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TECHNOLOGY INTERNATIONAL

January 2013

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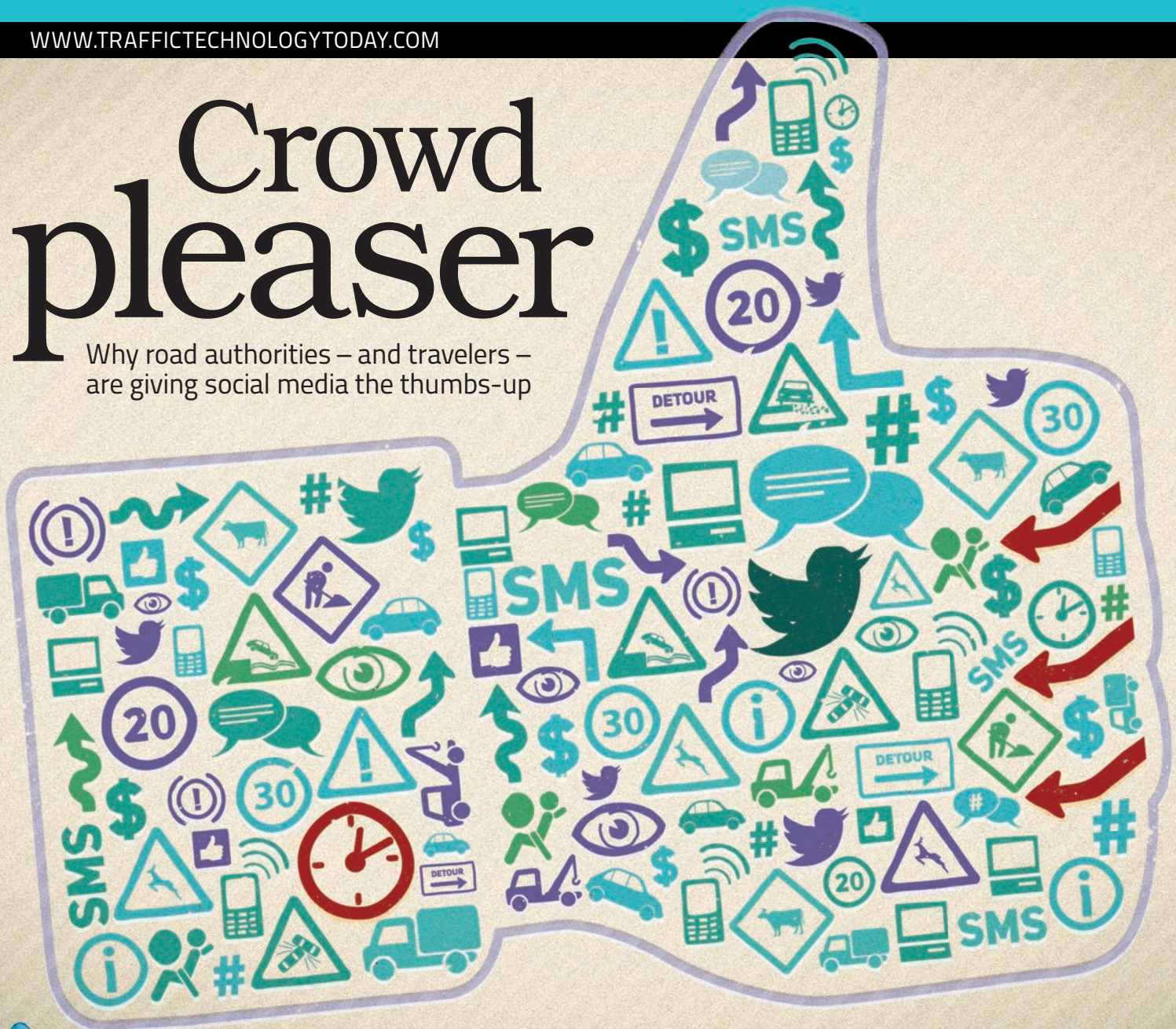

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LED by example
The safety, energy and financial benefits of getting smart with your roadway lighting systems

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Dr Thomas Novak reveals why – when it comes to safety-related VMS – not all products are equal

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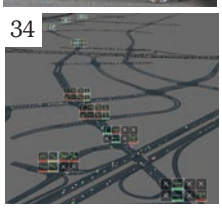

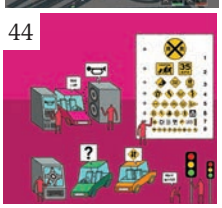

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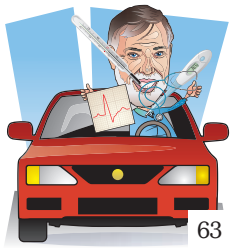
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Foreword

I'll be 38 this year. Not exactly one foot in the grave but my gray hairs are now so numerous that it's simply not worth the pain to pluck them out anymore. And if my feet aren't shrinking, that can only mean my stomach is going in the opposite direction, further obscuring the view of my size 11s. Fortunately, I'm a long-time moisturizer – Clinique Skin Supplies For Men, no less – so I'm relatively wrinkle-free. But I'm facing facts: I'm not getting any younger.

Among the faculties necessary for driving, I am thankful that my eyesight is, for the moment, still in good shape. My colleagues do question my auditory sense, though, which fluctuates between not hearing conversations at all to hearing entirely incorrect conversations. Deafness has its uses; my father tells me selective hearing runs in the family.

Aged 68, he is among the post-World War II baby-boom generation and, although he'd never admit it, he's not the confident, capable, and aware driver that I recall him being when I was a child. And physiologically, you wouldn't expect him to be – naturally, our vision, reaction time, and decision-making abilities deteriorate with age, and – in his defense – they haven't deteriorated anywhere near as quickly as my mother's have!

He is nevertheless in a demographic that is causing a huge amount of consternation for highway designers and traffic managers. Some of their concerns are highlighted in our article about senior drivers (page 46), but this isn't an opportunity to drag up the usual stereotypes about older drivers. We're looking at how DOTs and road authorities are factoring in the cognitive and physical needs of this enormous mass of over-65s on our roads today and – more pertinently – as we head into the future. And it's not just about helping them drive more safely but allowing seniors to stay mobile for longer, preserving their independence, and as a consequence positively impacting on their life expectancy. Eventually, I'm sure, I'll be extremely grateful to those making these necessary changes.

Something I didn't welcome so warmly, though, was my father treating me as 24-hour technical support after I gave him my old iPhone. And I'm even less enthralled that he now swipes his way around the device far better than I ever could. He relished telling me I had wasted £100 on a satnav for his birthday as he has since downloaded a much better app for free. Moreover, he gets most of his travel information via the 'Twittersphere'!

Of course Jack Dorsey, the chap who invented Twitter, was in part inspired by what he described as the "haiku of taxicab communications – the way drivers and dispatchers succinctly convey locations by radio". The use of social media by road users and, for our purposes, how DOTs can utilize this wealth of crowd-sourced data is the subject of our cover story (page 36). As Sam Schwartz noted in his column in our previous edition, we're merely at the start of this revolution. Maybe I need to get with the program, as my father has seemingly done, before I'm too old – or too fat! – to get behind the wheel. Enjoy the read!

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S E E I N G I S B E L I E V I N G

The positive data relating to red light cameras is sometimes disregarded at state level. Certain regions remain undecided, swaying this way and that. New Jersey recently introduced new laws to ban them across the state.

"It's clear that towns have little interest in actually making intersections safer," Senator Michael Doherty said of the situation. "They want violations to occur so that they can continue collecting fines to prop up government spending."

David Kelly of the National Coalition of Safer Roads believes that while there will always be anomalies such as New Jersey, there remains a net gain in the use of cameras across the USA. "Decisions are often made for political gain," he insists. "When you get a change in power or a shake-up at board level, these things can happen. Such outcomes are subject to many variables and we don't set much store by them. In the normal cycle of events, programs come and go. What we do know is that cameras work and people support them."

Mixed messages

Saul Wordsworth discovers that although the evidence for red light cameras appears overwhelming, the minority opposition continues to shout loudest

Kansas City Police Department recently reported its red light program to be so successful that for two years following its introduction in January 2009 there were no fatalities at the city's 17 enforced traffic intersections. Meanwhile a 2011 study by the Insurance Institute for Highway Safety (IIHS) found that red light safety cameras reduce violations by up to 50% and fatalities by 24%. You would think that such statistics would be enough to convince naysayers that red light safety cameras are a force for good – but you would be wrong.

"People on the other side of the argument are often highly vocal," accepts David Kelly, president and executive director of the National Coalition of Safer Roads (NCSR). "They put up websites, arrange petitions… They are highly motivated. The more reasoned side of the argument doesn't have the same fervor because red light cameras make too much sense."

In the USA notions of freedom and privacy are held dear. Owning a driver's license may be an agreement to abide by certain rules, but in some eyes cameras remain a breach of civil liberty. Although evidence that cameras act as a deterrent is overwhelming, there remains a strong and outspoken anti-camera lobby, often backed by a media that is quick to raise suspicions about revenue generation. It can be a challenge for Kelly and others to defend themselves against those who choose to ignore what to them seems obvious.

Brian Ceccarelli is a software engineering consultant from North Carolina. In 2010 he received two tickets for running red lights. Since then he has fought his case by challenging on a scientific basis the yellow change interval formula.

"I am not against red light cameras, merely against the duration of the yellow light," says Ceccarelli. "Based on the laws of physics, the formula doesn't give enough time to decelerate. It's the reason the red light camera industry is in business

> "Based on the laws of physics, the formula doesn't give enough time to decelerate. It's the reason the red light camera industry is in business

Private auto passenger liability rose 12% to US$64.1 billion in 2010 from US$57.1 billion in 2005, say figures from the Insurance Information Institute

Better enforcement of traffic signals using cameras is a solution that can quickly be implemented on a large scale

Prior to the installation of red light cameras in Dallas five years ago, nearly a third of the city's accidents at traffic signals were attributed to red light running. In the first year of camera operation, intersection accidents were reduced by 56% and tickets for red light running fell by nearly half. Dallas now has 60 red light safety cameras operating at the city's 1,300 traffic lights.

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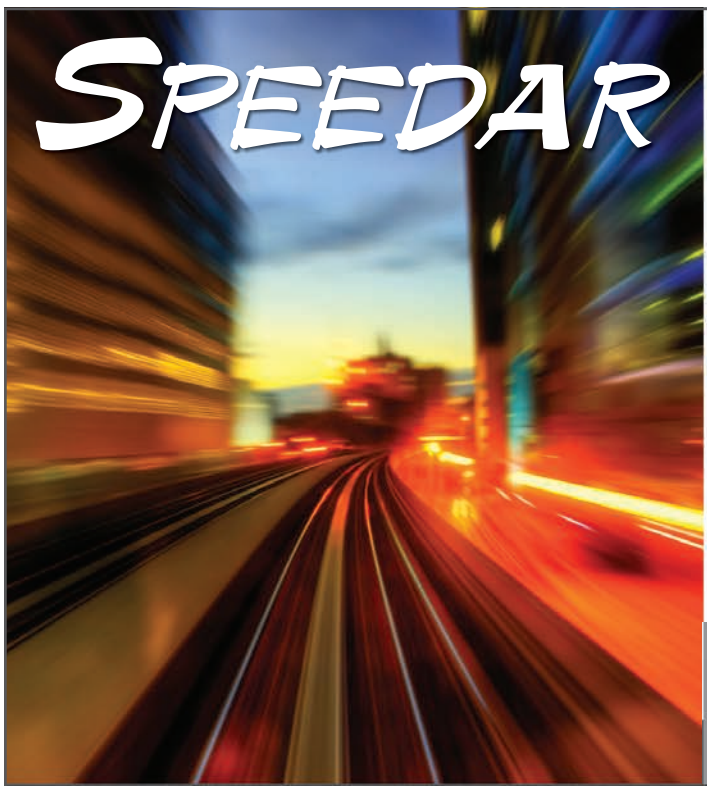

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formula doesn't give enough time to decelerate. It's the reason the red light camera industry is in business. Fix the formula and there will be no red light camera industry because very few people will be running red lights. Even if the car arrives in time, it is still necessary for the driver to know exactly what the safe stopping distance is, which is a mathematically exact value."

The case of Ceccarelli versus the town of Cary, North Carolina goes to court in January 2013. Backing him are several expert witnesses who will help defend his point of view.

Majority view

"The notion that there is some sort of great conspiracy to shorten yellow light time is wrong," says Kelly. "There are many factors that go into how you calibrate a yellow light timing interval. These are complex fact-based formulas. It is not an arbitrary number. The idea of simply extending the yellow light is something you get from people who don't understand the process. Traffic engineers are professionals and you are demeaning the most objective person in traffic safety to suggest otherwise."

The statistics weigh heavily in Kelly's favor. A 2007 study in Philadelphia revealed that after yellow lights were adjusted to one second longer than the standard three to six seconds, red light running dropped by 36% – but it dropped a further 96% after cameras were installed

"The interval times at intersections are constantly recalibrated," says Kelly. "Our opponents often demonize the wrong people simply because it fits their own political or personal objective."

(Top) **An estimated 122,000 people were injured in red light running crashes in 2010. A 25% reduction would prevent 30,500 injuries and save insurers US$1.95 billion** (Right) **Opponents are extremely vocal, but studies show they are in the minority**

Supporting data

In 2011 the study *Evaluation of Photographic Traffic Signal Enforcement Systems in Texas* was published. Researchers examined 11,122 crash records from 275 intersections in Texas where red light safety cameras were in use and compared crash frequencies both before and after cameras were installed. They found that side-on crashes decreased by 32% at intersections with cameras, and there was an overall fall of 25%.

"There are many reports that say red light cameras reduce crashes," says Ceccarelli. "The problem is they never investigate why the crashes happened in the first place. There is no forensic analysis, simply a before and after. They blame the drivers for all the bad things even though there could be gross engineering mistakes. If a report claims that these cameras reduce crashes by 25%, what about the other 75%?"

Kelly's riposte is to cite America's litigious society, which is "always looking to blame others," whereas in fact accidents happen "because of driver behavior" and red light safety cameras have been shown time and again to change such behavior and make motorists drive better.

"There is never one definitive study that proves once and for all the benefits of cameras, but the same could be said of all driver behavioral studies. The key is that all studies generally point to the effectiveness of red light safety cameras. The numbers vary, but if you were to complete a meta-analysis of all the surveys and research it would say red light safety cameras save lives."

Who, when and why?

Ninety-eight percent of Americans believe that running red lights is dangerous, yet 56% admit to doing it and 20% at the past 10 lights. Offenders cut across all demographics, though there are some interesting variables. According to results obtained by the Stop Red Light Running Partnership, parents with children younger than 20 years old are more likely (65.6%)

Support for the red

According to a 2011 poll taken by the Insurance Institute for Highway Safety (IIHS), more than 66% of drivers in 14 major cities were in favor of red light cameras at intersections. This follows a study across the same cities showing that cameras reduced fatal intersection incidents by nearly 25%. Of particular note was Houston, where the majority still voted in favor of cameras despite the city having shut them down in 2010. Of those polled, 25% said they opposed the use of red light safety cameras because they can make mistakes. Nineteen percent said they make the roads less safe. A similar poll taken in Connecticut in 2012 by the National Coalition for Safer Roads showed that 68% of those questioned were in favor of red light cameras at intersections.

FHWA
figures from the USA suggest that over a period of five years ending in 2010, nearly 800 people a year on average died in red light running accidents

Wise investment

Research body John Dunham and Associates recently completed an extensive report focusing on the potential savings that may accrue from the presence of red light safety cameras on US roads. The analysis, which calculated money saved through fewer accidents and traffic delays, the reduced impact on local hospitals, less property damage and insurance, and the redeployment of traffic officers, was commissioned by American Traffic Solutions. Although numbers varied from city to city, every camera was shown to provide a positive economic benefit to the local community. One red light camera in Hazelwood, Missouri was projected to save US$163,000 in one year and US$729,000 over five years.

> People see the consequences of not running the red light as greater than running it … not blood and guts and twisted metal

(Left) **Studies have shown that the presence of cameras reduces red light running** (Below) **Independent audits of red light camera enforcement have shown that in some jurisdictions fines exceeded program costs, while in others, the programs didn't break even**

to run red lights than those with older children (40.8%). Individuals are also more liable to offend than those with passengers, particularly if the passengers are children. Motorists who don't wear a seatbelt are also more regular red light runners.

Such statistics seems to contradict Ceccarelli's viewpoint, as does a recent NCSR Safer Roads Report, which concludes that violations are at their peak on Fridays (33% higher) and their lowest on Sundays. Reasons proffered by professionals for red light running include schedule overload, self-importance, and the human instinct of trying to get away with something.

"People see the consequences of not running the red light as greater than running it," says Ann Sweet, spokeswoman for the National Campaign to Stop Red Light Running. "They don't see it in terms of blood and guts and twisted metal."

Red light running is a fascinating subject but not one that can easily be examined, due to the lack of a controlled environment. However, one such opportunity arose in 2005 when a team of psychologists led by expert Professor Bryan Porter had a rare chance to study how drivers adjust their behavior in the presence – or otherwise – of red light cameras. Virginia had allowed camera enforcement to expire and researchers discovered that in the immediate aftermath the chances of someone running a red light were three times higher than they were when the cameras were in operation.

"Red-light safety cameras have proved to be an effective tool for law enforcement to combat red light running," says James Tuton, president and CEO of American Traffic Solutions

(ATS), a company responsible for nearly half of the 7,000 cameras in operation across the USA. "The goal of any red light safety camera program is to change driver behavior. For programs that our company operates, more than 95% of drivers that receive a violation don't receive a second, proving that penalization through technology alters driving habits."

Last words

"People run lights because they are too impatient to wait for the next light cycle," says Kelly, wearily dismissing Ceccarelli's proclamation that "99% of people run red lights because engineers make them." He continues: "People must take responsibility. Most motorists do it close to their home, where they know the intersection and are familiar with the timing. They do it because they don't think they are going to get caught – and when they get a letter three weeks later they become angry. There is always a need for more research, but even some of our opponents will acknowledge that these cameras save lives."

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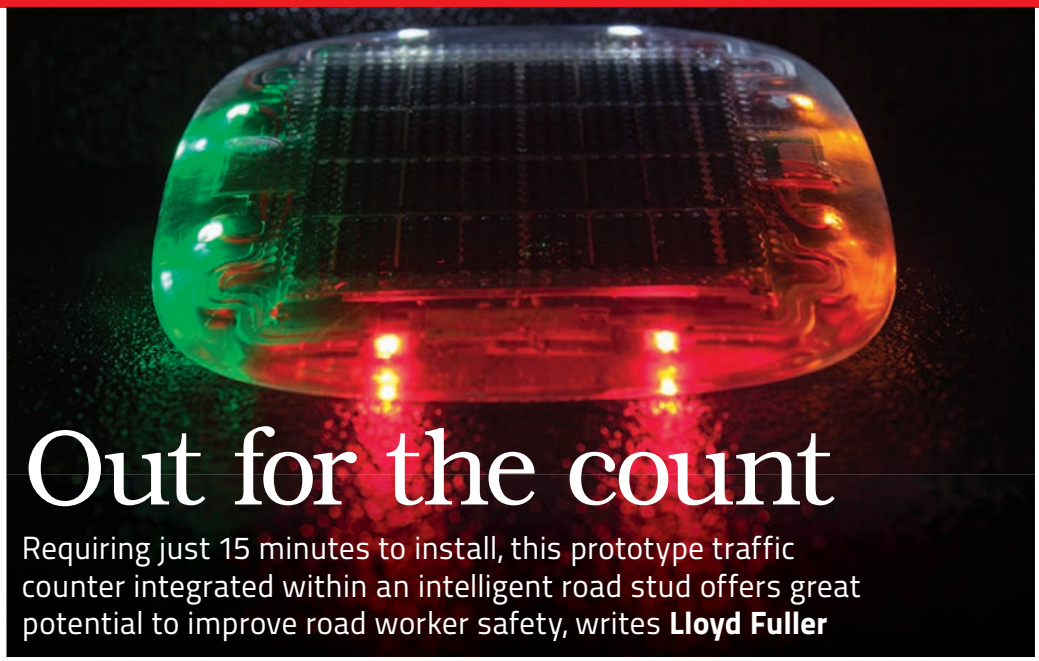


Out for the count

Requiring just 15 minutes to install, this prototype traffic counter integrated within an intelligent road stud offers great potential to improve road worker safety, writes **Lloyd Fuller**

Workers can be at significant risk when installing roadside equipment. Twenty-two-year-old Nick Micieli, for example, was killed last June in Milton – a Toronto suburb in Canada – while installing a traffic-counting device. He and a colleague were working on the road in front of their van, which was rear-ended by a Toyota pick-up truck before spinning around and subsequently colliding with Micieli, who was pronounced dead shortly after being rushed to hospital. Although just one example, such incidents are actually more common than you would think.

So-called hose counting or pneumatic devices are particularly challenging when it comes to installation as they have to stretch from one side of the road to the other. This is a potentially dangerous process that raised the alarm for Swedish road authorities, which subsequently approached Denmark's Geveko ITS to come up with an alternative solution. "That was about three years ago now," reflects Bruno Hansen, general manager at Geveko ITS. "And what we have in our prototype after a lot of research and development is a multifaceted, multifunctional alternative to hoses, embedded inductive loops and even radar," he reveals.

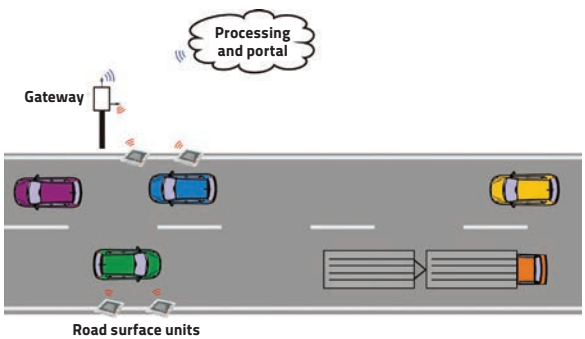
System setup

The LED-Guide – which measures around 12cm² and is a mere 7mm thick – performs traffic counting at lane level. "These compact dimensions actually allow you to collect data in the winter," Hansen continues. "With just a small groove, it can be mounted flush to the road so snow plows can run over the top without adversely affecting performance."

And because it's a lane-level installation, each lane on a road can be assessed independently. Housing the latest magnetic field sensors, vibration sensors and temperature sensors, the LED-Guide is not only able to detect vehicles but can also compute the vehicle length and number of axles, among other functionalities, potentially opening it up to applications such as weigh-in-motion, vehicle classification for tunnels, bridges, etc. "With two sensors in place, we can also calculate a point-to-point average speed, so you can assess traffic speeds on particular stretches of road," Hansen continues.

Vitally, though, LED-Guide is installed at the side of the road, so workers don't have to put themselves in danger during installation and removal. The system is composed of independent units that are connected with each other using wireless communication. For a two-lane road, there could be four road surface units performing the sensing task and low-level aggregation task. "The aggregated data is then transmitted through a nearby gateway into the processing unit located in the 'cloud'," Hansen explains. "When the processing of the aggregated and transmitted data is completed, that data is available in the portal and reports can be extracted."

Currently being evaluated in trials near Trondheim, Norway – and with a trial set to start in Sweden, too – LED-Guide could be ready for deployment as soon as mid-2013.



(Left) **The schematic shows the system level view of the traffic-counting system**

Intelligence as standard

In addition to traffic counting, Bruno Hansen reveals that Geveko's LED-Guide can unlock added-value features such as detecting what direction a vehicle is driving in: "If you are driving a vehicle the wrong way on a highway, for example, our system can provide a warning and detail the speed of the vehicle. Also, should you approach a sharp bend, a running light can indicate that you are driving too fast."

Contemplating a more active approach where technology and operations are concerned, Hansen says it's also possible to set up the infrastructure to communicate with the latest intelligent units from a remote location via the 'gateway' mounted along the line: "With this in place, all the road studs may be brought online and as a result can be monitored from anywhere in the world and – if required – the data forwarded to other systems."

iRoad
is an ongoing Swedish project involving Luleå University of Technology, Geveko, Eistec and Vägverket, which aims to develop intelligent road surfaces

Security tools

In line with the objectives formulated in the Directive of the Council 2008/114/EC on the identification and designation of European critical infrastructure and the assessment of the need to improve their protection, SeRoN – Security of Road Transport Networks, an EC-funded, 36-month (2009-2012) research project was set up. The consortium consisted of seven project partners: PTV, which coordinated the project; Germany's Federal Highway Research Institute, BASt; the UK's Parsons Brinckerhoff; the Technical University of Graz in Austria; Traficon; Ernst Basler & Partner; and NIRAS.

The group has developed a stepwise, holistic approach that enables road owners and operators to conduct assessments of road infrastructure objects (such as bridges and tunnels) and select suitable and cost-efficient measures to improve their resilience. Hence, available financial means can be used optimally, i.e. in a purpose- and goal-oriented way, to protect the road network for the benefit of the security of European citizens. The basis of assessment for deciding whether a protection measure is cost-effective or not can be adapted as desired or considered necessary to be able to represent the characteristics of the network considered.

The fire that occurred in the Channel Tunnel in 1996 and closed it to truck shuttle traffic for six months was estimated to have cost the UK economy more than £200 billion

> "The effects of events on road users have been identified using an evacuation model based on PTV's Vissim software

Critical assessment

Evaluating the criticality of road infrastructure and estimating the effects of its failure is a tricky task. **Georg Mayer** explains how a recent tunnel and bridge project is aiding this process

Images courtesy of PTV and AP Images

The European road network is of major importance for both the economy and the mobility of European citizens. Bridges and tunnels are especially important elements as the failure of such infrastructure objects could impact the entire network.

Within the EC-funded SeRoN project, a comprehensive four-step approach has been developed that enables the assessment of such infrastructure objects in terms of security. Using this new method, road owners and operators can analyze large road networks and assess individual infrastructure objects and the effectiveness of protection measures. During development of the method, two international workshops were organized to take into account the real-world experience of road owners and operators with regard to the security assessment of road infrastructure objects.

The entire procedure developed within the project is characterized by a very high degree of transparency and modularity. However, the level of detail and the complexity of the relevant analyses are growing step by step within the methodology. With the higher level of detail, the need for expert knowledge and more sophisticated simulation models also increases. But due to the modular structure, models other than the ones taken can be used.

First of all the infrastructure objects in a network have been roughly filtered and ranked. This step can be taken based on data such as average daily traffic (ADT) or share of HGV traffic – figures that are generally available to road infrastructure owners and operators.

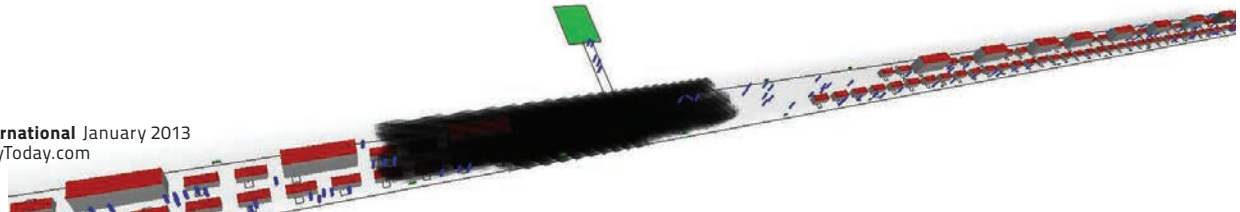
To determine the importance of an infrastructure object for a certain road network and the impacts in the event of its loss, a comprehensive and feasible assessment procedure has been developed. It enables the calculation of socioeconomic benefits arising from the prevented failing of the object due to protection measures. Benefit calculation takes into account the consequences for road users, the infrastructure object itself, traffic flows, and the regional economy that may arise from its non-availability.

In April 2007, part of I-580 in Oakland, California, collapsed as a result of a fire started by a gasoline truck that crashed

Upon closer examination

To examine improvements of the security level for individual objects due to suitable protection measures (preventive or mitigating), quantitative risk analysis has been applied. Based on defined scenarios, the occurrence probability of certain events and the corresponding risk has been modeled in a bow-tie analysis using fault trees (before event) and event trees (after event). Sophisticated models such as computational fluid dynamics, short-time dynamics/blast, and finite element method models have been taken to calculate the effects and to quantify the impacts on infrastructure and road users if an event occurs. The effects on road users have been identified using an evacuation model based on PTV's Vissim. It enables the describing of pedestrian movements depending on external influences, taking into account perception and behavior. The impacts of an event on the network are determined using Validate, PTV's own traffic and transport model.

Finally, the cost-effectiveness of protection measures has been determined as the difference between the monetized risk with and without a protection measure based on the effects of the. diverted traffic if the infrastructure object fails due to an event.



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Time to switch?

The convergence of cost-effective LEDs with more intelligent controls could go a long way to helping authorities balance the books. But **David W. Smith** discovers there is still reluctance to take a fresh look at roadway lighting deployments

Illustration courtesy of Lee Hasler

Arguments for and against LED streetlighting have raged for the past few years, but now another proposition is complicating the debate. Experts claim that LEDs are only the first step in the lighting revolution. To fully exploit their potential, control systems must be added, they say. Understandably, this news doesn't always delight cash-strapped local governments that are reluctant to add more expense to the high initial outlay.

But Kelly Cunningham, outreach director at the UC Davis California Lighting Technology Center (CLTC), says local municipalities that neglect to add controls could be missing out on 40-50% of the potential benefits. "Yes, LEDs are coming and, yes, they save a lot of energy, but what's after that?" she ponders. "We believe the future is in sensors, controls and data. Anyone who used the federal stimulus money to buy LEDs, well, good for them, but if they didn't add the extra node of communicative ability, they're not using the infrastructure to its maximum. US municipalities such as Oakland – which rejected controls outright – could live to regret it later."

A question of controls

Cunningham's colleague at CLTC, Professor Michael Siminovitch, went as far as to call a timeout on public purchases of LED lights until there was a nationwide controls standard that incorporated intelligent lighting capabilities. "The bulk of LED systems being installed are not pre-wired for control capabilities," he feels. "Streetlights with control systems offer dynamic dimming during long periods of inactivity, a feature with tremendous potential to save energy, mitigate waste, reduce light pollution, and increase safety."

The fixtures are likely to be in use for as long as 20 years, so ones that cannot be retrofitted will result in a significant loss in savings. Fortunately, manufacturers can easily add control-ready features by providing the fixtures with dimming drivers so that they can be retrofitted for full controls later on.

California's Bay Area Climate Collaborative (BACC) has made sure its lights are control-ready, even if it hasn't fully embraced the technology yet. With its Next Generation Streetlight Initiative, the BACC aims to catalyze the upgrade of more than 200,000 municipal streetlights in the San Francisco region to LEDs.

"Most local governments are interested in learning about controls but the discussion is at an early stage and the jury is still out," admits Rafael Reyes, BACC executive director. "Budgets are really tight so municipalities want to know the range of benefits. As a minimum, though, we want control-ready lights so that it's possible to tune and upgrade later when the technology is proven and cost effective."

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The CLTC's Cunningham believes politics plays a big role in whether municipalities opt for such sophistication. The presence of a local visionary can make all the difference. For example, Chattanooga Mayor Ron Littlefield embraced smart technologies when the Tennessee city opted to convert to LEDs.

Wireless connectivity

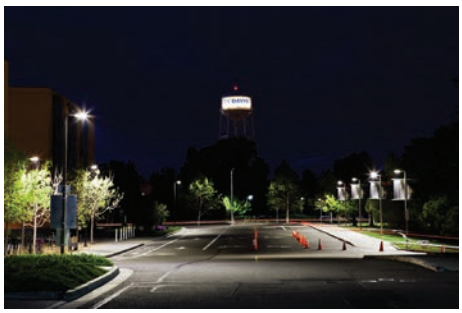
Chattanooga's project is one of the most advanced in the USA, with the city replacing its sodium lighting (HPS) fixtures with 26,000 induction and LED lamps, manufactured locally by Global Green Lighting and supplied with wireless connectivity from Sensus.

The FlexNet system creates a two-way wireless network using licensed spectrum in the 900MHz frequency range. It enables officials to control lighting from a single location that so streetlamps can be gradually brightened and dimmed, and uses energy when required instead of relying on a standard on/off cycle. By combining energy-efficient fixtures with FlexNet, Chattanooga expects to save up to US$2.7 million annually in energy and maintenance costs.

The CLTC – which is a research center as well as an advisory group – has been carrying out its own trials on controls. One major project was the Adaptive Campus Control System, which installed controls on 1,400 LED luminaires in a single network of streetlights, wall packs, bollards and post-tops on the UC Davis campus.

There were technical obstacles to overcome. Until recently, sensors spoiled the aesthetics of post-tops so the CLTC engineers found a solution by modifying a collar made by Philips Lumec – originally designed to house photosensors – so it could accommodate WattStopper occupancy sensors.

"These indicate the location of a cyclist or pedestrian and communicate accordingly with the lights, which can be on at full brightness, dimmed or off entirely," says Cunningham. "All are sub-metered with a high degree of accuracy so we can gather energy uses at every point. In an emergency, lights can be flashed, or switched off, which is another hot debate. Is it useful for police to bring the lights up when in pursuit of somebody – or does it attract attention and help criminals get away? Anecdotal evidence suggests SWAT teams prefer lights out."



(Left, top) **Out with the old and in with the LEDs** (Left, below) **Networked lighting at the UC Davis campus in California**

BLISS trials prove their worth

The Lancashire town of St Helens in the UK has taken the lead on the European BLISS project, which is evaluating options for streetlighting. Three other BLISS projects are running in the Netherlands, Belgium and Germany.

St Helens selected two areas for trials in a partnership with Philips Lighting. At Coronation Drive, it compared different types of lighting by walking from one street to another. One street used low-pressure sodium light sources; another used high-pressure sodium; and a third used Philips CosmoPolis ceramic discharge metal- halide lamps. In addition, Philips SpeedStar street lanterns were installed in three streets, each with different color temperatures – 3,000K, 4,000K, and 5,600K.

"The new lighting enables people to recognize colors and see objects much more clearly," explains Rory Lingham, assistant director, engineering, at St Helens Council.

Meanwhile, at Tithebarn Road, older lighting was replaced with 20 x 10m columns using SpeedStar lanterns. The higher light output enables fewer, taller columns to be used. Controls also dim the lighting to 50% between midnight and 6am.

"This was the first full-scale demonstration of SpeedStar lighting in the world," Lingham says. "The quality of lighting is much improved. It's far easier to see other vehicles and pedestrians."

Surveys showed 78% of the public preferred the whiter light of the LEDs. "And, because we are also achieving energy savings of 25-50%, it makes sense to install LEDs in these sorts of areas," Lingham adds.

> "As a minimum, though, we want control-ready lights so that it's possible to tune and upgrade later when the technology is proven and cost effective"
>
> **Rafael Reyes, Bay Area Climate Collaborative executive director, USA**

The green state

Cunningham believes California is an "early adopter state" and always ahead of the rest of the USA in implementing green technologies. There are a number of reasons for this, but an important factor is the decoupling of the Californian utilities companies, so their profits are now not dependent on volume sales and the companies can therefore focus on saving energy. Ambitious state legislation also encourages compliance. The California Strategic Lighting Plan adopted a strategic goal for 60-80% statewide reduction in electrical lighting energy consumption by 2020 from a 2010 baseline.

The biggest streetlighting initiative in North America is in California's largest city, Los Angeles – a project driven by the desire of Mayor Antonio Villaraigosa to make LA the greenest city in the

USA. In 2009, he announced a US$57 million plan to retrofit 140,000 of the city's 209,000 streetlight fixtures with LEDs.

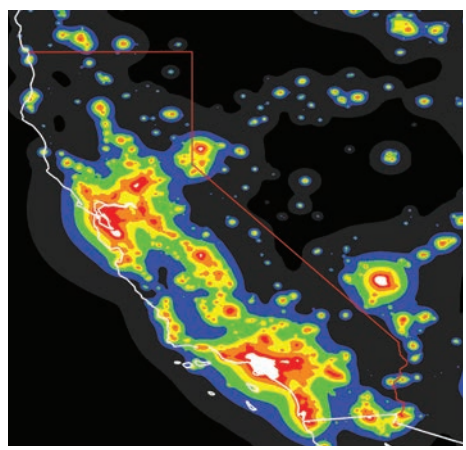
"There are other big projects, for example in Boston and Seattle, but none comes close to ours," says LA's Streetlighting Bureau director Ed Ebrahimian. "We get interest from all over the world but the hurdle everywhere is funding. If municipalities had the money, they would jump at this technology. It's got superior white light, lasts longer, has more energy, a better distribution of light, and is easier to control. It makes a huge difference with dark skies. You can easily control light pollution and light trespass."

Payback

Ebrahimian explains that once its loan is paid back in seven years, LA will save US$10 million per year in energy and maintenance costs, while removing 40,500 tons of CO_2 emissions annually. In the LA program, high-pressure sodium vapor cobrahead fixtures are being replaced with long-life, white light products. The old fittings had poor optical efficiency (about 65%) compared with the high optical efficiency (over 80%) of many LEDs. A remote monitoring system collects real-time performance data for each fixture, with the information gathered at the Bureau's GIS system. Equipment failures are coordinated with the its maintenance work orders, and the GIS collates kilowatt-hour usage for each fixture, in doing so creating a detailed picture of electricity consumption and energy savings.

To date, LA's forward-thinking approach is unusual in the USA. A recent study by the Northeast Group – a Washington-based smart grid market intelligence firm – revealed that LED penetration remained below 1% of streetlighting in the USA. Such a low level of implementation flies in the face of the almost universally positive assessments of LED performance. The Northeast Group interviewed 100 of the 400 US municipalities that have introduced – or intend to introduce – LED lights. Some 95% were

> It's got superior white light, lasts longer, has more energy, a better distribution of light, and is easier to control. It makes a huge difference with dark skies
>
> **Ed Ebrahimian, LA's Streetlighting Bureau director, California, USA**



(Top left) **LA will save US$10 million a year by switching to LED lighting** (Right) **Image showing California's light pollution**

UK councils turned off by safety risks

Councils in the UK have taken a number of approaches to saving energy but some projects have been better managed than others, according to Allan Howard, president of the Institute of Lighting Engineers (ILE).

The ILE man points to the unfortunate example of Milton Keynes Council, which in the summer of 2012 reversed a decision to switch lights off on grid roads following a 30% rise in accidents and two fatalities in unlit areas. Nearly 2,600 lamps were switched back on and £865,000 (US$1.35 million) will be spent on dimmers.

"They kept some lights on at roundabouts and at junctions, so you had approaches where drivers kept moving from lit to dark sections, which doesn't conform to any standards," Howard reveals.

He also disapproves of Hertfordshire Council's blanket streetlight switch-off on both rural and urban roads from midnight to 5:30am. "It's debatable if one answer fits all, whether you are in a town such as Stevenage or a rural village. In towns, there's the perception that streets become more dangerous," Howard adds.

Meanwhile, Buckinghamshire Council provided an example of good practice. "The county switched off a lot of lighting at 46 locations but it followed the Highways Agency's 10-step risk-assessment program on how to switch off lights."

Streetlights have been turned back on at five of the 46 locations. At four sites the number of accidents increased, although on average, injury collisions fell by 26%.

At the remaining sites, lights will remain off, but there will be improvements to signage, bollards and road markings. "If you turn lights off, you need to provide other measures of giving the right level of information," Howard insists.

satisfied with the performance of LEDs, which saved an average of 60% in combined energy and maintenance costs. And many local governments reported that the police in particular praised the lights for improving visibility and public safety.

Even in California, the uptake of LED technologies has been slow. The CLTC surveyed 212 cities encompassing 1.1 million streetlights. Although 74% rated energy efficiency as a high priority, more than 76% of their streetlights still use HPS lamps. LEDs and induction sources lag at 2% and 3% respectively.

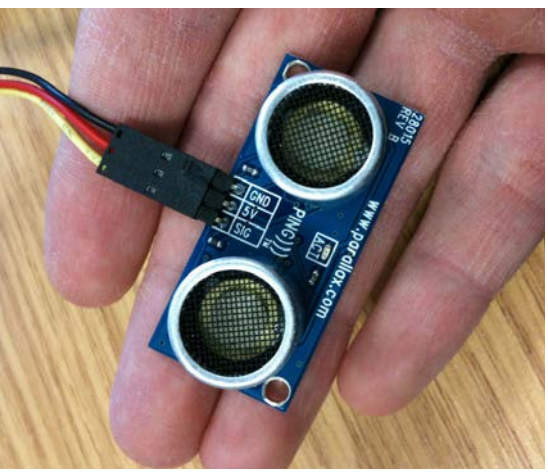
Siminovitch says the ineffective roll-out of another lighting solution once heralded as a breakthrough – compact fluorescent lamp (CFL) technology – is a major reason behind the reluctance to embrace LEDs. Consumer dissatisfaction with CFLs grew as color quality and longevity were compromised in the rush to lower production costs. The CFL debacle, he feels, is still fresh in American minds.

"We have a lot of damage control to do in convincing US consumers the next generation of lighting technologies is going to be better than the last," Siminovitch wrote in an article in *LD+A* magazine. "Even when we have better technology, most consumers will be suspicious of both government and industry claims."

BACC's Reyes, however, is convinced that a major breakthrough for LEDs is imminent: "We're at the point where the dam is going to break in terms of upgrades to LED lighting," he says. "Prices have dropped sharply so there's now the possibility for large-scale deployment by local governments. All of the investment in the lighting industry is in LED. It has been proved in the field and the time is now."

Join the future, now!

The CLTC's Cunningham is adamant that the convergence of cheaper LEDs with advances in smart technologies mean monumental gains in savings and efficiencies are around the corner. The ultimate light system might not be far away.



Sensors can be incorporated into lighting solutions to detect changing conditions

"For me, the ultimate light would have the right luminaire, the right source, and the right controls," she says. "The source would be tuneable across the spectral power density, so it could change color according to the needs of the environment, for example if a weather front came in. Or it would adapt to the needs of other creatures. So if an endangered turtle was migrating in winter, an amber color might be more sensitive.

"In other seasons it would revert to white light, which is preferred by humans. It would be well-directed so there would be less light pollution. Light would not be not going willy-nilly into the sky and it would be even so there would be no dark spots.

"Meanwhile, the controls would adjust it to the right level when it's populated and set it to an appropriate level when no one is there, whether that's off, or 10%, or 15.253%," she concludes.

Ed Ebrahiman has an even more futuristic concept. "The ultimate light would be a one-point source that is the size of a fingernail, but produces the same amount of light as large fixtures. That way, the poles can be smaller and not that visible. I have seen plasma lights that are one point and I think it will happen for streetlights in 20-30 years."

Making light of collision statistics

Having produced a series of research papers at the Lighting Research Center at Rensselaer Polytechnic, one of Professor John Bullough's most important conclusions is that the impact of lighting on night-time collisions is closer to 10% than the 30% figure widely reported.

"Considering the impact of other safety-related features – such as traffic signals, speed limits, and shoulder types – it is important to isolate the real impact of lighting, and that is the reason for the closer-to-10% estimate for night-time crash reduction with lighting rather than the 30% found in many studies," Bullough says.

Even though the effect of lighting is not as great as previously thought, it is still relatively inexpensive compared with the high cost of crashes. "We calculated that lighting can be justified at intersections on rural roads having 1,800 cars a day or more, and at intersections of urban roads having about 2,500 cars a day or more."

The greatest significance of his research, however, is in providing a way to relate visual performance – which can be predicted precisely – to safety. "It allows us to engineer adaptive lighting schemes to reduce energy use, cost and light pollution, while optimizing the safety benefits for the greatest number of drivers."

> The ultimate light … would be tuneable across the spectral power density, so it could change color according to the needs of the environment, for example if a weather front came in
>
> **Kelly Cunningham, outreach director at the UC Davis CLTC, USA**

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Scale your vision.

Image is everything

Timothy Compston takes a closer look at developments in the fast-moving world of machine vision cameras where sophisticated imaging capabilities are really grabbing the attention of integrators and operators alike

Illustration courtesy of Mayalenka

Machine vision cameras are certainly making their mark for traffic and transportation applications worldwide. The buzz around these smart camera solutions – the origins of which can be traced back to the indoor world of industrial processes, where accuracy is key – can, in part, be attributed to the highly detailed images they are delivering on the ground. This clarity of vision is certainly paying dividends across major ITS applications for DOTs and toll road operators, where the capture of clear, usable images of vehicles and their licence plates on the move (for ALPR, speed enforcement, etc) is a prerequisite.

But from a security perspective, machine vision solutions – by their very nature – also have a huge evidential value in helping to protect critical roadway infrastructure such as bridges and tunnels. This can range from authorities looking to utilize ALPR to flag-up specific vehicles on watchlists or, in combination with incident detection, delivering an early warning to an operations center that a suspicious vehicle has stopped on the roadway.

Coupled with the widely reported high-definition imaging advantages, machine vision solutions are also becoming a more affordable proposition as sensor technology improves in massive strides, CMOS being a case in point. Even lower-end models offer

Critical mission

Jopas Wulff from the Øresund Bridge discusses some of the vision technologies that are keeping this vital Danish-Swedish transport link safe and secure for travelers

By any measure, the Øresund Bridge – which first opened in 2000 – is an impressive structure, carrying seven million vehicles a year. This vital link between Sweden and Denmark stretches for 16km and comprises a bridge, artificial island, and tunnel, carrying a four-lane highway and railway line. For something so large, having the right surveillance in place is essential to ensure that traffic flows smoothly, tolling operations are supported, and the bridge is safe and secure for drivers and train passengers.

Jopas Wulff, traffic manager, Øresund Bridge, is responsible for managing nine operators in the 24/7 traffic center, with at least one person on duty at any specific time. In terms of surveillance, Wulff notes that there are 250 cameras on the bridge and 130 in the tunnel, plus cameras at the toll station: "We have them more or less every 500m over the bridge," he says. These are not currently high resolution, although Wulff feels that – despite their limitations – they are sufficient to allow him and his colleagues to see where a vehicle has stopped or is moving against the flow.

Looking ahead, though, changes are afoot on the camera front at the bridge, with Wulff confirming that there are plans to introduce much more capable high-definition models to provide better detection of license plates for tolling: "This is in the budget for this year so it is likely to happen for 2013/14," he reveals. "The new cameras will help to ensure that we take money from the right car and clarify customer queries. With high-resolution images, it should be easier to locate a specific car and the time it passed through the tunnel." The cameras will be based at the bridge's only toll station, situated at the Swedish end, and which caters for traffic going in each direction.

When asked about the role of the non-tolling cameras currently being operated by the Øresund Bridge, Wulff says their primary task is to provide the information needed to secure the flow of traffic and to detect if there are vehicles stopped in the emergency lane, or if an accident or other incident is in progress:

> "With high-resolution images, it should be easier to locate a specific car and the time it passed through the tunnel

performance levels that traffic practitioners could only dream about a few years ago. The wide field-of-view and resolution associated with many machine vision offerings means that multiple lanes can, potentially, be monitored by a single camera, as opposed to multiple conventional cameras. Vendors in the sector argue that this can help operators to rein in upfront purchase and installation costs as well as simplify maintenance.

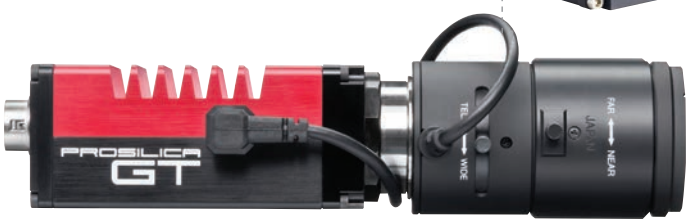
European community

Gauging opinion from the European Machine Vision Association (EMVA) about technological progress, general secretary, Cor Maas, finds that although most EMVA members have backgrounds in industrial applications, they are beginning to establish themselves in non-industrial sectors. In fact, he estimates non-industrial deployments account for between 10-15% of the total turnover generated around Europe and – crucially – traffic management is a significant proportion of this.

Furthermore, Maas points to a key announcement at the recent Vision 2012 event in Stuttgart, Germany, and the creation of the Future Standards Forum (FSF). This new initiative will see the three main machine vision associations – the EMVA, the Automated Imaging Association (AIA) from the USA, and the Japan Industrial Imaging Association (JIA) – engaging more closely to exchange ideas and expertise on standards.

The formation of the FSF signals a recognition by the three bodies that closer ties are needed because, practically, bundling the global competence of machine vision will help to avoid double-work in the development of new machine vision standards. Also, Maas adds, the industry itself isn't big enough to create standards for the multitude of sectors that their members serve: "We will look to pool our resources and monitor what is happening in different customer sectors," he explains. "There may be a standard coming out that we need to review to see whether it is applicable. We also want to communicate with sectors [such as traffic management] to develop standards in a more proactive way."

(Bottom) **Prosilica GT cameras are ideal for a wide range of demanding applications such as ITS and traffic imaging, security, and surveillance** (Below) **Teledyne Dalsa's Genie TS series camera**



Managers at the Øresund Bridge requested a redundant video detection system from Traficon for their tunnel, meaning the system is able to keep functioning normally in the event of a component failure

"Having the cameras in place enables us to see the extent of an incident and provide that information to the police and fire brigade before they arrive on scene," he says. "This could relate to the number of cars and trucks involved, or whether something has fallen onto the bridge."

As well as planning to upgrade camera resolution to smooth the tolling process for the Øresund, Wulff says enhanced incident detection software was provided by Belgium's Traficon: "This automatically picks up on stopped vehicles, traffic congestion, fallen objects, pedestrians, and traffic moving in the wrong direction, and brings them to our attention." A major focus of this effort is in the tunnel: "We don't have an escape or an emergency lane – just two lanes in each direction with an emergency tunnel in between – so the sooner we're aware of something the better."

> A major sticking point is that some government organizations are dictating that a specific system such as ALPR should be solely for that purpose
>
> **Steve Hearn, Stemmer Imaging, UK**

Security matters

Asked whether machine vision cameras are a natural fit for surveillance – as well as other traffic management purposes – Maas feels there is a real opportunity for more technologies to be developed with such roles in mind: "If you are able to observe something and use licence plate information, then that's undeniably an option," he says. "What happens in London, Stockholm and soon will happen in Gothenburg with the congestion charging systems are very good examples."

Stemmer Imaging's Steve Hearn believes, in principle, that it makes perfect sense for machine vision cameras to be employed to address a number of requirements, from security to traffic management: "The reality is that if you have a camera that's capturing an image, you can feed that image to anywhere you want in order to perform further analysis. Helping to secure bridges or tunnels on our road networks is well within the capabilities of machine vision."

According to Hearn, the detail and field-of-view offered by machine vision cameras are major selling points: "Systems can be set up looking at one lane or many," he says. "As long as you have sufficient data in each area so you can extract sensible information, that is fine. For a car passing through a tunnel, this could be to have enough pixels over the license plate to read it reliably. The same is true if you are looking elsewhere for fires or a vehicle that shouldn't be there."

Hearn reports that although there is a desire among some of Stemmer Imaging's customers to multi-task their machine vision cameras, some obstacles still lie in the way: "A major sticking point is that some government organizations are dictating that a specific system such as ALPR should be solely for that purpose," he says.

A development in the sensor world that is helping to increase the adoption of machine vision cameras for ITS is the advent of enhanced CMOS: "Most machine vision

Cameras... on the buses

Proof of the diverse applications of machine vision in the traffic sector can be seen with Redflex selecting Basler IP cameras for its Student Guardian system, which is intended to deter drivers in the USA from illegally passing stopped school buses, or to hold them accountable if they do.

Student Guardian uses two cameras per school bus – one on the front and one on the rear driver's side – to monitor traffic while the stop arm of the bus is deployed. Whenever cars illegally pass a school bus, the cameras capture high-definition video and high-resolution images of license plates and drivers. With a resolution of five megapixels, the Basler BIP2-2500c-dn IP cameras used can easily monitor three lanes so that no violation goes unnoticed. The image is then submitted to law enforcement to decide if a citation is warranted.

"ITS strives to make all of our lives safer," says Enzio Schneider, product line manager ITS at Basler. "This project safeguards those who need our protection most: our children."

Several pilot programs utilizing Student Guardian are already underway.

According to Redflex, Student Guardian can be operated with no upfront capital investment for cities and districts as the program can be fully funded by fines collected for violations.

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Manny Romero, product manger at Teledyne Dalsa, is an enthusiastic advocate of machine vision where highways and toll roads are concerned: "We're seeing an upsurge in demand every month," he reports. Romero also says that the solutions best placed to work here are far removed from a simple 'dumb' camera for capture and transfer: "People want a camera that has more flexibility, which can actually control its surroundings. This could be light intensity; it could be functions inside the camera such as auto brightness; it could be the host software such as ALPR."

Romero feels that this also ties in with the desire to improve the accuracy of ALPR applications: "Rather than settling for 70% validity, you can achieve more than 90%."

When asked about enhancing security at key points on the road network such as tunnels and bridges, he is certain the detail offered by the latest machine vision cameras offers them the edge: "You could be talking about 36 times more pixels than a typical VGA surveillance camera."

cameras were previously based on CCDs but the latest CMOS sensors offer low light sensitivity, a high-speed shutter and combine that with a low-cost interface. The end result is an extremely low-cost machine vision camera."

And when it comes to the images that customers want to obtain with machine vision cameras, Hearn says it can be anything from a simple board-level camera taking images based on a control system trigger – and outputting the data to PC for analysis – to a smart camera capturing an image and performing onboard analysis.

Stemmer Imaging is especially active in the traffic management and intelligent transportation sphere. "We are doing things such as traffic flow spot speeds, average speed, license plate recognition as well as vehicle classification," he says of the applications for which the cameras are most commonly deployed.

Beyond CCTV

So what sets machine vision cameras apart from their CCTV or surveillance counterparts? Essentially, Hearn feels, it comes down to control and resolution: "CCTV cameras are 'free running' so they will typically provide a compressed data output and most of the features are automatic – auto exposure, auto white balance, auto shuttering, etc. Basically you can't really control as much."

Machine vision cameras, in contrast, do not necessarily need compression and pretty much allow access to every feature and function within the cameras: "If necessary, you can synchronously trigger the camera with the camera set up in a certain way and do that several times a second using different gain settings and shutter speeds," Hearn explains. "Machine vision cameras are ideal if you want an image taken at a very accurate point in time to capture a fast-moving car before it moves out of view."

Traffic control and ITS technologies all rely on vision and image processing technologies. From road tolls and parking to traffic management and safety, machine vision is having a great impact

He suggests a practical example of machine vision's advantages is a car changing lanes and moving at high speed: "If you have a machine vision camera capturing 100fps at one megapixel, you are going to have a darn sight more chance of seeing what is happening in the scene over and above a CCTV camera running at 25 or 30fps and providing a compressed output."

Image matters

Image quality is a major focus for people who use machine vision cameras for traffic applications, according to Arlin Kalenchuk, product manager at Allied Vision Technologies (AVT): "If you take the resolution of the sensors, with machine vision a single camera could, potentially, give you multiple-lane licence plate recognition. To put this into context we offer cameras up to 29 megapixels, the same sort of thing that would be used for aerial imaging." The AVT man suggests that it may make economic sense to replace multiple lower resolution cameras – such as IP cameras – with a single higher-resolution camera.

> If you take the resolution of the sensors, with machine vision a single camera could, potentially, give you multiple-lane licence plate recognition
>
> **Arlin Kalenchuk, product manager, Allied Vision Technologies, Canada**

Beyond this, Kalenchuk explains that machine vision offers built-in flexibility in terms of how the camera captures data and the way that data is stored. He also cites the wide dynamic range of the sensors, such as those used by AVT, so they can cope with difficult lighting conditions, effectively distinguishing between bright and dark features that can otherwise prove problematic.

In light of the the strong interest from the traffic market, Kalenchuk reveals that AVT's Gigabit Ethernet camera, Prosilica GT, is geared specifically toward the sector as well as other testing outdoor applications: "One challenge the Prosilica GT addresses is the need to cope with an increased temperature range outdoors," he explains. "It can provide good, reliable operation at an ambient temperature of anywhere between -20°C to 60°C."

Out of the ordinary

Going beyond the hype regarding machine vision cameras, Joost van Kuijk from Adimec offers a reality check by emphasizing that the focus needs to be on the requirements of specific applications: "Normal cameras may be good enough if you just want to monitor traffic. Or if you are using ALPR when cars are entering a parking garage and you've only got a couple of seconds to detect where the licence plate is before running your optical character recognition."

Van Kuijk also feels that some of the features highlighted by machine vision camera suppliers that make their cameras suitable for outdoor use do not need to be used as they're not really solving the problems of the traffic industry: "Although promoting cameras for certain applications may work, it is important to always remember that integrators in the traffic sector are very knowledgeable about how to use cameras in an outdoor situation and have sold cameras on this basis for many years.

"The approach we prefer to take with our machine vision cameras is that we are not trying to provide a complete outdoor solution but instead offer capabilities such as running CMOS, running CoaXPress over long distances ,and have the features that will enable the integrator to build a high-end system like increased resolution. This is why you will find our cameras in high-speed ALPR."

Fast-track tolling

Known best perhaps for its tolling solutions, Q-Free is employing cameras from AVT for a new electronic toll collection solution based around a single-gantry solution. This combines the latest machine imaging systems, radio systems and ALPR software technologies to collect toll data.

Q-Free's single-gantry VRE960 Video Registration Unit features two Prosilica GX1920 cameras per lane. These capture high-quality images of vehicles' front and rear licence plates for ALPR. In addition, two AVT monochrome cameras are used per lane to track individual vehicles as they enter and leave the detection zone and change lane. It is claimed that Q-Free's solution can produce high-quality images of vehicles traveling at up to 250km/h and, crucially, has a 99.99% video triggering performance.

Dr Marco Sinnema, product manager, video and ALPR at Q-Free, explains that the secret to the success of the single-gantry application is not just the machine vision cameras but the way they are integrated: "We have processing in our imaging system that can tune the cameras in real-time. This means that we can re-tune the cameras as the weather or traffic conditions change, readily altering the exposure parameters to ensure that we still have good pictures."

> We can re-tune the cameras as the weather or traffic conditions change, readily altering the exposure parameters to ensure we still have good pictures
>
> **Dr Marco Sinnema, product manager, video and ALPR, Q-Free, Norway**

Q-Free's single gantry features two Prosilica GX1920 digital cameras by Allied Vision Technologies

Sinnema believes the single gantry reflects the widespread desire in the industry to adopt multi-lane free-flow systems where vehicles can be accurately identified for charging without needing to stop. He reports that a major consideration for the design of the imaging system is practicality: "You really don't want to have to close a road if you can help it," he says. "A system that is above the road needs to be made in such a way that it can be installed and replaced very quickly. Our image system is designed for quick replacement and installation. All configuration and alignment of the cameras in the right direction can be conducted remotely after deployment."

Considering the advantage of opting for one gantry, Sinnema says that not only does this lower the cost, it also makes it a realistic option for an urban environment: "This is what is happening in Gothenburg with their congestion charging. On an intersection, we can just have one gantry overlooking the area and using these cameras to take a single picture of each car. We know the cameras are constantly looking so they always know where the cars are driving," Sinnema says. "This allows us to put a virtual line there – like a virtual tripwire – that the vehicles have to cross completely for tolling and a picture of the vehicle front and rear to be taken."

Focused on the future

Ultimately, we are seeing a strong convergence between the requirements for security, traffic management and open-road tolling, and the exponential growth in the performance capabilities of the latest machine vision cameras. As a result, there is little doubt that these feature-rich solutions – which combine the high resolution and rapid frame rate much in demand, and the ability to adapt to changing lighting and weather – are likely to become an ever more common sight on our roadways.

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Strategic maneuvers

The first steps in an ambitious program to reform the Strategic Road Network have been mapped out in the UK. But, **Philip Bates** ponders, will the UK government do what's necessary to offer a better service to motorists and business users?

Main photograph courtesy of Jeff J. Mitchell

The current flurry of comment surrounding the future of the British Strategic Road Network (SRN) can be traced back to the *Spending Review* of October 2010, in which a re-assessment of the approach to operating, maintaining and enhancing the SRN was proposed. Undertaken by Alan Cook, the non-executive chairman of the Highways Agency, the findings and recommendations of the review were published in November 2011. In March 2012, Prime Minister David Cameron upped the ante by announcing plans to investigate ways to semi-privatize parts of the road network.

The announcement generated a lot of interest and comment in the media as well as across the transport industry. With Cameron's idea still in the air, the Department for Transport (DfT) responded positively to the reform proposals in the *Cook Report* in May 2012. In perhaps its most telling statement, the DfT said: "Crucially, in articulating what government wants, we will be ensuring that we are reflecting the needs of those who use and are served by this network." Some would argue a critical failing of recent years has been the lack of articulation of what government does want from the SRN.

To further stir up interest, in July 2012 the DfT issued a press release concerning proposals to upgrade and possibly toll the A14, in doing so re-igniting the debate about user tolls on UK roads. Although the details are unclear, it would appear that the proposal is for a relatively short (20 mile) stretch of tolled expressway, with free local roads either side. (More details were expected around about the time of going to press.)

Although it is unusual for a PM to become directly involved in policy formation in this way, what is equally as interesting is the way various interest groups have also been promoting reform at the same time. Although the government may not have intended to

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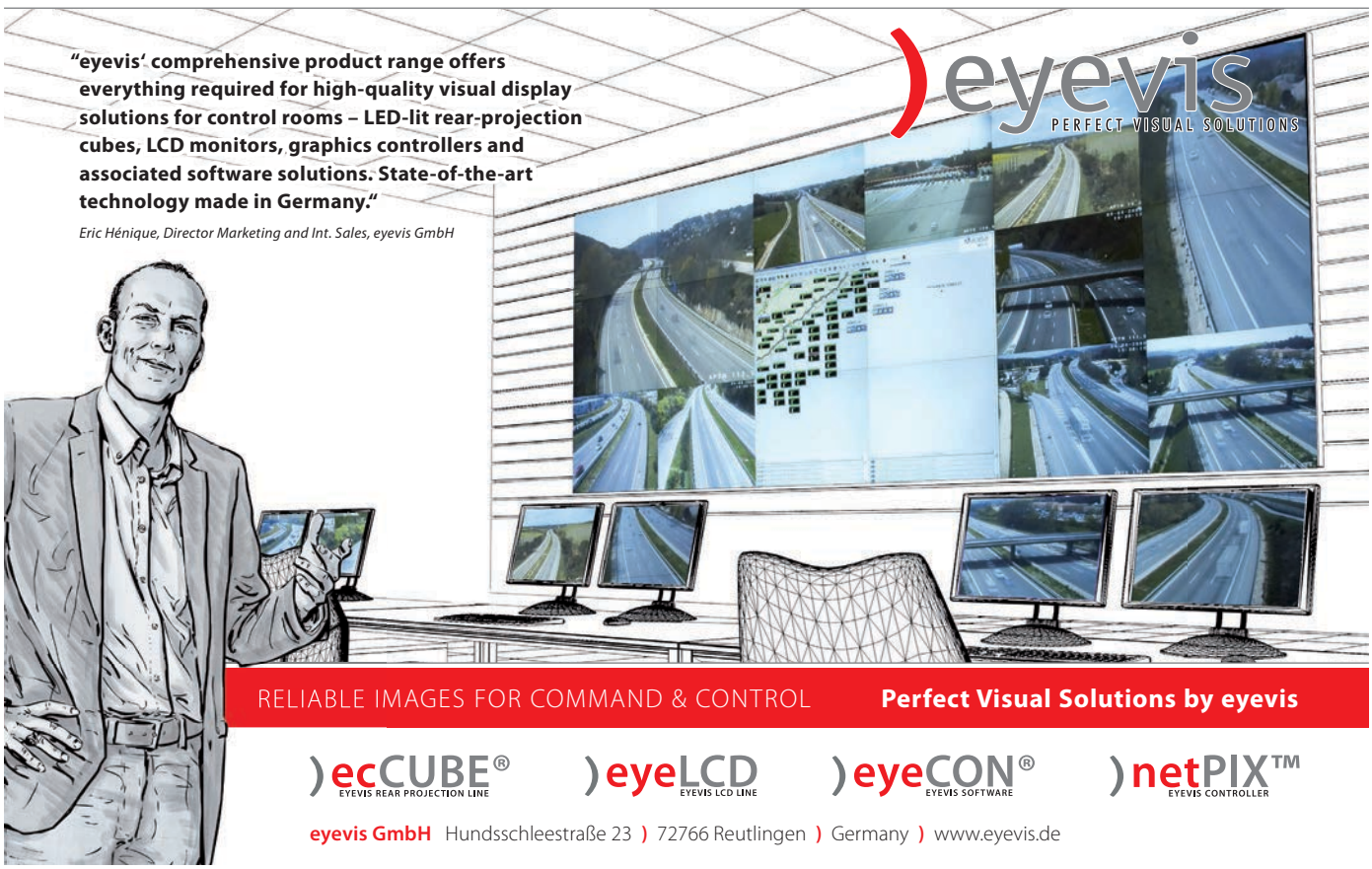

The 2012 Feasibility Study

In May 2012, the British government released the terms of reference for an internal feasibility study on roads reform as requested by Prime Minister David Cameron. The study is to consider a range of questions, including how different models could apply to roads, the investment needs of the road network, payments and the impact on the motorist, the role of regulation and performance frameworks, value for money, and efficiency and practical delivery issues. At the time of writing this article the report is still unavailable.

open a Pandora's box in October 2010, this is what it has done, and the various interest groups that responded seem keen to ensure the lid is not shut.

Taxation and the SRN

The debate has also regalvanized those who believe we need a new approach to road and fuel tax. The October 2011 report, *Moving On: Fairer motoring taxes and investment for growth and jobs* by Brian Wadsworth for the Road Ahead Group, presents a valuable summary of the current situation of road taxation and raises some interesting ideas about how a future tax system might look.

What is particularly interesting about this report is that it doesn't say road taxes should be reduced, and it acknowledges that there may be good reasons why these taxes may be needed to pay for things such as the National Health Service. However, it does highlight that because these taxes are likely to decline anyway, this is the perfect opportunity to review the role of road and fuel taxation in the overall tax mix.

Also, although the report says it is against universal road user charging, it does propose the introduction of what one might term 'congestion charging' in the sense of a system that works on the principle that there should be a cost for using busy sections of road (although it actually presents this as a discount for not using congested sections, in doing so ensuring drivers know the maximum they will pay in any year). Further, it puts forward the case for at least a proportion of road user revenues being ring-fenced for highway improvements, which some might argue is hypothecation.

The report's greatest value is in forcing us to ask ourselves two simple questions. Are road taxes there to cover the cost of roads (and indeed other government expenditures) or are they there for influencing behavior? How do we balance the potentially conflicting needs and outcomes of each objective?

He who pays the piper

So, eventually we reach the question of road tolls for trucks and cars. We see a growing trend across the rest of Europe to levy a toll for trucks using the SRN, even when other vehicles are not tolled. Interestingly, although the government says road users will not be tolled for existing infrastructure, in fact its proposed truck 'vignette' is arguably just that (although it is a day charge rather than a distance charge and, as it is combined with a reduction in road tax, so it is claimed it should be largely cash neutral for most UK-registered trucks).

For car tolls – and specifically the A14 through Cambridgeshire (a project specifically mentioned by the Prime Minister in March 2012 as well as in the July 2012 press release) – details remain hazy. Pricing to manage congestion appears to be what the government is currently most interested in, and there is a clear acknowledgement in the information released so far that the toll is being levied to provide the road user with an option that avoids congestion. Such an approach is also being promoted in the USA through the development of managed lane schemes.

There are numerous definitions explaining what managed lanes are, but there appear to be two common themes. First, they are freeway-within-a-freeway

> Economists might argue a willingness to pay reflects economic value, but the reality is that, at least in a situation like this, it actually reflects personal wealth and ability to pay

The UK government's plan is to increase the quality and efficiency of the national network, in doing so offering a better service to motorists and business users

Vital commodity

The SRN in Great Britain – while relatively short in length – carries around 90% of all passenger and freight movements undertaken by road, despite a decade of some of the fastest rail growth in our history. Even in the face of efforts to encourage non-road modes, it is clear that this balance will not fundamentally change any time soon. As a result, maintaining and, where necessary, upgrading our road network is critical if we are to retain the level of accessibility to which most of us have become accustomed, and which, many argue, remains critical to our ongoing prosperity.

Moving On Report

Brian Wadsworth's October 2011 report proposed a straightforward restructuring of a familiar motoring tax: Vehicle Excise Duty. "When the state has needed a bit more cash to balance its books, the words fuel duty have tripped effortlessly off the Chancellor's tongue," he states in the opening pages. "Ironically, the more successful the government becomes in achieving one of its key public policy objectives – fighting climate change – the faster its motoring tax income will decline. We don't advocate a return to the fully hypothecated 'road fund' that existed in the early years of the 20th century, but we do believe our national interests would be better served if a significant element of motoring taxes were formally tied to investment in network capacity."

facilities with the managed lanes immediately adjacent to the general-purpose lanes. Second, their use is controlled by a combination of tools and techniques to achieve optimal conditions for users of the lanes (normally free-flow speed). The methods adopted are sub-divided into three broad groups – pricing, vehicle eligibility, and access control.

However, before we assume managed lane-type improvements will solve all our problems, the following needs to be borne in mind. Most managed lane schemes in the USA are well utilized because they offer free use to high-occupancy vehicles (HOVs). As a consequence, total revenues are low. Furthermore, most US managed lane schemes are either on radial routes into – or orbital routes around – very large urban areas, and are dominated by large commuter-based peak periods – meaning off-peak usage and truck usage are very low. None of this seems to correlate obviously with the A14 in Cambridgeshire. It should also be remembered that – for the most part – the USA has embraced managed lanes either to boost the underutilization of existing HOV lanes or to raise revenue in the face of declining fuel tax revenues and their hypothecation to road maintenance and construction. In the UK, HOV lanes are extremely rare and in any case the problem is not a lack of road or fuel tax revenues but a decision to spend these revenues elsewhere.

There is one other issue with respect to tolling, especially given the relationship between the A14 and the port of Felixstowe. Trucks don't normally pay tolls to use short stretches of 'congestion-busting' highways. This is for a variety of reasons. Many truck operators cannot convert relatively small time savings into monetary savings and, as trucks travel at a slower speed than cars, time savings to avoid congestion are often a lot smaller for trucks. The real value of time is zero for small incremental savings. Also, trucks tend to travel much longer distances than cars, and achieving a time or reliability saving over a short length of the network is of little value if you know there is a great deal of delay and unreliability remaining in the rest of your journey. A long line of trucks exiting a motorway to travel 20 miles along a local road and then rejoin the motorway – simply to avoid a toll – is a common spectacle across the world. Let's hope we don't see something similar in Cambridge.

Finally, there is a more philosophical issue to be addressed. For a congestion-buster toll road to work, the existing free lanes have to remain slow and/or congested. You cannot solve the congestion and capacity problem for all; you simply offer a way out for those who can afford to pay to avoid it. Economists might argue that a willingness to pay reflects economic value, but the reality is that, at least in a situation like this, it actually reflects personal wealth and ability to pay. And that is a significant difference.

Conclusions

So, where does this leave us? The first thing to stress is that the UK government's decision to review how we fund and deliver the SRN is to be applauded. It is long overdue. However, if the process is to be ultimately successful we must have the courage to question the unquestionable, challenge the current paradigm and face up to some hard choices about priorities. We should all accept that this is an issue that will not be resolved quickly; ultimately, difficult and potentially unpopular decisions will need to be made. Finally, any decision needs to be integrated into a wider transport strategy, and we need to accelerate the delivery of the national transport network's infrastructure plan.

If we get all this right – and the first test will be the findings of the *Feasibility Study on Road Reform* by the DfT and the Treasury – then perhaps opening Pandora's box will not have been such a bad thing after all.

• *Philip Bates is the director of strategic infrastructure for international engineering consultancy, Buro Happold. To find out more, please email philip.bates@burohappold.com*

(Above left) **The proposals to impose tolls for using an 'enhanced' 20-mile section of the A14 in Cambridgeshire, represents a significant shift in government policy** (Below) **Tolls were abolished on the Forth and Tay road bridges in Scotland after years of campaigning by drivers**

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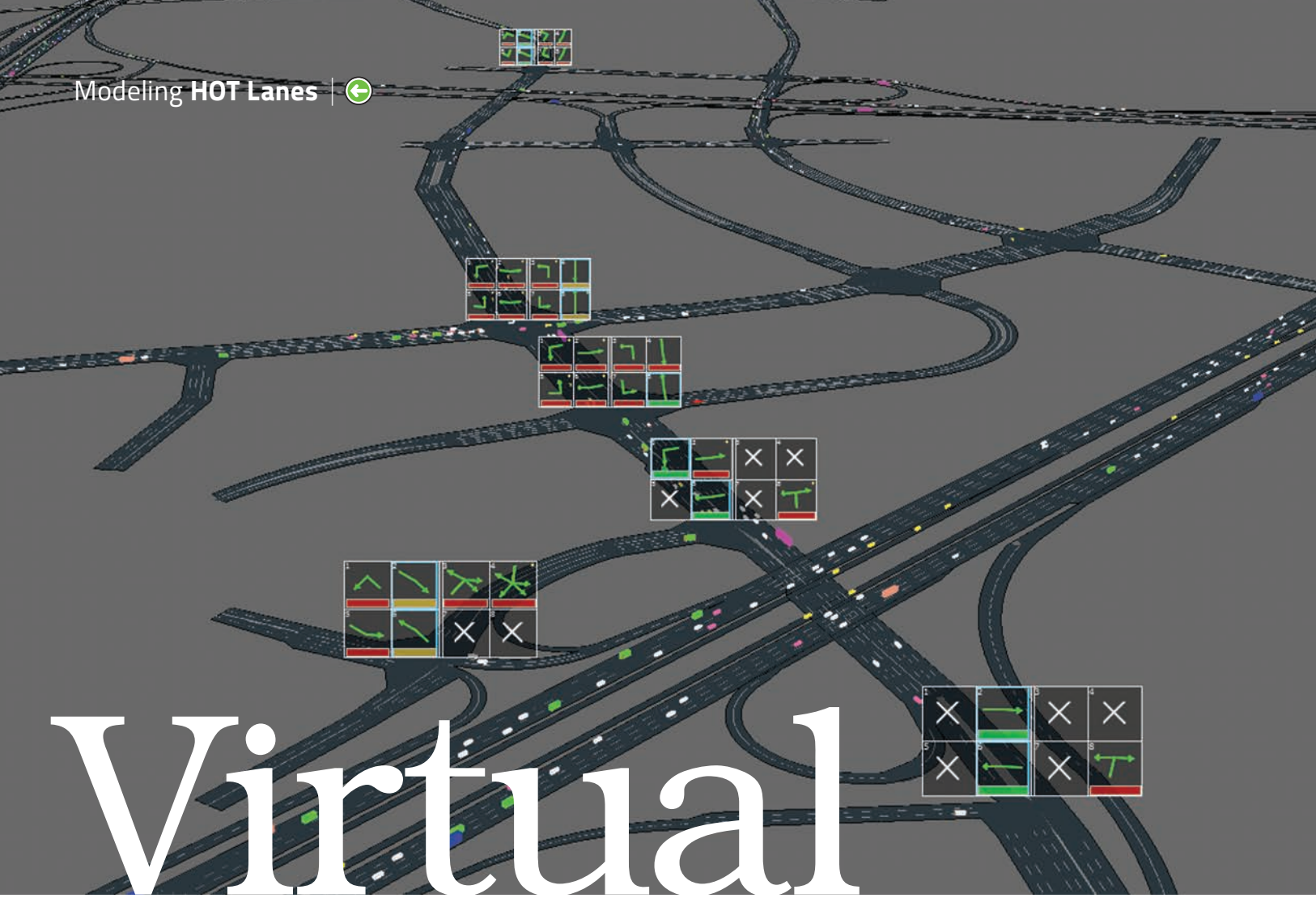


Virtual realities

By simulating various real-world HOT lane scenarios with next-generation modeling software, **Lenny Winsel** believes you stand a much better chance of achieving your revenue and mobility goals

Images courtesy of OCTA & Pitney Bowes Software

Industry professionals have long debated how best to provide sufficient transport infrastructure and to address congestion levels in the USA. High-occupancy vehicle (HOV) lanes introduced in the 1960s aimed to encourage higher vehicle occupancies through carpooling and thereby reduce congestion and pollution, but were rarely used to their intended capacity.

They continued to be underused into the mid-1990s and, as demand grew from owners of single-occupant vehicles (SOV) who were willing to pay a fee to use the HOV lanes, HOV became HOT – or high-occupancy toll – lanes.

The 91 Express Lanes (SR-91) in California is a fine example, a major 10-mile east-west tolled freeway starting from Orange/Riverside County and stretching to the Costa Mesa Freeway. It's been in operation since 1995 and the pricing scheme is based on a per-use basis with discounted rates depending on time of day and number of occupants per vehicle. I-394, meanwhile, is an 11-mile-long corridor with a combination of barrier-separated and diamond lanes, where the pricing is based on traffic density on a lane-by-lane basis.

Pros and cons of HOT lanes

The obvious benefit of HOT lanes is that they maximize the use of underperforming HOV lanes by permitting SOVs while easing the level of traffic along the general-purpose (GP) lanes, and in doing so potentially increasing overall capacity and traveling speed along the freeway. The cost of converting existing HOV lanes into HOT lanes is also minimal as most of the infrastructure is already in place and the additional revenues generated from HOT lanes will help provide for future improvements and maintenance.

Since the successful implementation of HOT lanes at SR-91, interest in the concept has grown. The scheme not only reduces congestion levels but also improves mobility and reduces emissions levels during peak periods. Traffic conditions improved immediately after the HOT lanes opened and the revenues generated from the HOT scheme eventually covered both operating and capital costs.

Despite the aforementioned benefits, HOT lanes are said to provide congestion relief to higher-income drivers only, and have been dubbed 'Lexus lanes'. Critics argued that the majority of lower earners tend to live further away from their workplaces, so the total cost of using HOT lanes would actually be higher for them than for higher-income groups.

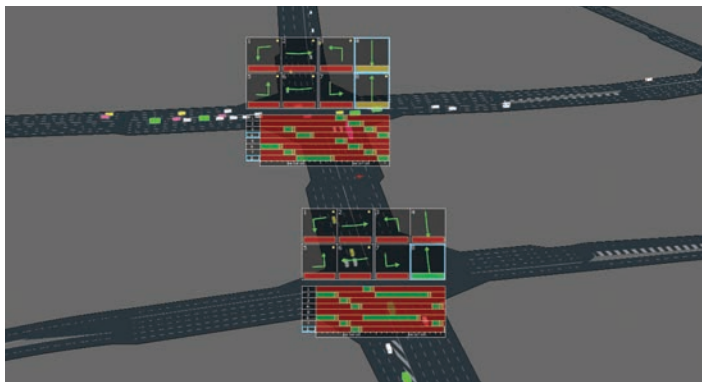
However, initial doubts that HOT lanes favored only high-income households were promptly dismissed as surveys show that the HOT lanes were actually used by drivers

On the HOT campaign trail

One of the challenges faced by government agencies with HOT lanes is to increase the awareness of their purpose and benefits. The Washington State Department of Transportation (WSDOT), for instance, conducted a public education campaign in 2010 to help drivers understand how HOT lanes operate and to explain the benefits of the lanes. The campaign website recorded, on average, more than three times the number of daily visitors than other campaign websites, which not only shows that there is great interest in HOT lanes but also that people require guidance on using them.

Although HOT lanes have been implemented in other states in the USA and Canada, few have been deemed 'successful' by industry professionals. WSDOT's SR-167, for instance, is an 11-mile HOT scheme and has been running for several years but hasn't as yet been able to generate enough revenue to pay off its capital costs.

Notwithstanding these and other challenges, HOT has gained popularity due to its reliability and journey improvement. In the case of SR-167, the majority of people found HOT lanes to be very helpful for business, citing time saving as the main reason.



Combined with comprehensive route-choice modeling, Paramics provides a powerful toolkit for assessing the cost/benefit decision drivers make when choosing to use or avoid tolled road facilities

from all income levels. One survey, for instance, found that the majority of drivers engaged in a home-to-work travel pattern do not use the HOT lanes on a daily basis and would do so only to avoid severe congestion, especially during the evening peak periods. However, as you would expect, the survey does show that higher-income groups are more likely to use the HOT lanes than the lower-income groups. Although there is a clear relationship between income groups and HOT lane usage, a higher percentage of higher-income groups have not used or infrequently use HOT lanes compared with lower-income groups.

Toll pricing is clearly the most influential factor in HOT lane usage as it determines whether a driver is willing to pay a fee for a reliable and quicker travel time. From a socioeconomic standpoint, HOT lanes appear favorable and the best solution for reducing congestion. From a driver's standpoint, the toll paid is a perceived value of time, something the driver is willing to pay in return for improved travel conditions.

Effective modeling

Although SR-91 has proved to be successful, that doesn't mean the same tolling schedule or pricing scheme will work elsewhere.

HOT lanes such as on SR 91 make better use of existing HOV lanes to provide capacity more efficiently than either conventional HOV lanes or general-purpose lanes, as well as reducing the number of lanes needed on new freeways by limiting peak-hour demand

There have been cases where companies have allegedly overestimated their traffic and revenue forecasts in order to gain public approval on HOT schemes. Supporters of rigorous HOT and price-point analysis via simulation and behavioral modeling would argue that these mistakes could have been avoided if modern traffic simulation techniques had been used to better understand the response of drivers to a change in toll charges.

Traditional modeling methods do not offer engineers the range of capabilities required to effectively model driver reaction to a change in toll pricing structure scenarios. However, the next generation of traffic simulation software does provide these capabilities.

Such software was used as a testing platform for SR-91 to dynamically simulate changes in driver behavior in terms of vehicle speed and toll prices. Various toll-pricing plans are available for the SR-91 HOT lanes, ranging from a monthly membership to pay-as-you-go. All fees are collected automatically via transponders.

The driving population generally understands the concept of value pricing and that a majority of drivers of SOVs would be willing to pay for improved travel conditions. This enables the user to incrementally test various HOT schemes, which may lead to a more comprehensive road pricing structure. Although most drivers of SOVs choose to use HOT lanes on a selective basis depending on the time savings, some studies show that reliability is becoming a major factor for them. The main challenge of including reliability as part of HOT pricing is the consistency and accuracy of perceived value of reliability of HOT lanes.

In Canada, for example, a recent study for the Greater Toronto and Hamilton Area (GTHA) showed that HOT lanes have the potential to generate annual revenue in excess of US$1 billion, which could be used to fund the expansion of the road network. How much of the revenue GTHA can actually secure via HOT pricing schemes will depend largely on choosing the correct tolling strategy and price point to encourage drivers to use the system while fulfilling its intended operational goals.

Quadstone Paramics, as used in SR-91, has been deployed throughout the world to model HOT schemes and is continually being refined to offer engineers a set of advanced analysis tools. Moreover, it presents a guide process they can use to design HOT schemes that promote a safe, cost-effective, and green use of road space by vehicles.

• *Lenny Winsel works at Pitney Bowes Software and is based in Edinburgh, UK*

Social climbers

DOTs, toll authorities and technologists tell **Timothy Compston** why there is heightening interest when it comes to the sharing – and collection – of travel information via social media platforms. Traffic managers: click 'Like'...

Illustration courtesy of Ben White

Moving beyond email, text alerts and websites, DOTs, municipalities and toll road operators are having to race to make sense of what can only be described as a social media whirlwind, coupled with the exponential growth in smartphone usage.

A multitude of traffic-related apps is now appearing from operators and independent providers looking to take advantage of this technological revolution. We have also witnessed social networking and micro-blogging sky rocket in the form of Twitter, with millions of these 140-character text messages disseminated to avid followers each day. And of course there's Facebook, which can now boast more than one billion active users – an increasing number of whom are accessing it via a smartphone or other mobile device.

Predicting gridlock

Reflecting on this rapidly changing landscape, Sam Schwartz, the founder of Sam Schwartz Engineering – who coined the terminology 'gridlock' back in the 1970s – says that social media was the essential communication tool during the recent Superstorm Sandy. "Every day transportation was changing. Bridges were open, then they were closed. Tunnels were closed, subways were running – but on different schedules," he recalls. "Social media became even more compelling given

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It's one thing to appreciate the benefits of more direct communication with your road users, but how do you go about getting an app out to the mass market?

Social media, apps, smartphones and all the regalia are revolutionizing how we drive, how we travel, which routes we travel on, and potentially even how DOTs manage traffic. But how does a traffic authority go about developing such a technology?

When considering its rollout of a new smartphone app for travelers, Colorado DOT (CDOT) took a bold step by going down the path of a public-private partnership. "We wanted a developer that would create the app, own the app, and at their own cost sell advertising to generate revenue from the app," reveals CDOT's Stacey Stegman. "As part of the deal with urHub, we endorse it as our 'Official App', in doing so providing credibility, and we've given them all of our information to populate the app."

Known as CDOT Mobile, the tool was launched in September 2012 and covers the I-70 mountain corridor. Stegman says there are plans in place for the I-25, a main commuter route in the Denver area, to follow this winter, as well as other highways in the Centennial State at a future date.

Offering information on highway conditions, closures, workzones, speeds and travel times, the app even supports feeds from CDOT's roadside cameras. "Its purpose is to communicate the right information so people can make decisions on the best time to travel," Stegman adds. But it doesn't end there. A new feature being added is geosensing: "Working with local businesses, when people are traveling and they cross into a particular area at a certain time of day, they may receive a notification informing them, for example, that if you leave the highway at that point, you'll receive 25% off at a certain restaurant. Where the highway is extremely congested, they may even be offered a hotel deal to stay the night to avoid the disruption. We're trying to make the advertising relevant to the travel experience and encourage people to leave the highway at the worst times."

John Cronin, the founder and CEO of urHub, sees the deal with CDOT as mutually beneficial: "This approach means they haven't had to face any upfront fees associated with the application and technology development and we are now in a long-term partnership." And although this is the first app urHub has worked on for a DOT, the initial success of the venture has

> "We're trying to make the advertising relevant to the travel experience and encourage people to leave the highway at the worst times

the real-time changes that were occurring on that very rapid basis."

For his part, Schwartz reports that he was tweeting and making observations throughout the recent crisis on the USA's east coast to his 6,000 followers, who know him as Gridlock Sam due to his *New York Daily News* traffic column: "I think in the future the trend will be for DOTs to almost become irrelevant in terms of real-time traffic information because people will be communicating between each other more rapidly than a DOT can possibly achieve."

The former chief engineer/first deputy commissioner of NYCDOT feels the accuracy of data provided by DOTs is by necessity at a very high level but that this – in itself – potentially causes delays. Moving forward, then, he contends the greatest impact of social media for DOTs will likely be in announcing when changes in traffic conditions are expected to happen: "A way around all the noise through Twitter – some of it accurate and some not – will be things that are more empirically based," he says. "A number of DOTs are contracting with services such as Inrix that monitor cell phone speeds so they know where there typically are delays and how traffic performs on a daily and even seasonal basis."

Schwartz notes New York already benefits from good historical information from the speeds of taxi cabs to ascertain the fastest and slowest days of the year for traffic flow. "We're really moving into the predictive element here," he adds. "A 'gridlock alert day', for example, could be declared when the General Assembly meets in New York. Travelers who are forewarned can then change their mode of transport or even decide not to drive in that specific area."

CDOT's Stacey Stegman (left) **says the new app** (far left) **is designed specifically to improve the travel experience on Colorado roadways by making critical information such as highway conditions and traffic information more accessible, dynamic and interactive**

led to discussions with numerous other transportation agencies about taking similar schemes forward.

Stegman is especially excited about the way Twitter allows a direct two-way communication with customers: "There is a real appetite for real-time road condition information," she senses. She also reports that with Twitter, people are very quick to respond and to point out things that are happening out on the roads.

One person is dedicated entirely to the task of tweeting updates to CDOT road users: "We have our traffic operations center that is responsible for the blast-out alerts to the media and our page-out system," Stegman reveals. "When there is a major closure, we take that information and repackage it for Twitter. And if there is something we don't know about, our followers on Twitter can tell us."

CDOT has decided not to automate Twitter yet as the level of engagement and communication requirements are so high: "People write back so frequently or ask questions so we need to ensure we can respond appropriately," she says.

And with regard to other platforms such as Facebook, Stegman believes this is more suited to policy discussions and feedback: "We post transportation-related stories to see what Coloradians think and use it to create dialog on educational issues."

> People will be communicating between each other more rapidly than a DOT can possibly achieve
>
> **Sam Schwartz, president and CEO, Sam Schwartz Engineering, USA**

Schwartz sees a growing role for intermediaries producing smartphone apps in the years ahead and cites one app, Roadify, in particular: "I have been very impressed with Roadify in a place as transportation-rich as NYC and recently used it for a project at the Barclays Center – the new home of the Brooklyn Nets basketball team," he reveals. "This opened two weeks ago and we haven't had a traffic jam yet." Roadify takes a multi-modal approach so users can readily find out when the next railroad or subway train is leaving, based on their location, and know if there are delays on particular routes or highways that should be avoided.

Driving Scotland forward

Peter Cullen, travel information manager at Transport for Scotland in the UK, says the agency's first foray into the realms of this new form of communication was the setting up of a Twitter account several years ago. "This allowed us to provide relevant traffic information in real-time," Cullen says. "Our Twitter service currently has 20,551 followers and continues to grow – and we have also introduced the use of social bookmarking to promote the service."

(Top right) **TRIP Talk senses when you are approaching a reported roadway condition on the PA Turnpike**

Cullen believes Twitter is ideally suited to instant personal communication with road users and also offers a means of engaging with other providers to clear up inconsistencies in the information being delivered. However, he is quick to acknowledge that – similar to many other organizations – Transport for Scotland is still on a learning curve where Twitter is concerned: "We need to continue to broaden our use of the tool both as a one- and two-way communication method."

Transport for Scotland's smartphone app, on the other hand, has notched up an impressive 203,000 downloads since first being introduced in November 2010. Cullen says the app – which recently won the 'Excellence in Technology and Innovation' category in the 2012 Scottish Transport Awards – is unique from a UK perspective: "It provides not only traffic but public transport and specialist information for HGV (Heavy Goods Vehicle) users," he says. "It also supports a round-the-clock Traffic Scotland internet radio service."

For Cullen, social media and exploiting smartphone technology has become an essential part of information service

delivery on the go: "We now have a much richer offering for our road users," he feels. "They can actively plan their journeys and if disruption occurs, it is easier for them to choose alternative options."

He does offer a note of caution, however, adding that although there are real benefits from going down this route, it is important to commit sufficient resources: "Technical systems that deliver content are key to front-end service delivery," he says. "You need to sustain investment to enhance your service and keep pace with evolving technology."

Social solutions

The whole subject of social networks was in fact center stage at a recent ITS-UK seminar held in London. When debating communicating with road users, John Miles from the Transport Associates' Network noted that – beyond the widespread deployment of variable message signs – smartphones and the mobile internet offer the very real potential to create what is often dubbed the 'connected vehicle'.

In terms of how social networks work in practice, Miles cited the example of TomTom's 'Map Share' resource, which crowdsources map data. In this case, millions of members in a virtual community are able to spot and quickly report changes they notice on the ground – such as new traffic directions and blocked roads – via their navigation device or online. He also pointed to Waze – a community-based traffic and navigation app based around social networking using GPS smartphones.

As to why those who manage our roads need to pay attention to social networks, Miles spotlighted a number of benefits during the seminar, including, significantly, the early notification of incidents, a greater ability to influence drivers and routing, better-quality traffic data, reduced signage costs, and increased journey-time reliability.

Putting a premium on safety

Remaining in the UK, insurance company Aviva is motoring ahead with an innovative approach to the setting of premiums for safer drivers by building up an individual profile of their behavior through data gathered via a newly developed and free-to-download app.

Back in August, the insurer issued a request for thousands of drivers with Android smartphones to volunteer to beta test and help refine RateMyDrive. With this new app, essentially a score is created based on a test over, say, 200 miles that measures vital driving elements such as acceleration, braking and cornering. Safer drivers identified through the resulting analysis can – according to Steve Treloar, Aviva's retail director – potentially receive a discount of up to 20% on their insurance premiums.

The Aviva man is enthusiastic about the capabilities of RateMyDrive, which works on the customer's own smartphone, and says that it is a more practical and user-friendly proposition compared with Aviva's previous telemetry-based motor insurance product: "The fact that thousands of people have already registered their interest in the app is testament to this," he says. "With our previous incarnation – which was on the market between 2006 and 2008 – a black box had to be permanently installed in the customer's car and collected data every time they drove. That telemetry technology was very much in its infancy and consumer awareness was much lower back then."

Gamification in transportation

To educate younger drivers about a major re-alignment taking place during construction work on the eight-mile-long San Francisco-Oakland Bay Bridge, Bart Nay, senior communications manager at Caltrans says a more creative approach – beyond the usual publicity campaigns – was needed to get the message across: "Bay Bridge Explorer was essentially a video game based on a 3D model of the bridge that allowed people to virtually drive over and familiarize themselves with any changes to the layout beforehand."

This effort was critical as the bridge had to continue to function as a busy arterial route while the West Span was being retrofitted and the East Span replaced entirely. In some cases, that work involved having to move traffic onto a newly constructed detour so an old piece of bridge could be removed.

Two key facts underline the success of the Bay Bridge Explorer app, in Nay's opinion: "Firstly, we had 10,000 downloads before we put the alignment change in place. These aren't Angry Birds numbers, but they represent real people getting the message," he says. "We had problems with our previous alignment change [before the app was brought in]. The message had been buried with our outreach on closing the bridge and we suffered both delays and accidents." Nay contrasts this with the latest re-alignment where there were "no issues" and the "buzz" associated with the app outweighed any negative press about the previous scenario.

Comparing apps and social media, Nay says the latter should be thought of as a pipeline for communicating a message whereas applications such as the Bay Bridge Explorer are more content-driven: "They are the story and they have to have a well-developed narrative," he feels. "Using video games to talk to an audience is not new for the gaming world but it's cutting-edge for public information."

> Technical systems that deliver content are key to front-end service delivery … You need to sustain investment to enhance your service and keep pace with evolving technology
>
> **Peter Cullen, travel information manager, Transport for Scotland, UK**

(Top left) **The award-winning free Traveline Scotland app** (Opposite, top) **The Minnesota Road Fee Test research is designed to record miles and road use**

Regarding the target market for the app, Treloar says it should appeal to a wide variety of safety-conscious drivers: "Some people will be attracted to RateMyDrive because they are into technology. Young drivers may be interested as their premiums are usually among the highest. And women are certainly likely to look at the app now that the EU Gender Directive has come into force, meaning insurers can't use gender as a rating factor, even though our claims statistics show them to be the safer drivers."

Talking point

Another agency looking to how smartphones and apps can offer customers something new and innovative is the Pennsylvania Turnpike Commission (PTC). The authority has established a reputation throughout its history as a pioneer when it comes to the deployment of new solutions and management approaches and this spirit is exemplified by TripTalk, a hands-free, eyes-free, smartphone application that is configured to broadcast timely and relevant travel advisories to drivers without compromising their safety.

Mary Farrell from app developer, Information Logistics, says that it simply didn't make sense for PTC to put out an app with advisories that had to be viewed or touched while underway on journeys, especially as the Turnpike has been a consistent campaigner against distracted driving. "Crucially, at Information Logistics, we had just been building a platform to broadcast content over apps using streaming technology, so we thought this would be perfect in this instance," she says. According to Lorie Gray, manager of customer communications at PTC, the TripTalk app is the first the Commission is targeting specifically at its customers and follows on from two internal apps: one that allows the maintenance force to communicate on-the-road reports of conditions; and another that dispatches technicians to undertake repairs.

Smarter measurements

The exponential growth in processing power of smartphones – and extensive user base – has also opened up the potential to support an intelligent mileage-based charging infrastructure as an alternative to a gas-based tax. So, similar to Aviva's pay-how-you-drive, this could usher in pay-as-you-drive.

A project that investigated this potential was the so-called Minnesota Road Fee Test (MRFT) – under the auspices of the Minnesota DOT – which, with three phases, started in July 2011 by deploying Android-based Galaxy smartphones in the vehicles of 500 volunteers. The participants self-installed the devices for six months through until the end of October 2012 and the gathered data is at the time of press being analyzed.

Parking matters

The very latest communication methods are also finding their way into the world of parking – a fine example being the SFpark project in San Francisco, which was created to trial smarter parking management in the Californian city. The pilot study currently covers 25% of the city's metered capcity – about 7,000 spaces – and 14 of the city's 20 parking garages. A report on the lessons learned from SFpark – and whether to expand smarter parking to the whole of the city – is expected this summer.

Crucial to the success of the project has been the ability to disseminate real-time information for drivers regarding parking availability, gathered from data feeds and parking sensors, so they can be directed to the blocks where there actually are spaces. The main communication methods adopted for SFpark include a dedicated website and, significantly, a smartphone app for iPhone and Android, which can boast 58,000 downloads to date. "We worked hard on the design of the app upfront with usability testing being a vital part," says Jay Primus, project manager for SFpark. "From the outset, we wanted to keep it relatively simple and thankfully our customers are pretty happy with the result."

Primus says that when it comes to enhancing the app, some people did suggest adding voice directions although he stresses that was a little beyond the scope of a government agency, while he believes that sharing data is the way to go: "There are limits, practically, to what we can do," he admits. "This was part of the reason for having an open data feed. Now other organizations, including app developers, have the opportunity to offer additional features [such as speech] and put the data out there for the maximum social benefit."

The fee-based element of the test – which was able to differentiate the roadways traveled, the time of day, and take account of certain zones – took place at the same time as the smartphones were used to run safety and mobility applications. The global research and development organization, Battelle, designed, built and tested all three of the proprietary software applications to combine these 'connected vehicle' elements and the fee-charging requirement.

Although a final report on the MRFT is still to be published, according to Ben Pierce, research leader in Battelle's national security global business, the research effort has underlined the value of smartphones: "What this project shows is that you can set up something like a road user charging scheme with off-the-shelf technology such as smartphones," he says. "It is a very viable technology and as we went along it got better and better: the processors were better; the memory was better; the GPS and our understanding of how people interacted with the equipment greatly improved."

Beyond the MRFT, Pierce reveals that Battelle is looking at other new projects with a number of DOTs that can take advantage of smartphones: "We are focusing on gathering data on the travel decisions that people make, why they choose to drive, fly or take a train," he says. "Using this sort of information, in future DOTs can start to understand and tailor their transportation systems to better fit the traveling public." Social media, he adds, is also playing a role here: "We can subscribe to a volunteer's Facebook page – with their permission – so if they post and geotag a picture after a trip, it gives us information so that we can ask follow-up questions about how they traveled."

> DOTs can start to understand and tailor their transportation systems to better fit the traveling public
>
> **Ben Pierce, research leader, Batelle, USA**

The results of the Minnesota Road Fee Test will help public policy leaders understand the challenges and opportunities in such a mileage-based road user charging system

At a wider level, Pierce believes that social media in the transportation domain still tends to be focused on disseminating information. "DOTs all over the country provide travel and traffic information and the availability of alternative modes of travel," he says. "But this contrasts with the use of social media and smartphones to gather information, which is really the new trend."

The future of communication

Ultimately, given the pervasive growth of social media and smartphone apps, the critical issue moving forward for those managing our roads and highways – just as in the early days of the internet – is to work out where these new communication channels actually fit in with the ongoing need to deliver timely information to drivers and to receive relevant feedback. Attention also needs to be given to the processes that should be put in place behind the scenes to manage this effort and, crucially, what metrics – if any – can be applied to measure the return on investment.

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THE QUEEN'S AWARDS FOR ENTERPRISE: INNOVATION 2011

Senior service

An aging driving population presents new challenges for highway designers. But **Max Glaskin** finds experts around the world are giving special consideration to enhancing the infrastructure for these baby boomers – changes that will benefit all

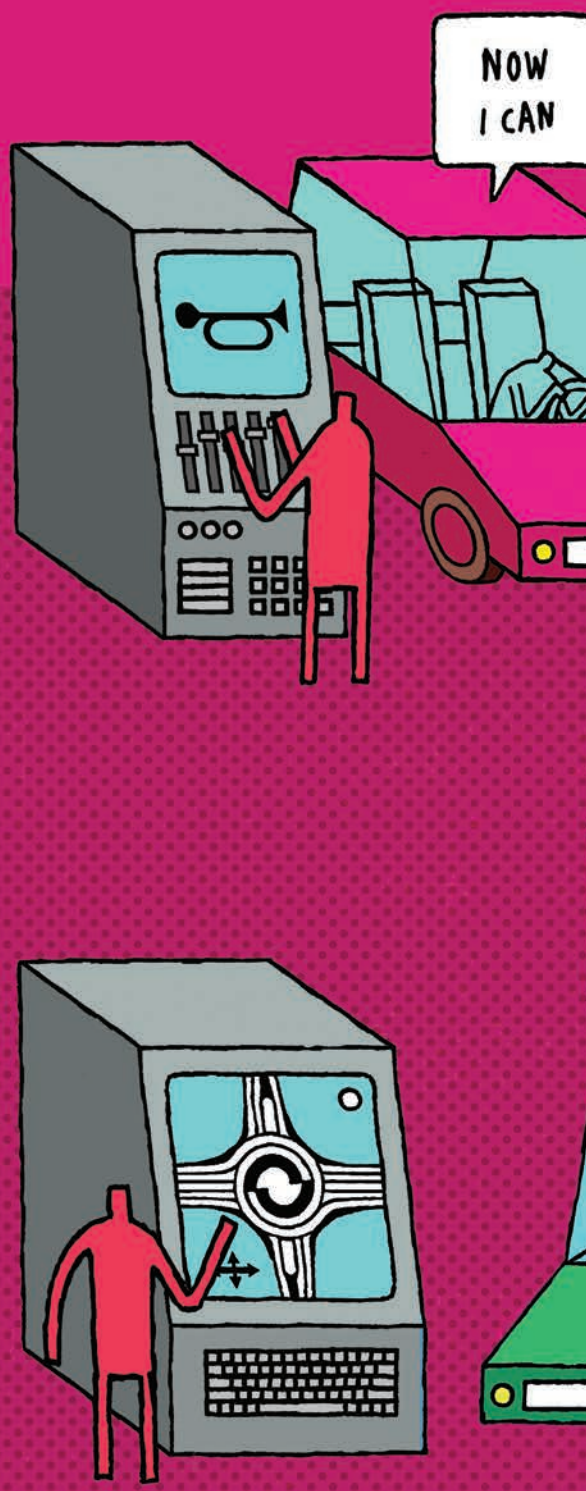


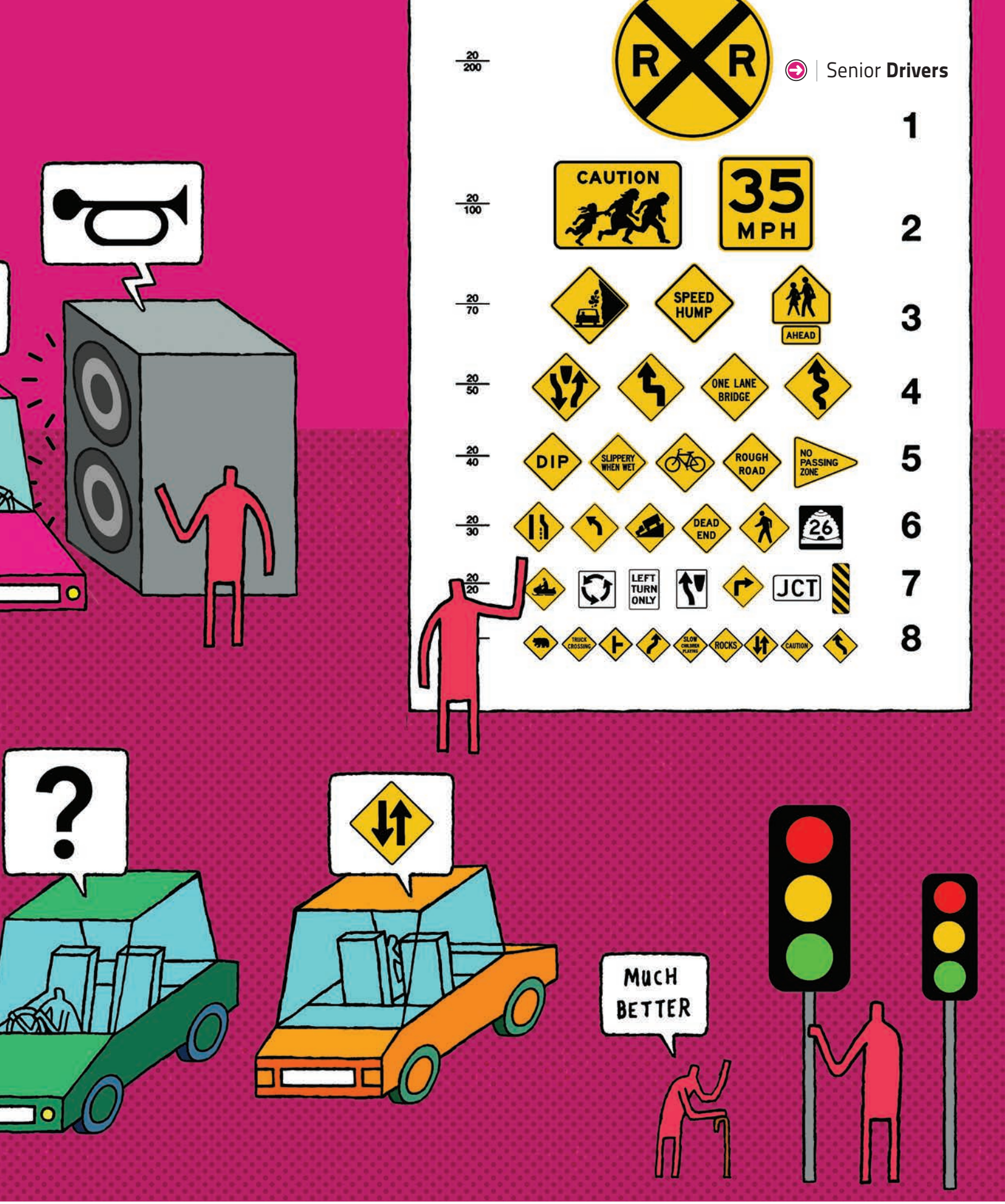
Illustration courtesy of Tim Ellis

As the saying goes, old age isn't for the young because they couldn't handle it. It was inevitable that our roads would be designed initially by younger people, and there was little reason for them to take into account drivers with failing eyesight, memory impairment, slower reactions and increasing frailty. But time changes everything, particularly age, and the elderly are an increasing proportion of national populations around the world. By the second half of this century they'll account for 20% in the USA. Almost a quarter of Australians will be over 65 and almost 30% in Europe. Many will be driving – perhaps to the gym, the health center or visiting their great-grandchildren.

Age concerns

As no one is getting any younger, the implications for road safety of an aging driving population are significant. "Although older drivers are not especially over-represented in crashes, they do have an increased risk of being involved in a casualty crash on a per-kilometer basis," says Melinda Congiu, manager of road user behavior, Royal Automobile Club of Victoria (RACV), Australia. What's more, the fatality rates rocket for drivers over 75 years. To prevent this figure from rising, one thing that can be changed by today's youthful highways engineers is the infrastructure. Renewal, repair and replacement programs could accommodate modifications that make driving safer for older people. Highways, signs and traffic control systems all deteriorate more quickly than humans, so a road system fit for all ages could be realized before those who implement the changes become senior citizens themselves.

Aging varies enormously between people. Apart from the obvious decline in sight, hearing and physical movement, there are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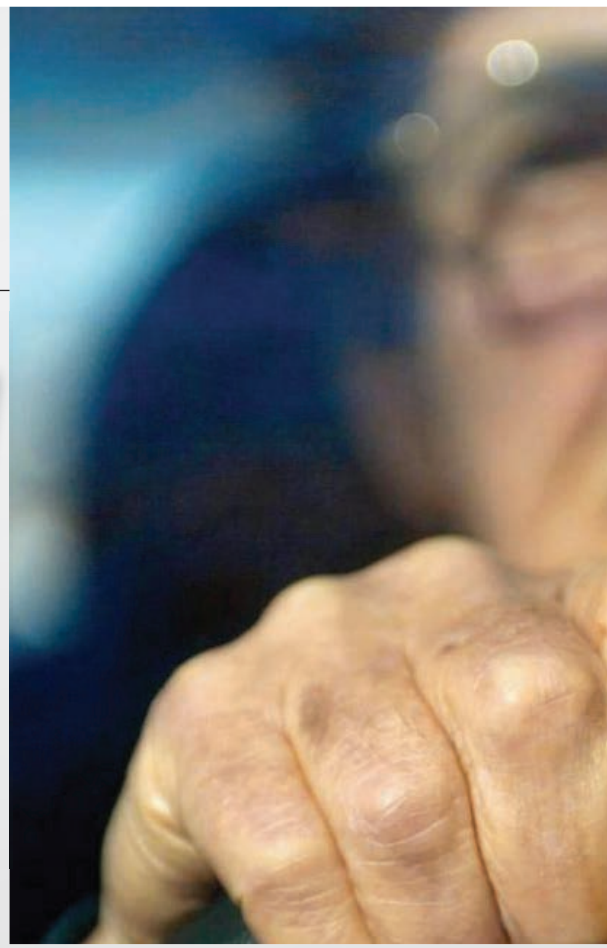
Licensed to roam

A local drive test offers a promising approach to keeping senior drivers safe and mobile, writes **Carol Ronis** from the AAA Foundation for Traffic Safety



Last year, a study from the AAA Foundation for Traffic Safety addressed the issue of driver licensure, and found that a specialized program designed to license drivers for local roads or under specific conditions showed promise as an option to enable some older drivers to stay safe and mobile behind the wheel.

In the report, *Keeping Seniors Safe and Mobile: An Evaluation of a Local Drive Test Option*, researchers Jane Stutts and Jean Wilkins assessed how local drive tests (LDT) could enable seniors to maintain a level of mobility without compromising safety. This licensing program examines drivers in their local communities on familiar streets near their homes. Drivers who pass this local test are then issued a restricted license that permits them to drive only in the area or within a radius around where they were tested. Additional restrictions – such as speed limit, time of day, or roadway type – may also be imposed.

"Senior mobility is a complex issue and one that the Foundation has been studying for several years," says AAA Foundation for Traffic Safety president and CEO Peter Kissinger. "Keeping seniors safe on the road is important and this study offers a promising alternative for some seniors who might not qualify for licensing under standard road tests. This option could provide a tool to help us reach the twin goals of improving both safety and mobility for seniors."

> "This study offers a promising alternative for some seniors who might not qualify for licensing under standard road tests

The study looked at the case histories and statistics related to 205 seniors, with an average age of 85.1 years, licensed under Iowa's LDT program between 2005 and 2008. Comparisons were then made between this group and a control group of Iowa drivers holding standard licenses.

Researchers found that the LDT-licensed drivers had 13 crashes in 167,251 days of driving, which translates to an annualized crash rate of 0.0284. That is lower than the state's overall crash rate for all licensed drivers (0.038), for Iowa drivers in their 20s (0.047), and for Iowa drivers in their 50s (0.030).

"Numbers such as these suggest that LDT-licensed drivers were as safe, or safer, than the general population," Kissinger adds. "At the same time, the LDT drivers enjoyed a level of mobility and independence that might not have been possible under a standard licensing program. That's a very exciting finding."

Comparisons with the matched control group yielded a slightly different picture, with the general population of Iowa drivers 65 and older having lower crash rates than the LDT-licensed drivers. Researchers concluded, however, that this slightly-elevated crash risk of the LDT licensees did not pose a general threat to the public, particularly given that their crash risks remained lower

than those posed by most other segments of Iowa drivers.

Researchers also found that the majority of LDT licensees in the study were able to continue driving for at least an additional two years with their restricted license, and noted that this is likely an underestimate given that some seniors received their LDT-issued license before the study began, and others kept it beyond the end of the study period.

"Driving is a privilege, but mobility is a right," Kissinger says. "For seniors who would otherwise lose the ability to drive themselves to the doctor, use their cars for errands, and enjoy the convenience of local driving, extending their safe-driving careers can have a huge positive impact on quality of life."

Kissinger adds that the study represents just one small population of senior drivers in a state with additional policies in place that may help contribute to the program's overall effectiveness. Other states with some form of local drive test option include Kansas, Minnesota, Wisconsin, California, and New Hampshire.

Around 8,000 baby boomers are turning 65 every day in the USA, and will continue to do so for the rest of the decade, which could reshape the landscape of transportation in the country

> Vehicle lighting and sign materials have got brighter over the decades, so older drivers were finding it difficult to distinguish some letters
>
> **Paul Carlson, research engineer, Texas Transportation Institute, USA**

cognitive changes to decision-making abilities, memory and reactions. "The older one gets, the more likely it is that one can be distracted by non-salient information," says Professor Andrew Parkes of TRL (the UK's Transport Research Laboratory), implying that cluttered streetscapes and barrages of highway signs and pavement markings may be detrimental. Furthermore, the combination of physical and cognitive changes can slow reactions. "It can take four seconds for an elderly driver to refocus on the distance after looking at the dashboard," says Parkes. Older people are also more likely to be suffering from medical conditions and taking medication.

Highway guidance

So why not leave car makers to produce technology that deals with these issues? "You can't wait until everything is possible with in-car devices," says Ragnhild Davidse, of the SWOV Institute for Road Safety Research in the Netherlands. Her PhD thesis was on older drivers. "We already had enquiries back in 2002 from provinces wanting to accommodate the increasing numbers of older drivers on their roads," she reveals. Fortunately, the FHWA in the USA had led the way more than 10 years ago, with its *Highway Design Handbook for Older Drivers and Pedestrians*, which has informed and influenced publications by other road authorities such as Austroads (*Road Safety Environment and Design for Older Drivers*) and institutes such CROW in the Netherlands. "[CROW] called it *Design Suggestions* which in my opinion is a little soft," says Davidse, "If you think something is really important, then you should be more forthright otherwise every municipality will do things a little bit different, so you then end up with a thousand versions and things become more complicated for older people."

Visible effect

The most visible infrastructure improvement that is beneficial to aging

Mobile retroreflectometer – LTL-M

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Behaviorial science

The need to improve infrastructure so that it is better for older drivers may be under-recognized simply because some people whose driving is impaired choose to avoid routes that they find difficult. "By and large, older drivers tend to self-regulate," says Bryan Reimer, research scientist in the MIT AgeLab and the associate director of the New England University Transportation Center at MIT. "When we get older, we don't place ourselves in the driving situations that many of us once did, whether that's by driving a little slower, choosing not to drive in snow or rain or at night. We balance our abilities and capabilities as we age quite effectively."

But that's not a good argument for doing nothing to our roads as not everybody can self-regulate. "The cognitive decline means our ability to make sound judgements may vary," Reimer continues. "So self-regulation may not be enough [to keep people off the road] if they're not capable of making that decision themselves."

The physical changes of aging are well known: poorer eyesight, weaker hearing and a slowing down in reaction time. Reimer says we are also more easily distracted as we age and have a harder time maintaining concentration on a given task. "Our pure cognitive capacity for making decisions declines and our memory isn't so good," he notes. One implication is that older drivers may see a roadsign but quickly forget it. "So we need to think not only in terms of increasing the legibility of signs but also their frequency."

drivers is, well, visibility. "Vehicle lighting and sign materials have got brighter over the decades, so older drivers were finding it difficult to distinguish some letters. Edges became blurred and letters such as 'e' and 'a' caused particular problems," admits Paul Carlson, research engineer and leader of the Visibility Research Laboratory at Texas A&M Transportation Institute (TTI). The work led to the current font for US signs, Clearview, and it has now been taken up by half of the states.

"We also completed a lengthy analysis of wider road markings and demonstrated they have particular benefits for senior citizens," says Carlson. "The standard had been 4in but three states had started using 6in wide markings. By analyzing the data, it was clear that the wider markings reduce crashes. They can also be useful where – for various reasons – it's not possible to install a rumble strip."

Safety at the edge

This change has been adopted enthusiastically by Virginia DOT. "The 6in marking will pop right at you," says the state's traffic engineer, Ray Khoury. "We use it on the edge lines, on the skip lines and on the side as well. We also elected to use snowplowable markers because when you have dark nights and rain, you lose most of your line markings. They wash out and you can barely see them. The only things that keep you where you are are those lenses that remain reflective." Khoury's team had assessed innovative wet reflective pavement markings but found it degraded after a year or two. In contrast, the standard tape has a six-year warranty.

(Top right) **Wider edge lines – from 4in to 6in – significantly improves visibility for older drivers** (Below left) **Highly visible VMS provide a prompt and efficient communication to drivers** (Below right) **The Clearview font results in faster reading, comprehension, and reaction time**

Virginia has also added new markings. "In Europe, the roads are marked all over the place, with words, arrows and symbols," Khoury says. "We've started to use some of that here but only where it's needed to give the older driver confirmation that they're in the correct lane. We put on the pavement the Interstate shield in red, white and blue, saying '95 THIS LANE'," he reveals. Improved reflective sheeting for signs with a larger font, and advanced signs giving notice of lanes and turnings are other steps toward making older drivers safer in Virginia.

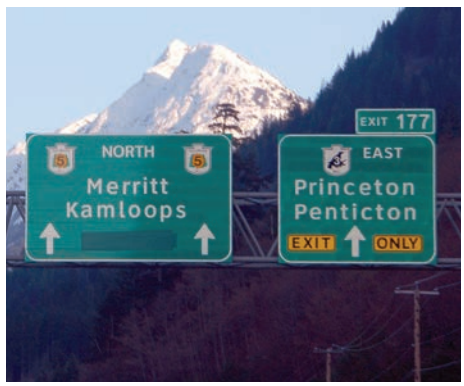
At the crossroads

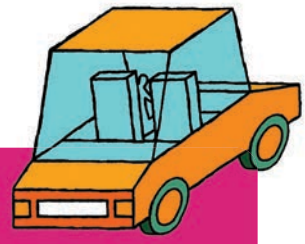
Research has shown that intersections are particularly hazardous for aging drivers and are over-represented among crashes involving at-fault drivers aged 75 years or older. "They're the most dangerous parts of the road network," agrees the RACV's Congiu. "Older drivers, more than other drivers, have difficulty negotiating intersections. Crash statistics demonstrate this, as older drivers are far more likely to have crashes while turning at intersections, especially unsignalized intersections."

"It's not that they are a risky group in the sense that they deliberately run red lights or speed, but it's just that older drivers have more difficulties combining all the information and taking the right decisions in a short period of time," concurs Davidse. "That makes some situations more difficult, such as turning left [or right in the UK and Japan] across the oncoming traffic flow."

The RACV promotes the installation of more fully controlled traffic signals. "That is, signals where there is an exclusive right turn phase," Congiu adds. The US state of Virginia, for one, is taking action by adding signals to more intersections.

The replacement of 8in-diameter lenses on the traffic signals with 12in lenses, recommended by FHWA following research at TTI, is progressing in Virginia and other US states. The enlargement more than doubles the signal area, and the addition of backplates (usually black) makes them more visible. Khoury's team is also changing the timing of lights by adding real-time system





Guiding lights and shining examples

The problems for aging drivers are compounded by aging road markings, which deteriorate over time and become difficult to see at night-time and especially during wet conditions.

Most authorities specify visibility standards that the markings must meet in terms of their retroreflectivity. The specifications dictate the sensitivity and accuracy of the assessment equipment used to measure visibility. "The European standard for white markings on a dry road is 100 millicandela/lux/square meter. That's the lowest level acceptable," says Kjeld Aabye of Delta Light & Optics in Denmark. "Often the requirement goes up with the category of road, so that there is more retroreflectivity where the traffic speed is faster."

It's a dangerous – often costly – task to assess markings if there is traffic present. The person operating the equipment is at risk and it can also be a protracted process.

Delta started to address this five years ago and in 2011 created the LTL-M, a retroreflectometer that can be fitted to a vehicle. Offering 100% measurement coverage of the markings, it works at

speeds up to 90km/h, and can even measure at higher speed.

"The operator sits comfortably in the vehicle, safely moving with the traffic flow, while the unit gathers and assesses data on 100% of the markings. It's no longer spot readings – it's continuous," says Aabye. "And it captures data for 70,000 points in every square meter." This has been achieved by harnessing digital camera technology that takes pictures 25 times every second. The road in view is illuminated by a flash that is synchronized with the camera to shine with the same frequency.

Even though modern vehicles have excellent suspension and dynamic movement damping, the sensitivity of retroreflectometers means they require extra stability. Delta thus used sensors and software to keep the camera and flash smoothly on track.

Since the LTL-M was launched, it's been used on three continents. "If you're a highways agency or a contractor that wants to check 10,000km or more of roads, then it will save you time and money, to say nothing of the improved operator safety and reduced hazards for traffic," says Aabye.

adaptive control. "The signals at all the intersections are talking to each other," he says. "I call it traffic signal timing on steroids. There's up to four minutes of travel time savings in 10 intersections. That's a huge improvement, which helps everyone, but especially older drivers who aren't going to have to react, stop and go and slowly start off again and again."

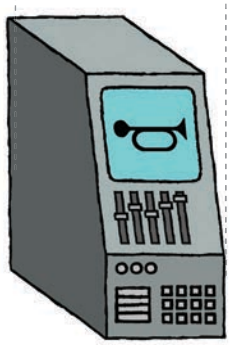
Singing from the same hymn sheet

Unsurprisingly, the American Traffic Safety Services Association (ATSSA) is clear about the need to improve infrastructure that will keep the nation's elderly safe on the road. Not only has it published information to help engineers improve infrastructure, but its government relations executive, Laura Perrotta, has brought several like-minded groups together in a coalition known as CORUS and successfully lobbied Congress.

Two bills have since been passed, releasing funds to raise awareness and amending the MAP-21 Highway Safety Improvement Program with language that highlights the issue of older drivers. If the fatality rate of older drivers increases in a two-year period, the State DOT Strategic Highway Safety Plan has to be reviewed.

US research group TRIP, with the American Association of State Highway and Transportation Officials (AASHTO), published in 2012 an impressive report, *Keeping Baby Boomers Mobile: Preserving the Mobility and Safety of Older Americans*. As well as the improvements described above, it also asks for brighter street lighting,

> One good thing is that if we make driving easy for older people, we'll make it easier for everyone else too
>
> **Ragnhild Davidse, SWOV Institute for Road Safety Research, the Netherlands**



particularly at intersections, widening or adding left-turn lanes, increasing the length of merge or exit lanes, widening lanes and shoulders to reduce the consequences of driving mistakes, adding rumble strips to warn motorists when they are leaving the roadway, and making roadway curves more gradual and easier to navigate.

But is the message really getting through or will several more generations of elderly drivers find the highways more hazardous than they need to be? "I would say it is getting into the minds of road engineers and designers," Davidse suggests. "To give an example, in the Netherlands we have turbo roundabouts – traffic can go through as quickly as possible. In my eyes, they are very difficult to understand. I spoke to the designer of one and he asked, 'You're the one who knows about older drivers. What would you do to help them?' In response, I said I would advise them not to take the turbo roundabout but to choose another route. So I know now he has it in his mind to make it easier for older drivers."

With age comes wisdom, and readers of *Traffic Technology International* will be wise enough to know that there is always another side to every story. "One good thing is that if we make driving easy for older people, we'll make it easier for everyone else too," Davidse concludes. "However, there will be a limit to that. Older drivers might want very wide roads, well illuminated and dead straight for three kilometers. But then young people will think 'this is a nice road' and drive down it at 100km/h. You don't want to have that."

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Sign language

Dr Thomas Novak explores the challenges that manufacturers must meet to create standardized, successful products that translate to all markets. As he reveals, when it comes to safety-related VMS, not all products are created equal

Illustration courtesy of K-Studija

Variable Message Signs (VMS) are now a very common method of information propagation for traffic participants from a higher-order control unit (HOCU).[1] Today's state-of-the-art VMS may consist of graphical parts where speed limits or warning signs are displayed as well as text parts that show relevant textual information (e.g. 'Congestion' or 'Accident'). Both components are made up of LED modules equipped with LEDs of varying colors (white, red, yellow or green). The modules are connected serially while the first module is connected via dedicated cables to a microcontroller. The controller runs software that includes functionality to receive commands via various protocols from a HOCU, and to process the commands and execute them by activating and deactivating aspects, respectively.

The safety factor

In the case of safety-critical applications such as lane control in a tunnel (see Figure 1), various requirements must be taken into consideration in addition to the ones specified in product standards such as EN 12966.[2] A VMS must be developed and operated according to safety requirements covered by European standard EN 50556[3] and German standard VDE 0832-400.[4] The challenge for manufacturers is to develop a solution that meets safety

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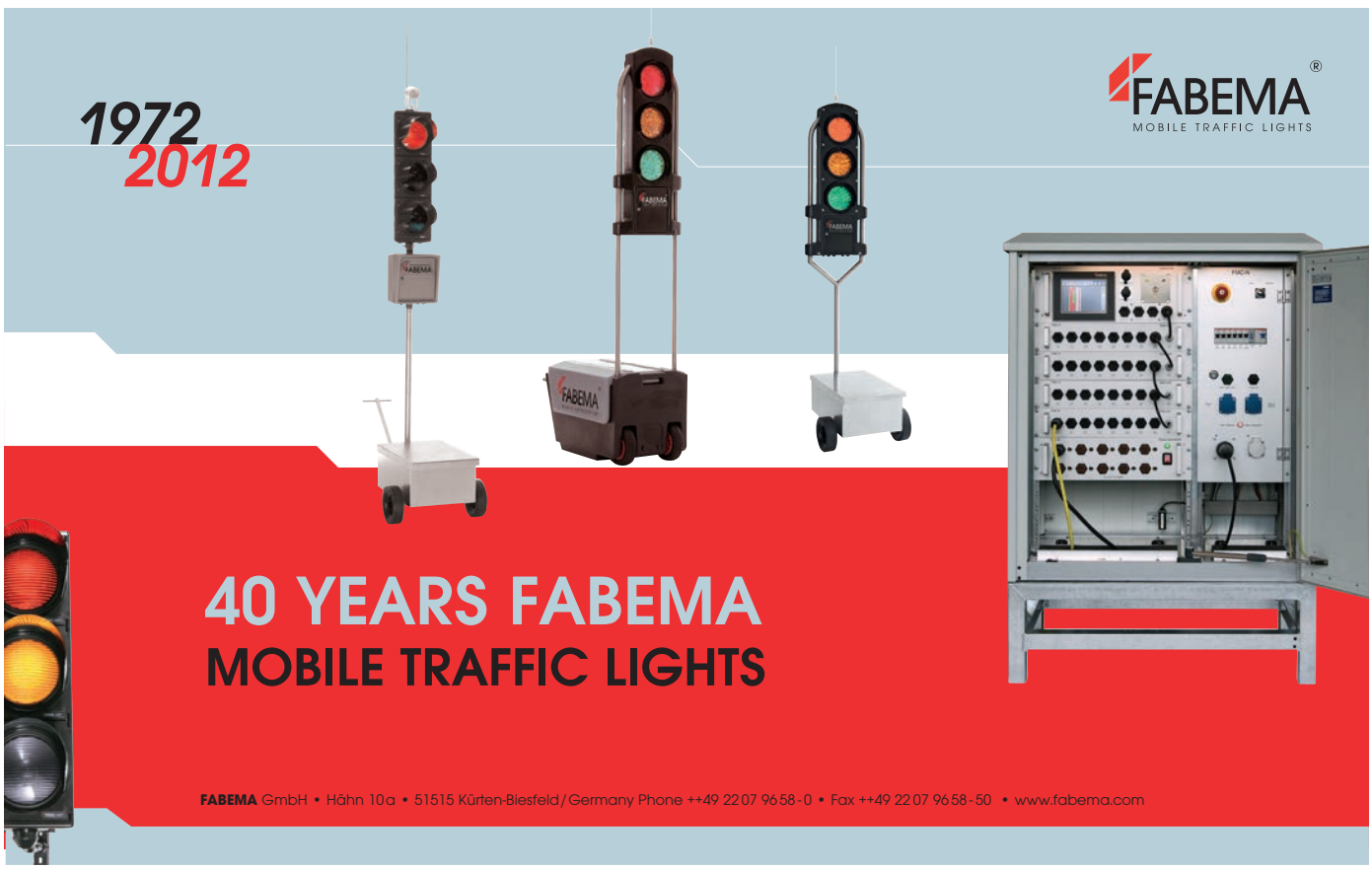
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The MIDAS touch

In the UK, VMS are controlled via the MIDAS (Motorway Incident Detection and Automated Signalling) system, which allows signs to be switched on or changed automatically – meaning that control room operators do not have to physically set these parameters. The MIDAS system uses inductive loops on the road to detect vehicle speed and the formation of traffic queues. Using the data provided by the loops, VMS are used to warn drivers of upcoming conditions on the road ahead, alongside gantry signs that display the advised maximum speed. Once traffic conditions have resumed their normal operating state, the system automatically turns the VMS off. Naturally, a fail-safe option has been considered: if the MIDAS suffers a severe malfunction, control room operators can override it.

requirements in a way that will be approved by safety authorities, is based on the common architecture of a VMS to be seamlessly integrated in legacy systems, and can be developed in an acceptable timeframe and at a cost that is competitive.

Hazard analysis and safety measures

In general, safety engineering deals with avoiding faults during design and controlling faults during operation. In other words, safety integrity has to be ensured throughout the whole life-cycle of the product. An important step in the design phase is hazard analysis, as detailed in safety standards including IEC 61508.[5] This examines hazards resulting from dangerous failures as well as their reasons. Safety measures are subsequently derived from the hazard analysis, and are considered in the design of the product in order to avoid faults, or implemented in hardware or software to control faults during operation.

The scope of the hazard analysis is in relation to hazards resulting in harm to traffic participants. The application area of the VMS will be on roads with two-way traffic. Safety class D is required according to VDE 0832-400. The communication interface between the VMS and the HOCU, meanwhile, is beyond the scope of the analysis because safety-related protocols already cover these requirements sufficiently.

According to VDE 0832-400, three types of dangerous failures have to be considered in the analysis. The first is when the aspect is unintentionally switched off. Due to a fault, for instance, the aspect is no longer shown yet it wasn't switched off intentionally by the user. The second scenario is when a corrupted aspect is displayed: due to a fault, the aspect is not shown as defined, with either too many or too few LEDs switched on. The third and final failure is when the aspect is unintentionally switched on: resulting from a fault, an aspect is shown that wasn't switched on by the user.

Table 1 below shows the results of the analysis with five classes of faults leading to one of the three failures. Almost all of the seven safety measures to mitigate the consequences of possible hazards are used to control faults and react properly within a specified time interval to a safety-critical failure. The measure of LED arrangement is applied to avoid faults with a very high probability so that a safety-critical failure cannot occur.

Implementation

A further step in the development is to implement safety measures. To demonstrate the flow of action, it is assumed the VMS includes predefined aspects such as 'red cross', 'green arrow', 'orange arrow right' and 'orange arrow left' (Figure 2). Every aspect has a unique ID; safety measures to control faults become active within 300ms, as specified in VDE 0832-400. Moreover, the fail-safe state of the VMS is always off (i.e. no aspect shown and error message sent).

An operator triggers the command 'switch on red cross' at the central station

(Figure 1, below) **Safety-critical application of VMS in a tunnel** (Table 1, bottom) **Fault classes and corresponding measures**

Fault (Reason)	Measure
LED driver broken	(1) Use of test pattern sent to driver and read back
	(2) Read back status of driver output
LED short-circuit, LED open-circuit	(3) LED open- and short-circuit test
	(4) Placement of LED and LED drivers
Communication line to LED driver broken	(1) Use of test pattern sent to driver and read back
	(5) Apply Hardware Watchdog on LED-boards
Corrupted non-volatile memory	(6) Use of hardware integrity proof tests
Blocking software function	(7) Software monitoring

and the message with the ID and the command 'switch on' is received by the VMS and stored temporarily in a buffer in the volatile memory. This and any other buffer is protected by a checksum, while memory is also checked at startup to detect any possible corruption.

After processing the message in the protocol stack successfully, the ID of the 'red cross' aspect and the command 'switch on' is sent to the display control. The next step is to prove the availability of the aspect as well as the integrity of the corresponding data to show the selected aspect. The last result of the time-triggered LED test is evaluated to check the status of the LEDs. Only if the failure limit is not exceeded – and test patterns sent to drivers are received unchanged – will the corresponding data byte stream to display the required aspect be sent to the LED drivers on the modules to activate the LEDs.

A further step is to check the display status, so the data of each driver on the LED modules is read back, then compared to the stored data in the non-volatile memory. If the comparison returns a positive result, the correct 'red cross' aspect is shown. Finally, a response message is transmitted to the HOCU, including the result of the execution of the command returned by the display control to the protocol stack.

(Top left) **Motorway VMS in Germany** (Figure 2, right) **Example of safety-related VMS** (Left) **Next-generation signs in Ontario produce clearer traffic symbols – improving readability about changing highway conditions and construction** (Table 2, bottom) **Measures to ensure safety integrity**

Integrity of display	Integrity of communication line	Data integrity	Software integrity
LED test	Cable test with hardware watchdog mechanism	Checksum	Software monitoring
Check of display status		Startup memory test	

Get the message

Swarco Futurit is a key player in the VMS market, with its product range used worldwide for dynamic traffic management on highways and for traffic guidance in urban areas. The company's VMS are certified by BASt and INTRON according to the requirements of EN12966 and provide superior legibility, efficient use of energy, and an excellent luminance ratio. Freely programmable VMS can be offered as text signs

as well as monochromatic, bi-color and full-color graphical displays with 12 - 30mm pixel pitch options. The new 3G optic allows the VMS to be operated at only 4% of their nominal current, which prolongs the LED life while further saving energy. In addition to the signs themselves, the company also offers its Sign Service Center (SSC) – a service tool that provides the functionality to maintain the VMS. This also enables the sign's high performance via a user-friendly GUI. Easy error detection and the visualization of any errors ensure that the sign maintenance is quick and reliable without additional and costly works.

> A very important step in the design phase is hazard analysis as mentioned in safety standards such as IEC 61508

If a fault is detected during memory access, data is discarded and a response message is sent. Faults on the display result in a fail-safe state where the display is switched off by means of a hardware watchdog. Moreover, a proper message is sent to the HOCU. If the software is blocking, software monitoring restarts the microcontroller.

The presented safety measures avoid or detect fault classes, ensure the safety integrity of the VMS as shown in Table 2, and obviate dangerous failures with very high probability. The hardware architecture of a typical VMS remains unchanged and is therefore compatible with existing systems. "Consequently, a competitive, cost-efficient and safety-related product is the result," concludes Christoph Stoegerer, head of development at Swarco Futurit.

• *Dr Thomas Novak is a research project manager at Swarco Futurit*

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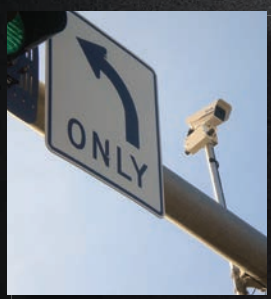

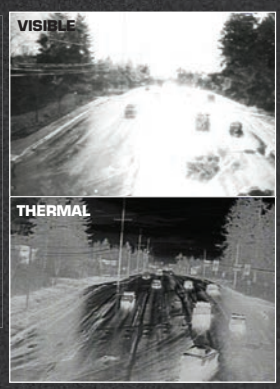

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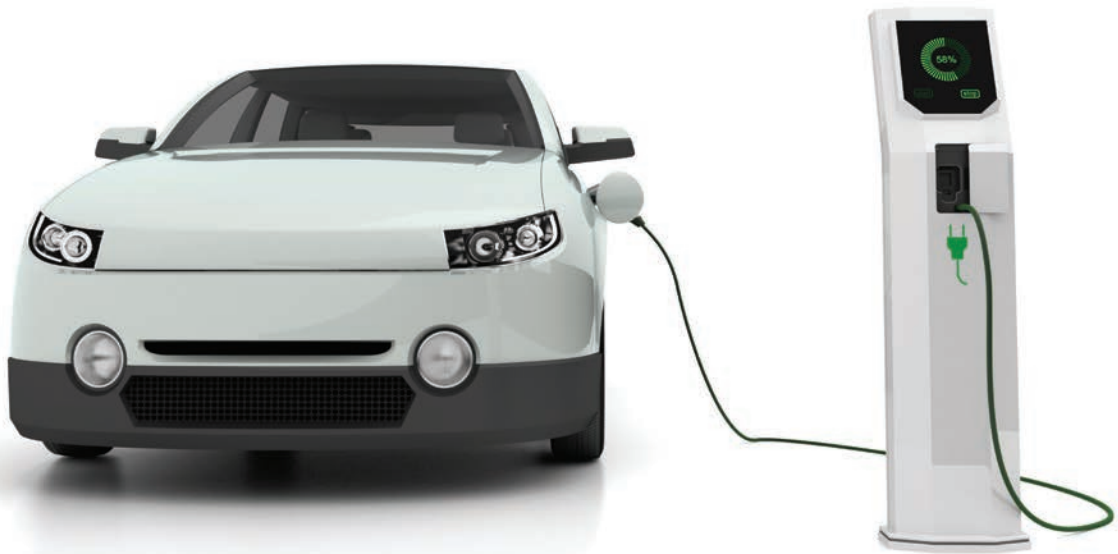

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Transport economist **Charles Komanoff** is determined to solve New York City's traffic problems – and mathematical models are his congestion-busting tools

Interviewed by Max Glaskin

> I began to be fascinated by the societal cost of the automobile … especially in the city of New York

Superstorm Sandy may have temporarily paralyzed New York but it didn't stop one tireless individual from continuing to plan its future in detail. "My office still has no internet or heat so I've been working from home," says Charles Komanoff from Manhattan, just days after the storm. "I've been adding more bells and whistles to the model."

He calls it a model but its scale is truly monumental, which is only right for a piece of work that could solve the Big Apple's traffic problems. Its full name is the Balanced Transportation Analyzer, and, so far, it has consumed five years of Komanoff's life. It's a spreadsheet – but don't turn the page yet because it's utterly extraordinary. It's a stack of 60 worksheets, some having up to 68,000 data cells, others with linked arrays and fourth power formulae. And he keeps building it because he knows it will unshackle his city's streets.

"I'm Sam's modeler," Komanoff says, referring to Sam Schwartz, the traffic engineer who three decades ago coined the term 'gridlock' and is the figurehead for 'Sam's Plan' to improve transport and travel in his native New York. "To some extent, I suggest to Sam how he might fine-tune the parameters of his traffic plan."

It sounds like nice work, so how did Komanoff get hired? If you're going to ask him a question, you have to be prepared to take the details. "I was at Harvard during the 1960s studying economics," Komanoff reveals. "I didn't come out with much professional training because I was very active in the anti-war movement. But I did come out with a habit of mind that said price is a fundamental driver for human activity. And I do subscribe to that, deep down in my bones."

The numbers game

Prices are numbers so Komanoff's training as a mathematician is crucial. "I'm not one of those abstract guys who can fill boards with equations that nobody outside the priesthood knows what the letters and numbers relate to," he continues. "You could say I'm a quantifier."

In the 1970s, he quantified the costs of building nuclear power plants in a revelatory way that had not been done before, and so he became an expert witness at regulatory hearings. "That gave me a certain professional standing. It also gave me a very good nest egg so that in the mid-1980s – when that work started to become a little bit repetitive and I was seeking a new challenge – I was able to jump to a completely unrelated field."

In the event, it was not so much a field, more a narrow strip of pot-holed asphalt next to the sidewalk. "I assumed the leadership of the cycling advocacy community in New York City," Komanoff recalls. Having grown up in the relative tranquility of Long Beach, Long Island, it was only when he'd got to febrile New York that he'd learned how to ride a bike – in Central Park – and by that point it was a travel mode that was being squeezed out of existence.

Komanoff toiled at reversing this decline. "In some way, I galvanized a movement of cycling revolutionaries," he says, not in any way boastfully. "We were extremely vocal, principled, ardent, and, I think, effective in not just winning one advocacy campaign after another but in establishing cycling at the vanguard of environmental activism in the city of New York."

> Janette Sadik-Khan has communicated the message that the streets are not just a habitat of motor vehicles and drivers but that they have multipurpose

It was toward the end of this six-year stint that Komanoff became interested in a larger segment of traffic. "I began to be fascinated by the societal cost of the automobile," he reveals. "I began attempting to quantify the societal cost nationally, but especially in New York, of traffic crashes, of traffic congestion, of traffic air pollution."

He goes on to rationalize the next 15 years of his life as "not very productive", even though he had two young sons to raise and became intimate with the minutiae of traffic pricing, tolls, and mass transit. Then he got a call from Ted Kheel, a skilled and wealthy New York arbitrator. Kheel was aged 93 by then but for decades he had wanted to unsnarl his city. He realized he needed verifiable numbers to define and support his arguments in favor of congestion charging. "I was charged with making the spreadsheet model that would crunch the numbers," Komanoff recalls. "I started putting it together in the summer of 2007 and by the fall I thought I had a profound piece of work that was as advanced as anybody could produce. It turned out it was barely the beginning. It's as if I had composed a one-movement string quartet and what I've got now is an evening-long symphony."

A man with a plan for New York City

Sam Schwartz's traffic plan for NYC – which involves toll rebalancing or restructuring – is simple yet breathtaking in the way it's put together and the politics implied, according to Charles Komanoff.

Sam's Plan includes a steep entry fee into the city's CBD. A portion of the revenues would be used to halve the existing tolls on half a dozen Robert Moses-built bridges that don't funnel traffic from the outer districts into the CBD but instead connect outer areas of the city to each other. "Sam wants to cut those tolls in half as a way of underscoring that a rational plan would charge fees for traffic that is contributing heavily to congestion but where there are good public transport alternatives," Komanoff says. "Also, the politics of this are brilliant as in the outlying areas where those Moses bridges are located are the people that must be won over to win approval in the legislature. It's not like London where Ken Livingstone put it through by fiat. We have to go through a tortuous process. So from a political, conceptual, and a traffic standpoint, Sam's Plan is quite imaginative, striking, and, dare I say, brilliant."

Balanced Transport Analyzer

That's because even after Kheel died in 2010, aged 96, his foundation continued to support Komanoff's work. The Balanced Transport Analyzer (BTA to its friends) grew to include modules taking into account transit fares, taxis, parking charges, times of day, trip characteristics, road network changes, air pollution costs, crash costs, longevity benefits from increased walking and cycling, and, crucially, time elasticity.

The latter estimates how people will change their travel plans as journey times change. Many changes to the price of traveling have an impact on journey times, which, in turn, affects people's journey decisions – and those rebound on journey times. So the BTA goes into great detail about time elasticity and repeats the calculations until the model settles down. "The thing has to reach an equilibrium and in my modeling it takes 10 iterations before equilibrium is reached," Komanoff reveals.

His model shows that the large majority of all the benefits in Sam's Plan are in time savings. "I sensed this five-and-a-half years ago when Mayor Mike Bloomberg proposed his congestion fee," he states.

In case you're thinking of standing on Komanoff's shoulders and applying the BTA to a city near you, think carefully. "I'm afraid that it's bespoke for New York," he says. "I would insist, though, that the underlying ideas – the spreadsheet architecture and how the different tabs of the model are linked to each other – can be duplicated. In addition, there is a set of assumptions that underlie the BTA and I would equally insist they can be applied to any other city."

Just as the BTA is dedicated to New York City, so is Komanoff. "I love it," he states. And he can't speak highly enough of transport commissioner Janette Sadik-Khan. "She has presided over a real transformation in the way New York's streets are thought of – and I would say she has begun a revolution in how the streets are used and what people refer to as 'repurposing the streets'. She has communicated the message that the streets are not just a habitat of motor vehicles and drivers but that they have multipurpose."

Our time is up. A New York radio station is about to broadcast a bulletin on the status of the subways, buses and transportation in the wake of Superstorm Sandy. It is important to Komanoff, both professionally and personally, to catch that news. He needs the details.

• You can download the Balanced Transport Analyzer by visiting www.nnyn.org/kheelplan/BTA_1.1.xls

Dark horse or odds-on favorite?

As a successful activist and campaigner – and with vast experience as an expert witness at regulatory hearings – Charles Komanoff is familiar with the fences Sam's Plan must clear in order to be adopted. But first there's a reality check. "I'm going to say something that is a little bit heretical: the economic slowdown and the very success of the public transport system have combined to slightly ease congestion," he says. "I don't want to say that traffic has ceased to be a problem but it's not the kind of burning public concern it might have been from 1999 to 2002."

So what are the odds of enough New Yorkers backing Gridlock Sam to make the Governor feel comfortable taking it forward? "I am somewhere between optimistic and confident that Sam's Plan, or some solid version of it, is going to be able to be enacted by the legislature in the next 18 months," Komanoff says. "Then it'll be some time before it can actually be implemented in terms of the tolling infrastructure and satisfying the environmental review, etc. I do believe the plan is viable, compelling, and necessary enough that it's going to succeed."

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Evolution of enforcement technology

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Innovation continues to drive American Traffic Solutions (ATS). This commitment to constant improvement is one reason why ATS is the dominant safety camera provider in North America and why, over the years, the number of cities and towns using its red-light and speed cameras has continued to grow. ATS recently delivered a new line of products to protect drivers and their passengers. One device in particular provides an important new layer of protection for the most vulnerable road users – children.

Every day in the USA more than 480,000 school buses are on the road and making stops to pick up children. And each day more than 88,000 vehicles illegally pass stopped school buses, according to the National Association of State Directors of Pupil Transportation Services. To stop this dangerous behavior, ATS launched the CrossingGuard school bus arm enforcement solution. Attached to the driver's exterior side of the bus, this completely automated system enables authorities to issue citations to drivers who illegally pass school buses.

Powered by AngleTrax's IntelliGuard automated detection system, the CrossingGuard solution captures high-resolution images and a short video of any vehicle that illegally passes a parked school bus with its flashing stop arm extended. Violation data – including GPS coordinates, date, time and more – is automatically embedded into the evidence package that is wirelessly transmitted to ATS' violation processing system, where the images can be reviewed and approved by law enforcement, resulting in the issuance of a citation to the owner of the violating vehicle.

The Auto Patrol system uses 2D radar technology to identify vehicle speed

Need for speed control

ATS also continues to enhance its speed camera offerings. The AutoPatrol speed camera system uses advanced 2D ranging radar technology, which identifies a vehicle's speed and lane position for optimal enforcement even in congested traffic. In the blink of an eye, 2D radar will know which of three vehicles across four lanes of traffic is speeding, or if all three are speeding.

The system deploys quickly and ATS claims it is less expensive and more reliable than rival technology. In addition, it is operationally immune to poor weather. As a complete unit, the system includes a high-resolution digital camera, a main processing unit, a graphical user interface, radar antenna, strobe and power source. Available in a variety of applications, the AutoPatrol speed camera system can be installed alongside streets in a fixed location, mounted into a vehicle for mobile use, secured into a portable cabinet for quick relocation and attached to a tripod for rugged conditions.

Even greater improvements were made to ATS' red-light camera program. The AutoPatrol intersection safety camera system applies 3D radar technology to signalized intersections where the most dangerous crashes occur.

The AutoPatrol RLSC-3D system emits a continuous radar signal to track the position and speed of up to 30 vehicles at one time, up to a distance of 330ft. It also paints virtual loops on the roadway. Vehicles that pass the virtual loops at a predictive speed that prevents them from stopping before the violation line trigger a signal to be sent to the camera to capture images of the violation.

Need to know?

A continuous quest to innovate is leading to demonstrable success for one industry expert

- In a bid to improve safety for the most vulnerable road users, a new school bus enforcement solution has been created
- There has also been technological progress in speed cameras – and the use of 2D radar is being embraced by the industry
- Radar-based red-light cameras are proving a popular choice for authorities in their continued battle to enhance safety at signalized intersections

AutoPatrol RLSC-3D can track the speed and position of 30 vehicles at once

Violation data for both speed and red-light camera systems is sent immediately over a secured wireless 4G connection to the ATS processing center, where it is decrypted and queued for review. ATS processors and police receive the video as well as images of the vehicle in the intersection with the traffic light, and a data bar showing the vehicle's speed, date, time, location and other details necessary for authorities to issue a fair judgment.

With innovations such as these, ATS is set for continued success in 2013 and beyond.

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My first car was a 1960 Chevy Impala – a great looking car with flat fins that looked like I could get airborne at the right speed. I had an AM radio, a heater, windshield wipers and turn signals. Other than that there were no other controls. Fast-forward 50 years and I now have a 2010 Volvo with climate control, GPS, a dashboard that can give me RPM, fuel efficiency, cruise control, buttons for mirrors, door locks, gas tank lock, AM, FM, and satellite radio, CD player, Bluetooth phone and iPod connections and other buttons that I haven't the foggiest what they do.

So when I'm behind the wheel I can be talking on the phone, listening to music, checking my GPS, turning up the A/C, upping the cruise control speed and even changing lanes. The driver I just cut off looks like he's texting. With all these gadgets that make my car look more like a jet cockpit than the interior of a 1960 Impala, am I sacrificing my safety and that of others around me? You bet I am. Luckily, the Swedes, first in traffic safety, are looking to save us from ourselves.

In an initiative known as Vision Zero, the Swedes' design philosophy is that any loss of life is unacceptable. Rather than design for maximum capacity, their approach is to design their systems knowing full well that people will make mistakes. However, in order for the system to bear the responsibility of safety, there needs to be a way for it to understand the driver. To accomplish this, they turn to the emerging field of driver monitoring technology.

With the proliferation of in-vehicle gadgets, driver distraction is becoming a bigger problem than ever before. To address this, researchers at Ford's European Research Center are developing a system, known as a Driver Workload Estimator, which can detect if a driver is not paying enough attention to the road. Using onboard sensors (both inside and outside the vehicle), the system can calculate how much concentration is needed based on the roadway conditions and tell if the driver is distracted from their eye movement and other biometric information. It can then notify the driver, block incoming calls, and even adjust the vehicle's own systems to compensate.

Driver monitoring technology can also be used to observe the physical wellbeing of the driver. Ford is also developing a system that can detect heart trouble using a special seat with contactless electrocardiogram technology. The system can warn drivers to seek medical attention immediately if it detects a problem. If equipped with a communications system, such as On-Star, it could alert emergency medical services at the first sign of trouble. In the future, with the arrival of self-driving cars, the system could even drive to the nearest hospital automatically if the driver becomes incapacitated.

The use of biometric sensors has researchers at Ferrari interested as well. The company's prototype system in development can measure a driver's respiration, blood pressure, heart rate, eye blinks, brain activity, temperature, and perspiration. The information gathered is then processed and accordingly adjusts the vehicle's performance level based on the driver's actual psychophysical condition.

Ultimately, this means that if a driver is perceived to be overly aggressive, the car can compensate by reducing power, enhancing traction control, and softening the suspension. Who needs a shrink?

In 1971, the cartoonist Walt Kelly sketched a meomorable comic strip where Pogo the Possum says: "We have met the enemy and he is us." There is hope, at least in traffic safety, that we can save ourselves from ourselves.

> With the arrival of self-driving cars, the system could even drive to the nearest hospital automatically if the driver becomes incapacitated
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

The analog-to-IP dance

READER ENQUIRY NO. 502

Many transport organizations are having to consider how to move to new IP-based platforms from traditional serial-based models. Often their technology infrastructure is large, complex, and has evolved over a number of years. There may be parts of it that are obsolete, coexisting with other sections that are relatively new. Small, discrete sections may even have begun a shift to IP or been completed as trial projects.

TfL moved its analog CCTV to digital before the London 2012 Games

Making the IP move

Although there are huge benefits in moving to an IP-based approach (and this is often a necessity), the challenge of having to move the technology infrastructure – and the applications that run upon it – to IP can be daunting. Defining and selecting the desired end solution is obviously important and it is widely accepted that this task requires significant time and care.

However, of equal importance is the manner in which the existing technology can be migrated to the end solution. In a willingness to reach the end solution, the migration plan can sometimes be underestimated and undervalued. Failure to spend sufficient effort in creating a detailed migration plan and continually monitoring and evaluating it can result in huge risks to the success of the project. This can lead to large periods of downtime as well as disenfranchised users, increased costs and a real possibility of ending up with a worse solution than you started with.

Working closely together, Serco, Simulation Systems Limited (SSL) and Transport for London (TfL) recently completed a very large and complex analog-to-IP migration, enabling TfL to transition its entire analog CCTV to a new digital platform in time for the London 2012 Games – one of the largest traffic management events in TfL's history.

Small steps aid the transition from legacy analog systems to IP-based platforms

The new digital platform enabled TfL to exploit all of the benefits and flexibility of IP CCTV in order to meet and exceed the unique expansion requirements placed upon the organization by the Games. The migration plan created, agreed and continually evaluated by all parties ensured that this was done on time and with minimal disruption, also enabling round-the-clock use of the crucial CCTV system during the whole migration period.

SSL has worked on a number of analog-to-IP migration implementations and strategies, from message signs and signals to CCTV. This experience has enabled it to define some key principles to adhere to when performing these migrations.

Use small steps

Even though there will be an increased number of steps, ultimately you will cover the ground more quickly, safely and elegantly than with a couple of large strides.

With small steps, companies are far less likely to tread on their partners' toes – and even if they do so, they can quickly step back without too much impact and disruption.

Smaller steps enable companies to identify the ones of lower impact and commence them at an early stage rather than putting off the start of the migration until the end of the project, expecting to do it in one large leap.

All partners need to know which steps a company is taking and when – there are many tools to ensure this happens but SSL finds that technical drawings – which may range from CAD documents to PowerPoint slides depending on the audience – of the different steps work best for common understanding.

Project managers should take every opportunity to practice all of the steps involved – and if this can be done involving a limited set of the audience (the system users), all the better.

Pausing between steps is sometimes a good idea, to provide all parties involved time to evaluate what has happened

Need to know?

Key considerations when making the move from analog- to IP-based systems

- As increasing numbers of organizations transition to IP-based systems, a well thought out migration plan is crucial to ensure that the process is completed smoothly
- Breaking the entire migration down into smaller steps reaps many benefits
- The aim is to achieve a constant flow of information between all parties to ensure that everyone is on the same page – at the same time

and deal with unexpected problems as they arise. Each occasion may be different. For each migration, some or all of the same steps may be used but they can be put together in different ways. Therefore each migration can be tailored to the audience's, the partners' and the judges' requirements.

Planning your migration 'dance' in this way may seem overly cautious but, in the heat of the competition, SSL has often been thankful for following this controlled approach, which gives a much better chance of pleasing the audience and the judges.

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In October 2012, the international ITS community gathered in Vienna for the World Congress. I usually attend these festivities but had a conflict that kept me away from this particular event. However, I thought that the occasion of the World Congress would offer a good opportunity to review what progress we have made since the first World Congress in the early 1990s in Paris, which I did get to attend.

It seems that most of us in this community tend to take a half-empty view of the industry. We always bewail what we have not yet done and the progress that we have not yet made. Perhaps instead we ought to look at the extraordinary progress that we have made – and celebrate it!

Twenty-five years ago, there were few centralized signal systems, even fewer traffic control centers and virtually no consumer electronic products. We got bad traffic advice from the radio along with bad weather forecasting.

Today, local government has state-of-the-art traffic control centers that look like NASA. They have widely distributed but by no means ubiquitous detection. Traffic signals are all controlled and many are adaptive. Transit has benefitted from technology with computer-aided dispatch and automated fare collection.

However, an even bigger change has been the explosion of consumer electronics to support travel. We all carry instant connections to the global river of information in our pockets. We have gone through two internet booms and one bust and our ability to navigate the road and transit systems is infinitely better than it was then.

We have map guidance for driving or walking that incorporates real-time traffic. Where the public sector could not afford additional detection, the private sector has stepped in with crowdsourcing. When transportation departments started to develop control centers, they provided their traffic data to the private sector. Now they need to redesign their systems to incorporate private data and they need to figure out a business model to cover it. Why build infrastructure if you can buy data?

We have my favorite, electronic toll collection, and it has evolved from in-lane systems to open-road, non-stop tolling with tags or just using license plates. Toll roads have achieved their Holy Grail of customers having to do virtually nothing and still pay a toll.

What we do not have is a US national consensus that the government should be spending more money on transportation infrastructure and a gas tax limitation that makes it very hard to identify any more money for infrastructure – even if there was such a consensus. Traditionally the ITS community aligns itself with the broader transportation community, seeking increased federal spending but in light of both how ITS has evolved over the past few decades and how little new money there will be, do we need a new deployment strategy?

The *Wall Street Journal* just recently published an article about the 'infostructure' and how it is becoming more important than the infrastructure. It's part of the argument to not spend more on infrastructure. We in the ITS community need not slavishly subsume our needs to the highway builders but can chart a new path building upon the gains of 25 years, the growth of consumer electronics, infrastructure banks and public-private partnerships. We should be able to mine the gold in our own hills.

> I thought the occasion of the World Congress was a good opportunity to review what progress we have made since the first one in the early 1990s
>
> **Larry Yermack, Wendover Consult, USA**

New advances in camera design

READER ENQUIRY NO. 503

Price reduction and commoditization is an ongoing trend in the technology sector. Even specialized cameras using global shutter sensor technology and high-bandwidth interfaces are not immune to this effect. These products – initially developed for the machine vision industry – are highly sought after in ITS. The growth of this demand, especially in specific territories such as China, has increased the number of available products as well as the breadth of their functionality. Competition has motivated camera manufacturers to compete based on price in addition to performance.

Improved price performance

In these price-sensitive markets, manufacturers need to redefine expectations of price, performance and value. In 2012, with the new Blackfly camera, Point Grey Research did just that. This GigE, power-over-Ethernet (POE) camera – which the company believes is the smallest in the world – will launch with a 1.3 megapixel, CMOS global shutter, 60fps model, priced at only US$395. To put this into perspective, cameras offering the same resolution and a lower frame rate were priced at about US$1,000 just a few years ago. What's especially remarkable about this product is the inclusion of onboard features such as look-up tables, gamma, saturation, color interpolation, POE, LED status or temperature readout. This is an impressive feat when compared to other aggressively priced products that strip capabilities to support a lower-cost solution.

In addition to a value-packed offering, the Blackfly's sensor selection is particularly well suited for applications such as license plate recognition (LPR) and enforcement. Although CCD sensors are widely used and often preferred for their sensitivity and low noise performance, a number of ITS integrators are pushing for CMOS in favor of eliminating smear and blooming artifacts that occur during bright, sunny days or specular reflections.

(Above) **Blackfly combines POE and affordability** (Below) **The Zebra2 fulfills a growing demand in traffic and surveillance installations**

The first Blackfly model uses a 1.3 megapixel global shutter CMOS device to address this demand. Devout CCD users will also be impressed with future Blackfly models, including a 0.9 megapixel, 30fps CCD camera that employs Sony's EXview HAD II pixel design, well known for excellent sensitivity and near-IR response.

In addition to lowering price and improving performance, manufacturers are reducing camera size and weight to accommodate mobile and portable applications, such as on-vehicle and hand-held installations. The Blackfly measures only 29 x 29 x 30mm and weighs a mere 38g, which Point Grey says makes it the smallest and lightest GigE POE camera available today.

Ultimate flexibility

Success in the ITS market has motivated machine vision camera manufacturers to develop vertically focused products, which provide unique capabilities uncommon in the machine vision marketplace. Although this option has always existed, growing camera sales combined with increased competition has created a rat race among manufacturers to bring to market the ideal traffic camera. The Zebra2 from Point Grey is an example of such an offering, and provides multiple interfaces, image compression, lens control and global shutter sensor technology to service multiple uses in a single installation. Capturing high-resolution images of license plates while transmitting low-latency video allows one Zebra2 unit to replace multiple products from different vendors.

Integrated image compression

The security camera market has been offering compressed image output for a number of years. Machine vision manufacturers have been slow to implement onboard compression, favoring uncompressed data for real-time image-processing applications common in automation. Many ITS applications, however, store image data for future review, processing or proof of violation. Enabling image compression in the Zebra2 allows integrators to minimize host processing and reduce the cost of integration. MJPEG compression was selected in favor of frame

Need to know?

Getting more for less from the machine vision cameras being put to use in ITS

- Advances in camera design are helping to maximize functionality while minimizing costs
- Fast technical evolution means that today's cameras are not only more powerful but also more cost effective than ever
- Single cameras can now replace multiple products from different vendors

compression, suitable for image processing such as LPR and lack of temporal compression artifacts that can occur when using formats such as H.264.

Advances in lens control

Although sensor and interface enhancements are common, remote lens control has been relatively unchanged for a number of years. Auto-iris methods such as video and DC auto iris were originally developed for analog camera systems and they continue to work well in security installations where continuous image capture is common. However, tolling or enforcement applications – which rely on asynchronous events and external trigger – require a new approach that prevents iris drift and allows the camera to control exposure, gain and iris in a stable fashion. Precise iris, or P-iris, is an emerging technology from lens companies such as Kowa, Computar, and Tamron. Replacing DC auto iris, P-iris lens control relies on stepper motors to manage the iris opening. Users can identify the iris location after initial calibration, optimize depth of field, and improve system dynamic range and adaptability throughout the day. The Zebra2 combines DC and P-iris lens control, allowing the integrator to use existing technology or test P-iris, which the company feels will prove to be invaluable in the future.

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Whether the weather be fine,
Or whether the weather be not,
Whether the weather be cold,
Or whether the weather be hot,
We'll weather the weather
Whatever the weather
Whether we like it or not
– Age-old children's tongue twister

Inspired by a research briefing by two esteemed institutions, the National Oceanic and Atmospheric Administration (NOAA) and the National Center for Atmospheric Research (NCAR), in my June/July column, I wrote about the 'embedded meteorologist', imagining the concierge-like pre-trip and maybe co-pilot-like en route advice my smart car information system could give drivers. This was, in my mind, not only literally but also figuratively down the road. I thought that along the slippery path to realization there would likely be waypoints of more research, of cajoling stakeholders for initial implementation, then interminable analyses to commit and build toward full deployment.

I now have a sunnier story to tell. Recently, I had the chance to talk with the 'embedded meteorologist' within the USDOT, Paul Pisano, the team leader for road weather and workzones. Paul works for the Federal Highway Administration and also (and particularly with road weather) with the Research and Innovative Technology Administration's ITS Joint Program Office. And yes, Paul is certainly not embedded within cars or telematics systems, as he couldn't quite fit into your car's engine compartment.

But his ideas are large, and those could readily fit. When he talks about the future of road weather to benefit travelers and system operators, he bespeaks urgency. I can see the fog lifting in but a few years, and Paul says even as early as 2015, if one considers that weather data and information from the National Weather Service could – with some effort – be assembled and provided for pre-trip planning. Readers of *Traffic Technology International* know full well that another catalyst – the presence and ever-growing functionality of traveler information and the telematics industry to feed the demand – is here and now. Simply stated, if great weather information is available, great weather information will be used. With good data, 'some effort' becomes 'small effort' and eminently worthwhile.

Given a bit more time, and the long-term forecast becomes better and better. There is within USDOT a program of Connected Vehicle research that involves standards from organizations such as the Society of Automotive Engineers and the Institute of Transportation Engineers; the institutional and policy leadership of the American Association of State Transportation Officials – known as AASHTO and consisting of the state DOTs; great universities; and the aforementioned NCAR. Like you and me, they imagine more and better real-time information connecting you, the driver, to dynamic conditions. If impending weather conditions that will influence travel are forecasted and given to you, the traveler, you could re-route yourself or even change modes – say park your car and take the train. And there's more: imagine near-real-time and very local predictions of upcoming visibility or even that puddle of water or slippery ice ahead – all life-saving information if you're driving pell-mell or even with delicate care. This is certainly futuristic. But with a bit more research and standards-building, the future can be here, whether the weather.

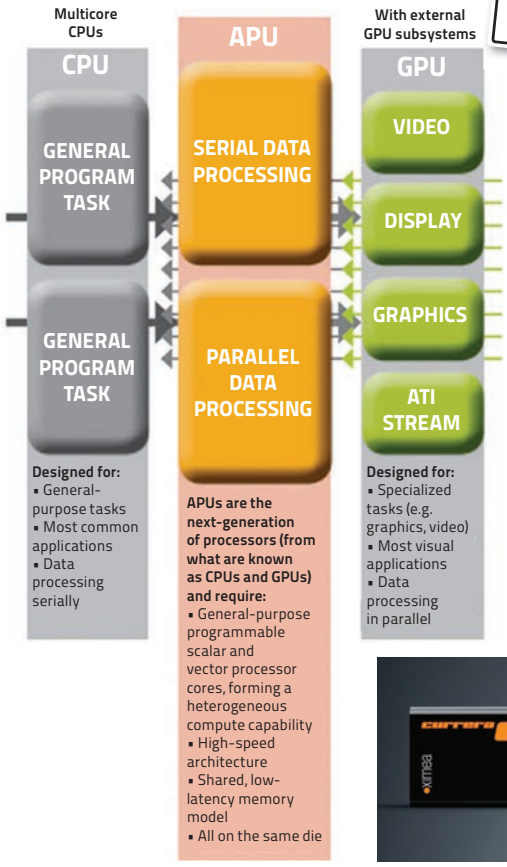
> Simply stated, if great weather information is available, great weather information will be used
>
> **Jim Misener, executive advisor, Booz Allen Hamilton, USA**

New cameras with PC for traffic applications

READER ENQUIRY NO. 504

Today's new class of PC camera includes all of the functionality of an industrial PC within a high-resolution industrial camera – supporting full OS and image-processing library functions, network functions, and traditional PC I/O and peripheral support.

New low-power, high-speed and heterogeneous processor architectures – such as Intel's Atom and AMD's Fusion processors – have led to this new category of compact vision systems. These PC cameras can deliver up to 90 gigaflops of processing power, 10 times the capability of a Pentium-M class single-core microprocessor – enough to support full image-processing libraries; sensor resolutions of five megapixels or more; and a standard consumer or embedded OS, including full peripheral and network functionality. These new cameras finally deliver on the 'smart camera' promise, decoupling the need to buy both software and hardware from a single vendor, offering simplified programming for new and expert designers alike, and improving remote support for today's global marketplace through the improved networkability made possible by running a full OS.



(Above and below) **Ximea's Currera-G camera** (Left) **Diagram showing the benefits of APUs**

In 2012, Intel paid up by adding a graphics processor unit (GPU) to the x86-based CPU, while AMD joined the fray with the Fusion accelerated processing unit (APU), which – like the new Atom E6xx class microprocessor – places a GPU core on the same die as the CPU. Using Fusion's 40nm lithography technology, the latest PC cameras – such as Ximea's Currera-G – can now deliver up to 90 gigaflops of processing power, more than enough to challenge any single-core PC-host vision system.

Quicker data transfer

In addition to running a full image-processing library and OS, the smaller footprint of PC cameras means that data gets from the sensor to the processor faster than on a comparable PC-host system, which reduces latency and jitter (dislocations in the image) between image acquisition and processing. The image-transfer speed and data integrity from a remote camera to a PC or embedded vision are limited by the cable bandwidth, length, and electromagnetic interference (EMI). Even an integrated webcam on a laptop can work much better than a remote head-based system.

Host of benefits

The benefits of PC cameras don't stop with better resolution and usability, higher processing speed, and lower latency; they can also considerably change the relationship between customer and vendor.

Ximea's clients, for example, no longer have to let hardware selection dictate their image-processing software. PC-class processing power and a full OS have allowed Ximea to develop APIs for the vast majority of major image-processing applications, achieving true plug-and-play compatibility in a machine-vision system.

Today, the company offers free APIs that are ready to use without additional drivers with all machine-vision libraries from major vendors such as Cognex, Matrox, MVTec, RoboRealm, ScorpionVision, Stemmer and many more. Some PC camera vendors still require users to develop their own APIs using a C-compiler. This step toward greater compatibility for vision technology is a big deal

Need to know?

Why a new breed of PC camera is redefining the ITS landscape

- Combining an industrial-grade PC with a high-resolution camera is opening up an array of benefits for the ITS sector
- This new generation of PC camera is proving its worth in traffic management applications such as electronic tolling and ALPR
- Benefits include better resolution, higher processing speed, and lower latency
- The remaining hurdle – hardware support – is also being tackled

for customers because integrators tend to sell the machine-vision hardware and software they know, which ultimately may or may not be the best solution for the customer.

ITS applications

Whether you need a system for tolling or are developing ALPR, you need an easily integratable, compact solution that doesn't constrain you in the choice of software for your specific application. In the near future, PC camera vendors will conquer the last advantage of PC-host systems over PC cameras: hardware support. The time is nearing when PC cameras will have 'snap-in' modular designs that allow the user to replace a failed motherboard, increase the sensor size, or add a higher-speed network interface. Imagine being able to re-purpose a PC camera for a high-resolution operation simply by snapping out the sensor box and replacing it with a larger array. ITS science fiction? Just wait and see.

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Loss aversion is the critical barrier to acceptance of mileage-based user fees (MBUF) or VMT charging. Well known to behavioral economists, loss aversion says that humans experience losses about 2.5 times more intensely than an equivalent gain. Losing US$10 feels as bad as winning US$25 feels good. Coupled with an exaggerated tendency to fear losses that incorporate uncertainty, loss aversion is built deeply into the human psyche with roots extending far back in evolutionary time, preserving gene pools. It cannot be ignored by transportation economists who wish to see a shift to paying for roads according to use.

Motorists' perceived losses associated with road use charging include a wide variety of uncertain effects: additional taxation, privacy invasion, comparative inconvenience, reduced autonomy of movement, government spending misallocation, inequity for one group or another, etc. That the degree of these presumed effects is uncertain – each can, in fact, be readily avoided – merely adds to the weight of loss perception.

Our explanations of counterbalancing gains also weigh far less than we imagine due to their uncertainty and imperceivability. The potential repeal of fuel duties, congestion abatement, improved environment, and better transit – if believed – mean little to drivers who feel at risk of larger personal losses. Abundant uncertainty further exaggerates the 2.5-factor spread between the loss of the status-quo and the tenuous gains of road user charging.

The way automobility and its taxation have evolved precludes a reasoned switch from fuel tax to road-use tax. We need to think about a different route to the change we seek, and DC Council member Mary M. Cheh has just shown us one.

In September 2012, Cheh introduced a bill in DC Council "to authorize autonomous vehicles to operate on the roadways of the District," provided that the vehicle "operates on alternative fuels," that "owners of autonomous vehicles pay a VMT fee of 1.875 cents per mile," and that "the VMT fee shall be tabulated using an autonomous vehicle's telemetry systems."

Cheh's proposal shows us a way out of the loss aversion problem. If you think about the AV of a few years from now, you can imagine it changing a lot of things. Besides the effects related to road safety, congestion, and fuel consumption, it will have dramatic effects on public transportation, shared vehicles and private vehicle ownership.

And the Jevons Paradox, which says that when we use a resource more efficiently we consume more of it – in this case, road space – suggests that we would likely experience an increase in VMT. Hence, Jevons predicts that a new efficiency given to us by the AV would tend to keep congestion and fuel use – and the need for road funding – running high.

AVs can sufficiently alter the evolution of automobility to change the perception of gains and losses between fuel taxation and VMT charging. Council member Cheh is right to take advantage of the move to the AV to switch tax regimes at the same time.

> The way automobility and its taxation have evolved precludes a reasoned switch from fuel tax to road-use tax
>
> **Bern Grush, principal, Bern Grush Associates, Canada**

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The revolution in tunnel lighting technology

READER ENQUIRY NO. 505

Safer, sustainable and above all, smarter: the Agmi R&D team has worked hard to make a leap forward in improving tunnel management. After a year of fine-tuning and testing, the company has achieved a breakthrough that combines a smart system and LED technology. With the new system it's possible to implement a far-reaching standardization. LED technology by itself has numerous benefits. It improves safety because it provides more natural light than conventional sodium lamps. It is more energy efficient and more reliable. Agmi's system has added intelligence. It increases reliability and the life expectancy to over 25 years and reduces service intervals.

The system has a modular design and can be adapted for the requirements of any operational situation. The

company's LED Driver – with a new protocol – can be directly integrated with PROFINET IP. In a smart LED line lighting solution, every light point communicates with a central control unit. The control has a redundant power supply and communication system and can handle multiple signals, such as temperature and current of the LEDs, traffic intensity, outside light intensity, and more. This has various applications. A practical example is the ability to increase the light in two neighboring light points to cancel out the impact of a failing one by maintaining the desired level of light. A more complex routine could be to have the LED line show a pattern that directs people to the nearest emergency exit. These are just a few examples that help to realize a tunnel that is safer, more reliable, and has less impact on the environment.

Drivers experience LED line lights as natural light. In contrast to conventional tunnel light, LEDs project the light exactly where you need it, resulting in smooth, evenly spread light. Color is another big advantage. In LED light, colors appear natural. The days of a tunnel filled with cars in an orange glow are over.

Using 50% less energy and 70% fewer cables are some of the results that the Agmi engineering team has achieved with its relentless focus on the environment. Combine these figures with the long life expectancy and low service intervals and it is obvious that this is not only good for the environment but also for the total cost of ownership.

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Contract win for enforcement expert

READER ENQUIRY NO. 506

Gatso has been awarded the first of four contracts that will be issued over the next two years to supply speed and red-light cameras in the Netherlands.

The contract is part of the EG100 framework agreement, which comprises the replacement of 300 to 550 fixed installations throughout the country. The first contract covers the delivery, installation and maintenance of 94 fixed installations for speed and red-light enforcement, with the company delivering its new T-Series units, which it launched in 2012. The complete installation of the 94 cameras will be conducted before the end of 2013.

The T-Series platform features: a compact 20MP GT20 camera and CMOS sensor that

captures clear images of fast-moving vehicles; 30fps full-frame image capture with high photosensitivity to enable the recording of multiple violations under all light conditions; an FT2 stroboscopic light unit to provide infrared illumination for high-speed video capture of passing vehicles under all light conditions, with extra illumination of still images provided by an FT1 xenon flash unit; and an RT3 dual antenna tracking radar that is designed to detect and track up to 12 vehicles in the coverage area at the same time, which provides all the data required to determine speeding and red-light violations. The cabinet, which can be delivered in any RAL color scheme, is designed for easy installation and low maintenance and can be mounted to existing roadside infrastructure or stock poles.

Gatso's director of sales and marketing, Edmar van der Weijden, comments, "We are very proud of this contract. It shows that our customers recognize the unique features of the T-Series, offering a top-performing solution with ample room for implementation of future needs. The design is both compact and lightweight, reducing installation time and making installation possible on existing street furniture. This, together with non-invasive detection and auto alignment, enables us to meet tight installation schedules."

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What are the biggest challenges facing the ITS industry over the course of the next 12 months?

"While there are many challenges facing the ITS industry, toll interoperability will grow especially large during the coming year. The approval of the MAP-21 bill in July 2012 in the USA has created a toll interoperability mandate in the same way Directive 2004/52/EC has created a looming deadline for the European market. ITS industry participants will need to begin taking action now in order to support these directives and avoid infringement proceedings if deadlines are missed. To meet this challenge, toll operators and government agencies will need to place even greater emphasis on license plate reading and image collection technologies, as well as data-sharing methods, in order to cut across the jurisdictional and technological silos that have developed as the industry has evolved. It will take a combination of both technology and process upgrades. Fortunately, there are a variety of solutions available to help achieve this objective."

Frank Long
traffic solutions manager, JAI, USA

"Privacy remains a primary concern of transportation agencies in the USA when tracking people, vehicles and goods. As a number of technologies have rapidly advanced – photo enforcement, ETC, VMT, WIM, and C2X technologies – research examining the privacy implications of system applications has lagged. In a recent national survey to determine how state DOTs are meeting the privacy needs of the traveling public, it was determined DOTs favor aggregating and masking data for protecting privacy of motorists while collecting travel times and speeds. For capturing video surveillance, abiding by legislation or agency policies was the preferred method of protecting privacy. Sadly, there are no national standards in the USA for the privacy protection of travelers as most privacy information merely takes the form of poorly defined precepts. With the increasing use of ITS – which are becoming more interwoven into the US transportation grid – there is a need to develop a national policy and related standards to ensure the privacy protection of the traveling public to ensure broader acceptance of ITS."

Ryan Fries
assistant professor and graduate program director, department of Civil Engineering, SIUE, USA

"New technologies are constantly evolving in ITS, offering new and innovative solutions to problems. One of the major challenges today is that the speed of new product development is much faster than the speed of new regulation. This provides a gap in state, regional and municipal adoption of new technologies, leading to a revenue gap for the companies – which again slows down innovation. Combining this with massive reductions in ITS funding –in Denmark the budget for ITS in 2013 has been cut to one third of what it was – focus is on the less advanced (and cheaper-to-manufacture) technologies. Road owners should allocate 10-15% of the budget for testing new and innovative technologies before regulations have been passed. Very often these new technologies could lead to savings in operating costs for the road owner as well as an increase in traffic safety. And isn't that what we're all looking for?"

Bruno Hansen
general manager, Geveko ITS, Denmark

"The ever-present challenges of funding, compatibility and legislation all exist but if I were an authority, I think my biggest challenge would be which supplier to choose. Which claim is to be believed? How can authorities judge if one solution is better than the next, and how can they seek to confirm the claim versus a counter-claim? There seems to be a ready supply of companies entering into the market with exciting innovation claims. I played a game recently at the World Congress on ITS of 'buzzword bingo', to see who could mix the latest 'trending' words into a presentation or pitch. Interesting results for sure! But the point is that this marketing seems to work. It's really easy to get drawn into the marketing pitch and think 'Wow, they must know their stuff! How did they do that? I must have that latest toy!'. But can they deliver on their claims? All I can pray is that authorities are intelligent enough to ask for proof. And if it doesn't exist, ask for a customer to talk with or to demonstrate the claims and success. If the authority doesn't have the expertise to ask the right questions, independent consultants out there can help. Don't be swayed by the marketing – and have a plan of what you want to solve, as well as what you need to solve it."

Gavin Jackman
head of Traffic and Software, TRL, UK

Readers are invited to answer the Burning Question for the February/March 2013 issue:

What needs to be done to encourage a more integrated approach to the role of parking within the broader traffic management picture?

email answers to:
louise.smyth@ukipme.com

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