traffic
TECHNOLOGY INTERNATIONAL

June/July 2013

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Features on AET coming to the Golden Gate Bridge, what the cloud could do for you, Tauern Tunnel, vulnerable road users – and much more!

The joy of six
ITSA's Best of ITS winners on the secrets of their success

Emergency measures
The safety benefits of improved traffic incident management

Give Death the day off!

Low cost, huge impact: 10 of the most effective remedial crash countermeasures you can deploy

PLUS

Weighing power
Why cross-border challenges could delay a direct enforcement strategy in truck overloading

Claes Tingvall, Vägverket
"No one has the right to play God or trade off life, so we had to set the number at zero"

A cure to the KSI epidemic
The World Health Organization's Dr Margie Peden charts the progress of the UN's Decade of Action

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Answers for infrastructure and cities.

Photograph courtesy of Texas A&M Transportation Institute

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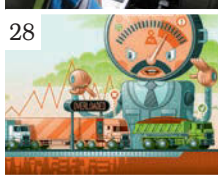
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Foreword

Developing ideas for covers and seeing them through to fruition is an especially enjoyable part of my job. In the consumer market 80% of a magazine's sales are determined by what's on the cover so it's crucial, given that, on average, people spend only three to five seconds scanning the front before deciding whether or not to part with their cash. Of course it's different with the trade press and controlled circulations.

With publications such as *Traffic Technology International*, sent out free of charge to subscribers, a cover that's done well should entice you to pick up the magazine and delve inside. When it lands on your desk or doorstep, it should stand out from the oh-so-appealing menus for every takeout within a 500-mile radius, offers for double-glazed windows and those annoying leaflets from companies that can smelt your gran's gold necklace (hopefully after she's removed said trinket). Standing out from any other titles you may also subscribe to is a prerequisite!

In the case of this June/July 2013 edition, the cover line, *Give Death the day off*, came first and sums up the theme running through the entire issue – reducing traffic fatalities and injuries on our roads. That we've illustrated this very serious subject with a not-so-serious and quirky illustration is not intended to make light of the matter at all. It's to urge you to investigate further. So whether it's weigh-in-motion technologies being used as a direct enforcement tool to keep dangerously overloaded trucks off the highways (page 28) or strategies to optimize traffic incident management (page 14), one way or another pretty much all the articles have a safety slant.

This edition also marks my seven-year anniversary in this hotseat, yet I recall as if it were yesterday my shock that, at the time I took over as editor, more than 44,000 people were dying in traffic-related crashes in the USA each year, with a similar number suffering the same fate in the EU. In all, 1.3 million traffic fatalities around the world. Progress in the developed nations since has been remarkable and while the figures may have been skewed recently by reduced VMT, aside from the odd blip they're generally on a downward trajectory.

There's a long way to go before we reach anywhere near zero – the subject of our interview with Mr Vision Zero himself, Sweden's Claes Tingvall, who, back in 2008, was my inspiration for *Traffic Technology International*'s sister publication about automotive safety R&D. Unsurprisingly, Sweden is closest to achieving his Vision Zero.

The World Health Organization's Dr Margie Peden tells us exactly what progress we are making toward the goal of the UN's Decade of Action for Road Safety (page 36) – to reduce road deaths by 50% by 2020. The picture, she tells us, is improving for vehicle occupants, but KSIs among vulnerable road users remain a concern (page 22).

And the Grim Reaper makes another fleeting appearance in our cover story on page 40, featuring 10 budget-friendly crash countermeasures. They're not magic wands for all scenarios, but they're cost-effective and proven in reducing KSIs. And in some accident blackspots, they've packed Death off for more than just the day. I hope you enjoy the read – it's a positive take on a negative subject!

Nick Bradley, Editor-in-chief

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SEEING IS BELIEVING

Cloud control

Cloud computing offers transportation authorities autonomy, mobility, decision support and a standard development environment for traffic management strategies, but as **Izzy Kington** discovers, it's not a cover-all solution

Cloud (jargon) busting

Infrastructure as a Service (IaaS): Users rent remote computer resources on demand, with the freedom to configure them as they wish.

Platform as a Service (PaaS): The remote computer resources are pre-configured with software, on which engineers can build, test and run their own applications, with no need for proprietary servers or operating systems.

Software as a Service (SaaS): Users pay for use of software rather than the platform or raw computer resources. Technical support may also be available.

The term 'cloud computing' is itself a little opaque. Broadly, it is the use of third-party remote internet servers to store and access software applications and/or data. By way of example, Gmail and Netflix are cloud-based applications familiar to many.

Nikola Ivanov, program manager at the University of Maryland's Center for Advanced Transportation Technology Laboratory (CATT Lab), says the main attraction of using cloud computing in traffic management is that it can save a lot of money on infrastructure (servers, networks, power and cooling), not to mention IT staff and maintenance: "DOTs can invest a much smaller amount and focus resources on actual traffic management and decision making," he explains. "Depending on the degree of immersion, users are able to focus on business logic and leave IT provision, management and maintenance to the cloud operator."

Josh Johnson, responsible for ITS at Southwest Research Institute (SwRI), adds that DOTs also save through scalability, as it is easy to add extra computing power on the cloud, in response to fluctuations in use. "A DOT can save money when it doesn't have to invest in the computing power to handle a maximum load, expected to only occur once or twice in a given year," he says."That capacity will mostly go unused for the remainder of the time, at significant expense."

Johnson adds that the lower investment in infrastructure makes it easier for DOTs to transition between vendors if necessary.

A further advantage is that users of cloud computing can access software applications and/or data from any computer connected to the internet, at any time. As Johnson points out, this could be particularly useful when a transportation emergency happens outside traditional work hours.

Natural fits

One of the first uses of cloud computing in the industry was for traveler information systems. "They are an ideal fit," says Johnson. "The data is not private, in fact the goal is to disseminate it directly to the public. Plus traveler information websites and interactive voice response systems, such as the USA's 511 services, are prone to bursts in usage during unusual weather events. The scalability of the cloud makes it perfect to handle this."

Another natural fit is data warehousing and research engines, such as the Regional Integrated Transportation Information System (RITIS) developed in 2003 by the CATT Lab, which is used by hundreds of US agencies to collect and analyze data. Ivanov says that for most users, RITIS represents a Software as a Service (SaaS) cloud: "Each agency is able to access all their data through analytical tools developed and provided by the CATT Lab. RITIS relies on virtualization and resource sharing to provide an affordable, reliable and secure data fusion solution."

> "DOTs can invest a much smaller amount and focus resources on actual traffic management and decision making"
>
> *Nikola Ivanov, CATT Lab, USA*

Virginia DOT awarded Serco a six-year contract worth **US$355m** to run its transportation operations centers and cloud-based ATMS

(Left) **One major advantage of the cloud is that it can negate the need for costly in-house servers** (Below) **FDOT uses cloud computing for a number of applications to help manage its busy road network**

But it has taken a little time for DOTs to embrace the concept. "Agencies often prefer to have a product that they can touch and feel, rather than a service that is outside their direct control – when in reality it makes no difference where the service is hosted," says Ivanov. "But as RITIS grew, DOTs became more accustomed to the concept of funding a service in the cloud rather than a product that would sit in their own data center."

Cloud computing is also used for third-party ITS data feeds, particularly in rural areas that might otherwise be neglected. The cloud harvests ITS data automatically and inputs it into the DOT's software.

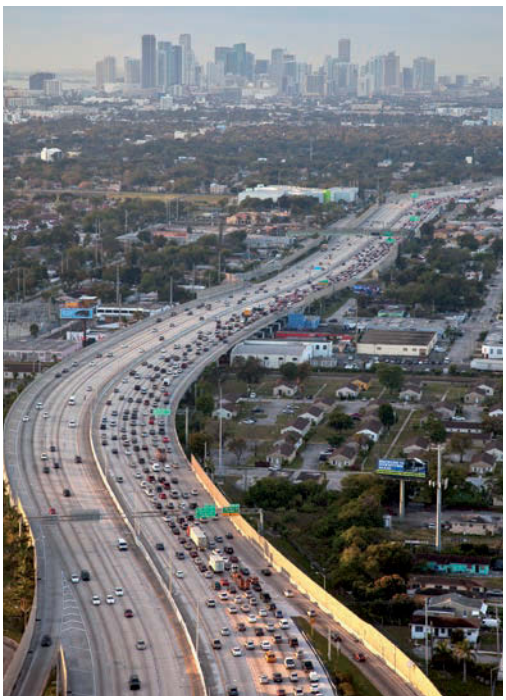
Shining example

One agency that currently uses cloud computing is Florida DOT (FDOT), for its centralized 511 traveler information system and data warehousing. In conjunction with Atkins (which manages and supports the state's SunGuide ATMS software) and SwRI, FDOT is considering using the cloud to also host its ATMS solution.

It is thought hosting SunGuide in the cloud would enable or ease certain functionalities. Atkins envisages it being especially useful for developing and testing software and configurations; operator training and demonstrations; software disaster recovery; and database and configuration back-up.

However, SwRI's Johnson explains why such an implementation requires careful planning: "Data hubs and traveler information systems are 'stateless' applications, and as such are an ideal fit for the cloud – a stateless service doesn't need to be consistently aware of the actions a user is making," he says. "In an ATMS, because the cloud-based services and end-user application have to share information, the cloud services must track the state of pending actions and requests, making it a 'stateful' application.

"This constant exchange over the internet can introduce complexity and latency issues that could impact real-time operations. It also makes real-time fail-over and recovery difficult,



Photograph courtesy of FDOT

as important information resides in the memory of the cloud-hosted system, not necessarily in a file or database. Therefore, a stateful application such as an ATMS has to be carefully designed and optimized to work as a cloud service."

Cloud concerns

In the industry as a whole, perhaps one of the main barriers to the wider implementation of cloud computing is the fear that the security of sensitive information might be compromised. But CATT Lab's Ivanov believes most DOTs can meet their security requirements by careful consideration of the options, from a secure private cloud to slightly less secure shared cloud solutions: "Many agencies are quick to identify all of their data as sensitive, when in reality a very small subset of

Cloud systems supplier Virtustream is leading the USDOT's FMCSA Gateway Augmentation project and will also host the FMCSA database and website

China's transition

China's total investment into ITS has now increased to more than €500 million a year and the amount of transportation data generated through metro, buses, taxis and traffic cameras, among others, is tremendous. However, its existing IT environment lacks the ability for predictive and advanced data analysis to proactively manage different traffic and transportation scenarios.

That's why the Chinese government recently entered into an agreement with SAP for the provision of advanced software solutions from SAP for big data powered by the SAP HANA platform, cloud computing and mobile computing. This should help manage traffic in China's fast-growing urban areas over the coming decades. "Urbanization is one of the biggest challenges for China with more than 400 million people expected to be added to China's urban population by 2025," says Gerd Oswald, executive board member at SAP.

The company plans to closely collaborate with the China Ministry of Transport (MoT) and may bring together the comprehensive domain expertise for traffic, logistics and transportation of the MoT as well as cutting-edge research and technology for ITS.

Providing Florida's SunGuide to TMCs via the cloud could open up the software to a new set of users

Photograph courtesy of FDOT

transportation data is sensitive. DOTs have many choices, depending on their needs and budget."

Johnson also makes a distinction between the "true cloud" – where agencies don't know where data is stored, and resources are shared with other applications – and a dedicated hosting solution, where the provider dedicates hardware and data storage for use by one organization alone. "In the latter option, systems are firewalled and separated from other customers, and your data is the only information on the servers," he says. "This is more expensive, but if your data is highly sensitive, then the cloud may not be right for you."

David Chang, ITS program manager at Atkins, adds that security within the cloud-based data center is the responsibility of the cloud service provider: "Network security between the agency and the cloud would be handled either by encryption or by a permanent VPN tunnel between a segment of the cloud and the agency."

Other potential pitfalls with cloud computing are reliability as a result of its dependence on internet service (a risk that can be somewhat reduced by the use of redundant circuits); responsiveness, particularly when large data packets are sent to and from applications not designed to run on the cloud; and the cost of moving 'big data', as vendors typically charge data usage fees. "RITIS addresses this by having a number of tools to visualize and present data without having to download all the granular data," says Johnson.

Suitable for some

Overall, Ivanov believes that cloud computing is an option for some, but not all: "Each DOT should carefully consider their needs, risk affinity and cost, and make an educated choice."

Likewise, Atkins' Chang clarifies that a cloud implementation of SunGuide would be most suitable for new deployments, rather than migrating existing ones: "Migrating from an existing data center would incur costs and may not be in the agencies' interests. However, the cloud will save money on new deployments because it enables resources to be shared."

Chang also thinks cloud computing will lead to the wider uptake of SunGuide. "FDOT would like to see more TMCs use SunGuide; however, in the past they have not been able to because of hardware and support costs," he says. "Providing SunGuide as a cloud service saves hardware, support and labor costs. Thus, we see it as a way to get SunGuide out to the arterials."

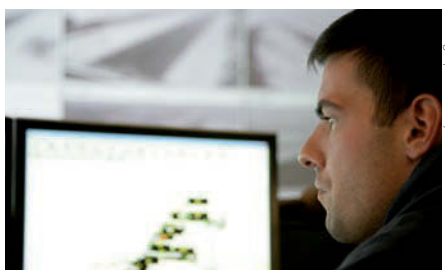
Johnson also sees cloud-based services as the future. "As the use of mobile applications grows, so will the supporting of cloud-based services for collecting, fusing and sharing data for these users. In addition, software service models work well and offer potential savings. If an application is a good fit, the cloud offers major opportunities for short- and long-term cost savings, in addition to other benefits for the ITS community."

> "Migrating from an existing data center would incur costs and may not be in the agencies' interests
>
> *David Chang, ITS program manager, Atkins, USA*

The cloud comes to traffic operations in Virginia

One agency that is transitioning its ATMS to a cloud computing solution right now is Virginia DOT (VDOT). It has just signed a contract with Serco (effective from 1 July 2013) for the statewide, 24/7/365 implementation of ATMS. After a transition period, Serco will operate the system for at least six years, all through a private cloud.

Murali Rao, chief information officer at VDOT, developed the architecture with an in-house team of engineers and IT architects. "Previously we had 11 contractors providing fragmented business and technology services and we were managing everything," he says. "We had two types of ATMS software in five locations. Now we will have one type of statewide software, with redundancy. The technology needs to be available 100% of the time. So we designed the solution with two identical data sectors,



Photograph courtesy of VDOT

geographically dispersed away from each other, in areas with different weather patterns, and with multiple redundant network lines."

This is not VDOT's first foray into cloud computing. Rao first used it in administrative and programmatic areas, which gave the agency the confidence to try it with some traffic operations (a 511 information system and a data gateway) about 18 months ago.

Rao says the agency initially explored cloud computing for two reasons – its ability to offer dynamic on-demand allocation of technology resources; and the relative ease with which costs can be calculated and managed. "There's no capital investment," he says. "It's down to how many servers and how much data and bandwidth you need, and for how long."

The main challenge has been ironing out security. "Fortunately we didn't have to worry about sensitive data; if the application was to do with personally identifiable information or critical infrastructure data I would not use cloud computing," says Rao. "However, sometimes you have to exchange data between systems inside and outside your firewall, through secure protocols, and that is the area that hackers try to exploit. So we had to take extra precautions to make sure that this data exchange is protected."

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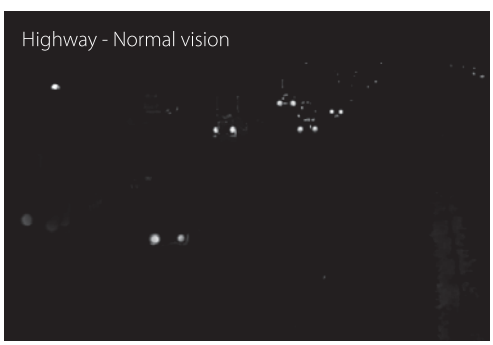

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Crawling in Frisco

Statistics on **San Francisco** in California paint a very congested picture, with only Los Angeles and Washington, DC ahead of it in the jam stakes. Not only that, rush-hour traffic in the area is projected to get much worse in the future

Infographic courtesy of Andrew Locke

The San Francisco County Transportation Authority (SFTA), created in 1989, is responsible for long-range transportation planning, analyzing, designing and funding improvements for the city's roadway and public transportation networks. The Authority's governing board consists of the 11 members of the San Francisco Board of Supervisors, sitting as commissioners of the Authority, with **John Avalos** as chair

Excess fuel consumption resulting from traffic jams burned an extra

25 million

gallons of gas, the sixth worst metropolitan region according to the 2012 Urban Mobility Report from the Texas Transportation Institute

In FY11/12, approximately 1.53 million parking citations issued by the San Francisco Municipal Transportation Agency generated

US$83m

The San Francisco 2010/2011 Collision Report from the SFMTA published last August reveals 844 non-fatal pedestrian injury collisions, 17 fatal pedestrian collisions, 630 non-fatal bicycle injury collisions, four fatal bicycle collisions, 3,111 non-fatal collisions in total and 28 fatalities

9,581

According to Department of Motor Vehicles (DMV) data, there are **9,581** vehicles registered per square mile

13,849

13,849 red light camera violations were issued in 2011 – just 25 intersections are covered by safety cameras

61 hours of delay a year

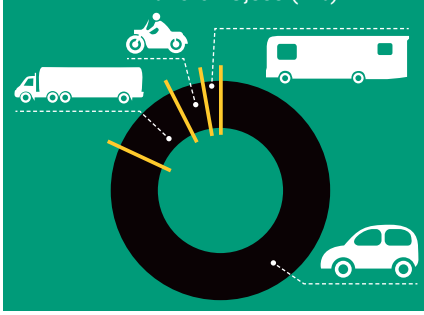
The 2012 Urban Mobility Report – which is based on 2011 data – ranks the San Francisco-Oakland region second alongside Los Angeles in terms of annual delay, with commuters enduring **61 hours of delay a year** (Washington, DC, with 67 hours of delay a year, led the pack)

Each commuter generates **503 lb** of CO_2 during their year of traveling to and from work

503 lb

Vehicle registrations as at December 31, 2011

Autos – **380,621** (82%)
Trucks – **56,407** (12%)
Motorcycles – **21,065** (5%)
Trailers – **8,355** (2%)



806,696

2011 American Community Survey (ACS) three-year estimates from the US Census Bureau put the San Francisco resident population at **806,696**, with a daytime population of 945,480

There are an estimated

7,200

intersections, of which **1,193** are signalized

Despite all the negatives, San Francisco-Oakland folks aren't letting their travel woes get them down – the region ranked 37th on the Commuter Stress Index

1,088

miles of roads in total, of which 59 are freeways (including ramps and freeway-to-freeway interchanges)

US$1,266

The yearly financial impact of congestion per commuter in the San Francisco-Oakland region is US$1,266, which ranks it fourth worst in the USA. Washington, DC, is the worst, at a cost of US$1,398

Human factor

The bridge garnered a lot of media coverage over the fact that moving to AET meant the loss of its toll collectors. There were various nostalgia pieces bewailing the loss of the human interaction that made the move seem a lot more controversial than it really was. Mary Currie says the actual response has been far more positive. "It's been more like a feeling of 'Were the collectors ever even here?' I was here when we did the conversion a little after midnight on March 28 and it was like a ghost town at that time. But then by morning commute it was like the collectors were never there – people were speeding through the plaza! We haven't heard anything from customers like, 'This was the biggest mistake' – it's been more like, 'I really love this because I don't have to stop!' The transition has been smoother and more accepted than we probably could have imagined."

Currie says it also helps that great care was taken to ensure this was not simply a case of technology replacing people. "I think we were able to make great inroads," she comments. "Of the 28 full-time collectors we had as we started building this program, all but nine were taken care of either by getting another job here or through retirement and separation. Only nine got severance packages. We took the sting out of it as best we could."

US$4m
will be spent to bring AET to the Tobin Memorial Bridge in Massachusetts. This covers the installation of a new toll bridge, demolition of the existing toll plaza and ETC software updates

> "The FasTrak market share has grown to over 80% already

Golden opportunity

Louise Smyth discovers how a combination of modern toll technology and an extensive outreach program has helped San Francisco's Golden Gate Bridge switch over smoothly to AET

Image courtesy of Golden Gate Bridge Highway & Transportation District

Mary Currie, the Golden Gate Bridge's public affairs director, has been rather busy of late. "With all the outreach we conducted, I did something like 457 interviews in three months," she reveals – outreach that contributed greatly to the bridge's transition to all-electronic tolling (AET) at the end of March. In fact, Currie describes the exercise as just as critical to a smooth transition as the AET technology itself. "We did everything we could think of doing in terms of traditional advertising, to a press conference on a different element of the program every 10 days so we stayed on air, to reaching out by email to community organizations, and public speaking, postering and more. We also installed a 27ft changeable message sign to instruct drivers to continue through the toll plaza. People were not that interested in the specifics of the technology – other than, 'What do I do and when do I have to do it?'"

To answer that question, the thing that quite a lot of people had to do was to get a FasTrak tag. Those without a tag had to open a license plate tolling account or use the one-time-only payment system. The bridge already had the FasTrak system up and running way before the move to AET, but as Currie reveals the uptake in new registrants was impressive. "We already had 70% of motorists using FasTrak during the morning commute, but we've seen the all-day average market share grow to over 80% already."

And it's this all-day figure that Currie says is relevant in terms of what AET can bring to the iconic bridge. "Because we already had FasTrak in place, we didn't have much delay at our toll plaza during peak times. So we weren't trying to address the peak times congestion per se, but rather trying to keep traffic flowing smoothly through the plaza at weekends, where we have many more visitors moving around the area.

"We have seen congestion relief at the plaza. However at the north and south ends of the bridge, there are choke points that can't be solved through the use of AET because you go from four lanes down to three. So there can still be delays in getting onto the bridge but once you're on, you move completely free flowing through the toll plaza and beyond – so in that regard it's working perfectly."

Teething problems

But the move to AET has not been without its hiccups – the most notable one being some confusion between 'free-flow' and 'free for all', as Currie details. "On day one people were just driving through the plaza like they were on the autobahn! So we had the California Highway Patrol come out and have an increased presence, and so the speeds have calmed down now."

The other hitch that Currie outlines has been "confusion" surrounding the carpool-only lane – confusion meaning that a lot of single occupant vehicles were using it. "That was a little trickier to tackle but we did follow up news stories saying that we're going to start enforcement and it's costly so you'd better stay out of that lane. We also recorded commercial vehicles that were using the lane that shouldn't have been and reached back out to them to remind them."

As Currie's mention of enforcement reveals, the move to AET has been staggered enough so people can get used to the new system before any enforcement is introduced. "We added an interim step in our toll processing, so now issue a toll invoice instead of a violation, so you're no longer a violator the minute you cross the plaza without paying." It's too early for Currie to have figures on how efficiently these invoices are being paid, but no doubt we'll receive a press release as the next wave of her outreach kicks in.

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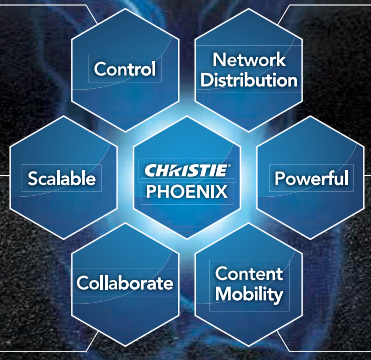

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Highway patrol

Various tools and strategies have been developed and implemented in an effort to improve overall traffic incident management. **Louise Smyth** speaks with some of the many stakeholders ensuring the very best first response

Illustration courtesy of Ian Dodds

Traffic incidents account for around 25% of all congestion in the USA. Figures from the USDOT actually show that for each minute a freeway travel lane is blocked during a peak travel period, an additional four minutes of delay occur following clearance of the incident. So as well as the vital safety factors to be considered in improving how we manage incidents, there are also clear economic and social benefits.

In addition to the deaths and serious injuries that befall the motorists involved in traffic incidents, there are some shocking statistics revealing how the people tasked with responding to those incidents risk their lives every time they attend a call-out.

So-called 'struck-by' incidents, where drivers collide with responders dealing with initial incidents – and in doing so cause a secondary incident – are increasing at an alarming rate. On average two emergency responders are struck every day in the USA. Around 20% of all firefighter deaths have nothing to do with firefighting – they're caused by vehicle-related incidents. Law enforcement personnel, highway workers and towing service personnel complete the line-up of those dicing with death just to do their jobs.

Task force

A rapidly growing group of safety-minded individuals are trying to change that situation for the better. Eric Rensel, who manages Gannett Fleming's Traffic Incident Management (TIM) Group, describes his job as two-pronged. "I focus on helping to solve issues that inhibit good, quick clearance of crashes at a practitioner level," he says. "And on a broader scale I'm trying to help set a national direction where we progress to take the next step in ensuring that people are safer on our roadways."

When asked whether all the relevant stakeholders fully appreciate how important TIM is, Rensel worryingly says he spends a lot of his time arguing the business case for TIM. "The DOTs have huge infrastructure programs – replacing bridges, fixing roadways,


POLICE
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implementing transit and so on. Incident management plays a crucial role in all of them but it's not seen everywhere as a core business function," he explains. "When it comes to elections, politicians can get re-elected based on a photo opportunity at a ribbon-cutting for a new bridge. But getting a crash cleared faster at 5pm on a Friday probably wouldn't help them in the polls, even though that's arguably just as important as opening that new bridge."

So aside from changing the image of incident management, what are the remaining hurdles to improving the situation on the roads? Technology, evidently, isn't a problem. "Technology evolves overnight!" Rensel exclaims. "And with the proliferation of Bluetooth devices and other kinds of non-infrastructure-based detection, the ability to understand the characteristics of flowing traffic is better than it ever has been. Having systems that can give you the information is one thing, but having a qualified workforce able to interpret the information and apply it to operational action is totally different."

> Technology is a great thing. It will continue to evolve but ultimately operations incident management is a people business and always will be
>
> **Eric Rensel, Traffic Incident Management Group, USA**

Program within a program

While believing that national standards for incident management are essential, Wisconsin DOT's **John Corbin** reveals how valuable it is to incorporate TIM into traffic management strategies from the ground up

Although John Corbin's day job is director of traffic operations for Wisconsin DOT, with responsibility for the entire statewide traffic operations program, he is also chair of the National Traffic Incident Management Coalition. That's what makes his experience in the rather acronym-heavy "establishing TIM within TSM&O"area so valuable.

Transportation Systems Management and Operations (TSM&O) is a "primary area of opportunities for improvement", Corbin tells us. "We can influence incidents. We can prevent some by making highways safer, but those we can't prevent we can plan for and be better prepared to respond to. By doing that we can better cater to the needs of victims. And secondary to that, we can limit the traffic impacts and ultimately the impact on the economy of the disruption to traffic flow."

According to Corbin, it took until the 1990s before TIM was truly given consideration within DOTs' everyday

TSM&O programs. "This was when the FHWA started to facilitate some understanding of best practices," he explains. What started to emerge is recognition that if you're going to be effective at managing incidents, you have to build a multidisciplinary partnership and an ongoing TIM program. In transportation we don't deal with incidents alone; in fact we're not even the primary player in the clearance of most incidents. The leadership on the scene is law enforcement interacting with fire and rescue – transportation and public works are often in a support function. So recognizing our context in a multidisciplinary team has been very important to TSM&O understanding of how to facilitate TIM."

Wisconsin is tackling TIM within TSM&O at a statewide level, which Corbin regards as key to success: "It's enabled us to be more efficient in our allocation of resources. However, the other thing that is vital and unique to Wisconsin is that our

> Organizationally we have a built-in merger between the state law enforcement and the state transportation function *John Corbin, WisDOT*

While lamenting the fact that transportation operations management is so low on the agenda in the academic world, Rensel also believes that not enough new blood is coming into the industry. "A large proportion of the current operations workforce is going to retire in the next 15 years. The baby-boom generation is aging and we're not taking the steps necessary to fill that void.

Power in the people

"Technology is a great thing and it will continue to evolve, but ultimately operations incident management is a people business and always will be. Even if we encapsulate the best technology in the world in a decision-support system, unless we understand how to use it to make intelligent decisions, it's simply wasted. Just because technology is progressing doesn't mean the understanding of it is. We need an educated, professional workforce."

Despite these hurdles, Rensel sees a wealth of opportunities, particularly when it comes to training. A shining light in this regard is Colonel Tracy Trott from the Tennessee Highway Patrol, who Rensel says is "currently leading the nation in terms of how law enforcement goes about training for incident management".

Trott oversaw Tennessee becoming a pilot state in the FHWA's Train-the-Trainer TIM program in 2011 and agrees with Rensel that it's through the personnel that real change can be effected. "We've had troopers killed at the side of the road at traffic incidents and a lot more injured by secondary crashes, so I looked at the safety factor and how I could train both our people and other disciplines,"

state patrol is actually part of the state DOT, so organizationally we have a built-in merger between the state law enforcement and the state transportation function."

But technology is also as important as good relationships. "We're working with the state patrol to deploy an automated vehicle resource location system that makes real-time information about the location of specific response resources available across multiple agencies," Corbin reveals. "This will enable scenarios such as control room operators being able to see how close a tow truck is to an incident, or staging fire trucks upstream of an incident so that they can be called onto the scene incrementally. It allows much more enhanced situational awareness."

(Far left) **Incidents such as crashes, spilled loads and stalled vehicles and the congestion caused by them account for approximately 25% of all delays on Wisconsin's highway system** (Above) **WisDOT's State TOC handles traffic management for the state and communicates regularly with sheriff, fire, police, and Wisconsin State Patrol to ensure smooth TIM**

(Far left) **Operational staff in the TMC work with partner agencies and emergency responders to manage incidents quickly and effectively** (Above) **A multi-agency approach to incident response will reduce clearance duration times and restore highway capacity back to free-flowing conditions**

> In addition to the economic, environmental and quality-of-life benefits of TIM, it just made sense to embrace it if it could help protect my people
>
> **Colonel Tracy Trott, Tennessee Highway Patrol, USA**

reveals Trott. "In addition to the economic, environmental and quality-of-life benefits of TIM, it just made sense to embrace it if it could help protect my people."

Following a successful pitch to Tennessee DOT, Trott has been given the go-ahead to build a completely realistic 800ft stretch of Interstate at the Tennessee Highway Patrol Academy. "It will go live at the end of the year and the idea is to open up our facility to emergency services, wrecker drivers, trucking companies, DOT workers – all the people who participate in incident management, with us as the guiding force."

With different barriers (Jersey, cable and guardrail), a staging area, an entrance ramp and more, the highway will comprise 400ft of a four-lane section and 400ft of a two-lane section. Traffic will continuously run around a loop to simulate real-life conditions. "We'll be able to set up all kinds of problems, from vehicles lying on barricades to those needing to be cut out of guardrails – and we'll learn how to station cars safely, what protects you best, and what gets you the best and quickest results in terms of getting these incidents cleared. And we'll be able to do all that with live traffic streaming past."

Compared with the current method of using model cars for training, Trott's new approach is revolutionary. "We'll be able to recreate hazardous spills and all the things that go into HAZMAT operations. We'll also be able to perform night-time training

Tech toolkit for TIM

An area of opportunity to improve TIM lies with interoperable communications, according to Eric Rensel. "In the USA, transportation operations are mostly performed by DOTs and the emergency management function is the remit of emergency management agencies. Those two functions are seldom combined, so the greatest technology improvements right now are being found with interoperability between systems and between agencies, with a continuing emphasis on communication types and availability.

"Legislation has 'deregulated' the 700MHz bandwidth, so that's something that first responders can get a hold of now – just being able to talk across agencies on the same radio is a big part of our progress. And if I'm sitting in my TMC and you're in your public safety access point or law enforcement dispatch center, the chances are we have some software that has a mapping interface that helps us understand where things are, and we should be able to see each other's information overlapped onto the same map to create a common operating picture. You'd think that would be the norm but it's just not."

So why is that the case? "It comes back to institutional issues with the sharing of information and the improvement of standards in software development. Even as recently as five years ago, a lot of the software was proprietary – tremendous costs, time and effort for integration. Today's standards for software and device development, and the improvements in the understanding of the links between them, are enabling the interoperability of the technologies needed to improve TIM even further."

sessions so that emergency personnel can experience the contrast in lighting conditions. We've probably not even scratched the surface yet in terms of what we'll be able to do."

Multi-agency collaboration

Other stakeholders in addition to highway patrol and DOTs are also becoming more involved in TIM. Doug Smith is a transportation planner at the Southwestern Pennsylvania Commission (SPC), the Metropolitan Planning Organization (MPO) that serves the 10-county Pittsburgh region. "A couple of years ago, the FHWA came to our region with a workshop – it had been looking at MPOs to step up and take the lead on some of the TIM stuff. The idea was for us to serve as a facilitator – to get all these levels of government and different agencies together at the table, which is something we excel in."

That FHWA workshop led to the creation of a list of action items, one of which was for the MPO to form a Regional TIM Steering Committee, which Smith and his colleagues did in August 2011. But this alone wasn't a gamechanger. "We can get together and talk but if it's only talk, it does nobody any good. So we decided to set up local TIM teams, picking much smaller geographic areas down to the grass roots, and get the first responders in those local teams to train together.

"Whenever there's a big incident we get everyone around the table to produce after action reviews. For instance, we recently had a water mains break that shut down a major arterial during the PM peak. So we got everyone together afterward to discuss what went well, what could be done better next time, what equipment we didn't have and so on. These local teams are where the benefit really is."

And where does Pennsylvania DOT fit into all of this? "They're one of the key stakeholders," Smith says. "They've participated in our local TIM teams and they're also participating in our Regional Steering Committee, which lobbies for policy change at the state level. We're trying to encourage better communication between the local first responders and our regional TMC, which is run by the DOT.

> "Any TIM strategy has to be something that's maintained and updated periodically"
>
> **Doug Smith, transportation planner, Southwestern Pennsylvania Commission, USA**

(Above left) **There were more than 158,000 motor vehicle crashes in Tennessee last year** (Top right) **With SPC's TIM workshops, improvements in interagency traffic incident management can be achieved due to better collaboration, cooperation, coordination and communication**

Smith also echoes Eric Rensel's emphasis on an educated, professional workforce. "In most of the cases here, we're dealing with volunteer fire companies – they're not paid fire departments – and there's a lot of turnover in these places," he says. "Six months after a training session, not all the people you trained will necessarily be there any more. So any TIM strategy has to be something that's maintained and updated periodically."

A measure of success

Someone else who's in favor of a constant brushing up on policies is Captain Jeff King, executive officer in the Highway Patrol Division of the Arizona Department of Public Safety, whose expertise is in introducing performance measures to TIM – something he believed the industry was crying out for. "Prior to my current role, I commanded our vehicular crimes unit,

so I was exposed to a lot of the bad events that happen when poor traffic incident management is out there, coupled with the secondary incidents caused by 'D Drivers'." For the uninitiated, D drivers are those who are drunk, drugged, drowsy, distracted, or just plain dumb – i.e. more likely than others to meander into the path of first responders.

So what exactly are these TIM performance measures? "We have to go back to the advent of electronic reporting," King comments. "Prior to that, when it was all done on paper, we had various disparate databases. But when we went electronic we incorporated everything. So now we record the occurrence time of the incident, the time the officer arrived, if there was a blockage in the lane – which is one of the added performance measures that we never collected before – and the time that the roadway was cleared."

King also added an 'incident clearance time' performance measure. "This is the time it takes until you're no longer creating a distraction on the mainline road. We changed our policy so officers are required to move minor crashes completely off the road to where they're not a distraction – not just onto the shoulder, but to the off-ramp and onto an arterial or parking lot – before they finish the paperwork."

All in the timing

It's remarkable this strategy isn't deployed more widely, especially given its success. "We never used to collect a lot of the data, so it's hard to know what our baseline for secondary incidents was. But we do know that since having performance measures, secondary collisions on the state and federal highways system in Arizona have been running at between 5% and 7% for the past two years – compared with the national average of 20%.

"Just moving to electronic forms and citations means our officers can save eight minutes per traffic stop," King says.

(Left) **Arizona's Highway Patrol officers make more than 500,000 traffic stops a year and respond to thousands of traffic collisions, requests for motorist assistance and other calls for service** (Bottom left) **Secondary crashes due to congestion caused by a previous traffic incident are estimated to represent 20% of all crashes, according to the FHWA**

> Just moving to electronic forms and citations means our officers can save eight minutes per traffic stop. We perform 500,000 stops a year so you can see how many minutes of risk of secondary accidents we're removing
>
> **Jeff King, executive officer, Highway Patrol Division, Arizona Department of Public Safety, USA**

"We perform 500,000 stops a year so you can see how many minutes of risk of secondary accidents we're removing.

"Traditionally we focused our TIM initiatives on the big wrecks, but those only happen two or three times a month, whereas focusing on all these little ones has a much larger impact. Around 97% of our crashes are property-only crashes – if we do 27,000 of those a year and can save 20 minutes on each one, it's a much larger impact than saving 20 minutes each on 300 fatal crashes."

King also points out that performance measures basically equate to daily, on-the-job training. If an officer is reminded that he needs to wear a reflective vest, to put out cones, etc, for every incident he attends – and then documents his operational process during every single incident – then safety measures become consistent and routine. "We're also finding great value in the debriefs we've started doing after incidents," he adds. "A lot of times you'll debrief a bit on the scene but you don't get everyone involved – the traffic operations center personnel are not involved and fire has typically left already. But we implemented a program where we pick one incident a week that's got some key factors, and with everyone's input we learn something new every time. It's invaluable."

Over the past few decades, the traffic management sector has achieved great things in terms of detecting incidents. But when it comes to actually dealing with them, it's clear that there's still a long way to go. But as the stories above illustrate, progress is undoubtedly being made. And with help from the people interviewed here and their associates, faster, more efficient incident management is coming to a road near you soon.

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Although real progress has been made toward improving road safety for vehicle occupants, considerable effort needs to go in to protecting vulnerable road users such as pedestrians, cyclists and motorcyclists. **Max Glaskin** investigates what's being done on the ground to reverse a worrying trend

Main image courtesy of Henrik Lehnerer

Usain Bolt aside, human beings are not built for speed. Our light, fragile frames can withstand most impacts with static objects at our running pace, but when our ancestors started traveling faster on horseback, some 5,500 years ago, our injury risk increased. Eventually the motor vehicle multiplied significantly the kinetic energies human bodies would have to absorb in road transport collisions. No wonder hundreds of thousands of vulnerable road users (VRUs) are killed or seriously injured every year.

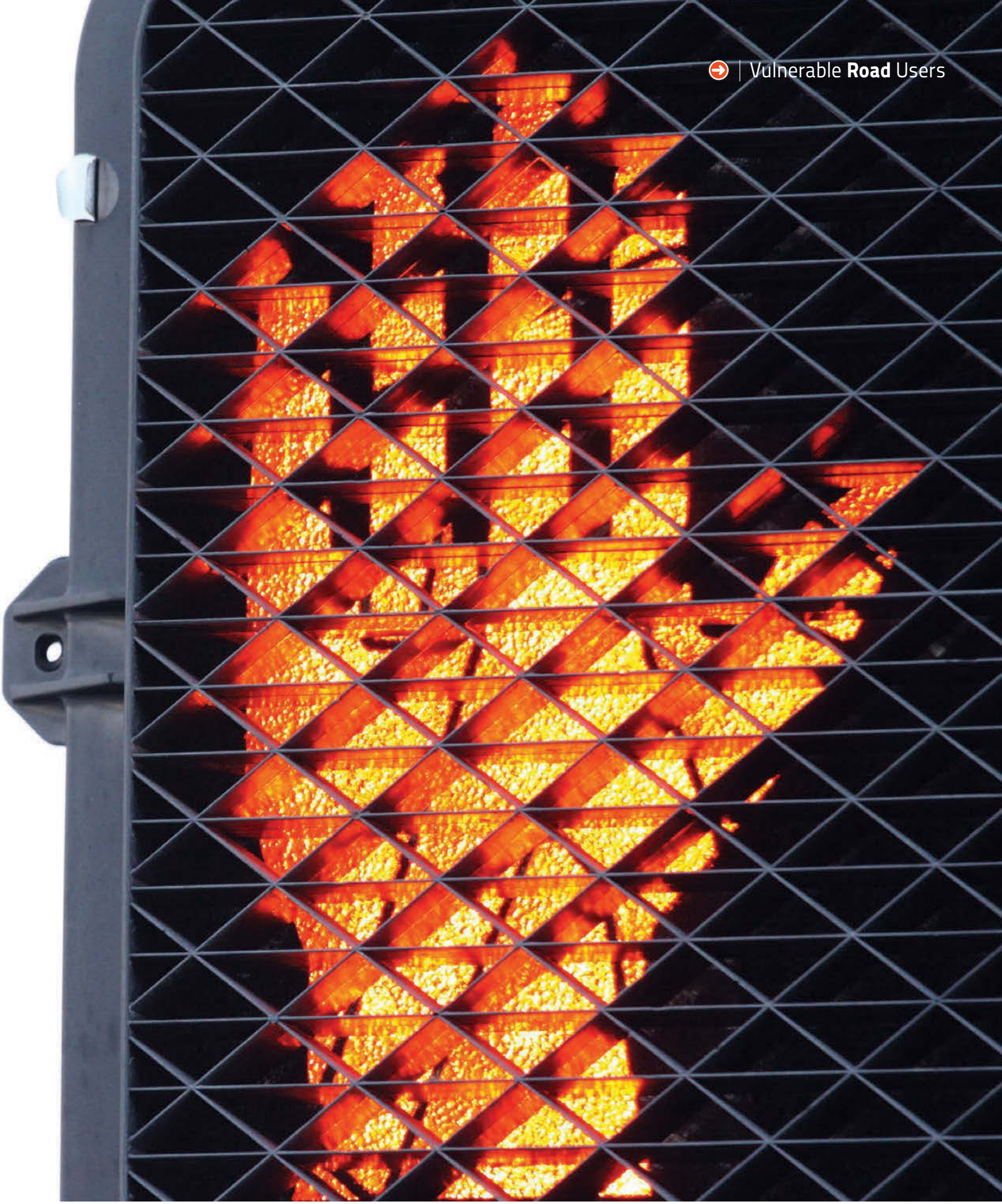
In fact, the World Health Organization (WHO) reports that 22% of all road traffic deaths per annum are pedestrians. That's 270,000 people killed each year, usually because they've been hit by a vehicle of far greater mass that's been traveling far faster, too. Considering that the early motor cars once had to be preceded by a VRU on foot carrying a red warning flag, clearly the pendulum of danger has swung too far the wrong way. The UN's Decade of Action for Road Safety is evidently a nod to that fact, hence why its global plan puts pedestrians and cyclists first.

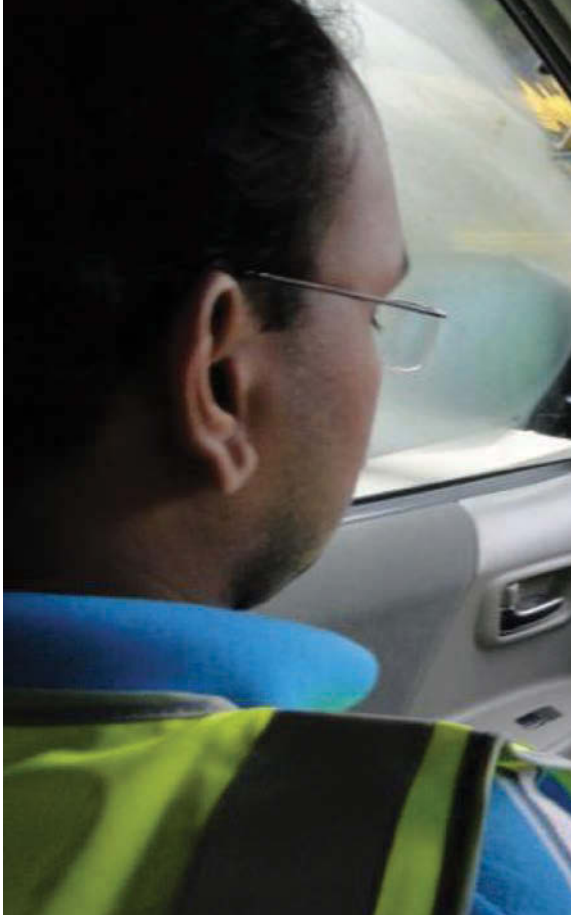
According to the World Health Organization, to reduce the number of road traffic injuries, the pace of legislative change and enforcement needs to be hastened, with more attention paid to vulnerable road users such as pedestrians, cyclists and motorcyclists

Starting points

The universal dimensions of time and space are crucial here. When all road users have more time and space to avoid each other, they have a better chance. The right technology and infrastructure can do this, but in the poorest countries, such as Liberia where 66% of road death victims are pedestrians, technological solutions can be too expensive – not just to install, but also to maintain. So the first step is to design roads with VRUs in mind.

"The needs of pedestrians have been neglected for decades, often in favor of motorized transport," believes Dr Etienne Krug, director for violence and injury prevention and disability at the WHO. "We need to rethink the way we organize our transport systems to make walking safe and save pedestrian lives."





Down to the planning?

Véronique Feypell de la Beaumelle from the International Transport Forum, the OECD's intergovernmental strategic think-tank, says that designing for pedestrians needs to be a full component of urban planning. It follows the OECD's mission to promote policies to improve the economic and social well-being of people around the world and, naturally, includes road safety.

"There's often very little consideration for pedestrian safety when new roads are built," says Feypell de la Beaumelle. "Two-lane highways are put between residential areas and schools, but it's not too

costly to include footways and safe crossing places, particularly at the outset. It's a matter of changing the mindset of planners."

But ignoring or forgetting pedestrians isn't just an issue in the low- and middle-income countries. "It's also a problem in high-income OECD countries, where traffic flow has been facilitated at the expense of pedestrians. In US cities, for example, many kilometers of parallel roads offer few cross-connections for pedestrians," Feypell de la Beaumelle says. "It has become highly challenging, especially for older people and children, to cope with the complex, sometimes hostile, traffic conditions that characterize today's cities and towns. It's possible to look back and say that it was one of the bad developments in planning in the 20th century."

An ITF working group of transport experts and urban planners from 19 countries has published a detailed report, *Pedestrian Safety, Urban Space and Health*, which includes 12 ways to make roads safer for pedestrians.

So the WHO has a shopping list of road features to increase VRU safety, with footpaths topping the bill. According to surveys from the International Road Assessment Programme (iRAP), in low- and middle-income countries, 84% of roads where pedestrians are present carry traffic at 25mph faster yet there are no footpaths. "Pedestrian footpaths can reduce the likelihood that people will be struck by vehicles while walking by as much as 40-60%," says John Dawson, iRAP chairman.

Installing footpaths with curbs isn't cost-free, but iRAP reckons it's justified because the high costs of crashes are then avoided. Adding them to 330 miles of road in Chile is expected to prevent 6,100 KSI collisions over 20 years, saving 28 times more than the cost of improvement. Installing 310 pedestrian crossings in Costa Rica should prevent 3,100 KSIs, recouping the cost 19-fold. Footpaths and crossings in Moldovan villages cut KSI risks by 40%.

The role of technology

Before improving infrastructure, technology can help. In Cape Town, video surveillance is used to reveal which permanent measures are likely to increase pedestrian safety. Similar studies of collision black spots in Mexico City have led to many design improvements, including shorter crossing distances, medians and island refuges and – as used already in many high-income countries – countdown signals that permit VRUs to judge whether they have adequate time to cross before traffic flows again.

Raised table crossings have been introduced in Abu Dhabi to slow traffic. Well-planned traffic calming, including the 'psychological' calming of Shared Space schemes, is also beneficial. Research from Toronto, Canada, published in *Injury Prevention* by the BMJ Group in May 2013, confirms that traffic calming was the only measure positively associated with reducing child pedestrian injury near playgrounds.

Living in denial

But it's not just low- and middle-income countries that have sacrificed the lives of thousands of VRUs through neglect. "Many countries, including some leading economies, are still in denial about the extent of their road safety problem," believes Lord

> We need to rethink the way we organize our transport systems to make walking safe and save pedestrian lives
>
> **Dr Etienne Krug, director, department of violence and injury prevention and disability, WHO**

Robertson of Port Ellen, chairman of the Commission for Global Road Safety. A 'quick fix' being rolled out across the UK is to reduce urban speed limits from 30mph to 20mph, with signage being key to advising drivers about the appropriate, safer speed – vehicle-activated signs even more so.

Lower speed limits in themselves aren't necessarily effective – they need to be enforced. Speed cameras can do this extremely successfully and red light cameras discourage drivers from ignoring traffic signals. Street CCTV, installed originally for crime prevention, can be seconded by spotting illegal parking that increases risks for VRUs.

Pedestrian-activated signaled crossings have become ubiquitous across western Europe because they stop the traffic safely. Those

equipped with pedestrian-detectors allow traffic to continue flowing when people are no longer waiting to cross. Brighter street lighting increases the visibility of VRUs at night.

Cooperative systems

In-vehicle technology is evolving to cut collisions with VRUs, but the next possible step is to link pedestrians and cyclists into the ITS network by equipping them with sensors, transceivers and alarms. Researchers from Chalmers University, Sweden, suggest that cooperative active safety systems could alert VRUs to incoming threats and advise them how best to stay safe.

Although most conflict between pedestrians and motorized vehicles happens when each strays into what's normally regarded as the other's space – the roadsides or the roadways – cyclists usually have to travel in the road, among the traffic. So they are currently viewed as particularly vulnerable – although perhaps the statistics exaggerate their risks relative to pedestrians. For example, levels of cyclist KSI crashes in the Netherlands have been rising, which is in contrast with the overall trend of increasing road safety.

But according to Malcolm Wardlaw of the Transport and Health Study Group, the analysis is wrong because the KSI data includes off-road cycling incidents, such as trail riding, and all single-bicycle falls. Yet sidewalk falls among pedestrians are excluded from highways statistics. The actual risks are clearer when the figures are corrected, says Wardlaw. "In the Netherlands, one-third of serious injuries on the roads are cyclists, and one-third pedestrians. However, 18% of time spent traveling is by bike, as opposed to 12% walking. Therefore in the Netherlands, the average risks of walking are higher than for cycling," he explains.

(Top) **An engineer using the Road Assessment Programme Inspection Device (RAPID) equipment and software from iRAP** (Above left) **SafeWalk from FLIR integrates stereovision technology and intelligent detection for pedestrian presence detection** (Above right) **Siemens' Heimdall aboveground pedestrian detection system** (Right) **The map shows the individual risk faced by a pedestrian traveling on the inspected road network in Chile**

Cycle path

Nevertheless, there's a lot to be done to make road cycling safer, as 2012 Tour de France winner Sir Bradley Wiggins and his then team coach Shane Sutton know – both cyclists were in collisions with vehicles on successive days, many miles apart. "In the low- and middle-income countries assessed, 85% of roads where bicyclists are present carry traffic at 25mph or more and have no bicycle facilities," notes iRAP's John

Dawson. Just as footways protect pedestrians, separated cycle paths can save lives. "Bicycle paths reduce the risk that bicyclists will be struck by fast-moving cars, trucks or buses, by physically separating travel lanes. Well-designed on-road bicycle lanes can reduce bicyclist crashes by 25-40%," Dawson emphasizes.

This has been shown in high-income countries, where cycling is being promoted to improve health and the environment. A new study in Iowa, USA, shows that simply painting a cycle lane on the road surface is more protective than mere signage, particularly at intersections. Research from this year in New Zealand shows that a raised divider and small bollards are even more effective at keeping bikes and traffic apart.

Intersections with traffic signals have attracted technological solutions because the minority of cyclists who jump red lights are conspicuous. Smart cameras can spot cyclists undetected by induction loops and so trigger a green signal. The Intersector micro-radar does likewise in Pleasanton, California, and Bournemouth in the UK.

Wet weather makes waiting cyclists even more impatient so the signals at junctions in Groningen in the Netherlands automatically give them a green signal more often when it's raining. Cyclists in Aalborg, Denmark, are paced to a junction by a sequence of LEDs embedded in the road so they arrive at the signal as it turns green.

Action speaks louder

VRUs have long been a neglected group when it comes to injury reduction, according to David Ward, director general of the FIA Foundation – a UK charity for the automobile and society that operates globally. "It's a group that warrants a lot of attention, but you have to tailor safety interventions for each country as the dynamics change all over the world."

The FIA Foundation helps by working with several influential global groups and is also a leading donor to the World Bank Global Road Safety Facility – a resource to help low- and middle-income countries. "We work with iRAP because it is doing a lot of work developing road safety ratings for vulnerable users," Ward says. "In the emerging economies, the total fleet sizes are doubling every decade and there is subsequent growth in road infrastructure that can cause problems for VRUs."

The campaign for global road safety, Make Roads Safe, has been coordinated by the FIA Foundation since 2006 and in 2009 it helped spur the First Global Ministerial Conference on Road Safety and approval by the UN for the Decade of Action for Road Safety 2011-20. "During the Decade of Action, we will continue to campaign to make sure politicians, institutions such as the World Bank, vehicle makers and transport planners put road safety first," Ward says. "We'll work to ensure the Decade is action."

> The response of bilateral donors, multilateral institutions, the private sector and large philanthropies has, with a few honorable exceptions, been miserably inadequate
>
> **Lord Robertson of Port Ellen, chairman, Commission for Global Road Safety**

(Left) **Dutch suburban and rural areas benefit from networks of safe and convenient cycle paths** (Below) **Geveko's LED-Mark lights being installed**

Intelligent agents

ITS company Geveko of Denmark uses its LED-Mark lights to increase the delineation between cycle lanes and the highway during the hours of darkness. The company has also developed road-embedded LEDs that sense approaching cyclists and then flash to alert drivers who are about to cross their paths.

Europe's initiative to use technology for increasing cycle safety, SafeCycle, considered 121 proposals. They include on-bike lights that project cycle lane symbols onto the road fore and aft, rear-view cameras linked to a screen on the handlebar to display vehicles approaching from behind, braking lights and a bicycle airbag. Researchers at Rutgers University, New Jersey, have been prototyping bike-mounted vehicle detectors using both video and audio analysis in real time.

Bicycles have always attracted a constant flow of homespun innovations and it's the same with cycling safety systems. Dutch engineers have linked smartphone satnav to a vibrating belt so cyclists are directed to their destinations without diverting their attention from traffic. Such solutions are relatively expensive and cyclists in low- and middle-income countries need more affordable protection, particularly as the number of motor vehicles increases. These countries need financial support to improve safety for all VRUs. "The response of bilateral donors, multilateral institutions, the private sector and large philanthropies has, with a few honorable exceptions, been miserably inadequate," concludes Lord Robertson. So will 270,000 VRUs continue to pay the price with their lives every year?

Direct approach

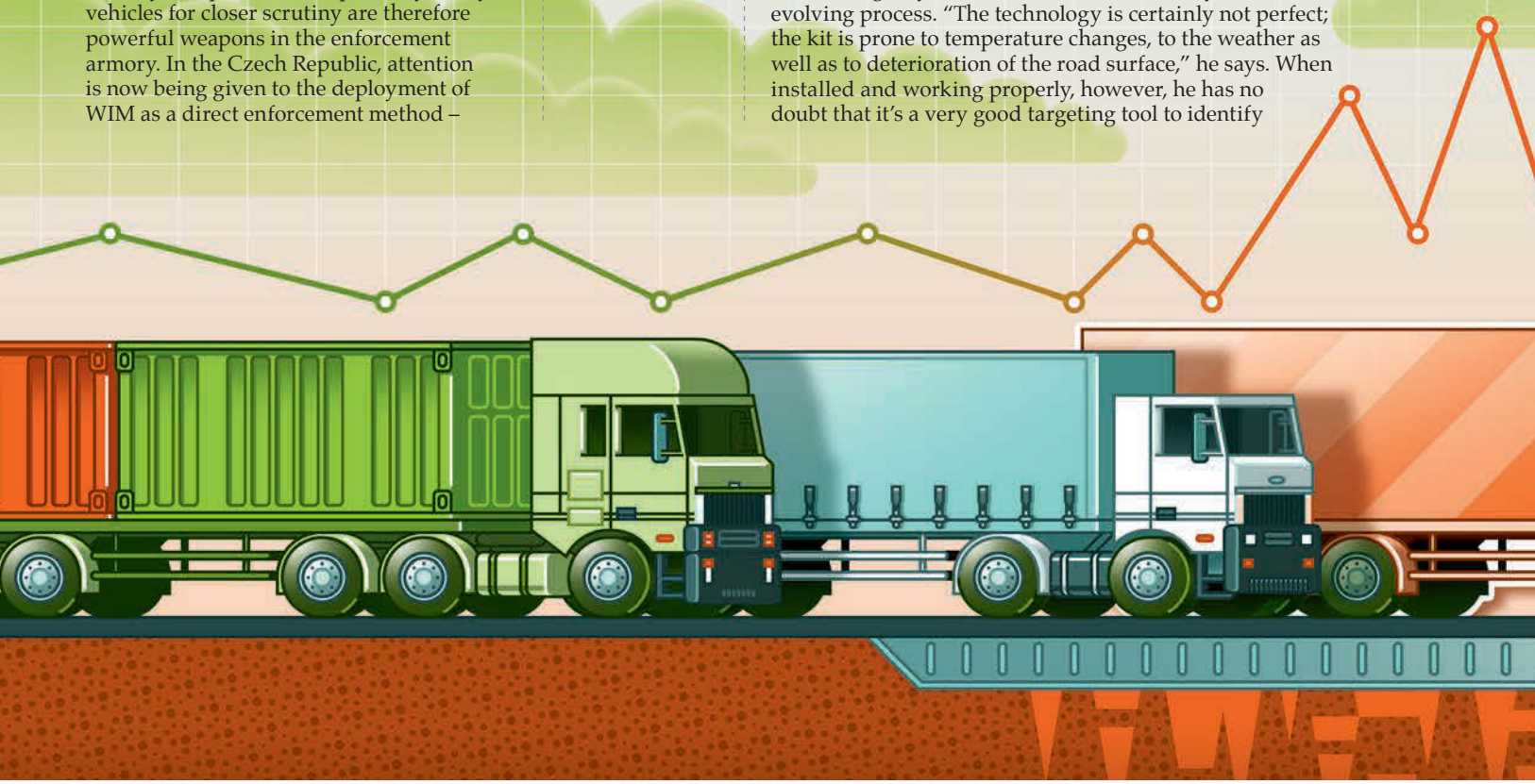
Weigh-in-motion technologies have been helping authorities keep dangerously overloaded trucks off our roads for years. **Timothy Compston** investigates whether a more direct enforcement approach might make sense for all stakeholders – and save lives at the same time

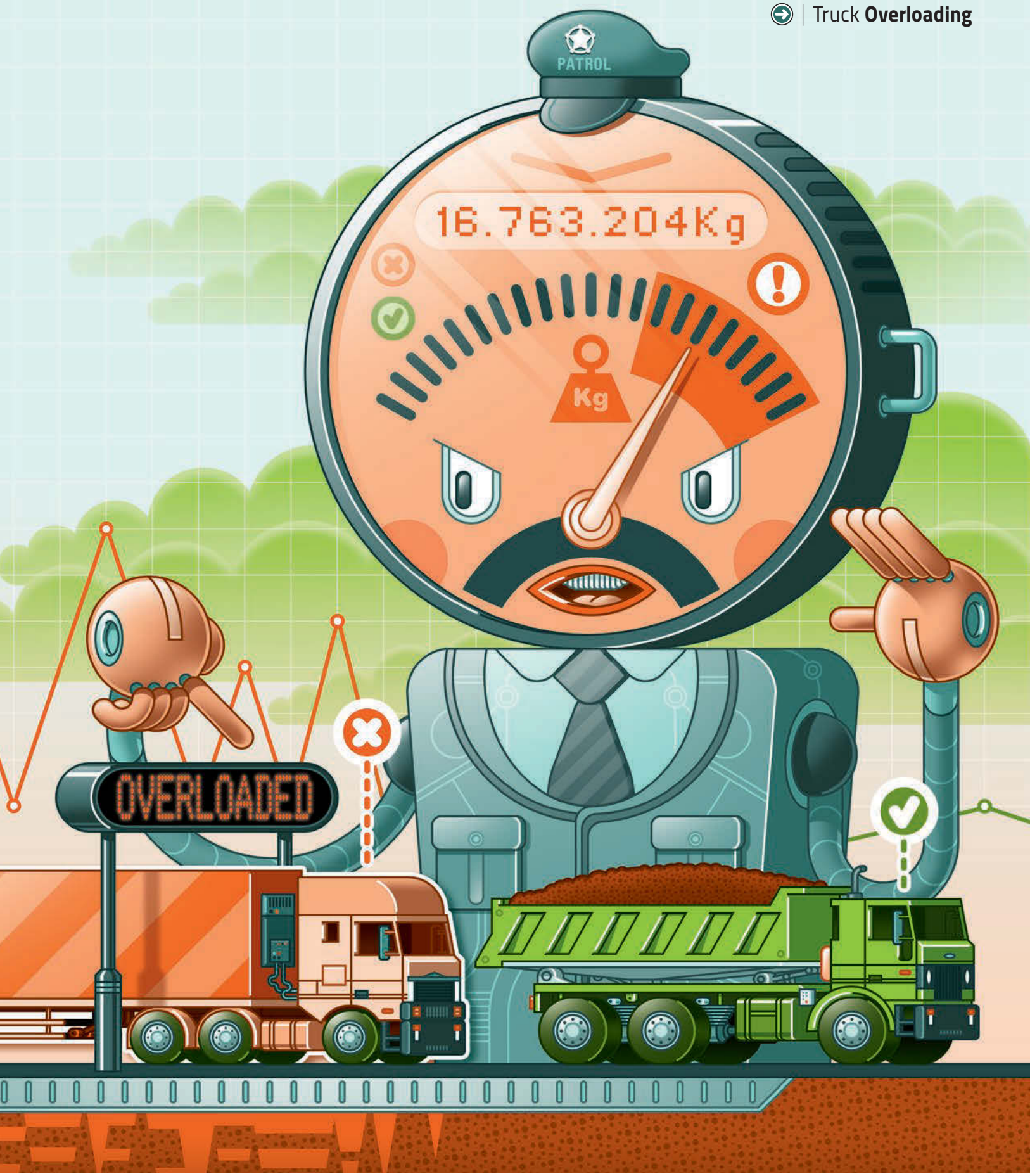
Illustration courtesy of Lee Hasler

Left unchecked, overloaded trucks can pose a serious safety hazard not just for the drivers of the vehicles themselves – which is bad enough – but to any law-abiding road users they may encounter along the way. Weigh-in-motion (WIM) technologies that can help authorities identify and pre-select suspiciously heavy vehicles for closer scrutiny are therefore powerful weapons in the enforcement armory. In the Czech Republic, attention is now being given to the deployment of WIM as a direct enforcement method – although that particular country is very much the exception given the legislative hurdles that still need to be tackled.

A numbers game

When contemplating WIM being used for direct enforcement in order to enhance traffic safety, Gordon Macdonald, who heads up enforcement policy at the UK's Vehicle and Operator Services Agency (VOSA), believes it's still very much an evolving process. "The technology is certainly not perfect; the kit is prone to temperature changes, to the weather as well as to deterioration of the road surface," he says. When installed and working properly, however, he has no doubt that it's a very good targeting tool to identify

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US heavyweights

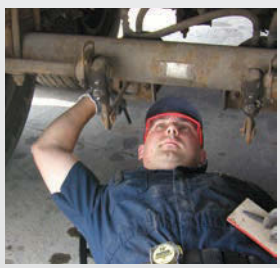
Steve Keppler explains how the **CVSA** is gathering data about commercial vehicles on US roads to paint a more accurate picture of conditions – right down to the individual axle level

One of the items included in the transportation bill that went before Congress in the USA last year was a truck size and weight study that investigated a range of issues in the context of overloaded vehicles and traffic safety. "Rather than choosing to enact legislation straight away, Congress thought this would be a more sensible route," reports Steve Keppler (pictured above), executive director of the Commercial Vehicle Safety Alliance (CVSA), which comprises local, state, provincial, territorial and Federal Motor Carrier Safety Administration officials.

The CVSA was actually involved in one of the key elements of the study. "A long-standing question is, do we really have enough safety data to determine whether it makes sense to increase vehicle weight allowances?" says Keppler. "The part of the study we took on is designed to fill this void on safety."

"When we were first questioned about safety, it was something we could only really answer from our own experience or based on gut feeling – we didn't have enough data to refer back to," adds Captain Jay Thompson from Arkansas Highway Police, who chairs the CVSA Size and Weight Committee. "We put together a Heavy Vehicle Data Collection Effort within which we asked roadside officers in our member states when a vehicle exceeded the legal weight if this exceeded the total gross for the roadway or just one particular axle or axle group.

> "Do we really have enough safety data to determine whether or not it makes sense to increase vehicle weight allowances?



The CVSA has maintained, updated and published the North American Standard Out-of-Service Criteria annually for more than 20 years

"They then had to perform an NAS Level 1 inspection using the special study fields in the program and tell us one of two things. Was it overweight illegally or legally [with a permit]? We didn't just want to get data for the guys breaking the law. The question we were being asked was, do heavier weights have a negative or any impact on vehicle safety? Hence it was important that the good operators were included."

The CVSA now has almost a year's worth of data and already this has thrown up some concerns relating to vehicles declared 'out-of-service'. "It appears that some of those that are exceeding the weight limit are offenders who may be running their vehicles in an overloaded and potentially dangerous state.

"At VOSA, we have experimented with WIM as an indicator of overloading for a number of years now," Macdonald continues, yet only recently has the organization merged the WIM sensors with automatic license plate recognition. "We initially trialed the approach at just one site to find out how effective the two technologies would be in tandem. The idea was that systems incorporating ALPR could gather data on a particular vehicle registration number. If a vehicle is seen on the motorway, a combined system will recognize it and bring up relevant data – for

In the UK, VOSA checks are held all over the country, either at the roadside or at permanent sites such as weighbridges

also above the national average when it comes to being placed out-of-service," says Thompson. Looking at it in more detail, the majority of out-of-service violations relate to brakes: "They're out of adjustment or are worn down, which is something that needs to be investigated further."

The CVSA's work is still ongoing, so major announcements regarding the implications of these findings will have to wait until the federally sponsored study is complete.

On the wider subject of vehicle weight and enforcement, Thompson sees WIM as primarily having a screening role: "The tolerances with WIM systems simply aren't to the level where you can write tickets but they do help to screen, especially when most of our weighstations are just hammered as a result of the volume of commercial vehicles."

Approximately four million commercial motor vehicle roadside inspections are conducted annually across North America by government enforcement agencies

instance, what the vehicle weight should be in terms of axle gross and the train weight (GTW) – and compare this to the actual weights calculated by the WIM system."

The pilot Macdonald cites concluded back in December 2005 and involved VOSA, the UK Highways Agency (HA) and the Central Motorway Police Group (CMPG). It was held on the busy M6 freeway and featured three ALPR cameras (one per lane), a side-view camera and a WIM system, including piezoelectric electric sensors. "We measured thousands of vehicles and compared them with the calibrated dynamic axle weight so we were able to analyze the accuracy," reports Macdonald.

Highlighting the effectiveness of the trial, there was a significantly higher prohibition rate compared to most other sites – in excess of 90%, which was well above VOSA's national average of 24% at the time. "The reason for this was that we were only physically weighing the vehicles that the WIM system had deemed were overweight in the first place," Macdonald continues. "I think we now have around eight or nine of these ALPR-based WIM sites nationally so it's not something that is widespread or massive within the organization. We have around 70 sites with dynamic weighbridge facilities already."

As well as being an effective weapon for 'tactical' enforcement targeting, Macdonald says the ALPR-WIM combination is helping to build up data and intelligence. "It's always running in the background, so at any time you're able to trawl the databases to find out which vehicles are running heavy, the times they are most likely

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(Left) **The fatal crash rate for large trucks in the USA is 2.4 deaths per 100 million vehicle miles traveled – more than 50% greater than the rate for all vehicles on the roads** (Below) **Large trucks in the USA make up just 4% of all registered vehicles and 7% of all VMT**

to do this, and so on. There are various types of analysis that can be performed off the back of the data that's constantly being retrieved from the system."

As to why heavyweight offenders are such a concern for VOSA, Macdonald says the performance characteristics of an overloaded truck change drastically, including steering, brakes and braking distances, plus the suspension – hence vehicle handling significantly alters. "It really depends on the extent of the overloading," he adds. "Recently in Ashford, Kent, for instance, we had reports of a Belgian vehicle that was carrying a consignment of potatoes that was almost 50 tons! Was that just a case of carelessness or was it a deliberate attempt for one vehicle to transport the load of two trucks in order to reduce freight costs?"

Enhancing enforcement

Hans van Loo, the information officer at ISWIM (International Society for Weigh-In-Motion), says hard figures quantifying a direct relationship between overloading and traffic safety are hard to come by, despite what common sense may tell us. "Accidents are normally caused by a combination of factors and it depends on the type of accident whether overloading is considered by the person who fills in the statistics," van Loo says. "But if you have a truck that is heavier than it should be, the impact of an accident is generally going to be greater. Overloading on the axles especially will result in higher wear and tear on components such as tires, increasing the risk of a blowout, while also affecting truck maneuverability and steerability."

In van Loo's opinion, the deterioration such trucks cause to the road pavement is also a major cause for concern, hence pre-selection being one of the most common enforcement applications for WIM. "Essentially, it increases the efficiency of your overloading control. You only have to stop certain trucks and based on experience, more than 95% of the time these are overloaded," van Loo reveals. Not only is there a benefit for the police in targeting their efforts but the operations of legally compliant transport companies are also not disrupted by overloading controls.

> Recently in Ashford, Kent, we had reports of a Belgian vehicle that was carrying a consignment of potatoes that was almost 50 tons!
>
> **Gordon Macdonald, head of enforcement policy, VOSA, UK**

A virtual approach

The Technology Implementation Group (TIG) of AASHTO shares what it terms 'high-payoff, market-ready technologies' among transportation agencies through its lead states teams. A case in point is Virtual Weigh-In-Motion (VWIM) sites that wirelessly link real-time WIM data automatically collected at unmanned locations to the laptops of highway patrol officers in their vehicles.

One state pushing ahead at a fast pace with VWIM is Florida, where the DOT has 12 sites up and running. Craig Wilson, statewide scale maintenance/facilities supervisor, describes the impact it's having: "Trucks were coming off at an exit ramp on I-95 in Central Florida to intentionally bypass the existing weighstation on the Interstate by taking a country road around it. But we're now picking them up through our VWIM site nearby." Wilson believes the extra infrastructure is critical at a time when they have to take account of the different weight limits on the Interstate – 80,000 lbs – and permits for state highways that go up to 88,000 lbs.

VWIM has truly enhanced what is possible, says Wilson. "For fixed weighstations, the capture rate is under 2% whereas a VWIM site can easily be as high as 25%."

The need for an agreed future

There is currently intense debate surrounding the role and future of WIM, which van Loo reports was in full swing at

(Left) **Overloaded vehicles cost EU taxpayers around €950m each year in road damage** (Right) **The damage bill from overloaded trucks in the USA is estimated to be from US$0.08 to US$2.50 per ton-mile, depending on weight**

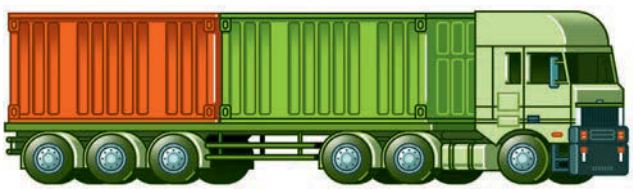
a February 2013 workshop held in Brussels under the auspices of ISWIM, Euro Control Route (ECR) and TISPOL. The Weigh-In-Motion and Enforcement workshop covered everything from Directive 96/53/EC to WIM technology developments and where WIM and enforcement meet.

Many workshop attendees seemed to be in agreement that it's more legislation and standardization than technology presenting stumbling blocks to a more direct enforcement approach becoming widespread. "Once the legislation is in place, the technology that can meet the necessary requirements is available," van Loo says.

So how has the Czech Republic seemingly moved ahead of the rest of Europe? "Although their systems are deployed and operational, I am not sure if any citations have actually been sent out at this point," van Loo says. The technology itself has also only been certified to meet a national Czech requirement, and van Loo laments there's nothing coming near an agreed European standard requirement for widespread use. "There have been initiatives but even within ISWIM, not everybody agrees on the best road forward," he says. Essentially, there are two schools of thought, with van Loo in favor of a straightforward, simple document outlining the key requirements while others want a far more extensive document with all types of recommendations and research results.

Whether manufacturer or enforcement agency, van Loo thinks it's high time that somebody, somewhere takes the initiative – which doesn't look as if it will happen any time soon. "For enforcement agencies, at an international, cross-border level there are still many issues to be resolved and in my view, we're only at the start of this road; they're not yet ready to enforce directly using WIM," he says. "There are other less challenging areas where cross-border enforcement still has to shape up, so WIM isn't foremost in their minds."

> For enforcement agencies, at an international, cross-border level there are still many issues to be resolved and in my view, we're only at the start of this road
>
> **Hans van Loo, information officer, International Society for Weigh-in-Motion**



And from a WIM manufacturers' standpoint, van Loo feels there might be a degree of reluctance on their part to engage in a time-consuming and expensive standardization process as most vendors are relatively small and simply don't have the resources for such development work.

Keeping overloading in check

There will likely always be some rogue transport companies trying to break the rules to remain competitive. Keeping these dangerously overloaded vehicles off our roads in an intelligent and manageable way will therefore remain a crucial consideration. For the time being, and despite improvements in accuracy, WIM systems seem set to remain largely confined to spotlighting and filtering offenders for further investigation rather than acting as a direct method of enforcement. As we have discovered, that scenario is only likely to change when national and cross-border regulations on the enforcement of vehicle weight limits are revised to reflect the high levels of accuracy that are now possible with WIM systems.

Moving ahead with WIM

Weigh-in-motion has proven to be successful when the sites can be kept operational, says Guy Boruff, the division director for Public Safety Operations at Indiana DOT. "WIM systems are quite accurate – at least within the tolerances that we require," Boruff admits. He is particularly impressed with some of the recent sensor upgrades that have taken place. "On I-65, our technicians put in Kistler quartz sensors and since then we've been reading about 97-99% of what a truck actually weighs."

As with the story elsewhere in the world, for the moment WIM systems in the USA are merely operated as a screening tool. "The advantage with WIM is that the only people you end up bothering are the ones who are candidates to be overweight," he adds.

An extreme overload example offered by Boruff involved one truck on I-94 close to the Illinois state line running more than 124,000 lbs on five axles: "The truck didn't get caught at the time," the INDOT man reveals, "but it showed up later on the WIM sensor data collected by Purdue University."

Progress report

The latest WHO road safety study acts as a benchmark for monitoring the evolution of the Decade of Action. **Izzy Kington** finds that the results reveal there is plenty that lawmakers, road builders and car manufacturers can do

Photographs courtesy of Make Roads Safe & WHO

More people equals more vehicles, which means more deaths. It's a horribly logical equation that could lead to 2.4 million traffic fatalities a year by 2030, according to the 2009 World Health Organization (WHO) *Global status report on road safety: time for action*. That's if countries around the world fail to implement the many proven strategies to prevent road traffic crashes and the resultant deaths, injuries and disabilities.

In 2010, a UN resolution tabled by Russia designated 2011-2020 the 'Decade of Action for Road Safety', the aim being to prevent the death toll rising. Deaths were predicted to increase to 1.9 million annually by 2020, so the resolution hopes to save around five million lives over the Decade. The WHO is tasked with monitoring what progress – or otherwise – is made over that time. A second *Global status report on road safety* using data from 2007-2010 was published this February.

Intended to provide a picture of the situation at the start of the Decade, it reveals that the death toll has actually remained static since 2007, despite a 15% increase in registered vehicles. "Taking into consideration the population, the number of vehicles and the number of people who are now learning to drive, it's miraculous we've been able to keep it relatively static," believes Dr Margie Peden, WHO coordinator for unintentional injury prevention, who was involved in compiling the latest report. "If we can keep it around 1.2 million or so I'd be happy, as it's actually an improvement."

The overall picture is very mixed, however. Of the 182 countries that participated in the 2013 report, 88 posted a reduced death toll, while 87 saw theirs increase. Traffic death rates are now 8.7 per 100,000 people for high-income countries, 20.1 per 100,000 for middle-income countries and 18.3 per 100,000 for low-income countries. The middle-income countries – which are home to 72% of the global population – account for 80% of the world's traffic death toll, despite having only 52% of its vehicles. Africa has the highest death rate, and Europe the lowest. "The countries with increasing numbers are mainly those in low- and middle-income countries," Peden continues. "Middle-income countries are the hardest hit at the moment. Infrastructural changes are occurring, with more roads being built and cars being sold – but safety is not keeping up."

Infrastructure

The report contends that the safety of motorcyclists, pedestrians and bicyclists (groups that together account for 50% of the global death toll) needs to be taken more into account in the early stages of infrastructural development. "It's really important that engineers don't forget that they're building these roads for people not only inside cars, but outside cars as well," says Peden. "Particularly in low- and middle-income countries, where huge expanses of roads are being built, some of these issues are overlooked. Roads have to be built that separate traffic out, and that allow pedestrians to get from one side to the other safely, either with under- or over-passes."

She also feels low- and middle-income countries need to learn from high-income countries' mistakes. "We know, for instance, that really wide, multiple-lane motorways are not the most conducive when they go through villages with people living on either side, and that narrower, one-lane roads with a middle island are better."

Hence, Peden sees the International Road Assessment Programme (iRAP) as key in disseminating those lessons. It visits countries to audit existing and new roads, advising governments as to how they can develop or upgrade them for the safety of all road users, while ensuring that road development loans are spent wisely. "In the past there has been a gap between the World Bank giving

(Main) **Dr Margie Peden is global coordinator of the 'Road Safety in 10 Countries' project** (Below right) **People using phones while driving are around four times more likely to be involved in a crash than those not using a phone**

Speed

WHO's recommendations: Limit of 50km/h in urban areas; limit of 30km/h in areas with lots of pedestrians and cyclists; ability for local authorities to further reduce these limits where necessary.
Uptake: 114 countries apply the speed limits but only 59 also allow local authorities to modify them. Between 2008 and 2011, six countries improved their speed laws.
Enforcement: 26 countries rated as 'good'.

Drunk driving

WHO's recommendations: Blood alcohol concentration (BAC) limit of 0.05g/dl or less; BAC limit of 0.02g/dl or less for commercial, young and novice drivers.
Uptake: 89 countries apply the 0.05g/dl limit; 42 also apply the 0.02g/dl or less limit for young and novice drivers.
Enforcement: 39 countries rated as 'good'. 74% of countries employ random breath testing.

Motorcycle helmets

WHO's recommendations: Helmets to be worn by all riders, on all road types and with all engine types; helmets to comply with a national (based on local traffic and weather conditions) or international standard.
Uptake: 155 countries (up by 24 since 2008) stipulate the use of helmets; 98 apply a standard; 90 have comprehensive laws and apply a standard.
Enforcement: Roughly one-third of countries rated as 'good'.

Seatbelts

WHO's recommendation: Seatbelts to be worn by all vehicle occupants.
Uptake: 111 countries (up 10 since 2008) have comprehensive laws.
Enforcement: 25% of countries rated as 'good'.

Child restraints

WHO's recommendation: All infants and young children to wear restraints appropriate for their size and weight.
Uptake: 96 countries (up by seven since 2008).
Enforcement: 9% of countries rated as 'good'.

A 5% cut in average speed can result in a...

30%

...reduction in the number of fatal crashes

countries money to build roads and the quality and safety of the roads that are built," Peden says. "The World Bank is now putting in checks and balances, saying to countries, 'You can build these roads as long as they comply with X, Y and Z'."

False economy

The main obstacle to constructing safer roads, however, is money – "some governments take the cheapest bid, which isn't necessarily the safest" Peden states – which is why the WHO is trying to highlight the false economy inherent in that thinking. "We need to promote the huge cost of road traffic crashes to governments, and show how putting some of these safety interventions in place would save them money; how they could spend more on the infrastructure and the cost/benefit would be in their favor," she says.

In financial terms, non-fatal injuries have a greater impact on health care systems than deaths. "Those millions of people who end up in hospital beds – often with head and lower-limb injuries that necessitate long orthopedic procedures, possibly even left with disabilities and requiring rehabilitation – are huge drains on the health economy," Peden explains. "That's one of the big reasons why the WHO got involved in this area in 2004, and why we wrote the report."

As well as making walking and cycling safer, the report recommends reducing congestion through greater investment in regulated public transport, especially in low- and middle-income countries. "There are a few examples of good investment in public transport – by countries such as Mexico, Brazil, India and South Africa, which are now putting in these mass bus transit systems – but the majority of countries are not there yet," Peden explains. One success story is that of Ahmedabad in India, where a bus rapid transit system began operating in 2009. Since then, there has been a shift away from private vehicles, and a 50% reduction in road traffic deaths along its corridor.

Peden also believes vehicle manufacturers can do more to protect people outside the car, too: "They've done an amazing amount in the past couple of decades, and made vehicles so safe for those of us inside the vehicle. But the same can't be said for people outside the vehicle."

She points to the UN Forum for Harmonization of Vehicle Regulations, which includes proposed changes to the fronts of vehicles to make them more forgiving to pedestrians or cyclists in a collision. "The problem is that they make the front of vehicles look really ugly, hence manufacturers have been a little reticent to take up those recommendations," she says. "The bulk of manufacturers don't actually think about the people outside, and yet they account for 50% of those being killed, so they really do have to step up to the plate as far as that's concerned."

> A lot of countries do have good laws on their books, they just don't enforce them, so they're not worth the paper they're written on
>
> **Dr Margie Peden, coordinator, Unintentional Injury Prevention, World Health Organization**

Addressing the population

Dr Margie Peden feels that hard-hitting mass-media campaigns encourage the public to abide by road safety laws, and praises the efforts of the UK and Australia in this field.

In Afyonkarahisar, Turkey, seatbelt wearing rates have increased from below 5% in 2011 to about 49% in 2012, following a decree from the city's governor that was heavily publicized through radio, TV, billboards and adverts on buses, accompanied by stronger police enforcement.

Cambodia is one of the more recent adopters of this approach – in 2012 the country launched a holistic advertising campaign (TV, radio, print and billboard) to encourage greater abidance to its motorcycle helmet law, passed in 2009.

Also on the theme of empowering the public to help themselves, Peden praises graduated driver licensing systems for "incrementally teaching novice drivers how to drive and to deal with the risks on the road".

Peden believes the NCAPs are very useful for sensitizing the public to the safety of individual models, encouraging the population to demand safety from manufacturers. The latest (2012) results from the Latin NCAP – which began testing South America's best-selling cars in 2010 – showed an increase in models with four-star ratings, an increase in airbags fitted as standard, and improved child restraint systems. Both Argentina and Brazil plan to bring in a mandatory requirement in 2014, forcing airbags to be fitted as standard.

Legal matters

Lawmaking is one of the main areas highlighted by the report as in need of development. It details the uptake of laws covering speed,

Compiling the report

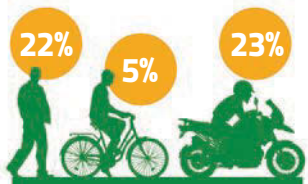
Compiling the report was a mammoth task. Each of the 182 countries had a national data coordinator, who selected up to eight of the country's top road safety experts and stakeholders – health, transport and communication ministries; the police; NGOs; and individual academics. In most countries, each attendee completed a questionnaire, before attending a national consensus meeting, where the group agreed on a final set of answers for each country. That final questionnaire was then approved by government and submitted to the WHO.

A big headache for the compilers was that data for most countries came from a single source, usually the police, and is hugely under-reported in some countries. There are also various definitions of 'traffic deaths' – some only counting on-the-spot deaths, some including those within seven days of an incident, some up to 30 days, and others with an open-ended term.

The report thus includes the information reported alongside 'comparative estimates'. "We combined the reported data with that from ministries of health through their vital registration systems," explains Dr Margie Peden. "If countries had systems that covered more than 80% of their population, we took their vital registration data. For others with really bad data, we used a model to form a comparative estimate, which are for unlimited time periods so can be compared with other health issues."

Another complication was that several countries have federal systems where laws can vary between states. "It's easier in some instances – such as Australia, where although they do pass laws state by state, they tend to all be the same – but in others such as the USA, it's vastly different by state."

The chance out of 100,000 of dying in a road traffic crash depends on where you live...



50%
of all road traffic deaths are among pedestrians, cyclists and motorcyclists

drunk driving, motorcycle helmets, seatbelts and child restraints – and the enforcement of those laws. Sadly, it found progress to be slow. Although 35 countries (governing less than 10% of the world's population) addressed one of these areas over the study period, no more joined the 28 (home to only 7% of the global population) who had already passed 'adequate' laws in all five areas.

Peden believes it would help if there was an agreed set of recommended laws that every country should have as a minimum. "The WHO has taken a stab at that by virtue of the laws we assess in this report, but we need to come up with an agreement as a global community," she adds.

With funding from Bloomberg, the WHO is working in 10 countries on road safety intervention, and one of the areas it is assisting with is the modification or improvement of laws. One of the problems, though, is that the process of passing laws is "extremely long and laborious", requiring a lot of human capital, Peden says.

Even having comprehensive laws is not enough, if they are not enforced. Globally, the report found enforcement to be 'inadequate'. "A lot of countries do have good laws on their books, they just don't enforce them, so they're not worth the paper they're written on," Peden suggests. "There's a lot of capacity development that still needs to happen in some countries. Maybe splitting police forces into dedicated traffic and other divisions – as they have done in some countries – would help. But there are also broader issues that need to be addressed, such as the perception of the police and equitable pay, so that the police force can do its job optimally."

Regardless of how good a country's laws, enforcement, infrastructure, vehicles, education and standard of driving are, post-crash care will always be extremely important. "No matter how hard we try at a prevention level, we're never going to eradicate every single crash, so we need to be prepared," Peden says. "Looking at the report, it's very sad to see that the large majority of countries don't have ambulance services. In fact there are only 59 countries that have a fully functioning ambulance service that can transfer the majority of injured people to hospital, and doctors and nurses are not trained adequately in emergency care, particularly in low- and middle-income countries. So we need to look at it pillar by pillar and see what we can do."

The road ahead

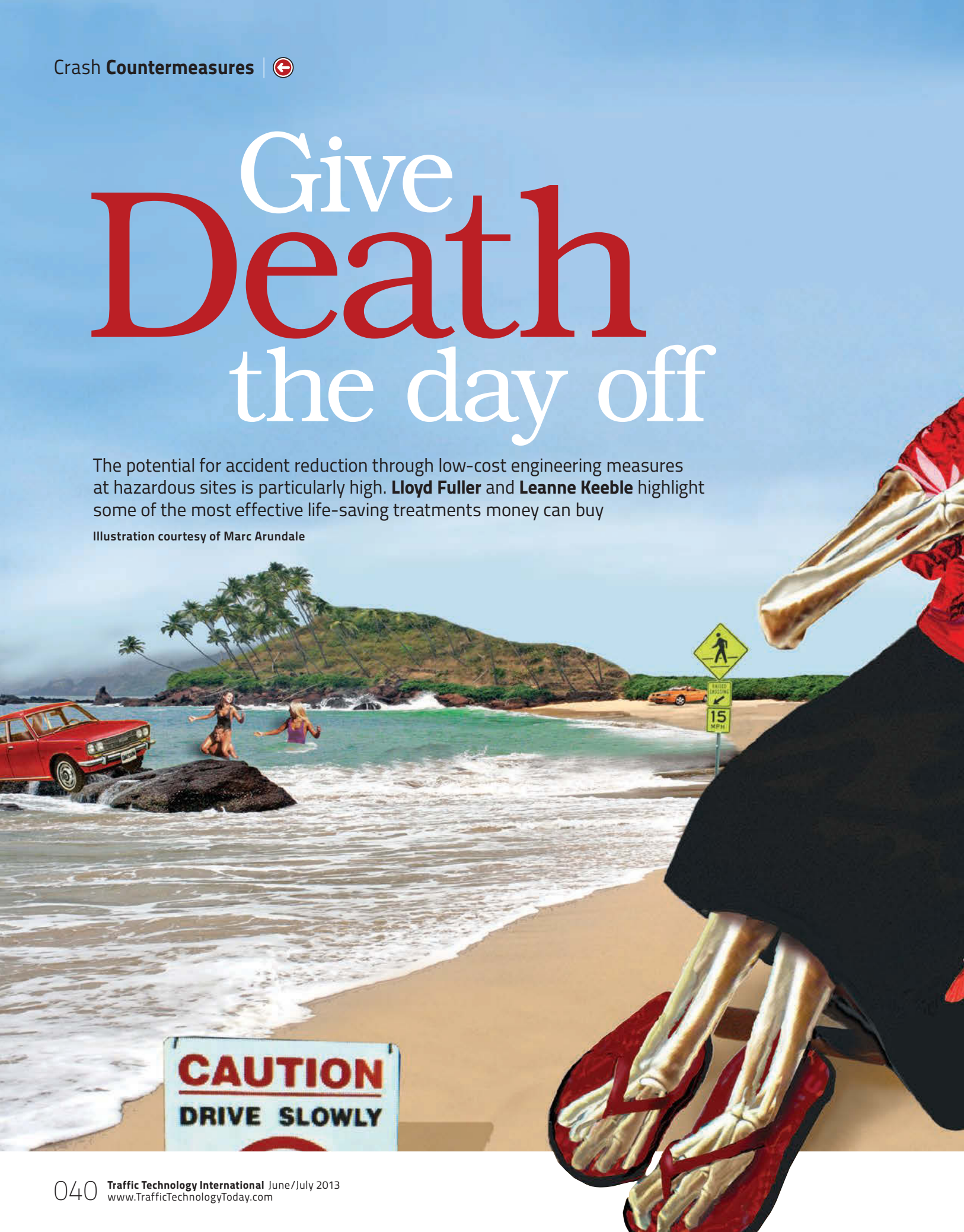
As this report is based on data from 2007-2010 – before the Decade started – it cannot be used yet to assess whether or not the world is on track to meet the goals of the Decade. The picture will, however, become much clearer when the findings of the next report can be compared with those from this one. That will probably be published in 2015 (using 2013 data) to coincide with a ministerial meeting planned to review the situation midway through the Decade. The WHO will use exactly the same methodology as it has established for this second report, to make direct comparisons possible. Nevertheless, having gone through detailed data from 182 countries with a fine-toothed comb, Peden is in a position to offer some insight: "I think we may be making a little bit of progress, but we have to work harder, together, if we want to attain the goals of the Decade." ○

(Right) **More than 11,000 people are killed annually on Vietnam's roads, where 95% of the traffic is motorcycles**
(Far left) **Rapid growth in the use of PTWs has been accompanied by increases in injuries and fatalities among their users**

Give Death the day off

The potential for accident reduction through low-cost engineering measures at hazardous sites is particularly high. **Lloyd Fuller** and **Leanne Keeble** highlight some of the most effective life-saving treatments money can buy

Illustration courtesy of Marc Arundale



Automotive technologies often grab the limelight when it comes to focusing on reductions in death and injury on our roads. So in this article we're shining the spotlight on an important supporting cast – it's time for low-cost, effective remedial crash countermeasures to take center stage. The USDOT's Federal Highway Administration has a list of nine proven safety strategies, which includes but isn't limited to rumble strips, retroreflective backplates, roundabouts, high-friction surface treatments and reconfiguring infrastructure with road diets, some of which you'll read about over the following pages.

Traffic Technology International's 'perfect 10' countermeasures have been selected based on impressive figures relating to KSI reductions and in some cases astounding returns on investment. It's not a top 10 – and nor do they appear in any particular order. But they're well worth considering for your networks, especially given a worrying spike in traffic fatalities in many countries in 2012.

In the USA, for instance, there were approximately 36,200 traffic deaths last year, a 5% increase over 2011. Prior to the 2012 figures, annual traffic deaths had followed a downward trend; the 2011 fatality count was 2% lower than 2010, which had in turn been 2% lower than 2009. And that decline in US traffic fatalities stretched back to 2005 – the last time an increase was recorded. The reason is most likely fatalities finding a 'truer' level following a period of fewer vehicle miles traveled during the economic travails, but it's concerning nonetheless. Effective solutions do exist to treat accident blackspots – and they don't always have to blitz your budgets. So read on to discover some great ways to give Death the day off!

Smile for the cameras

SPEED/RED LIGHT ENFORCEMENT
VICTORIA, AUSTRALIA

1 The aim of a 2011 study by Laurie Budd, Jim Scully and Stuart Newstead from Monash University's Accident Research Centre was to evaluate the crash effects of 87 signed fixed digital speed and red light (FDSRL) cameras and accompanying warning signs. They were placed at 77 signalized intersections across Victoria.

Data was analyzed using a before-after quasi-experimental design incorporating controls and Poisson regression to calculate the adjusted percentage reduction in the number of casualty crashes at treated sites in the post-treatment period compared with pre-treatment.

Analysis results estimated large decreases in casualty crashes associated with the cameras and their associated signage. When considering only the crashes involving vehicles traveling from the approach intersection leg where the camera was placed, the estimated casualty crash reduction was 47% . When crashes involving vehicles from all approaches were compared, the estimated casualty crash reduction was 26%. There was also an estimated 44% reduction in right-angle and right-turn-against crashes.

Newstead explains that although the use of the FDSRL cameras was associated with a reduction in overall casualty crash risk, there was no evidence of a reduction in relative crash severity, meaning the cameras were associated with equal reductions in minor injury crashes and serious injury and fatal crashes.

Across the 77 sites where the evaluated cameras were installed, it was estimated that 17 serious or fatal crashes and 39 minor injury crashes would be prevented a year – a crash cost saving to the community of more than A$8m.

"The results spoke for themselves – these cameras proved their worth in reducing crashes resulting from speeding and red light running at dangerous intersections," concludes Newstead. "And given that fewer than half the FDSRL cameras in the state were analyzed in depth, you would expect both the road safety benefits and the consequent savings to the community to be even greater."

Guiding you around the bend

CURVE WARNING SIGNS
NORTH CAROLINA, USA

2 A recent study conducted by the University of North Carolina Highway Safety Research Center (UNC HSRC) showed that giving motorists advance notice of curves, by using road warning signs and marking the edges of the road as it turns, can be a cost-effective approach to improving overall road safety.

Led by Dr Raghavan Srinivasan, senior transportation research engineer at HSRC, *Safety Evaluation of Improved Curve Delineation* provides analyses of these improvements to assess their safety and economic benefits. "These types of analyses are very important as they indicate which improvements are likely to reduce crashes and injuries," says Srinivasan. "They also provide the biggest bang for the buck."

Addressing the safety of curves is a vital step toward achieving the overall goal of the AASHTO Strategic Highway Safety Plan of reducing fatalities on US roads. Statistics from the Fatality Analysis Reporting System reveal that in 2006 approximately 27% of the 38,588 fatal crashes occurred along curves, predominantly on two-lane rural highways. The average accident rate for curving sections of road is about three times what it is for straight sections.

Using data collected in Connecticut and Washington, researchers evaluated the safety implications of improvements such as reflective posts that mark edges, known as post-mounted delineators, chevrons with higher retroreflectivity, and advanced curve warning signs. The results indicate impressive crash reductions before and within the curve – an 18% reduction in crashes resulting in injuries or fatalities, a 27.5% reduction in crashes at night, and a 25.4% reduction in crashes at night caused by running off the road or crossing into the opposite lane.

Srinivasan reveals that an economic analysis showed the signing improvements to be a highly cost-effective treatment with the benefit-to-cost ratio exceeding 8:1. "This estimate was made by comparing the annual cost of installing and maintaining these signs and the expected reduction in crashes based on information about the average cost per crash," he confirms.

Do you see what we see?

RETROREFLECTIVE MARKINGS
MICHIGAN, USA

3 Although many assume there's a correlation between pavement marking retroreflectivity and safety, until now it hasn't been proved. "It's difficult to measure," says Texas A&M Transportation Institute (TTI) research engineer Paul Carlson, who leads TTI's Visibility Research Laboratory. "To gather good data about safety you would have to know the level of brightness or retroreflectivity a pavement marking had at the time someone ran off the roadway," he says. But Carlson had a good opportunity to conduct a study, thanks to the Michigan Department of Transportation (MDOT). MDOT has measured the brightness of pavement markings on individual roadways for years.

"Michigan DOT is serious about keeping its pavement markings maintained. If measurements show markings are dull, they would be replaced. By comparing both dull and bright markings with crash information, we could determine if retroreflectivity characteristics played a role in safety."

So *An Investigation of Longitudinal Pavement Marking Retroreflectivity and Safety* got underway. Carlson, sponsored by the FHWA, gathered crash data and retroreflectivity measurements from 2002-2008. He compared the measurements with single vehicle, night-time crashes that occurred during dry conditions and non-snow months.

Carlson completed the research in July 2012 and concluded that fewer crashes occurred when pavement markers were brighter and newer. "The evidence is pretty compelling," he says. "It demonstrates that maintenance of pavement markings can have a positive effect on safety. Brighter markings mean safer roadways."

In the meantime, Carlson has been working with the FHWA as it comes up with a retroreflectivity standard, which would help US DOTs know when pavement markings should be replaced.

Under construction

WORKZONE SAFETY
TEXAS, USA

4 Last year in Texas, nearly 17,000 statewide workzone crashes resulted in 132 fatalities and many more injuries. So far in 2013, there have been 4,713 workzone crashes, resulting in 24 fatalities. One fatality is of course one too many, but the reduction is an improvement resulting from Texas DOT (TxDOT) introducing a first-in-state highway safety feature incorporating an end-of-queue warning system and temporary rumble strips to reduce the collisions in these busy, complicated areas. They are two relatively simple and cost-effective technologies that are having a priceless effect.

The system, which made its debut along a central Texas stretch of Interstate 35, uses sensors to measure the speeds of approaching vehicles and then warns drivers through portable VMSs about upcoming traffic back-ups due to night-time lane closures in workzones. The rumble strips are spaced between sensors to send mild vibrations through oncoming vehicles to get the attention of distracted or drowsy drivers. The advance warning system has been deployed as part of the 155km (96 mile) Central Texas I-35 Expansion Project that will widen the highway

Let's get ready to rumble

RAISED MARKINGS
ERZGEBIRGE, GERMANY

5 Cold plastic-based transverse rumble strips (TRSs) have recently proved a success at the approaches of hazardous bends on a section of road in Germany's Erzgebirge region. TRSs are a common strategy implemented by local authorities to enhance road safety on rural roadways in numerous areas of the world – in many cases, successfully alerting road users to a changing environment. They are especially effective where there is a need to exercise extraordinary caution, by generating a certain sound and vibration as a warning to vehicle drivers going over them.

BASt, the German Federal Highway Research Institute, has recommended TRSs on stretches of roads with high crash rates. Germany's ADAC also advocates the use of rumble strips on certain approaches, particularly on rural roads where there may be hazardous bends.

The rumble strips applied in this Eibenstock project were created using a two-component cold plastic (methyl methacrylate – MMA) material. Once applied to the road, it sets quickly. The strip pattern and spacing used is based on a BASt experimental trial. The rumble strips were applied on the approaches to a hairpin bend leading to a popular meeting spot for motorcycle riders in the Erz Mountains, a site where between 2007 and 2009 12 motorcycle accidents resulted in seven people sustaining severe injuries and nine others suffering bruises.

According to the region's accident commission, most of the crashes occurring at the bend – a magnet for bikers – were a direct result of excess speed. Measures were thus taken in July 2009 to reduce the risk of accidents and saw 2cm grooves cut into the asphalt surface at eight partial sections of the road extending through the switchback. The grooves created a bumpy road surface to alert the road users to drive more carefully.

"Since the installation, not a single accident has been reported," says local traffic engineer Benjamin Schultz. "This shows tactile road surfaces are an efficient means of reducing crashes and alerting drivers to changes in the road environment and to exercise caution. Hopefully these measures will permanently reduce the number of accidents that have occurred on this section of road, and in doing so help to make road travel in the Erz Mountain area much safer."

Get a better grip

HIGH-FRICTION SURFACES
KENTUCKY, USA

6 Annually, more than 25% of US highway fatalities occur at/near horizontal curves. But pavement improvements for surface characteristics, particularly for friction, at certain locations are an effective way to increase safety and reduce crashes. High-friction surface treatments (HFSTs) can provide a long-lasting, higher level of pavement friction than traditional surfaces to meet the demands of a specific road.

In addition to curves, other roadway characteristics create variable roadway friction demand. The Kentucky Transportation Cabinet installed HFSTs at some locations with a history of wet roadway departure crashes. Tracy Lovell, transportation engineer at the Cabinet's Division of Traffic Operations says that HFSTs were one of eight countermeasures identified when the Cabinet implemented a statewide Roadway Departure Safety Plan to address problem curve sites. They identified the 30 worst curves: 15 for wet crashes and 15 for total crashes. Ten of the worst ramps were also selected.

One such location is Oldham County. Through a four-year before-and-after (August 2007 to August 2011) study period, lane-departure crashes were reduced from 47 in the two years before to only five crashes in the two years after.

In Knox County, HFST was installed on US 25 to address rear-end crashes at an intersection. The friction treatment was applied only on the southbound lane, which featured a downgrade approach. For a three-year period prior to the installation, there were six wet weather crashes and 27 dry weather crashes (11 crashes per year) – mostly rear-end. In the 1.3 years since the installation, there have been two wet weather crashes and five dry weather crashes (5.38 crashes per year).

from four to six lanes, from four to eight lanes in the Temple and Waco areas, and change two-way frontage roads into one-way lanes. The projects under construction are scheduled for completion in 2017. Covering McLennan, Bell, Falls and Hill counties, the first-in-Texas combination is deployed as needed through construction zones and is designed to improve safety in one of the most heavily traveled corridors in the USA. Each day, between 55,000 and 115,000 vehicles travel the I-35 corridor, with 25-35% of the traffic being trucks.

"We're hopeful we can expand the system in other areas of the state," says Phil Wilson, TxDOT executive director. "This technology represents the future of roadway safety, as it uses a comprehensive approach to warn drivers of traffic back-ups, thereby decreasing the likelihood they will enter a workzone at an unsafe speed. Any technology that has the potential to simultaneously protect motorists and roadside maintenance workers is well worth pursuing."

Photographs courtesy of Texas A&M Transportation Institute

Safer at the intersection

LNF OPERATIONS
NORTH CAROLINA, USA

7 A traffic signal study by Bo Lan and Raghavan Srinivasan from the University of North Carolina's Highway Safety Research Center found that converting late-night flashing (LNF) operation to normal phasing resulted in a 48% reduction in total night-time crashes, a 53% reduction in night-time crashes resulting in injury and fatalities, and a 57% reduction in night-time frontal impact crashes.

LNF is a practice in which traffic signals operate in 'flashing mode' when traffic volumes are low – yellow to indicate caution on the major street and red on the intersecting minor street, meaning drivers should stop and proceed after yielding to traffic on the major road.

"LNF saves electricity and reduces delay to drivers, but it makes drivers responsible for looking for other traffic, and errors can happen," says Srinivasan. "Removing such operations may cost drivers a little more time in some cases but will improve safety."

Previous studies also supported this, although the magnitude of crash reduction varied greatly (from 27% up to 78% fewer crashes). Using data for 61 intersections that were converted from LNF to normal phasing operation and 395 intersections that stayed on LNF operation from 2000 to 2007, Lan and Srinivasan estimated more precisely the crash reduction effects when LNF operations are removed.

Circles for life

ROUNDABOUTS
WISCONSIN, USA

8 Every day in the USA, more than 20 people are killed and many more seriously injured in crashes at intersections. Most of these KSIs are the result of right-angle crashes at signalized and stop-controlled intersections.

Investigations by the University of Wisconsin Traffic Operations and Safety Laboratory (UW TOPS) reveal the crash-reducing power of roundabouts. Wisconsin DOT's Patrick Fleming, standards development engineer, says the Badger State has more than 200 roundabouts and a study of 24 of them showed a 52% drop in fatal and injury crashes and a 9% fall for all crashes.

Other studies often cited in their support include the Insurance Institute for Highway Safety and the National Cooperative Highway Research Program (NCHRP) 572, both of which indicate that roundabouts reduce crashes at

intersections where stop signs or signals were previously used.

"The cost of building a roundabout and a traffic signal is comparable," says Fleming. "Plus, roundabouts eliminate the hardware, maintenance and electrical costs associated with traffic signals, which can amount to US$5,000 per year."

Twenty's plenty

20MPH ZONES
LONDON, UK

9 Many Londoners bemoan 20mph speed limits yet the average travel speed of their car commute is just 9.3mph. With 20mph zones and speed limits increasingly being implemented, do they actually have a safety benefit? Figures from the mid-1990s showed that following the introduction of 20mph zones, the average number of accidents in those areas was cut by 60%, the number of accidents involving child pedestrians and cyclists fell by 67% and overall vehicle speeds fell by an average 9.3mph.

The Department for Transport's current guidance encourages and supports local authorities to implement 20mph zones in situations where there is a particular risk to vulnerable road users.

In 2011 in the UK, there were 25 child and 311 adult pedestrians killed in built-up areas. In the same year there were a total of 25,346 pedestrian injuries. Cyclists are also vulnerable in built-up areas and there were 59 cyclist fatalities and 17,789 casualties of all severities.

Reactive force

VEHICLE-ACTIVATED SIGNS
SURREY, UK

10 Vehicle-activated signs have been employed in the UK county of Surrey since 1992, the first being for overheight vehicle detection. By 2005, there were 68 VASs deployed, 264 installations by 2008 at 161 sites and as of June 2009 there were more than 500. Today there are considerably more.

Before-and-after collision analysis of 218 sites highlights the safety benefits of these unassuming traffic tools as well as the return on investment. Across the county, the signs have led to a 20% reduction in the number of KSIs, which Surrey County Council equates to 28 KSIs saved over a three-year period. There's also been a 30% reduction in the number of personal injury collisions (PICs), which translates to 273 PICs saved in the same period.

"That's a saving to the community in the region of £28.6m," a Surrey County Council spokesperson told us. "The average cost of a VAS is £2,500, so that's around £660,000 for the 264 installations. That's a benefit-to-cost ratio of 43:1."

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Reversal of fortune

Having gone from bottom of the class and a deadly disaster to model student in a little more than a decade, Austria's Tauern Tunnel is now regarded as a benchmark in tunnel operations. **David W Smith** learns how ASFinAG has done it

Photography courtesy of ADAC & ASFiNAG

Drivers using Austria's Tauern Tunnel can be sure of one thing. It is vastly safer than it was back in 1999, when one of the most notorious European tunnel disasters killed 12 people and injured 50. At the time, the Tauern Tunnel was rated 'very poor' in the rigorous European Tunnel Assessment Programme (EuroTAP) tests conducted by the German automobile club ADAC. But in the 13th and most recent examination conducted last year, it earned the highest rating and is now held up as a flagship for other European tunnels to copy – a source of great pride to its operator ASFiNAG.

The Tauern Tunnel in Austria now boasts everything a safe, state-of-the-art tunnel needs to score top marks in the EuroTAP assessments

Spending power

The state-owned ASFiNAG – which operates 150 tunnels in Austria – has spent more than €4bn (US$5.2bn) on a wide range of safety programs since 2001, including €212m (US$278m) on the Tauern Tunnel itself, one of the longest frequently traveled road tunnels in the country, which lies not too far from Salzburg. ASFiNAG plans to spend another €1.5bn (US$2bn) over the next six years to add second bores to several of its tunnels, as well as upgrading the escape route systems on a further 81 tunnels.

"The catastrophe in the Tauern Tunnel was a hard hit for everyone responsible for traffic and tunnel safety at ASFiNAG but we've spent a lot of money to meet our goals," says Günter Rattei, a tunnel safety expert at the motorway operator. "So we are very proud of what we've done since, and because of these changes we think Austria has become a pioneer in the area of tunnel safety. Our efforts will continue because any accident is one too many."

There were no safety guidelines at a European level until the 1999 fires in the Mont Blanc and Tauern tunnels, and the 2001 fire in the Gotthard Tunnel in Switzerland. Coincidentally, 1999 was also the year when ADAC – which coordinates EuroTAP – published its very first tunnel safety evaluations. Grades were 'very good', 'good', 'acceptable', 'poor' and 'very poor'.

ADAC testers inspected Tauern Tunnel's nearly 7km-long (4.4-mile) single-bore construction just before the 1999 fire. Rated as 'poor', it ranked near the bottom of the list, which was partly attributable to there being no escape routes other than the portals themselves.

Tauern's first modernization was in 2000, which improved its rating to 'acceptable'. Then, in 2006, construction work began on a second bore, which was officially opened on 30 April 2010. And improvements didn't stop there because the first tube still needed to

be refurbished. On June 30, 2011, traffic ran through both tubes for the very first time.

In the most recent test in 2012, Tauern scored top marks in seven of the eight categories and was one of only two tunnels to receive an overall 'very good' rating. "We can safely say it's now a modern, state-of-the-art tunnel and one of the benchmarks for European tunnels overall," insists Nicolas Adunka, project manager of both ADAC's Test Centre Mobility and EuroTAP. "The foundation of the improvement was deciding to build a second bore. Since 2011, this has made it much easier to introduce numerous technical improvements, especially to ventilation and emergency management."

A control center now oversees operations, with CCTV images beamed back 24/7 to trained operators who keep a watchful eye on the tunnel. In the event of an accident, they can guide motorists to safety using traffic lights and variable message signs, as well as traffic radio and loudspeakers.

"All the measures interact to make the tunnel safer, but the biggest factor is the improvement to detection speeds," Rattei continues. "This includes everything from monitoring smoke and fire to spotting broken-down cars hidden in niches."

Emergency measures

Escape routes are also much easier to access. Both bores have cross passages, leading to safety in either the adjoining tunnel or outside the whole structure. Cross passages suitable for emergency vehicles are present every 1,000m (3,281ft) and there are pedestrian passages every 250-500m (820-1,640ft). There are also lay-bys every 900m (2,953ft) and soundproofed emergency phones equipped with fire extinguishers every 180m (591ft).

(Right) **Tunnel operator ASFiNAG expressed particular satisfaction that its Tauern was one of two tunnels to receive a 'very good' rating in the EuroTAP test, along with the Roer tunnel in the Netherlands** (Bottom right) **Evacuation lighting for tunnel escape routes, showing the escape direction and distance to the nearest exit**

> Because of the completely new ventilation system, the smoke-free zones give people far more time to get to safety
>
> **Günter Rattei, tunnel safety expert, ASFiNAG, Austria**

"The escape routes between the tubes are one of the most important measures," Rattei notes. "We've put in 28 of these in total, of which 17 are for pedestrians and six are for emergency vehicles. It's now much easier to reach a safe haven."

Better lighting has also been installed near the escape routes to aid visibility, which highlights the direction of escape and makes it simpler to gage the distance to the nearest exit. A modern ventilation system also helps visibility by extracting smoke from near the fire. Smoke cannot penetrate the escape routes and doors are fire-resistant.

Signs of improvement

The Wattkopf Tunnel near Ettlingen in Germany has been on a similar journey of improvement as the Tauern Tunnel. Once rated 'very poor' in tests, it now has a respectable 'good' rating.

ADAC experts first inspected it in 2004, at which time its list of problems was extensive. Featuring a bidirectional, single bore with no extra escape or rescue routes, no fire emergency lights, no automatic detection of traffic disruptions and no barriers

in front of the portals, there were additionally insufficient shoulder markings and the ventilation system was inefficient.

A second test in 2008 would have seen a 'good' rating, although the tunnel was downgraded to 'acceptable' due to the fact that it still didn't feature any escape and rescue routes. Plans to build a parallel rescue tube were already underway, though, and on March 30, 2012, a 1.5km-long (0.9-mile) escape bore with six cross passages were unveiled.

The reward for the tunnel enhancement was an easy 'good' rating, although the Wattkopf Tunnel fell short of 'very good' because it has only one bore for bidirectional traffic, which will always remain a potential source of risk.

The heat of the moment

The €1.3 million (US$1.7m) thermal scanner in use in the Karawanken Tunnel is particularly useful for reducing the dangers posed by heavy trucks.

All HGVs and buses weighing more than 7.5 metric tons pass through the scanner on a dedicated lane, with the temperature of the vehicle measured using five lasers. In addition, two infrared cameras record the temperature from both sides. The data is subsequently used to create a 3D image, which is fed back to the control center. The system identifies possible breakdowns or fires that could be caused by hot tires, or overheated turbochargers.

The size of the scanner at the Karawanken Tunnel is unique in Europe. A smaller system is already in place on the approach to the Gotthard Tunnel in Switzerland, although it only records one side of the vehicles.

If the ASFiNAG scanner proves successful, similar systems will be introduced in other Austrian tunnels. Such technology would be particularly useful in tunnels with two-way traffic or those at the end of a long climb or descent, such as the Gleinalm Tunnel, on the Pyhrn Autobahn. Thermal scanners might also be useful for the Tauern Tunnel, as nearly 20% of the traffic is made up of heavy trucks.

"The ventilation system is highly sophisticated," notes Rattei. "We've built four exhaust air systems and four supply air systems in each of the bores. Because of the completely new ventilation system, the smoke-free zones give people far more time to get to safety."

High-tech future?

ASFiNAG is keen to embrace technology to reduce risk still further. For example, it has installed the AKUT monitoring system – rather like equipping a tunnel with ears – at the Kirchdorf Tunnel in Styria. In this instance, AKUT identifies the sounds of accidents using 49 microphones installed near the video cameras inside the 2.7km-long (1.68-mile) tunnel. The 'ears' are incredibly sensitive to unusual noises, such as when a truck brakes heavily, a tire bursts or two vehicles collide. Such infrequent noises trigger the alarm and the control center can respond swiftly. The maximum distance between the sensors is 125m (410ft) and the location of the sound can be identified to within a tolerance of around 100-150m (328-492ft). The biggest advantage of the system is speed of response, which can make the difference between life and death.

If there is a downside to AKUT, it's the high initial cost of at least €100,000/km (US$131,000) of tunnel, which for Kirchdorf Tunnel totaled around €600,000 (US$786,500). ASFiNAG intends to equip more of its tunnels with these 'ears' in the future and is considering whether Tauern would benefit from the system.

Another major trial of smart technology sees a thermal scanner system used in the Karawanken Tunnel, near the Slovenian border. It was installed in March 2012 at a cost of €1.3m (US$1.7m) and uses thermal imaging cameras by the tunnel entrance to measure the temperature of incoming vehicles. Overheated HGVs that pose a safety hazard are diverted to a parking area to cool down.

The high cost of advanced technology is an issue for some tunnel operators and ASFiNAG recommends focusing on critical areas. "The most cost-efficient way is to concentrate on the constant development of the most important systems, such as ventilation, and to perceive the whole facility in terms of risk management," Rattei advises. "Buying all the latest technology is not a sustainable solution for most operators."

Overall, ADAC's Nicolas Adunka has been impressed with the Europe-wide commitment to improving tunnel safety, with the investment into modernization running into billions of euros. "We've seen a revolution in our understanding of how to manage tunnels," he suggests. "IT-based infrastructure and video surveillance are helping. But technology isn't everything. It's important to realize staff training is vitally important and it's here where the Tauern Tunnel scores highly. They have specially trained fire services and CCTV operators. It's not just one measure; it's the sum of all these developments."

Next year represents a significant milestone in the evolution of Europe's tunnels as it is the 10th anniversary of the dull-sounding but vitally important EU Directive 2004/54/EC. This document provides guidelines on tunnel development until at least 2019 and is the basis for EuroTAP's methodology of assessment. EuroTAP will mark the anniversary with a major reassessment of Europe's tunnels.

"We will carry out a pan-European analysis in 2014 to see what our member states still have to do," Adunka reveals. "We'll test between 30 and 50 tunnels to get a feel for the whole situation. The trend has been very positive for the past 10-15 years, but many tunnels don't attain the same levels of safety we see at Tauern. And it will only take one big accident to re-open all the old discussions about tunnel safety." ○

The Tauern Tunnel control center is manned around the clock by trained staff


APRIL 24th
BEST OF ITS AWARDS
NASHVILLE

America's finest

Rewarding innovation in ITS deployment and development, the Best of ITS Awards have firmly established themselves as the premier accolades of the traffic world. **Louise Smyth** meets the stars of this year's show

Illustration courtesy of Iveta Angelova

This isn't the first time we've covered ITS America's Best of ITS Awards, but if the recipients of these prizes were not continually innovative and inspiring, we would have ditched our coverage long ago. The fact remains that ITSA's annual gongs have emphatically continued to do justice to their name; the following pages really do showcase the best of ITS. And here we're talking about best practices, best-in-breed technology, best leadership and, quite simply, achieving the best results.

At the cutting edge

When presenting the awards at ITSA's Annual Meeting in Nashville, Tennessee in April, the organization's president, Scott Belcher, commented: "Each of the winners has demonstrated that they are not only at the cutting edge of transportation innovation, but that they are leading the industry forward". And that is ultimately why such acknowledgments have value in the real world – the fanfare around them gets people to think about whether lessons learned from the winners can be applied in their own jurisdictions.

Belcher also hinted that the competition was much stiffer this year. "With more applicants than ever, each of the winners exemplifies how technology can be used to create a safer, more efficient and sustainable transportation system," he said at the ceremony.

What is interesting is that despite the broader range of entries, the winners were noteworthy in terms of geography. Of the six awards, two were won by Virginia DOT and two by Florida DOT – although different teams were responsible for each project. Of course you can't read too much into this, especially without seeing the entire list of award entries, but it's worth pondering exactly what Virginia and Florida are doing that other states may not be.

The awards, and therefore our coverage, were broken down into two categories – Best Innovative Product, Service or Application and Best Innovative Practice – with three winners in each of the two categories. And over the coming pages you will hear from the winners themselves about why they were deemed to be the stars of this year's show. >

Maximizing network efficiency

Applying predictive algorithms and real-time modeling tools to forecast traffic

The San Diego ICM project went live in March 2013 and sees an innovative system deployed that is designed to manage and optimize all available infrastructure, routes and modes in a proactive and coordinated manner. As part of the USDOT's larger initiative for reducing congestion in metropolitan areas, the San Diego Association of Governments (SANDAG) is leading the San Diego demonstrator project, with Delcan Corporation as systems integrator.

Focusing on a 20-mile stretch of I-15 between San Diego and Escondido, the project combines smart traffic management technologies and introduces concepts never before used together in the USA. The project's Decision Support System (DSS) uses strategies such as network traffic prediction, online microsimulation analysis and real-time response strategy assessment to give system managers comprehensive awareness of the current and predicted future performance of the entire corridor.

Rather than reacting to traffic conditions, managers can now anticipate problems before they arise and take preventative action using ICM strategies such as responsive traffic light synchronization, coordinated ramp metering and bus priority on arterials.

Core to ICM is the ability to forecast and simulate congestion and capacity imbalances in real time or near-real time. The multimodal DSS integrates two tools – the Delcan Intelligent

NETworks ATMS, for field device monitoring and control, center-to-center data fusion, event management and response plan generation; and Aimsun Online, a tool from TSS-Transport Simulation Systems. Aimsun Online uses live data feeds and simulations to dynamically forecast traffic conditions based on the current state of the network, which helps system managers evaluate incident response and congestion-management strategies.

Alex Estrella, senior transportation planner and ICM functional project manager at SANDAG (pictured), sees the Best Innovative Practice award as an acknowledgment that real-time simulation has the potential to completely transform traffic management.

"The San Diego ICM system is unique for incorporating the network prediction subsystem (NPS) and real-time simulation subsystem (RTSS)," he says. "The project transforms transportation management because it is based on a multi-agency and multimodal platform that leverages the application of innovative network prediction and real-time simulation technology, which ultimately helps our transportation partners implement coordinated response plans for managing congestion.

> "The project transforms transportation management because it is based on a multi-agency and multimodal platform

"System managers can now make traffic management decisions based on current and predicted traffic conditions, something that's been missing from ATMS solutions. The ICM will not only change how we can manage congestion but is also a groundbreaking approach for getting the best out of our existing transportation systems to maintain and maximize capacity and efficiency."

Delcan's Dan Lukasik has some advice for others looking to establish a similar scheme: "Establish a strong regional partnership with all agencies and work to gain an understanding of how to operate, both before and during the project."

Lastly, Peter Thompson, senior regional ITS architect at SANDAG, comments, "The truly innovative aspect of this project is not that we did something cool with software – although the Delcan/TSS teams did – but more that the ICM partners provided this region with an approach that finally gives us the opportunity to answer in the affirmative the question, 'Can we be more proactive and less reactive?'"

Ensuring a smooth, predictable trip

Virginia DOT's 495 Express Lanes recognized for use of innovative technology

The first of two wins for Virginia DOT was for a PPP involving the DOT itself along with the FHWA, Transurban as the scheme's operator, and Fluor. Michael Whelan, Transurban's VP of Operations (pictured), picked up an award for the Best Innovative Product, Service or Application. "In Northern Virginia, driving is often synonymous with congestion," he states. "In 2012 Northern Virginians had a solution to constantly gridlocked traffic with the 495 Express Lanes: 14 miles of four new high-occupancy toll (HOT) lanes on I-495. The scheme introduced new traffic patterns, new entrances and exits, a new E-ZPass and new rules of the road. The lanes opened early and on-budget in November 2012."

The scheme features a dynamic tolling pricing system – the first time such a complex dynamic tolling pricing and traffic management system has been implemented. AET is almost a given here, and variable toll prices based on real-time traffic conditions manage traffic in the Express Lanes – providing a regional, free-flowing network. "Car poolers and transit can use the lanes for free with an E-ZPass Flex transponder," Whelan continues. "Other drivers can access the lanes by paying a toll via E-ZPass."

The scheme also has dedicated incident response and a high-tech operations center that Whelan says "combines the technology, infrastructure and personnel necessary for 24-hour operation".

> The scheme introduced new traffic patterns, new entries and exits, a new E-ZPass and new rules of the road

Tony Adams, Transurban's vice president of Infrastructure, proudly adds: "Northern Virginians now have the option for a faster, more reliable trip on the Capital Beltway. The Express Lanes provide much needed traffic congestion relief to drivers around Washington, DC – where traffic is often rated among the worst in the country."

The nearly US$2bn project also replaced US$260m worth of aging infrastructure by rebuilding 58 interchange bridges and overpasses. Dedicated Express Lanes ramps, meanwhile, were constructed to provide convenient access to major employment and retail destinations.

Response to increased workload demands

Streamlining functions and automating manually intensive tasks for FDOT teams

The Operations Task Manager (OTM) software was created to improve the quality of services provided by the ITS Program to the motoring public in southeast Florida. "It enhances the program's output by increasing its internal efficiency in response to our area's growing demands," says FDOT District 6's Rory Santana, who collected a prize for Best Innovative Product, Service or Application.

"The combination of adding new high-profile projects along with new ITS devices increased the daily responsibilities and tasks for our TMC operators, supervisors and support staff," explains Alicia Torrez, FDOT's public information officer. "The team became directly in charge of operating the state's first dynamic pricing facility, posting messages onto the 511 Traveler Information System (TIS) and managing additional roadway events. Faced with the need to produce more with the same resources, the FDOT District 6 Office developed OTM to manage the workload increase and improve internal efficiencies and service quality."

OTM features 10 software modules that, under one interface, support daily traffic management, incident management, traveler information, device maintenance and reporting tasks. The modules automate these program functions to streamline operations. "This improvement optimized our staff's time, which led them to increase their performance and program output," confirms Torrez. "As a result of OTM, in FY 2011, operators published 340% more traveler information messages and updates onto the 511 TIS while responding to 22% more events and performing 60% more event management actions compared with FY 2010.

> This reduction produced time savings for our drivers of equivalent to US$1.7bn

"It also allowed operators to detect 561% more incidents, increased ITS device maintenance support by 215% and enabled staff to sustain the successful operations of the managed lanes project despite increased traffic."

Operations staff were able to reduce the average lane blockage to 27.5 minutes in FY 2011/2012, which is a 45% reduction from the 2005 baseline of 50 minutes. Torrez adds, "This reduction produced time savings for drivers of equivalent to US$1.7bn. As a result, the program's benefit-to-cost ratio is US$36 to 1."

The OTM software was completed in 2012 but there may still be additions as its has been designed to be modified according to operational need.

Statewide ITS infrastructure management

Supporting the needs of ITS managers, engineers, IT professionals, and maintenance technicians

Florida DOT was honored that its ITS Facility Management (ITSFM) project scooped an award in the Best Innovative Product, Service or Application category. Elizabeth Birriel, deputy state traffic operations engineer in the ITS Program (pictured), who picked up the trophy, offers some more detail about the system: "In coordination with its Districts and regional partners, and collaborating with private industry, FDOT State Traffic Engineering and Operations Office (FDOT Central Office), designed the ITSFM system to enable long-term ITS asset and configuration management for all transportation agencies statewide," she explains.

"This system compiles ITS asset information in a single, web-accessible repository, allowing Districts and the Central Office to collectively manage the entire system in a coordinated manner," she continues. "FDOT has dramatically revised its maintenance operations to take advantage of this new tool to gain efficiencies, resulting in major savings and increased system availability and reliability."

The ITSFM system was much needed due to a historical lack of statewide standards for ITS planning and operations coupled with a distinct lack of data. It was built on the robust types of management systems found in the telecommunications industry and designed to manage the overall ITS network. "The ITSFM system is GIS-based and accessible from any internet-capable device, providing ease of access and portability to increase the efficiency of staff – and increase overall use of the system for maximum program effectiveness with a level of control previously not thought possible," Birriel adds.

> "FDOT has dramatically revised its maintenance operations to take advantage of this new tool to gain efficiencies"

The pilot deployments of the ITSFM system have proved that FDOT can successfully solve the challenge of managing its ITS infrastructure assets so that it has a complete understanding of its system 'top to bottom' across agency owners. It has been fully implemented in District 6 and FDOT is aiming to deploy it statewide.

Supporting ITS through PPPs

A PPP arrangement that is greatly accelerating the Commonwealth's ITS program

According to Dean Gustafson, state operations engineer (pictured), Virginia DOT's prize in the Best Innovative Practice category is a "top honor" for VDOT's ITS practices.

"By partnering with broadband providers to construct a network where the infrastructure is predominately owned and maintained by the providers, VDOT has accelerated the transitioning of 111 traffic cameras, three DMS and 17 traffic signal systems onto the network," says ITS communications manager Melissa Lance. "We've reduced our monthly recurring costs while increasing network bandwidth, security, availability and reliability. Maintenance costs for communications infrastructure is reduced, too, as most of the fiber infrastructure is owned and maintained by the resource-sharing partners."

The partnerships were developed through VDOT's Fiber Optic Resource Sharing Program, through which telecommunications providers are allowed to to place fiber-optic infrastructure along VDOT's limited-access right-of-way. In exchange, the providers allow VDOT to make operational use of several strands of dark fiber within the network. The program has been the foundation to the development of VDOT's ITS network backbone. Without these partnerships and the development of their networks, VDOT wouldn't be able to afford to design and construct the current 650-mile fiber-optic network.

> "The program has been the foundation to the development of VDOT's ITS network backbone"

Through agreements with four partners, VDOT deployed a network between its Salem and Richmond TOCs in 2009/2010. While much of the deployment occurred prior to 2011, VDOT didn't actually begin connecting most of the devices and taking advantage until 2011-2012. Lance explains that during that time VDOT was busy connecting the previously mentioned cameras, DMS and traffic signals to its ITS backbone network. VDOT also connected an adaptive traffic signal system along a corridor and provided reliable fiber communications from VDOT's Salem TOC to two remote mountain tunnels, enabling 71 cameras from the tunnels to be remotely monitored from the TOC. Finally, VDOT activated a physically redundant fiber communications path into the Salem TOC to enable a regional self-healing ring.

"Ultimately, it's addressed a lack of reliable communications; high telecommunications installation costs; and operating and maintenance responsibilities," concludes Lance.

Wireless communications deployment

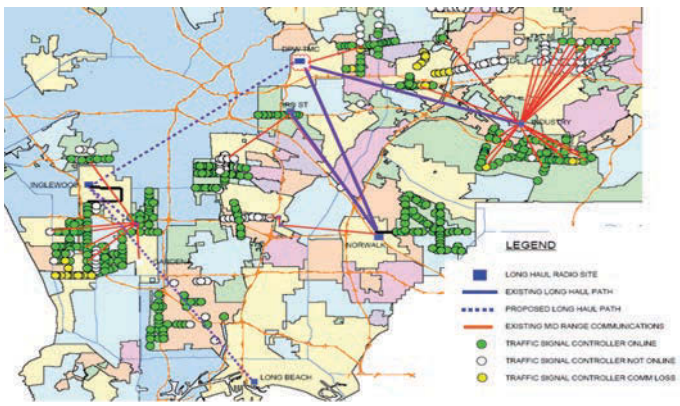
LA County is using wireless communications to traffic signals to cut congestion, costs and emissions

Jane White, LA County Public Works' ITS program manager, is extremely proud of the agency's innovative, wireless communication system deployment. "We believe it is a unique deployment, which has saved Los Angeles County millions of dollars over more traditional communication methods," she says. "We are delighted that ITS America recognized it with this Best Innovative Practice award."

This wireless system is a crucial part of LA County's regional traffic management system and involves the deployment of traffic signal control systems (TCS), primarily using a wireless Ethernet broadband radio communications system (WCS). This WCS includes radios that work in conjunction with twisted-pair cables and fiber. In addition, CCTV cameras are installed at key locations to enable direct viewing of the operation of the intersection in real time. The communication goes from the traffic signal back to the LA County Public Works' HQ in Alhambra. "With LA County as both leader and facilitator, this project seeks to get as many signalized intersections throughout the county as possible connected and communicating to a TCS," says Marty Amundson (right), senior civil engineer and head of Signal Systems section – Traffic and Lighting Division.

LA County Public Works maintains around 1,600 traffic signals, 840 of which are partially or completely within the unincorporated area of the county and 760 in some of the county's 88 cities. When it first took on this role, Public Works found that the communications infrastructure was largely non-existent or included twisted-pair cables interconnecting traffic signal controllers within individual cities. Much of the existing cabling was old. "To establish communication, the primary challenge was to transmit traffic signal and CCTV data over our wide geographic area and relay that information to Public Works' TMC in Alhambra," White says. "It needed to be deployed quickly and reliably. It also needed to be cost-effective, manageable, expandable, flexible and supportable by county maintenance staff.

> "This project seeks to get as many signalized intersections throughout the LA County as possible connected and communicating to a TCS



"The ultimate challenge is to connect and combine both larger and smaller cities' signals into one network that can be efficiently monitored or managed by Public Works and city staff to serve all residents of the county."

The Alhambra TMC, together with eight other city TMCs within the County, is currently connected to more than 1,000 intersections and 50 CCTV sites. So far the wireless system has generated savings of at least US$500,000.

"This project has been successful due to the efforts between the contractor and Los Angeles County," says Larry Pomatto, the project manager from communications system contractor, Systems Integrated. "Each organization was able to use its best resources. The County field crews took on the responsibility to install the radios, which enabled them to develop expertise and they are now able to maintain the devices. It's been a win-win from the start."

"This program has enabled the development and deployment of ITS for smaller agencies that didn't have the means or resources to effectively operate their traffic signals," White maintains. "Before these initial efforts by the County, traffic signals were uncoordinated and there was very limited communication to traffic signals. In addition there was no traffic signal coordination across jurisdictional boundaries."

How is the concept of Vision Zero shaping up in 2013? **Claes Tingvall**, the man behind it all, brings us safely up to speed

Interviewed by Saul Wordsworth

> System providers are really the ones who are accountable; the rest of us just follow the rules and regulations

Two weeks after Claes Tingvall started life as traffic safety director at the Swedish Transport Administration, the then minister for transport, Ines Uusmann, paid a visit. "She said it was nice to have a new director on board," recalls Tingvall, who still occupies the position today, almost two decades later. "She then asked me what my target was – and I told her, 'It must be zero'. She looked at me, smiled and said, 'Let's go with that'.

"Shortly after, the director general came into my office and said, 'A traffic safety director who suggests his target is zero won't be working here very long!' He said it jokingly yet I got the message: it's nice to have dreams but they are just that – dreams. But from that point on, I knew it was going to happen. The minister cited the zero target soon after and it all just clicked into place."

Since then, Tingvall's vision and enthusiasm have helped shaped a whole new agenda globally, winning an army of disciples along the way. His views are shared by the EU and by many countries globally, along with 30 states in the USA. A network of open communication, shared data and regular conferences bind the movement. There's even a new standard for the management of traffic safety, ISO 39001, based on the notion of Vision Zero.

Tingvall remains determined not only to maintain this culture but also to develop his vision, which has evolved since its inception back in 1997. "There has been a shift in the way we view Vision Zero, from an economic way of managing different aspects of the road transport system to a more ethical standpoint wherein life and death are viewed as paramount. Today we see the responsibility lying less with the individual and more with the system provider. They're the ones who are accountable; the rest of us just follow the rules and regulations."

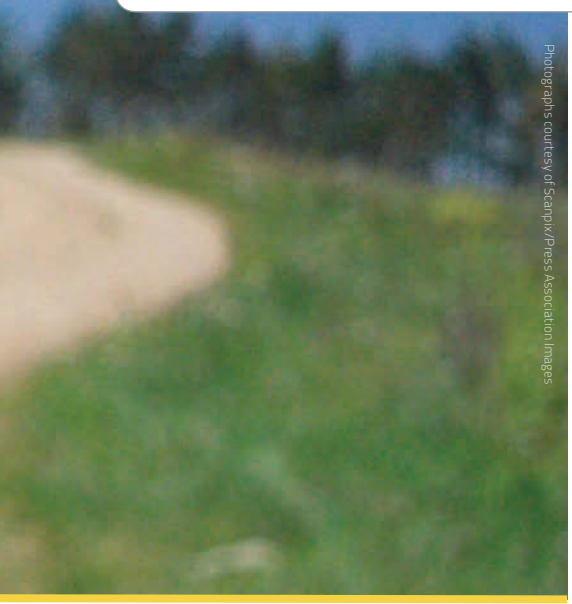
Advancement

By devising – albeit on the hoof – a policy of complete eradication, Tingvall set himself some very extreme aspirations. This meant 'working backwards' from zero fatalities and deciding on the best solutions to reach for the unreachable. His plan has led to solutions that wouldn't have come about were it not for his far-reaching goals. "Volvo and other car makers bought into the philosophy," he continues. "What we didn't expect was competition driving innovation

The secret of my success

The man behind Vision Zero feels his greatest achievement is that he didn't shut up. "I was naïve enough to be persistent," he says. "It felt right to have this kind of policy. At the beginning people either laughed or shouted at me. But the idea – to grow up and take responsibility – seems like the only option if you have respect for the lives of others.

"No one has the right to play god or trade off life, so we had to set the number at zero," Tingvall explains. "It's been extremely tough, especially at the start. Many people resisted taking on that kind of responsibility, saying it was impossible and would limit accessibility, integrity and mobility. It's true these things can be spoiled, but only if you approach the vision in the wrong fashion. Sometimes I ask skeptics whether the vision has had any adverse impact on these aspects. Invariably they say 'Not at all'."



Photographs courtesy of Scanpix/Press Association Images

in the way it has, forcing the pace of change more quickly than we anticipated."

Global picture

The EU's target was to halve road fatalities between 2001-2010. Overall, the figure fell by 43%, a highly commendable near-miss. The results from Tingvall's home country are even more impressive, with the road death toll among vehicle occupants falling from around 500 in 1997 to just 150 in 2012.

"With what we know is on the horizon in terms of technologies to be mandated, we should be able to get this down to around 70 fatalities in 2020," Tingvall says. "Serious injuries to vehicle occupants are also dropping at an exponential rate."

The latest EU target is to halve fatalities yet again, between 2010 and 2020, and to be close to zero by 2050. Numbers are certainly falling. Last year there were around 28,000 deaths on Europe's roads, still a high number but down 3,000 from 2011.

In the USA, meanwhile, road deaths in 2012 increased for the first time in seven years – from 32,300 in 2011 to 34,000, a rise of almost 5%. "In some states their way of dealing with the road transport system is antiquated and features elements discarded by other developed countries years ago," says Tingvall on the upswing. "There's no doubt they're making advances and will see success if they do a lot of the important things. But even when it comes to basic requirements such as seatbelt use and drunk driving, they haven't addressed the problem wholesale.

"In order to be successful you need 100% seatbelt use, 100% sober drivers, good infrastructure, excellent speed management, and so forth, before you really see substantial gains. A number of states have fine safety records but they sit alongside truly horrific ones, comparable with the worst in lower middle-income countries."

One of the positives that Tingvall has witnessed in recent years is the maturation of road infrastructure design, which he says is helping road users to make the right decisions, as well as mitigating injuries by being more 'crash-friendly'. "Outside urban areas, around half of Sweden's traffic flow is on divided roads," he explains. "We've brought in a new speed limit system. Volvo were insistent about their Vision Zero targets but in order to fulfill them didn't want cars going around at 80km/h if the road was unseparated. That's design criteria that other stakeholders haven't necessarily picked up on – the interplay between the modern vehicle and the infrastructure."

One of the greatest potential advances in the march towards Vision Zero is the driverless car. "As little as two years ago people were saying it wouldn't happen," Tingvall recalls. "But already you can buy a car that is almost completely autonomous on highways. Automated driving needs to be supported by the infrastructure in ways we haven't understood fully yet. It will be adopted by the executive car market first but will very quickly move to almost all cars. That's why we are seeing a greater preponderance of 360° cameras, radars and emergency braking. This revolution won't be planned or regulated, it will simply happen – but the infrastructure provider must understand what is going on and work out what is required to support it. Automated driving is not merely another new fad or technology but a move forward into a world that is poles apart from the current one."

Frustrations

The Swedish safety guru says one of his greatest bugbears is the refusal of commercial vehicles such as taxis and buses to lead the way in improving safety standards, in contrast to other industries. In his opinion, this type of traffic sets the norms in communities and their failure to adopt new practices holds the entire industry back.

"Professional traffic should have much higher safety standards," Tingvall suggests. "It should be at the cutting edge. Normally in industry there is great attention to detail with regard to safety and sustainability. The same is not true of the transport network."

Tingvall's complaint relates not only to how such vehicles drive but also how they pick up technology and use it to support their operating methods. "These vehicles tend to emit far more CO_2 than they should, they're not economical, and they have no real management or self-control systems on board. When you consider automated driving, where you exist within a system, there is clearly an awful lot of work to be done. It is vital to stay within the envelope of such a system. You would hope that professional traffic would be the first to go down the automated route as there is so much potential gain, but it doesn't seem to be happening."

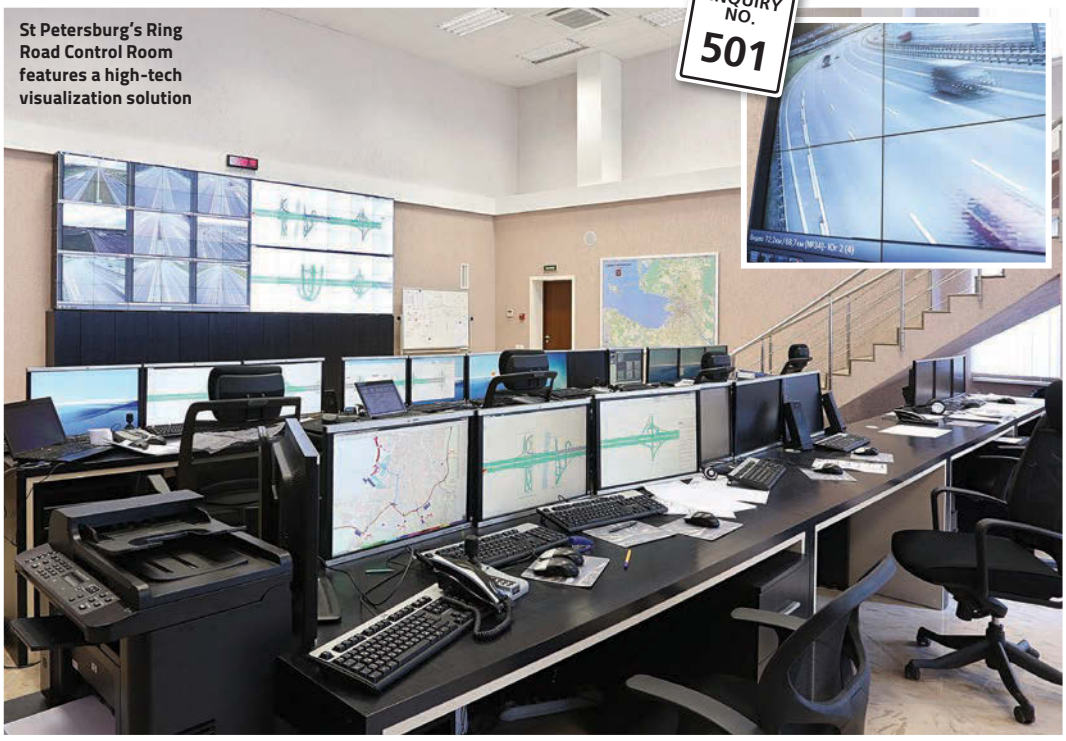
The future

The role thrust upon Tingvall – that of 'Vision Zero Man' – was crucial in the beginning, he feels, as it was "important for someone to stand up and not fall down". Today he is just as happy to remain behind the scenes, bringing on a new generation of visionaries.

"I have a lot of doctorate students I work with and it is great to see the potential of the future," he says. "As for myself, I am determined to stand down before too long. I am nearly 60 years old and wouldn't wish to outstay my welcome like others I have seen, but you have to have discussions with yourself and your ego. I'm so happy and grateful that so many people have believed in my vision, have taken ownership of the idea and developed things that I could not have imagined." ○

Modern take on visualization

READER ENQUIRY NO. 501



St Petersburg's Ring Road Control Room features a high-tech visualization solution

The St Petersburg Ring Road is the city's main traffic artery, linking all the major routes leaving the center for Moscow, Helsinki, Kiev, Tallinn and Murmansk. The Ring Road Control Room was opened in December 2010 and is the most important part of the project. The main contractor was NefteGazOptimizatsiya (NGO), which specializes in developing ITS for roads. The visualization aspect of the project was implemented by Viking, a company based in St Petersburg, and one of Christie's long-time partners. The selection of Christie MicroTiles was central to the decision to create a videowall.

A new ITS system had to be set up to resolve a whole range of issues: increasing the Ring Road's capacity; improving traffic flow; improving road safety; optimizing traffic speed; minimizing the time spent entering and exiting junctions; improving fuel efficiency and minimizing emissions; as well as enhancing the efficiency of road services.

"This is the most important component of the St Petersburg road network, and that is why these road safety issues have been a priority for us," comments Artyom Filimonov, head of ITS operations for the Ring Road. "The intelligent transport system we have set up, of which the control room is an integral part, meets all the present-day challenges that face road traffic infrastructure facilities."

RTA detection

One of the main problems in this location is road traffic accidents (RTAs). The automated, intelligent RTA identification system includes more than 600 sensors monitoring the traffic flow and identifying hold-ups, and more than 60 video cameras which, when in manual mode, allow events on the road to be observed, and in automatic mode are able to recognize irregular occurrences. Without doubt, the 'heart' of the control room is the visualization system itself – a remote viewing display. Created from 72 MicroTiles (in a 12 x 6 layout), it gives a precise, bright, detailed image in high resolution, 24 hours a day, seven days a week, year in, year out.

An intelligent system removes the 'human' factor: an operator may not notice an accident on a given section of the road, but the automated system can identify the spot and notify the operator itself.

The videowall in the control room displays images from the network's monitors and the system's servers. Control room staff are able to look out for events happening along the entire route and analyze them in real time. Content is managed through eight MicroTiles external control unit cards and a controller with eight DVI outlets, eight VGA/DVI outlets, and the ability to be connected to the local network.

"Twenty-six interchanges and 106 bridges, overpasses, flyovers and tunnels: these are significant numbers," comments Michael Eidemiller, head of the project for Viking. "The need for continuous uninterrupted service combined with impeccable image quality was the deciding factor in choosing the visualization technology. This was the first project in which we have used MicroTiles in this kind of installation. The client was convinced they were the right choice following a demonstration of the improvement offered by these small video-projector cubes when compared with the performance of standard-size models. Therefore we jointly decided not to go with the 50in

Need to know?

Specialists have used 72 video projection cubes to create a new visualization system

- Visualization solutions are critical to all modern traffic management and incident detection operations
- The St Petersburg Ring Road is a particularly challenging location that demands high quality traffic monitoring 24 hours a day
- 72 video projection cubes have been deployed in the control room to create a high-tech video wall
- The cubes feature LED lighting, which is a step forward in terms of creating an ever-reliable solution that lasts

or 70in traditional video-projector cubes that we had originally seen."

Another advantage of this visualization system, according to Eidemiller, was the high density of pixels in the images (one pixel measures 0.56mm), and the fact that the display modules are only 26cm deep, with the control input for the video wall on the front surface.

Igor Popov, chief engineer in the Capital Construction and Technical Supervision Department of NGO, says the MicroTiles provide a better image display than that offered by plasma screens. "As the clearance between the modules is minimal – just over 1mm – the eye scarcely notices the divisions in the image, and the picture is seen as a whole rather than piecemeal."

The merits of LED lighting

"MicroTiles are a forward-thinking development, in which the light source is an LED," adds Evgeniy Blinov, Viking's technical director. "Unlike other high-pressure gas-charged lamps, an LED lighting system is not susceptible to sudden drops in power supply, does not require intensive cooling, and has a useful lifespan of around 65,000 hours. The image on the screen is generated by a DLP chip, and the absence of a color selection wheel (color is generated by LED) improves the reliability of the equipment."

Now that they have experienced this advanced visualization system, specialists are looking at extending its application and using the technology in other projects.

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I was recently sitting in a taxi as it passed by a well-lit, glass-enclosed gym. As we waited at a traffic light, I watched the people inside on their elliptical machines and stationary bikes burning all that energy and I had a thought. What if we used those machines to recapture some of that energy? By moving the treads and pedals, perhaps we could recharge the machine itself. Then my trail of thinking went to the taxi I was riding in. What if the road was treated like those exercise machines and we could recharge the taxi? Thinking of the millions of miles of road just laying there, I saw the potential for a giant opportunity to supplement our existing energy supply. As it turns out, some researchers and engineers apparently read my mind and have the same idea: using roads to help address our growing global energy problem and climate change.

One promising technology that could have a significant impact in how the world consumes energy is the piezoelectric generator. When vehicles travel over a roadway, a certain amount of ambient mechanical energy is transferred onto the road. Engineers at Innowattech Energy Harvesting Systems have developed a system using piezoelectric generators to harness those stresses, strains and vibrations from passing vehicles and convert them to usable energy. Known as the Innowattech Piezo Electric Generator (IPEG), recent tests have shown that a little less than a mile of a piezoelectric roadway can generate half a megawatt of power (assuming four lanes carrying 1,000 vehicles per hour). All of that energy that normally would have gone to waste could be collected and used to power street lamps, traffic lights, or even be connected to the local energy grid to power nearby homes and businesses.

Another energy source that can potentially take advantage of our countless miles of roadways is solar energy. An electrical engineer named Scott Brusaw came up with the idea of embedding solar panels into roads and other outdoor paved surfaces. In 2010, he developed a prototype solar panel, strong enough to withstand moving traffic, yet translucent enough to allow sunlight through. His invention, Solar Roadways, may well be a key element in reducing our dependence on burning fossil fuels. If his solar panels replaced all of the paved surfaces in the USA alone, he estimates that it would generate nearly the amount of electricity needed to power the entire world.

As an added bonus, the panels could be integrated with LEDs, allowing them to emit pavement markings and warnings that could change on the fly. Accident up ahead? The road's LEDs can spell out "SLOW DOWN" in the pavement to warn oncoming traffic. Sensors could also be installed to detect animals crossing the road and warn drivers in advance. Heating elements could also be embedded in the panels to prevent the roads from icing over. Ultimately, using magnetic induction technology, the panels will be able to transfer power wirelessly to electric vehicles. This would enable electric vehicles to travel much further distances than possible today.

When it comes to the future of ITS, we often think of self-driving cars, GPS and all manner of high-tech gadgetry. Yet we seldom hear anything truly revolutionary with the infrastructure our cars drive on. Well, if these recent innovations are any indication, the highways of the future may be far more intelligent and efficient than what we drive on today.

> As an added bonus, the solar panels could be integrated with LEDs, allowing them to emit markings and warnings that could change on the fly
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

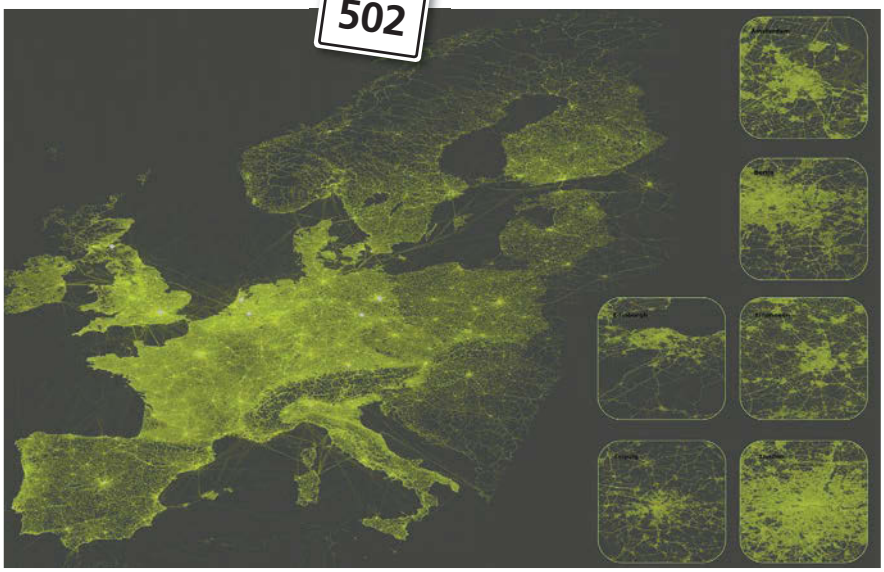
The power of navigation and real-time traffic

READER ENQUIRY NO. 502

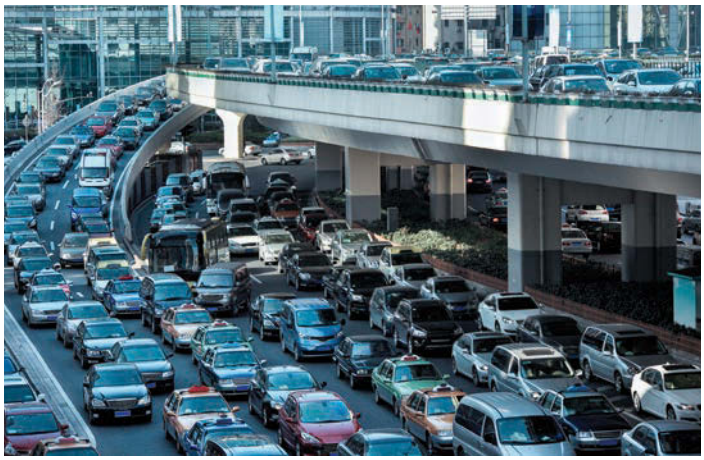
Friday September 21 was Los Angeles' worst day for traffic in 2012, attributed to the space shuttle Endeavour's low-level flyover in the skies above the Californian city – everybody stopped to take a look. For Seattle, it was Thursday January 19, when Governor Christine Gregoire declared a weather emergency as an ice storm swept into the state of Washington. And in San Francisco it was Thursday June 14 – a fire at Oakland Station temporarily shut down Bay Area Rapid Transit (BART).

TomTom's Nick Cohn says the traffic data specialist can't always be sure of the reason for the congestion when it peaks, unlike these examples from the company's *Congestion Index Report*, its barometer of clogged roads in the world's major cities. But what he is sure of is the accuracy and completeness of the floating car data being collected by the probes that TomTom has out on the roads, detailing precisely how quickly or otherwise traffic is flowing.

Once upon a time these anonymous probes would have just comprised TomTom's aftermarket navigation devices and its factory-fitted systems within the vehicles of its OE customer base (fleet customers included). Authorities' existing data from traditional data collection sources was also merged, as were GPS signals from cell phones. Now, of course, it includes data pulled in from TomTom's real-time traffic apps that users have downloaded onto their smartphones. "We started to extrapolate this speed data back in 2007 and now we have a speed database created for around 40 countries on six continents that boasts more than six trillion individual measurements – and it's growing all the time," says senior business developer Cohn. "It's the world's largest database of historic travel times and the most detailed and accurate real-time traffic information you could find. When we began collecting it, the idea was to improve our navigation in a static way, but then we developed the real-time service and the scale increased enormously – not just in terms of the number of probes but the amount of applications, the markets that we serve and even the scale of the competition."



(Left) **Example of plots of anonymous GPS measurements in Europe from a few months of TomTom probe data** (Right) **Schematic shows the continuous cycle of data sources being fused and the resulting services being disseminated**



(Left) **Detailed knowledge of the entire road network helps businesses and governments make more informed decisions about how best to tackle and avoid congestion**

Need to know?

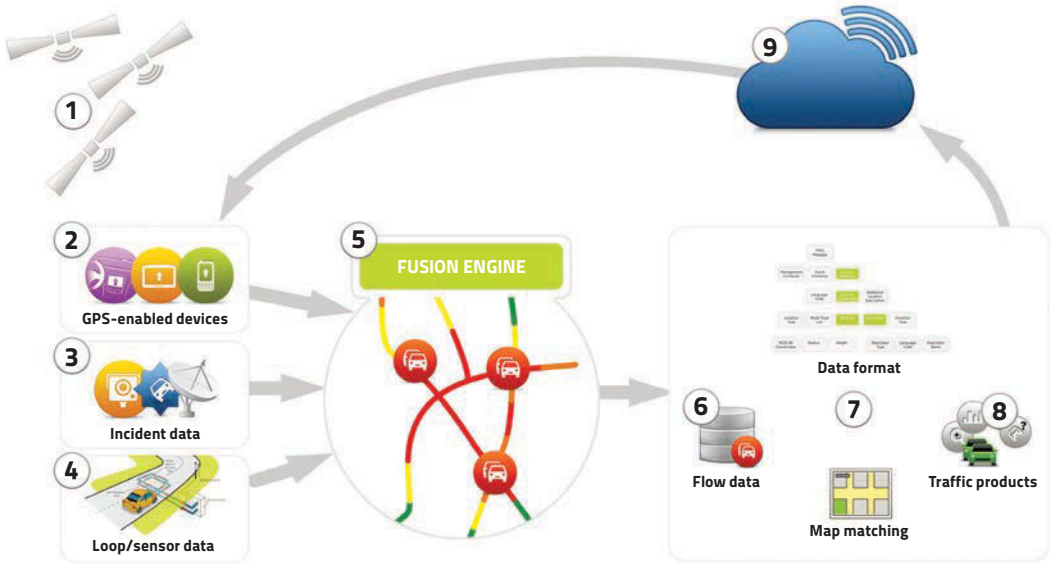
Using floating car data to support decision-making by both road users and road authorities

- Providing the general public, industry and policy makers with unique and unbiased information about congestion levels in urban areas
- How assisting drivers to find faster routes can also increase the total capacity of your networks
- Helping to identify and pinpoint congestion trouble spots more effectively

Major influence

Floating car data has evolved greatly since 2007 and is having a huge effect on the way DOTs manage their roads. As for road users, once that data's been crunched and disseminated as travel information, it's empowering them to travel smarter than ever before.

"Actual driving speeds and road conditions are absolutely



critical to the road travel experience as well as trip-related decisions made by individual drivers," Cohn confirms. Meanwhile, at a more holistic level, they inform about overall mobility and accessibility conditions as well as associated economical and environmental costs for users and planners. "If you know where the congestion is actually building up, you can make more informed decisions about where and how to invest, whether or not to consider adding capacity or deploying new technologies," he adds.

TomTom's *Congestion Index Report* was created for this very purpose. First published in 2012 and showing first quarter figures, it identifies areas of concern and assists in the investment decision-making process. Using a single, uniform data source collected from the navigation users across multiple countries and continents, the report is a benchmark of traffic performance, making it possible to evaluate congestion levels in a much more objective way.

Smooth operator

One of the many operators that's embracing floating car data is VMZ Berlin, which runs the German capital's Traffic Information Centre, for which TomTom is providing real-time traffic information not only for Berlin but also selected parts of the state of Brandenburg. "By using our HD Flow traffic product, they're able to react much faster to traffic congestion and improve traffic information for the people, businesses and media outlets reporting traffic updates," Cohn suggests. "They're seeing more reliable speed measurements on more of their network – that's the biggest benefit if you're comparing the benefits of floating car data to traditional technologies such as loops, cameras or infrared."

Potentially, then, could we eventually abandon embedded or existing wireless devices and rely solely on GPS, Bluetooth or even connected vehicles? "I think that could happen fairly quickly," Cohn says. "What it would do is make a lot of cost-intensive strategies such as Active Traffic Management feasible financially and help to speed up deployment. DOTs wouldn't have to spend millions and millions installing a huge, complex system. By calling upon a fairly simple data feed and using what's already out there in the field, they could monitor what's happening much more accurately, in true real time, and realize some of the benefits you're seeing on schemes such as on the M42 in the West Midlands in the UK, in the state of Washington, in the Netherlands and in Germany."

Cohn is adamant there's now much less hesitancy on the part of road authorities to consider floating car data as a viable traffic management resource. "We know they have responsibilities and legal requirements," he accepts. "They've always been in control of all their data collection in the past so any reluctance to a dependency on an external source provided by a third party was perhaps understandable.

"But times have changed and there are various models, such as in Berlin where floating car data is just part of the overall mix. It adds coverage without having to invest in more fixed systems. Some authorities tell us they have so many cameras and detection systems hanging up everywhere that they simply can't deploy any more – yet they do want more coverage of their networks – on their highways, major and secondary roads and local roads – hence why they're interested in our data feed."

Authorities are also becoming more proactive in alerting TomTom to changes on their networks – roadworks, road layout changes, speed limits, etc – which helps TomTom to improve its map data quality and ultimately, the quality of its offering.

Add connected vehicles into the mix and the way we travel and the way our roads are managed could alter irrevocably. "A lot of exciting things are materializing with connected vehicles entering the fray," Cohn says. In fact, the map data provided by TomTom and others could become the bedrock of automated driving and assistance functionalities. "It all starts with totally reliable information about the road geometry, about speed limits, about curvature, gradient, etc – everything about the road environment itself," he adds. "With that connectivity you can do so much more. Things will be much more intelligent, more effective, much safer, cleaner, quicker, less stressed. And that's good for everyone."

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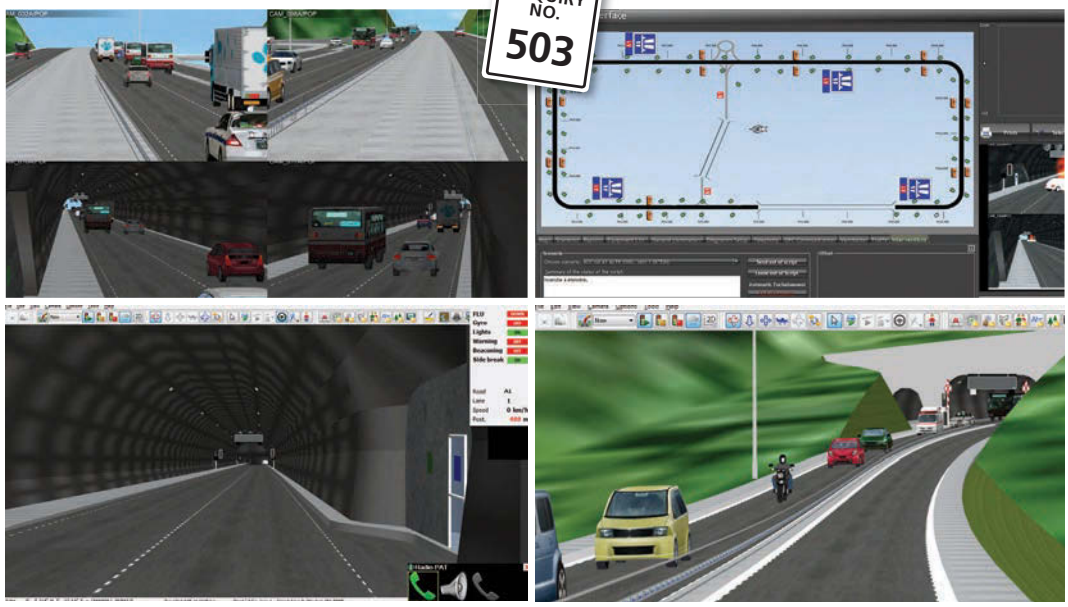
Software tool to support safety training on roads and in tunnels

READER ENQUIRY NO. 503



The operation of highways has become increasingly complex in recent years. Highways and tunnel facilities have been upgraded with sophisticated measuring and control technology. Comprehensive monitoring systems, coupled with automatic event detection, allow immediate access to information. It is now possible to respond to incidents immediately – although sometimes incorrectly.

The increasing complexity of infrastructure coupled with technological progress increases the need for more extensive instruction and training of operating personnel.

While professional requirements for employees of traffic monitoring centers are well defined, they are specialized requirements that are not generally found on the job market. Therefore, employees from many different types of professional backgrounds are often recruited to these positions, meaning that all operating staff to be trained must work under the supervision of an experienced person only. The common practices are "on-topic" training and "learning on the job".

The need for operating companies to familiarize future operators with potential event scenarios under realistic conditions, safely and without disruption of ongoing operations, was the driving force for the development of the Simcoach simulator, an Egis Road Operation solution.

Simcoach was developed as a portable simulation environment with a modular structure. The trainer goes directly to the operating companies and leads the training session on-site.

The mobile aspect is essential, since the target groups are often working on a shift schedule and, as a result, external training programs often fail due to the duty rotation.

The software is designed for specific groups of employees and concessions: traffic management operators, tunnel operators and patrollers, who will each get their own working environment in a customized virtual reality. The simulator consists of three positions.

The first position is for the control room operator. This includes a supervisory screen for graphical representation of processes on the user interface, which reflects the status of the technical equipment in real time and allows the management of the operational processes. This mode also features an alarm screen with status and error messages. Emergency messages are transmitted visually, where they are acknowledged on the alarm screen and the necessary emergency measures are initiated. Finally, this position has a video screen that offers the ability to display four cameras as well as a wall screen.

The second position is for the patroller. This consists of a multifunction steering wheel and a screen. All the actions of the patrollers are controlled by way of the steering wheel.

The third position is for the trainer. Through this interface, the exercise parameters – such as the type, distribution and volume of traffic, meteorological conditions, visibility and the size of the available equipment – are entered and determined, and the operating status is then influenced. The trainer launches operating scenarios and develops them further in the course of the exercise. The trainer also serves as the interface with all external parties involved in managing an incident – such as fire departments, emergency rescue services, police and breakdown services.

Finally, a telephone network enables communication between operators, patrollers and a third party; this can be supplemented by a wireless network as well.

Need to know?

As roads and tunnels get more complex, smarter software is required to train those tasked with managing them

- A new software product has been developed to improve traffic management operations training
- The virtual reality offers different modes for control room operators, on-road patrollers and the people conducting the training
- Simulation can teach staff how to react to situations that they would rarely experience in the real world

The virtual environment

Simcoach was developed using a 3D traffic simulation software with the ability to generate

(Far left) **Screenshots from the Simcoach software**
(Left) **Tunnel management training being conducted**

traffic in a realistic and interactive environment, to generate incidents, to simulate the behavior of the operating systems in the field and to provide the generated states via available virtual cameras.

The simulator's "playing field" is a 12.3km-long two-lane highway, crossed by a 2.5km-long national road, connected by two junctions. Two tunnels are embedded in this virtual environment.

The first tunnel is a twin-tube system. Each tube is composed of two lanes without hard shoulders. The tunnel is 1,500m long and is located on the highway. It displays five emergency niches per carriageway.

The second tunnel is a single-tube tunnel with one lane in each direction without hard shoulders, and is located in the area where the national road crosses. The tunnel is designed with a parallel service tube accessible via three cross-cuts. The second tunnel also has fully equipped emergency niches.

Fixed operating equipment

The virtual highway, national road and tunnel facilities are provided with complete fixed operating equipment. However, this equipment is variable, and can be suppressed or added to.

On the virtual highway, the equipment provides complete video coverage via available pan/tilt/zoom video cameras and a network of emergency roadside telephones and traffic counting stations.

In addition, the tunnels are equipped with barriers at the portals, jet fans, extractors, lane control signs, VMS, traffic lights, speed limit signs, cameras for automatic incident detection, traffic counting stations, fire detection and CO/NO-sensors, opacimeters and more. A system of alarms and detection is associated with this equipment.

This allows the operator to manage the equipment and the traffic just the same as in real situations. It means the operator can apply his or her own procedures and management plans, and also understand the role and action of each piece of equipment.

Since mid-2012, safety training using Simcoach has been performed in several operating companies of Egis Road Operation in various environments in countries including France, Portugal, Croatia and Poland.

The preparation and planning of safety training requires a detailed analysis of current business processes by the instructors, but is essential for the development and subsequent evaluation of scenarios. An easy adaptation of the virtual infrastructure to the site's technical equipment, and the adaptation of the system language to the local language, completes these preparations. After a short introduction, the employees being tested become familiar with the virtual environment as it is very similar to their own workplace.

The actions carried out by the operators and the patrollers during the management of accident and fire scenarios, their reaction under stress and their ability to communicate and interact with the third parties involved in the events are followed with interest and assessed through a joint debriefing. Through automatic recording in a report, the accordance and conformity of the actions with the procedures of the operating companies are testable. As a result, the report can subsequently be used as a basis for meaningful changes in the local procedures or for possible further specific personalized training needs.

The simulation of fire incidents will not entirely replace traditional fire drills, but it quickly increases the level of knowledge of staff without the enormous organizational efforts that a real fire drill involves (closing of the motorway, coordination with the fire brigade, etc). It also allows the training of more operators, in more varied situations, because several scenarios can be played in the course of a single afternoon, ranging from a 'simple' incident, such as an object on the road, to a more complex accident, with debris or a fire. This way, in a short period of time, the operators and patrollers can be exposed to a variety of situations that they would only encounter in real life over a long period of time. The simulator provides the added advantage of being able to make mistakes and correct them, before the operators or patrollers need to get it right the first time in the field.

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Next generation of pedestrian detection

READER ENQUIRY NO. 504

When it comes to improving safety and efficiency in urban areas all around the world, pedestrian detection technologies play a hugely important role. Since their conception, the SafeWalk pedestrian presence sensors from FLIR Intelligent Transportation Systems (formerly Traficon) have been making a positive difference to urban locations across the globe. This video-based detection of pedestrians allows for the dynamic control of traffic lights and warning lights, such as flashing beacons. Now SafeWalk is also able to see how crowded the curbside is, making it possible for traffic managers to run their intersection even more efficiently.

Seeing how busy a sidewalk is, in other words 'occupancy detection', is a very useful capability when it comes to intersections that have varying pedestrian patterns. Imagine a crosswalk near a sports stadium before an important football game compared to that same crosswalk on a regular weekday. Compare a city crosswalk during rush hour with that crosswalk during a quiet early afternoon. Clearly, those are completely different traffic situations. The new product's occupancy detection capability will easily handle those varying pedestrian patterns.

Need to know?

The latest evolution of an established pedestrian detection solution

- Now incorporating occupancy detection, the next generation of the SafeWalk product is finding new applications as well as new customers
- Being able to assess occupancy assists in tasks such as traffic signal timing coordination
- The new technology also offers benefits to city planners due to the valuable data that is logged

Urgency of green time

It makes good sense to give priority to a group of pedestrians to allow them to cross the street safely. However, when a single pedestrian is crossing the street and thereby interrupting a steady flow of busy traffic, there is an imbalance. Clearly, the benefit of pedestrian priority should be weighed against the mobility and efficiency of traffic in general. This is where the new SafeWalk comes in. Not only does this product detect the presence of pedestrians on the curb, it also takes into account the occupancy of pedestrians in that particular sidewalk zone. This means it is possible to decide that pedestrians are given green time ahead of vehicles only when a certain number of pedestrians is present. In other words, the more people occupying the zone, the more urgent the green time becomes.

Adapted crossing time

Larger groups of people need more time to cross the street. Another application of the latest generation of the SafeWalk system is to adapt the time to cross according to the number of people detected. In addition, the time provided to cross can be displayed on counters.

Walking around campus

American university campuses are typical examples of places with varying pedestrian patterns. Not only is there a difference between pedestrian traffic during classes and at the time when students are let out, university campuses also see different pedestrian traffic patterns at crosswalks close to other facilities such as university sports stadiums or athletics sites.

A university in the state of Texas recently called upon FLIR Intelligent Transportation Systems to evaluate the new SafeWalk with occupancy detection. The university was focusing on six different intersections with traffic from visitors and students present all day, every day, combined with temporary peak traffic from the nearby campus sports stadiums. The environment required a detection sensor that could give different pedestrian traffic light green times based on the occupancy in the zone of detection, for example, normal operation versus heavy traffic during major events.

"Installations such as this are very efficient in combining pedestrian safety with mobility and efficiency in general," comments Farid Semmahi,

The SafeWalk system now features the ability to conduct occupancy detection

US technical support manager for FLIR Intelligent Transportation Systems. "This technology is an ideal fit for any college town in America that also has sports stadiums."

A matter of statistics

The new sensor with occupancy detection will also help statistics. City planners responsible for installing new pedestrian or bike facilities, such as crosswalks, sidewalks or bike routes, rely on real data to build their case. Data on the occupancy of pedestrians or other vulnerable road users for a given traffic environment is essential for the decision on whether it makes sense to make the investment. By logging the data that is generated by SafeWalk in real time, a clear view of the pedestrian traffic can be given.

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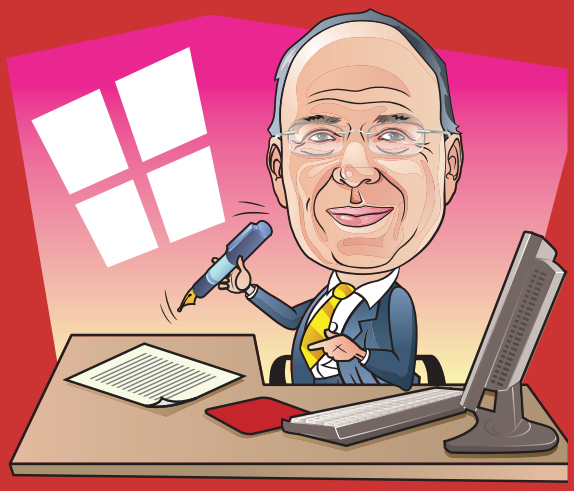

Larry Yermack

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An Open Letter to Secretary Designee Anthony Foxx…

I've wanted to write to your predecessor at the DOT many times but fell into the all-too-common trap of not wanting to be critical of The Secretary. Actually I rarely read any criticism of your predecessor despite the fact that I couldn't find anybody who had much good to say about him. The truth was that he neither had a deep background in transportation, nor did he listen to the industry. When he did speak at conferences, he didn't engage with his audience. He did have one cause though. Don't get me wrong, distracted driving is a serious issue but it's only one of many issues in our transportation system and he seemed to be consumed by a limited focus.

You have had a broad experience with delivering transportation services and that's what we're all about in this business. We start out with a lot in common.

We have all heard a lot over the past few years about the condition of the infrastructure and the declining resources to address it. Frankly we lost the past four years as we were distracted from the real problems and got caught up in the No Tax chorus. But now you have a new four-year slate and I hope that you use it well. Transportation has been non-partisan in the past and maybe it can be again.

So let me be so bold as to make a few suggestions. First I think you need to engage with this professional community and need to listen to what they have to say. It's made up of dedicated and smart folks who have thought deeply about the issues. Don't just call a meeting of the 'experts' and invite them to your office, but really open up the dialogue. Go speak at the major transportation conferences such as American Association of State Highway and Transportation Officials (AASHTO), ITSA (ITS America), American Public Transportation Association (APTA), International Bridge, Tunnel and Turnpike Association (IBTTA) and the American Road & Transportation Builders Association (ARTBA). Challenge them to offer solutions and after you speak, have an open forum with the attendees. You will learn a lot about what can be done!

I will share my prejudice towards ITS as a way to relieve the pressure on the infrastructure, relieve congestion, save lives and improve the environment – so I'd like to see that as a major part of your agenda. The leaders of the state DOTs are starting to recognize that microchips and telecommunications offer more cost-effective ways of managing congestion than asphalt, but those trends need reinforcing from the top.

Finally, you may not be able to solve all of the problems in Washington so the states will need more flexibility to solve the problems themselves. It's no longer reasonable to live with a shrinking Trust Fund and also prevent the expansion of tolling. However, as user fees are resisted at the local level, leadership by you to endorse the concept of the user pays could go a long way.

I'm really glad to see a DOT Secretary with your experience taking over. I hope that this can be the start of a beautiful friendship.

> I'm glad to see a DOT Secretary with your experience taking over. I hope that this can be the start of a beautiful friendship
>
> **Larry Yermack, Wendover Consult, USA**

Optimizing tunnel safety and availability

READER ENQUIRY NO. 506

For traffic expert Dr Thomas Sachse, two of Siemens' road tunnel installations in particular highlight the safety strides that have been made since Directive 2004/54/EC came into force on April 30, 2004. But as well as these projects in Turkey and Berlin being benchmarks, they're also a reminder that many other tunnels within the European Union fall woefully short in terms of safety and security.

"Our Turkish Black Sea project on the Espiye-to-Sarp freeway is one of our flagship road tunnels and was completed in under two years," reveals Sachse, whose 24 years' experience in motorway and tunnel control covers control

(Left) **All the control and monitoring processes of the 29 tunnels are coordinated from the Trabzon TOC** (Above) **Systems from Siemens can recognize any traffic flow disruptions and activate alarms as necessary**

models and algorithms, automatic incident detection, situational analysis, and evaluation of road transport informatics. "The freeway itself runs for 359km along Turkey's northern coastline, and we provided many solutions and subsystems for its 29 tunnels, which span 33km. At the core is our Sitraffic International Tunnel Control Center (ITCC), which is based on our Simatic WinCC Open Architecture."

Seamless interaction between the subsystems and components is a prerequisite to ensure the highest safety levels, improve tunnel availability, and lower operational costs. "Turkey's General Directorate of Highways, KGM, wanted a solution that could be administered centrally, 24/7, from the Trabzon control center," Sachse continues. "In addition to this main control center, another six substations were installed and enable the various sections to be monitored independently at any time."

But these systems aren't just monitoring the traffic inside the tubes – they're controlling lighting, ventilation, power distribution and supply, as well as coordinating fire detection, firefighting, and much more.

Need to know?

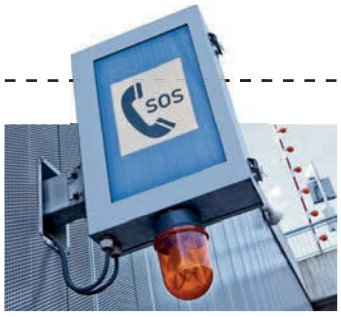
Drawing on a tradition of innovations in the fields of fire and incident detection, evacuation and response

- Optimal operational safety and efficiency as a result of integrated multidiscipline system management
- Improving compliance with national and international safety regulations
- Holistic tunnel safety solutions that deliver measurable long-term value
- The modular tunnel control center – universal and individually adaptable

"Because of the technology deployed, the Espiye-to-Sarp tunnels are easily among the most advanced traffic arteries in the world, with unprecedented levels of traffic intelligence and safety," notes Sachse confidently.

Command and control

And the overall significance of the US$88m project to Siemens is evidenced by the sheer scale of the deployment. Around 389 fixed and 44 moving cameras have been installed, each of which features AID, while 125 electronic message signs are in place to display relevant information to tunnel users. "These are controlled by the supervisory control and data acquisition system," confirms Sachse. There are also 825 speakers to deliver audible information if necessary, SOS communications devices placed every 200m, fire-resistant emergency pass doors between the tunnel tubes, nearly 4,000 lighting fixtures, 1,860km of power cabling, 150 sets of low-voltage boards, 140km of cable trays, 140 jet fans, and 89 sets of variable traffic signs. And all of the above systems are as high-tech as they come. "As an example, the illumination and ventilation is adapted automatically to the conditions and traffic situation, which



(Far left) **A highly modern automation system maximizes the safety of the tunnels along the route** (Left) **Safe havens and emergency measures are positioned at regular intervals throughout**

further enhances safety and comfort," Sachse notes proudly.

Siemens tunnel management solutions are designed to combat every eventuality, including hazardous goods detection, modern smoke and fire detectors, wrong-way driver detection, incident warnings and environmental sensors to name just a few. "We have tools that constantly monitor NOx levels, for instance, visibility range and wind velocity, and an algorithm calculates which and how many ventilators or jet fans have to be activated.

"Fire and smoke detection systems have been improving for several years, so much so I'm not sure how much more effective they can become," Sachse adds. "The detection of critical vehicles much earlier is thus key, such as monitoring for overheated vehicles with copper and fiber-optic cables to sense heat build-up, which could help prevent the types of disasters we've witnessed in the past.

"Knowing in advance what types of hazardous loads are being transported also makes it easier for emergency services to respond accordingly should something go wrong, or adjust operations to permit safer passage through the tunnel."

In that regard, Sachse points to Siemens' recently developed Sicore ALPR camera, which reads the vehicle plate, the nationality and the Kemler and UN codes on the hazardous material sign, with the resultant data displayed for assessment and easy analysis in the back-office. "Knowledge of what you could be dealing with at an incident can make a big difference," he maintains.

Complex environments

Sachse is no less proud of the Tunnel Ortsteil Britz (TOB) in Berlin, a six-lane underground artery on the A100 in Germany's capital city. "At 1,733m, it's the longest tunnel in Berlin, but due to its design, the number of curves, etc, accidents have occurred in the past," he says.

Technologically the TOB is now up there with the best in the European Tunnel Assessment Programme (EuroTAP). In all, 21 radar detectors extract lane data once every 15 seconds, in doing so providing insight into traffic density, speed, the number of cars and lorries in the tunnel, the average speed and standard deviations, etc. Meanwhile, permanent two-way light signals optimize traffic flow by opening or closing specific segments and regulating and harmonizing speed. Electronic height controls above the tunnel entrances automatically shut the tunnel if over-height vehicles attempt to gain entry. "The tunnel contains more than 700 different VMS, barriers, insert lights and traffic lights," Sachse reveals. "It's a tunnel that requires special treatment due to its complexity in this urban environment. To do this effectively, the Como software module is used."

With advances such as these, the risk of being involved in an accident in a road tunnel is now much lower than out on the open road, although the outcome of a tunnel accident is usually more serious. "The control system and the operator are just parts of the overall system. The driver is another part," Sachse cautions. "You can equip tunnels with lots of the latest kit, but you can't legislate for drivers behaving inappropriately or not knowing how to behave. Many of the drivers who have died in road tunnel accidents might still be alive today if they knew how to behave in an emergency. Others just behave badly. We often observe drivers proceeding into tunnels regardless of red crosses on the VMS or traffic signals being red – we've even seen them trying to beat the barriers!

"Tragedies such as those in the Mont Blanc, Tauern and Gotthard tunnels are fortunately rare, and although we'd like to think they'll never be repeated, only through enhanced detection and monitoring and better situation management can you mitigate the risks. Updating tunnels in accordance with Directive 2004/54/EC takes time and planning, but as our projects in Turkey and Germany show, with intelligent, scalable and flexible solutions, you can really stay on top of any situation."

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Cameras to detect cracks in tunnels

READER ENQUIRY NO. 507

In order to assure their safety, tunnels must be inspected on a regular basis to detect and document defects such as cracks, scales, spalls and corrosion at an early stage. In the past, this has often been done using traditional procedures such as manual recording from mobile scaffolding. But this method can only file cracks that have been detected visually by the people inspecting the tunnel surface. This procedure is time-consuming, labor intensive and subject to a high degree of interpretation. So the time was right to develop a new technical solution to survey tunnels economically – an automated and systematic tunnel inspection approach with complete documentation.

Swiss engineering company Terra International Surveys, located in Zurich, has done just that. Using the company's vast experience in civil engineering, hydrography, digital photogrammetry, GPS surveying and cadastral surveying, Terra's engineers designed a novel tunnel inspection system called tCrack, as well as the necessary software for evaluating the captured data. It combines digital high-resolution Basler pilot cameras with absolute, kinematic positioning technology. The system is being used successfully in the famous Gotthard Base Tunnel in Switzerland, and has proven to be very reliable in tunnels of up to 25km in length, accurately detecting, classifying and documenting cracks within pre-defined tolerances.

No cracks left undetected

The tCrack system includes 10 Basler pilot cameras mounted on a site vehicle such as a locomotive in tracked tunnels, or on a cart in tunnels without railway tracks. The vehicle is driven along the center of the tunnel so that the cameras can scan the entire walls and surfaces. All 10 cameras capture images simultaneously and are controlled by a central computer mounted on the vehicle. Individual image strips, each covering a tunnel surface area of around 10mm width, are stored in separate files. The strips are then automatically merged into continuous overlapping images, providing a complete picture of the tunnel's condition. The inspection vehicle can travel at around 2.5km/h, handling and processing the data collected from the 10 cameras. This means that the tCrack system can inspect one 10-15km tunnel per shift.

New levels in tunnel safety

Gabriele Kadner of Terra International says, "The camera requirements were challenging – they needed to be very reliable, easy to handle, and had to deliver excellent image quality. We decided to go with Basler's 5MP pilot cameras because they best fitted our requirements. We are very excited to be able to offer this efficient and reliable system, which takes tunnel safety to a new level."

Terra International's solution is now used regularly for tunnel inspections because it collects much more detailed documentation than other technologies, especially manual ones, and increases system reliability. It also reduces the overall time spent in a tunnel, making the inspection process more efficient and cost-effective.

Need to know?

A camera-based solution can bring huge gains when it comes to tunnel safety

- Road tunnels require regular inspections to ensure they are safe
- In the past, visual detection of cracks was required, but a more modern solution is to use high-quality cameras instead
- As well as being highly accurate in detecting cracks, the cameras also mean the inspection process can be automated, which is a big benefit to tunnel operators

(Main) **The pilot area scan camera** (Above) **The tCrack system at work in a Swiss tunnel** (Left) **An engineer sets up cameras and lighting**

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Analyzing traffic at intersections

READER ENQUIRY NO. 508

Driving across an intersection in an urban area is a complex task. The large number of vehicles and multiple driving directions, and the resulting possible conflicts, increase the demands on the driver. This is reflected in the increased number of accidents and near accidents at crossings.

In order to gain a better understanding of the processes at intersections, The German Aerospace Center (DLR) is addressing the detection, tracking and classification of motorized road users in the area of a multi-lane inner city intersection using installed sensors. This is a joint research project and Jenoptik's Traffic Solutions Division is one of the partners. Jenoptik is equipping the intersection, in Braunschweig, with the required technology.

(Left) **The equipped intersection in Braunschweig** (Right) **The mast construction**

Need to know?

A new intersection project that could lead to smarter assistance systems

- The DLR, the state of Lower Saxony, the city of Braunschweig and other partners are creating a unique way of linking up research, development and applications for ITS and mobility services via the Application Platform for Intelligent Mobility (AIM)
- This intersection project is part of a broader vision to improve driver behavior and road safety in Germany via technology

The overall aim is to gain a complete picture of traffic flow to better understand the processes at intersections. The data streams collected provide a complete image of the traffic flow with which critical road situations can be analyzed and automatically predicted. This prediction permits the development of new, innovative assistance systems. A so-called intelligent intersection could solve traffic problems in the future by 'talking' to road users.

An intersection traffic controller can provide assistance to adapt driving behavior to the specific situations, reduce stress and increase traffic safety for all concerned.

Implementation

A multi-sensor system installed at the intersection is built to be robust and resistant to the elements, and will avoid blind spots thanks to the placement of the sensors.

Camera and radar technology has been installed on four sides of the intersection, including two cameras (an overview and a detail camera) with infrared lighting, and a tracking radar for each branch of the intersection. The systems are precisely synchronized and capture the traffic situation from four angles across the whole intersection area. Information acquired about the objects includes the location, direction of travel, speed and classification of the vehicle, on which the processing chain is based. This is also the basis for the later analysis of the traffic situation.

Each camera and radar combination per mast covers a specific area of the intersection. The first fusion stage combines the information for one branch. The object flow for each fusion unit is sent to a second fusion stage. In this second stage, the object flow of each fusion unit is merged into an overall intersection coordinate system. This second stage gives good overview information about the whole intersection.

The processing chain is in five parts, beginning with the camera. Using image processing algorithms, the calculation of

(From left to right) **How the intersection is tracked with a detail camera, a radar and an overview camera**

the optical flows takes place using the camera data. The radar data then provides the trajectories of individual objects.

In the partial fusion component, the optical flow of the camera and the trajectories of the radar system are used to create a 3D reconstruction of the data from the corresponding branch of the crossing.

For overall fusion, the pre-fused data from all branches of the crossing is united into an overall scenario.

The final element is prediction. The input crossing geometry, together with the data collected and the corresponding driver behavior, permit a prediction of the trajectory.

The system is in test operation and is being expanded in cooperation with Jenoptik.

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Future's So Bright I Gotta Wear Shades (Ode to Baby Boomers)

Gotta wear shades, got to wear shades
I'm heavenly blessed and worldly wise
I'm a peeping-tom techie with x-ray eyes…
Timbuk 3, 1986

Demographers tell us that the distribution of our driving population in developed regions of the world will markedly shift over the next decade or two. Forget for now the Millennials, who according to popular myth don't drive anyway. (They do drive, but by and large, they drive less.) Let's focus instead on me, well, my generation… By 2030, today's 35-54-year-old drivers will be, let me think… oh, 17 years older. (I am quite good at addition.) The change is inexorable: the US Census Bureau estimates the US population aged 70 years and older will increase from 28.5 million in 2011 to 52.7 million in 2030. There are a lot of us Baby Boomers.

Many in my demographic will age in place – that is, they like their suburban homes. They will either eschew or won't have access to public transportation. They will continue to listen to rock and roll, assuming improvements in hearing aid technology. Focusing on their transport needs, the infrastructure and transport services may adapt to my demographic if at all possible. (There are just too many of us.) For some, there will be changes in travel behavior and mode choice. However, most of us will want to drive, even in light of diminished capability.

Will the smart car rescue us from the boundaries of our homes and neighborhoods? Will trends in advanced driver assistance systems (ADAS) trend with our age mode? Given the economics and the fact that we will be noisy (from yelling over strains of rock and roll), the universal design paradigm will have to change, perhaps equating to 'older driver design'. Displays will be larger, interfaces more obvious, and controls will be more intuitive. Will there be speed limiters, more side sensors to adapt to diminished useful fields of view and other technologies?

What may be most intriguing for older drivers is the prospect of a self-driving car, sort of an automated chauffeur. There are those in the transportation community who predict that by 2030, this ultimate smart car will be fait accompli. Will it take the fun from driving? Intriguing also is that perhaps there is an incentive for efficient self-driven delivery of this special, smart car to older drivers. Or concepts where we simply take cars or even pods from our homes, with mortgages long paid off, to transit stations, then complete the bulk of our trips via some shared, public conveyance. We can sit alongside our fellow octogenerians, then at the end of our journeys retreat to the comfort of our homes.

However, in the end, many of us will still want to take our cars for a spin, and those ADAS functions had better be working and the car very smart.

> Given the economics and the fact that we will be noisy (from yelling over strains of rock and roll), the universal design paradigm will have to change, perhaps equating to 'older driver design'
>
> **Jim Misener, transportation and technology consultant, USA**

The perfect ingredients for free-flow tolling

READER ENQUIRY NO. 509

Improving road safety, optimizing traffic management and reducing environmental impact are major challenges facing today's urban areas. Adding to the complexity of meeting these challenges is the ever increasing number of vehicles on our roads.

Modern free-flow tolling systems represent a solution that can help to address the above challenges. Free-flow tolling needs a minimum usage of infrastructure. At the same time, it includes a maximum usage of intelligent systems such as license plate recognition, classification systems and software for the analysis of protected data. The great advantage of such a solution is that it involves far lower operational costs than traditional tolling systems.

The first major benefit of a barrier-less tolling system, formed by free-flow multi-lane portals situated on the roadway before every junction, is the elimination of toll booths. This allows not only for a reduction in the use of space and its associated costs, but also for a considerable reduction in congestion.

Data delivery

It goes without saying that when needing to optimize traffic flow on highways, highly accurate data collection is imperative to deliver the full picture of what's happening on the roads. In this context, an automatic license plate recognition system must be equipped with top quality features and functionalities. The need for both high accuracy and simplicity is delivered in Tattile's modern automatic license plate recognition systems. License plates are processed on board the camera, with no need for a separate PC. The camera transmits only data that has already been processed. As a consequence, the data transmission is far less bandwidth-intense than older generation systems. This all results in a simple and therefore less expensive and complicated installation.

The Vega 2HD camera is the perfect fit for free-flow tolling

Need to know?

Free-flow tolling has huge potential but it needs powerful tools to be truly effective

- Reducing congestion and emissions, free-flow tolling is proving to be a popular solution to today's traffic management challenges
- A free-flow system has high-quality license plate recognition at its heart
- The cameras required should be designed to be highly accurate as well as easy to install with a minimal visual 'footprint'
- A new generation of cameras is now stepping up to the mark

The ability to combine functional license plate recognition for free-flow tolling with enforcement is another key aspect of Tattile's new generation of systems. For example, the Vega 2HD camera can be used for average speed detection up to 250km/h.

It has been demonstrated that free-flow systems will contribute to a considerable reduction in air pollution. The smooth flow of traffic combined with controlled speed heavily reduces CO_2 emissions.

It is likely that we'll see a surge in free-flow systems in the coming years as new infrastructure is built according to this new traffic management trend.

There is a particular demand for these systems in developing countries, where the minimization of environmental impact and low-cost systems, such as completely electronic ones, are priorities. Free-flow systems are largely in use in Southeast Asia and the Middle East, where huge investments are made for the construction of smart traffic management systems. In fact, these regions have historically been characterized by a strong interest in environmental issues and the commitment to create Smart Cities via a rationalized reduction of traffic.

Similarly, some North European cities, having extremely advanced platforms used as models for the European market, can be defined as the trendsetters of Smart Cities. Free-flow is certainly to be considered the new main tolling system. It creates easier flow at competitive prices, while also being in line with the aim to minimize the aesthetic disruption of street furniture. This is also one of the reasons why the Vega 2HD is provided with an on-board auto-trigger, meaning it does not need external triggers. The result is a light installation with no need for further vehicle detection devices. Its non-invasive aspect also makes it pleasant from both aesthetic and architectural points of view.

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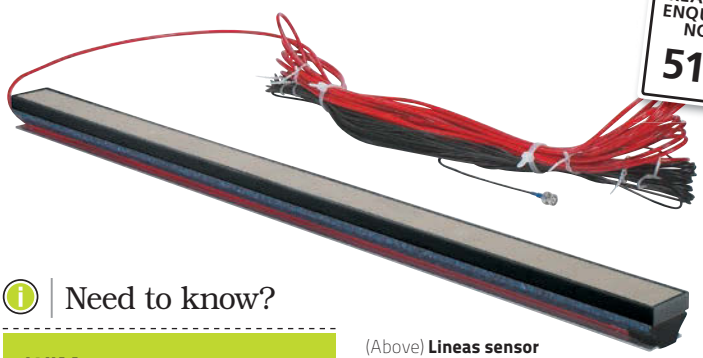
Borneo weigh-in-motion project

READER ENQUIRY NO. 510



(Above) **Lineas sensor** (Top right) **Quick, easy installation of the WIM system** (Right) **A truck is ready to be weighed**

Need to know?

WIM sensors are enabling highly accurate weighing results in Indonesia

- A mining application has found new uses for the WIM sensors used traditionally in traffic management schemes
- The Indonesian project first deployed the sensors to weight coal trucks but they are also now being tested for use in a tolling application
- Quartz-based sensors offer both high accuracy and durability, making them very attractive to systems integrators

Traditionally, weigh-in-motion (WIM) systems are used for the permanent monitoring of road traffic. They provide highway authorities, police agencies and road concessionaries with accurate measurement data for statistical purposes, infrastructure maintenance planning, overload monitoring and collection of toll fees. The range of use for these systems was recently expanded to coal mines.

This new application involves a huge mine in Melak, central Borneo, Indonesia, which produces more than 7,600,000 tons of coal every year. The coal is transported about 100km by truck from the mine to the coast. The trucks that are used are 40m long with one or two trailers, have up to 12 axles, and weigh a total of 200 tons. Before unloading, the trucks are statically weighed; the subcontractor is paid for the amount of coal delivered. However due to wet weather conditions, several tons of coal can often stick to the inside of the trucks after unloading, resulting in the customer paying for coal that was never unloaded.

To tackle this problem, the owner of this mine decided to install a secondary weighing system to determine the actual weight of the trucks after they have unloaded the coal. By comparing the weights before and after unloading, the exact amount of coal delivered can be calculated. Because of the huge amount of coal – and money – involved, the company required an accuracy of at least 3% for the total weight of the trucks. This measurement accuracy should be achieved at a speed range of 2–25km/h and with axle loads of up to 25 tons.

Based on its broad knowledge of road applications worldwide over the past 15 years, Kistler suggested using its Lineas sensors for this new WIM application. The Lineas product is a quartz sensor that measures the wheel as well as the axle loads of vehicles passing under rolling conditions. The sensor is installed in the road surface and provides highly accurate measurement signals. Thanks to the physical properties of the quartz, the Lineas sensors combine high measurement accuracy with long-term stability and durability. The sensors can be used in a variety of measuring conditions, from low to high speeds, and they are insensitive to temperature variations. The sensors are quick and easy to install in the road surface, and are available in three different lengths, to match all lane widths.

Sensor configuration

For the Borneo application, to ensure the high requirements were met, eight – instead of the usual four – Lineas sensors were installed in a 60m-long concrete platform. Custom-made electronics and software developed by a Kistler business partner were used to maximize the measurement accuracy. The sensors were installed by a local construction company under the supervision of a Kistler specialist. Following calibration of the WIM system (using a standard 40 ton truck), it was launched in February 2013. Finally, the system was also tested and certified by the local institute for legal metrology (UPTD Metologi).

Lineas sensors are used worldwide for high-speed applications such as for statistics and pre-selection for weight enforcement and tolling. This installation demonstrates that the sensors can also be used successfully for high-accuracy weighing under low-speed conditions.

In the future, the coal mine operator also plans to use WIM to issue fines for overloaded trucks. This is not because the mine has many damaged roads. The issue is rather that trucks try to carry far more coal than their carrying capacity. This leads to the loss of tons of coal (and therefore money) on the way between the mine and the dump as the overloaded vehicles shed some of their loads.

In the final 'success story' for this Indonesian project, the system integrator was highly impressed by the accuracy of the sensors under such harsh conditions. Therefore this customer has also installed Lineas WIM sensors at a toll booth to verify the accuracy for this type of application.

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Traffic control software for improved adaptability

READER ENQUIRY NO. 511

Basically it should be quite simple. Any textbook on system design will tell you that you just have to collect the system requirements, reformulate these into some tangible goals, derive some concept variants and select the one with the best rating with regard to the goals for implementation. There are tons of design and development process models that show how to develop and implement the proper systems this way.

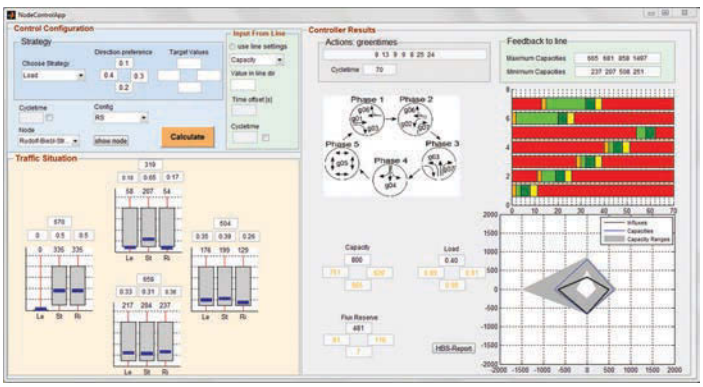
But why then, do we still have to deal with so many suboptimal traffic solutions? Why are there still so many complaints about traffic in cities?

One reason for this is that there's no such thing as optimal traffic. The requirements for traffic systems are intrinsically conflicting. If you prioritize some traffic lines, somebody else always has to pay the price. Therefore the story is very seldom about optimizing; it's more about balancing conflicts and keeping the overall level acceptable.

Additionally there is rarely a fixed set of requirements and goals available that one could focus on and aim for. For example, if you change some traffic control strategies, you influence the traffic in such a way that the resulting situations may themselves lead to additional new and different requirements. So the implementation of a fixed control setting may become incomplete and invalid as soon as it is implemented.

Consequently, one could argue for traffic control systems that have adaptability implemented in their design from the beginning and can incorporate new requirements very quickly. Adaptability here refers to a radical approach: the traffic controller can be adapted or even autonomously adapt itself to new situations and requirements as well as the necessary control strategies (control goals). It can also adapt to the different local conditions and new traffic information or predictions.

(Left) **Intelligent traffic control solutions demand smarter software** (Figure 1, bottom left) **Shows the interface of Andata's new software**



A new way forward

With this in mind, the engineers at Andata have developed a new type of traffic control software. It is designed to be a modular construction kit, where comprehensive traffic control systems can be arranged by plugging uniform traffic control modules together in the form of a hierarchical, subsidiary network of decentralized controllers with distributed local intelligence. The single traffic control modules can be adapted very quickly to local conditions when being implemented and also adapt themselves to the locally relevant traffic.

An example for the interface of such a controller can be found in Figure 1. Depending on the current or predicted traffic situation (see the lower left part of the dialog in Figure 1), the controller for a traffic node immediately delivers the optimal green times and phase coordination plans in real time (see upper right part of the dialog in Figure 1). The green times are calculated in real time with respect to the goals

Need to know?

New software is addressing the critical need for adaptability within ITS solutions

- Traffic is complex and relatively unpredictable, so there is no 'one size fits all' solution to managing it
- Control solutions that are flexible enough to acknowledge there's no set rule book for each traffic scenario are the future of ITS

of a given control strategy, which can be selected manually or autonomously.

For instance, it may be better to optimize traffic flow rates in the case of congested conditions instead of minimizing travel times in the case of lower traffic rates. In some cases it may also be beneficial to restrict the traffic flow by reducing flow rates to avoid flooding a subsequent region, or to spread jams out a little to get a crowded street flowing again. Andata's software will immediately deliver the optimal green times with respect to the relevant strategy and traffic situation, unburdening the user from requiring any knowledge about the underlying phase coordination plan, intersection architecture and realization details.

With systems that have such immense flexibility and high adaptability, one always has to take care not to end up in chaos or extensive trial and error due to the sheer amount of possibilities. The medicine for this ailment is a scenario-based approach for the representation of the functional requirements. All relevant traffic situations are collected systematically, stored in some form of requirements database and fed back for the training of the control system. This also helps with the identification and quantification of requirement conflicts, closing the loop to the beginning by nailing down the system requirements iteratively until all relevant traffic situations are identified.

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So many changes, so little time…

When I returned from ITS America's Annual Meeting I reflected on today's wonderful technology and how it connects to all aspects of our daily lives. Walking through the exhibition it was amazing to see all of the systems that can talk to each other in our vehicles today. I remember when it all started, with ABS braking, adaptive headlights and rain-sensing windshield wipers. Now it's advanced to active blind spot monitoring and in-car fiber optic networks. Today's vehicles can even park themselves or give the driver an overhead bird's-eye view of the space around them. Technology is advancing at higher speeds now than ever. Even the devices in our homes have to talk to each other to give us the features that a new generation of consumers demands. Our home theater system is connected to the internet, which enables it to be controlled by a cell phone or iPad and stream music and videos wirelessly to televisions. Our thermostats not only talk to each other but know what the temperature is outside and we can control them from anyplace in the world. We can not only view our security cameras and status of lights and energy use but also control them from our phones.

So what is driving this rapid change in technology? How do we in the toll and ITS industry keep up? How do we give our customers what they demand and are still able to afford? How do we manage it all with limited resources? For that matter, how do we even turn around technology procurements fast enough to keep up? It seems that the more things our technology will do for us, the more we demand of it. We used to install a toll system and it would last 10 or 15 years. Today some systems become outdated and unsupported in less than 10 years. Just look back 10 years ago: our customers were all carrying cash. Just three years ago the 6C protocol wasn't even being considered for tolling systems. Even the back office side of technology is rapidly changing. We are demanding such advancements as cell phone applications, cloud-based access and storage, and systems with detailed financial reporting. And then there is standardization. The more we try to set standards, the more disruptive technological advances are.

At first look it appears that our customers are driving this technology shift as they want faster, non-stop service; they want instant gratification using whatever latest and greatest gadget they can carry easily with them. Cash? Forget about it! Our customers have all of this advanced technology at home and expect it from us. So we need to look at our systems differently. We need to design them to be more versatile and upgradable. We must be able to update them and to grow by a module or subsystem at a time – and not replace the entire system. We need to look to more of a standardized yet flexible system approach – and not each of us developing our own unique hardware or software and system requirements to meet our unique business rules. All this is contrary to where this industry has been for the past 50 years, in particular since the advent of ETC. We need to stop just looking at the present and start looking to the future. What will toll collection look like five or 10 years from now? The good news is I think this discussion is just starting. I think it is going to be more difficult for some, but economics and our customer base will demand it.

> We need to stop just looking at the present and start looking to the future. What will toll collection, look like five or 10 years from now?
>
> **James Eden, director of tolling, AECOM, USA**

Tools to make roundabouts more visible to motorists

READER ENQUIRY NO. 512

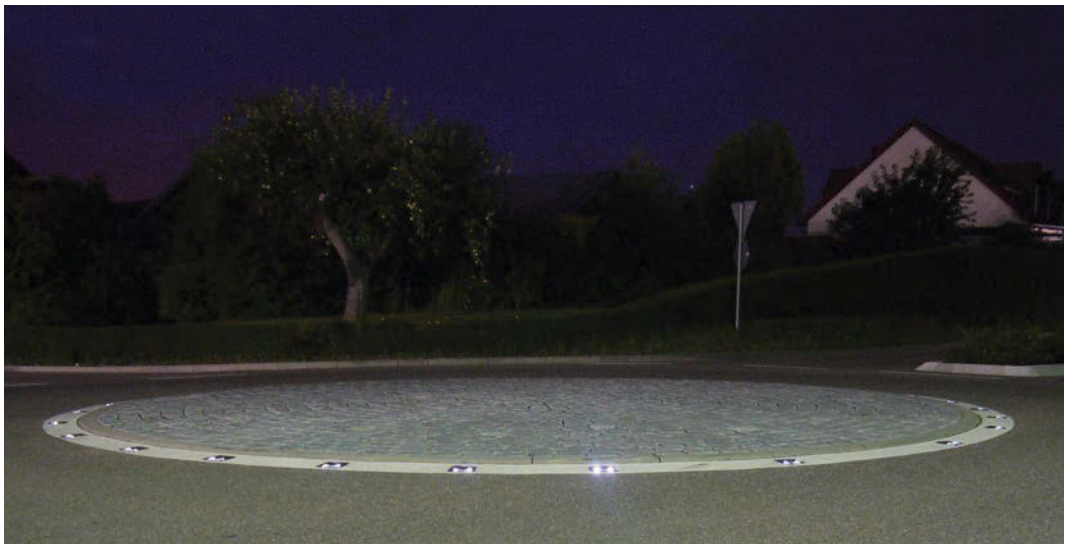
Developments in solar road stud technology have been ongoing for many years, and a few companies have led the way in finding new application areas where the studs prove to be a viable and low-cost tool for increasing traffic safety. One of these applications is the use of solar road studs to make roundabouts visible from a distance at dusk and at night.

Solar power

Solar road studs are an effective way to enhance safety because they are placed directly where the focus of the driver lies – on the road ahead of the roundabout and in the center of the roundabout.

In doing this, motorists benefit from a clear image to show them that road conditions are changing up ahead, and they're encouraged to react by lowering their speed or simply taking more care when approaching the roundabout. Placing the road studs in the side of the approaching road and in the center of the roundabout is enough to show the nature of the 'curve' they're approaching.

Danish company Geveko ITS has launched LED-Mark, a solar road stud that emits light in a very narrow angle of 3° horizontally and 7° vertically. The narrow angle makes the light highly visible to drivers. The aim is to slightly attract the attention of drivers with a highly visible light effect, so that they become aware of the risk that lies ahead. This concept is one of Geveko's governing principles – and it has proved to be a very worthwhile philosophy for the company.

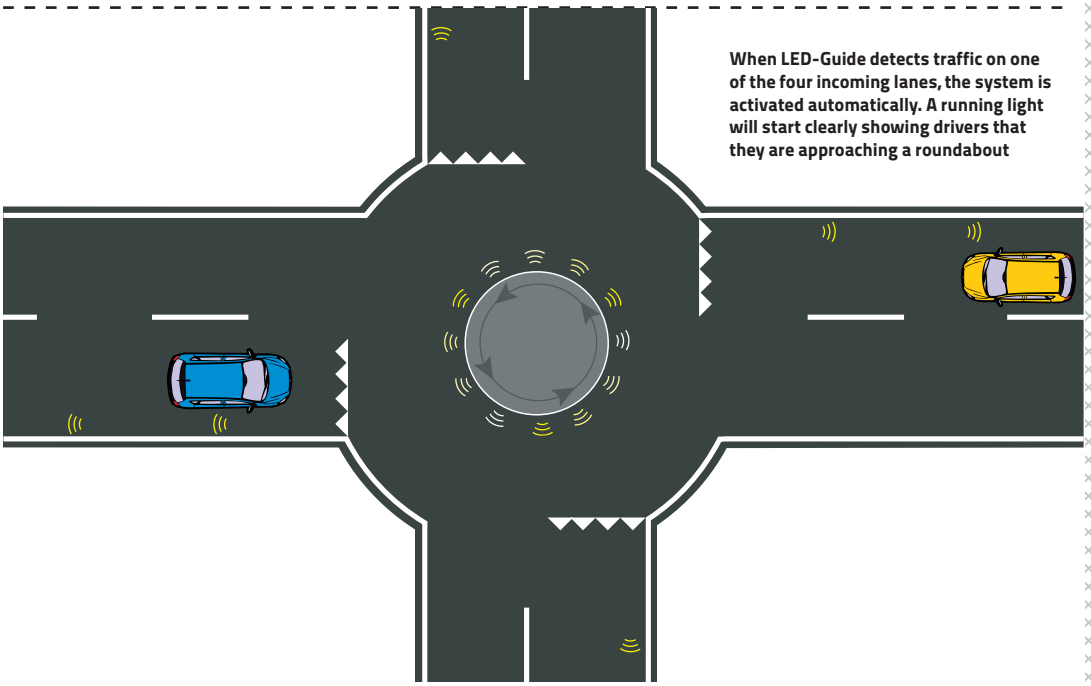


(Above) **Roundabouts with LED-Mark solar road studs mounted in the inner ring**
(Below left) **The standalone system turns on when it's dusk or during the hours of darkness**

Need to know?

A new application for solar road studs has emerged: using them to improve the visibility of roundabouts

- How a distributed and interoperable system of wireless sensors is capable of creating intelligent functions by communicating with each other
- Information about what happens on the roundabout, can be collected in a database
- Solar-charged LED markers can be installed wherever safety needs to be increased



When LED-Guide detects traffic on one of the four incoming lanes, the system is activated automatically. A running light will start clearly showing drivers that they are approaching a roundabout

It is always a good idea to use only the minimum number of studs necessary to achieve the safety effect that the road owner would like. Budgetary considerations aside, a key issue is the intense light pollution that can come from using too many studs in an installation.

Solar road studs cost around one-tenth of the installation and one-third of the running costs of threaded light technologies. Plus, they're CO_2 neutral in operation and are a 'green' way to enhance traffic safety without having to increase budgets.

It's also worth noting that Geveko's LED-Mark products (and LED-Guide – more on this later) are completely self-sufficient, which aligns well with customers' goals to reduce CO_2 emissions.

In rural areas in particular it is often very costly to get power supply for a light in the center of the roundabout, and it is in these areas that drivers are less likely to notice upcoming roundabouts. But even in urban settings it is worth considering making roundabouts visible at night, as increasing numbers of municipalities are turning off lights at night-time.

Ask the right questions

When a road owner is about to select a solar road stud for a roundabout, it is important to discuss some key parameters with suppliers.

The first and most important of these is operational time – in other words, the time the solar road stud can remain lit up without sourcing new energy from sunlight.

In most areas of the world, sunlight is in short supply during the winter months, so there's always the risk of the stud not lighting when it's supposed to. Some studs are also placed partly in the shade, and because of this the charging time is reduced. The operational time for a fully charged standard solar road stud should be approximately 2,000 hours.

New intelligence, new possibilities

Typically, solar road studs do not include any intelligent reaction patterns – they merely light when it gets dark. Road owners are well advised to consider whether they want the solar road studs used at roundabouts to have built-in intelligence so that they can be an active part of increasing traffic safety. Active and intelligent road studs such as Geveko ITS's LED-Guide can detect traffic, guide motorists and communicate with traffic information systems – and this actually makes it possible to achieve an active running light that is present only when traffic is approaching the roundabout.

Geveko has built an intelligent roundabout lighting system at the Luleå University in Sweden, featuring integrated dynamic traffic guidance via LED-Guide that detects when a car is approaching and starts a running light to ensure the motorists pass the roundabout in the correct way. Geveko is able to control the way the solar road studs light up and thereby also improve the interaction with motorists. It is even possible to count the traffic levels going in and out of the roundabout, all by using just this one product.

In summary, road owners should consider carefully whether the safety levels of their roundabouts need to be improved. And given that the budget implications are not necessarily that large, it's worth considering solar road studs.

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With many tunnels throughout Europe still failing to meet Directive 2004/54/EC, what can be done to improve traffic safety and efficiency?

Answer the Burning Question via our LinkedIn group page at www.traffictechnologytoday.com

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A "All new tunnels need to be safer by design. The Fehmarnbelt Tunnel, for instance, will be one of the world's safest and most modern tunnels and will meet all relevant safety standards, including the EU's Tunnel Directive. The detailed planning and design has focused on three priorities: accident prevention; minimizing the consequences of accidents; and emergencies. All new tunnel designs must ensure that the emergency services can handle accidents and emergencies rapidly and efficiently and with a high degree of safety for rescue personnel. Emergency exits have proved to be very important to improving the level of safety. All new tunnels should focus heavily on this element. In the Fehmarnbelt tunnel the emergency exits to the safe tube are located at approximately 100m intervals. There will also be emergency stations with firefighting equipment and direct phone links to the control center at the same intervals. The road tubes will be equipped with emergency lanes and will be monitored by a traffic control system, which includes dynamic signage and radio communication to provide motorists with essential information about their journey and accident warnings. Such advanced traffic management systems can benefit existing tunnels as well as new ones because they can be added at any time."

Kim Smedegaard Andersen,
contract director, Immersed Tunnel at Femern Bælt A/S, Denmark

A "The number of serious crashes in motorway tunnels in the Netherlands is low, as there are only 14 such tunnels. They occupy less than 0.5% of the total length of motorways here yet 1% of the total number of serious crashes takes place inside them. Of course a tunnel has many extra risk factors. Since these usually occur simultaneously, it is often difficult to pinpoint the main cause of tunnel crashes. The risk factors distinguishing tunnels from our open stretches of motorways are the closeness of the tunnel wall, gradients, speed differences, road alignment and (limited) sight distance. Tunnel safety can be improved by adding emergency lanes to increase the distance to the wall, shallower gradients (or separate lanes for heavy traffic) to minimize speed differences, and making unavoidable bends wider. Entrances and exits should be designed carefully: the lighting should be of a high quality, and entry and exit lanes and weaving sections should be avoided, both inside and in the vicinity of the tunnel, if there are no emergency lanes. The tunnel should be provided with a high-quality outlet system for fluids."

Fred Wegman, managing director, SWOV, the Netherlands

A "The Mont Blanc accident led to the EU Directive and also to new Swedish legislation on fire safety. Evacuation failed very badly in the fire, with many people dying in their vehicles. The danger was not made apparent to them. One lesson here is the importance of clear instructions for those using the tunnel in terms of evacuation – through the use of loudspeakers and information signs. Another basic requirement is concerned with the prevention of the spread of fire. In the Mont Blanc accident, the fire spread to several goods vehicles, a situation that can be prevented with transverse ventilation that immediately extracts hot fire gases. Another way of limiting a fire and its spread is the use of a fixed extinguishing system in the tunnel, which has the dual effect of cooling the fire and adjacent targets. Although the Mont Blanc Tunnel had a transverse ventilation system, it had inadequate capacity and wasn't used correctly, so the fire was able to spread over hundreds of meters between vehicles. This illustrates the importance of organizational fire protection and ensuring that systems work in practice. The Mont Blanc fire also revealed major shortcomings in how the rescue service and the tunnel control technicians dealt with the accident, underlining the importance of training exercises and having a well-trained and informed organization."

Jonatan Gehandler,
researcher, SP Technical Research Institute of Sweden

A "Thirteen years after being devastated by a fire, the Tauern Tunnel has set a new European standard for safety. The approximately 7km long tunnel tubes cost around €200 million to renovate, an investment that was worthwhile and earned it first place and a 'very good' 2012 rating in the European Tunnel Assessment Programme (EuroTAP). This is just one of a growing number of success stories to emerge from the 375 tests conducted in 21 countries since 1999. Large-scale national schemes for tunnel upgrades in Austria, Switzerland and Germany are already contributing considerably to the structural and operational safety of tunnels. At the same time, there are indications that individual EU member states find the strict requirements hard to comply with. All the more reason for the EU to monitor individual progress, consistently warn any non-complying states and take action in good time. EuroTAP stays on the ball as well and is already laying the groundwork for a major test on the 10th anniversary of the EU Directive in 2014."

Nicolas Adunka,
project manager, Test Centre Mobility, ADAC, Munich, Germany

Readers are invited to answer the Burning Question for the August/September 2013 issue:

With it being awards season in our industry, which ITS project of the past 10 years would you give the 'Most Valuable Deployment' award to – and why?

email answers to:
louise.smyth@ukipme.com

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