traffic
TECHNOLOGYINTERNATIONAL

June/July 2011

Safety in numbers
Tony Bliss contemplates
the impact of ISO 39001

Power drive
Is wireless electricity ready
for traffic management?

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SEAL OF APPROVAL

Calculating risk: How the naming and
shaming of Europe's dangerous tunnels
is paying safety dividends

PLUS

Harold Worrall

"The ITS industry has this
tendency to create solutions and
then look for problems to solve"

In-car versus roadside

Why continued investment in fixed
infrastructure will render intelligent
transport systems unintelligent
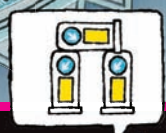
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Cover story

40 Scores on the bores

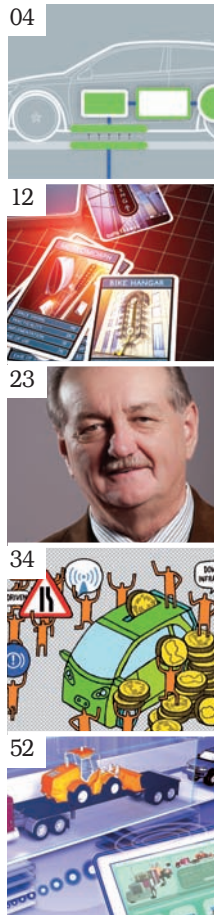## EuroTAP's mission to vastly improve tunnel safety

Nick Bradley meets the men at the center of the EuroTAP program – as well as a host of suppliers and integrators all working toward the common goal of getting safety in tunnels up to scratch

Foreword

My lack of organizational skills is legendary among friends, perhaps best demonstrated on December 24. Having had 363 alternative days to buy my wife her pressies, Christmas Eve is nine times out of 10 the day I brave the masses, my preferred destination being Kingston-Upon-Thames, Surrey. I buy on the fly, with little or no clue as to what I'm after, although I can't go wrong with two jars of Smucker's Goober Grape!

The worst thing about this last-minute spree is not the crowded streets or the 400 or so charity Santas at every shop entrance, but parking. The Bentall Centre is notorious; I've queued for over an hour just to get to the entrance. So it was much to my surprise – actually, suspicion – when a few Christmases ago I rolled up at the busiest time to find no queue at all. The streets were filled with the usual hordes, the car park was near capacity, yet I parked with ease. It was surreal.

After establishing that I wasn't the focus of some TV prank, I noticed these green and red LEDs above each space – the components of a parking guidance system. You should know this was before my time at the *TTi* helm, so my interest then was industrial vehicles, not intelligent transport. But this piece of ITS obviously worked!

So with parking as my inspiration for the Design Challenge in this issue (*page 12*), I was intrigued to find out how towns such as Kingston – or even cities such as San Francisco, New York, etc – will cope in 2050 when it's predicted there

will be another 800 million cars on the roads globally and parking availability will in reality be much more scarce. Such a prospect is almost enough to convert me to internet shopping.

The first person I approached was Jeff Ferzoco, whose contribution to our intersections challenge I found particularly met my out-of-the-box brief. "It's exciting to imagine how we could squeeze more cars into densely packed cities," he tells me. "Motorized carousels, stackable mini autos, and inflatable cars sound terrific – but if the traffic is still terrible, it's not going to be a pleasant ride!"

His future concept focuses on catering for inner-city residents and commuters individually. For the former, it's ubiquitous, ambient, real-time information that's key. "Once a commuter is behind the wheel, the information to find a place to park should be within sight – dashboard, windshield, or even eyeglasses," he says. "Cities should also turn to real-time variable pricing to control behavior." For residents, he proposes that auto-shares should replace parking facilities, with a fleet of bicycles and cars – say 10 cars per 50 people – built into every building. Mass transit use and information would be the most vital part of the equation, and added investment in pedestrian zones, cycle lanes, personal transportation, and sophisticated multimodal transit systems.

His vision for increased economy and happiness is progressive but entirely imaginable. Given the choice, I'd certainly do my Christmas shop there – no matter how late I leave it!

Nick Bradley
Editor, Traffic Technology International

Road tested

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S E E I N G   I S   B E L I E V I N G
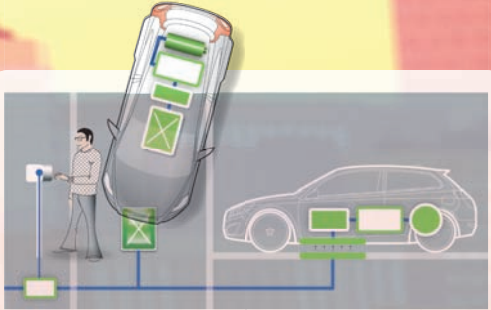
Volvo is one big-name OEM that's involved in an inductive charging project. The CED (Continuous Electric Drive) scheme sees Volvo working with Flanders Drive and others to modify a C30 Electric to enable it to be inductively charged. It's expected it will take around one hour 20 minutes to charge a battery of the size fitted to this particular vehicle.

Transfer
strategy

The potential for the traffic management sector to power infrastructure wirelessly has its benefits – not least in terms of reduced invasive maintenance. **Louise Smyth** connects with some of the bright sparks in the field of inductive power transfer

Illustration courtesy of Magictorch

Inductive power transfer (IPT) is being used within a tunnel project in the UK. New Zealand company 3i Innovation has supplied 628 IPT road studs for use in the Saltash Tunnel in southwest England. The illuminated studs are used to deter drivers from straying into the center lane (which would be against the tidal flow of the tunnel's system). Cables were installed in the pavement surface and wrapped around inductive nodes that can be powered to automatically illuminate the direction of traffic traveling toward them.

Readers of another publication within our stable, *Electric & Hybrid Vehicle Technology International*, are likely to be familiar with the idea of wireless electricity; readers of *Traffic Technology International* perhaps less so. But the concept, as the name suggests, is deceptively simple: transferring electric power or energy over distance without wires. The implementation, however, is easier said than done, and has had scientists scratching their heads for years trying to crack it.

Two men who are undoubtedly pioneers in the inductive power transfer (IPT) arena are Professors John Boys and Grant Covic of the University of Auckland's Electrical and Computer Engineering Department in New Zealand. Both have successfully dedicated much of their careers to researching and commercializing applications for IPT using something known as 'resonantly coupled systems' for more than 15 years with power transfers from 1-200kW in materials handling, roadway lighting and EV charging.

"In the late 1980s, we developed a particularly efficient electronic converter," reveals Boys, before explaining how he and his colleague first became involved in the field. "We said to ourselves, 'It's been dismissed as an impossible dream for the past 100 years, but we actually might be able to do something with this IPT thing' – and that's exactly what we did!"

Rapid progress

Fast-forward to 2011 and after the initial systems found commercial use in sectors such as industrial automation (generally IPT over 1-2cm of a moving vehicle above a track), the automotive industry – and consequently the traffic sector, too – is beginning to develop its own applications for the technology.

"Over the past decade, we started to move away from closely coupled systems and tackle those that move relative to the track," Covic says. "New magnetic and control ideas now enable us to couple power over large and substantial air gaps very efficiently. We are further ahead now than we ever thought possible just three years ago. We can couple over air gaps of 300mm (1ft) – and with a misalignment of just 300mm in any direction – and yet we still couple at a high efficiency."

In the automotive sector, the obvious application is charging electric vehicles and indeed this is the space in which a great deal of research and effort is being conducted today, for obvious commercial reasons. Boys and Covic have been developing such systems since the 1990s. The basic premise is simply to remove the need for cumbersome plugs and offer the freedom for EV drivers to park up on a charging pad and let the intelligent technology do the rest.

In the early 2000s, Professor Marin Soljacic, a physicist at MIT, discovered a mode of wireless

Stable when wireless?

When you hear the words 'wireless electricity', visions of thousands of volts careering through the air like lightning bolts are hard to dispel. But the experts in this field are well versed in explaining the safety level of their respective technologies. "Firstly, it's not electricity moving through the air, it's magnetism," says David Schatz from WiTricity. "We convert electricity into magnetism and that's what is being moved. It's completely invisible – there's certainly no spark – and it's very safe for us human beings. Our system is designed to adhere to the same guidelines that exist for other sorts of machinery."

Auckland University's John Boys agrees: "The existing standards ICNIRP (International Commission on Non-Ionizing Radiation Protection) are incredibly conservative and we are well within those," he says. "In our systems, the amount of magnetic field is no more than you'd have flying around your rechargeable toothbrush!"

Using contactless power transfer for urban rail transport, Bombardier's PRIMOVE system ensures continuous power by charging during operation

❝ It's tough to assess whether traffic management or ITS will be a big market for this technology… this is a new technology and there are many potential applications

Tunnel exit signs are increasingly using IPT lighting for its safety merits

energy transfer known as highly coupled magnetic resonance, which he was certain would deliver superior efficiency and distance range over traditional inductive advances. The MIT inventions were patented and are now being commercialized by the Boston-based company, WiTricity, founded in 2007 by Soljacic and several of his MIT colleagues. "It transfers the energy by creating a magnetic field that operates at a high frequency," explains David Schatz, director of business development and marketing. "Traditional electricity relies on wires, cords, and cables, and there are many applications where eliminating these components would be very desirable. The one we're focused on is charging EVs: it's far preferable to charge your vehicle just by driving into a parking space than it is to take a cable out of the trunk and plug it into a kiosk that could be across the road."

Taking their academic research into the market, Professors Boys and Covic have set up HaloIPT, which is focusing on the EV charging market

WiTricity is working closely with automotive OEMs to develop systems that will enable this vision to become a reality, with Toyota the latest to have signed up to work with the company. However, Tier 1 supplier Delphi has been first to actually equip an EV with a wireless charging system, and Schatz is anticipating market-ready versions in 2015.

Once that happens, the next logical step is to bring the charging technology to roadways themselves so that vehicles can charge while in motion. And after that? "It will eventually be possible for the vehicles to use this wireless connection in a bi-directional way – to be charged as well as to be a source of energy to the grid," Schatz predicts.

Boys concurs that this next advance is likely, although both he and Covic believe it will happen at a lower frequency (below 100kHZ) where they presently have commercial systems that couple to a car at charging efficiencies comparable to plug-in systems. "What we have now is a technology that can inductively couple to a car and we've developed it for stationary charging, but we've done that in such a way that you could potentially lay it along a highway and provide a continuous power transfer, which removes the so-called 'range anxiety' associated with EVs. You could drive onto a highway and be confident that when you get off again, your battery won't be depleted."

Both academics are more cautious about the notion of bi-directional charging, however. "We can certainly do the transfer of energy in the opposite direction – it's just whether that would be the optimum way to do it," Covic warns. "The battery and its cycle costs are so high compared to the cost of electricity that there may be another, cheaper way of doing this – something called 'dynamic demand control'.

Shed load ahead

"You can get the same impact on the grid just by shedding load," he says. "Most vehicles driving along a highway are taking a reasonable amount of power, so if the network wants to recover some energy or gain capacity, all it really needs to do is ask those vehicles to stop taking power. They'll get the same net benefit of taking it back the same way, plus when you take the energy off these vehicles it saves you having to figure out where to put it, how to shunt it, where to direct it, how to manage that reverse flow, and so on. If you suddenly just shed the energy, then you're not having to worry about the bi-directionality."

So although the idea of a self-sustaining electricity network is still up for debate, the next question for readers of this magazine is how the ITS market can grab a piece of the action? Look no further than 3i Innovation, which is currently using its license from Auckland University to answer that question with regard to road studs.

"This involves cutting a groove less than 5mm wide and 20mm deep," reveals Boys. "You put a wire in there and glue road studs on the top, which are powered by a magnetic field from the wire. This is then used for directing traffic."

"3i is also interested in bringing the technology to signposts along the side of the road," Covic adds. "Where today red reflective tape is used, you would instead apply road stud technology, which shines a much brighter light."

Road tunnels are clearly the obvious environments to benefit from the safety merits of such advances: if there's a fire in a tunnel, lighting and time are key to survival. Indeed, legislation in some countries is now dictating that exit doors must be lit by inductively coupled lights, as wiring under the concrete can survive for far longer than exposed cabling.

Schatz also sees the potential for WiTricity's charging technology to be deployed in other traffic management applications. "Mobile equipment that's going from A to B and needs to carry its energy with it could be charged from a source in the ground at point A and obtain its energy directly from that source just as if it were a car charging its batteries," he says.

He also suspects that there are other uses that remain as yet undiscovered. "It's tough to assess whether traffic management will be a big market for this technology. Although we believe that charging electric vehicles will be a huge market, it's a new technology and there are many potential applications for it – including things that we haven't even thought about ourselves." ○

(Above) **IPT wireless charging uses strongly coupled magnetic resonance to transfer power from a transmitting pad on the ground to a receiving pad on an electric car** (Right) **How wireless charging for EVs is conducted**

1: **Power supply**
2: **Transmitter pad**
3: **Wireless electricity**
4: **Receiver pad**
5: **System controller**
6: **Battery**

Everyone's a winner

Ian Ragsdale reports on a new scalable and adaptive traffic signal system that through making intersections more efficient will promote pedestrian safety without compromising the performance of vehicular traffic

Images courtesy of Stevens Institute of Technology

As a traffic engineer in New Jersey, Andy Kaplan confronts the issue of pedestrian safety daily. According to NHTSA, 64,000 pedestrians are injured and 5,000 are killed every year after colliding with a vehicle. In New Jersey, one out of every five traffic fatalities is a pedestrian – double the national average. In 2010, returning to his *alma mater*, Stevens Institute of Technology, Kaplan tasked faculty and students to invent a new system that incorporates pedestrians into the flow of traffic just as cars and trucks are today. "We need a new technology that can cause a fundamental change in pedestrian interactions," Kaplan says.

The Stevens research team includes Dr Hong Man, professor of electrical and computer engineering, Dr Michael Zavlanos, assistant professor of mechanical engineering, and senior students Abel Alvarez, Kyle Brisson, Eric Chirlin, Cassidy DeSchryver, and Jeffrey Lichtenfeld. Their result is Ped-Aware, which combines smart imaging with a hybrid control module to detect pedestrians and dynamically control traffic signals according to the demands of both walking and vehicular traffic.

Development

Man oversaw the development of the imaging software that Ped-Aware uses to distinguish an empty sidewalk from a street corner full of pedestrians waiting to cross. When in operation, it compares updated images of the street corner with a static background model free of people. In a straightforward process, the software simply conducts a pixel-by-pixel comparison to determine 'active' areas within the current image. The presence of a pedestrian is evidenced when the number of pixels in one of these areas falls within expected values for a human being. The next step is to determine in which direction someone wishes to cross without relying on the notoriously ignored pedestrian push-button. Motion estimation is possible using video libraries provided by OpenCV, an open-source computer vision platform. These library functions can be used to determine intention of motion, and can build on experience to become more effective at accurately predicting behavior. "Because we move relatively slowly, the imaging module does not have to be very fast," Man says. "This combined with the simplicity of the operation allows the system to run without requiring major computing resources."

Development of the hybrid control module was overseen by Zavlanos, whose research focuses on control of complex systems. Hybrid systems outperform purely static routines – such as the fixed signal timer found in a current traffic intersection – by combining continuous and switched dynamics that allow real-time input to influence how a system or machine performs. In Ped-Aware, pedestrian data derived by the imaging module is fed into the control system, which calculates the ratio of waiting pedestrians to cars. If the ratio reaches a threshold, the signal will change to give priority to pedestrians. The control system also repeatedly queries a static timer to determine the elapsed duration of the signal period, and will change the right-of-way if the timer reaches its maximum even if the pedestrian-to-car threshold is never breached.

"We need to extend the control algorithm to handle more complex intersections or networks of intersections and create a robust housing for the prototype, but the concept is solid," Zavlanos states. "The team chose to pursue a project that offers a holistic solution for both the technical and cultural limitations of the current traffic signal," Kaplan concludes. "It's cheap, effective, and above all else it can save lives." ○

(Left) **Ped-Aware uses cameras that compare images over time**

Urban warrior

Andy Kaplan, who works for the Transportation Safety Resource Center at Rutgers Center for Advanced Infrastructure and Transportation in Piscataway, New Jersey, is eager for a technology to replace the 50-year-old push-button. Pedestrian safety supports other urban initiatives such as downtown revitalization and public transit improvements, which depend on foot traffic for success. These initial implementation outlays are expected to incur long-term savings due to reduced emergency response costs and lawsuits against transportation authorities following collisions. To promote the realization of these goals in the USA's most urban state, the FHWA has targeted New Jersey as a Pedestrian Safety Focus State.

Despite traffic deaths in the USA dropping by around 8% in 2010, pedestrian deaths rose by 0.4%. NHTSA says distracted walking could be a factor

> " We have tried to change pedestrian behavior through education and enforcement efforts, but that has not been fully effective

The methods of research

During the course of the EWENT research, two main investigative methods were used. There was first an extensive review of literature relating to extreme weather events and their impacts and consequences. More than 150 scientific and professional references were studied and listed, followed by a review of media-reported cases, of which there were almost 200. Based on these two methods and the material provided, critical threshold values for the most relevant weather phenomena affecting the various transport modes were listed – phenomena that might have impacts and consequences resulting in deterioration in the transportation system's service level. A dozen different impact mechanisms are charted and annexed in the report. Finally, a brief summary of the results is drawn, including a first-impressions discussion on strategic implications.

Impact analysis

Extreme conditions affect the safety and reliability of transport but to what extent and what are the financial ramifications? **Dr Pekka Leviäkangas** hopes the first findings from EWENT will reveal more

The snow of late November and December 2010 cost the UK economy an estimated £1.2 billion a day as authorities struggled to keep roads open

Despite being very early days for the EC-funded EWENT research program, the initial findings announced recently nevertheless make for interesting reading. EWENT, or Extreme Weather impacts on European Networks of Transport, aims to identify the impact and consequences of extreme weather phenomena on all modes of the European transport system.

Weather has long been an external factor adversely affecting transport, but it's an issue that's been investigated surprisingly little – even after years of intense debate about climate change. Ultimately, transport's resilience to weather extremes is perhaps not what it should be in a modern society in which mobility is a most basic function that should, in reality, be predictable and reliable.

The whole system affected

Although all aspects and functions of the transport system are affected by the weather, they're affected in different ways in different parts of Europe – and on different timescales when impacts are distinguished between operations and infrastructure. Operations are more or less flexibly adapted to a changed situation, yet infrastructure requires long-term planning if modifications relating to weather resilience are to be achieved.

The EWENT research group aimed to highlight the most relevant weather phenomena, the results of which led to an empirical-heuristic conclusion: empirical in the sense that it relies on past events and recorded incidents and

studies; heuristic in the sense that it cannot be stated that there will not be other, even more attention-requiring phenomena.

The report concludes with an 'extreme weather impact map' (shown opposite), an oversimplification perhaps but nonetheless adopted to visualize where the priorities are and what they should be. The first priority includes accidents leading to casualties and injuries (A); the second involves infrastructure collapse or damage (I); the third time delays (T); and the fourth is sub-optimal operations (O).

The different phenomena symbolized on the map are the most common extremes with identifiable consequences – i.e. heavy rain, heavy snowfall, extreme winds, extreme heat, drought, and visibility. The map merely highlights the most urgent problems arising across Europe and shouldn't be regarded as one of the main findings of the EWENT research however.

The most harmful weather phenomena

Identifying the most critical phenomena on the basis of gathered information is relatively easy. Precipitation in all its forms very quickly affects all land transport modes and when it falls as snow, aviation is likewise affected. Precipitation also affects inland waterway transport operations significantly. For land transport modes, precipitation has a similar type of impact in all regions. Excessive rain and snow also block urban transportation more effectively than any other weather phenomena.

When heavy snowfall is encountered, the only essential difference between regions is the availability of snow removal and maintenance equipment (and in the Nordic countries, studded

(Below) **Summary of critical weather phenomena, their occurrence by region where the effects are most severe, with the most affected modes of transport and consequences**
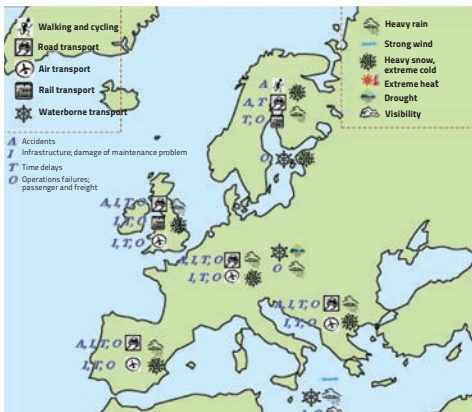
tires in the winter). Furthermore, snow and ice especially cause severe road accidents, the consequences of which should be considered a top priority. This being the case, the greatest responsibility for mitigating the above effects falls on the owners and managers of the road infrastructure. How effectively they'll be able to answer this challenge in terms of resources and preparedness is, in the end, another matter.

Precipitation is the phenomenon that most likely has the severest impacts on the transport infrastructure, in particular on road and rail embankments. Even relatively modest but frequent flooding quickly deteriorates land structures over the years, although one single event does not in itself appear to be very serious. Road transportation certainly seems to be the most vulnerable mode, the reasons for which are self-evident. First, the

traffic volumes are highest on roads and the capacity usually most limited in densely populated areas. Also, one relatively insignificant crash can quickly create chaos on urban highways. The second reason is that road traffic is least controllable and manageable. Whereas air traffic control or a railway traffic management center can quickly decide on and execute adaptive and corrective measures, road traffic remains mostly a slowly, self-adaptive system that is geographically widespread and scattered.

As to climatologic regions, most of the reported cases from both the literature and media reports seem to come from mainland Europe, the UK and Scandinavia. This is probably the result of the active research media in those regions. Consequently, the summary of results could underestimate weather phenomena such as heatwaves and sand storms, which are common in southern parts of the EU. However, this bias is considered to be insignificant in terms of the overall conclusions.

Mitigation and adaptation

Two tentative strategic options arise and be distinguishable in a broad sense for decision-makers responsible for adapting to and mitigating extreme weather consequences. Efforts can be focused on those modes and places that are already quite well controlled, such as railways and aviation, and ensure that their resilience to extreme weather is enhanced. These modes can then serve as back-up systems when other modes (roads) fail to be of service. This could well be a cost- and resource-efficient option from the point of view of society as a whole. Alternatively, we can start working on the road mode, trying to increase its resilience in different ways such as improving maintenance preparedness and road traffic control and information services. The vehicle sector has already been active in developing anti-skid systems that are definitely useful in instances where roads are covered with snow and ice. But relying on ADAS and information services probably puts the onus (both effort and cost) on users rather than the public sector. Inland waterways and short-sea shipping are special cases, and without underestimating their importance they are probably in a better position to meet extreme weather events. In fact, their share of transport could even be increased and improved by recognizing them as more resilient modes that have greater reliability. ○

• Pekka Leviäkangas is EWENT coordinator, and chief research scientist at the VTT Technical Research Centre of Finland. More info at http:// ewent.vtt.fi

> **Road transportation certainly seems to be the most vulnerable mode … the traffic volumes are highest on roads and the capacity usually most limited in densely populated areas**

Rainfall
results in approximately a 5.0–6.5% average decrease in traffic speeds, according to a 2003 University of Virginia study; heavy rain is 25–30%
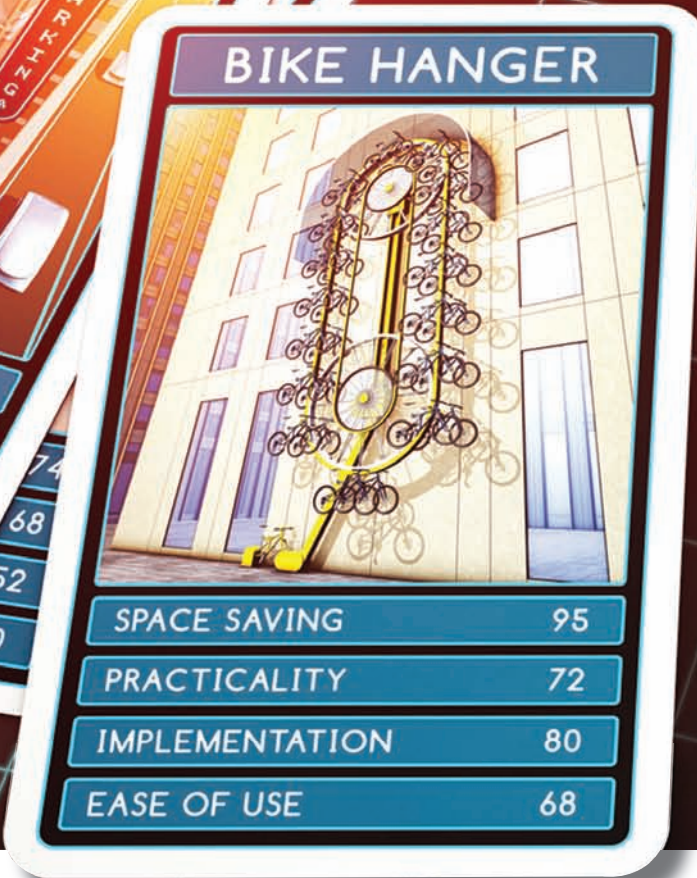
Space
explorers

If you thought the parking problems of 2011 were difficult to resolve, wait until you hear what 2050 has in store. Setting a course for the future, **Nick Bradley** scours the earth for some forward-thinkers with the tools to win the space race

Illustration courtesy of Magictorch

Were Benjamin Franklin to have lived in the 21st century, he may well have added the nightmare that is finding a parking space to his death and taxes witticism. With three billion cars predicted to be on our roads by 2050, up by 800 million on 2011's figures, it's a nightmare that is certain to continue.

Parking's contribution to our cities' congestion problems is well founded. In his book, *The High Cost of Free Parking*, UCLA's Donald Shoup suggests that anything between 8% and 74% of jams in our downtown areas are a direct result of people cruising for a space. Furthermore, this widely known 'prophet of parking' says that in major cities such as New York, San Francisco and Sydney, drivers spend an average of 3.5 to 14 minutes looking for a space every time they park. The impact that another 800 million cars will have on these figures doesn't really bear thinking about.

Fortunately, though, people such as Shoup are thinking about it. As the title of his work suggests, he points the finger

congestion, sprawl, wasteful energy and air pollution. He also argues that the high cost of our cities' required parking adversely impacts the prices we pay for everything else, including housing. Ultimately, he writes, with expensive housing and free parking we have our priorities reversed: "When street parking is free or inexpensive – as in many cities – the demand simply exceeds the supply, and people spend time and fuel cruising for scarce spaces."

The gospel according to Donald Shoup

Shoup's book, regarded by many as a parking bible, has led to a number of cities to charge fair market prices for curb parking – a theory being put into practice in San Francisco with SFpark. This intelligent parking pilot covers 7,000 of the city's 28,800 metered spaces and 12,250 garage spaces. Sensors installed in the spaces track when and where parking is available. The data is uploaded wirelessly to the SFpark data feed, information that is made available to the public via a website, smartphone applications and eventually text message and 511. SFpark adjusts meter prices based on demand to encourage drivers to make trips in off-peak hours and to use parking lots and garages. If you're looking for cutting-edge parking management in 2011, look no further than SFpark.

We can only hope that schemes such as SFpark evolve with burgeoning motorization, although as this latest Design Challenge proves, he isn't alone in his parking mission. Over the next six pages, we've tasked some similarly forward-thinking individuals

Reclaiming the streets

Bike Hanger is an essential facility for dense urban areas seeking to increase bicycle-friendliness. Existing systems of high-density bicycle storage facilities often take up large amounts of space, or if in the form of a vertical tower rely heavily on electricity and computerization for operation, resulting in high operational costs and unnecessary energy consumption.

The Bike Hanger – which has the capacity to store between 20-36 bicycles – offers a low-maintenance and environmentally friendly solution to high-density bicycle storage by featuring a control station that functions like a geared stationary bicycle where the pedaling of the user operates and rotates the storage area. Furthermore, rather than taking up valuable public space in plazas and pedestrian passageways, it takes on the form of a tower and can be installed on vertical surfaces such as buildings or retaining walls, reducing the footprint even further. This creates opportunities for Bike Hanger to reclaim under-utilized spaces that exist around the city and allows for minimal interference with pedestrian traffic. The bicycles hang above the height of the pedestrians and can be lowered through retractable hooks similar to those used to transport bicycles on the back of automobiles. Each of these hooks features a locking mechanism to prevent theft. Where no wall is present and space permits, a standing version of the Bike Hanger can also be installed on the ground. Multiple units of the standing version can also be connected in a series to infinitely increase its storage capacity.

The patent-pending design is currently being introduced to various equipment manufacturers so that it may be realized and delivered to various private institutions and city governments in countries such as Korea, Japan, Australia, France and Germany, which have shown interest in it as a sustainable and design-conscious solution to increase bicycle usage in our crowded city centers.

Alongside design partner, Jeeyong An, Sang Hwa Lee (right) **is the principal of the New York-based architecture consultancy, Manifesto**

BIKE HANGER

SPACE SAVING	
PRACTICALITY	95
IMPLEMENTATION	72
EASE OF USE	80
	68

Image courtesy of Manifesto Architecture

Hanging out in the future

Millions of new vehicles are being made every year, yet parking lot capacity isn't increasing at the same rate so the result is inevitable – massive traffic jams and chaos on the roads. My LIFT TC concept is not strictly just a parking concept, but a vision of integrated city mobility of which parking is a key component. It combines my idea for intelligent transport, the 'Smart Car' – a street-smart solution to soaring traffic and parking problems – with a futuristic form of public transportation.

Improving the latter is key for mobility in our congested cities, yet has to be finely balanced with people's need for independence to move in their own time and space. My LIFT TC idea, a winner in the Seoul Design Olympiad in 2009, allows you to use your own car and combine it with a new public transportation system based on hanging rails. Vehicles are parked – or hung – in vertical modules so take up much less space when not being used.

The rear-wheel system moves vertically and hitches into the public transport rails, at which point the vehicle is operated in autonomous mode, in doing so maximizing space better than a standard road. As it is controlled by a central system, the result is no congestion, pollution or driver stress.

The car – a small vehicle for one or two people, driven by an efficient electric motor in the rear transmission – adjusts itself in the aerial parking bay without the need for additional space. You simply drop it down after you finish a day's work and drive home.

Chile's Roberto Vackflores founded Crab, an industrial design and product development company, in 2001

The only way is up

Roberto Dei Lidi is an industrial design student at Hochschule Pforzheim University in Germany

Car-sharing makes the rising costs of personal transport more bearable and in addition to preserving mobility, fewer cars on our roads means better quality of life in our cities. A great example of this can be seen right now in Ulm, Germany, with Daimler's car2gether scheme.

But the lack of an appropriate EV infrastructure is currently hampering pioneering efforts in future-oriented areas such as electromobility. Renewable energy is at the heart of my concept, Smart Tower², which deals with these problems head-on by providing a parking system designed specifically for EVs.

Parking lifts and rotatable modules allow for space-saving stowage. There are three main components – one lift for transporting the cars upward, another one for bringing them back down, and a terminal that serves as an interface allowing customers to select the desired car. The rotatable modules link the lifts with the specific slots containing the cars and transport them down to the ground for the user to drive them away. The physical structure is a vital

aspect to be considered when constructing a building aimed at reclaiming lost capacity. A vertical approach has established itself in various concepts, such as Daimler's famous Smart Tower, but my approach is scalable: at strategic locations such as a rail station, a higher capacity (e.g. 30 smarts) makes more

sense whereas at less trafficked sites four cars might suffice. My design also draws on nature, the Tower being reminiscent of a tree.

This project addresses two related topics aside from the storage of electric cars; it also serves as a recharging station through the use of solar panels and a wind turbine. The former is flexible and doesn't therefore pose restrictions in terms of design while the vertical conception of the latter aims to reduce noise and increase efficency. The panels are applied on a transparent mantle, which simultaneously protects the cars from the effects of weather.

Guide like a butterfly, park like a bee

My designs are borne through observation, product attribution and my own intuition. Parking is one of those things I've tried to address and something that affects us all – more often than not adversely.

My solution, which I designed alongside my colleague, Po-Hsien Yang, at Avec+ in Taipei is called BeeParking. Essentially, it is a parking card that features a flexible display and Zigbee network protocol chipset, and shows an arrow to indicate the location of an available parking space.

Parking lots in our urban cities are often full. Whenever we enter parking garages, even if there are some available spaces, you can waste a lot of time and gasoline looking for them. Way-finding systems are becoming more common, with lights in

the ceilings indicating empty spaces, but our BeeParking concept is more intuitive and user-friendly, and can be adapted for further applications.

Zigbee devices are distributed all around the parking lot, which detect and calculate the location of the driver. Infrared sensors, meanwhile, are also installed at each parking space, so drivers know which space is available. All of this information is subsequently transmitted to the BeeParking card via the Zigbee network protocol. The card will then display information, as well as indicate the direction of available space or the exit.

There is, of course, much more useful information that can be shown, such as space number, entry time as well as the parking fee. These aim to help users to manage the parking cost and remind them where they've parked their car, which I'm sure we've all needed at some time. After you have paid the parking fee, the arrow will then provide directions to the exit.

Jacky Wu is a multi Red-dot award-winning designer based at the Taiwan-based industrial design firm Avec+

Driving you up the wall

Roman Mistiuk is a car designer working with start-up company Rivian Automotive

As a former San Francisco resident, I experienced the parking and congestion problem first-hand, spending at least US$40 a month on fees. Not only that, you have to drive around for ages with the stealth and guile of a shark to make sure you get your space. This is only going to get worse in the future. As our cities increase in size and become ever more populated, parking will become more of a hassle than it already is. Real-estate will be a scarce commodity, so existing parking lots are likely to be snapped up for living space, compounding the problem further. I propose this could be solved by my Metromorph concept, which I started creating a few years ago for Peugeot as part of my industrial design program at the Academy of Art University in San Francisco.

The premise of Metromorph is a futuristic urban electric vehicle created for a city with vertical roads integrated into the exterior façades of buildings, similar to those seen in the movie, *Minority Report*. The car itself doubles as an elevator on a rail system and once the vehicle reaches its destination, your apartment, it can be transformed into a balcony to save parking space and time. I envisaged the vehicles being managed centrally, like air traffic control, so they're perfectly coordinated and don't collide on the outside of the building.

The vehicle is powered by two in-wheel motors placed at the rear housed nearby two battery cases. Within the interior of the vehicle, the seats are held in position by rotating arms that keep the seat level when the vehicle travels vertically or horizontally. When the vehicle becomes a balcony, the seats are placed on a rolling base, which allows them to become loungers. The impact on the ground will be fewer cars parked on the streets, which would alleviate congestion, too.

Overall, the car is designed to not look like a car vertically mounted to a building but still look like a vehicle when it's on the road, so the wheels are concealed toward the inside. Rather than go vertically like many scissor doors today, Metromorph's arms rotate closely around the vehicle, allowing the doors to freely open in a cramped area such as a garage.

When I unveiled my concept, some people said, 'There's no way I'm getting in that!', but it's not too dissimilar to elevators that run up the exterior of skyscrapers. Metromorph is just a concept, but in terms of feasibility, in conceptual stages, it is viable. Production-wise, it's not possible today, but you never know about tomorrow. Right now, vehicles function on a 2D plane; it's time that we start thinking 3D and going vertical.

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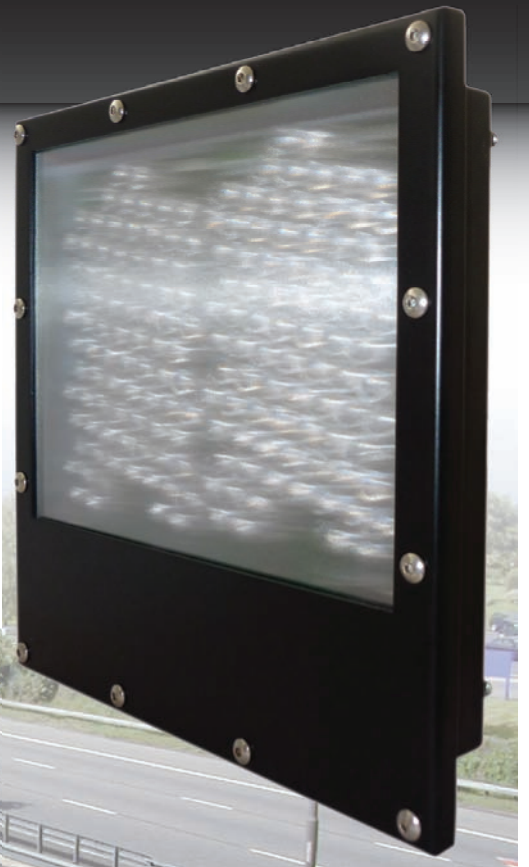
Gardasoft's VTR2 850nm lights are being used to create a unique and innovative solution to open road tolling. Users of the motorways in parts of Europe display windscreen licences or passes that need to be checked. These are analysed using high resolution camera technology that enables the imaging of both the windscreen and licence plates at the same time. To complement this high resolution imaging, a high quality light source was required. Gardasoft VTR lights were chosen because they offered the most intense source of light available, combined with a high degree of control and flexibility.

Images supplied courtesy of Iskra Sistemi and Normacom Plus d.o.o, Slovenia

Work, rest and play

Our TATA Tower concept was designed as part of a project to address Mumbai's increasing congestion and pollution. Just seven people in every 1,000 own a car in India (whereas the USA has 647 cars per 1,000 people), yet have you seen their traffic jams? What will happen when that number increases as India makes bigger economic strides?

The TATA Corporation is the country's largest automaker and manufacturer of the Nano – at US$2,500 the world's cheapest car. The TATA Tower is seen as a development for TATA offices and employee residences, all of which will drive alternative-energy Nano cars. TATA Tower aims to be part of a much larger solution to the city's crumbling infrastructure. Energy demands of the building and vehicles are met by photovoltaic louvers, building-integrated wind turbines, tri-generation, and an algae farm that produces

biodiesel. Vertical parking allows for maximum density, gathering parked cars to act as a parking resource for neighboring linked towers. This also frees up space for a more pedestrian-oriented ground plane, allowing for parks, recreation and increased public transportation. Cars will move up and down the towers on small personal elevator platforms with each resident having the ability

to park their car in a private greenspace or garden area.

Mumbai is on the brink of collapse. Public transportation is either non-existent or far beyond capacity, which is contributing to the growing number of cars in the city. Our building is envisaged in the year 2030 and along with strategies such as congestion charging, etc, aims to address several issues in one fell swoop.
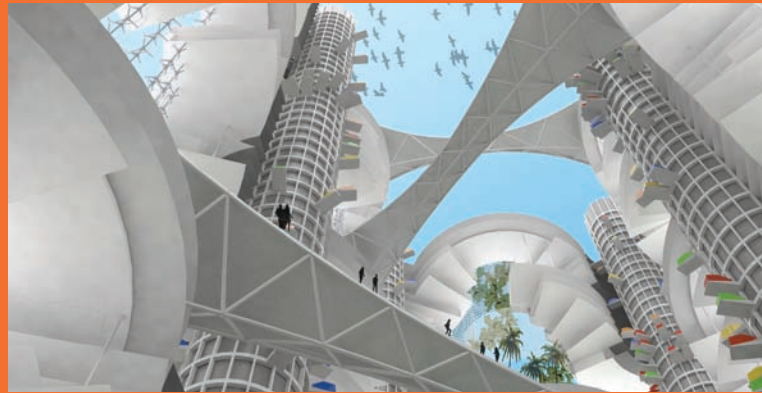
Seth Ellsworth is a Chicago, Illinois-based architect and designer, who was part of the team that conceptualized the TATA Tower

Satellite-guided parking management

JD Hassan is the chief commercial officer for Skymeter Corporation, based in Toronto, Canada

Parking management by satellite can improve mobility, municipal finance and the driver experience. It handles any kind of parking circumstance with incredible flexibility, while dramatically reducing the cost of compliance. In addition to street, lot and garage parking, it is even possible for an individual to hire out their driveway to a stranger. As the system can determine where its aggregate participants are concentrated, the use of variable message signage permits a city or private operator to vary pricing – by event or demand – in near-real-time. In addition to parking payments, financial-grade GPS (FGPS) telematics addresses road and parking congestion, transit ridership, peak-travel and pay-as-you-drive

insurance. Our accurate telemetric devices use FGPS, a liability-critical form of positioning, which offers four key values for parking – privacy-shield, self-audit, self-compliance and lower per-transaction cost.

Wireless, in-car FGPS devices mount behind the rearview mirror and use a stored, cloud-updatable pricemap with geo-bounds for all participating parking locations, individual time and price rules, and a code for the parking operator (or spot owner) who will receive payment. The pricemap rules can include user rewards (discounts for repeat customers), green-municipal rewards (discounts for non-peak travel or reduced usage) and perks (free minutes for retail customers).

Price and reward calculations are privacy-protected and retained within the system itself. Only a billing feed (how much and to whom) is released after each parking episode to prevent losses. Similar to Garmin or TomTom, a pricemap can cover any number of cities and towns and the driver is not tracked. It can catalog all parking

operators and locations on an entire continent.

Participants park in legal spots and receive a monthly statement – all hands-free. Contracts can be pre- or postpaid, structured in any of the ways that currently apply to cell phones.

Time and location data remain the exclusive property of the participating driver, while parking operators receive monies due. Drivers can audit their parking payments and parking operators can audit payments due without observing individual drivers.

LEDs and encrypted near-field communication signals indicate whether a meter is working so that a compliance officer can simply ignore legally parked participants – at speeds of 15-25km/h in the case of reliance on NFC. Without valid indicators, a non-operational or tampered device – or one without sufficient credit – would be subject to citations as if there were no meter. As participants are volunteers who enjoy considerable value and convenience, gaming the system would defeat the purpose of volunteering.

Frido Stutz is the founder and inventor of Skyline Parking

The perfect lift for parking problems

The flipside of global mobility is an immense volume of traffic, congestion, increasing pollution and growing parking problems – particularly in city centers. A way out of this revolves around infrastructure that handles and controls traffic more efficiently, more safely, and in a more environmentally friendly and targeted way. So I came up with the idea for a compact automated parking system that would tick all boxes in relation to required space, input/output performance, reliability, design, economy and ecology. To take my idea further, I set up Skyline Parking and now we have developed two different technologies. With a requirement of only 18 x 18m, the Skyline Parking T-Park system can be built on sites where there is not enough land for any other parking solution. The Skyline Parking L-Park, meanwhile, can be integrated into existing buildings.

While the car is being driven onto the entry ramp, the high-precision sensors scan and measure the shape of the vehicle. The driver is then instructed to switch off the engine and apply the brakes, all of which is then immediately verified by the system. If the process is confirmed, the driver is asked to leave the entry stall with his or her passengers. Now the car is carefully centered and then taken hold of under the tires by a robot, raised and conveyed onto one of the high-speed lifts. Based on space criteria, the lift takes vehicles onto the parking spaces. With our systems, the parking spaces are of different sizes and heights; the computer calculates the optimal space for each car to ensure that the least possible amount of costly space is wasted. In addition to efficient use of space, easy integration, security, and outstanding environmental performance, the
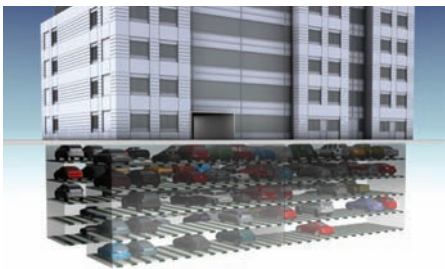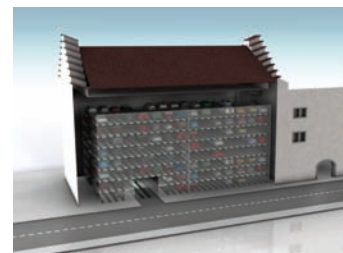
Time to reach for the sky

Nikolay Kolev is a Bulgarian architect working at Grossman Visuals in Kehl, Germany

In the past, I studied lighter-than-air (LTA) and heavier-than-air (HTA) aerostats. It's now possible to make an HTA aircraft with 1,000 tons lifting capacity, which equates to approximately 500 mid-sized cars (structural elements included). With this as a basis, I came up with several options.

Flying parking lots can have different sizes and shapes but naturally the bigger, the cheaper. The first solution is a big air-parking space comprising an airship carrying a platform with cars either in or outside its main corpus. It could be an LTA or HTA ship where engines contribute to its lifting power. Equipped with fast lifts that use helium or some other inert gas, this ship could be used to increase parking capacity at fairs, concerts, etc, and even in city centers. Selling advertising on the outside could be a great way to fund such an enterprise; it could even be used to carry goods when off-duty, to further reduce expenses. The downside is obviously the flexibility versus size (respectively cost) balance.

A second option is to equip each vehicle with a balloon that could be inflated from a valve on the sidewalk. You just go outside, press a button, and up it goes. No car crime, no parked cars on the streets, and a much more interesting skyline. But the time needed for inflation and deflation could be a problem here. Balloons would also add too much weight and take up space in the vehicle, while stability on windy days could be an issue.

The third option is to use individual or two- and three-car rigid corpus garage cages for transportation and storage of

advantages of Skyline Parking technologies are a comparatively high conveyor capacity, cost-effectiveness, a short construction time and reliability, the latter being a top priority for parking systems today. Not only that, the systems are easy on the eye! As a result of the integrated building support structure, the Skyline Parking system offers architects and town planners more options and variants than conventional multi-story parking lots. The system can be designed to fit almost invisibly in back yards, in existing buildings, in gaps between buildings and underground constructions, or as attractive high-rise buildings with an aesthetic appearance. As the façade is not a component of the supporting structure, creativity can be exercised in the design and in the choice of material – glass, plastic, metal and textiles are all conceivable. The façade can even be clad in solar cells or advertising screens can be mounted onto them, which provides the operator with additional income. This means that parking lots no longer have to disappear from sight – they can be integrated into the cityscape just about anywhere.

Given the benefits of automatic parking, such systems are – and will be – indispensable both now and in the future in any place where maximum parking space has to be created within a minimum surface area.

vehicles. Each parking unit consists of a skeleton, a fabric cover that encloses the helium compartments and protects from the elements, a garage space and a door. It can be folded for storage, too. A rigid version made out of resin and fiberglass could be made for durability. The elliptical shape reduces drag but can also be poly-planar to ease handling and stacking. Versions for two or three cars are possible.

The implementation of such a unit is quite diverse and although probably not possible to provide lifting power solely from the gas buoyancy, it will certainly decrease the costs of lifting or self-propelling to the storage area. With just a few modifications, they can be lifted to roofs and façades for urban environment aesthetics, or big clusters of garages could hover on helium-supported structures in the sky. Thus, having the benefits of big one-body airships, self propulsion could be an option, with the cost penalty balanced by flexibility.

Towering example

CarTowers was designed specifically for Volkswagen's Autostadt plant in Wolfsburg, but theoretically it could be transferrable to a city setting – you can see similar automated parking systems elsewhere, although perhaps not with such a focus on aesthetic design. If the system works successfully in a high-throughput automotive plant – you can see it for yourself – then why not in an urban environment?

More than 48m high, each of the two 20-story silos holds up to 400 vehicles, which are clearly visible through the steel and glass construction. Part of my brief was to design CarTowers to provide a bold contrast to the four soaring smokestacks high above the VW powerstation at the opposite end of the plant. Covered in glass on all sides, the cylindrical structures fit perfectly into the Autostadt's open-architecture philosophy.

The concept is unique in many respects. New cars arrive from the production facility on robotic skids that transport them through an underground system of tunnels. After they reach the towers, they are hydraulically lifted to a shelf where they are kept until ready to be picked up by the customer, usually within 24 hours. Two fully automated car shuttles in each tower

Gunter Henn is a German architect, who set up Henn Architekten in 1978

rotate 180° to serve the two halves of the giant silo. Scurrying up and down the shaft several hundred times a day at a speed of 1.5m/sec, the shuttles take the cars up to their parking positions and bring them back down. When it's time to deliver the vehicle, it is gently lowered to the ground floor and rolled on a platform through a tunnel to the adjacent car distribution center.

Certainly the footprint left by the CarTowers is much less than that of a standard parking lot, even multi-level parking garages such as those at airports. I see no reason why this couldn't one day become a reality of new parking spaces in our dense urban environments, where an automated system would simply pick up your car at the entrance, safely store it for a fee, and return it to you when you come back to pick it up.

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A familiar name in these pages, Harold Worrall talks consultants, ETC technologies and spiritual guidance

Interviewed by Louise Smyth

O one of the industry's most popular characters pauses then chuckles when asked how long he's worked in the field of transportation, as if reminded that it's 42 years and counting. "My whole career," responds Hal Worrall. "I started as a structural engineer for the Ilinois DOT in January 1969, so it's fair to say I've been around for a while."

Perhaps known most for his work in tolling, Worrall's experience actually spans a variety of sectors, initially specializing in financial roles, including stints as deputy commissioner for finance at Virginia DOT and controller for Utah DOT. When he moved to Florida in the late 1980s to assume the role of deputy secretary for finance and administration at Florida DOT, he developed a passion for tolling that's stayed with him. "Toll operations was one of the divisions under my responsibility, so that's how I first got into tolling," he recalls.

Even as early as 1990, Florida was looking to assess the potential of ETC. Worrall and others such as Jim Ely (Turnpike president at that time) went west to see how authorities in Oklahoma and Dallas were faring with their new-fangled electronic systems. In 1991, however, they concluded that ETC presented too much of a risk to revenue streams to be deployed at that stage.

What Hal did next...
In 1992, though, Worrall had no choice but

> " I saw situations and still do – where the public sector has very unrealistic and changing requirements, contracts and contract administration, and it yields failures

to get on-side with ETC – and do so quickly: "Joining the Orlando Orange County Expressway Authority (OOCEA) as executive director, my first job was to get everybody's act together since the Authority was in such dire financial straits. I'd been advising the secretary of transportation and had issued warnings that if they didn't get things in order, we'd have to step in as we didn't want the reputation of the state as a whole to be tarnished. The chairman of the board then called me to say, 'Well, if you're so smart, you come down here and do it for us!' So that's exactly what I did!

"I arrived in Orlando in May 1992, but they had signed a contract to proceed with electronic toll collection six months prior to that. Twelve months previously, I was saying 'no' to doing it in Florida, and all of a sudden there I was in the throes of one of the first projects. And it was not going well."

With his experience in finance and some well-honed computer expertise, Worrall

inadvertently took on the role of project manager until he hired a consultant to assume the position. In 1994 (and after pretty much re-writing the contract) the first ETC plaza opened, and Worrall is proud that the system remains in place to this day.

Fast-forward a decade, to 2004, and things were not so rosy at OOCEA. Politics and principles meant that Worrall felt he could no longer stay with the authority and his resignation, although upsetting at the time, prompted a positive move that brings his story up to date. "I was semi-retired but as I liked the industry so much, I wondered if there was some way I could contribute to it from the outside. So I decided to start a little company. I had no business plan, no agenda, I saw no gap in the market – not the typical business style of thinking! I'm a person of faith and I felt certain that God would guide me. For me, Transportation Innovations Inc was created with the sole concept of being a catalyst for innovation."

> I always say that the ITS industry in general has this tendency to create solutions and then go looking for the problems to solve – we've got it backwards

True to that sentiment, over the past seven years Worrall has hand-picked projects where he's simply seen an opportunity to innovate. "I saw situations – and still do – where the public sector has very unrealistic and changing requirements, contracts and contract administration, and it yields failures in the process," he continues. "There were opportunities to get involved in projects and create new concepts of contract management. Sometimes you have to renegotiate a contract to accommodate changed conditions, but the public sector doesn't do that very well. The framework they operate in is controlled by politics from above and fear of audits, which means there is a fearfulness to move away from the contract and think for themselves. The public sector can learn a great deal from folks who have gone through these processes before – not just me but many others, too."

Consequently, Worrall can now reel off a list of clients he's helped. Public agency assignments range from management consulting to toll operations. When asked to pick one or two projects that highlight 'transportation innovations', he exclaims: "Honestly, they're all innovative – otherwise I wouldn't do them! For one example, the New York State Thruway Authority is interesting because there's a lot of history, politics and union activity – many factors that are challenging to reaching a high performance level. Key to the financial side of tolling is that you have to match up the revenues coming in on a periodic basis with the capital expenditures you're going to have: not the capital contracts you have outstanding, but the expenditure that will result from those. It's a complex scheduling and planning process and getting it right can make a huge difference to authorities.

"One of the most innovative recent projects I've worked on is for Georgia State Road and Tollway Authority. This is a unique HOT lane application in that there's no physical barrier between the HOT lane and the general-purpose lane. They have an 'electronic' barrier – a double white line that people are not supposed to cross, although you just know some people will. So they are deploying gantries every 0.5 miles or so with antennae and cameras to monitor vehicles that come in and out of the lanes. If drivers cut across the line, they'll be issued with a violation. It's a new technology and it remains to be seen whether it will be successful, but I found it intriguing."

Consultation process

Although Worrall is fortunate enough to be in a position to choose only the jobs that interest him, he does offer a word of caution when it comes to his peers in the consulting arena. "What most people don't realize is that consulting is not a hugely profitable undertaking," he says. "Most companies only make around 10-12% profit on every billable hour. If your staff are out marketing or at association meetings, that's just racking up unbillable hours. So as these businesses have become more corporate, the emphasis is on keeping people billable and since the bread and butter civil work has declined, it is even more important to generate billable hours.

"I don't want to be too unkind to these companies, but the motivations are not properly aligned. Too often we write epistles of requirements that are just not necessary: we describe the precise size of a cabinet door when all we really need to say is 'we need a cabinet'. It's not the individual consultant's fault – it's the motivations that are pressed by this business trend."

An inquiry about the motivations of another key player in this equation, the systems integrators, prompts Worrall to get on his soap box about another issue close to his heart – the need for open architectures. "A lot of integrators are focused on proprietary solutions," he explains. "But I believe that open architectures are better for everyone. We'll get a more robust, wider market if we head in that direction. It's not just about ETC – there are lots of other areas that this could impact, such as parking and electronic vehicle registration, for instance.

"I always say that the ITS industry in general has this tendency to create solutions and then go looking for the problems to solve – we've got it backwards. If I come up with a product and I have good profitability, a good sales force, strong marketing and so on, then I'm able to influence the industry to pick my product. It may not necessarily be the best technology.

"Again, it goes back to the need to move away from proprietary solutions. Integrators have some of the most technically qualified people in ITS: they should be able to put their heads together and decide 'Yes, we'll be competitors but we'll have technologies that complement one another. Sometimes you win, sometimes I win, but ultimately the market is much bigger and we all win'."

Worrall's point here is proved by the successful work he's done on bringing together several firms in merger and acquisition activity. "By combining smaller yet innovative companies, larger markets can be accessed and the synergies can create new and better solutions for the industry." ○

Communicate to innovate

Of course, the ITS/tolling communications challenge is not just about bringing companies together – getting people from different sectors together is an ongoing hurdle. Worrall is in a rare position in that he's served on the boards of both toll and ITS associations – the IBTTA and ITS America.

His interest now is on getting key players from each market to come together for the greater good.

"I've been thinking about putting on some seminars to bring these different groups together. Though associations themselves are businesses and as such, don't generally wish to try things such as sharing meetings, for most of us in the industry, the two areas (tolling and ITS) are inextricably linked: the technologies are similar and many companies are in both industries. I'm a very idealistic person and what I'm trying to do is innovate the industry as a whole – that and mentor younger people coming up through the ranks." He concludes: "When you get older, you start thinking about your legacy. I'm not really concerned about what anyone else thinks my legacy is: I know what my legacy is and that's what's most important." And, as hundreds of ITS and toll industry practitioners would agree, what a remarkable legacy that is.

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Spatial recognition

Ever-more sophisticated GIS systems are being developed in a bid to counter traffic-flow problems and encourage innovative commuter initiatives. **Timothy Compston** finds two innovative uses of the technology

Images courtesy of ESRI, Seattle DOT & TranSystems

One of the key trends in geographical information systems at the moment is undoubtedly the development of publicly accessible web mapping to transform driver behavior and enhance real-time awareness of traffic issues.

Dana Trethewy, a senior GIS analyst in Seattle DOT's Information Technology Section, has been a pivotal figure in the Emerald City's development of its GIS mapping capability, with a focus primarily on transportation-based applications.

Seattle DOT has embraced web mapping to tackle everything from parking to planned construction schemes

Indeed, she is scheduled to discuss the DOT's use of web mapping at the forthcoming ESRI International Users Conference being held in San Diego in July. Obviously keen to stress the technology's benefits, she says it provides a powerful method to bridge multiple enterprise systems and convey data visually, which can be far more effective than traditional, non-spatial products. "The ability to analyze data and provide tools to decision-makers is one of the most powerful parts of GIS," she feels.

"Within the Seattle DOT over the past 19 months, there has been a very focused effort on building web applications and this has culminated in six maps and two more in development," Trethewy continues. "By releasing web map applications, we have been able to provide the public with a 'live' spatial report of the city's assets and infrastructure while internally using and maintaining data in our enterprise systems."

Current applications implemented in Seattle include the CityWide Planned Construction Map, which allows users to see the potential impact in their travel within the city, a Pothole Repair Map, and the Seattle Parking Map: "The Parking map displays on- and off-street parking facilities and information with a special focus on short-term parking in downtown and neighborhood business districts and eligibility for restricted parking zones," Trethewy explains. "One of the perceived benefits of this map and the associated e-Park program is to decrease traffic congestion caused by drivers circling multiple blocks trying to find parking spaces. Through e-Park, short-term parking information is provided on signs located around downtown, displaying space counts for six garages and, crucially, users of the Parking Map can access the same real-time information to plan their journeys by clicking on the appropriate icon."

She contrasts the flexibility of GIS mapping with static alternatives: "We have large numbers of static maps on the Seattle. gov website, which are difficult to maintain and out-of-date almost

as soon as they are posted," she says honestly. "These aren't factors with the new web map applications."

In terms of the response to the web mapping, Trethewy is encouraged by the positive reaction: "We've had very good feedback from the public," she continues. "The Pothole Repair Map garnered a lot of press and really showed that the city had been listening to the citizens, along with providing a means of showing them that we were responding and fixing repair requests."

Future GIS applications being created by Trethewy and her colleagues in Seattle include the building and deployment of a map to support the city's Bicycle Master Plan.

Commuting 'reThink' for Florida

Also delivering a presentation at the ESRI International Users Conference will be Doug Lynch, senior GIS planner for consultant TranSystems and Courtney Miller, the reThink program manager at Florida DOT. Lynch and Miller are to present on how GIS is being applied to address Central Florida's roadway congestion as part of the Regional Commuter Assistance Program – otherwise known as ReThink.

The goal with ReThink is to reduce congestion by encouraging central Florida commuters to consider transit, car-pooling, car-sharing and cycling/walking as an alternative to driving to work alone – currently more than 70% of individuals in the area commute. By implementing GIS technology through ESRI ArcGIS software, the ReThink program has been able to take the maps that have been generated to reach out to communities – employers, citizens and employees – to encourage them to change their commute practices and also to use GIS to help monitor and manage the key ReThink initiatives.

"GIS is used every day for planning and to identify problems," reveals Lynch, highlighting the pivotal role played by GIS in central Florida. "In fact, I tend to call GIS a 'decision support system'. Here in Florida we are able to take key metrics such as the Annual Average Daily Traffic and look at where there are potential opportunities to reduce congestion and air pollution. For the ReThink program specifically at TranSystems, we are the prime consultant, working with Florida DOT, and have been instrumental in providing ride-match software, looking at where people work and where they live, and helping to identify marketing outreach opportunities. For instance, I have created a map showing the

> One of the perceived benefits of the Seattle Parking Map and the e-Park program is to decrease traffic congestion caused by drivers circling multiple blocks trying to find parking spaces

Steering traffic management

Terry C Bills, who is the transportation industry manager at ESRI, believes that the application of GIS has been the catalyst for a major shift in approach to traffic management: "In the early days, it was not uncommon to see a large bank of CCTV monitors as the central component of a traffic management center. Today, we simply have too many cameras and sensors to effectively monitor in that fashion. Increasingly, traffic managers have come to rely on GIS systems to identify problem areas, and to carry out incident management."

Bills sees one of the key drivers for the take-up of GIS by transportation departments and road network operators as the need to optimize the performance of the existing infrastructure: "The reality is that in much of Europe, North America and parts of Asia, we are no longer building many new highways. This requires a change of mission for most to one where information systems and information management becomes key to successful performance."

The Pennsylvania Turnpike is, Bills feels, a good example of the growing scope of solutions that are now able to bring together ERP systems, asset and maintenance management systems with GIS sources: "In Pennsylvania, they have integrated SAP with GIS and created an executive information management system monitoring more than 100 performance metrics – many based on real-time data."

GIS maps show more clearly commuter patterns as they relate to the largest employers in central Florida

largest employers in central Florida, and the impact of their commuting so they can be encouraged by ReThink to commit to workers car-pooling.

"I am also involved in a program to manage park-and-ride lots and recently provided GIS mapping to demonstrate to a mall that it would be perfectly feasible to set up a small park-and-ride in their parking lot and still leave sufficient capacity except at peak holiday periods such as Christmas."

Courtney Miller, reThink's program manager, is enthusiastic about the power of GIS to change people's commuting habits: "The ability to make our case through this visual medium has been extremely helpful. A common barrier to sharing the ride to work is the belief that no-one lives near me. Being able to demonstrate to people by way of an irrefutable image – showing the density of co-workers living within a certain postal code – moves us one step closer to getting them to try car-pooling. GIS has also allowed us to analyze the potential for van-pool groups and to be better able to target our limited outreach resources."

• The ESRI International User Conference takes place in San Diego, California, from July 11-15. For more information, please log on to www.esri.com/events/user-conference

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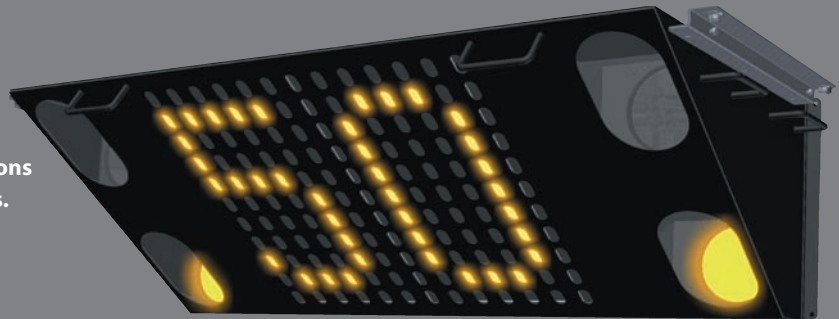
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Help is at
hand

With international traffic safety standard ISO 39001 soon to be issued for public consultation, **Timothy Compston** asks how it could affect road traffic management

Images courtesy of Phil Smith

Given the high profile of the landmark ISO 39001, it is perhaps unsurprising that standards bodies across the world have been paying close attention to its development and offering their input. A case in point is the British Standards Institution. Certainly, Sara Walton, committee manager, standards development, governance and resilience at the BSI, believes there is a strong case for a globally recognized, generic road safety management system such as the proposed ISO 39001.

"Although projections show that between 2000 and 2020 road traffic deaths will decline by about 30% in high-income countries, without effective action they are sadly predicted to increase substantially in low- and middle-income countries. By 2020, road traffic injuries are likely to be the third-leading contributor to the global burden of disease and injury," Walton says. "For low- and middle-income countries, the estimated cost of US$65 billion is more than they receive in development assistance."

Walton sees a number of key advantages that can be realized from a Road Traffic Safety (RTS) Management System Standard (MSS) being applied equally in the developed and developing world that is common to all relevant parties: "Once in place such a generic benchmark enables the division of responsibility based on an agreed approach between organizations and the meeting of customer requirements on the road transport system. Developing countries are also better placed to benefit from the best practice already adopted in developed regions. The creation of ISO 39001 also reflects the growth in the number of providers operating in the global marketplace, delivering services and products used in the road transportation system, who need to cooperate with a plethora of national and local bodies. A generic RTS MSS makes sense as it reduces costs compared to a situation where compliance is required to meet a number of specialized and disparate standards."

A world view

For a wider global view on ISO 39001, *Traffic Technology International* caught up with New York-based Tony Bliss, the road safety advisor in the transport, water, and ice department (sustainable development network) at the World Bank, who is a fervent supporter of the standard. Bliss traces some of the key drivers for the creation of IS0 39001 back to the mid-1990s: "There was a growing recognition, at that stage of the global public health crisis resulting from road traffic injuries, especially in developing countries. Publication of the findings of the path-breaking Global Burden of Disease project served to awaken road safety and health

professionals to the sheer scale of road crash costs to society."

Another important factor, says Bliss, was the paradigmatic shift in road safety management to what is now called the 'Safe System' approach: "The long-term goal became the elimination of deaths and serious injury in the road transport system. Health losses resulting from road crashes were no longer regarded as an acceptable price for mobility and leading road safety professionals and governments in Sweden and the Netherlands began to promote the vision that such losses could be systematically eliminated, and developed the means to achieve this."

The focus on road safety as a development priority subsequently resulted in the publication of the *World Report on Road Traffic Injury Prevention* by the World Health Organization and the World Bank in 2004. According to Bliss, this was a catalyst for the Make Roads Safe Campaign of the Commission for Global Road Safety and the UN's declaration of the Decade of Action for Road Safety (from May 2010).

"The global consensus concerning the unacceptability of road trauma in the developing world – coupled with its cost-effective preventability, and the sustained quest in high-income countries for continuous improvements in road safety performance – led to an increased focus on management systems," Bliss says. "This in turn created a 'hothouse' environment for the emergence of ISO 39001, with leadership for this initiative coming from the architects of Sweden's Vision Zero policies."

Although ISO 39001 is clearly targeted at industry that is heavily engaged in road transport, and is familiar with ISO quality assurance processes, Bliss feels it has also had a strong resonance with global actors focused on road safety as a development priority for low- and middle-income countries. Consequently, there has been strong support for the initiative from The World Bank and its road safety partners.

Accident prevention

Roger Bibbings, occupational safety adviser at the UK's Royal Society for the Prevention of Accidents, has been involved in the BSI Committee looking at the implications of the ISO 39001 standard from a British perspective.

"Connected to the UN Decade of Action for Road Safety, the new ISO 39001 standard is an attempt to lay down a management standard for road safety that is applicable to both national authorities, as well as to individual organizations," he says. "It is highly generic, but is based on a 'plan, do, check, act' risk management model."

Bibbings stresses that UK stakeholders, via the BSI, have been striving to ensure that the standard ties in with some of the road safety best practice already adopted in the UK: "Our key focus is to underline the highly effective approach to the management of occupational road risk that we have developed in this country in the past 10 or so years."

From Bibbings' perspective, the jury is still out on the utility of ISO 39001: "Being an ISO standard, it has of course to be negotiated with delegations from other countries and, consequently, the eventual shape of the standard and its usefulness to regulators, road safety practitioners, educators, and employers remains unclear."

Looking in more detail at the draft ISO 39001 standard, Bliss says: "The standard is specified in such a way to ensure a transparent alignment with the road safety management framework developed and promoted by the World Bank (and endorsed by the OECD and the International Transport Forum). It provides an integrated view of key elements of the management system by linking organizational functions with interventions and results.

> ❝ A practical impact of ISO 39001 will be the potential for users to better align their road safety programs with overall road safety arrangements in place at country, provincial, and city levels

Tony Bliss, lead road safety specialist, The World Bank, USA

In this way, it allows for the systematic specification of what ISO 39001 calls 'road safety performance factors' within a management framework focused on continuous improvement.

"A practical impact will be the potential for users to better align their road safety programs with overall road safety arrangements in place at country, provincial, and city levels. Where there is an absence of such arrangements, as in some developing countries, implementation of ISO 39001 by private sector and NGO actors could help to create more systematic arrangements.

Business benefits

In terms of companies implementing ISO 39001, Bliss cites several potential benefits: "In a business context, when applied intelligently, this has the potential to translate into improved financial performance resulting from lower vehicle operating and maintenance costs, reduced downtime costs resulting from crashes avoided, lower employee healthcare costs, reduced compliance costs (where there are incentive-based compliance schemes in place) and reduced payouts for third-party damages."

When it comes to the timetable for ISO 39001, Bliss confirms that it is currently planned to commence implementation in January 2013, following publication of the new standard by December 2013. A draft of ISO 39001 is close to being finalized and is expected to be issued shortly for public comment. ○

A major player in PPP road projects and managing customer services across a range of tolling/road pricing sectors and stakeholders

Courtesy of Nikos Danilidis

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Egis Projects Road Driver Services key business references include:
• Information Exchange Agent project in Ireland (covers ETC interoperability)
• ORT system for the Golden Ears Bridge in Vancouver, British Columbia
• Mobile speed enforcement services in Ireland
• Easytrip Services

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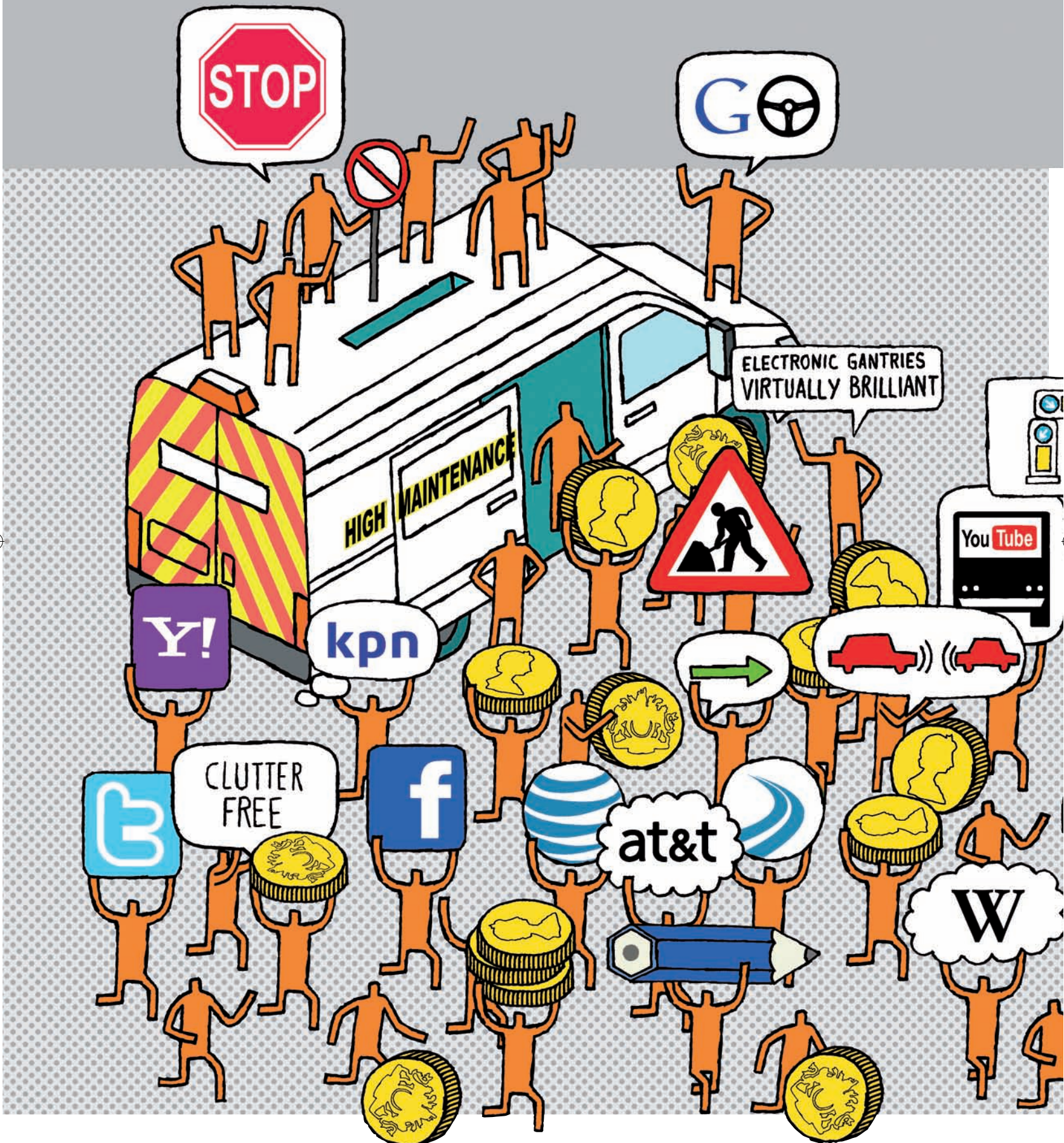
Turn
the corner

Changing expectations and rapidly developing technology means we need to review ITS research strategies constantly. **Bern Grush** asks if now is the time to think about relative investments in the development of in-car versus roadside instrumentation

Illustration courtesy of Tim Ellis

I n the development of large, complex systems we are often challenged to plan some distance into the future. This holds true for healthcare, weapons, urban transit and – within the covers of this publication – intelligent transport systems. Depending upon what we are planning to develop, questions need to be asked that are relative to decades from now. How many people will be sick and with what? Where and how will our enemy engage? How dense will our city population become? What will automobility be like in 20 years?

Not yet one mind

There are a large variety of opinions regarding the future of roads and cars. Most predict greater congestion. Many predict an electric fleet. Some predict self-driving vehicles and convoys. Many would like to see safer vehicles. Some would like to see more roads. But none of us can reliably describe an automotive utopia. It is safe to say that we have a very large and complex problem both now and throughout the
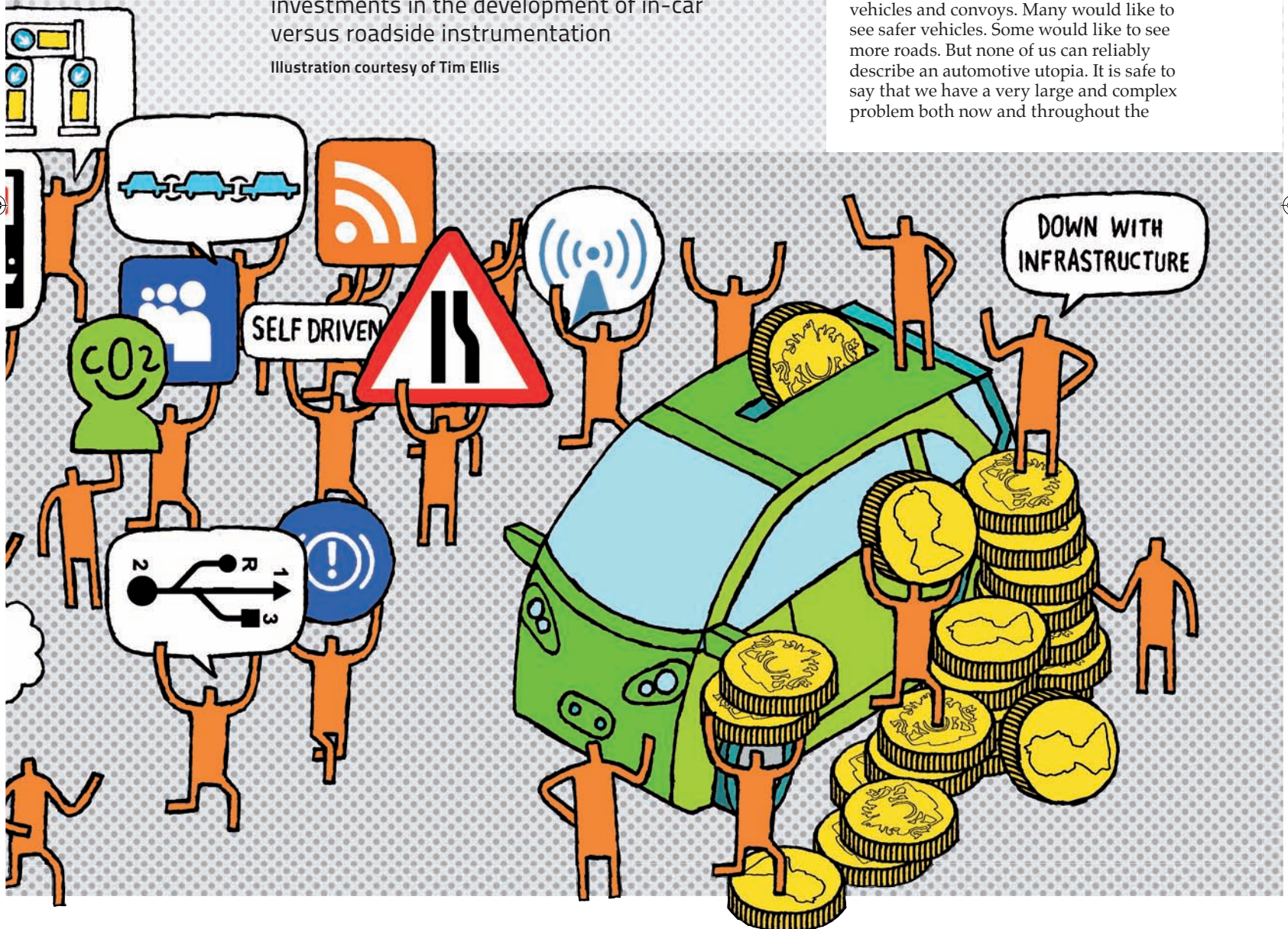
> The connected vehicle provides an opportunity to reduce the amount of roadside infrastructure deployed on the highway, with consequent reductions in operating costs and maintenance delays

imaginable horizon – a problem that we will not solve perfectly. It is also safe to say that those who are optimistic are optimistic for a variety of contradictory reasons. Exactly the same can be said of the pessimists.

The solution to mechanized human mobility has multiple optima – each is elusive and none have been conclusively described. With no single 'best way', even the mere setting of criteria for solutions to safety, congestion, access, as well as competing modalities such as cycling, transit, walking, and telework, becomes complicated. This complication is exacerbated because each of these modalities – with their benefits and drawbacks – has champions who sometimes argue bitterly with one another and, especially in the case of the automobile, even among themselves. I am a participant on the CON-PRIC listserv hosted by the University of Minnesota. Its members – all generally advocates of road pricing – have been known to engage in some fairly corrosive dialogue. If you suspect exaggeration here, search the keyword 'pezzotta' on *tollroadsnews.com* (but be wary of the characterization that you read there, however).

(Above) **SARTRE is a synthesis of personal and public transport to allow cars to be daisy-chained and auto-controlled by a lead vehicle** (Below) **Managed motorways on the M42 in the UK**

Even if we were to agree on where we should, could or will be in 10 or 20 years, the design problems would still be difficult. So, let's look at the forces in play…

The broadest vision for ITS – i.e. the vision that instruments all vehicles and perhaps generous portions of the roadside to address safety, optimization, infrastructure performance (e.g. cars per lane-hour), traveler services and user fees with dozens of integrated features – keeps growing. The technology we can use for these systems is changing dramatically. Sensors are rapidly improving and getting cheaper, roadside equipment is also improving (albeit less dramatically), and ideas about what we could or should do change with new enablers.

We have a moving systems target – and it moves along multiple dimensions. Each new idea or new technology does not automatically point the way to an optima or even a best practice. When we cannot reliably predict outcomes, every investment carries greater risk.

Until recently, the shepherds of the ITS research vision have been CVIS in Europe, IntelliDrive (previously VII, now the Connected Vehicle) in the USA and the research facilities of numerous automotive manufacturers. Here there are already critical biases. Government labs prefer to focus more on aspects such as speed management, traffic calming, signage, demand management, road pricing, traffic signals, pedestrian and bicycle safety and public acceptance. Automotive manufacturers are biased toward navigation, traveler information, and crash avoidance. Of course,

ITS: then and now

ITS got its start in the 1980s in Europe with DRIVE and PROMETHEUS. DRIVE, or Dedicated Road Infrastructure for VEhicle safety, was targeted to improve traffic efficiency and safety and the environmental effects of motor vehicles. It focused on the infrastructure requirements, traffic operations and technologies of the road transport system. Meanwhile, PROMETHEUS, or PROgraM for European Traffic with Highest Efficiency and Unprecedented Safety, aimed at developing IT, telecommunications, robotics and transport technology to provide information to drivers. This would be to aid them in an informative way, establish a network of communication between vehicles and to establish systems for efficient use of the road network. (see *Acceptability of In-Vehicle Intelligent Transport Systems*

to Young Novice Drivers in New South Wales, K. Young et al).

After that, the UK established the Road Traffic Advisor (RTA) project. RTA was a collaborative project between a number of leading companies, academic organizations and government departments that ran from 1997 to 2001 on the M4 from Cardiff to London. The RTA technology provided location-specific information relevant to the road and direction being driven by the user and could collect information about recent past performance on that road for both road management and driver information purposes.[1]

"Mistakes were made," suggests Robert Cone. "Too much was spent on infrastructure but not enough on instrumenting the vehicle. What was proven, however, was that data could be delivered with accuracy to
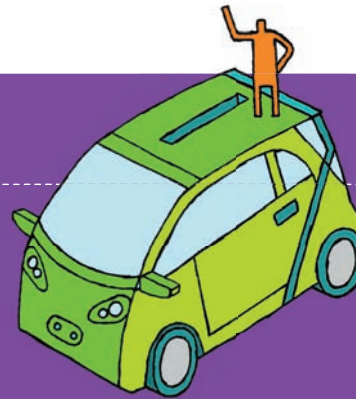
the vehicle when required and without distracting the driver. There were a lot of advantages to this. We could get VMS information at the right time to the right vehicle. We could blend both fixed and dynamic information. We could monitor the driver and deliver info during periods of inactivity. We could also feed information from one vehicle to another.

"Launched in 2006, the European projects, CVIS, SAFESPOT and COOPERS, used much more compact and versatile technology to demonstrate more

traffic, safety and convenience applications that could take advantage of both dedicated and commercial infrastructures. Rolling out a lot of infrastructure over a large region might be unworkable but providing infrastructure at hot-spots is viable. The fully integrated solution allows the driver to get both long- and medium-range information from commercial networks and short-range safety information from other road users and roadside networks. Everybody wins, the driver pays for the device and the service level required, the industry has a platform to develop and sell new services, there'd be capital expense savings, reduced risk of casualties, improved environmental and aesthetics and reduced costs of revenue."

[1] 2002 abstract on IEEE-Xplore

there are areas of common interest such as safety, weather mitigation, self-driving vehicles, platooning, liability and data mining (although, perhaps for different ends).

Where are we headed?

An example of recent excitement involves self-driving cars – à la Google, a company very new to the automotive sector. Self-driving cars have been envisioned for several decades – mostly in science fiction. DARPA has had real ones operating in isolated desert environments for several years, largely with a military appeal and, of course, festooned with incredible and expensive sensory and control equipment. And now suddenly reaching the public imagination (but admittedly still very early), we can watch YouTube videos of self-driving vehicles in traffic on city streets. According to some sources, there have been approximately 10 research labs experimenting with driverless vehicle technology in the past decade alone.

I am unwilling to predict when a standalone, self-driving vehicle – i.e. with no driver – will be feasible (much less legal) but I am willing to believe that convoys of passenger vehicles, dozens of vehicles long with only one driver in the lead, will be feasible in the very near future.

My observation is that ITS is in the midst of a corner-turn that started in the decade just past. The trend in innovation has been toward autonomy – i.e. with all the instrumentation inside the car. Volvo- and Google-inspired self-driving versus the Epcot-inspired 1960s guided vehicles of my youth and the virtual gantries of GNSS tolling versus the physical atavism of RFID/DSRC tolling gantries are just two examples. Others apparently on the near-horizon include in-car signage versus VMS and more investment in V2V communication versus V2I communication.

The trend toward autonomy will become a juggernaut fueled by the 'connected vehicle', 4G, software innovation, sensor innovation, social computing, and companies such as Google that see the potential of the dashboard as the next expansion of the web. (Did

V2V communication will be integrated in the refined telematics platform of vehicles on the road

you think you would be reading a newspaper in your self-driving car as they simulate on the Volvo YouTube videos? You'll be reading online – because you'll be shopping). And already the telcos such as AT+T and KPN are joining the parade.

An ideal state of automobility would have autonomous vehicles move among and relative to each other, as do birds in a flock or fish in a school. Yes, this is science fiction. But how close can we get? And if we explicitly treat autonomy of movement as a design criterion, as Google's engineers obviously do, where would most investment dollars be spent? I would never suggest that we need nothing beyond concrete and guardrail for our highway infrastructure,
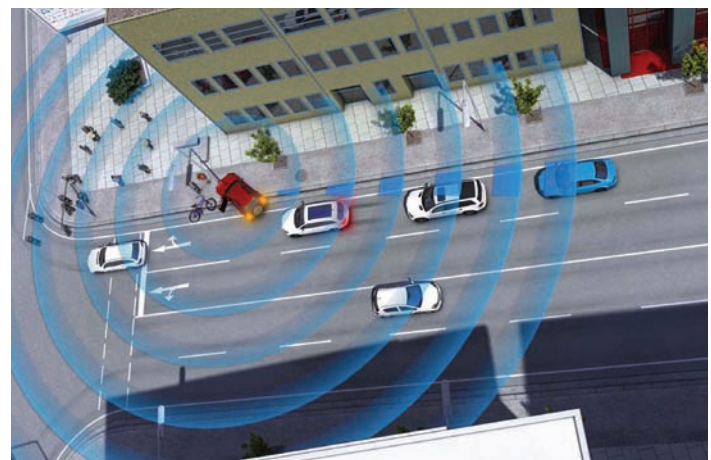
but I suggest that we spend less on roadside innovation and instead spend more research dollars on in-car smarts.

Besides its disincentive to autonomy, there are several other problems with roadside equipment that are more easily overcome with V2V and V2N/N2V (vehicle to net) telematics.

Safety: Reflecting on years of responsibility for roadside infrastructure and awareness of the lives lost to car-to-roadside collisions, Robert Cone, who currently chairs the PIARC-FISITA Joint Task Force for the Connected Vehicle and was past director of roads at the Welsh Assembly Government as well as a past ITS UK chairman (see sidebar on previous page), recently wrote to me: "Many of us dream about the uncluttered highway disappearing off into the sunset. This may be unrealistic but there is a huge potential for reducing the amount of fixed and variable signage, making the most of the ability of in-vehicle systems to do the job better, all in the service of making our roads and our trips safer." Of course, Cone is referring to the opportunity for using telematics to reduce roadside equipment, but his point is perfectly made. More in-car intelligence and fewer roadside hazards equates to greater safety.

Cost: Derek Turner, director of Network Delivery and Development at the Highways Agency in the UK, agrees. "In the longer term, the connected vehicle provides an opportunity to reduce the amount of roadside infrastructure deployed on the highway, with consequent reductions in operating costs and maintenance delays." Certainly, maintenance and maintenance delays also put roadside workers and drivers at some risk.

Taxpayer expense: Roadside equipment is almost always necessarily paid for by the taxpayer, while telematics devices are more likely to be paid for by drivers or private partners with commercial (and regulated) interests.

Flexibility: In-vehicle telematics can do so much more: they can change more nimbly; they can integrate dozens of functions; they can scale. Similar to smartphones, higher-end devices can be tried by a minority until perfected and prices drop for the majority. The opposite is true for roadside equipment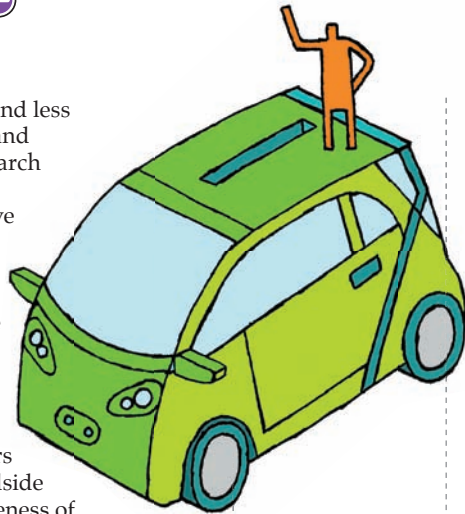, which soon becomes a barrier to change. Consider how odd it is that we often struggle to change things only to design replacements that then prevent change.

Extensibility: In-vehicle telematics can operate everywhere. A change to the network software can extend their range from a region to a state or from a country to a continent.

Innovation: In an era of wireless communication, cheap sensors, miniaturization, near-free processing and storage, cheap redundancy and some pretty amazing software, one of the best ways to stifle ITS innovation and halt its evolution is to install roadside equipment in concrete. As Google engineers had no choice but to operate on the roads and with the road markings that were already in place and the cars that happened to be there already, they could innovate independently of any new taxpayer-paid roadside equipment.

Non-pervasive: Uniformly capable roadside equipment cannot be pervasive – i.e. on every road segment and every street corner. Telematics can be. Car-attached systems (especially aftermarket installs) can change and multiply rapidly and dramatically as smartphones did.

Monolithic: Roadside equipment is necessarily simple, large, heavy and immobilized. And it has constrained intelligence.

Anti-evolution: Most things that work well mature during long periods of evolution. Small, light, changeable and autonomous things evolve faster than heavy, fixed ponderous things. Instrumentation that private enterprise finds profitable (even when regulated) evolves faster than large, expensive, government-supplied equipment.

Voluntary: The greater the autonomy of any ITS system – i.e. the greater the ability for a single vehicle to participate in

> " Time and roadside equipment tends to automatically turn intelligent transportation systems into unintelligent transportation systems – and sometimes this implies less not more safety

Before ITS…

John Senders is Professor Emeritus, Industrial Engineering at the University of Toronto. He has worked on a wide diversity of problems including the mathematics of visual attention, especially as it pertains to the demands of automobile driving. I was his student in 1973/1974. In the mid-1960s, before ITS became ITS, Senders and some colleagues at Bolt Beranek and Newman (now BBN Technologies), carried out some seminal Human Factors studies attempting to model the role of human attention in operating a vehicle safely.[1] Back then it was about the man–machine interface and 'information

theory'. The BBN researchers were interested in how many bits per second a driver needs to process to successfully drive a car. Understanding this would impact dashboard design (similar to issues of aircraft cockpit design). Today, 45 years later, this work is being revisited in the context of 'distracted driving' and texting.

It is this kind of modeling of human behavior that can be exploited by instrumentation inside the vehicle but not by roadside equipment. I predict that within 10 years distracted driving will be managed by cheap, autonomous, in-car, aftermarket sensor systems that require no driver action to function. Assisting drivers by having them attend more reliably or by driving for them will save more lives in the long run.

[1] *The attentional demand of automobile driving*, Highway Research Record, 195, 15-33, 1967

a safer mode of operation – the easier it is for a driver to volunteer participation. Voluntary participation reduces capital expense, increases acceptability, permits greater trial and error, attracts thoughtful use (and feedback), and promotes evolution. *Aesthetics*: Our landscapes are cluttered with many roadside artifacts, many of which linger after use due to the expense of removing them. Increased autonomy of instrumentation reduces this problem.

Technical impedance

Roadside infrastructure can never keep pace with telematics development. You can see this in the entrenchment of older-style E-ZPass gates in the face of GNSS tolling that utilizes virtual gantries instead of steel and electricity. You can even see it in the newer-generation E-ZPass devices that lower emissions and reduce congestion by enabling open-road tolling (ORT).

Technical impedance is a measure of the differential rates at which technologies evolve and the fact that the ones with the slowest rate of evolution set the pace for the others. The Pennsylvania Turnpike (the roadway itself) started as a railbed in the 1880s and was built out as a highway in the late 1930s and has seen little change beyond extensions, an additional tunnel, bypasses to decommission three other tunnels, and some widening and repaving. Hence the technology on this turnpike changes once every 65 years or less.

The toll collection system on that turnpike has changed once since its initiation in 1940, when it went electronic with E-ZPass in 2001. Hence, this tolling system changes once every 35 years or so. The median age of the vehicle fleet that uses the highway is currently under 10 years, and the median age of the aftermarket electronic gadgets inside those cars and trucks (cell phones, GPS navigators, etc) is well under two years. What this says is that aftermarket instrumentation, especially if it can be self-installed, is easiest to meaningfully innovate, because its turnover is measured in years. Factory-installed instrumentation has a turnover measured in decades. But roadside evolution, measured in quarter-centuries, has far less opportunity for innovation.

From toll booths to ORT, tolling is a prime example of infrastructure finding it hard to keep apace with telematics development, such as those being explored in the DARPA Grand and Urban Challenges of the past decade

There will always be strong, positive correlation between the volume and expense of fixed infrastructure and rapid obsolescence. Everything we build into the roadway will be with us long after its relative intelligence declines. Since the slow change of fixed infrastructure impedes change, ITS cannot long be mounted in concrete because that automatically discounts their intelligence year over year. Time and roadside equipment tends to automatically turn intelligent transportation systems into unintelligent transportation systems – and sometimes this implies less safety rather than more. ○

• Bern Grush is the principal at Bern Grush Associates. If you would like to contact him, feel free to email bg@berngrush.com

SEAL OF APPROVAL
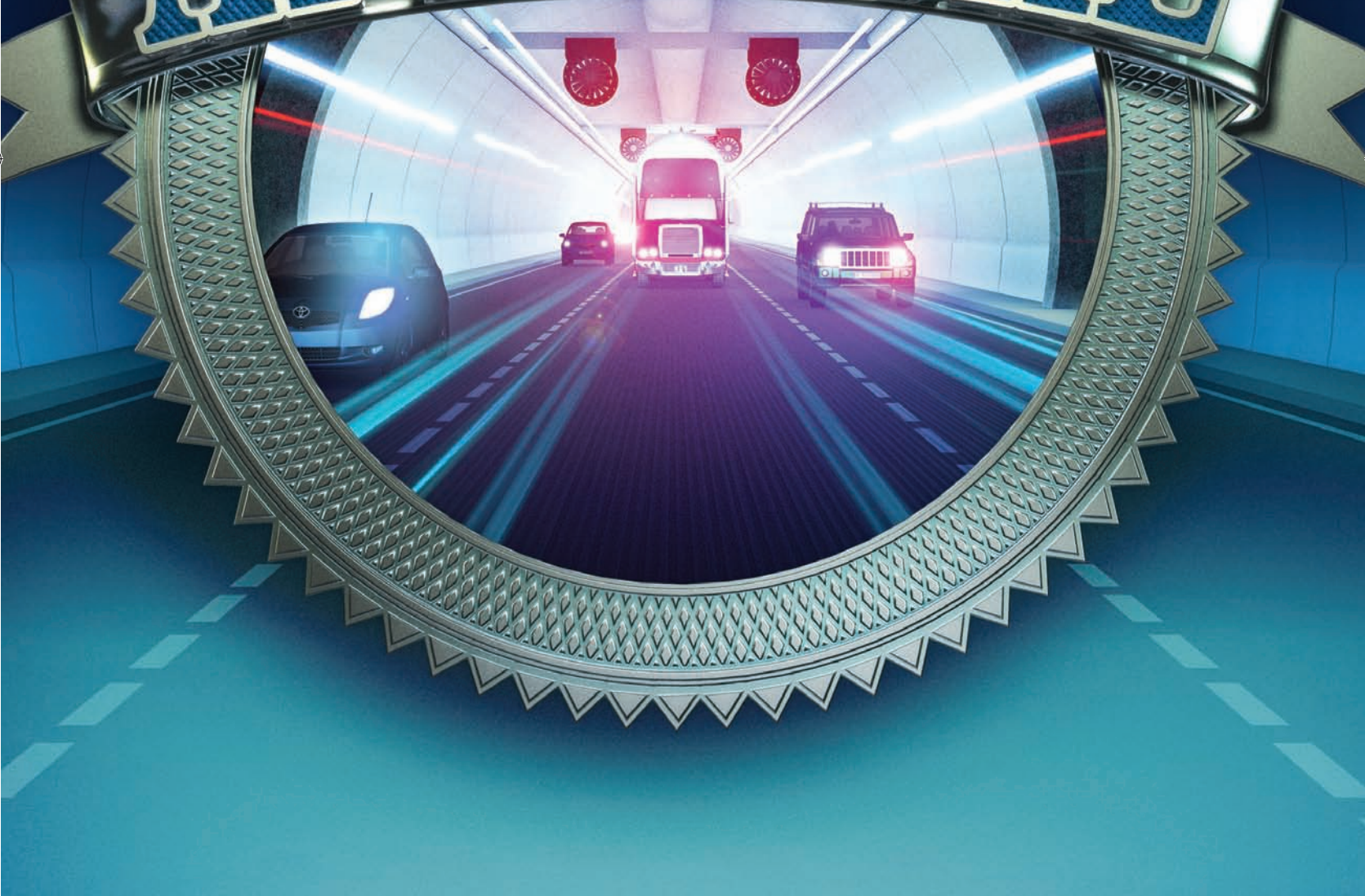
Scores on the bores

Tunnels are a lot safer today as a result of the efforts of EuroTAP, the mission of which is – quite frankly – to name and shame operators who aren't taking their duty of care seriously. **Nick Bradley** speaks with the men at the center of the program who aren't afraid to point the finger

Illustration courtesy of Magictorch

Pivotal in many ways, 1999 was the year the tunnel world decided enough was enough. The horrific fires that within months of each other engulfed the Mont Blanc Tunnel between France and Italy, and Austria's Tauern Tunnel, killing 51 people between them, served as an almighty wake-up call.

Coincidentally, 1999 was also when German motoring club, ADAC, published its first European tunnel safety evaluations. As Robert Sauter reveals, the relevance of the report – particularly the section on Tauern just two days after the disaster – helped to generate miles of column inches in the press, especially as ADAC's examination was the only independent survey to have been conducted on the Salzberg tunnel. "That's basically how the European Tunnel Assessment Programme came about," recalls Sauter, who is the director of ADAC's Test Centre Mobility as well as chairman of EuroTAP. "After 1999, we conducted our tests every year and up until 2004 included as many as 150 tunnels," he says.

The investigations are published on the basis of grades – a five-level scale of 'very good', 'good', 'acceptable', 'poor' and 'very poor'. Sauter says such transparency started something that was hitherto unknown in Europe by "creating competition among road tunnels whose safety standards were now suddenly visible and comparable".

A new chapter in the EuroTAP story kicked off in early 2005, with added support from the EU Commission – a three-year mammoth effort with a further 152 tunnel checks that also saw the introduction of education programs to promote proper driving behavior in these high-risk infrastructure. Represented by 16 automobile clubs from 15 countries, some 29 million member motorists, to date EuroTAP has conducted 365 tests in 21 countries.

ADAC has always been responsible for project management, with the FIA European Bureau in Brussels responsible for coordination. The respective motoring clubs represent EuroTAP to policymakers, experts, tunnel operators, and motorists in each individual country, while the German engineering consultancy, DMT, has been the project's technical partner from the outset.

Impact analysis

EuroTAP's impact over the past decade is not to be underestimated. There were no safety guidelines of any kind at a European level until the 1999 fires in the Mont Blanc and Tauern tunnels and the fire in the Gotthard Tunnel in 2001. Pioneers calling for change early on included the UNECE Group of Experts on Safety in Tunnels,

Help is at hand

The role of fire operations is critical to maintaining tunnel safety. **Zrinko Hrzic** from Egis explains how it runs like clockwork on the Zagreb-to-Macelj motorway

The Zagreb-to-Macelj motorway in Croatia and its tunnels already operate according to many European requirements and standards, including permanent monitoring through a centralized control room, dedicated intervention and first aid teams, as well as periodic drills and feedback in order to continuously enhance the skills of the operator staff.

Although Croatia is not a member of the EU, it is one of the candidates to join soon. And while the Zagreb-to-Macelj motorway is not part of the Trans-European Road Network (so not subject to Directive 2004/54/EC), the high level of services already provided by the operator, Egis Road Operation, will result in compliance with EU rules when needed.

According to Croatian law, it is mandatory for tunnels with a length of more than 1,000m and less than 3,000m (the Sveta Tri Kralja tunnel is 1.7km) to be classified into a special category with respect to endangerment from fire, referred to as categrory Class II b.

In this case, Class II b obliges Egis to engage a fireman on duty, with two professional firemen per shift, or one professional fireman and three specifically trained volunteer firemen. To fulfil the Class II b requirements, Egis's fire brigade is organized in a specific manner. The brigade consists of four professional firemen (at least one fireman is always present in the operations and maintenance (O&M) center and ready for intervention) and 15 volunteers (all of whom have fire training and certification). Of these 15 volunteers, five are patrolmen (from the northern portion of the highway), five

are security guards, and five are from the toll collection department.

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The organization of the fire brigade with one professional and three volunteers is optimal from a safety and cost point of view. The main advantage of having this dedicated team is that it provides autonomy, an important consideration for responding

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to emergencies in terms of the time needed to arrive at the scene of an accident. The brigade also contributes to staff satisfaction as well as the employer's confidence in its staff, in addition to providing additional monthly payments.

Croatian law specifies special requirements for dangerous goods transport through tunnels longer than 1,000m. These include explosives, goods marked with an

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ADR danger code with the number '2' as the first digit (except for the number 20), and goods marked with an ADR danger code with two of the same digits in the code. It also includes goods marked with an ADR danger code with first sign, 'X'. The escort of dangerous goods going south (toward Zagreb) is performed from PUO Lepa Bukva where Egis 'S employees must check the vehicle for accuracy, issue an approval and escort the transport of the dangerous goods through the Sveta tri Kralja tunnel.

Escorts north are slightly different: when the vehicle transporting the dangerous goods arrives on PUO Sveti Kriz Zacretje (east), the driver must first contact the operator on duty from the O&M center in Krapina. The operator then gives directions to the driver to come to the Krapina interchange, at which point Egis employees will perform a check for accuracy, issue an approval, and escort the transport of the hazardous vehicles through the Sveta tri Kralja tunnel.

Vehicles transporting dangerous goods that are arriving from the direction of Krapina toward the Krapina interchange and are going north stop at a designated place near the Krapina toll plaza.

The simultaneous transport of explosives and other dangerous goods through the tunnel is prohibited, as is the simultaneous transport of dangerous goods in both directions. When a group escort is organized, it can contain a maximum of three escorting units, the price for a single escort being €20 + VAT. In the future, though, with the new classification for the tunnel, the escort of these vehicles must be organized only between July 1-August 31.

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connections exist within – and between – the escape and rescue routes and ventilation categories. In this sense, operations in oncoming traffic and in one-way traffic have great significance on the selection of the ventilation system, the management and supervision of smoke extraction, and the arrangement of emergency exits."

This is especially applicable for one-tunnel road tunnels without emergency exits, or those that feature large distances between exits. "This generally means that serious deficits can be offset only by other measures – a lack of emergency exits cannot, for instance, be offset by excellent lighting or stable energy supplies."

For the tests, this means that if a tunnel is to receive an overall positive assessment, all eight safety potential categories should if

Dr Dieter Tetzner from DMT conducts a thorough examination of an emergency call system for EuroTAP

(Left) Dedicated fire-fighting vehicles are on standby to respond to any incidents, while (far left) **trucks carrying dangerous goods are safely escorted through the Sveta tri Kralja tunnel**

Photograph courtesy of ADAC

To go with the flow

Studs based on inductive power transfer (IPT) technology have received a thumbs-up from those running the Saltash Tunnel in the south west of England. This is the first deployment of these new LED-based delineation markings, and David Bowerman, designer and supervisor of the project for Balfour Beatty Mott MacDonald (BBMM), says that three months after installing 345 units, they've experienced just one failure. "With any other type of signal, we would have expected a much higher failure rate than that," he reports. "This means we'll save a lot in maintenance costs and we won't be disrupting the traffic with tunnel closures for repairs."

The A38 Tamar Crossing operates as a three-lane tidal flow, using gantry-mounted overhead signs supplemented by the red studs to deter drivers from straying into the center lane against the flow.

Working on behalf of the Highways Agency, BBMM's Bowerman says a second phase of the project to extend the studs onto the bridge deck will start in late summer and could only have been possible with IPT, supplied by New Zealand's 3i Innovation. "The bridge deck is only 40mm deep before you hit metal, but as these studs are low profile, just 22mm, we can expand the tidal flow across the bridge.

"They feature the latest LEDs so we're quite confident that they'll last for 10-15 years, whereas the previously installed hardwired studs, as the records reflect, wouldn't have got anywhere near that."

which presented a number of recommendations at the end of 2001. Renowned experts from across Europe – as well as organizations such as PIARC and CEDR – were also highly vocal, with the various motoring clubs contributing experience from their annual tests.

According to Sauter's colleague, Nicolas Adunka, project manager of both ADAC's Test Centre Mobility and EuroTAP, though, the milestone was Directive 2004/54/EC. "This will continue until at least 2019 and it will be the member states that are responsible for realizing the dream of safer tunnels across Europe. The EU is responsible for its implementation and ordering sanctions and corresponding measures in terms of content and deadlines."

So how do EuroTAP and those charged with enforcing EU Directive 2004/54/EC coexist? Are they not competing bodies fueled by the same motivation yet in danger of getting in each other's way? "Our methodology and assessment is based on the benchmarks of the Directive," Adunka says, with the national regulations of nations such as Italy, Austria, France, Spain, the UK, Switzerland and Germany all considered. "The connection between EuroTAP and the EU Directive is reflected explicitly in the fact that a tunnel

(Above right)
Fire engines inside the Mont Blanc Tunnel, much better placed to reach the scene of an accident than before the 1999 fire (Below left) **Thermographic gate at the French entrance to the Mont Blanc Tunnel**

that satisfies the EU Directive's minimum standards achieved a EuroTAP rating of at least 'acceptable', thereby avoiding a fail with a 'poor' or 'very poor' rating."

You get the impression that 'acceptable' is not a good enough benchmark for Adunka and his colleagues at EuroTAP, hence why he feels the competitive environment is key in convincing operators to take standards to new levels. "EuroTAP is a dynamic process," he insists. "The methodology – the individual test criteria and the overall assessment system – is reviewed annually, discussed with national and European experts, and adapted to new technologies and regulations to the extent that's reasonable and in line with objectives."

The process is so comprehensive that it's easy to see why a thumbs-up is much sought after – and why a thumbs-down is to be avoided. Comprising well over 200 individual criteria, eight main categories are covered including: traffic and traffic surveillance; tunnel system; lighting and power supply; emergency management; fire protection; escape and rescue routes; communication; and finally ventilation. Each criteria is assessed and receives a particular number of points, a weighting so to speak, the total of which represents the result of a tunnel's safety potential. It describes all construction-related and organizational measures that prevent emergencies or which are intended to limit the extent of emergencies.

The risk potential is also calculated, highlighting first the likelihood of incidents and second the potential for damage. The safety and risk potential are aggregated for the tunnel assessment, with the safety potential being multiplied by a tunnel's specific risk factor, derived from the respective calculated risk potential. "Tunnels with medium or low risk potential are not required to satisfy the same safety requirements as tunnels with high risk potential," Adunka points out. Categories including tunnel system, lighting and power supply, and traffic and traffic surveillance essentially comprise preventative measures. The categories including escape and rescue routes and ventilation relate to rescue and self-rescue

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measures, while fire protection, emergency management and communication reflect measures that manage emergencies. "The safety measures in the categories can prove mutually supplementary or compensatory, but can also be more or less mutually independent, such as in prevention."

Adunka goes on to say that it's quite a different case with measures to detect and manage special occurrences: depending on the opportunities available to detect and report an incident, safety systems are activated automatically, or not at all, and there is also sufficient monitoring and management as well as the involvement of external forces such as the fire and rescue services, police, etc. "However, the strongest

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Photograph courtesy of ADAC

A sign for things to come

For every tunnel that raises its safety game, it's easy to forget there's a supplier in the mix adding more than a dose of innovation. The Hatfield Tunnel in Hertfordshire, UK, is one such case, with VMS Limited having to come up with an entirely new design of roof-mounted signal to not only meet relevant standards but fit within the confines of the height restrictions.

"They had to put in extra fire-resistant protection that limited the overall height of the signage to 355mm," explains Roger Stainforth, deputy chairman of the Tyne and Wear company. "But the specifications in the UK call for a traditional-style signal that was 650mm high. Our task was to come up with a solution that had the same optical, environmental and physical attributes of the

9241 G yet fit within the new dimensions."

Stainforth and his technical team developed a clever solution that features a sloping front face, a so-called low-profile sign that – including all brackets and mounting equipment – fulfils the space requirements but delivers everything a 9241 G would… and more. "As it was a new signal, we and our customer, Skanska Balfour Beatty JV, had to obtain the approvals necessary from the DfT and the Highways Agency, which we did, and now we have a signal that could cure a lot of headaches for other tunnels with similar constraints.

"Maintaining readability was one of the big challenges," Stainforth adds. "It was also the first tunnel
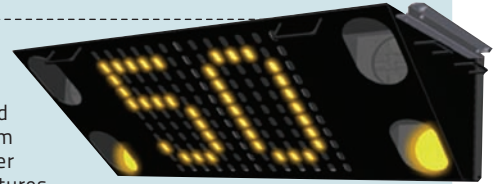
scheme to commit to an IP protocol, which brought about hurdles in terms of integrating the hardware." The resulting signal is a few steps ahead of other signs today. "The legibility in particular is better than the 200m minimum required, and even the bracket design saving just a few millimeters was acknowledged by the approvals teams as being innovative. These tunnels are also subjected to high-pressure jet-washing, but as the signal is IP66 this doesn't pose a problem."

Thirty units are now in the tunnel, 15 in each direction at 200m intervals.

possible carry positive ratings, or there should at the very least be no categories with any shortcomings. If this is the case, a downgrading of the overall rating – a 'knockout criterion' – comes into play.

Essential selection

Tunnels in the EuroTAP report are selected by the motoring clubs, although the tests only take place with support from the tunnel operators. On the whole, this has been forthcoming, although Adunka does report initial skepticism. "Voluntary cooperation generally prevails – even when it's known there will be safety issues," he says. "There have only been a few cases where more intense efforts were required to gain access. Instances where cooperation was made difficult or partially or even entirely refused are few and far between."

Hands up Italy, where private operator companies in particular have granted as good as no access to their tunnels, even up to the present day. That aside, Adunka says there is more willingness today than ever to be a part of the tests. "Even in the case of newcomers and less well-known tunnel nations such as Iceland, Slovakia and the Czech Republic, there is enormous interest and a keenness to face up to the challenge.

"Everybody wants to be the 'best' or at least achieve a positive rating – and nobody wants to be the 'worst'," he continues. "To top the ratings on even a national comparison fills operators with pride, and can also be regarded as reward for a job well done. But high expectations are not always satisfied by the test result as, in the final analysis, it is the safety-related overall assessment that determines the result, and thus the respective placing within the test."

Adunka also credits the media, who he suggests make a "decisive contribution" by "stoking the trial of strength" within

(Above left) **In the event of a fire, the primary function of any ventilation system is to maintain a smoke-free egress path for escaping tunnel users and to allow smoke-free access to the fire location for the fire brigade**
(Below right) **Emergency exits in the San Bernardino Tunnel, now clearly marked with signs and lights and fire- and smoke-proof doors**

countries as well as across Europe through their reporting. "They tend to focus on the candidates at the bottom, but the consequence of this is that poor results generate accelerated improvements."

So now we know EuroTAP's genesis, its mission, and how it works, but what has it achieved? Is the naming and shaming of Europe's high-risk tunnels producing results? Adunka is adamant it is. The San Juan Tunnel near Alicante in Spain, for example, failed the test in 2002 with a 'very poor' rating. "The press across the country ripped into it, billing it as 'Europe's worst'," he recalls. "Subsequent progress was very rapid due to the media circus surrounding its shortcomings. The Spanish government quickly brought it up to scratch with around €4 million of investment." At the retest in 2005, the tunnel was deemed to be in a modern and safe condition, and rated as 'good'. There are many similar cases.

The German Kappelberg Tunnel near Stuttgart came under fire in the 2002 test and the 'poor' rating was followed by €12 million being poured into its renovation. The outcome was a 'very good' rating in 2006. In Switzerland, the San Bernardino tunnel was rated

Trouble down below

Just 14% weighting is given by EuroTAP to a tunnel's construction and civil works – the remaining 86% is mechanical and electrical systems. **Louise Smyth** looks at a few key technologies

Proving that incident detection can be effectively conducted without the need for costly, state-of-the-art hardware – as long as the video analytics software is top-notch – is a case study relayed by Aluisio Figuerido, the COO of Intelligent Security Systems (ISS). "The Krasnopresnenskiy Tunnel is located at the north-east end of Moscow and two and half years ago we won the contract for their tunnel management," he reveals. "They had these legacy encoders, 80 legacy analog cameras connected to them and our brand new software. The integration was difficult as the previous supplier had gone out of business: we had to use some protocol analyzers and effectively hack into their encoders! But the final result was good; we were able to control the cameras, receive the video feed and do what we needed to do."

Today, ISS's Traffic Monitoring OS module detects a host of tunnel incidents, including stopped vehicles, congestion and objects. It's a familiar list, but Figuerido is insistent that ISS incident detection is superior to other systems on the market, and he's got some convincing arguments to support the claim. "Most systems try to understand the scene by itself; they point a camera at the scene and

take a long time to detect anything that's happening – I've seen a company offer a demonstration of its system where a motorcycle accident in a tunnel took 35 seconds to detect. Our approach is all about tuning. We take an awful lot of measurements, such as the exact distance the camera is from the road, to build up a picture of the bigger scene, not just one area in isolation. Fine-tuning the system is hard work, but it's worth it not only for detection but to cut false alarms.

"The difference between us and the competition is that they come from the analog world; we come from image analytics and we've been doing just that for 20 years. We've focused on ALPR, facial recognition and container recognition for years, so for us to jump into incident detection is not such a leap. These other companies need to acquire knowledge and that takes time. A lot of them are failing and are over-promising what they can deliver – their behavior on that front is the biggest problem I face!"

Figuerido is as forthright on the analog-versus-IP debate. "I believe analog cameras are better for this application, hence the legacy equipment in Moscow not proving problematic. But we had a tunnel project in Brazil a few years ago where they opted for analog cameras converted to H.264 with some new encoders. We found they couldn't maintain a constant frame rate: they're supposed to deliver 25fps but when you test them, the fps fluctuates wildly. This was a disaster for us: as a car enters the scene and we start tracking it, all of a sudden you miss a few frames and it's gone. We had to work hard on the tuning to compensate for this.

"I'd always go with analog as I know I'll have a straight 30fps. I don't need mega pixel; a car is so big there's just no need. Plus, they're expensive and there's no five mega pixel camera to deliver 30fps. It's better to use a good analog camera and go straight into our encoder – we have our own capture card where we get raw images to analyze, there's no compression, and we have much better results!"

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Some 6,700 miles east of Brazil is Turkey, which is yet to participate in EuroTAP. Judging by tunnels such as the new 2km-long Sariyer-Cayirbasi, linking two parts of Istanbul, operators would have nothing to fear from assessors. Systems integrator Telegra, through local partner Ultra Teknoloji has been busy recently deploying all the requisite tunnel systems and more so that if the country does decide to join EuroTAP, the scores on these particular

The Kagithane-Pyalepasha tunnel, which is one of three tunnels in Istanbul to have benefited from Telegra's topXview software platform and various subsystems

bores will be highly favorable. Around 25% of Telegra's business is in tunnels, with the company scoring some notable EuroTAP gongs between 2006-2010 – the Brinje in Croatia, for instance, came top of the pile in 2007. But what the Sariyer-Cayirbasi highlights is that each job is different with its own set of challenges. Under normal circumstances, the tunnel is controlled from a remote control center, the Main Center, which already operates two existing tunnels, the Kagithane-Pyalepasha and the Bomonti-Dolmabache. Near the tunnel there is a center for monitoring and managing only the Sariyer-Cayirbasi, to be used only in exceptional cases, for instance if the Main Center is disabled, if there is major servicing, etc. The integration of such a huge amount of equipment was a challenge, although a bigger hurdle was providing a redundant system where both the main and auxiliary centers can monitor and manage the equipment.

Telegra's topXview software allows tunnel control staff to remotely monitor the status of all of the equipment – measurement devices, fault detection, etc – and manage everything from smoke detection and speed enforcement to lighting, incident detection and ventilation. It makes the job much easier, so ultimately means a safer tunnel.

SecurOS TRAFFIC is a video analytics module for ISS SecurOS and provides traffic monitoring capabilities utilizing traffic incident detection, real-time traffic flow metrics and statistical analysis

as 'very poor' in 1999 and was subsequently renovated at a cost of €150 million. The reward was a 'very good' assessment in 2008 – and in Adunka's opinion it now stands as a "paragon of a modern, single-bore road tunnel". Likewise, Austria's Katschberg received a 'poor' rating in 1999 and €112 million was provided for the construction of a second tunnel and renovating the existing tunnel. "It is now a modern, two-tunnel infrastructure that fully meets the high safety requirements and was assessed in the most recent report in 2010 as 'very good'."

Over the past 12 years, though, on average every fourth tunnel examined doesn't strike the right chord with EuroTAP assessors – 12% have failed with a 'poor' and a further 12% with a 'very poor' rating.

> Although there is probably a lower chance of accidents occurring in tunnels than on open roads, if it does happen the damage to life and limb is much greater

Robert Sauter, chairman, EuroTAP and director, ADAC, Germany

DMT expert Thomas Nierth checking distances with a laser analyzer

A further 25% of the 365 tunnels achieved only an 'acceptable' rating. The fact that these failings are brought to light is perhaps one of EuroTAP's biggest achievements: the primary goal is still to get as many tunnels as possible to raise their game ahead of the deadline, although Adunka is the last person you need to remind how much work is still left to be done. "Around 25% of Europe's most important tunnels failed to offer even acceptable safety," he says. "The challenges for individual countries and operators are great, but member states do have until 2014 to implement retrofitting and until 2019 in exceptional cases. It will cause problems in many instances, and not

A bottom-to-top approach to tunnel safety

When speaking with Shaun Pidcock, development and delivery manager at Transport for London (TfL), you get a real feel for some of the difficulties that arise when renovating a tunnel.

The last serious refurb of the Blackwall Tunnel in London was in 1964, though, hence its lowly position in the 2007 EuroTAP report, so few will deny this main artery to places such as Canary Wharf and the O2 (Millennium Dome) wasn't in need of some TLC. "The tunnel is vital not only for the local community, but for cross-river trade as well," Pidcock points out. "One of the problems is that the next crossing east that can handle heavy trucks is at Dartford, while the next one west is on the other side of London at Kew Bridge."

With around 1,300 overheight vehicle incidents a year at Blackwall, they're by far the biggest culprits for tunnel

Around 50,000 vehicles a day pass through the tunnel, so during the peak it's impossible to increase capacity any further

closures. "When these vehicles hit the cladding, we not only have to retrieve the vehicle but repair the damage done. We therefore decided to remove the cladding altogether and grind away some of the sidewall in certain locations and spray them with

concrete to reduce this type of problem in the future."

New overhead vehicle-detection systems are also being deployed as part of the £70 million renovation, as well as emergency radio interrupt, enhanced CCTV and comms, and the integration of refuge areas for breakdowns. "Everything we're putting in will not only improve safety but subsequently mean fewer closures due to maintenance. The 40-year-old ventilation fans, as an example, were well past their sell-by-date."

Aside from the enormity of getting all the work done at night

and what will amount to just seven weekend closures, the TfL man says a big challenge was the integration of the mechanical and electrical subsystems – a lot of which is down to performance specification. "For instance, if the VMS signs are just 200mm too big, all of sudden they might be clashing with the incident detection cameras or the vehicle space envelopes. Interestingly, we changed the tendering from a restrictive procedure to a competitive dialog, which meant we got around the table with a lot of tunnel experts, and we were able to speak with a lot of specialist suppliers."

Due for completion in December 2011 – one year ahead of schedule – Pidcock is certain that if the EuroTAP assessors were to return, they would be impressed with the changes. "We meet the requirements of Directive 2004/54/EC where it's physically possible," he confirms.

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just financially. The EU will be responsible for policing, pursuing and punishing delays or infringements by its member states."

Hopefully such actions will be rare. Some countries that fall under the EU's umbrella seem to be taking the Directive seriously if the level of retrofitting activity is anything by which to judge. To be invested between 1999 and 2019, Austria earmarked an astonishing €4.1 billion for 140 tunnels. Germany will spend €810 million on 232 in just over a decade up until 2014. Switzerland is investing €800 million on 126 between 2008 and 2018, while Spain will spend €357 million on 405 tunnels over eight years up until 2016, with Norway plowing €115

Thomas Pieper, an expert from DMT (in the white shirt), conducting his investigations at a Cofiroute tunnel control center

million into 131 up until 2019. "Austria and Italy definitely face the biggest challenges within the EU," Adunka confirms.

You might note the absence of the UK in the above list, which pulled out of EuroTAP in 2007. A source at the AA, the UK's motoring organization, suggested it did so because it was "expensive" and was "an excuse for people to tell us our tunnels were rubbish!". Tongue in cheek though the statement was, the caveat was that the assessment criteria of EuroTAP couldn't always be applied across the board, citing London's Blackwall Tunnel as a prime example (see *A bottom-to-top approach to tunnel safety* sidebar).

Blackwall has undergone a huge renovation program over the past few years, with the installation of new lighting, ventilation fans, CCTV and communications systems, 26 inlets in the tunnel wall (including emergency phones and fire extinguishers), and much improved fire protection. But the 113-year-tunnel would probably still fall foul of EuroTAP as a result of its infamous 'kink' – a quirk inserted during its construction back in the Victorian era, reputedly to prevent horses from bolting toward the light.

The UK in particular has a number of tunnels that fit into this bracket, which hasn't gone unnoticed in EuroTAP corridors. "Veteran tunnels such as Blackwall face quite unique and special challenges when being retrofitted, but neither the Directive nor national regulations protect old tunnels," Adunka acknowledges. "Modern safety philosophies must be realized and aging tunnels in particular require sensitive examination, and individual renovation within the scope of what is economically feasible."

Keen to prove that the UK is not alone in this sense, Adunka cites EuroTAP's investigations into a number of older city tunnels that experience similarly high traffic levels. "In 2006, we assessed the Rovira Tunnel in the center of Barcelona as 'very poor'. Around €11 million of special funds were released, and we'll conduct a retest once the work is complete. As for Blackwall, we're prepared to do a retest if the renovations have been implemented successfully."

SEAL OF APPROVAL

The total length of the Fehmarnbelt Tunnel will be approximately 18km from end to end. At a speed of 110km/h, this will offer users a journey time of around 10 minutes from Denmark to Germany

Undoubtedly retrofitting brings special challenges, particularly with tunnels that are aged and where the options for new-build are limited. The Fehmarnbelt Tunnel that will connect Scandinavia to mainland Europe will face none of these issues. According to Kim Smedegaard Andersen, project manager, the new multi-billion euro tunnel, due to open in 2020, will be the safest in the world. "The main safety issues will be conventional traffic accidents and fire," he admits. "But we have proposed separate tunnel tubes so traffic will only flow in one direction, as opposed to the Mont Blanc where traffic flowed in both directions, while we have continuous emergency lanes throughout. As with an open road, we cannot prevent accidents completely, but we have minimized the risk with 24-hour monitoring, advanced control and comms systems, traffic information via radio, computerized traffic control, dynamic signs, and road lighting and varied lighting to prevent driver fatigue."

That latter point is an interesting one. "Our studies show that some users feel unsettled when driving through a tunnel; for some, their feelings of discomfort are so great that they choose a different route," Andersen explains. "Studies also show that such feelings can be eliminated or reduced by using creative and good lighting, decoration, high maintenance standards, clear information with frequent signage, and welcoming design at tunnel portals."

This 19km-long combined road-rail tunnel will connect the coast of Denmark to Germany. Andersen predicts an average of 8,000 vehicles a day in the first year rising to 10,800 the year after at a projected growth rate of 1.7% a year. To combat against any repeat of previous serious incidents in tunnels elsewhere, Fehmarnbelt will

have emergency lanes running in both directions for easy access by rescue vehicles, while rescue teams will have access from the opposite end of the tube at approximately 108m intervals. "A sprinkler system covering all areas in the tunnel can be activated from the control center immediately when fire is detected, while emergency stations with hand-operated fire extinguishers, fire hydrants and emergency phones will be every 54m," Andersen adds. "The ventilation system will also ensure smoke is extracted from the tunnel straight away in the direction away from motorists.

"The requirements for road tunnels have increased a great deal over the past decade," the Danish engineer accepts. "The design of Fehmarnbelt takes all of the relevant safety

"Studies show that such feelings can be eliminated or reduced by using creative and good lighting, decoration, high maintenance standards, and clear information with frequent signage

Kim Smedegaard Andersen, project manager, Fehmarnbelt, Denmark

standards into account, including the new directive." So when EuroTAP comes knocking, expect the report to be glowing.

"Tunnels are both complex and individual," admits EuroTAP's chairman, Robert Sauter. "There will never be 'ultimate' tunnel systems, just as there will never be a 100% safe tunnel. Research, development and the deployment of new technologies naturally represent a further and indispensable pillar. But along with equipment and operations, you always have the decisive human factor. What's needed here is the consistent education and training of motorists, as well as consistent education and training of tunnel staff.

"The EU's goal of halving the number of people killed in traffic accidents backed up by various traffic safety programs is working," Sauter concludes. "Fatalities are falling and will hopefully continue to do so. Tunnels, though, remain extremely sensitive pieces of the traffic infrastructure. Although there is probably a lower chance of accidents occurring in tunnels than on open roads, if it does happen the damage to life and limb is much greater. The risk of being killed is also higher, particularly in tunnels with oncoming traffic. That's why the EuroTAP principle of 'testing, assessing, informing and improving' continues to prove effective."

Steer into a dynamic future

There's an acceptance worldwide that high contrast on road warning lights do reduce the number of accidents; an alerted driver will travel at a slower speed and will drive with greater awareness, therefore reducing the number of accidents and ultimately saving lives.

Core to 3i Innovation's success (see *To go with the flow* sidebar, *p43*) has been the underlying technical advantages created through wireless power. As there are

no wired connections to its ONROAD LED marker, there is also no corrosion, so markers have a much longer life expectancy. Fast to install, the 3i system is also easier to maintain than traditional approaches.

As for the future for on-road lighting, there will

be more dynamic systems generating greater traffic control. 3i Traffic systems not only send information to lights but can receive data from each light unit. Each has independent diagnostic capabilities, including such things as a report of the marker performance, road temperature and vehicle speeds. This could turn into on-road lights that respond to drivers speeding into dangerous curves by flashing or alerting drivers to black ice by changing color to blue.
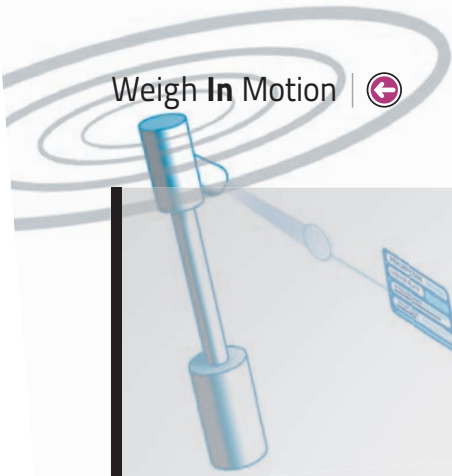
Identity parade

As **Saul Wordsworth**'s report on the latest weigh-in-motion trends reveals, for a small community, the sector is never short of developments. Alongside continued success in improving road safety and minimizing asset damage, there is growing excitement about the emergence of direct enforcement

Illustration courtesy of Jason Cook
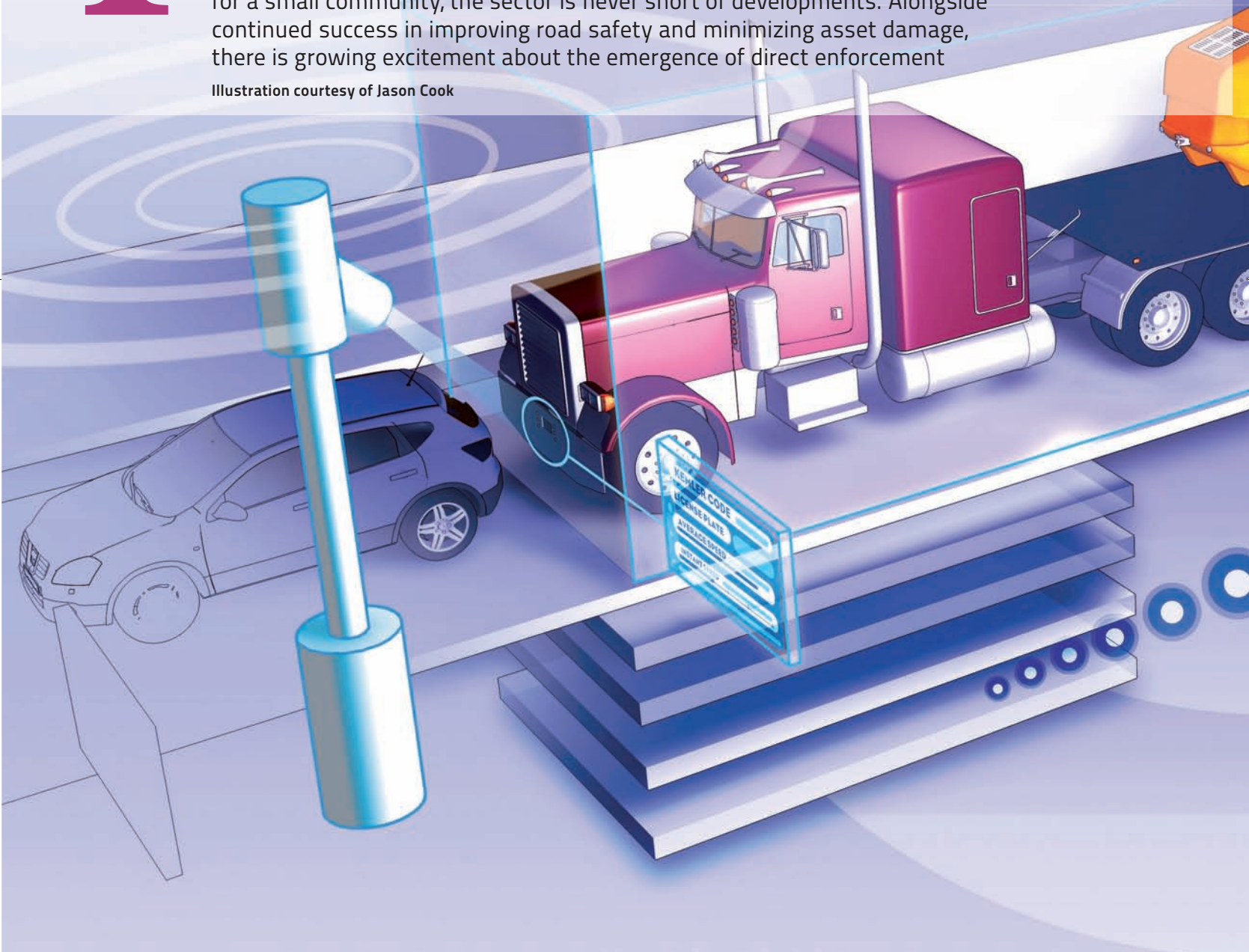
Heavyweights on tour

PTV's **Sonja Koesling** visits a truck safety test area near Munich that is highlighting the potential problems posed by heavy trucks on Europe's roads

Almost every 20th truck on Bavaria's main highways is overloaded and hauls at least 5% too much weight, according to investigations conducted as part of the ASSET Road Project. The European Commission initiated the Advanced Safety and Driver Support for Essential Road Transport project in July 2008 in an effort to achieve better road safety levels – a direct response to the fact that over 33,000 people lose their lives in Europe annually as a result of traffic-related causes.

Heavy goods transportation is on a continual rise on Europe's roads, at a time when cost pressures are increasing in the logistics sector. The two don't make a happy cocktail. The result is that numerous drivers violate the legal driving times and rest periods or go over the permitted speeds. Overloaded vehicles are increasingly observed, with randomly inspected trucks often having a flaw rate of up to 55%.

Mobile and stationary vehicle inspections are time-consuming and labor-intensive. The goal of ASSET Road is to implement and integrate already existing technologies in such a way as to detect violations efficiently and automatically while a vehicle is in motion. A subsequent goal is to automatically hold violators liable with little effort. "To test the technical possibilities, in May 2010 we set up a test area monitored by video cameras on the A8 German federal motorway between the Inntal interchange and regional capital Munich," explains Dr Walter Maibach, head of the Traffic Control Systems department at PTV AG in Karlsruhe, Germany. Although PTV is best known for its software and consulting expertise for maintaining mobility, Maibach is also the coordinator of the ASSET Road Project. "The test area serves the development of new automatic sensors and aims to determine breaches by trucks and passenger cars."

At the entrance to the test area, a high-speed weighing field (WIM) has been installed, the purpose of which is to determine the weight of overloaded vehicles and axles while they are driving. A newly developed dynamic weighing sensor system (high-precision WIM) is used and offers high accuracy and subsequent calibration suitability as well as integrated electronics, the goal being to provide fully automatic disciplinary action for driving overloaded vehicles. "Cameras take a lateral video picture of overloaded vehicles so the police can fully identify them and prove that overloading took place according to court-required standards," Maibach reveals. "The image and data record are then sent to the communication processor at the control station for further processing."

A 3D camera system enables the classification and the identification of the vehicles. From the 3D images, the computer can calculate the speed according to calibration suitability as well as calculate the height and the distance between

> " The weighing sensor's goal is to provide fully automatic disciplinary action for driving overloaded vehicles
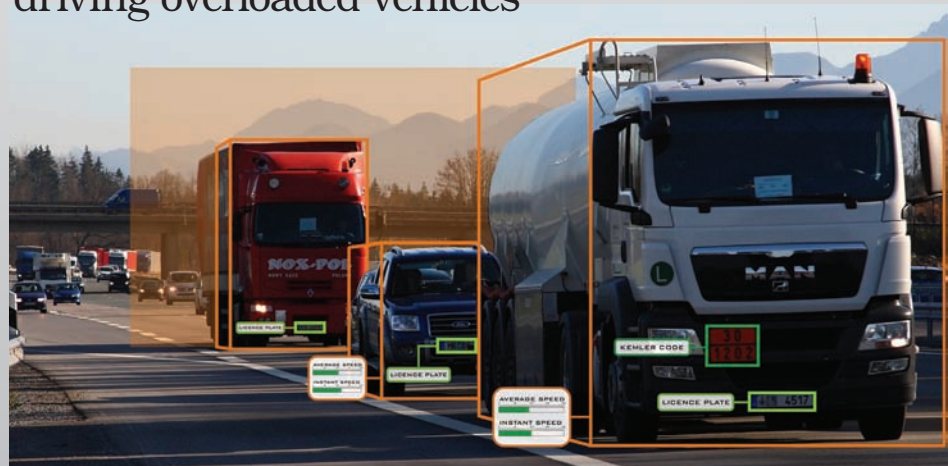
In case of overload a lateral freeze-frame picture of the overloaded vehicle is taken. The picture and related data set are transmitted to the communication computer at the control station for further processing

Another element that contributes to the increase of safety is the installation of a system measuring the depth of the tire profile

Weigh-in-motion technology is highly divisive: some agencies swear by its qualities and accuracy while others refuse to go near it. Texas, for instance, the USA's second-largest state in terms of both area and population, doesn't have a single municipal WIM site in situ, yet many small European countries are littered with weighstations on roads and bridges for counting, weighing, pavement planning and enforcement purposes. Ultimately, a nation's transportation infrastructure is its lifeline, so failure to protect it by whatever means harms economic prosperity as well as social well-being.

> " We automated Oregon's 22 busiest weighstations back in the 1990s, one of the largest such schemes in the USA. Rather than pulling trucks into the weighstations, we monitored traffic on the freeway

Operating a heavy truck is estimated to cost US$1.96 a minute and stopping at a weighstation can take five minutes. On that basis, truckers in the Green Light program have saved 1.17 million hours of travel time and US$137 million in operating costs in the past 12 years

vehicles. If the high-speed scale suspects an overload violation, the official at the sorting station (located prior to the inspection station) receives the lateral video image on his laptop. He can then get the vehicle to exit to the inspection station to check the alleged violation again so that any offense can be proved. A penalty can then be issued if warranted.

More than 147,000 trucks passed the Bavarian test area in the inspection month, corresponding to an average of about 4,700 trucks a day – this equated to around 3.6 million tonnes of mass passing the high-speed scale with a daily maximum weight of 119,000 tonnes. "More than 4% of all trucks that drove over the scale were driving while overloaded," Maibach reports. "A maximum of roughly 10 trucks per hour can be checked at such an inspection station, which takes two officials between 60-90 minutes." If overloading controls were automated the earnings would more than cover the costs. "More than €670,000 in fines would be collected if the average fine was €108 per violation."

Good to go...

One of the great WIM success stories belongs to the US state of Oregon. Although its first WIM scales may have been employed as far back as 1955, it was the introduction of the Green Light program 40 years hence that really caught the eye. Created with US$20 million from the federal government, the scheme was made available to any truck company that frequently stopped at one or more of the Beaver State's 55 weighstations.

"We automated Oregon's 22 busiest weighstations back in the 1990s, one of the largest such schemes in the USA," reveals David Fifer of the Green Light program. "Rather than pulling trucks into the

⬇ | Everything in order?

As a truck approaches the weighstation on I-55 at Bloomsdale, Missouri, magnetometer loops set in the highway mainline pavement measure the density and distribution of steel in the vehicle body. Each vehicle's metallic 'fingerprint' is unique. This information is stored for verification with subsequent verification activity.

A camera also snaps a photo of the vehicle, the mainline WIM scale measures the weight, and the PrePass sends a signal to communicate with transponder-equipped vehicles. Compliant PrePass-enrolled vehicles receive a green light to bypass the station. PrePass trucks that receive a red light (for a random check or to investigate an issue) and those not equipped with a transponder take the ramp into the weigh facility. As CMVs pull onto the ramp, another set of loops captures the trucks' fingerprints as specialized cameras read the USDOT and license plate information. As one system

compares the fingerprints and attaches the scale reading to the corresponding USDOT and license plate numbers, another queries the state CVIEW system to check the carrier's credentials. The Tracking Network is then passed WIM data, camera images, and credential violation flags to analyze, direct, monitor and display data for each CMV.

This all occurs as the truck approaches a fork

in the ramp. If everything checks out, a traffic signal directs the driver to continue down a bypass ramp and re-enter the interstate lanes. If there are any inconsistencies, the truck is directed over a static scale and inspection lane where Missouri State Highway Patrol commercial vehicle officers are shown the vehicle's information to investigate and make an enforcement decision with the static scale manager. Operation at the static scale is automated to control traffic flow on and off the scale, change the vehicle information displayed to the one presently on the scale, and even auto-release the vehicle if it has no violations.

Smart Roadside links commercial vehicle safety, security and mobility systems into a coordinated, comprehensive roadside program

will create a more usable interface for troubleshooting, providing us with more features for remote functionality. It also works on reduced power output, meaning we won't need to add an air-conditioning system cabinet to keep it cool during the summer or a heating system to keep it warm during the winter."

The direct approach

Some 4,400 miles east, a company in the Czech Republic is on the cusp of achieving what it feels will be a world first in WIM, and could in the future render manned weighstations obsolete. Cross has been manufacturing WIM systems for the past five years – a technology based on the popular and highly accurate Lineas piezo quartz crystal sensors from Kistler. "We have reference sites all over the world, from our home in the Czech Republic to the Baltics, Thailand, Saudi Arabia and Africa," reveals Cross's Tomas Pospisek.

The company's head of sales has an idea up his sleeve that could prove popular in any country around the world that deploys WIM. Toward the end of 2010, the Czech government announced its plan to allow the use of direct enforcement by means of automatic high-speed WIM. In other words, no police officers or traffic police – just a WIM system combined with ALPR.

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weighstations, we monitored traffic on the freeway," he says. "We have just bypassed our 14 millionth truck. Aside from the fact that so many of our weighstations didn't have the space to expand, it helps our enforcement team. We know the trucks that receive a bypass are legal, which leaves us with more time to check out those that might not be compliant."

Then there's pavement repair. Green Light has saved Oregon in the region of US$110 million over the past five years in cost avoidance alone, a figure independently evaluated by Oregon State University. On top of that, trucks save time – on average between five and 20 minutes – by bypassing stations at highway speed, while they also save money as bypassing a weighstation is free, and benefits from improved fuel efficiency. On this note, most trucks use up to two liters of extra fuel when stopping then pulling off, suffering wear and tear in the process.

In 2008, the Oregon Department of Environmental Quality calculated that a truck traveling at normal highway speed compared with one stopping at a weighstation emits between 36% and 67% less PM, carbon dioxide, carbon monoxide hydrocarbons and nitrogen oxides. This transmutes into thousands of tons of saved emissions. "I've actually noticed an increase of late in the use of WIM scales in congested areas for purely ecological reasons," Fifer notes.

Green Light is in the middle of upgrading its systems' electronics alongside systems integrator, International Road Dynamics, to the new iSYNC programme. "Accuracy has never been an issue," Fifer adds. "But this upgrade to the next generation of systems electronics

One legal 80,000 lb tractor-trailer truck does as much damage to road pavement as 9,600 cars
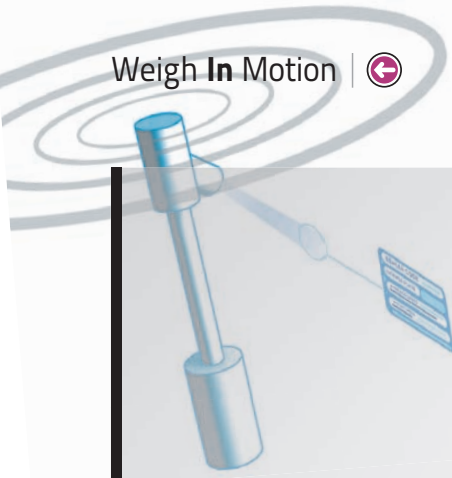
Smarter at the roadside

The Smart Roadsides Initiative in Missouri is a testament to the clever application of technology and great teamwork among various agencies. But, reveals **DeAnne Rickabaugh**, the traveling public is the biggest benefactor

About 30 minutes south of the St Louis metro area, a weighstation stands along I-55 South. To casual travelers, it's just a building, some posts and poles, lights and pavement. To transportation and technology experts, though, it's the point where technology, safety and accountability meet.

The state-of-the-art roadside enforcement site came about when plans for a new interstate interchange called for the removal of the existing weighstation at Barnhart, Missouri. The Show Me state needed to relocate the facility, but as was the case with many other states, funds were tight. In Missouri, the DOT builds and the Missouri State Highway Patrol operates weigh and verification sites. Together, they selected a site near Bloomsdale, on I-55 South.

That was the first of several cost-saving moves. The new facility was built at the site of a recently decommissioned rest area, eliminating land purchase costs. Existing utility and other infrastructure connections were repurposed, saving thousands more. Those savings and a spirit of innovation led the state to embrace a smart roadside approach.

"We watched with interest as other states developed smart roadside facilities,"

reveals Barb Hague of MoDOT. "It was exciting to learn what was possible. We took what we learned from others, added a dose of innovation, partnership and fiscal responsibility, and created an enforcement aid sure to improve highway safety and economic fairness."

Technology improvements already helped bring Missouri-based motor carriers into compliance with rules and regulations. In the early 2000s, MoDOT established a one-stop shop that serves all credentialing needs for Missouri-based carriers. Its internet-based MoDOT Carrier Express system verifies carriers'

credentialing status across registration, fuel tax and other programs, helping carriers fulfill their responsibilities. Now, advanced technology is used on the roadside to improve the efficiency and effectiveness of commercial motor vehicle enforcement operations.

"We knew about license plate readers, photo recognition and data verification

and hoped for an opportunity to employ the technology," adds Jan Skouby, MoDOT Motor Carrier Services director. "With the relocation, we had that chance. We also had a very tight budget."

As the build team met with vendors, learning about the components needed to support a smart roadside system, one fact stood out. Some of the technology needed was already available. Intelligent Imaging Systems, one of the technology subcontractors on the project, found that tools already developed by HELP, Inc, creator of the PrePass system, could be enhanced to serve multiple purposes.

> " On this project in particular, it was important that we obtained the best value for every dollar, and we achieved that goal

"Our partners at Intelligent Imaging Systems contacted HELP, Inc, and asked for something unprecedented," continues Skouby, who also represents states as a PrePass board member. "In order to meet our budget, we needed access to the PrePass WIM information."

Seeing the value, the companies and state worked out an agreement that benefited all. "It was a win for everyone," confirms Rick Clasby, the new president and CEO of HELP, Inc. "Missouri receives the data they need without the cost of a WIM installation or compliance reader; we receive incredibly accurate data that we use to make our products better; and drivers and carriers who play by the rules avoid delays."

The partnership with PrePass and Intelligent Imaging Systems is augmented by another feature unique to the Bloomsdale site. Magnetometer loops encased in the
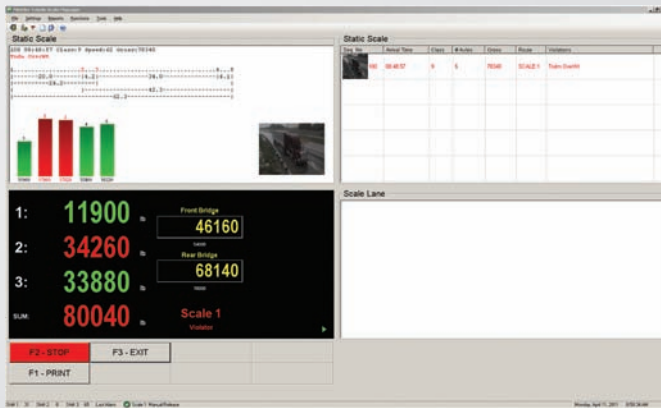
interstate driving lane and weighstation ramp trigger electronic equipment as they do in many other applications around the world. Here, however, the loops also take a reading of the steel makeup of the vehicle.

"Those readings are unique to each truck," Hague says. "They act as a fingerprint of sorts. We compare the fingerprints measured by a loop on the interstate with those taken by a second set of loops on the weighstation ramp. That way, we can identify a weight measurement that came from a particular truck without requiring trucks to queue up in a certain order. In this, a new use for existing technology solved a major procedural concern."

"On this project in particular, it was important that we obtained the best value for every dollar, and we achieved that goal," says Tim Richmond, the MoDOT transportation project manager in charge of the project. "It required true partnership among contractors and state agencies. Working together, we've improved safety verification on the interstate I use all the time. That makes me proud."

Smart Roadsides is an integrated system deployed at strategic points along commercial vehicle routes to improve safety, mobility and efficiency of truck movement and operations on the roadway

"The moment we heard this was coming into effect, we started to develop a WIM system for enforcement to the most accurate specifications possible," Pospisek reveals. "It had to work in very different climatic conditions and be technically comparable to any existing WIM system. If enforcement means a ticket or fine for the driver or company that owns the overloaded vehicle, we have to be 100% confident that our technology is up to the task."

Pospisek says that in order for a WIM system to be directly enforceable, it has to adhere to the highest standards of accuracy, meaning a requirement of ±5% for total weight and ±11% for axle load. Both figures are achievable using the technology available to Cross – indeed, under idle conditions and a good state of road, the

> **If enforcement means a ticket or fine for the driver or company that owns the overloaded vehicle, we must be 100% confident that our technology is up to the task**

system can measure the weight of the vehicle to within 3% or even less.

In January, Cross became the first company in the Czech Republic to obtain a certificate from the Czech Meteorology Institute to implement direct enforcement – on a two-lane road situated in Zlin in the east of the country. "There are now three lines in our law books stating that automatic enforcement based on high-speed WIM is legal," Pospisek adds. "Of course, to be put into real life, we need regulation."

Cross's system consists of double loops and weight sensors for each monitored lane, and also a camera system for ALPR
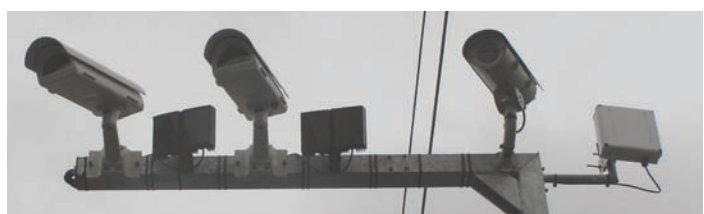
Minor wrangles remain over how the technology will be certified along with who will issue the ticket however – state or city police, city or road authority, etc. "We're just waiting for the regulation to be issued, which is somewhere in the Ministry of Transport," the Cross man says. "We were hoping it would be finalized by March; my guess is it will be before the end of the year."

For now, then, the location is being used for standard preselection, with information from the site being conveyed to the police online, enabling them to intercept an illegal vehicle a few kilometers down the road. "The other week, we pulled over four vehicles in a row transporting timber and each was overloaded by at least 10%. Once the regulation is passed, such law-breakers will be auto-ticketed. This is the future and the Czech Republic is at the forefront of it."

Rock and a hard place

Trucks transporting bulky construction materials such as timber are quite often

Overweight trucks can lead to fines and extensive delays, with many local governments requiring them to be offloaded prior to returning to the road

In the UAE, trucks weighing in excess of 110,000kg are identified and weighed in less than 30 seconds and a full report of each site's transactions is transmitted to the Fujairah Municipality

overloading offenders, with countries going through development booms facing the biggest crises. The demand for rock and quarry material has reached an almighty high in the United Arab Emirates. Fujairah, one of the seven Emirates, has such rock in abundance, which has been extensively used in two of Dubai's most ambitious projects – The World and The Palm Islands. Up to one million tonnes of the stuff can be transported from the crusher plants in Fujairah in a single day, so the trucks carrying this material must be weighed. UK WIM specialist Central Weighing was selected to undertake this immense task.

Conventional platform weighbridges were considered but dismissed as a result of a combination of speed and durability considerations. A conventional platform weighbridge can take up to two minutes to weigh a vehicle whereas Central Weighing's Supaweigh WIM system can process the same truck in less than 30 seconds, so essentially allowing for four times the number of vehicles to be weighed every day. The result was a saving of at least 12 weighing stations and all the associated equipment and infrastructure. The trucks, many weighing over 100 tonnes and with axle weights of 35 tonnes, would have resulted in durability problems for conventional platform weighbridges. In Europe, 44 tonnes is considered the maximum permitted load, although in Fujairah the WIM systems have been designed to cope with loads of up to a staggering 240 tonnes.

In all, 32 WIM sites were established in strategic areas between the crusher locations and access to the country's main highways. Up to 9,000 trucks a day can pass through the weighstations, each fitted with an RFID transponder that automatically identifies the truck, its tire weight and owner details, permitting access to the weighing stations. The loads are computed and the data transmitted automatically by GPRS modems to the Fujairah Municipality Head Office, at which software is in place to automatically invoice the crusher operators with a fee for each load transported.

Bridging the gap

Despite the many benefits of well-executed WIM installations, sometimes it can be a victim of its own success. The UK-based TDC Systems, for instance, recently saw the decommissioning of some of its smaller WIM sites as a result of the accuracy of its larger ones. "We have a longstanding contract with the Department for Transport that had seen our WIM technology installed at nearly 50 sites across the UK to help aid pavement design at the Highways Agency," explains Andy Lees, business support manager at TDC. "After a while, the DfT realized they could get good data from just five or six high-volume sites."

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TDC has plenty of other business to fall back on, however. At the recent International Weigh In Motion Conference held in Brazil, Lees presented the company's experiences in Bridge WIM. "We have a number of B-WIM sites including the Humber and Kessock, but for the conference we focused on the Erskine Bridge in Scotland and the West Gate Bridge in Melbourne, Australia," he reveals.

Bridge load monitoring provides a low-cost means of recording bridge transit vehicle classification and axle load data without interrupting the traffic flow. It can also act as a preselection tool to prevent overloaded vehicles from traveling across vulnerable structures.

Both bridges are subject to heavy loads crossing daily, especially the West Gate Bridge which partially collapsed in 1970. Its original design capacity of 40,000 vehicles a day is regularly exceeded four times over. The Erskine itself was damaged in 1996 when an oilrig was towed on the river beneath it. As an aid to improving the integral safety and operation of both bridges, monitoring systems were installed.

Overloaded trucks and the multiple negative effects of overloaded axles create safety risks and economic problems as a result road infrastructure deterioration

The protection of bridges in an environment of increasing traffic volume and weight ensures road safety and bridge structure integrity

"In both cases, it can be seen that WIM technology can offer effective bridge protection if installed with care," Lees says. "The case of the West Gate Bridge has also shown that they can be installed in areas where it was previously thought difficult – on the bridge itself rather than the approach. Although carrying extremely high volumes of traffic on a daily basis, West Gate appears to be operating safely as a result of accurate WIM data being provided to the bridge operator. As a consequence, the operator is able to calculate with reasonable accuracy any future pavement or bridge structure maintenance work that may be needed by the volume of traffic, its gross weight and the percentage of overloading that occurs. In the case of Erskine, the same is also apparent with the added benefit of the identification of offending vehicles and the subsequent targeting of offenders by the enforcement agencies."

Measuring a country

The protection of infrastructure still remains one of the main deployment reasons for WIM, whether it be on a bridge or on a stretch of road. Bad roads mean increased traffic congestion and maintenance costs, as well as heightened danger for motorists. Accurately predicting performance and durability are therefore critical to maintaining and improving pavement design, which is where WIM really comes into its own.

The US Long-Term Pavement Performance (LTPP) program has addressed these issues since 1987. By investing around US$40 billion a year, LTPP saves the US interstate system an estimated US$737 billion per annum when factoring in the associated safety benefits, time saved and reduced fuel. To understand the effects of loading on pavement performance – and in particular loading from heavy trucks – LTPP has utilized advanced WIM systems across 2,500 different test sections throughout the USA, a huge project that encompasses at least half the country's state highway agencies.

Quality data is paramount for such a scheme and WIM has not been found wanting. Numbers are collected on a daily basis to ensure there are no faults or unexpected changes. Although a number of highways authorities were already using WIM technology to aid new pavement design in their state, LTPP has raised the bar for collecting traffic data and has paved the way for WIM workshops that are now regularly held across the country.

The data aspect is an important one, as explains Ralph Haas concludes. The professor of civil engineering at Canada's Waterloo University says: "After 24 years, the LTPP program has met a critical need by providing pavement engineering researchers with access to large amounts of research-quality data that would not have been available without it." ○
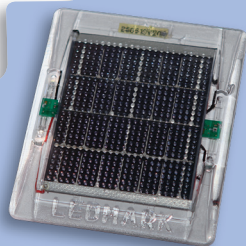
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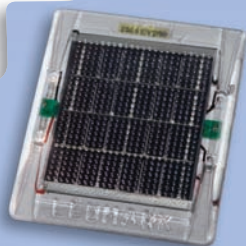
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The ergonomics factor in 24/7 control room operations

Commuters in New Orleans and the surrounding areas are getting around a little bit easier these days as a result of the new 29,120ft² New Orleans Regional Transportation Management Center (RTMC), recently completed by the Louisiana Department of Transportation and Development (DOTD).

The center uses ITS technology and regional coordination to facilitate better communication among drivers, traffic operations staff, emergency response personnel and other agencies in order to maximize the efficient use of existing roadways in the parishes of Jefferson, Orleans, Plaquemines, St Bernard, St Charles, St John, St Tammany and Tangipahoa.

The RTMC employs DOTD traffic management staff to actively monitor real-time traffic information on roadway conditions and distribute this information to drivers and emergency response personnel by using tools such as traffic cameras and vehicle detectors, Dynamic Message Signs, Twitter and the 511 Traveler Information System. As a result, drivers can avoid traffic congestion by planning alternative routes, and emergency response personnel – such as Motorist Assistance

Patrol (MAP), police and firefighters –can decrease the response time to an incident and quickly clear lanes of travel.

Operators staff the RTMC continuously to monitor the interstates and dispatch MAPs to incidents ranging from fender benders to stranded motorists. Operators actively monitor 150 real-time traffic cameras along the interstates circling Lake Pontchartrain.

DODT worked with audio-visual firm Creative Presentations to help design and integrate the A/V systems that make this monitoring possible. Two significant elements in the design of the control room include a videowall and several command center consoles.

ⓘ | **Need to know?**

How state-of-the-art control room consoles are helping operators keep traffic moving on New Orleans roads

> Ergonomic, modular, and adaptable consoles, giving users flexibility in any control room environment
> Sight-Line consoles feature the Versa-Trak monitor support system, which offers new levels in adjustability, allowing users to easily modify sight lines and monitor viewing angles based on personal needs
> Comfort Edge work surface enhances operator comfort and gives the work surface a sleek, contemporary look

The videowall at the front of the control room consists of 12 67in Mitsubishi rear projection cubes. Winsted's Sight-Line command center consoles were selected for the operator workstations.

"Winsted is very well known throughout the AV industry, especially when it comes to control room application-specific furniture," says Stephen Bohrer, integration manager for Creative Presentations, explaining the selection process.

The RTMC control room is arranged with two rows of consoles: the front row consists of four workstations; the back row consists of two consoles with two workstations each.

In 24/7 monitoring environments such as this, reducing operator fatigue and increasing efficiency is crucial to control room design. Creative Presentations conducted some line-of-sight drawings to minimize the amount of fatigue on operators looking from their computer screen up to the videowall and back. These drawing specifications had a lot to do with the placement of the consoles, the height of the videowall, the height of the monitors and the height of the consoles themselves. "Winsted also provided the ergonomic, 24/7 operations chairs, which are extremely comfortable," Borher continues.

Each individual monitoring station is equipped with a headphone system, which enables operators to listen to their own audio or whichever news station they want at any given time. Operators can watch up to eight news stations on the videowall at one time, but obviously you only want to listen to one.
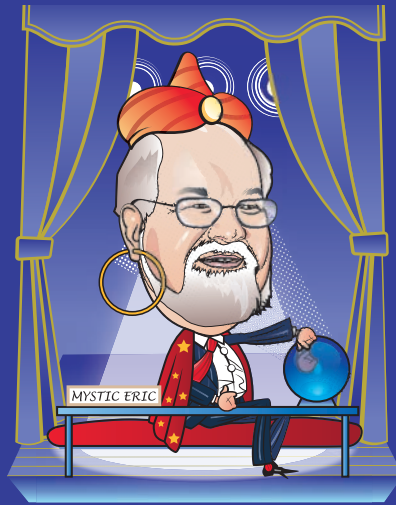
Paul Hsu was the system engineer in charge of the project

(Top) **Inside the New Orleans RTMC**

(Left) **Keeping traffic moving is the RTMC's main goal** (Right) **The RTMC is housed in a 29,120ft² space**

for DODT and was involved in the design, installation and integration of the new control room from the start. For him, one of the most challenging aspects of a project like this is making sure every piece of the puzzle falls into place in time to meet the deadline.

"I was very involved with every step of the installations process and I was there every day during construction," Hsu reveals. "All of the A/V components, furniture and wiring were part of my responsibility."

Hsu goes on to say that at times there were at least seven to eight different contractors in the control room at one time working to meet the deadline.

Winsted Sight-Line consoles are designed to maximize operator comfort and productivity in 24/7 control room environments. They feature Winsted's Comfort Edge work surface, Versa-Trak monitory array mounting system and plenty of customizable features to increase workstation privacy, enhance appearance and improve operator comfort and efficiency.

"From an install standpoint, the consoles were some of the best pieces of furniture we've ever used," concludes Bohrer. "They made for very easy organization and a very easy install. As well as very efficient and well thought out access for both maintenance and installation, with a lot of room for expandability." ○

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66 | Eric **Sampson**

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I've always enjoyed a good paradox, of which there are many examples in transport. Take, for instance, the introduction of air travel safety regulations requiring the purchase of seats for infants, rather than allowing them to travel free on a parent's lap, which led to a net increase in fatalities as families switched modes to avoid the charge and consequently more travelers were killed on highways than infant lives saved on aircraft. A similar effect has been claimed – but contested – for a mode shift from air travel to road within the USA after 9/11. [For more examples see Yvonne Huebner's excellent paper *Unintended consequences from transport policies and technology innovations*].

My Mum often harangued me with "You're an accident waiting to happen", which on the occasion that I came home from school with a broken arm was quite a good retrospective prediction. C. P. Snow observed that Einstein's formulation of the Special Theory of Relativity was not as amazing an achievement as many thought, arguing that it would have been devised by someone within five or so years anyway, it was "an idea waiting to be discovered". Regardless of the nomenclature, Mystic Eric is now going to predict a sort of paradox, an accident that will happen around seven years from now based on an idea that has already been discovered assuming the government develops a sensible energy policy.

Most readers in the UK will be aware of the government tax referred to as Fuel Duty – its technical name is actually Hydrocarbon Oils Duty and it generates around £25 billion (US$40 billion) a year for the Chancellor. Along with Airport Passenger Duty, it is the cheapest tax to collect by a very large margin. Let us suppose that income from the Duty falls by a large amount – 50%, say – then what might be the consequences? Well, obviously the Chancellor would want to make up the loss so how might that be done? There are various choices, individually or in combination. For example: increase Income Tax by 9%; or VAT by 15%; or Corporation Tax by 30%; or double Stamp Duty or double both Alcohol and Tobacco Taxes.

Why is this gloomy scenario of relevance? Because the government has embarked on a praiseworthy 'green' policy to move us away from using vehicles based on internal combustion engines to all-electric vehicles or hybrids and, as any 'fule kno', an all-electric vehicle doesn't consume the substance that generates income so generously for the Chancellor. So it looks to me that an accident is starting to prepare itself to happen. Now the folk at the Treasury are not really fools and they may well have a cunning plan to deal with this situation but the most likely and the most effective options are both going to be very unpopular.

The most likely option is to try to recover the missing £13 billion (US$21 billion) from increases in the price of electricity; but add on a bit for profits by the utilities and a bit more for the increased collection costs and the net household impact will be painful. On the other hand, there's the most effective option. Introduce limited road user charging – motorways only, for example – and you can recover the money (but not at the current 0.15% collection cost) by linking payment to congestion rather than just traveling and thereby also deal with the topical problem of giving some sort of Fuel Duty abatement to residents in rural areas.

I'll report on progress with this issue in 2015 after the General Election.

> ...an all-electric vehicle doesn't consume the substance that generates income so generously for the Chancellor. So it looks like an accident is starting to prepare itself to happen

Professor Eric Sampson, Newcastle University/ITS-UK, UK

Trends behind the lens

As the proliferation of ITS technologies on US roads continues to grow so, too, does the use of cameras at the heart of many of these systems. From red-light and speed enforcement to electronic toll collection and AID, many applications are dependent on high-quality camera images to perform their tasks.

As a result of the increasing adoption of cameras for ITS, the companies manufacturing these essential components have had to up their game. Transportation is by its nature a highly uncompromising environment. Capturing an image of a license plate on a car traveling at 80km/h on a dusty desert road, for example, brings with it unique challenges you simply wouldn't experience with other applications. So the technology used must be robust, accurate, and able to withstand a whole host of complex situations.

One of the most trusted names in this sector is Sony Visual Imaging, which offers a range of camera technologies that have found their niche in ITS. Its transportation customers tend to be systems integrators, purchasing non-branded units and integrating them into an overall system that's marketed under their own brand. This means there's a lot of Sony technology out on our highways quietly doing its job without the end operators even being aware of the famous name behind their systems.

Trends in ITS

A dominant trend in the transportation sector has been toward what Sony calls 'block cameras', such as its FCB camera line. "We are, however, seeing an increasing move toward machine vision technology, with our GigE, digital and smart cameras establishing themselves in the US ITS market," reveals Drew Buttress, product manager, Sony Visual Imaging. "Europe and China have already been using these technologies, and the US is starting to see their potential."

For certain ITS applications, camera triggering can be a very significant factor. One of the selling points for these digital cameras is that they offer the ability to be externally triggered. That is, these cameras can be

Need to know?

A range of camera products designed for the most demanding traffic applications

> Digital cameras that can be externally triggered are an attractive option for many ITS applications
> Color block cameras cover a variety of features, optical zoom ranges and advanced capabilities including progressive scan imaging
> Suited to applications such as toll collection, red light and speed enforcement, ALPR and traffic monitoring

triggered to instantly capture a single image. This is in contrast to block cameras, which provide continuous video. For ITS applications that require as much speed and autonomy as possible – such as red-light enforcement – the instantaneous snapshot that you get with an inputted trigger from machine vision cameras is an attractive draw.

However, block cameras still have a strong foothold in ITS applications; the point is that Sony is enabling customers to choose the best technology for their needs. Buttress says: "Our block cameras are very popular for traffic-monitoring projects, where they are installed on a pole above the road and provide a constant stream of images. For applications such as this, where there's no need for that triggering, the block cameras are ideally suited."

(Main) **Cameras from Sony Visual Imaging are designed with the ITS market in mind**
(Left) **XCG series camera with optional lens**

IP and GigE

The shift to IP is ongoing in the USA and is a big selling point for security cameras. The security cameras division of Sony has responded to this trend for IP-addressable variants, and now the Visual Imaging team is also offering a similar type of solution with its GigE cameras. "While the GigE cameras are IP-addressable, it's unlike a security camera in that you're really talking about a point-to-point network," Buttress explains. "These cameras communicate using the GigE vision interface, which is different to what your typical IP security camera would be using. The best way to describe it is that most IP security-type cameras have their own web server, and so through a web browser you access and control the camera, but GigE vision

cameras aren't quite aligned that way. Typically you'll communicate through a set of drivers with the camera. That's not to say that you couldn't have multiple cameras tied to a PC that's then networked so your application software would give someone from outside the same access. It's simply a different sort of interface."

The motivation for Sony's ongoing development again goes back to what is most appropriate for its individual customers. Buttress says the company prides itself on offering the best technology for the task in hand. It also strives to respond to customer demands, with the launch of the Sony Vapor Lamp Mode being one such example. "If you are imaging under sodium vapor lamps on a highway or in a parking lot, the lights can

adversely affect the color of the image," Buttress says. "This mode compensates for that and provides a more color-accurate image. When we conduct a demo and show people the same image with and without that mode activated, they're astonished by the difference."

Special features are not the only things that Sony is developing for the ITS sector. Buttress details how the latest GigE cameras have been tailored purely to meet the demanding needs of ITS practitioners: "The XCG-U100CR, a two megapixel, 27fps color camera, and the XCG-5005CR, a five megapixel, 15fps color camera, are designed specifically for the ITS market. Sony will soon be releasing a new high sensitivity GigE (HD format) monochrome camera – the XCG-H280E – that is ideal for challenging lighting

environments. Additionally appealing is its low power consumption, compact size and robust vibration resistance. These new additions to Sony's GigE camera series are all hardware- and software-triggerable: you can put the camera into a free-running mode and do video, but the real strength is that asynchronous reset, so it's able to take a snapshot at any point."

Systems integration

It's no secret that Sony is now actively targeting the ITS market – and indeed many other markets too. Part of the company's strategy has been to team up with systems integrator InterTest. In March 2011, Sony Visual Imaging named InterTest its first authorized national systems integrator. Ken LaMarca, vice president of Sony Visual Imaging, said at the time: "Start-ups and other companies with integration requirements but limited engineering capabilities will be better able to utilize Sony Visual Imaging products with InterTest's integration talents."

"InterTest is working with us to penetrate the ITS market," Buttress says, echoing the positive feeling about the news. "They have vast experience in providing bundled system solutions utilizing Sony camera technology to municipalities and government agencies In the US market, they are our go-to guys." ○

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A fresh approach to tunnel air-filtration and safety

Ever-larger tunnel projects are being realized worldwide to protect people and the environment, subsequently leading to an increased demand for filter systems to clean the air. Austria's Aigner Tunnel Technology has been developing the requisite filters and safety equipment since 1990. The Austrian company's big breakthrough came with its ECCO filter concept, patented in 2000. A further development, the ECCO*EP*, was installed in the Mont Blanc Tunnel in 2010.

Aigner offers a range of services, encompassing design, development, installation and maintenance all from one source. The company works in close collaboration with the Technical University of Graz in Austria as well as other renowned research institutes. Close-knit organization ensures quick decision making with cost-effective performance for individual solutions.

"Filter systems for tunnels are subject to their own very specific requirements," says Heinz Aigner, managing director. "Our systems are optimized continuously to meet the latest economic criteria."

Experience counts

Since 2004, Aigner has equipped filters to many new tunnel filter systems installed in Europe.

One key project is the famous Mont Blanc Tunnel, an 11.6km-long tunnel linking Italy and France. Designed as a single-tube tunnel for bi-directional traffic, the tunnels sees traffic volumes totaling around 1.8 million vehicles a year. Leaving aside the beneficial results of building the new Mont Blanc Tunnel, the steadily deteriorating air quality was

(Left) **The famous Mont Blanc Tunnel** (Below) **Aigner's tunnel filtration helps keep motorists safe during their journey through the tunnel**

ⓘ | Need to know?

A range of filters for removal of particulate matter and gases as well as safety products for road tunnels

> The high efficiency of ECCO makes it possible to reduce particulate matter load and to intercept carcinogenic diesel soot particles
> The ECCO filter system can be used in any tunnel project, whether a new construction or refitting during renovation
> The four-stage filter process of the ECCO*EP* results in 98% efficiency for particle sizes from 0.1– 20µm
> FIRE*CURTAINS* safety product aids visibility and promotes safer emergency operations
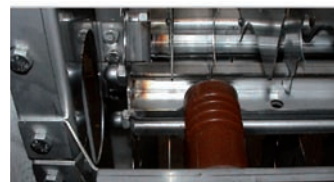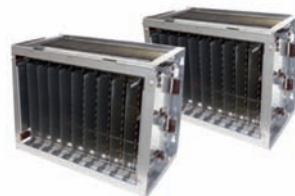
becoming an unacceptable side-effect for residents in the nearby town of Chamonix. The tunnel operators decided to integrate an air-filtration system into the existing tunnel.

The Mont Blanc Tunnel company had good reason to select Aigner's ECCO*EP* system. This latest generation of filter technology is space-saving and makes for minimal pressure loss and low energy consumption. A four-stage filter process, meanwhile, results in highly efficient particulate separation,

even of ultra-fine diesel soot particles. The degree of efficiency for all particulates lies at over 90%.

Aigner took a leading role in the project in terms of design and installation of the filter system, including all additional technical equipment, with the filters adapted to fit an existing ventilation system. This was also the reason for the two-part solution using ECCO*EP*, to guarantee the highest degree of efficiency despite the limited space available. Interested in the

potential, a delegation of South Korean tunnel construction technicians has recently seen for themselves how this works.

In case of a fire

A tunnel fire poses a high risk for tunnel users, although it's not the fire itself that presents the biggest threat but the smoke generated, which causes people to panic. For this reason, smoke must be efficiently extracted at the right place and as quickly as possible. The FIRE*CURTAINS* developed by Aigner promote sufficient visibility in such cases so that people are able to orientate themselves in the event of a fire. It's a double-pronged approach: on the one hand, the danger of suffocation is prevented by controlled smoke extraction; on the other, clearly visible signs in the form of exit arrows on the curtains instruct drivers to drive slowly through and leave the tunnel. Such a system was installed for the first time in the Roppen Tunnel in Austria in 2009.

A further pioneering idea from Aigner is the

Fire curtains promote visibility and instruct drivers how to behave safely

ECCO*NOxCAT* gas filter system. This system – featuring activated carbon and special catalytic properties – filters a large proportion of the nitrogen dioxide out of the air and has been in use – without requiring maintenance – since 2007 in the Calle 30 tunnel in Madrid. ○

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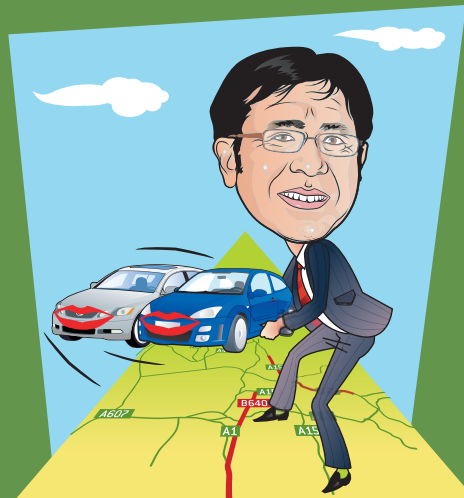
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Presumably, fair reader, you recall those days of unfurling your map as you drive, then peering at it while casting glances to the road ahead, hoping to safely navigate that next road juncture in your journey. Under no circumstances did you want your bumper to kiss that bumper just ahead.

Presumably, also, you've witnessed the advent and then advancement of in-vehicle or personal navigation devices, first in tiny screens with basic navigation functionality and nowadays commanded by voice and replete with traffic and travel time information that may motivate you to alter your route. Nowadays you might receive this sort of real-time pre-trip or en route traveler information via your smartphone. And that smartphone may be in your hand (and wearing a safety hat, bad), mounted via suction cup contraption in your windscreen (better) or used as a gateway to an in-vehicle display (best). No bumpers here – just kisses to these small electronic devices.

What's next? In keeping with the theme and mindset of this particular columnist, I dare say that safety is next. Can safety information be reliability delivered via an intrinsically unreliable communication link? Maybe, I answer. I contend that it depends on one's definition of 'safety information'; furthermore, I contend that understanding hazards such as an end-of-

congestion queue seconds to minutes into the future is indeed safety information. How difficult could this be to deliver? Seconds ahead may be difficult, because that connotes positioning, navigation, and timing (or PNT to some of us acronym-loving engineers) to high reliability. Minutes ahead, while difficult, seems easier.

Let's take this end-of-queue example a bit further. Consider the reliability or quality of service from the communication link to a hazard, say a message from the last car in the queue saying, 'Please stop. It's my rear bumper that's hanging out there…' Another would be that very same car saying, 'Um, my rear bumper is located right here. At this spot. Really.' Where? That brings us to that figurative link between your front bumper and that car's rear one: the distance between the two bumpers which we do not want to kiss. One can determine the relative distance or lay both vehicles on a map – and this time a digital map and not a paper one – and you or your car can make the decision to reroute, slow down or even slam your brakes.

Wait a second. Slam your brakes? That would mean that my front bumper senses or receives communication from your rear bumper that we share a lane (and are not in adjoining lanes). That's sub-lane resolution communicated in a near-instant – an expensive PNT solution. OK, what if my front bumper is a few more seconds or even minutes from your rear one? That's an easier PNT solution because obviously, location and map information need not be so accurate.

OK, where am I going with this? Somewhere there is today's real-time traffic and PNT solution, and somewhere a bit further in the future are ever more capable and cheaper PNT solutions. I contend that our bumpers need not kiss with technology that's just around the corner. That's my position, and I am not moving from it…

❝ Somewhere there is today's real-time traffic and PNT solution, and somewhere a bit further in the future are ever more capable and cheaper PNT solutions. I contend our bumpers need not kiss with technology that's just around the corner

Jim Misener, executive advisor, Booz Allen Hamilton, USA

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Light the way to better road safety

New and more advanced technologies are being introduced all the time, prompting road owners and operators to continuously evaluate the potential benefits. The current focus on ITS, traffic safety, cycling and citizens' health has increased the need for systems that can be combined, which has clear benefits in terms of cost among others.

This is being aptly demonstrated in the Danish city of Aarhus, which has created the Aarhus Cycle City project headed up by Pablo Celis, project manager. Running over five years, the scheme has a budget in excess of €10 million and aims at getting people to switch from using their cars for personal mobility to using bicycles. "It has both an environmental and a health effect if we are able to make the citizens of Aarhus choose the cycle over the car," Celis explains. "It's not based on any moralistic views about making everybody in Aarhus cycle to work every day; we know this is not possible," he adds. "But if we improve conditions for cyclists, it will be a whole lot easier for them to choose two wheels over four. On top of this, we hear from cyclists that dark cycle paths are an issue when it comes to cycling to work, which is why we felt we had to do something about it. However, the costs involved in installing and maintaining such lighting systems can be considerable, more than €40 per meter, so we were really happy to learn that it

*Bottom left photo of Geveko's LED-Guide device*

Need to know?

A Danish project featuring solar-powered road studs aims to increase cycle usage by making the mode a safer option

> A solution for cycle paths that requires one-tenth of the investment of cabled technology and a third of the operational costs
> LED-Mark can be used for supplementary marking of dangerous road sections, for example as additional road markers to warn about frost or in locations where particular risks are likely to occur
> LED-Guide detects and processes information and communicates directly with road users and indirectly to road owners, via GPS, for example

is possible to solve our problem with a technology that is only one tenth of that cost."

Solar-charged road studs make the guiding lights efficient and cheap in operation: "A colleague of mine met Geveko ITS at a road safety conference, and he brought home a sample of the technology that was extremely convincing," Celis recalls. "The conversations that followed led to further product development, so much so that the lifetime of the LED-Mark is now a minimum of five years, making it possible to install the LED road studs as guiding lights on 10km of cycle path."

As its name suggests, the LED-Mark is based on light emitting diodes, complemented by solar cells and batteries that are recharged throughout the day and illuminate at dusk via

*(Main image) Guiding lights in Aarhus*

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simple built-in controls. The technology can also be used for highlighting potential risks, such as freezing temperatures. Ultra-slim, the operation costs of the LEDs are less than a third of threaded technologies, which given the price of energy is a key concern.

Ready to hit the road

In development over the past 10 years, the products are now in serial production and the application areas are huge, according to Bruno Hansen, general manager for Geveko ITS. "They can be used for stretches of road with dangerous curves, along dark highways, unlit cycle paths and roundabouts – essentially wherever there is a potential risk of accidents."

Intelligent LEDs can do so much more, reports Celis, adding that he knows of no other technology available that can achieve what he needs, as well as being entirely adaptable to potential future demands as and when they arise. "We're envisioning scenarios in which green waves can be established so that cyclists will not have to stop at red lights at all," he says. "Or you could record the number of cyclists or their speed on a given stretch of road, which would give us more

(Main image) **Guiding lights in Aarhus** (Right) **Close-up of the LED-Mark** (Bottom left) **Geveko's LED-Guide**

data about how to increase the number of cyclists in Aarhus."

Together with the Luleå University in Sweden, Geveko ITS has developed a version that includes a mini-computer, various sensors and a communication device. "Based on our new LED-Guide, we are able to detect and count vehicles or cyclists, so we can warn people when a particular risk is present, and actually prompt them to a specific action by communicating directly from the road via light," says Hansen.

By embracing new technologies such as these, Aarhus may quickly achieve its goal of making cycling a more appealing alternative to driving. The project could also open up new applications for Geveko ITS. Innovative lighting for tunnel safety, for instance, is an area the company is exploring. ○

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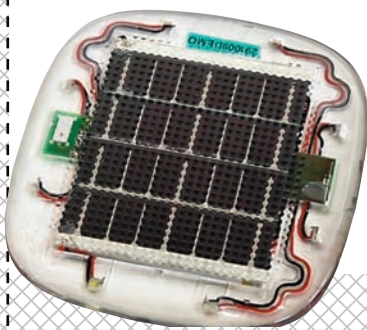
Virtual weighstations with image-capture systems

As the volume of commercial vehicles using highway infrastructure increases worldwide, the capacity of existing conventional weighing and inspection stations is being surpassed. Some enforcement agencies are forced to allow vehicles with violations to bypass inspection stations when over capacity or temporarily closed, while trucks can avoid stations by using secondary highways. Expanding the capacity of existing stations or building more stations is costly in terms of land requirement, construction costs, and personnel, and also increases environmental impact. A viable and complementary solution is the use of virtual weighstations (VWS).

VWS are weigh-in-motion (WIM) systems that provide vehicle records for enforcement, traffic surveillance and/or data collection in real-time over a computer network connection to a laptop, mobile device or workstation computer.

IRD's VWS system automatically weighs vehicles as they travel at normal speeds along a road, classifies them based on weight and axle spacings, determines when vehicles are in violation of regulations, produces records of commercial vehicles, and provides a display of the records on a computer with a network connection to the system. The system consists of WIM sensors, a signal processor, image capture and/or automatic vehicle identification (AVI).

Single-site and multi-site
The single-site system collects vehicle records on a server located at the site of the VWS and allows authorized users to connect to the server via a web browser to view the records.

Need to know?

Responding to the trend for moving WIM systems from the physical to the virtual

> How virtual weighstations can contribute to the need for sustainable, efficient weigh-in-motion
> Real-time information is sent to operators for enforcement, surveillance and data collection
> The intelligent system interface and network controller collects, interprets and processes signals from WIM sensors
> How images of the vehicle are captured and used for identification or classification purposes

LPR is often used within WIM systems

A weatherproof cabinet houses the iSINC

Authorized users can access vehicle records via the internet

A multi-site system collects vehicle records from any number of VWS and stores them on a central database server. The records are stored for a specified period, and can be searched by a number of criteria including date/time, partial vehicle identity (if available), vehicle class, and percentage overweight.

System hardware
The heart of IRD's VWS is the iSINC (Intelligent System Interface and Network Controller), a standalone controller with the ability to collect and interpret the signals from the WIM sensors, process these inputs into a vehicle record, and act as the VWS network server. The iSINC has an integrated modular design capable of processing signals from multiple types of WIM sensors.

Image capture and filtering is performed by the iSINC, which then inserts sequence numbers for vehicle records to correspond to the sequence of arrivals at the WIM location. The iSINC will interface with industry-standard vehicle imaging, license plate imaging, or USDOT number imaging subsystems.

Based on the rugged industry-standard CANbus design, iSINC has a modular design to aid in system maintenance, troubleshooting and in-field servicing. All components' input/output lines contain electrical protection to prevent damage from electrical surges, spikes and lightning.

The iSINC is housed in a rugged roadside cabinet, which contains a standard rack for the iSINC system controller, video controller, network electronics, power supply and cabling terminations.

Camera systems and vehicle identification
Images of the entire vehicle are used to assist in vehicle identification or classification. Cameras used for capturing whole vehicle images are typically mounted at the roadside and shoot at an angle that will allow the entire vehicle to fit in the image frame. License plate recognition (LPR) systems capture a high-resolution image of the front of vehicles for the purpose of recording the license plates. These systems may include optical character recognition (OCR) technology to automatically convert the image
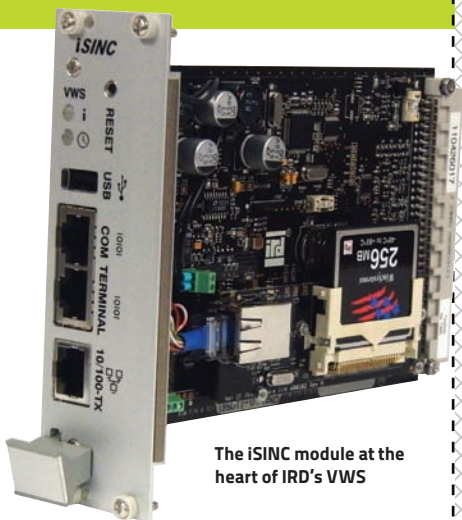
The iSINC module at the heart of IRD's VWS

of the plate to digital characters. The digitized number provides the vehicle identification, which may then be used to look up information on the vehicle or carrier in a system database.

Side images are used to capture a picture for vehicle identification, usually of the side of the truck cab. The identification may include DOT numbers, carrier names or logos, or fleet numbers. Side-imaging cameras may also make use of OCR to translate DOT numbers into digital format so the numbers can be referenced against a system database.

VWS systems that incorporate vehicle identification, such as LPR or AVI – and have a system database connected to a credentialing program such as CVISN/PRISM – will allow the user to display the credential record for a selected vehicle, driver or carrier.

IRD's VWS is an efficient, cost-effective method for both enforcement and data collection, and provides an unobtrusive way to monitor traffic in real-time on a 24/7 basis, requiring significantly less infrastructure for installation and operation than conventional commercial vehicle inspection stations. ○

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Adrian **Walsh**

France (38%)
Poland (89%)
Germany (89%)
Italy (89%)
UK (41%)
Spain (68%)
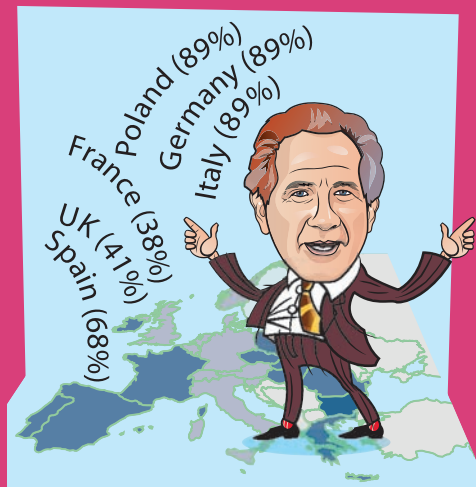
awalsh@roadsafe.com

Electronic stability control (ESC) has been hailed as the most important safety advance since the seatbelt and is already in use on many new vehicles in Europe. It is welcome news that a recent survey by the European consortium, eSafety Aware, reveals that when it comes to selecting a new car, safety is the number one purchasing criterion.

It is perhaps surprising, though, that the survey also shows that the two criteria considered next most important are fuel consumption and running costs. This perhaps indicates that car buyers are also relatively cost-conscious when it comes to buying a new car, with surprisingly the vehicle brand scoring relatively poorly, coming behind running costs, size, fuel type and emissions.

The survey – which looked at levels of awareness of six important safety technologies (speed alert, ESC, adaptive headlights, advanced emergency braking, blind-spot monitoring and lane-support systems) – followed one carried out in 2009 that was conducted in five European countries (France, Germany, Italy, Poland, UK) to support the eSafetyChallenge event in Vallelunga (Italy). The 2011 survey was on a much larger scale but has provided comparable data with a focus on personal ratings of car selection criteria and awareness of life-saving technologies.

Another surprise was that marked differences exist in awareness levels between systems and between countries. For instance, 68% of Spanish respondents are aware of the advanced emergency braking system, while in France awareness is lowest of all countries at only 38%. In the case of the most significant life-saving technology, ESC, 89% of those interviewed in Germany were aware of the technology although in the UK it was only 41%.

It also showed that the internet was the most used source of information when buying a new car, followed by car dealers. Interestingly, men search for information from dealers and the internet more often than women. Compared with male car buyers, women rely more often on advice from family and friends.

ESC, advanced emergency braking and adaptive headlight systems are equally important for men and women, while respondents who had been involved in a critical situation rate the importance of safety systems higher.

ESC helps avoid a crash by reducing the risk of skidding during a sudden emergency maneuver by stabilizing the car by braking individual wheels. Advanced emergency braking uses sensor technology to monitor the road ahead and will – if a potential collision is detected – warn the driver of the danger. If there is no reaction to the warning, the technologies activate the brakes together with systems such as seatbelt pretensioners to avoid an accident or mitigate the impact of a crash. ESC is set to become a legal requirement for newly introduced vehicles in November this year and all new car registrations from November 2014. Let's hope that, by then, public awareness levels will be such that car buyers at least have some idea of what they are getting!

> " It is welcome news that a recent survey reveals that when selecting a new vehicle, safety is the number one purchasing criterion
>
> **Adrian Walsh, director, Roadsafe, UK**

Direct approach to overloaded trucks

Discussions concerning the potential of weigh-in-motion (WIM) enforcement have been intensifying in recent months, as delegates at the 1st Brazilian International Seminar on Weigh-in-Motion held in April can testify. Yet the Czechs are not just talking about it, they're doing it – and were the first to officially introduce automatic high-speed WIM enforcement policies.

When it became clear that the much-debated policies were going to be made lawful, Cross of the Czech Republic responded by ramping up the development and certification of its technology. As of January 6, 2011, the company has a certified automatic enforcement site, fully compliant with the new legislation. Naturally the company hopes this means it is also in a prime position to enter new territories as soon as other countries develop their own equivalent legislation.

Although achieving this 'first' is good news, particularly in terms of preventing overloaded vehicles from participating in the transport network, Cross sounds a warning that WIM still has shortcomings that need to be overcome, which are areas the company is looking at resolving.

As new projects kick off, authorities will install high-speed WIM enforcement sites at various locations they deem suitable – on highways, at entrances to cities and other places where overweight vehicles are expected and where there is a need to minimize their impact on the road network. Unfortunately, it is also expected that truck drivers will soon learn of these locations and attempt to avoid them or use dubious 'tricks' to prevent an accurate measurement from

ⓘ Need to know?

Solving the technical issues related to the growing deployments of WIM systems across the world

> High precision weigh-in-motion systems for vehicle weighing based on inductive loops and quartz crystal sensor technology
> Consists of double loops and weight sensors for each monitored lane, and camera-based ALPR
> High precision output for multi-lane free-flow, unique 'validity of measurement' parameter as well as customizable vehicle classification

(Above) **Raw data is processed and evaluated in a computer using advanced Cross algorithms** (Left) **Showing the vehicle detail via the CrossWIM system**

being taken. Such tricks – including sudden turning, heavy braking or accelerating, and changing lanes – could invalidate the data obtained by current comparative measurement methods.

Measurement accuracy

With this in mind, ongoing technical development is crucial. Cross believes that WIM measurement accuracy can be drastically improved through the use of what it calls a validity of measurement parameter,

a procedure embedded in the CrossWIM system that's used to identify non-standard (and likely dangerous) driving behavior and to indicate the measurement success. Facilitated by speed and vehicle height enforcement along with a very precise vehicle categorization function, the validity of measurement gets the system extremely close to full multi-lane and free-flow traffic functionality.

Although speed and height enforcement are off-the-shelf technologies, the vehicle categorization engine was custom-developed for the CrossWIM system. Based on three independent inputs, it detects more than 100 vehicle types, the aim being to produce the broadest pool of categories to satisfy the many potential interests of the traffic engineer. This could even be taken further

and used to establish a unique identifier for individual vehicles or same vehicle types.

Cross believes there is no other remote and non-intrusive detection system available today that provides as precise and detailed information as CrossWIM, best demonstrated by the unprecedented weight measurement standards the company has set itself. As this particular WIM technology evolves, a whole realm of exciting possibilities will be opened up, all pointing toward the development of an ever-more accurate, reliable and detailed picture of the traffic. ○

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ANPR ENGINE

The systems that work use Neural Labs ANPR technology

Deployed for detection and protection

The transport industry, public road operators and enforcement agencies have come to realize that the best way to reduce truck overloading and its negative effects is to consider the transport chain as a whole. Currently, the liability and responsibility lies solely on the transport operator or the driver. With a new approach, the responsibility will be shared among all protagonists in the transport chain, i.e. consigners (dispatchers), shippers, loaders, container handlers and consignees (receivers). This is still far from common practice in Europe, although a number of initiatives have been started along these lines in recent years.

An essential element in all the initiatives is a quick and accurate weight measurement that is accepted by all stakeholders. For this, weigh-in-motion (WIM) is key. One of the initiatives in the transport industry involves the use of WIM systems in transport terminals, for example at a container terminal in a harbor or a railway loading station. Such terminals are, in fact, the ideal location to implement WIM, as the same system can be used by different stakeholders for their own specific purpose, and various partners can cooperate to reduce the problems resulting from overloading.

Use cases

During a recent port project in the Mediterranean area, Kistler installed a number of WIM systems with Lineas sensors at each entrance and exit to the port. Trucks entering the area are identified by a 'check-in' system and weighed dynamically by the WIM system. The weight and other

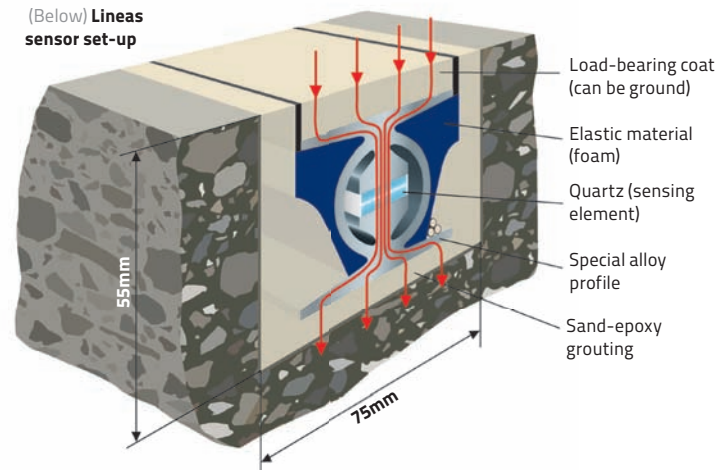**Ports are reaping the benefits of WIM sensing**

Need to know?

Smart deployment of WIM can prevent overloaded trucks even making it to public highways, as well as sharing responsibilities

> The Lineas quartz-based sensor technology at the heart of quick and accurate truck weight monitoring
> Covers all speeds from walking pace to highway speeds
> Maintenance-free and very safe, as it's secured in the road without frames and screws
> Overload detection applications include pre-selection, weight enforcement and bridge and construction protection
> Use cases include port, customs and road authorities

(Below) **Lineas sensor set-up**

Load-bearing coat (can be ground)

Elastic material (foam)

Quartz (sensing element)

Special alloy profile

Sand-epoxy grouting

55mm

75mm

relevant information is forwarded automatically to the port authority, and is then compared with the loading documents to check whether the weight declared corresponds with the weight measured. As most fees are also based on the weight, it is essential for the authorities to have a system that allows for verification of the declared weight.

Multipurpose equipment

The same system can be used by customs for a different purpose. Again, the real weight of a container – measured by the WIM system – is compared with the declared weight on the loading documents. When an overload is detected, this indicates that the container may violate other regulations. The suspicious containers in
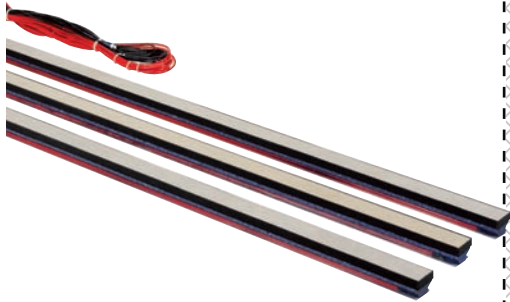
Kistler's sensor is increasingly popular for WIM applications across the world

question can therefore be inspected more thoroughly.

WIM can also be used by the road authority to monitor all trucks leaving the port area with a 'check-out' system. In case an overloaded truck is detected, access to the road network can be refused. The overloading problem can therefore be solved before it reaches the public roads. Sometimes it's only a question of selecting the appropriate type of truck for transport, such as using a tractor with an additional axle for the semi-trailer combination.

WIM offers a quick and accurate measurement of the actual weights of the trucks and cargos both when entering and leaving the facility. As it may be installed in a normal road and operates at traffic speed, it causes no disruption to the logistics process, i.e. no queuing to be weighed, which is especially important in this field where time literally is money. Kistler's Lineas sensors are highly stable and accurate as a result of the use of quartz sensor technology. The design enables a quick installation, typically within a few hours. Finally, the Lineas sensors are based on a proven technology that has been in operation for more than 10 years and is currently used in a wide range of applications worldwide. ○

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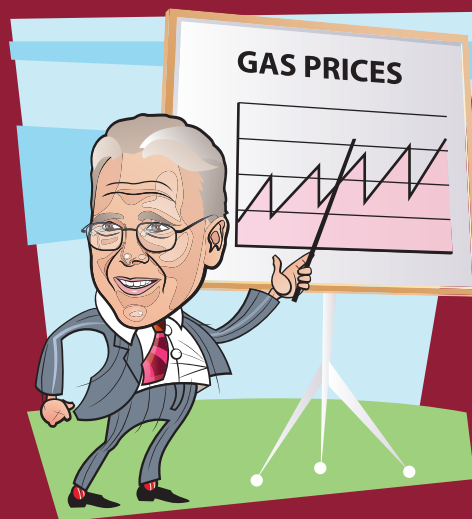
bg@berngrush.com

By now you know that prices for carbon-based fuels will continue to go up more frequently and more aggressively than they will be coming down. You already appreciate that this makes the extraction of costlier and dirtier carbon fuels more likely – fuels such as oil from tar sands, coal, and natural gas from fracking. Likely you also appreciate that as these fuels can only increase in cost, work on alternative vehicles and fuels has become more attractive for innovators and investors.

This means there are two competing ways out of the corner into which we are painted. One will impose changes in modal choices and on how and where we build and live; the other on the kinds of cars we drive and energy we use. Hence we will soon arrive at a societal decision point that I am arbitrarily targeting for 2020, alluding to useful puns on 'good vision' and 'hindsight'. This is also far enough away that my predictions will be forgotten, giving me some freedom from fear of retribution for my heresy.

I propose that we think about this 2020 decision point as a fork in the road called 'cars-as-we-now-know-them'. I propose that at this fork we have two fundamental choices. Toward the right, we have the 'New Automobility' – alternate forms of energy for mobility. Regardless of whether this is biofuels, electricity, compressed air or fuel cells, motive force will increasingly originate from renewables such as solar, wind and a dozen other ways to trap the sun. This route will make cars, energy, and mobility greener, cheaper and more plentiful. We will have more cars and generate more VMT. Congestion will threaten every last spare minute, and we will have a devil of a problem to fund infrastructure. The more of us that take the Right branch, the greater our societal evolution – and the more we will need road pricing.

Toward the Left, we have the "New Modalities"– we will change our modal mix to tons more of carpooling, vanpooling, transit, biking, walking, telework and moving toward the center of dense cities. This route means changes in transit and urban livability and in health, settlement density and planning. The more of us that take the Left branch, the greater our societal revolution – and the more we will need road pricing.

I have traveled both branches in my thinking over the past nine years, first the Left, then the Right. That is in the permanent record. Good people line both branches. We will not make uniform choices, but perhaps we can make informed ones. The question now is: "which approach will dominate the final numbers?"

Will we turn 50% toward New Modalities and 50% toward New Automobility? Or will it be 10:1 in favor of one or the other? The evidence, I argue is in favor of the New Automobility – simply because it is the path of least resistance. Rather than moralize, just look at the mathematical imperatives of entitlement, habit, culture, innovation, investment, desire, fear and inertia. To set these aside in favor of pure and correct systems thinking makes us worse than blinkered.

We need to explore both branches of the fork. At least as we start making these choices in the coming years, someone will have thought about their consequences. In the end, thoughtful solutions are all that can win the future back for us (or not).

❝ There are two competing ways out of the corner into which we are painted. One will impose changes in modal choices; the other on the kinds of cars we drive

Bern Grush, principal, Bern Grush Associates, Canada

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Jenoptik scoops US$28.5 million Saudi Arabia contract

READER ENQUIRY NO. 508

Saudi Arabia officially has the worst traffic safety record in the world – that's according to a recent report issued by the World Health Organization (WHO), which states that 49 out of 100,000 people are killed in road accidents in the Arab state every year, equating to around 6,500 people. The one common denominator among the 486,000 reported accidents throughout the Kingdom is speed.

In a bid to reverse the trend, authorities are employing a wide range of measures, focusing not just on driver education and better – and safer – traffic infrastructure, but also engineering advancements including enforcement. One of the companies enjoying success in the region is the German optoelectronics expert, Jenoptik Group, which recently announced its Traffic Solutions division has received a major order for systems and equipment for traffic monitoring from Dallah Trans Arabia,

located in Jeddah. Jenoptik will supply several hundred stationary systems for monitoring red light and speed violations. The total equipment order is worth in excess of €20 million (US$28.5 million) and will be delivered and installed through this year and 2012. A key component of the systems ordered is the 3D Tracking Radar Sensor, a recent development for the company. The non-invasive sensors can simultaneously monitor several lanes of traffic for speed and red light violations. The ultra-precise lane assignment offers optimum analysis speeds and indisputable evidence for the operator or public sector client.

During the competitive tender for this major project, Jenoptik benefited from its position in the Middle East region and won out over numerous competitors. About 100 systems for mobile and stationary speed monitoring, as well as a comprehensive software support system have been in use in Saudi Arabia since 2010. Jenoptik is already supplying equipment for the Saudi Arabian ATVAM project (Automated Traffic Violations Administering and Monitoring), which is widely considered to be the largest and technically most ambitious single project ever in the history of traffic law enforcement worldwide. Over the next few years, the project aims to substantially reduce the number of KSIs in Saudi's roads.

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TRL expands its traffic solutions with STREAMS

READER ENQUIRY NO. 509

TRL Software has built a reputation for the software and traffic control products that it researches, develops, and sells globally. But the company also resells best-of-breed applications that are considered complementary, including HDM4 from the HDM Global Consortium, IMTRAC from IRC, and CarShare Online from CarShare Online Limited.


The latest addition to this list is STREAMS, with TRL recently signing an agreement to resell the product from Transmax; TRL is the first STREAMS reseller to be signed up.

The product is an integrated ITS that includes: motorway management including ramp metering and lane use management; tunnel management; incident and event management; real-time passenger information; driver information including parking guidance; business intelligence; and ancillary system interfaces.

"This is a fantastic chance for TRL to expand its role in delivering intelligent traffic

management systems to its customers," enthused Gavin Jackman, TRL's head of Traffic and Software. "STREAMS has proven itself through its deployments in Brisbane, Melbourne, Adelaide, and other Australian cities.

"When we were looking for new technologies and through its recent software successes in Australia, STREAMS was often mentioned. From what we have seen to date – and the quick relationship we have built with Transmax – we know this is a partnership that can go far."
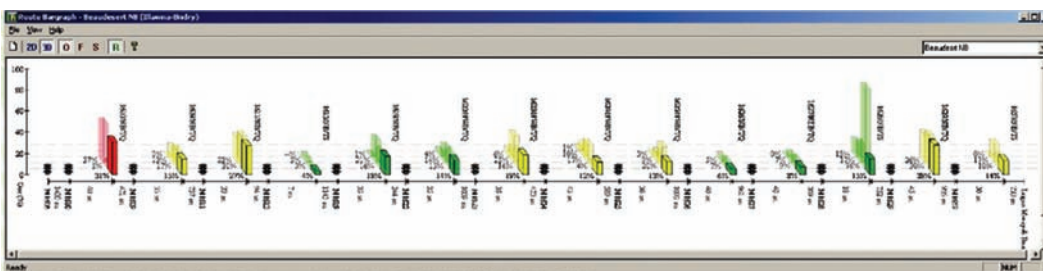
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Burning Question ?

? How can technology – be it surveillance-based, analytical or even communications – help us better manage incidents?

A "As networks become more congested, timely detection of incidents (including stopped or reversing vehicles, unauthorized pedestrians, or even dangerous tailgating) on our roads is vital in order to take appropriate action quickly. Only with early and reliable information can appropriate steps be taken to avoid the escalation of an otherwise minor incident into wider network disruption, with the associated costs. Of course for any deployed system, detection and false alarm rates should be maintained under all operating conditions to a level that ensures operators continue to treat detected events seriously. Equally, wide-area sensor coverage, minimizing the installed roadside equipment, will help to keep a lid on the capital expenditure and operating costs – both of which are always key concerns in the economic climate nowadays."

Dr Stephen Clark
business development director, Navtech Radar, UK

A "Maximizing the road use under all conditions has benefits for many reasons: maximizing owners' revenues for toll roads and improving national productivity with reduced journey times and reduced travel stress to name just a few. Maximizing road use means managing road use. Managing roads means knowing what is going on and having the means to control it. This is where technology comes in. A lot of the day-to-day road management can be automated and the most valuable tool providing live information regarding the situation on the highway is CCTV. This surveillance plays a key role in incident detection, incident management, vehicle tracking, traffic flow management, highway lane control, emergency management, input for driver information systems, and security service applications. When a road is blocked due to an incident and traffic comes to a standstill, incident detection and management takes precedence as the only timely alternative to CCTV is to investigate the situation using helicopter surveillance. Preemptive action using CCTV allows for assessing, controlling and preventing incidents. CCTV can help detecting criteria leading up to an incident – such as bad weather, congestion or breakdowns – and then taking appropriate action can reduce the probability of such events occurring. CCTV is also invaluable in the management of any incidents that cannot be prevented."

Dr Alan Hayes
managing director, AMG Systems, UK

A "Classical ways of signaling incidents on the road to officials consist of phone calls and video monitoring. Today it is mandatory to implement fire detection systems for public buildings, so why can't we do the same on our roads ? Neavia has been developing smart devices in order to prevent or warn about accidents by detecting dangerous or abnormal situations, such as sudden congestion or wrong-way drivers – and of course, collisions. Our solutions are based on totally wireless technologies. In addition to managing traffic data on up to six-lane roads, they can easily be installed where they can be relevant for the most; that is to say, on very winding or less-frequented roads, where no power or telecom wiring possibilities are available. Who has never felt unsafe while driving alone on a mountain road during a low-visibility night? Very low error rates in events detection enable the systems to do without human operators and they inform the emergency assistance and drivers in real-time by using the GPRS/HSPA network. This prevents an incident becoming an accident and speeds up rescue operations. Let's make these benefits more visible!"

Jean-Hubert Wilbrod
president, Neavia Technologies, France

A "Technology has helped us improve the management of incidents – but are we putting enough focus on user notification tools to prevent incidents? For example, drivers in foggy conditions drive faster than drivers in normal weather conditions due to the perception of speed. Incidents that occur in the fog usually involve higher speeds and rear-end collisions. The integration of technologies and the datasets behind the technologies is critical to manage incidents better, efficiently operate the transportation system and notify travelers. Wireless device applications currently exist that inform drivers of traffic conditions via a map or a text message. The integration of existing datasets (i.e. traffic, weather, and voice) could allow for drivers to be notified in advance when approaching severe weather conditions, incidents, special events, etc, via a phone call to their wireless device. We could be told, 'Fog warning! Roadway closed one mile ahead: be prepared to stop'."

Michael Morris
director of transportation,
North Central Texas Council of Governments USA

Readers are invited to answer the Burning Question for the August/September 2011 issue:

With less funding available for new schemes and fewer deployments than ever of spot-speed systems, is there a future for speed enforcement?

email answers to:
l.smyth@ukipme.com

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