TOWARDS SAFER TRAFFIC MANAGEMENT

Potential industry led initiatives to increase the protection of life in and around temporary work zones over the next decade

A Discussion Paper prepared by Altus Traffic and students from the Monash Industry Team Initiative

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ALTUS TRAFFIC

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Foreword

As an industry, few would argue that we have an obligation to continuously work towards zero deaths and injuries on our roads. However, the number of Australians killed or suffering trauma because of crashes each year remains high. New thinking and a redoubling of effort is required if we are to truly make up ground on what has become a regular feature of our road network.

This is why we commissioned research and analysis into imagining a safer road network for both travellers and road workers. My hope is that it contributes to a maturing of our industry sophistication through the investment in new safety solutions for the most vulnerable on our roads, both now and into the future.

As a traffic management company, we send a large contingent of staff onto the road network each day, so we know all too well the risks they face, and the inherent vulnerability attached to their profession. At Altus Traffic our core mission is to 'get you home safely' and we apply that not only to our own workers, but to all road users – contractors, drivers, passengers, cyclists and pedestrians.

In a partnership with Monash University, a final year Civil Engineering Student (Jacob Couroyannis) and a final year Mechatronics Engineering and Finance Student (Kevan Vuong) were seconded to Altus Traffic for 12 weeks to research a range of safety initiatives and technology trends. Their aim was to evaluate what the industry could develop and implement locally with the support of Government and regulatory bodies to make the environments in which we work safer for everyone.

I believe many of the ideas set out in this discussion paper are innovative and worthy of exploring in greater detail. We have created this whitepaper to begin a conversation and hope that in partnership with road safety stakeholders and regulators we can improve the safety of all on the roads by working together.

I would like to thank Jacob, Kevan and James Pennings from Altus Traffic for their fantastic enthusiasm and dedication to this project and I invite everyone working in the roads industry to become involved in this discussion to help the best of these initiatives become a reality.

Introduction and Overview

The anticipation of connected and automated vehicles promises much in terms of safer outcomes for road users and is representative of the potential that technology can play in saving lives. However, with varying estimates on timeframes for adoption, take up and critical mass, we must guard against the temptation to frame such an exciting prospect as the silver bullet for improved road safety.

The fact is that the Australian road network is an inherently dangerous environment and will remain so for some time. It is where some 1,200 lives are lost and a further 35,000 directly changed by severe injury each year, with no reasonable expectation for a reduction in those numbers any time soon.

Such numbers, while bad enough, are only the tip of the iceberg as they don't include innumerable close calls and near misses – stomach churning situations that but for a metre, or a second's difference, could have resulted in even more unnecessary death or injury. A myriad of independent variables - spanning road user behaviour, vehicle condition, weather and the physical environment - combine in creating an environment that is both inherently risky and difficult to fully control.

This is the environment into which we, as a company, send more than 1,800 staff each day, and the environment into which our industry peers and other upstream and downstream organisations send hundreds of thousands more. We owe it to them and to the families, workplaces and communities in which they belong, to make every effort to get them and every road user home safely.

1,200 LIVES ARE LOST AND A FURTHER 35,000 DIRECTLY CHANGED BY SEVERE INJURY EACH YEAR

Towards Safer Traffic Management

In partnership with the Monash University Team Initiative (MITI) Program, we commissioned this work to complement our internal work on continuously improving the safe working environment of our staff by seconding two undergraduate students to undertake a range of targeted research and analysis. Specifically, the MITI team were tasked with the following project objective:

Draw on existing and emerging technologies to innovate the design and operation of the temporary workzone, such that it achieves zero harm to people, without compromising mobility or business efficiencies. The solutions should be consistent with safe system principles.

The physical area they focused on was the temporary workzone, that is, the envelope of protection established by a traffic management company to allow its customers to fulfil their core objectives safely. This could include:

- Long-term quasi-temporary construction related traffic management treatments, such as for the building or widening of a road;
- Short-term stationary temporary traffic management with daily setup and pack up, such as for the routine maintenance of assets; and
- Mobile temporary traffic management for rolling services, such as for grass mowing or pothole repair.

Additionally, the team were asked to consider the movement of staff to and from the temporary workzone, as there are a range of risks attached to getting to and from a different location each shift.

Without wishing to constrain the range of design and operation initiatives that may be uncovered, the team were further asked to frame potential solutions over a period from now to 10 years into the future. Thus, the initiatives set out later in the discussion paper are framed as having potential to trial and implement over the immediate, medium and/or longer-term.

Finally, because safety outcomes are not purely a function of technology, and that other elements prevail in how safe a temporary workzone is, the team were given a wider remit to give consideration to other factors that could contribute to their project goal, including industry structure, regulation and capability.

Safe Operating Principles

A valid criticism of the traffic management industry has been its general inability to foster step-change improvements in its mode of operation. One need only consider the number of people still being required to work near moving vehicles or plant, to acknowledge this to be the case.

While there have been some welcome improvements in traffic management operating methods underpinned by technology developments (such as truck mounted attenuators, drop deck trucks with harnessed operators, mobile traffic lights and boom gates), these could at best be characterised as being incremental. To put it another way, it would be difficult to suggest that rapid innovation has been a hallmark of the industry.

Part of the reason for this, in our estimation, is that we do not have access to a supply chain informed by a cogent representation of the principles that should guide innovation for our industry. In other words, while there is a raft of singular innovations, they are not being developed with an overarching goal in mind, rather they are seeking only to solve a specific issue or need. Innovation needs to be commercial, it needs to be supported by the regulatory environment, and perhaps most importantly, it needs to be congruous with the workflows embedded within the business model governing the industry.

Consequently, we hold that in addition to being commercial, approved and practical, innovation should be guided by these five aligned principles.

1. **Separation of Vehicles and People**
2. **Separation of People and Plant**
3. **Clarity and currency of information and instructions**
4. **Public confidence in the professionalism across a site**
5. **Demarcation**

1 Separation of Vehicles and People

One of the two highest risk factors for road user injury or death is the mixing of pedestrians with moving traffic. This may occur inside or outside of the temporary workzone subject to the phasing or design of the traffic treatment and the prevalence of hard or soft barriers around the area where customers are fulfilling their core activities.

Site bump-in and bump-outs are notably risky activities for example, given that the full array of traffic treatments has yet to be assembled or alternatively, is in the process of being removed. Cone or bollard delineation of a workzone does not offer an engineered physical barrier to vehicles and hence vehicles may trespass into a site containing workers. End of queue accidents are similarly risky given that high speed vehicles may either plough into the back of stationery vehicles pushing them forward, or alternatively swerve to miss the end of queue, either into oncoming traffic on the right, or worker and worker equipment on the other side.

Innovations that assist in removing road workers from being in or near the vicinity of moving traffic, or that establish an impenetrable barrier such that vehicles cannot trespass into the workzone, would be of high value to the industry.

2 Separation of People and Plant

Within the workzones themselves, a significant risk of injury to staff can occur through the unsafe mixing of people with mobile plant. Depending on the type of work being undertaken by a customer such plant may include skid steer loaders (or bobcats), excavators, or specialised equipment for the development of roads and road surfaces. Each type of plant carries risk in terms of clear visibility of staff and may be compounded in some cases by high mobility.

Safety non-negotiables on such sites will often (however not always) encompass a minimum exclusion zone around the plant, or relative to the site lines of the plant. Again, these are not engineered solutions but rather rely on the proper instruction and execution of such rules by both people on foot and plant operators.

Innovations that assist in alerting mobile plant operators and people on site as to their proximity to each other have been and are in development. These technologies may include sensors that emit a sound or vibration when a pre-determined distance has been breached, or laser type set ups that indicate proximity and physically limit the movement of plant. While such developments are useful, they still rely on human behaviour to work. In our view innovation that physically prevents an impact between mobile plant and people would be significantly preferable.

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Clarity and currency of information and instructions

A common criticism of temporary traffic control is the clarity and currency of signed instructions to motorists driving through or around the site. Signage and other ancillary traffic devices are intended to provide an intuitive guide to how drivers should behave in the lead up to, upon entering, and when leaving a temporary workzone.

The placement, accuracy, condition and visibility of signage across the spectrum of times and locations is crucial to optimising the behaviour of drivers who care to do the correct thing. Where signage is not optimal, confidence in the instruction is undermined and drivers are more prone to behave in accordance with the vehicles around them.

Similarly, temporary traffic management that is established in the clear absence of any work being undertaken remains a frustration for motorists, who rightly question why their speeds are reduced, and the risk of being found to be speeding increased, where there is a perception of no risk to safety. A kind of peer pressure can emerge in such situations whereby motorists feel obliged to drive to the original speed limits lest they impact the traffic around them.

In our view, improvement and confidence in information and instructions is best facilitated when innovation allows for communication that is unequivocally clear and current. This should consider placement, such that all vehicles have a clear line of site to signage, and to responsiveness, in that signage is updated to reflect the changing conditions of the site. If costs and workflows can be solved, digital, overhead signage with remote management would offer significant benefits.

Additionally, the ability to have accurate information delivered to in-vehicle systems such as satellite navigation systems may assist with providing drivers the information they need to drive as intended through such sites.

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Public confidence in the professionalism across a site

The traffic management industry generally has low barriers to entry, both for companies setting up, but also for the educational skill level of staff who enter the industry as practitioners. Consequently, there is a wide range of capability on display across the industry. While sophisticated clients will generally seek to use well reputed companies, there is a segment whose primary concern is cost and hence, will use companies and staff who may reflect poorly on the industry.

Key opportunities for improvement to the overall professionalism of the industry therefore centre on improvements to both company and staff performance. Where a critical mass of high level and safe performance in these can be achieved, public perceptions of the industry will improve and trust in the directions prescribed across multiple temporary workzones will become increasingly adhered to.

While there are regimes that seek to ensure the proper performance of traffic management companies, these are often ad hoc or relatively easy to be complied with at a single point in time. A genuine pre-qualification or registration scheme that requires continuous compliance would be a welcome contribution to industry. Supplier purchasing criteria that aligned with, or even exceeded, the requirements of such a scheme would assist in reinforcing the importance of a professional industry.

The above would work to incentivise companies to employ staff who did not place their venture at risk, consequently encouraging them to invest more in training and skills development, and sanctioning staff who do not hold the requisite attitude, competencies or character to work safely. The proposed harmonisation of traffic controller training accreditation will also assist in this regard.

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Demarcation

Our final principle relates to providing a clear demarcation of when motorists are moving from a normal operating environment into one in where the level of awareness needs to be heightened. While signage in advance of a temporary traffic control set up is important, particularly on regional roads where queues may form, it is often not clear enough how far ahead the workzone is until the environment changes.

More can be done to better communicate to motorists exactly when they need to become even more vigilant, and conversely when they may return to normal driving behaviour. Our view is that innovation in this area may encompass physical treatments such as rumble strips, overhead signage such as mobile gantry set ups, or in-vehicle messaging that clarify entry into a workzone.

In other words, the principle here is to create an environment in which it would be difficult to suggest that one didn't know they needed to act.

Technology and the Road

There are a two major technology trends at varying stages of maturity that should be considered in terms of potential innovation for the traffic management industry.

The Internet-of-Things (IOT) is fundamentally re-imaging functionality through facilitating the interconnectedness of computer devices that are embedded into every-day objects for the receiving and sending of data. It is estimated that by 2020 there will be over 30 billion devices connected to the internet. This offers significant potential to the transport and traffic control sectors through the ability to underpin more intelligent transport systems and networks through both Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) options.

V2V technologies enable vehicles to communicate between each other, relaying positional information and road conditions, so they can theoretically prepare for near-future conditions and mitigate the chance of a collision occurring between them.

V2I technologies enable vehicles to communicate with a wide array of infrastructure for information that may not be readily available from other vehicles. This information may include traffic conditions, changed road alignments, lane closures, or other changed road conditions.

In addition to V2V and V2I the IOT provides an ecosystem for potentially low cost, highly tailored solutions to a range of common risks and problems. It is foreseeable that temporary workzones are sensorised to feedback information to stakeholders such that they are prevented from making errors.

Connected and Automated Vehicles (CAVs) are a rich source of research and development for large global technology and vehicle manufacturing companies, with the promise that vehicles will be able to drive themselves in a fully autonomous mode without the need for human intervention.

While there is some debate about the steepness of the adoption curve for such technology over time, many trials are being undertaken with the support of regulators, and the technology continues to develop to address real world constraints. In time, fully autonomous CAVs will be a feature of metropolitan road networks. Equipped with a wide array of sensors, CAVs could theoretically be programmed to recognise and act in a specific way around temporary workzones. With the removal of human error, safety risks would be expected to reduce significantly.

More broadly, the other technology trend that is occurring is the consistent reduction in cost of computing and sensing devices. This has the potential to bring developments such as digital traffic signage onto a more commercial footing over time.

MANY SAFETY INITIATIVES ARE BEING TRIALLED OVERSEAS WITH COMPANIES LOOKING TO ADOPT THEM SHOULD THEY BE FURTHER IMPROVED

Key Initiatives

A range of key initiatives have been set out below for consideration by industry and government. Each initiative has been placed within a timeframe to reflect its potential for industry implementation. These categories are:

- Immediate future (0-5 years);
- Medium to long term future (5-10 years); and
- Long term (10+ years)

For initiatives categorised within the immediate future, the technology surrounding them is available with products currently being used around the world. These initiatives only require backing from local organisations to be deployed locally and in many cases are relatively simple solutions.

Initiatives deemed to fall with the medium to long term future have a framework set out and are on the verge of being commercialised for industry entry, following a period of extensive trialling. A majority have begun trialling overseas with companies looking to adopt them should they be further improved.

Long term initiatives are not necessarily based on yet to be developed technologies, but rather assume the set of actions required to implement them may take significant time due to their scope, including considerations of policy and regulation.

Advanced Technology:

Theme/Initiative	Summary	Time Frame
Fatigue Management System	Wearable technology to assess if a worker is fit for work (or driving) before they commence shift	Immediate
Automated Trailer Hitching	Attach/detach VMS from a vehicle without exiting the vehicle	Immediate
TMA Driver Access	Making space in vehicles so drivers can exit on the left side into the closed lane	Immediate
Wearable Technology	Increase both health monitoring and the performance of workers through wearable technology	Immediate
Automated Early Warning System	Early warning signals so remedial action can take place before an accident occurs	Medium to long term
Mobile Gantry	Large portable gantries for use on major arterials and worksites	Medium to long term
Plant Proximity Controls	Pre-set sensor to determine objects in close proximity that can cause damage	Medium to long term
Intelligent Infrastructure	Technology that communicates to both humans and machines especially CAVs	Medium to long term
Digital/LED Signs	Increase use of linked digital signage for more accurate information with less maintenance required from workers	Medium to long term

Human Factors:

Theme/Initiative	Summary	Time Frame
Improved Signage Description	Increase information available to drivers through accurate signage	Immediate
Internet of Things Integration	Collaborate to supply real-time disruption information to drivers	Medium to long term

Compliance:

Theme/Initiative	Summary	Time Frame
Mandatory Drive Through Footage	Video surveillance to increase safety and legislative compliance	Immediate
Speed Enforcement/Feedback to Drivers	Speed feedback signs increase driver responsibility	Immediate
Auditing/Road Rental	Create funds for workzone safety auditing through new revenue raising channels	Medium to long term
Collection of Speed Data	Use of speed cameras in and around work zones.	Immediate

Safe Systems:

Theme/Initiative	Summary	Time Frame
Module Vehicle Barriers	Use of barrier systems at smaller workzones	Immediate
Mobile Barrier Trucks	Alternative barriers for large workzones	Immediate

Methodological:

Theme/Initiative	Summary	Time Frame
Rumble Strips	Cheap and simple solution to alert drivers to traffic change	Immediate AND/OR medium to long term
Mobile Operations Centre	A virtual operations centre to allow for real-time management of digital signage	Medium to long term
Automated Drop Deck Trucks	Automation of cone drop off and pick up	Medium to long term
Drones	Drones to remotely set up and manage workzones	Long term
Automated Traffic Planning	Automated planning system to remove risk of human error and authorisation delays	Medium to long term

Industry Structuring:

Theme/Initiative	Summary	Time Frame
Data Collection	Improved integrated data collection of crash statistics	Medium to long term
Training Methods	Virtual reality as a training tool	Medium to long term
Standardisation	National standardisation of road rules for drivers and workers	Long term
Faster Approvals Environment	Automation of the approvals process	Medium to long term
Pre-qualification	Expand prequalification requirements to all roadworks	Medium to long term

Advanced Technology Initiatives

Fatigue Management Systems

A common concern raised by industry participants who were interviewed for this report was fatigue. Fatigue is probably one of the most significant factors contributing to incidents in the workzones. Fatigue leads to dangerous symptoms such as slowed reflexes, impaired decision making and judgement, impaired hand-to-eye coordination, blurry vision, short-term memory problems, poor concentration, hallucinations, reduced ability to pay attention to the situation at hand and low motivation. A survey conducted in 2013 found that 35.6% of all crashes were fatigue related, demonstrating the significance of the issue.

Fatigue Science, a leader in the field of fatigue research has noted that Australia is one of the leading countries in fatigue risk management, due to the vast distances and minimal infrastructure between cities, especially for the trucking industry which is at high risk of fatigue related incidents. They also note that not managing fatigue can be extremely costly for the business in terms of cost incurred from injuries or poor use of the tools of their trade, as well as relationships with other companies due to the image of poor employee management.

Currently, the only way that fatigue is being combated in the worksite is through policies. In Queensland the State Government enforces that there must be set work and rest hours, work diaries, fatigue management accreditation schemes and a clear chain of responsibility when driving heavy vehicles. However, policy-based measures such as these rely heavily on the responsibility and integrity of employees.

There have been a variety of innovations developed to determine fatigue in the workplace and when driving. There is EEG monitoring (monitoring of brain waves), in-cab driver monitoring (through multiple cameras to monitor body movements such as eye movements and head nodding), psychomotor vigilance tasks (PVT) (such as reaction speed testing), and telematics analysis (monitoring steering inputs).

Nissan, for example, has implemented technology they call “Driver Attention Alert” which monitors the telematics of the vehicle and provides a visual and audible alert when the driver may be drowsy or distracted.

However, Fatigue Science notes that these sorts of technologies are “Reactive” in that they detect fatigue once the physical symptoms of fatigue appear, instead of predictive, where fatigue is detected ahead of time.

There are predictive systems under development harnessing wearable technology which aim to analyse a person’s sleep to determine when fatigue will occur, providing both advance notice for appropriate intervention, and root-cause treatment.

By equipping the entire workforce with wearable technology, it will be possible to determine who is and isn’t fit for work in hazardous environments on the day. It will also be possible to identify who needs a break if fatigued and who is suitable for overtime. It does however require a reasonable amount of sleep data for an accurate prediction, so policies would need to be instituted to ensure that the smart watches are worn for at least two nights prior to working (at the minimum).

This is a far more proactive approach to fatigue risk management, which has potential for adoption within the near future. The technology will most likely have to be supplied to staff however, damage and repairs can be subsidised by the workers depending on the cause.

Summary: Wearable technology to assess if a worker is fit for work (or driving) before they commence shift.

Automated Trailer Hitching

This technology seeks to keep the road worker in the safety of their vehicle. Alois Assfalg, a German inventor developed a patent for a similar technology in 1980. However, in that period it may have been considerably more difficult to sell this as a product as it would have needed significant skill and experience to line up the couplings.

Today, with a vast array of technology already being pre-installed into vehicles, including reverse cameras, it would be considerably easier to line up the couplings. The technology itself is not very complicated or revolutionary – it would just have to be developed in such a way that it is simple, robust, and reliable. Similar technology can be found on trains, known as multi-function couplers, as they also connect air lines and power.

Creating a system suitable for retrofitting to the traffic controller fleet consisting of utes and trucks would consist of taking what currently works for trains and adapting it for use with trailers.

An interviewee agreed this would be a good idea as this is one of the times when staff have the most exposure to risk besides the time when they are laying out cones. This would allow the driver to attach / detach the variable message signs (VMS) from the back of their truck or utility vehicle with the push of a button, without having to exit the safety of their vehicle.

Summary: Attach/detach VMS from a vehicle without exiting the vehicle.

TMA Driver Access

Currently TMA (Truck Mounted Attenuators) policy states that drivers are always required to be harnessed into the vehicle during operation. The reason for this is that there are several roles that the driver must fulfil, such as alerting the work zone when a dangerous situation occurs using the airhorn, and supervising the work zone.

As drivers are working when they are sitting in the cabin, they are entitled to the same working benefits that other traffic controllers are, like regular breaks. This however poses an issue. As the TMA is a large vehicle and is also a right-hand drive, exiting the TMA for a break can be a particularly hazardous exercise. This is due to the potential for TMA drivers to be opening the vehicle's door and exiting into live traffic lanes.

There is a relatively simple solution however. Excluding the option of switching the vehicle to a left-hand drive, the cabin can be modified such that all monitoring and controlling equipment is retractable or able to be moved out of the way.

This will allow drivers to move the equipment such that instead of exiting the vehicle from the right-hand side of the vehicle into potentially live traffic, they will be able move across to the left side of the vehicle and exit into the closed lane, presenting a much safer operation.

Summary: Making space in vehicles so drivers can exit on the left side into the closed lane.

Wearable Technology

Wearable technology has the potential to be a revolutionary addition to temporary work zone. There is a large variety of wearable technology currently under development in the technology sector, such as smartwatches, smart shoes, smart bracelets and wristbands, smart headphones, smart textiles and smart glasses.

Smartwatches have the advantage of replacing objects already commonly worn by many people in their day-to-day activities - watches. The location on the wrist is also very convenient as it sits over arteries relatively close to the surface of the arm. This opens several opportunities for smartwatches already being realised in the world - monitoring vital signs. In the traffic management industry, where traffic controllers are nearly always exposed to the extreme weather conditions of Australia, there are occasions when the traffic controller's health condition is at extreme risk. For example, heat stroke is commonly measured by core temperature. If smartwatches or a combination of smart devices can be adapted to accurately determine and predict heat stroke it could save a considerable amount of lives on the road. Team leaders would be able to monitor their team's health, and in the event that someone is at risk, let them take a break or go home for the rest of the day, mitigating the risk of persisting health problems.

Smart glasses are another type of wearable that has the potential to improve the temporary work zone, and are already being developed in areas such as the military for heads-up-displays and the medical industry for information overlays. The benefit of smart glasses is that they can provide information to users without overly distracting them or obstructing their vision. For example, traffic controllers would no longer have to look down at their mobile device or in-car entertainment unit to get directions to their worksite allowing them to keep their focus on the road. They would be able to have a map of their work zone displayed in the corner of their vision, so they can guarantee that demarcation is performed correctly. Alerts, warnings and notifications may also be able to be displayed that are issued by the team leader, allowing traffic controllers to focus on the road until something requiring their attention occurs.

These devices which all increase the amount of information about the situation and the personnel can be invaluable and may provide predictive and preventative behaviour management of traffic controllers and road workers.

Summary: Increase both the health monitoring and the performance of workers through wearable technology.

Automated Early Warning System

An automated early warning system could be a relatively cheap and effective method to give workers a little bit more time to react to an emergency. Making use of currently available and developing technologies such as image recognition and neural networks, RADAR or LIDAR, it should be possible to identify, within several kilometres, erratic driving behaviour stemming from fatigued or ignorant drivers. If a problem driver is detected and is likely to cause an incident, staff may be warned in a manner of methods such as a siren and prepare themselves for what may be about to occur.

Interviewees felt that for road workers a couple of seconds may be all that is needed to change a potential fatality into hopefully at worst serious injury, which could be reason enough to adopt this system.

Another significant issue was the risk that plant presents to roadside staff.

Whilst exclusion zones are implemented, it is not always possible to stay outside the exclusion zone.

Making use of this kind of “overwatch” system would allow drivers and personnel to be alerted when someone was too close to plant and were under significant risk.

This would allow employees to stop and reposition themselves to move out of the way before proceeding.

This technology is readily available and can be developed almost immediately. Computer learning is rapidly developing and can be used to identify traits and patterns in scenarios which result in injury and then help to prevent them. An example of such technology is currently in development by Vidur Prasad, a student at the University of Michigan. He is attempting to make use of computer vision and machine learning technologies to identify dangerous drivers on the road through traffic cameras.

Summary: Early warning signals so remedial action can take place before an accident occurs.

Mobile Gantry

Overhead signage is becoming more and more popular, especially on larger roads and highways. They provide motorists with a variety of important road information, from travel speeds to the time required to reach roads. The key concept behind having information on a gantry is that it can utilise space that is mainly untouched before reaching worksites. Large signs that are placed higher can be seen further back, alerting motorists further out without having to use as much signage.

Economically they would make sense on larger scale roads and longer work zones due to their size. Most portable gantries currently are too small for use on large roads but having a device that can be set up and manoeuvred with ease would be a great tool for a work zone.

Summary: Large portable gantries for use on major arterials and worksites.

Plant Proximity Controls

Sick, an intelligent sensor corporation, creates sensors for a variety of jobs and purposes. A particularly relevant range of products are their safety proximity sensors, which make use of LiDAR technology.

There are specially designed safety sensors available on the market today. These sensors can be modified for a specific resolution, to determine specific size objects that would trigger the sensor, e.g. for body size or an object significantly large enough to cause damage to the plant. As safety models, they have been tested to rigorous standards and can also be wired directly to the plant for it to shutdown should the sensor be triggered.

A recent and unfortunate incident occurred when a skid-steer driver was unaware that a traffic controller had tripped in close proximity to his vehicle, and ended up rolling over her leg, causing serious injury requiring the amputation of her leg from the knee. Retrofitting all plant vehicles which are exposed to personnel with this kind of technology will provide the necessary safety precautions to shut down or stop the vehicle if the worker is in dangerous proximity to the vehicle.

These kinds of proximity sensors have been successfully implemented in industrial applications such as production lines for when people get too close to moving arms or booms with great success, so there is no reason why these should not also be implemented into heavy machinery as there is so much more risk for human error and as a result, serious injury.

Summary:
Pre-set sensor to determine objects nearby that can cause damage.

Intelligent infrastructure

Intelligent infrastructure will be a core component of V2I integration and ultimately intelligent transportation systems. It is defined as roadside infrastructure that can communicate or provide information to on-board equipment on vehicles.

One of the significant needs for intelligent infrastructure is signage for autonomous vehicles. An issue given by Road & Maritime Services (RMS) was the failure of autonomous vehicles in determining the difference between yellow and white line markings. This is due to autonomous vehicles currently being unable to interpret unrecognised signs or scenarios. If signs could communicate digitally to vehicles to inform them of the changed road conditions ahead, and provide the required instructions directly to the vehicle, it will know to follow the yellow lines instead of the white ones. However, that does not mean a single antenna can be installed into the ground as there will still be human drivers on the road. Thus, signs need to be adapted to support both human and machine vision.

Some of the technologies that are currently under development are:

- Advanced Road Markings: modernised pavement markings that are both visible to humans and machines in any road conditions, which identify the correct lanes to travel in, differentiating between old and redundant lines with the new and current lines.

- Smart signs: modernised signage that are both visible to humans and machines in any road condition. They should be clear and simple so that vehicles can interpret the language and symbols as a human is able to. They could also have embedded information that only specific vehicle mounted sensors could interpret which could provide extra information to the driver such as detours, safety hazards and road work locations.

However, those technologies are not all encompassing of intelligent infrastructure. For example, a new, smarter edition of traffic cones could be produced. These would be specifically designed so that autonomous vehicles can clearly define the separation between the work zone and the thoroughfare. It could inform vehicles to slow down, or even provide the adjusted temporary work zone speed limits for that region.

As autonomous vehicles will be in operation soon, it is in our best interests to cater for them so that it is safe for all parties on the road, whether it be on a vehicle or on foot.

Summary: Technology that communicates to both humans and machines especially CAVs.

Digital/LED Signs

Variable message signs are increasing in popularity around work zones. There is an array of variable message signs currently on the market that are noticeable and significant on the roads. Most of the signs are attached as a trailer with an example of this being a VMS flashing ROADWORKS AHEAD.

Making these signs smaller and portable would be ideal as there would be no requirements for an added trailer. There are some other smaller type LED signs that flash variable messages on the market already that are used as radar speed signs. Radar speed signs have a 'proven ability to influence driver behaviour'. They have been designed to have highly visible LED display which warn drivers when they are over the speed. They also display simple graphics which may be a smiling face or check mark.

There are other portable smaller signs which are available and easy to implement for temporary traffic conditions such as LED illuminated signage for temporary traffic conditions that are solar powered.

Also, on the market are power portable digital signage that can be used beneficially on smaller scale sites as they are set up in minutes, have a limited footprint and don't have high shipping and storage costs. There are different sized screens ranging up to 75-inch displays that are positioned on a robust container.

These signs can be used at events also as there is plenty of room available for sponsors to place their logos.

A good way to use these signs is to link them up on a worksite through a main device such as an iPad, so that the workers on site don't have to manually change or cover each sign. This concept would work best on mid/long term sites that require multiple days of works. Not only does it inform drivers exactly when there are works going on, but it can help minimize the risk of people choosing to ignore signs that are providing false information about the worksite at that current time. The main issue currently would be the cost of maintenance as they're considerably more expensive than the regular sheet aluminium with plastic coating.

Summary: Increase use of digital signage for more accurate information with less maintenance required from workers.

Human Factor Initiatives

Improved Signage Description

In many states, a considerable amount of VMS does not present overly informative messages. They may show “ROAD WORKS AHEAD” but displayed information is at a minimum. These road works could still be several kilometres down the road from where the VMS is deployed, which can cause confusion and a lack of attention from drivers on the road.

A simple improvement is to include some sort of measure of distance for drivers, i.e. “ROAD WORKS AHEAD 2KM” to allay confusion and increase trust in the system. New South Wales already makes use of messages like these.

In the event of heavy traffic congestion, it helps to provide information to those stuck in traffic and has the potential to reduce frustration as people are informed that congestion is not due to other drivers or an accident.

Summary: Increase information available to drivers through accurate signage.

Internet of Things Integration

With the internet of things (IoT) ever expanding, there is an opportunity to make use of increased interconnectivity to improve safety at the temporary work zone.

An underexplored area is the vast amount of opportunities that Google Maps provides to traffic controllers. Should traffic controllers be able to accurately plot the location of their workzone in Google Maps, traffic can be rerouted away from the work zone to create less congestion and traffic, and less risk around the workzone.

Currently, only complete road closures can be reported to Google Maps. There is no method to report a temporary work zone that closes off a single lane or two. The only way that roadworks and road incidents are reported are through the sister app Waze, which is a communal map and road condition app also owned by Google. Arguably road works could be listed on Waze instead of Google Maps, but it loses a little bit of credibility and meaning when the reports are on a community platform instead of their flagship Maps program.

Google Maps is managed by the Sydney division of Google, and thus it should be relatively easy to develop a relationship and work together with Google to implement an effective system.

While State agencies do have databases of their planned roadworks, sometimes it is not all inclusive. This is because generally construction companies seek approval for work on a site for long periods of time (up to several months) such that they can work on the road at any time within that period that is convenient. However, they will generally only be there for a small portion of that time period such as one to two days. Yet the database may still state that roadworks will be occurring over the entire period when there is nothing occurring on the road.

A goal to be achieved from this is reliability and consistency. When notifications only occur when a worksite is existing, including set up and pack up, confidence is built and trust is gained in the system. Detours will be adhered to, congestion around worksites and ultimately the risk, will reduce.

Summary: Collaborate to supply real-time traffic disruption information to drivers.

Compliance Initiatives

Mandatory Drive Through Footage

For a more administrative approach to compliance, team leaders can be asked to provide a “video tour” of the workzone just after setting up, using the iPads they are equipped with, or a truck mounted camera.

If an incident occurs, managers will be able to virtually inspect the worksite to ensure that all rules were followed, and that the incident did not occur due to non-compliance.

This will also provide a deterrent for workers to taking shortcuts or not following rules as there is the possibility that any incident that occurs could be as a direct result of their actions.

A study on organisational behaviour found that there was an increase of over 90% in staff compliance when staff were being obviously recorded, providing reasonable justification for visual recording of the worksites.

The technology is already heavily developed and readily available, and can easily be integrated with a variety of the other surveillance and auditing technologies, providing a relatively cost-effective measure for worksite compliance.

Summary: Video surveillance to increase safety and legislative compliance.

Speed Enforcement/Feedback speed to drivers

Enforcing speed limits within worksites is an aggressive tactic to influence driver behaviour, although it can be protested heavily by the public as a “money grabbing” scheme. Currently in NSW the RMS (Road and Maritime Services) use point-to-point speed cameras to monitor the speed of heavy vehicles. It works effectively to lower speed over a sustained segment of road rather than just a particular spot. Overseas research has indicated that a “50 per cent reduction in fatal and serious crashes” occur using point-to-point speed cameras. Currently point to point cameras are only used for heavy vehicles on roads that are deemed to have “higher frequency of heavy vehicle crashes, heavy vehicle speeds” and other road conditions.

Providing point-to-point mobile cameras can become a much-needed revenue raiser to government regulators for funds to improve auditing and monitoring work zones. However sometimes they are lacking the resources and funds to allow for upgrades.

Providing speed feedback signs can help put the onus further on the driver as they can be publicly shamed for exceeding the limit.

Studies indicate that the greatest speed reductions from these signs occur shortly after the sign, so strategic placement of signs near work zones could help lower overall speed further out from a work zone. As they work most effectively temporarily, they could be of great use.

The equipment is out there, with companies producing simple and effective signs that can be implemented in traffic management plans. Products have been developed that don’t require the use of a large trailer. There are signs also out there that can record data as well as displaying driver speed.

Summary: Speed feedback signs increase driver responsibility.

Auditing/Road rental

According to industry-based sources, non-compliance is easily one of the biggest sources of risk seen in the work zone. They lamented that there were so many traffic controllers operating on the roads with set ups that were arbitrarily placed or deemed "good enough" by themselves. This creates considerable risk as the signage placed may not give drivers on the roads enough warning to slow down, may cause excessive congestion, or may not even give drivers a large enough taper such that they must merge dangerously.

If auditing is regularly conducted at worksites, there will undoubtedly be better compliance with the work zone safety rules. However, as with all initiatives this requires funding and is not necessarily high priority.

A simple solution can be proposed to this – identify another potential source of funding specifically earmarked for auditing.

Charging rental to traffic management and companies for time on the road and the volume of road closed is one of the ways this money could be raised. By funnelling all these funds raised back into each governing body, auditors can be trained and hired and from there, compliance can be enforced.

Understandably this may create barriers to entry into the industry, but it is a minor detriment to the amount of risk that compliance can minimise.

Summary: Create funds for workzone safety auditing through new revenue raising channels.

Collection of Speed Data

A very common method to enforce speed compliance is with speed cameras. This is proved through a study performed by RTS (now RMS), which studied the effect of speed cameras on speed compliance and crash prevention. They note that from their speed survey data in New South Wales there has been a considerable reduction in light vehicles exceeding the speed limit over the past 8 years.

The use of speed cameras to deter speeding in work zones is therefore a potential solution to help force compliance of speed limits. Understandably it may be very difficult to convince officials to allow fining with these portable speed cameras.

However, with the correct signage (e.g. speed cameras ahead), and with functional, visible cameras, these pseudo speed cameras could have a significant effect.

A by-product that can be gleaned from these cameras is speed statistics in and around work zones. Altus Traffic has a wide network of operations and being able to gather accurate and reliable traffic information across Australia may be very useful for future projects and studies, such as awareness raising for safety and risk to both commuter and traffic controllers.

It would be very simple process to retrofit a camera to a variety of vehicles within the fleet, as well as being relatively cost effective for the potential safety improvements and the awareness it may bring.

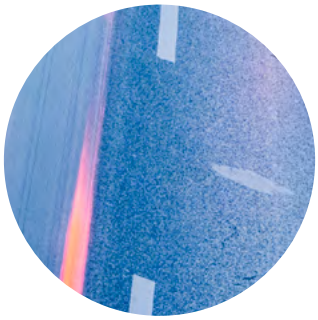
Summary: Use of speed cameras in and around work zones.

Safe System Initiatives

Mobile Vehicle Barriers

A difficult and challenging area of focus that needs to be addressed are smaller and less protected work zones. These work zones generally consist of two traffic controllers, a utility vehicle, and a collection of signs and cones. The traffic controllers have no physical protection from stray vehicles except for their truck, which in the event of a collision would not provide very adequate protection. To solve this, affordable light-weight crash barriers can be used as a primary defence against these vehicles, such as those used in hostile vehicle mitigation activities.

There are a variety of companies developing portable and modular vehicle barriers today. Their goal is to develop portable and practical approaches to vehicle barriers that do not require the use of the extremely dense concrete barriers, or the use of cranes to erect, whilst maintaining or improving on the effectiveness of the barriers.



There are small form-factor barriers rated for a 2.5 tonne vehicle travelling at 48km/h at a 90-degree angle of impact, suitable for most small work-zone requirements. There are also a variety of other portable vehicle barriers, rated for significantly heavier vehicles, which based on specifications, are all significantly better than concrete barriers.

For example, the small form-factor barriers can be used at the beginning of a worksite or at the end of a taper. They are considerably more compact and lighter than concrete barriers and water barriers, weighing in at roughly 27kg per segment, as opposed to concrete barriers which weigh around 600kg per metre. Set up times are also considerably shorter at several minutes and can be assembled by a single person.

The other, larger barrier systems are still lighter yet more effective than their concrete counterparts and can be used for alternative and more dangerous situations such as on freeways and for hostile vehicle management.

These kinds of barriers are being trialled across the globe, and are currently supported and approved by the ANZCTC (Australia and New Zealand Counter Terrorism Committee) as a temporary measure for hostile vehicle mitigation.

Summary: Use of barrier systems at smaller workzones.

Mobile Barrier Trucks

This alternative can be looked at mainly for high speed, large scale highways and freeways. Currently VicRoads has approved the use of the MBT-1 mobile barrier truck which has been set to use on roads for speeds 100km/h or greater. Mobile barrier trucks are currently the best and safest form of separation between vehicles and people. The barriers are giant steel units that are connected to a truck trailer. These units are expandable, so they can be made to fit larger scale worksites. They allow for safe works right up to the edge of the barrier, utilising space so more work can be done. A downfall is the overall cost, as they are much more expensive than other engineering controls or cones. A benefit is that the barrier truck system can work in conjunction with a TMA and can hold VMS.

Some alternatives that are currently in use include water filled plastic barriers. These are lighter and cheaper, with a downside being that they have larger deflection zones when hit unless they're tied into the ground.

Currently the safest option is the concrete barrier, but these are only used for larger scale sites as they require cranes to lift them into place.

The military have developed a type of barrier system which is quick to deploy but requires sand fill. This could be an alternative for larger scale projects or even act as a crowd control barrier as it can be manoeuvred to suit corners and bends. The deployment of the system is extremely quick, with the only time-consuming part involving sand fill.

Summary: Alternative barriers for large workzones.

Methodological Initiatives

Rumble Strips

Rumble strips are a cheap and simple solution being used around the world already. Although they are heavier than cones and deployment has been difficult in the past, there are currently new methods to use them.

Recently developed is a pick up/drop system on the front of a truck that is easy and relatively quick. These trucks allow for the automatic placement of more than one rumble strip which some other vehicles can't do.

Tests and studies have been done to determine the effectiveness of rumble strips on driver behaviour. A study in IOWA shows that a standard layout of rumble strips in a lane closure situation will help effectively decrease drivers speed prior to approaching the worksite.

This can also decrease end of queue accidents if vehicles recognise a sudden change in speed earlier as it causes drivers to become more alert to sudden changes of driving condition.

Despite most rumble strips being heavy and inconvenient to handle, there has been attachments developed for any vehicle including a ute, where the rumble strips can fold in half allowing for easier manual handling. Depending on the road speed, they can be spaced accordingly and manoeuvred easily. They can also be used as an extra lane divider providing extra insurance to any cone marking laid out.

Summary: Cheap and simple solution to alert drivers to traffic change.

Mobile Operations Centre

A prominent issue raised with commuters complying with speed limits is the reliability of the signage. In Victoria at least, there is often “road work ahead” signs with reduced speed limits when there are either no road works occurring, or road works have finished for the day.

When drivers repeatedly see road work signs and no reason to reduce speed, confidence in the accuracy of the signs diminishes, leading to drivers ignoring signs and speeding through work zones. Overhead gantries can be included in this issue with variable speed limit signs on them. Traffic controllers may have requested the speed limit to be reduced or for a single lane to be closed, but when works are no longer occurring, the gantries may not revert to the original speed limit.

A simple solution is to provide traffic controllers more autonomy. One method of doing this is equipping team leader’s iPads with site management software.

An example of this could be on a freeway road-side temporary work zone, which may include overhead gantries, digital signage, and VMS systems. Currently, the traffic controller would have to contact the roads authority to change the overhead gantry signs, walk up to each of the signs and VMS and either cover them or turn them off.

A virtual operations centre on their iPad would change this, as all the signs can be either turned on or off with the touch of a few buttons. Gantries can then be changed quickly without the need for a middle man, better reflecting the actual current road conditions.

When commuters trust the signs and believe that there are unpredictable conditions ahead, they are much more likely to comply with stated speed limits.

Summary: A virtual operations centre to allow for real-time management of digital signage.

Automated Drop Decks

Recently traffic companies have acquired newly innovated drop deck vehicles. These vehicles have been designed to achieve the intended purpose of reducing the amount of time traffic controllers are out on the road. It is manned by a minimum of three people, two who are harnessed into the deck on the back of the truck to lay out cones, and one as the driver. This provides some sort of safety to the traffic controllers whilst doing a job that would normally place them at considerable risk. However, this method only works for the body of the demarcation, not for the taper. The taper still requires the traffic controllers to dismount from the vehicle and manually place out the taper, losing the safety previously provided by the drop deck.

Whilst providing extra safety for the workers, the drop deck is a very basic and jury-rigged solution to the problem at hand. Staff are still required to manually place cones, and whilst their exposure to traffic has been reduced, standing on the tray of a truck is still not an extremely safe act.

A proposed solution is to automate the picking and placing of traffic cones. Verdegro, a company based in Switzerland has already attempted this approach with the M.A.R.S Automatic Cone Machine. This idea could be taken and improved upon. For example, of the existing automatic cone pick and place machines, none of them can place the taper automatically. All of them require a traffic controller to exit the safety of the vehicle to lay the taper. The reason for this is generally due to the presence of a truck mounted attenuator and variable message signs, preventing any cone manipulation from the rear of the vehicle. If a robotic arm like that used by garbage trucks with a few more degrees of freedom could be implemented, there is potential for cone placement to be a single person job.

Even if such a robotic arm would not be cost-effective, just automating the cone laying and retrieving process from the side of the vehicle would be greatly beneficial to the safety and overall risk levels of the workers.

Being inside the cabin of the truck in a five-point harness is much safer in a crash than being exposed whilst attached to a bar in the back of the truck.

Summary: Automation of cone drops and pick up.

Drones

Drones are an emerging technology with an enormous amount of potential for uses both discovered and undiscovered.

Heavy lift drones can have several possible uses in the traffic management industry, from remotely setting up sites to hoisting high visibility signage for mobile worksites. This could be extremely useful in mitigating risk in high risk environments such as winding, low visibility roads, as well as providing visible signage that can be observed from above the tree line, or tall trucks.

Heavy lift drones are still a relatively emerging field of drones, however there are some teams developing gas powered heavy lift drones. One team's goal is to develop a heavy lift drone capable of lifting 200kg whilst travelling 3 hours from Canberra to Sydney. It is a heavy lift drone such as this that may be able to fulfil the use cases for drones in the traffic control industry.

Drones however are not limited to just flying drones. The use of swarm robotics combined with autonomous rovers can be used to rapidly deploy demarcation and set up worksites. Purpose built rovers which have the strength and ability to lift cones and place them down such that staff do not have to exit the vehicle to place cones could be an invaluable asset to reducing risk in the work–zone. With the push of a button, traffic controllers would be able to mark out the entire work–zone without leaving the safety of their vehicle. Cones may have to be modified to make the process significantly easier, however since they are mass produced and easily modified it should be a cheap modification for the amount of risk it reduces. Now, researchers are researching and developing swarm technology to make exercises such as these possible.

It seems to be a consensus amongst those interviewed that one of the key issues to address is to minimise the time necessary for workers to be on the road. This is a potential solution to the problem, where in combination with a variety of other technologies such as accurate and automated planning and site mapping it will prove to be indispensable in reducing exposure to staff.

Summary: Swarm and flight drones to remotely set up and manage workzones.

Automated Planning

Many of the mistakes that occur in the industry are due to human error. Ideally, being able to minimise or remove entirely the decision-making process from people will remove a significant portion of activities that may have room for human error as the process of planning a work-zone is very methodical – drawing the map and placing the necessary signage and demarcation in the necessary places according to guidelines and rules.

This is where software excels with clearly defined steps and rulesets. Currently, best practice is to use Rapid Plan, a software developed by Invarion. However, this does not really "automate" planning processes as such, rather it complements the traffic planner, making their job faster, clearer, and easier to understand.

It still depends on the traffic planner to know their rules and regulations, and to make decisions based on that knowledge, leaving some room for human error.

Theoretically, it should be possible to develop a traffic control planning system relatively quickly (in 1-2 years). Given that geographical information such as roads and terrain are all provided in a relatively consistent matter, all map drawing and sign placement can become automated. Using image recognition will be able to verify whether information supplied, matches satellite imagery, providing greater validation of the supplied information.

Automated planning will reduce planning time considerably whilst making plans more reliable. Existing traffic planners will then only need to verify that plans are valid and provide correspondence with government agencies. As the planning process will now be bound strictly by the rules and regulations through software, government agencies will find it easier to verify, validate and provide memorandums of authorisation (MOAs), decreasing overall turnover time for MOAs.

The decrease in time to receive an MOA has several follow-on benefits as well. Currently the request for an MOA will be for a significantly larger time period than necessary, i.e. 30 days for a 1-2 job, as authorisation time can take up to 15 days. Should the authorisation time be reduced to 1-2 days at most, information across the board will be more reliable and in turn can be relayed to commuters as a reliable representation of future works.

This will also free up a lot of staff from government agencies, allowing them to attend to more pressing issues, such as unexpected circumstances like obstructions to sign placement.

Using an automated planning system will also ensure plans better comply with the work zone rules, making the work zone a safer environment for everyone.

Summary: Automated planning system to remove risk of human error and authorisation delays.

Industry Structuring Initiatives

Data collection

Data collection is an extremely important part of any type of planning as it allows forecasts and estimates, as well as trends and patterns to be determined. Currently, all data gathered with regards to vehicle crashes and collisions are only recorded via police reports for serious and fatal injuries. There is no log of minor or serious collisions where both parties left unscathed or with minor injuries.

A very simple and basic point of data to be collected that isn't already being collected is vehicle crashes on the roads.

The Australian Road Research Board (ARRB), a team dedicated to improving the safety of Australian roads, has been pushing for greater data collection on the roads for over a decade.

Information garnered currently from serious injuries and fatalities helps to identify black spots - locations where incidents occur often enough to warrant a change in traffic conditions in those areas. However, it does not cover areas where there may be frequent but not as serious collisions, which cost Australians $27 billion dollars in 2016.

Obtaining this data will provide valuable insights into a huge variety of issues which may help to benefit all parties involved. It will help to provide better and more reliable information for research and analysis, identify previously unforeseen black spots, as well as perhaps help to identify underlying reasons as to why crashes are occurring in specific locations.

Retrieving and collating the data will be a relatively straight forward method. As the majority of cars will have insurance of some sort, it will be a matter of creating standardised communication channels between insurance companies and a statistics company (i.e. the Australian Bureau of Statistics).

Regular reports with detailed but anonymised data can be collected from every insurance company and from there, a reasonably accurate and reliable representation of Australia's road safety can be compiled and further actions can be made to better the safety of Australians and Australians on the road.

Summary: Improved integrated data collection of crash statistics.

Innovative Training Methods

The methods of Traffic Control training have not changed very significantly over the course of the past decade. Training is still classroom based, which is extremely outdated. Eric Mazur, a professor at Harvard University, notes that in the passive, classroom style teaching often found in physics (reflected in this industry), students are unengaged with a significant lack in learning and retention of information. Through his extensive studies he determines that an interactive style of learning is far superior, achieving up to three times the "learning gains".

Learning from his experience the current teaching practices can be adapted and modified such that retention from these classes can be greatly improved, and ideally, more knowledge and better practices can be instilled into employees. This includes greater interaction between employees and mentors, as well as inspiring students to develop their own method to reach the solutions.

Alternatively, a more modern approach can be considered. Virtual reality training is currently being trialled by many industries as an effective and economical way of providing hands-on training that is almost impossible to replicate in the real world. It makes the kind of deep impression that classroom training on 2D monitors does not. Research has shown that learning retention rates with VR can be as high as 75%, versus just 10% from reading or lectures.

By ensuring that students will retain the information taught in these classes, and by imprinting on them the importance of compliance with the rules and how it affects both their own and their co-worker's safety, the overall risk level seen by the work zone can be reduced. Additionally, it can expose students to the atmosphere and environment found on work zones, which may help them realise if the job is not suited for them, due to the intimidating nature of highway and freeway traffic.

Summary: Virtual reality as a training tool.

Standardisation

A recurring theme from our research is the lack of standardisation in both areas of training and traffic control across Australia. One of the reasons for this is the wide dispersion of control of individual roads. Rules are made and passed on the federal level, which then progress to the state level, where each state adds their own ideas, and then finally at the local level where again, they add more components to the rules. This creates a lot of convolution when navigating between rule sets for individual regions, leaving a lot of room for mistakes to be made.

Ideally, there would be a single, comprehensive set of road rules and traffic management practices that govern the entirety of Australia. Standardisation of the road rules across Australia would be hugely beneficial to numerous parties, including the government, traffic control companies and commuters.

In terms of government benefits, the Belgian Electrotechnical Committee note that standardisation can result in greater safety, user friendliness as well as interoperability.

The research report completed by Standards Australia explains the economic benefits that can be achieved from standardisation, such as the diffusion of technological innovations throughout the industry, and with enough scrutiny, greater safety at a reduced cost. Traffic control companies will see benefits as they will be able to work together on developing a unified and effective training regime for their employees. Due to differing road rules across Australia, a traffic controller trained in one state is unable to work in another state without getting recertified to work in that state. However, this creates a margin for human error due to confusion, complacency, and old habits. A standardised road as well as training program will ensure that learning is identical and traffic controllers will have the freedom to move interstate and continue working safely, saving money for both employees and traffic control companies.

Road signs will also be able to be mass produced and relationships established with suppliers, lowering the cost for everyone involved.

Commuters will also benefit from a standardised road, especially those who travel interstate. The less reliance on drivers to interpret different signs on the road, the safer everyone will be. International travellers who may have had experience driving in a single state will no longer have to drive in unfamiliar road rules found in other states. Having road works with identical signage and identical setups will ensure that all drivers on the road are familiar with the conditions expected around road works, and in an environment where people's lives are at risk, standardisation is vital to minimise their exposure.

Austroads is currently undertaking a data harmonisation project whereby they are attempting to standardise the data formats of road information between road agencies such that it can be manipulated and used far more efficiently and effectively. We believe they have already completed a training harmonisation project, that is being adopted at a State and Territory level.

Summary: National standardisation of road rules for drivers and workers.

Faster Approvals Environment

A faster approvals environment will provide cascading benefits to the entire industry. Currently, in some states, the time from requesting to receiving a MOA ranges anywhere from 15-20 days, and if no response is heard by 20 days, an approval is assumed.

One method to improve authorisation speeds is to automate and streamline the process as much as possible. Although this may prove to be a significant initial investment, the payoffs in the long run may be priceless.

Direct channels to traffic planners can be established for urgent requests, such as unplanned circumstances like parked traffic or existing construction allowing approvals of plan changes immediately provided they are still within regulation. This would ensure that work zones are still guaranteed to be compliant, instead of traffic controllers just moving signs as they see fit since there is currently no method to efficiently seek approval for immediate changes to the work zone.

Alternatively, a (premium) service can be offered by road agencies for expedited response times to paying customers. This would provide an additional income stream for road agencies which can be put towards other departments such as recruitment and auditing. It would allow large or urgent projects which are generally not very flexible with their scheduling to obtain a far more responsive communications channel with road agencies and ensure safety and compliance for everyone involved on the road.

If approvals could be submitted and approved within a few hours, the information can be relayed to all parties as reliable and current information.

The information could be valuable not only to commuters but for mapping services such as Google Maps.

Companies would no longer need to seek approval for month long periods at a time as insurance, rather they can simply request a new approval should the need to adjust times for any circumstance. It would help to improve the roadwork monitoring service, as the times that the road works would be operating would be more clearly defined.

Improving the ability to predict congestion through mapping services will be able to benefit commuters, as the services would allow for detours to be planned for and taken, which will ultimately reduce risk.

Summary: Automation of the approvals process.

Prequalification

Prior to any companies being authorised to perform any sort of work on the road, they must first pass and complete their prequalification. Prequalification is currently only required for companies wishing to work on larger state and federally owned roads. For smaller, local roads, no sort of prequalification is required to operate on them. This is not ideal as it does not provide the government or the community with any indication that the company is capable of operating on the roads or complying with the rules to ensure adequate road safety.
A solution is to enforce prequalification on all companies wishing to create work zones on the road. Understandably not all companies will need to operate on large highways and so a tiered prequalification system can be implemented. For example, a three-level system can be employed. The first tier would allow companies to work on local, residential streets. The second tier would allow companies to work on main roads and arterials, and the third tier would allow companies to work on highways and freeways.

From there, additional prequalification criteria can be added. For example, for prequalification in Queensland, a certain degree of company stability (i.e. financial status) is one of the criteria, as you must be able to afford a variety of heavy-duty equipment, as well as compensation in the event of injury. Yet this may not be necessary for lower tiered companies not operating on suburban roads.

As part of the prequalification scheme, companies must also be subject to regular checks to ensure that the companies are still qualified under the prequalification criteria. However, industry sources find that these checks are rarely, if ever performed. This creates cause for concern as companies may become insolvent over the course of their operation, putting both stakeholders and their staff at significant risk should an incident occur whilst on the roads. It is unclear whether this is due to insufficient human resources or insufficient funding, however, to ensure that companies are still ensuring that they can protect their staff on the roads, compliance with the criteria should be enforced continuously.

Summary: Expand prequalification requirements to all roadworks.

James Pennings

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Next Steps

As you can see many of the initiatives are low cost, immediately possible and relatively simple to introduce but require co-ordination across the traffic management industry, construction and infrastructure industry and Government.

We invite all interested parties to contact us if they want to be involved in developing these ideas either by trialling new technologies or working together with the industry and Government to create safer work zones for our workers and all on the roads.

To get involved, please contact James Pennings at Altus Traffic:

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References

3M. (2017, October 6). What is Vehicle-to-Infrastructure (V2I) Communication and why do we need it? Retrieved from 3M: https://www.3m.com/3M/en_US/road-safety-us/resources/road-transportation-safety-center-blog/full-story/?storyid=021748d7-f48c-4cd8-8948-b7707f231795

Altus Traffic. (2015, November 2). Innovative Systems. Retrieved from Altus Traffic: https://www.altustraffic.com.au/Features/Innovative-Systems/

Anderson, J. (2014, November 17). The Benefit of Interactive Learning. Retrieved from Harvard Graduate School of Education: https://www.gse.harvard.edu/news/14/11/benefit-interactive-learning

Austroads. (2018). Road Data Harmonisation Project. Retrieved from Austroads: http://www.austroads.com.au/road-operations/asset-management/road-data-harmonisation-project

Barrier Group. (2015, November 25). Rumble Strips. Retrieved from Barrier Group: http://www.barsec.com.au/Traffic-Calming-Humps/rumble-strips.html

Beanland, V., Fitzharris, M., Young, K. L., & Lenné, M. G. (2013). Driver inattention and driver distraction in serious casualty crashes: Data from the Australian National Crash In-depth Study. Accident Analysis and Prevention, 99-107.

Belgian Electrotechnical Committee. (2009). What are the benefits of standardisation? Retrieved from CEB-BEC: https://www.ceb-bec.be/en/develop/benefit

Blain, L. (2017, March 2). SOAP drones variable pitch quadcopter uses petrol power for heavy-lifting endurance. Retrieved from New Atlas: https://newatlas.com/soapdrones-variable-pitch-multirotor-endurance/48202/

Centre for Road Safety. (2017). Speed Camera Programs: 2016 Annual Review. Sydney.

Department of Transport and Main Roads. (2017, July 25). Fatigue Management. Retrieved from Department of Transport and Main Roads: https://www.tmr.qld.gov.au/Business-and-industry/Heavy-vehicles/Fatigue-management.aspx

Designing Out Crime. (2017). Hostile Vehicle Guidelines for Crowded Places. Sydney: Australia-New Zealand National Counter-Terrorism Committee.

Devic, A. (2014, December 30). Drivers Confused by Electronic Speed Advisory Signs. Retrieved from Herald Sun: http://www.heraldsun.com.au/news/victoria/drivers-confused-by-electronic-speed-advisory-signs/news-story/0a2f7f05d37047ea6e91f07d4054d41d

Espacenet. (2017). Automatic decoupler for trailer and tractor - uses electromotor to raise coupling bolt on receipt of command signal from cab. Retrieved February 6, 2018, from https://worldwide.espacenet.com/publicationDetails/biblio?FT=D&date=19801218&DB=&locale=&CC=DE&NR=2924359A1&KC=A1&ND=1

etech. (2016). Power Portables. Retrieved February 6, 2018, from http://etechevents.com/power-portables/

Fatigue Science. (2016, November 2). Reduce workplace fatigue risk in industry and transport. Retrieved from Fatigue Science: https://www.fatiguescience.com/applications/industry-transportation-fatigue-risk/

Fatigue Science. (2017). In the Science of Sleep and Workplace Fatigue (pp. 32-43). Vancouver: Fatigue Science.

Fink, C. (2017, October 30). VR Training Next Generation of Workers. Retrieved from Forbes: https://www.forbes.com/sites/charliefink/2017/10/30/vr-training-next-generation-of-workers/#3f415e7264f5

Google. (2016, April 19). Sydney. Retrieved from Google Careers: https://careers.google.com/locations/sydney/

Hawkins, N., & Knickerbocker, S. (2017). Field Measurements on the Effect of Temporary Rumble Strips in Work Zone

Flagging Operations. Iowa: Institute for Transportation, Iowa State University.

Hesco Bastion. (2015, September 10). RAID. Retrieved from Hesco: https://www.hesco.com/products/defensive-barriers/raid/

Invarion. (2017, September 18). Features. Retrieved from Invarion Rapidplan: https://invarion.com/features/

JD Traffic Safety Systems (Director). (2015). Rumble Strip Pick & Place Machine [Motion Picture]. Retrieved from https://www.youtube.com/watch?v=ddy8wKnlgws

Jeffrey, B. (Director). (2017). Rumble Strip Best Practices (CA) [Motion Picture]. Retrieved from https://www.youtube.com/watch?v=tK4jk07IT_E

Jess Macy Yu, M. K. (2017). Chipmaker Nvidia's CEO sees fully autonomous cars within 4 years. Retrieved February 6, 2018, from https://www.reuters.com/article/us-nvidia-ai-chips/chipmaker-nvidias-ceo-sees-fully-autonomous-cars-within-4-years-idUSKBN1CV192?feedType=RSS&feedName=technologyNews

Mifram Security. (2016, September 5). Crowd Control & Vehicle Barriers. Retrieved from Mifram Security: http://www.miframsecurity.com/solutions/barriers/

Mnih, V., & Hinton, G. E. (2010). Learning to Detect Roads in High-Resolution Aerial Images. Toronto: Department of Computer Science, University of Toronto.

MS-012. (2009). Australian Standard Manual of Uniform traffic control devices. Sydney: Standards Australia.

National Highway Traffic Safety Administration. (2016). U.S DOT Advances deployment of Connected Vehicle Tehcnology to prevent hundreds of thousands of Crashes. Retrieved February 6, 2018, from https://www.nhtsa.gov/press-releases/us-dot-advances-deployment-connected-vehicle-technology-prevent-hundreds-thousands

Nordrum, A. (2016). Popular Internet of Things Forecast of 50 Billion Devices by 2020 is outdated. Retrieved February 5, 2018, from https://spectrum.ieee.org/tech-talk/telecom/internet/popular-internet-of-things-forecast-of-50-billion-devices-by-2020-is-outdated

Oriti, T. (2017, January 2). Government estimates road crashes costing the Australian economy $27 billion a year. Retrieved from ABC News: http://www.abc.net.au/news/2017-01-02/road-crashes-costing-australian-economy-billions/8143886

Pagano, A. (2017, April 22). Controlling Robot Swarms with Augmented Reality. Retrieved from IEEE Spectrum: https://spectrum.ieee.org/video/robotics/robotics-software/controlling-robot-swarms-with-augmented-reality

Prasad, V. (2017). Traffic Camera Dangerous Driver Detection. Retrieved February 6, 2018, from https://www.drunkdriverdetection.com/about-me

Queensland Goverment, 2010. Registration of TMR Prequalified Contractors and Consultants to deliver Traffic Management Services. [Online]

Available at: www.tmr.qld.gov.au [Accessed 8 February 2018].

Redpine Signals. (2014, March 5). 802.11p. Retrieved from Redpine Signals:

http://www.redpinesignals.com/Technology/802.11p.php

Roads & Maritime Services. (2017, August 9). Point-to-point speed cameras. Retrieved from Roads & Maritime Services: http://www.rms.nsw.gov.au/business-industry/heavy-vehicles/safety-compliance/speeding-camera-enforcement/point-to-point-cameras.html

Roads and Transport Authority. (2010). Use of Variable Message Signs (VMS). Sydney: Roads and Transport Authority.

Robert P. Loce, R. B. (2017). Computer Vision and Imaging in Intelligent Transportation Sytems (1st ed.). West Sussex: John Wiley & Sons Ltd.

Royal Industry Safety and Standards Board. (2015). Glossary of Terms. Retrieved February 6, 2018, from https://www.rissb.com.au/products/glossary/?f=m

SETON. (2016). LED Illuminated Signage. Retrieved February 6, 2018, from https://www.seton.net.au/signs-labels/road-signs/traffic-control-led-signs/led-illuminated-signage-supabrite-no-entry-450mm-dia.html

SICK Sensor Intelligence. (2015). S3000 Anti Collision. Retrieved February 6, 2018, from https://www.sick.com/au/en/opto-electronic-protective-devices/safety-laser-scanners/s3000-anti-collision/c/g329351

SICK Sensor Intelligence. (2017). MRS6000. Retrieved February 6, 2018, from https://www.sick.com/au/en/detection-and-ranging-solutions/3d-lidar-sensors/mrs6000/c/g448151

Slate. (2017). When is that breakthrough Technology Coming. Retrieved February 6, 2018, from http://www.slate.com/articles/technology/future_tense/2017/09/in_technology_everything_is_always_five_to_10_years_away.html

Standards Australia. (2013). The Economic Benefits of Standardisation. Standards Australia.

STRIVR. (2018). Immersive Learning & Training in Virtual Reality. Retrieved from STRIVR: https://strivr.com/

Today Tonight Perth. (2017). The Perth Grandmother who was run over by a bobcat. Retrieved February 6, 2018, from https://thewest.com.au/news/today-tonight/the-perth-grandmother-who-was-run-over-by-a-bobcat-bc-5647265965001

Traffic Calm Systems. (2017, June 28). 9 inch "Your Speed" Signs - (Value Sign). Retrieved from Traffic Calm Systems: http://trafficalm.com/9in-your-speed-signs-value/

U.S Department of Transportation Federal Highway Administration. (1999). What's A Work Zone. Retrieved February 6, 2018, from https://www.fhwa.dot.gov/publications/publicroads/99mayjun/workzone.cfm

United States Department of Transportation. (2018). Vehicle-to-Infrastructure (V2I) Resources. Retrieved February 5, 2018, from https://www.its.dot.gov/v2i/

Verdegro. (2018, January 25). Auto Cone (AC). Retrieved from Vedegro: https://www.verdegro.com/products/traffic/auto-cone-ac/23

VicRoads. (2012). Pre-qualification Guidelines. Worksite Traffic Management, 8.

VicRoads. (2012). Guidelines for the use of Truck Mounted Attenuators (TMAs). Melbourne: VicRoads.

VicRoads. (2017). Working within the road reserve. Retrieved from VicRoads: https://www.vicroads.vic.gov.au/business-and-industry/design-and-management/working-within-the-road-reserve

VicRoads. (2018). VicTraffic. Retrieved from VicRoads: https://traffic.vicroads.vic.gov.au/

Victoria State Government. (2015, June 29). Fatigue. Retrieved from Better Health Channel: https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/fatigue

Voxson. (2017). Traffic LED Signs - Radar LED Signs. Retrieved February 6, 2018, from https://voxson.com.au/traffic-led-signs/#sc-tabs-1517888928712

Wagner, J. A., & Hollenback, J. R. (2015). In Organisational Behaviour: Securing Competitive Advantage (p. 392). Abingdon: Routledge.

Waze. (2018). Waze. Retrieved from Waze: https://www.waze.com/

Wareables. (2017). 50 wareable tech gamechangers for 2017. Retrieved from Wareables: https://www.wareable.com/wareable50/best-wearable-tech-2017

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