

# CALM AND COLLECTED

The collection and dissemination of atmospheric and road information can go a long way to saving lives and enhancing roadway efficiency. **Nick Bradley** looks at some of the latest developments designed to ensure maintenance teams remain stress-free

Illustration by Tim Ellis

**A**dverse weather is any traffic manager's worst nightmare. Snow, rain, fog, ice, wind, and even high temperatures are conditions that directly influence how quickly and safely traffic flows. Fortunately, advances in road weather management are enabling authorities to stay if not one step ahead, then at least level-pegging with whatever Mother Nature can hurl.

"For a long time, the focus has been on winter weather," says Vaisala's Danny Johns. "It's always been about ice and snow clearance, probably as these grab the headlines. But we've started to see a move toward a more holistic approach to weather in traffic management. We're seeing an increase in the number of systems for specific parameters: fog systems, high wind, and so on. It's a wider appreciation of the impact certain weather can have on traffic."

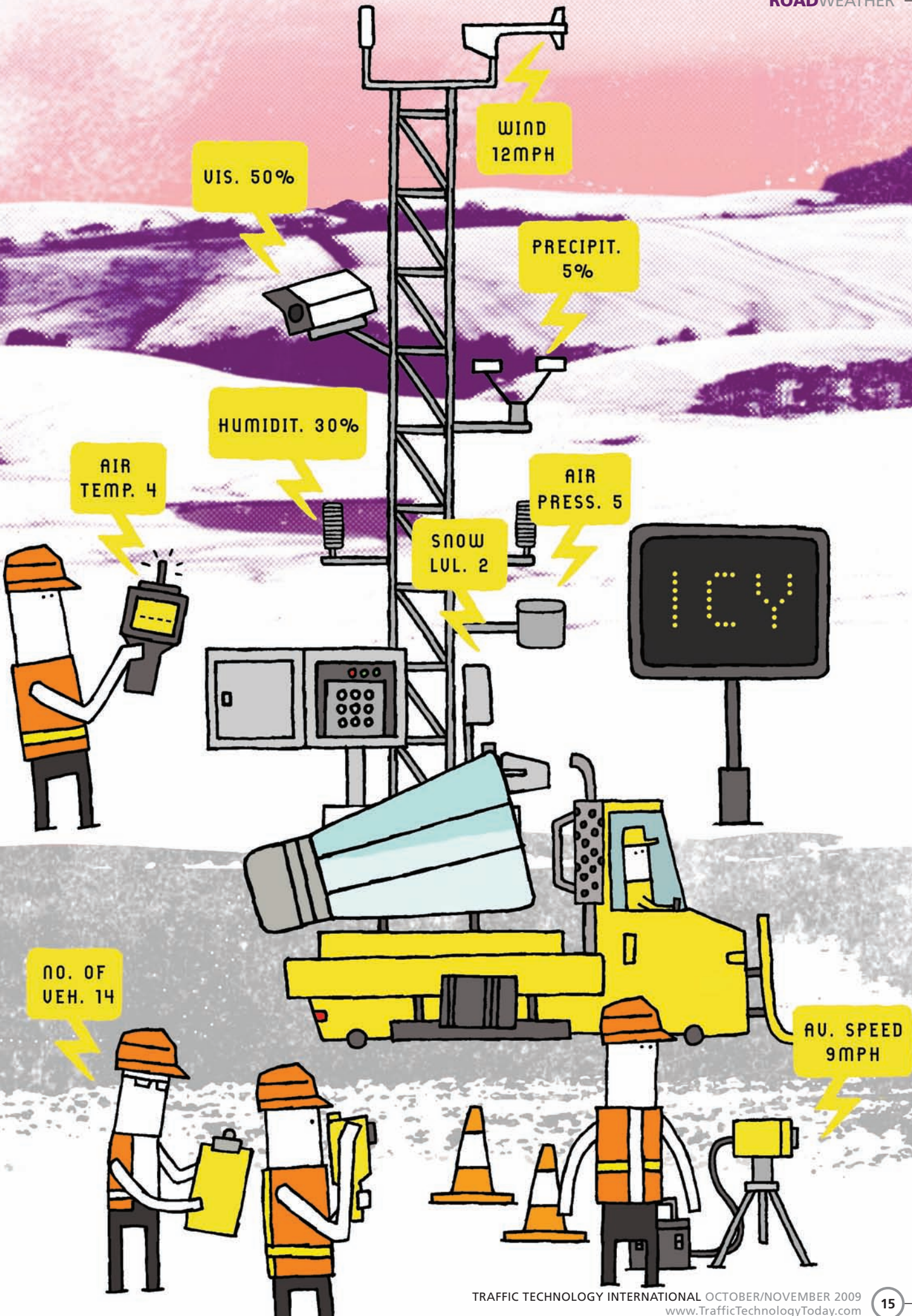
And it's not just about crashes either. "I think one of the big areas for potential gain is in understanding how weather affects traffic flow. If you've got a relatively long journey to work and you wake in the morning to find it's raining or foggy, you should expect a certain amount of delay to your commute as a result. It's about trying to understand that relationship and getting the use of the available systems right so that traffic can be managed in an effective way."

## INFORMATION OVERLOAD?

Johns spent 21 years working with the UK Met Office, some of it as an operational forecaster before moving to Vaisala's roads business three years ago, so he's been on both sides of the fence. "We've got an interesting challenge to try to understand how we're going to use all of the data coming in from the weather stations. You









can collect as much data as you want, but someone has to sit in the control room and decide to mobilize the gritters at 03.00hrs, and there's such a narrow window in which to make those decisions that somehow we need to synthesize all that data down into relatively simple messages."

A lot of Johns' work is currently focused on the way this data is visualized. "Clients require intelligent data that's focused on the way they actually carry out their operations; it's entirely to do with the procedures that they actually follow. It's about streamlining the decision-making process." On decision-making, Vaisala recently purchased the Federal Prototype Maintenance Decision Support System (MDSS) from the USDOT and is expanding its capabilities by adding Road Weather Decision Support Systems (RWDSS) to its portfolio. "The beauty of this is that the practices of the individual operator can be incorporated," Johns says. "It's a decision aid, a real tool for helping to make decisions in the way that you want to make decisions. So if you've got limitations – i.e. the length of time that it takes to get back to the depot on a maintenance run – that needs to be somewhere within the decision support system so that it can understand whether a route is viable or not given the circumstances."

"The MDSS is a federally supported program that most of the US state DOTs have co-funded up to the prototype



**"Clients require intelligent data that's focused on the way they actually carry out their operations; it's entirely to do with the procedures that they actually follow"**

**Danny Johns, RDS online offering manager, Vaisala, UK**

stage. The idea now is that organizations such as ourselves turn it into a viable commercial solution for the market. It's something that the market has said it really wants, so the customer pull is certainly there for us."

#### PASSIVE VERSUS ACTIVE

Sensors are at the heart of every weather data collector, and Saab's Patrik Jonsson has spent the past 13 years looking into the effectiveness of various types – passive and active – from several different vendors. With Saab since 1996, his research has formed the basis of a recent paper, prepared as part of his PhD at Mid Sweden University. "There's a big difference between how a university works and how the industry works," he says. "In the industry, the objectives are obviously more commercial. At universities you have to know a lot of background; what you want to achieve, what you want to gain, etc. So far we have evaluated sensors installed in the road, although in the future I hope also to study

the newer remote sensors. That's a very interesting area because everyone wants non-intrusive sensors, but they come with a price tag. Another issue is that you don't have the possibility to get a prognosis of how the road status will change. With embedded active and passive sensors, you can follow the freezing point over time so you can predict when the road will freeze.

Some other sensors take more or less a snapshot of the actual condition, so it will tell you that the road is slippery – you might have already crashed by that point!"

Saab's biggest customer is unsurprisingly the Swedish Road Administration and Jonsson has worked with the SRA on many weather-related products, not just with RWIS, but also variable speed limits based on climate. "The winter months are harsh here," he explains. "Such an environment ensures that our own systems are very robust and reliable. I know our competitors have a hard time in terms of managing the power network, power conditions, and problems such as icing and cold climate. In Sweden, we have a reliability rate across our network of about 99.9% – and we even include the phone network in that figure. We've also calculated mean time before failure (MTBF) on all our platforms, and our computer units have more than 100 years of MTBF – that's one of our USPs."

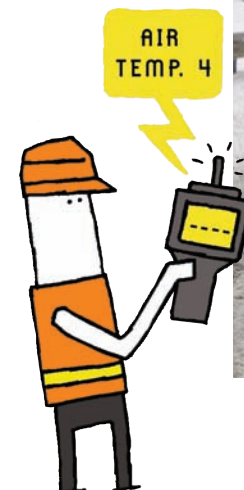
Jonsson's personal experience regarding infrared sensors is that they are sometimes

information to ingest into our road forecast model, but also so that our meteorologists can closely monitor road conditions, assess the performance of our forecasts every hour of the day, and advise our clients accordingly." All information is specific to the client highway network, so forecasts of road surface temperature and road condition (e.g. hoar frost, ice, etc) are supplied – not general atmospheric information.

More recently, Meteogroup has developed a technique for providing forecasts for the length of any routes within a client network. "This enables managers to decide upon their anti-icing action based upon forecast conditions around their network (rather than basing a decision on the site-specific forecasts). Surveys of the client network are conducted to measure the influence of radiation during the day

calibrated for some surfaces to achieve a good reading. "There is a problem when you have an ice-covered road when compared with a dry or a wet road, and that means that they have an accuracy span," says the 41-year-old Swede. "According to the SRA this is not good enough for accurate winter road maintenance. I can recall reading a study by the Aurora group, which tested one brand of sensor and concluded that the temperature could sometimes vary by  $\pm 4-5^{\circ}\text{C}$  compared to the true value. Swedish authorities are looking at  $1-2^{\circ}\text{C}$  between road temperature and the freezing point – a very narrow band – before they do the salting." Jonsson says this is to optimize the salting process, and to lower the cost of the road maintenance and the amount of salt spread. "If it was all about traffic safety, you'd just spread huge amounts of salt," he

**➔ A man skies along a main road in Reinosa in northern Spain; a traffic sign in County Kildare, on the N4 near Dublin, advises traffic to slow down for bad weather; gritters try to cope with the snow**

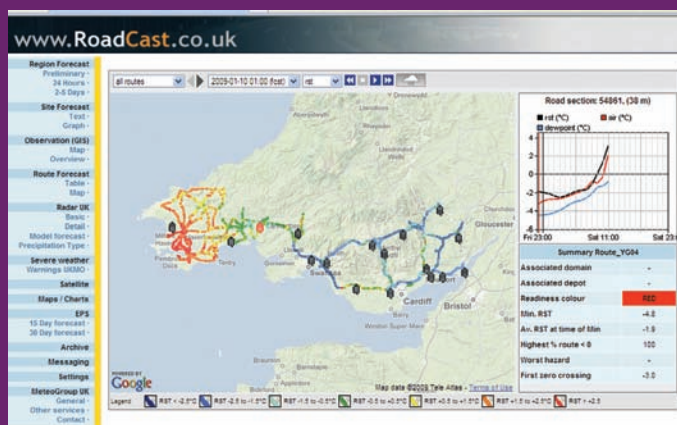




(heating) and night (cooling), along with temperature profile measurements to verify variation within the route-based forecast."

Forecasts generated by MeteoGroup's route-based model are visualized within the same client internet portal, and simple color-coded presentation of the client network on a map interface demonstrate how road surface temperatures and road 'state' will vary over the forthcoming 24 hours. This enables managers to not only target their operations at particular points of the network in timely fashion, but it can provide valuable data that means certain routes may not actually require treatment.

"We are experiencing considerable interest in this new forecast technology, and have recently been awarded a European innovation award for our network forecast technology," Giles enthuses.



Ensuring public safety and minimizing delays requires decisions to be based on the best quality weather forecasts

states. "It's difficult to use infrared systems with those kinds of margins. Sometimes in Sweden, regarding variable speed limits, you're not interested in prognosis, you're more interested in the actual situation. If you detect a slippery surface on the road, you just want to warn the traffic that the road is slippery." But, he adds, if the road is slippery, the road maintenance has failed. "If everything works, that should never happen."

"People often ask me what the best type of sensor is: passive or active? It really depends on what you want to know. Sometimes it's very important to know whether the road is dry or wet because that helps a great deal when conducting winter maintenance. If the road is dry it's no problem, but if it's wet it will become icy. Passive sensors are much better at detecting dry or wet, yet an active sensor will give a

much more accurate reading of the freezing point." The best system, therefore, would be one that features both a passive and an active sensor. Indeed, in Jonsson's opinion, the more sensors you have, the better. "It will be a long time before just one sensor gives you all the data you need. The more sensors you have, the better the information and prognosis. My research has helped us to understand that active and passive sensors really complement each other."

In the future, Jonsson predicts that many of the improvements in weather forecasting and road weather management will revolve around advances in the sensors themselves. "We'll have better accuracy, that's for sure," he says. "But I think that maybe the main work will be in better prognosis, more local climate prognosis – trying to predict weather over a stretch of road more accurately." He

says that today technology is based more on standard meteorology, but some companies, such as the MeteoGroup (see box, above), are working specifically with road weather, and there remains an important distinction. "They are looking at a whole host of parameters," he says. "For instance, a road stretch where you have bridges will be much colder, or warmer and much faster, than surrounding roads. Areas where you have forest on one side of the road and perhaps an open field on the other side will affect readings as well. I think technologies that can take account of the surroundings with climate mapping and imaging techniques will evolve more in the future."

## VEHICLE PROBES

The future is something that preoccupies Sheldon Drobot, a scientific program manager for the Weather Systems and Assessment Program (WSAP) within the National Center for Atmospheric Research (NCAR) in Colorado. "What we're doing here at NCAR with our Vehicle Data Translator (VDT) project is really tied in to the whole larger ITS framework that is related to weather, but kind of beyond weather, too," he explains. The basic idea behind the VDT is to combine traditional weather measurements from atmospheric sensors – such as roadside sensors and weather stations at airports, weather model data, radar, and satellites – with a new way of collecting data from mobile platforms. This work is supported by the Research and Innovative Technology Administration's (RITA) IntelliDrive initiative, and overseen by RITA's Ben McKeever and Paul Pisano at the FHWA Road Weather Management Program.

"In the USA, there's some 250 million vehicles out on the road, which represents a much bigger network than the more traditional forms of weather collection can



Photo by Juan Manuel Serrano/AP/Press Association Images



Photo by Haydn West/PA Archive/PA Images





provide," Drobot says. Of course, at the moment, those vehicles are not providing data from functions such as ABS, windshield wipers, etc, but in the near future Drobot insists they could. Ultimately, the aim is to combine those mobile observations with the traditional sensing capabilities and develop road and atmospheric hazard products, with the goal of saving lives and increasing mobility. "Studies over the past decade show that every year we are losing about 7,400 lives in crashes during hazardous conditions, such as rain, snow, and ice. It's a huge problem that hadn't really received a whole lot of attention. Not only that, other studies show that we were easily losing a couple of billion dollars in economic terms as a result of mobility issues, such as trucks getting stuck in bad weather."

In Drobot's vision, vehicles will essentially become mobile weather probes, collecting, disseminating, and transmitting information about road and atmospheric conditions in real-time to other vehicles and agencies. If ABS or traction control systems are activated, it could be that a patch of ice is posing a hazard. If headlights are activated, maybe visibility has reduced due to fog. Likewise, if windshield wipers are activated, is it raining? If so, how hard? "For the average driver, it will provide situational awareness," Drobot adds. "Your car will feature a navigation unit that will have built-in weather information based on the

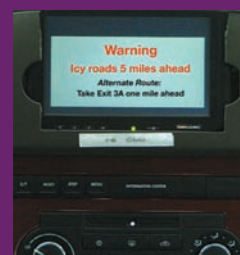
## What next for the VDT?

**N**CAR's VDT is presently just a prototype, with tests in Detroit (where RITA has a testbed for the IntelliDrive program) hoping to compare the collected data with that from traditional weather systems. "We did a 25-car test in the fall of 2008, and then we got funding to run a separate experiment this past April with another 10 vehicles," says Sheldon Drobot. "We can see how the VDT data compares to what we're seeing from the traditional instruments, in terms of things like vehicle temperature and vehicle pressure. We can also compare in terms of accuracy and bias to the more traditional sensing that we would get from meteorological instruments."

Drobot reveals that he has been pretty impressed so far with what he's been seeing. "We've been comparing the vehicle data with traditional observations at Detroit International Airport. That's about 50km from the actual testbed, so there's a bit of ambiguity in the sense that on certain days that we were testing, there were some subtle differences in what was going on at the airport and at the testbed." By and large, Drobot reports, the majority of vehicle-based temperatures were within about  $\pm 1.5^\circ\text{C}$  of those recorded at the airport. "It gives us a lot

of confidence that the temperatures that we're getting from the vehicles are consistent with what we get from traditional observations, so that bodes very well for going forward.

"We want to refine the algorithms and get them to be a little bit more accurate," he adds. "And we're basically planning that in the early part of next year we'll have the next version of the VDT software ready to go. That probably won't be something that will be ready for wide distribution, but it will be an improvement nonetheless."



← The sheer amount of data potentially flowing through a vehicle-based data network could be immense



**"Our studies over the past decade show that every year we are losing about 7,400 lives in crashes during hazardous conditions, such as rain, ice, and snow"**

Sheldon Drobot, scientific program manager, NCAR, USA



Photo by Owen Humphreys, PA Images

research we're currently conducting. Five miles ahead, cars could be reporting icy roads, or there could be a thunderstorm 10 miles down the road. Imagine you want to drive from Denver to Colorado Springs and you have a route that you would normally take, but via the display your system is telling you that a rainstorm is moving in that could delay your journey, so an alternative route might be a faster and safer option.

"At a state transportation level, they'll see these cars reporting different conditions and if they're charged with de-icing – and they see this stretch of road where cars are activating ABS or stability control – they

could send out a truck and conduct some spot de-icing. Not only does that improve safety, it will save a ton of materials because they don't have to blast the whole road."

Going mobile is likely to be a big part of road weather management in the years to come. Having developed a remote sensing capability known as spectroscopy, Vaisala's Danny Johns says that the next step is to mount it onto vehicles. "What the sensor does is actually calibrate to the extent that it can show what the friction change is – or is likely to be – given the fact that there is now something on the road surface." It's not an absolute measure of friction, but an index

that is described as 'grip' that shows how slippery the road has become due to weather conditions. "It does that by looking at the different combinations of water and ice crystals on the road surface. That is particularly groundbreaking."

### THE FORECAST

Johns and many others in the weather sector believe technologies such as NCAR's VDT will have their day. "One thing I would be wary about, though, is the quality of the data," he says. "We spend a great deal of time and effort making sure factors such as the natural car temperature doesn't conflict with road temperature readings. I think you'll find that a lot of the existing sensors on a car give a good indication of what's happening in the air, but when you start looking at road surface temperature you're going to get bounceback from other cars, heat from tailpipes, etc – so it's something to consider in the early days. I'm not saying it's not going to happen, just that a lot of thought needs to be given before we go down that route."

"It's definitely a really exciting time," Drobot concludes. "There's so much going on that it seems that every year there's some new kind of development or innovation that will have a big impact. By the time that those people born today will get around to driving a vehicle, it's going to look remarkably different to how it looks today – and I think that's pretty cool." ■