up to two-thirds and delivering a 7 per cent increase in fuel efficiency.

Mazda says the name SKYACTIV comes from its engineers' belief that “the sky's the limit.” When the Mazda CX-5 launches in early 2012, it will not only be one of the best driving cars in its class, but it will also be among the safest and cleanest – perfect for those who believe conventional thinking is best left on the ground.



To learn more about SKYACTIV TECHNOLOGY visit [www.mazda.co.uk](http://www.mazda.co.uk) or [www.mazda.de](http://www.mazda.de)

## The Future of the Car

# Crash avoidance becomes the new priority

### Safety

Carmakers are looking beyond the vehicle, reports **Bernard Simon**

The perpetual quest to reduce deaths and injuries on the roads is heading in a new direction.

For decades, the focus has been on safety improvements inside the car in the form of devices such as seat belts, airbags and headrests. But with the help of new technology, the emphasis is shifting outside the vehicle.

Preventing crashes "is where we're heading in terms of vehicle safety", says Matt Roney, vice-

president for product planning and business development at Michigan-based TRW, a safety equipment supplier.

David Strickland, head of the US National Highway Transportation Safety Administration (NHTSA), underlined the point in a recent speech: "Crash avoidance projects and programmes are a priority because they provide the first opportunity to save lives and reduce injuries by preventing crashes from occurring in the first place."

Much of the pressure is coming from insurance companies that are increasingly willing to lower premiums for vehicles equipped with collision-avoidance systems.

Santosh Anishetty, head of North American passive safety and advanced driver

assistance systems at Germany's Continental, says the insurance industry "drives progress a lot better than any carmaker or supplier trying to drive it in the marketplace".

Further impetus has come from Toyota's much-publicised problems over the past two years with unintended acceleration.

Although investigations have so far ruled out some of the most serious accusations against the company, the public outcry, especially among US politicians, has pushed collision avoidance up the regulatory – and thus the industry – agenda.

Priority is being given to three areas: lane departure warning systems, crash-imminent braking, and electronic stability controls, helping prevent rollovers. Mr Anishetty expects the

NHTSA to produce draft regulations on lane-departure and pre-collision braking systems by early next year.

The quest to prevent collisions has benefited from big advances in radar, laser and camera technology – and, in some cases, a combination of all three.

Continental has developed laser technology sensors able to track the movements of a vehicle up to 10 metres ahead at city driving speeds. If the gap between the two vehicles closes suddenly, the system can warn the driver of the rear vehicle and, if necessary, automatically apply the brakes.

Continental will unveil an advanced version of these systems at the Frankfurt motor show, based on a stereo camera mounted behind the windscreen that can provide two distinct

fields of view to detect pedestrians and crossing traffic.

Norbert Hammerschmidt, Continental's director of customer programmes for advanced driver assistance systems, compares the technology to "two eyes and behind them the brain to make the calculations".

TRW is working on a radar-based system that will sense an imminent side collision. Airbags will be inflated immediately when crash sensors on the side of the car detect the impact, reducing by a fraction of a second the time needed to confirm a collision has taken place. "What used to take 12 milliseconds becomes four milliseconds," says Mr Roney, noting that the eight-millisecond head-start could be enough to save a life. He is confident

such systems will become reality within the next couple of years.

Advances in camera technology have spawned numerous improvements in vehicle safety. For example, some models are now fitted with systems that automatically dim headlights when a camera detects the tail-lights of vehicles ahead or the headlights of oncoming vehicles.

Looking seven to 10 years ahead, Continental's Mr Anishetty foresees vehicle-to-vehicle systems that would give drivers longer advance warning of potential collisions. Traffic lights and other roadside infrastructure could be equipped with devices that communicate directly with vehicles.

As a result of last year's furore over unintended acceleration, the NHTSA

will soon require all cars to be fitted with devices that give the brake priority over the accelerator. Moves are under way to require event data recorders – a simplified version of aircraft "black boxes" – in all passenger vehicles.

The agency is also starting research on the placement and design of accelerator and brake pedals. Many cases of unintended acceleration have been traced to driver error rather than mechanical defects.

But these innovations come at a cost. For now, advanced sensor and camera systems are mostly confined to high-end models. Mr Hammerschmidt says one of the challenges facing carmakers and suppliers is to bring down prices and make the technology available to the mass market.



'Crash avoidance is the first opportunity to save lives and reduce injuries'

**David Strickland,**  
Head of US National  
Highway Transportation  
Safety Administration

## Weight-loss programmes slowed down by cost challenges

### Materials

Lightweight vehicles are straightforward to build but remain expensive, writes **John Reed**

Less than a decade ago, Jaguar and Land Rover looked like they were driving into serious trouble, or even car-marque oblivion.

As regulators in Europe and the US readied tough laws to make vehicles smaller and cleaner, the conjoined UK carmakers had no small or fuel-efficient cars in their range. Land Rover looked especially vulnerable with its line-up of big-engined, heavy 4x4s.

But then Jaguar Land Rover, which is owned by Tata Motors of India, made lightweight construction a central plank of a five-year, £7.5bn programme to overhaul its product range and catch up with Germany's premium producers.

At this week's Frankfurt motor show, Land Rover is unveiling the DC100, a concept car that will preview plans to replace the Defender, its hulking classic 4x4, in a radically lighter and lower-emission version.

In July the brand launched production of the Range Rover Evoque, the smallest vehicle in its range, with a carbon dioxide count of 129g/km – 1g less than the European Union's fleet average target for 2012.

JLR saved about 7kg of weight from the vehicle's bonnet, and a similar amount from its roof, by making them from aluminium rather than steel.

The vehicle's front bumper is made from plastic, saving 3kg, and the instrument panel, made of magnesium, is 6-7kg lighter.

"Materials are clearly a big game-changer for us," says Mark White, head of lightweight vehicle

strategy in JLR's body engineering division.

Carmakers do not lack the technical means to make cars lighter, whether by using thinner steel or lighter materials such as aluminium and carbon fibre, which have long been used in racing or high-end sports cars.

The challenge, however, is to produce and apply these materials cost-effectively, carmakers say. "You can do lightweighting at any cost – look at aircraft technology – but that is expensive," says Carl-Peter Forster, the Tata Motors board member who recently stepped down as chief executive of the company. The marques, he says, want to offer vehicles that handle well, but they "don't want to blow our price out of the segment".

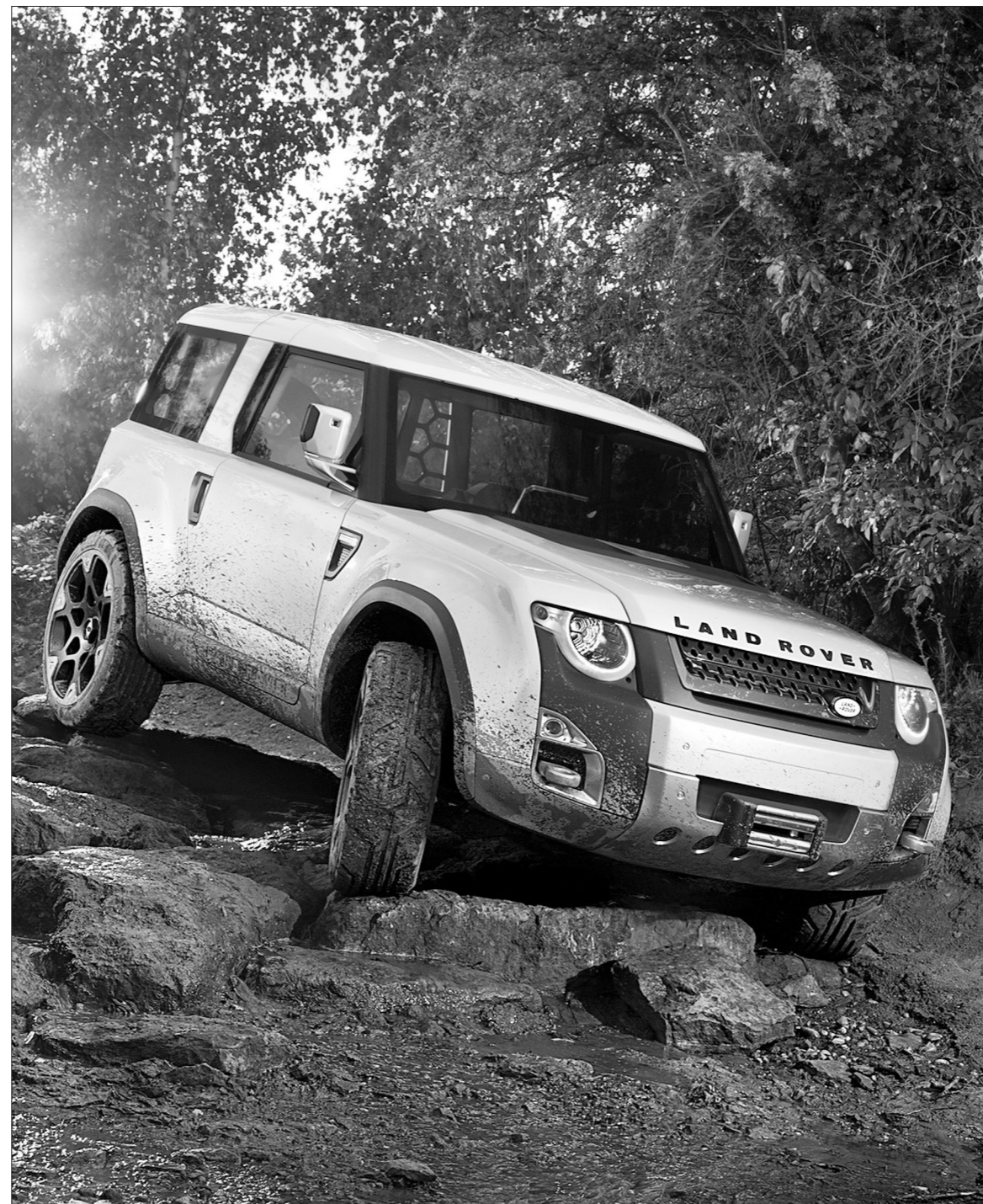
While all carmakers can come up with an aluminium body, he says, the aim is to strip costs out so the technology can be made

Premium carmakers, with their large margins, are the best placed to afford research and development spending

available even for lower-priced vehicles. To this end, JLR has worked to reduce the thickness of the aluminium and the number of rivets it uses in its vehicles.

"It is hundreds of larger and smaller improvements, both in the process and the manufacturing technology," Mr Forster says.

The race to build lighter cars is provoking some competitive jockeying to shore up partnerships with suppliers with the knowhow to deploy lightweight materials effectively. In March Volkswagen took a minority stake in SGL Carbon, a German carbon fibre producer that is already in a joint



Lighter touch: Land Rover's DC100 concept cuts weight and emissions from the Defender

venture with rival carmaker BMW to make carbon-fibre-reinforced plastic bodies for its BMWi sub-brand's forthcoming hybrid and electric cars.

Premium carmakers such as JLR, BMW and its German rivals Audi and Mercedes-Benz, with high average fleet emissions, face the steepest challenges in cutting the weight of their vehicles. However, premium carmakers, with their large margins, are the best placed to afford the research and development spending.

The stakes are high, even for mass-market producers. PSA Peug-

ot Citroën, which has one of the lowest CO2 fleet emission averages of any carmaker – 129g/km – is investing €1bn (\$1.4bn) to meet the EU's requirement of 95g/km by 2020.

Automotive engineers face conflicting pressures, as in so many other areas, as they seek to strip excess weight out of their cars. Enhanced safety regulations and customer expectations for features such as infotainment are making cars heavier, so the savings need to be that much deeper.

Audi claims to have reversed the "spiral of weight", largely by

use of its trademark aluminium space frame. The VW-owned premium marque says its latest A6, for example, is up to 80kg lighter than its predecessor.

Porsche says that when changing over to the new model of its Cayenne sport utility vehicle, it shaved about 200kg off its weight. The carmaker's new 911 is also lighter, thanks to a strategy of applying steel, aluminium or magnesium as needed. "Intelligent light building, we call it," says Rolf Frech, Porsche's director of complete vehicle engineering and quality management.

## Flexible hire is the talk of the town

### Sharing

Car producers are making big inroads into urban rentals, writes **John Reed**

Alex Schwan, a 36-year-old marketing specialist who lives in Munich, leads an enviable life. He lives in the city centre, runs an events agency specialising in sports such as snowboarding and skateboarding, and is a commentator for television channel Eurosport. Cars, however, play only a marginal role in his urban professional idyll.

Mr Schwan and his wife, Ingrid, have a Mercedes-Benz estate that she uses to ferry their son to kindergarten. He cycles to work, and has no wish to own another car – nor does he like to pay for parking in town.

"I hate driving in the city, especially when I go to work," he says. "But sometimes you need a car, and when it's super-hot I don't like taking the tram or the underground."

In June Mr Schwan signed up for DriveNow, a one-way car-sharing service run by BMW and Sixt, the rental company. He can search on the web or his mobile phone for a Mini or BMW 1-Series parked nearby, reserve it and open it with a sticker implanted with a chip attached to his driving licence.

A screen in the car greets him by name, and prompts him to comment on the car's cleanliness and condition. With a push of the stop-start button, he is off.

He pays 29 cents per minute, or 10 cents when the car is parked – a fee that includes parking, petrol and insurance. If he chooses to fill up the car, there is a card to pay for it, and he gets 20 minutes' driving credit. When he is done, he leaves the car at any city centre parking spot.

BMW and Sixt plan to take DriveNow to Berlin in September, then a third, as yet unnamed, German city later this year, and London in 2012. They plan to roll out the service in two to three cities per year.

"Our overall strategic goal is 1m DriveNow customers by 2020," says Nico Gabriel, DriveNow's managing director. "BMW sees a business model in this mobility framework."

"Mobility" is, without doubt, the car industry buzzword as it seeks to make money from – and form relationships with – younger, urban drivers such as Mr Schwan who do not want to own a car.

The average age of a DriveNow customer is 32, according to Mr Gabriel. "It's a group of people for whom an iPhone or an iPad might be more important than owning a vehicle at their age," he says.

Carmakers also see short-term rentals as a growth area as more cities enact congestion charging or other regulations aimed at keeping most cars out. France's PSA Peugeot Citroën offers customers short-term rentals of cars, vans,

bikes or scooters under a service called Mu by Peugeot. The company claims to have signed up some 9,000 regular customers around Europe through 75 of its dealers.

"It's not a big deal in terms of business, but it is in terms of forming a new link with customers," says Nadège Faul, Peugeot's spokeswoman for client mobility services. "We are bringing into the brand new customers, 60 per cent of whom do not have a Peugeot and 25 per cent of whom have no car at all."

Daimler, BMW's arch rival, pioneered one-way car sharing in 2008 in Ulm, Germany, with its car2go service, which offers its Smart minicars for short-term hire. While car-sharing companies such as Zipcar and Streetcar offer urban drivers short-term rentals of cars parked in fixed places, Daimler pioneered a model – now followed by BMW – of one-way car hire.

"We came to the conclusion that car sharing needs to become more flexible and convenient," says Robert Heinrich, car2go's founder and chief executive. "You need to have a car available 24/7, you need one-way rental and you need open-ended rental."

Manufacturers see short-term rentals as a growth area, as more cities bring in congestion charging

Car2go expanded to Austin, Texas in 2009, then this year to Hamburg – where Daimler works with rental agency Europcar – and Vancouver. Amsterdam and San Diego will follow this year, along with two further unnamed cities.

Car rental has rarely been a core business for automakers. One sign of its growth in importance is the way they talk about it: while Daimler described car2go's initial steps in Ulm as a pilot, it now claims to have 20,000 users registered, in a city with a population of 170,000. "Obviously, we have a first-mover advantage," says Mr Heinrich.

BMW's expansion plans for DriveNow suggest it will not be left behind willingly. "It's really something we think we can make money with," says Mr Gabriel.

The Munich-based carmaker began to offer "classic" car sharing in Berlin three years ago, and now claims to have 4,000 customers. However, it now speaks about car sharing as part of a more flexible "integrated mobility service" that combines DriveNow with other modes of transport, such as bike schemes and public transport.

In a further sign that "mobility" is more than just a fashionable word, BMW, when it launched its BMWi electric-car sub-brand last year, put up \$100m for iVentures, a venture capital fund earmarked for investment in services ancillary to cars.

## Innovators enjoy head-start in parts race

### Suppliers

Technology can help boost margins, say **Bernard Simon** and **Chris Bryant**

Pressure on car parts suppliers around the world to come up with innovative products while keeping a tight lid on prices shows no signs of abating.

Many parts makers ran into serious difficulties during the recession, but consolidation and restructuring – often under bankruptcy protection – have greatly improved their financial health and operational efficiency.

Even so, just 5 per cent of chief executives polled recently by the US Original Equipment Supplier Association expect that the next decade will be "significantly better" than the past one. Six out of 10 predict it will be even tougher.

Tim Lieuliette, a former supplier executive and now

an adviser to the industry, estimates that more than 50 parts makers with annual revenues above \$500m are ripe for mergers and acquisitions. The question is: what will separate winners from losers?

Research by McKinsey, the consultancy, suggests the most successful suppliers over the past two industry cycles – Canada's Linamar, Autoliv of Sweden, US-based Borg Warner and South Korea's Hyundai Mobis, among others – are marked by continual product innovation, high barriers to entry and sustained cost containment.

McKinsey cites numerous products still open to a high degree of innovation: variable valve timing for improved engine efficiency, some electric power train components, low rolling-resistance tyres, navigation systems and active driver assistance systems, such as adaptive cruise control, driver drowsiness detection and lane departure warning.

Many traditional mechan-

ical components have become commoditised, generating razor-thin margins for suppliers. Much of the production of these parts has moved to emerging economies.

"Increasingly, we invest in understanding and developing new technologies that go beyond the next generation, but rather are two or three generations out, offering new value to our OEM [original equipment manufacturer] customers and their consumers," says Han Hendriks, head of Johnson Controls' global product development and engineering for interiors.

"This is clearly the direction Johnson Controls is going, becoming more focused on technology – as opposed to manufacturing – than we were in the past."

Thus, suppliers stand to benefit from the growing popularity of electric and hybrid vehicles, and consumer demand for high-value in-car communication and infotainment systems.

Bernd Bohr, head of Bosch's automotive technol-

ogy sector, says that Suppliers field of expertise is electrical and electronic systems. Together, he adds, these have a share of value added in today's vehicles of 40 per cent, but this will rise to 75 per cent in tomorrow's electric cars.

Big suppliers can capitalise on these trends with diversified product lines

Product innovation, high barriers to entry and sustained cost containment are what matter

that create significant opportunities for cross-pollination.

Bosch's experience in the power-tool business, for example, gave it a head-start in developing lithium-ion batteries for electric cars.

A carmaker's brand identity historically has been closely linked to its mastery of internal combustion engines, so it is likely that

some carmakers will want to continue to develop the key motor architecture of an electric vehicle alone.

"From our understanding, the drive train is more or less the heart of the car. So, with this in mind, you cannot really outsource the batteries, motors and power electronics," says Jürgen Leohold, head of research at Volkswagen. "Our strategic ambition is to have the competence for these technologies."

The same may apply to the software at the heart of the car's telematics and infotainment systems.

Stefan Kampmann, executive vice-president of electric vehicles and hybrid systems at Bosch, says: "Things that will not differentiate your car to the car buyer will probably go to a tier-one [supplier], because the tier-one can develop economies of scale across OEMs. The things that really differentiate your car will stay at the OEM."

"If you look at many of Apple's products, you will see it does the concept, the

# Gadget makers try to minimise distraction

## Technology

The aim is to keep drivers' eyes on the road, says **Chris Bryant**

As consumer electronics become a staple of the modern automobile, the industry has a responsibility to ensure drivers' eyes stay focused on the road.

Only a few years ago there was little to distract a driver, save for switching radio stations or adjusting the heating.

But drivers more commonly carry smartphones and vehicles themselves become infotainment centres and communication hubs, the dizzying array of options, apps and gadgets risks diverting drivers from the task at hand.

"Drivers are used to always

being connected. But the number of distracting elements in vehicles is proliferating. There is more and more stuff that takes eyes off the road," says Nick Langdale-Smith, sales and marketing director at Seeing Machines, an Aim-listed company which makes face-tracking technology that senses when drivers are sleepy or not paying attention.

"Of course, nobody in the industry wants to see more people get killed. But carmakers are also under constant pressure to offer better in-car technology than their competitors, and with that comes the risk of additional distractions."

Unless they can prove that their systems are safe, carmakers risk intervention by regulators that could strangle a valuable source of revenue.

Of the 33,000 people killed in road accidents in 2009 in the US, some 5,500 deaths were linked to

driver distraction, according to the US National Highway Traffic Safety Administration.

David Strickland, NHTSA administrator, did not mince his words when addressing an industry conference in Detroit in June.

"I'm just putting everyone on notice. A car is not a mobile device," Mr Strickland said. "I'm not in the business of helping people tweet better. I'm not in the business of helping people post on Facebook better."

"We will not take a back seat while new telematics and infotainment systems are introduced. There is too much potential for distraction of drivers."

Carmakers are keen to show they are taking the initiative. BMW, for example, has sponsored an advertising campaign to discourage mobile phone use while driving. Chrysler and Ford are backing federal legislation to do the same.

But carmakers and suppliers are aware they need to do more.

"From my point of view, it's a very big issue," says Uwe Thomas, head of car multimedia at Bosch, the world's largest automotive supplier. "We can sit and wait, and sooner or later governments will tell us what they will and will not allow in the car."

Voice activation is set to respond to everyday speech and dialects rather than pre-set commands

"But a better way is to develop intuitive, modern human-machine-interface (HMI) solutions that create more safety and convenience and make government regulation unnecessary."

An important focus for the industry is the development of in-car systems that respond differently depending on the driving situation.

If a car is stuck in a jam or stopped at a traffic light, it might be safe for the driver to watch a news broadcast on an LCD display.

But if a car is travelling at speed at night and in poor weather, the driver should probably not be talking on the phone, even with a hands-free kit.

Therefore, in the future, car systems may be able to sense factors such as traffic conditions or the curvature and surface of the road before deciding whether to permit certain activities.

"If it's a complex driving situation, you would postpone incoming phone calls or the car would offer to switch on advanced driving assistance sys-

tems," says Guido Meier-Arendt, an HMI expert at Continental, a German supplier.

Carmakers are also investing heavily in the interface itself. Audi's flagship A8, for example, pairs an innovative touchpad featuring handwriting recognition with voice recognition technology, to enable the driver to input a destination without scrolling through complicated menus.

Meanwhile, the head-up display in the new Audi A7 projects important information directly on to the bottom of the windscreen in the driver's field of view.

Ford's MyTouch system, which combines a touchscreen, steering-wheel switches and voice activation to handle phone calls, music selection and other activities, was praised by many reviewers.

However, Consumer Reports criticised the interface as

"overly complicated and distracting".

A potential alternative to the touchscreen are buttons that provide tactile feedback, so the driver can intuitively "feel" – rather than look at – what he is pressing.

Meanwhile, voice activation is set to become simpler and more effective by responding to everyday speech and dialects rather than pre-set commands.

As a back-up, face-recognition technology – such as that produced by Seeing Machines – can warn a driver when he is not paying sufficient attention and activate assistance technology as appropriate.

The key, say industry experts, is the effective co-ordination of all these operations and functions into a single interface that allows drivers to stay focused on the road, while enjoying all the benefits of the modern connected vehicle.

# Robots to remain back-seat drivers

## Automated driving

Vehicles that pilot themselves are here, but humans like to be in control, writes **John Reed**

It is a recurring image in fictional renderings of the future: cars that can drive themselves.

In the 2002 film *Minority Report*, Tom Cruise's character leads police on a high-speed chase in a driverless car, the Lexus 2054, named after the year in which the story supposedly takes place.

As long ago as 1939, General Motors imagined a future that included automated highways in its Futurama pavilion at the New York World's Fair.

Today, carmakers, including GM, BMW and Volkswagen, are experimenting with vehicles that can pilot themselves. Google recently grabbed headlines when it tested a driverless car.

Automakers already have cars on the road that can brake or accelerate autonomously, park in tight spots or make other decisions on behalf of the driver.

Industry participants say, however, that fully self-driving cars will present a legal minefield and are unlikely to be commercially available for about two decades, if then. Drivers are unlikely to want to surrender full control of their cars, nor will most automakers or lawmakers want them to.

"I don't know that we should aspire to a society

where cars completely drive themselves," says Shankar Sastry, dean of engineering at the University of California at Berkeley, who has conducted extensive research on unmanned vehicles.

He adds, however: "It will be very useful to have cars take over from humans when they are distracted or fatigued or would like to do something else."

Manufacturers are offering more cars with "semi-autonomous" driving features, mostly to enhance safety.

A number of them, including Mercedes-Benz and Ford, have introduced adaptive cruise control, lane departure warnings and blind spot monitoring to their cars.

Mercedes says its upcoming cars will be equipped with enhanced camera systems and programmed with more advanced algorithms to allow them to make more critical decisions about safety. "We have a goal of accident-free driving," says Ralf Lamberti, who heads Mercedes' telematics division.

In the US, several carmakers are working with safety officials to set and test common standards for crash-avoidance systems based on vehicle-to-vehicle (V2V) communications.

The US National Highway Traffic Safety Administration hopes by 2013 to make decisions about regulating V2V, which carmakers say can be deployed at low cost using WiFi connections and GPS. "We recognise that this is a co-operative undertaking, and we have been working with other carmakers," says Mike Shulman, a

**Power to the Porsche** The long and winding road to semi-autonomous driving



I am sitting behind the wheel of a car straight out of a banker's boyhood dream or – for an overcautious driver like me – a pulse-quickening nightmare: a Porsche that drives itself.

The car, a technologically kitted-out version of a Panamera, drives, accelerates and brakes on its own. All I have to do is steer.

Two Porsche engineers who developed the car are coaching me to keep my foot on the floor and my eyes on the road as we whip around corners at a speed I would never venture on my own. We are zooming through the winding roads of what Porsche calls the "Weissach Lap", a circuit of five towns near its technical centre outside Stuttgart.

The car "drives through curves swiftly but harmoniously", Porsche promised in a video presentation before we got on the road. But I am finding the experience unnerving. Suddenly a cyclist veers on to the road ahead. Another vehicle is approaching in the opposite lane, so there is no room to overtake.

I brake, disengaging the car's self-driving system, called ACC InnoDrive. "Safety first," I say, a little dopedly. Good thing, though: the car knows to brake at stop signs, junctions and other points marked on the map but would not have "seen" the old man on his bike.

At first glance, ACC InnoDrive has the frivolous, pointless feel of an executive toy. But Porsche developed it to make some serious points about the future of driving and – of all things – fuel efficiency.

The car uses a "predictive drive" strategy, which Porsche says has never been used before. By mapping out the terrain over which the car moves, the company's engineers say they can cut fuel consumption by about 10 per cent. Taking curves at high speed without applying the brake, it seems, is part of the plan.

ACC InnoDrive is an advanced version of the adaptive cruise control systems in use on some cars that allow for semi-autonomous driving on highways. But this car can be used within city limits or on

winding, complicated semi-rural routes like those of the Weissach Lap, because it is programmed with digital map data that include speed limits and the profile of the road ahead. The car then plots how fast it should drive, when to shift gear and what brake pressure to apply.

"Traditionally, the engine was the focus when reducing fuel consumption," Martin Roth, Porsche's head of advance development, tells me. "It has become clear you need to look at the complete vehicle and optimise the interaction between the driver, the car and the environment."

There is a computer that takes up most of the boot space. In the cabin, a display screen is attached to the passenger side of the dashboard.

As we drive, two jagged, roughly parallel lines appear on the screen, through which a third line describes a smoother, snakier path. The outer lines are fixed limits Porsche's engineers feed into their algorithms – speed limits, crests in the road or acceptable speeds at which drivers

will want to accelerate as they leave town. The algorithms then plot an optimal curve through these confines: the line in the middle.

The system takes some getting used to, not least for an average driver unfamiliar with the dynamic handling of sports cars and the mechanics of cruise control. You engage the system by clicking an indicator to the left of the steering wheel, but it automatically disengages when you brake. I have trouble keeping my foot off the brake and soon lose track of whether the ACC is engaged.

Porsche has made no decision on whether to install ACC InnoDrive in road cars. However, it says, the technology might be applicable for electric and hybrid cars, although a bigger hurdle is the digital map data, which will be available in two to three years. While this probably is not the car for me, I can certainly imagine it arriving in modified form in years to come.

**John Reed**

member of Ford's advanced engineering team involved in the effort.

A fleet of 3,000 cars equipped with the technology is to be deployed in a yet-to-be-named US city next year. Cars, trucks, buses and intersections will be equipped, allowing them to communicate with and warn one another as necessary.

Ford and other carmakers

are also working with the US Department of Transportation on vehicle to infrastructure (V2I) projects that warn distracted drivers about stop signs or traffic lights ahead. Such test intersections are in place in some US states, and similar systems are being tested in Europe and Japan.

Alongside their joint efforts on V2I and V2V systems, automakers continue

to work alone to push the boundaries of what their cars can do autonomously, including cruise control systems adapted for complex urban settings.

Manufacturers say they have the technical means to produce such cars but lack the maps to implement them.

Most carmakers blanch at the legal implications of allowing drivers to surren-

der responsibility to the vehicle. Driverless cars are in any event banned in most places – Google had to petition Nevada's legislature for a legal change to allow trials of its self-driving car.

PSA Peugeot Citroën, for example, does not offer systems that accelerate its cars autonomously – a function it thinks should be left to the driver.

Berkeley's Dr Sastry, who has done work on robotic surgery, says robots can replace a great surgeon's hands, but they cannot match humans on spatial reasoning – and the same applies to cars where many functions will be automated but the driver will remain front and centre.

"It's a lot better to keep the human in the loop," Dr Sastry says.

# Visions of mobility in the megacity

Continued from Page 1

is having to develop new core competencies in areas such as electronics and batteries. The big consumer electronics shows in Las Vegas and Hanover have become stops as fashionable as the big car shows for automotive executives.

The shift towards more battery-powered, digitally connected cars also presents new opportunities and risks for suppliers, which are seeking to keep their share of the profits when faced with carmakers' old reflex to keep costs down.

Carmakers need to decide which parts of the emerging battery and electronics technology they will keep in-house.

The digital age is also pushing carmakers outside their own comfort zones

Questions include which connectivity features drivers will value and which they will reject

into new areas such as car sharing. BMW and Mercedes-Benz both operate expanding one-way car-sharing businesses.

The other big industry buzzword, "mobility", comes as carmakers try to find ways of earning money from young and urban drivers sceptical about owning a car at all.

As carmakers deal with some of the biggest technological and market changes in their history in the midst of an economic downturn, the future is uncertain.

Unanswered questions include which connectivity features drivers will value and which they will reject, and how many will want electric and hybrid cars, even with generous state subsidies.

This much is certain: the future will be full of a record number of cars.

# Positives outweigh negatives in battery power

## Test drive

Recharging and range figures are improving, writes **Rohit Jaggi**

The strange thing about the future is how close the parallels are with the past. Ferdinand Porsche, founder of the sports car marque, built a hybrid electric car with in-wheel motors and an internal combustion engine to generate the power to drive them – in 1900.

Even the flying car – a motif for over-the-horizon modernity in fiction from *The Jetsons* cartoons to the somewhat darker *Blade Runner* movie – took wing in reality in 1919 with the Autoplane of aircraft pioneer Glenn Curtiss. The new Transition – the most convincing example of the concept since the 1970s Ford Pinto-based Mitzar killed its creators when the wings detached in flight – is said by its US manufacturer Terrafugia to be only a year from delivery.

Meanwhile, the road vehicle

industry is still sniffing around hydrogen power and fuel cell technology to deal with the twin problems of diminishing oil resources and carbon pollution. But it has largely settled on using electricity derived either from the grid or from on-board generators.

In volume terms, especially in China, electric two-wheelers are showing cars the way. Even in Europe, more electric motorcycles and scooters are sold than pure electric cars. The 11,000 sold in the first half of 2011 represented a jump from the 5,567 in the same period last year, although just 0.3 per cent of the European Union powered two-wheeler market, according to Acem, the Motorcycle Industry in Europe, the trade body.

That carmaking giants such as BMW are displaying electric two-wheeler concepts indicates how far the vehicles have come. The first electric scooter I rode, an early attempt by US manufacturer Vectrix, tried to kill me when the transmission locked up at speed. Later versions by the same company, and some other electric motorcycles, have been startlingly good, though let

down in the case of fellow US manufacturer Zero by an extremely limited range if I used the power available.

Many in the current crop of plug-in electric four-wheelers are not only sophisticated but also address range concerns.

Nissan's plug-in Leaf, aside from the £31,000 (\$49,220) price tag before a £5,000 government incentive, impresses with its quiet capability compared with conventionally powered five-seat hatchbacks. Good acceleration and a respectable top speed of 90mph can be traded against a potential range on a full charge of 105-plus miles – indicated very clearly on a well-integrated satellite navigation system.

Warnings in the charging instructions made me fear that suspect wiring in my central London house, courtesy of the previous owners, might not be up to the job of topping up the car's lithium-ion batteries. But the lead snaking in through the kitchen window from the rain-lashed driveway did the job overnight, and a fast charge of 80 per cent of battery capacity within 30 minutes is possible using the infrastructure Nissan promises to install at dealers.

The Japanese manufacturer has also shown a system that uses the batteries of a plugged-in Leaf as an electricity storage medium for homes – a neat way of smoothing out the supply and demand mismatches in power produced domestically from solar cells or small wind turbines. Or coping with power cuts. Nissan says a typical home could be powered for two days by a Leaf.

Tesla, the US manufacturer of an £88,000 high-performance plug-in two-seater, says the car's electronics can deal with charging from any source – it too passed my Camden Square suspect-wiring test.

The Tesla Roadster is a good example of what an electric car can do, which is supply driving pleasure equalling that provided by internal combustion engines – up to 295lb-ft of torque and 288hp yield a 0-60mph time of 3.7 seconds. Or, in more subjective terms, more acceleration than usually can be used on the road.

Not using all the power available helps to maximise the distance that can be travelled on a single charge, too – up to 245 miles is claimed – and I



Almost here: Terrafugia Transition

found that even hard driving failed to ruin the range. A charge from empty to full takes two to four hours using the fastest method possible, and 14 hours with the slowest.

How people use the cars is the crucial element. Car users often dismiss a 100-mile range as inadequate, despite longer trips being quite rare. Information from user studies indicates that when drivers' confidence in the batteries and understanding of their usage grows they may plug in cars

only every two or three days.

The forthcoming seven-seat Model S Tesla, promising up to 300 miles on a single charge, will be interesting. But focusing on extending the range of electric vehicles, which battery and controller technology improvements are bringing, is in part missing the point.

Pilots of aircraft, skippers of motor boats, and drivers who venture away from the filling-station network already know what it is to plan their journey given their reserves of fuel and the opportunities to top up.

Electric light aircraft are starting to appear, and their pilots are performing the same calculations about refuelling – but with electricity rather than aviation gasoline.

Car and motorcycle drivers could easily grow used to doing similar sums, though with less risk if they get the decimal point in the wrong place.

Once they do, the revolution in vehicle propulsion can really start motoring.

*Rohit Jaggi writes a monthly cars column for FT Wealth magazine, producing written articles and video vehicle reviews*

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