Safe System complementary thinking on the Bruce Highway: a step change safety improvement

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(The Bruce Highway project was awarded a 3M Diamond Safety Award at the Australasian Road Safety Conference in 2015. This report provides details of this award winning project and the impact it has had in improving road safety and saving lives).

Introduction

One of the traps often confronting road safety engineers is a project level solution with an improvement focus directed solely on the '*here and now'* and without considering the contextual longer term asset management implications. Naively hoping that funding will match the requirement to complete all projects to the same standard of treatment will lead to increases in crash rates at other locations with marginal, at best, improvements in safety to the network overall.

Furthermore, when designers or consulting engineers are charged with designing a project without the correct direction or network-wide context, the result will be an inconsistent network comprising project driven standards or a network vision which will never be met. A project manager or project designer is not in the right position nor has the information at their disposal to fully understand the context to make the right decision for driver consistency and for an achievable total network solution. How can the right direction be provided?

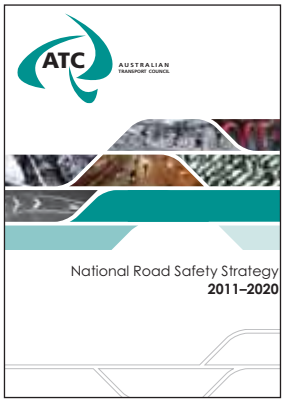
This paper provides a comprehensive approach to address this question. The approach has been implemented on the Bruce Highway in Queensland from the planning undertaken in 2012 with the early signs showing a significant step change improvement in performance. The photograph shows the completion of the first project on the highway.

General

The Australian National Road Safety Strategy 2011-2020 (NRSS) has set targets for a 30% reduction in the number of fatalities and serious injuries over the 10-year timeframe. It also indicates that the rate of achievement made up until 2010 has slowed in recent times:

"… the overall performance [of Australia] in recent times has not kept pace with the achievements of other developed countries, and there is a need for a major shift in thinking by governments and the community." [Refer NRSS 2010-2020 page 11]

In more recent times, it is getting increasingly more difficult to achieve safety improvements via the traditional safety treatment processes. For example, the "Black Spot" approach through the bottom up identification of problem locations is not seen to deliver the step change in performance that is required. Also, as each site is treated, this generates two more higher risk interfaces with untreated sections and therefore promoting an elevated crash risk at each inconsistent interface. Analysis of crash performance suggests that crashes move to the next worst location due to the level of *inconsistency* of the road.



As most of the "low hanging fruit" have been addressed at crash locations through these programs, new approaches are needed. The NRSS explains:

"Although black spot programs do a good job of fixing problems in specific locations with poor crash records, the majority of crash sites are widely dispersed across the network."

The NRSS goes on to say that a new approach of treating high risk sections is proposed. However, both of these treatments (black spot and high risk sections) can be considered reactive (bottom-up) problem driven approaches. These solutions are implemented with the

knowledge that it is only time before crashes will occur at other locations/sections.

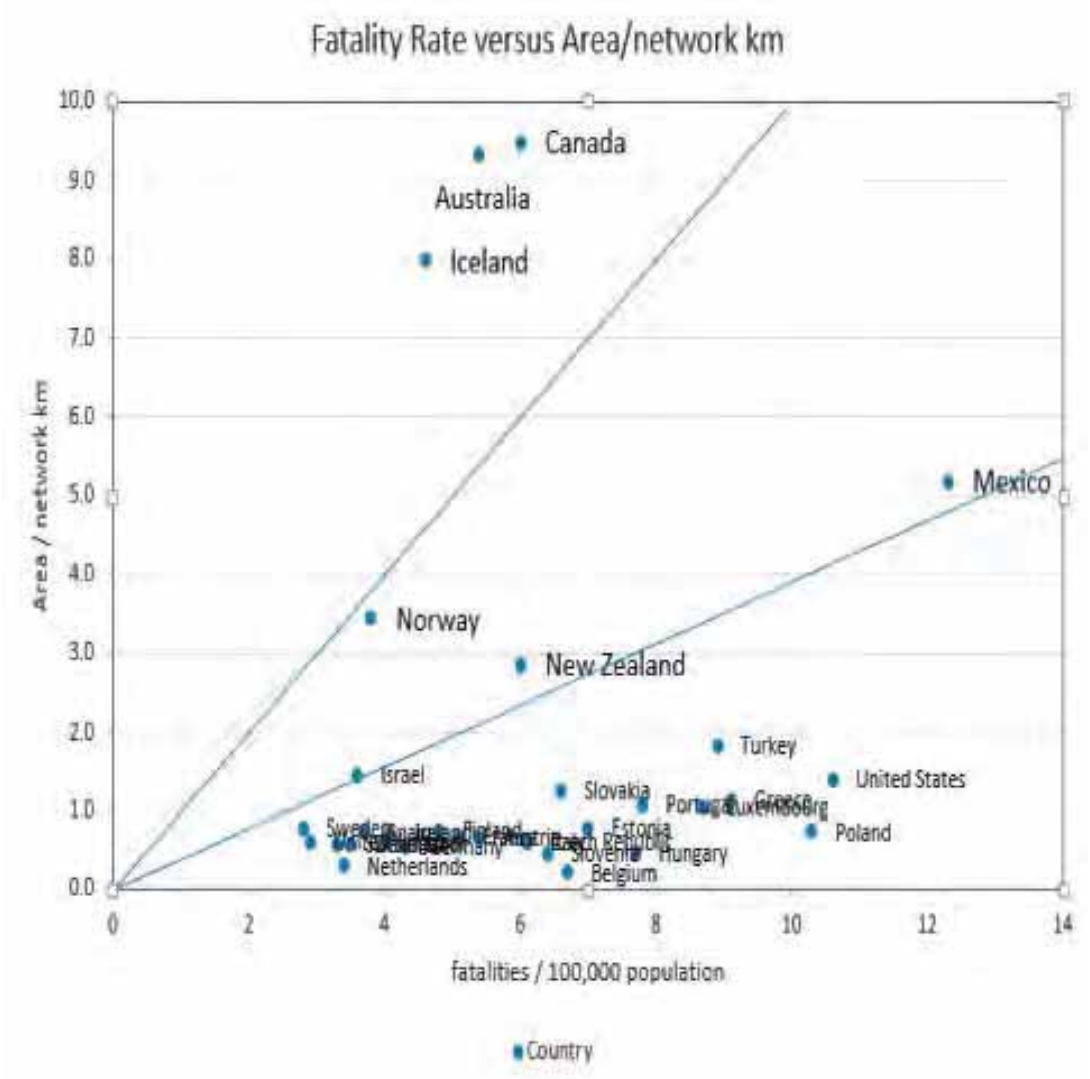
Experience suggests that by reactively treating historic crash locations, only a limited benefit will be realised. A model treating location by location may help to contribute to the 30% reduction target set under the National Road Safety Strategy 2011 – 2020 but will not achieve the step change required to meet the anticipated 50% reduction target set by the United Nations or the *Vision Zero* target.

A truly proactive means to address the problem is to consider a total network implementation through vision standards for road stereotypes. This relies upon the design practices moving upstream to the network planning phase so that network level design analysis is undertaken (rather than being solely applied to project design) to ensure the best decision is made for that specific network stereotype.

Also, with the removal of the non-feasance rule, road agencies no longer have immunity from legal claims arising from not knowing of road deficiencies. Therefore, a comprehensive assessment approach would be expected to mitigate legal risk on a consistent basis and not just treating past crash locations. Such an approach has been applied on the Bruce Highway. This work has led to many outstanding results and is described in the sections which follow that detail the findings.

Australian and New Zealand Context

The NRSS [page 53] emphasises the "need…to find and apply cost effective and innovative solutions". With Australia and New Zealand having some of the most challenging demographics (see Figure 1) with long lengths of road outside urban areas, corridors supported by low population density, and roads in areas with limited local construction industry support, smarter approaches to better mitigate the challenges of distance and delivery efficiency are required. The learning from the Bruce Highway implementation across six key principles will be outlined to complement existing safe system practices to address this challenge.



(Figure 1. Source OECD 2013 traffic data and WHO 2013 road safety data)

Recent Experiences

Some specific and fundamental changes in practice on the Bruce Highway over the last three years has led the way to rapid implementation of treatments to bring about this change in performance. These benefits come through a change in organisational thinking and a shift in decision making from the context of project management to network planning and programming with road design decisions being critical in these earlier phase of road system management.

The initiating concept and prime objective of this strategy was to develop consistent network-wide standards by balancing crash risk for significant components and which are also matched to the likely investment profile. This approach, shown by Figure 2, was developed to guide the strategy and planning completed in 2012.

The application of this objective relied upon the integration of disciplines or specialist practices as a necessary and mandatory prerequisite to truly maximise the benefits through a safe system. More detail on these disciplines is provided in the following Network-wide Strategy section.

This led to a significant change in thinking when compared to traditional approaches. As a means to simply communicate this concept, provocative statements have been developed to emphasise the necessary change in thinking and are included in Attachment A.

Through the Bruce Highway implementation, significant benefits have been realised by motorists (see Figure 3) showing the reduction in fatalities as the new type cross section has been rapidly implemented over long lengths of highway and with relatively little initial investment.

This was only possible through a concerted effort to integrate design, safety, asset management, network analysis and delivery thinking from the earliest phase of network-wide planning. Also for noting is that this task of planning to set practical and affordable network-wide standards is not undertaken by many road management jurisdictions.

While implementation has now slowed with higher investment costs per km to be incurred for the balance

Figure 2. Balanced risk strategy

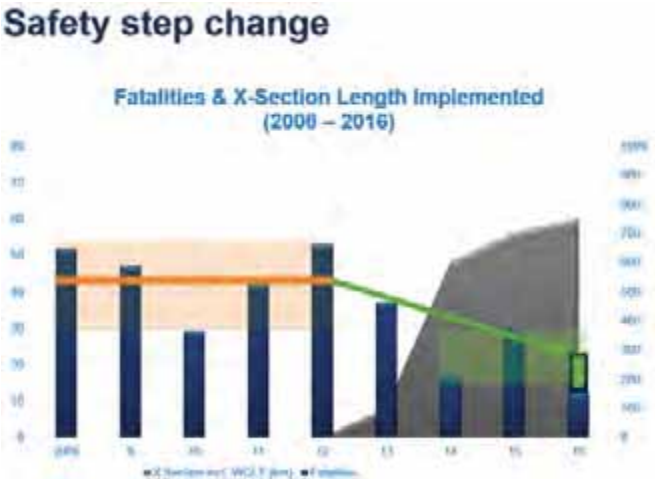


Figure 3. Step change Bruce Highway implementation

of the highway and for the remainder of the ten-year investment timeframe, only a limited safety-focused investment of less than $15 million has been needed to implement the majority of the safety focused treatments to date. This is primarily due to the balanced approach to crash risk together with a tempered but engineered intervention standard.

A number of basic principles have been derived from this work which are complementary to the current safe system direction and which provides further refinement and constraint to ensure the best outcome is achieved for the (whole) road system. These principles and the associated necessary change in thinking is emphasised in Attachment A through the use of some proactive and challenging statements. The change in thinking is summarised below under six basic principles which will be outlined in the following sections:

1. Use a Network-wide Strategy
2. Set Realistic Network-wide Intervention and Construction Standards
3. Balance Crash Risk
4. Prioritise for Delivery Efficiency
5. Consider Risk Compensatory Influences
6. Focused Management of the Road System

Finding 1 – use a network-wide strategy

Network-wide focus

The findings suggest greater strategic control is exercised through a total road network strategy to maximise the beneficial outcome and to not leave the safety solution to chance through many decisions on many projects.

Strategy driven focus

The network-wide focus is a top down network strategy-driven process to set a realistic network vision and not the aggregation of bottom-up driven solutions for problem sites. The specific vision standards are covered in the following section. Problem sites would automatically be included in the strategy.

Incremental improvement in stages

This top down strategy proactively sets standards to improve the total network in increments thereby consciously making deliberate decisions on the consistent standard for the infrastructure that will be met over the desired time frame. This is outlined further in the next section - Finding 2.

Integration of disciplines

Design, safe system, delivery and asset management disciplines were integrated as part of the network analysis. These related disciplines were integrated and applied in the following way:

- Network-wide planning to develop a strategy which brings together the various disciplines when trying to match the vision standards with a realistic funding profile.
- Application of a new concept of network-wide design where the key technical aspects of design are decided at a network level rather than at each project.
- Asset management to set the evaluation lifecycle for the strategy development and to accommodate the impacts of changes in standards for key components such as pavements.
- Program Delivery management practices to prioritise projects and achieve cost savings due to the realisation of free projects through the application of '*economy of scale'* and '*economy of location'* principles.
- Integration of road design and road safety practice to balance crash risk for key components which have a significant influence and sometimes a competing interest on the outcome.
- Network-wide economic analysis to demonstrate the benefits for the best total network option.

Road stereotype

One of the first steps is to identify the road stereotype which comprises more than just the traditional functional hierarchy classification. It comprises the function (such as arterial), characteristic (such as multi-lane) and traffic volume. These are important characteristics which influence the setting of standards for a "self-explaining road". The Bruce Highway is a high speed, highly trafficked, two lane/single carriageway national highway. It is important to recognise the stereotype of the specific network as the significant components (used in the analysis) will differ between stereotypes. While this approach has been applied to this major national highway stereotype, the same principles can be applied to other stereotypical environments such as low speed urban streets, multi-lane urban arterial roads, rural regional connector roads, high-speed highly-trafficked motorways, and hilly/mountainous rural secondary roads. Each of these components will require the setting of vision standards so as to balance crash risk. This is outlined in the following sections.

The Risk of applying a Black Spot approach to a network

If a blackspot solution is applied to networks with many deficient sections, every project will potentially create two new crash risk locations at adjoining higher risk sections. Also the blackspot treatments have traditionally applied a high level solution treatment at the location rather than a tempered network-wide solution.

Treating a whole network/link relatively quickly to a consistent standard creates a much lower overall crash risk. This means that the safest project driven solution which is not aligned to the network assigned standards will have implications on either network affordability or driver consistency.

Finding 2 - set realistic network-wide intervention and construction standards

Set both network-wide intervention and construction standards

Traditionally, a vision standard has been set for a network to describe the ultimate vision for the operation of that road. However, does this mean the total length of the road will be upgraded instantaneously?

To ensure a practical and realistic approach was applied to the Bruce Highway, the treatment process was clarified through the setting of both:

- A network-wide intervention standard (which is the trigger for enhancement work) and
- A network-wide construction standard (the completed construction standard for new work).

It is critical to the process that both these standards are identified to bring the road up to a consistent standard within a desired timeframe and to ensure the intervention and construction standards are relatively consistent. The ultimate vision is still relevant and can be explained as the standard which current and subsequent increments will meet. However, each increment is both realistic and practical and will be completed in a timeframe which links with the asset lifecycle and will avoid asset wastage or rework.

Road consistency

Setting such standards on a network-wide basis will reduce the variability in standards for a link/network, facilitate quicker implementation, mitigate the non-feasance legal risk, and provide greater consistency for the driver. This will also implement treatments in a way where the resulting road will be "self-explaining".

Also, for a rapid change to occur, an approach which brings the network up in completed whole-of-network incremental stages will result in a consistent driver experience over a shorter period and achieve total network benefits earlier.

Iterative approach

This strategy process is iterative and requires various checks on affordability, design limits, developing safety treatment options, balancing crash risk, maximising benefits, minimising risk, and considering complimentary flooding and efficiency enhancement projects to arrive at the best result for the network-wide stereotype (see the figure below). More on this will be outlined in the following sections.

Design competency in setting network-wide standards

The intervention and construction standard for each component is considered through a calculated and informed process relying upon a network-wide design exception or extended design domain to justify the decisions for the stereotype. It is not about naively accepting a traditional standard as a project treatment. This analysis process relies on a proficient design engineer, who also considers network and asset performance, to be involved in and approve the standard. The resulting network-wide analysis will thereby limit any decision for a standard within a contained project. This concept has historically been referenced as the project needing to "*strategically fit"* or align with the network strategy.

As an example, the considerations to support the Bruce Highway decision and gain approval of a "tempered" but engineered standard are shown in Figure 5.

Figure 5. Considerations to support the Bruce Highway decision

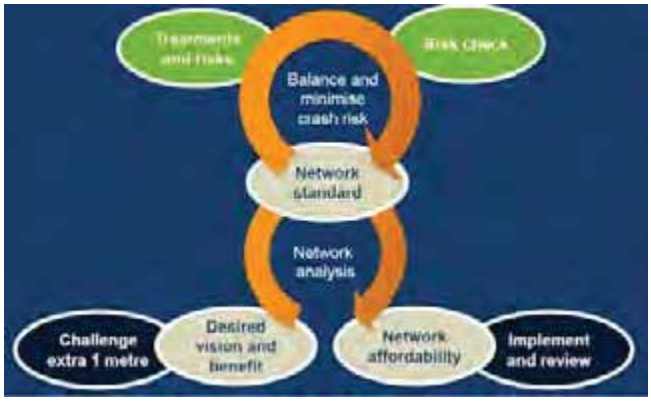


Figure 4. The iterative approach to the strategy process

As an example, significant savings from the application of the critically reviewed network-wide standards were achieved (estimated at more than $5 billion) to complete the Bruce Highway with consistent standards through:

- reduced lengths of higher cost treatments resulting from the network-wide intervention standard and
- reduced cost for new enhancement works through a realistic network-wide construction standard.

Identify the significant components

For a specific road stereotype, there is a need to focus on only the significant components which are those that will influence the balanced crash risk, the benefit and the cost so that insignificant components do not adversely or inadvertently alter decisions and compromise the achievement of maximum network benefit. For the Bruce Highway stereotype, the following significant components have been evaluated with clear vision and intervention standards:

- lane width, shoulder width WCLT
- intersection type
- seal width and pavement width
- formation width, average height and culvert widening
- batter height and slope
- obstructions and clearing
- overtaking lanes
- specific exceptions (such as substandard horizontal geometry)

In contrast, the significant components for an urban street stereotype would be different and involve a focus on components like speed environment, pedestrians, cyclists, traffic light phasing, skid resistance, traffic management devices, crossings etc. Of course, any treatment which has an insignificant cost can be applied to compliment the main objectives.

Evaluate the existing asset condition

The network strategy will comprehensively evaluate the gap from the intervention standard and the existing asset condition to determine the extent of work to be completed. The new work will be built at the construction standard. Of course the remaining asset life will also be considered as part of the treatment so as to avoid wasting remaining infrastructure life.

Funding driven reality

Traditionally, while one project may be solved with a fantastic solution, it is troubling that this nearly always means there are numerous other unidentified sites left untreated and with delivery presumed to be unachievable or not even known. The funding profile is to be considered for the typical asset life for any treatment when setting the vision standards (intervention and construction). This ensures that a realistic program can be implemented for a total network solution in a practical timeframe.

A further upgrading of the standard can be adopted in the next asset renewal cycle thereby enhancing the network in stages and aligned to asset lifecycle and realistic funding profiles. The strategy will also help to justify and support the call for funding. Also, the likely funding profile can be set at a slightly optimistic level so that the strategy may help in gaining commitments to an ongoing elevated funding profile, particularly when network-wide benefits can be quantified, defined and used to garner support.

Setting standards equated to star rating

There is also an opportunity for the standards used for various road infrastructure components to be equated to star ratings. In this way, decision makers during the planning phase can advise stakeholders of the star rated standard for the network. There will be significant effectiveness and efficiency benefits that can come from this initiative.

Finding 3 - balance crash risk

Treatments for all crash types

The history of crashes on the Bruce Highway indicated that 40% of crashes were head-on. However, designs traditionally focused on upgrading shoulder treatments and maintaining lane widths making the addition of cross-centreline mitigation treatments almost impossible due to the high costs involved with widening narrower seals and formations to meet the requirements of traditional standards.

Balancing crash risk

The solution to this was through balancing the crash risk of significant components. This meant that a calculated and risk assessed reduction in shoulder width and lane width made space available for a wide centreline to facilitate quick retrofitting to existing narrow asset formations.

As a result of this approach to balance crash risk for significant (influential) components, more than 500km of the Bruce Highway was able to be retrofitted with WCLT in two years, making it by far the longest length anywhere in the world. (Since 2012, more than 700km has now been completed as at January 2016.)

Traditionally, design practice had a keen focus on lane widths and shoulder widths with empirical crash modification factors (CMFs), however, there was no CMF for the most significant crash type of cross-centreline crashes. As part of this Bruce Highway strategy work in 2012, a cross-centreline CMF was deduced from available performance information. Table 1 summarises how the relationship between CMFs was balanced (at approximately 1.1) to achieve the optimum result.

Table 1. Balancing crash risk to achieve optimum results

Balance crash risk

Shoulder Width	CMF	Lane Width	CMF	C Line Width	Hazard	CMF (L shoulder)	AF
1.5 m	1.08	3.5 m	1.02	1 m	1.4 m	1.0	0.7
1.25 m	1.14	3.25 m	1.1	150 mm	0.55 m	1.32	1.0
1.0 m	1.2	3.0 m	1.3				

Consistency for road components

Also design guidelines have espoused the principle of *"road consistency"* which has traditionally been considered to mean a consistent user experience while driving along the road. This new term of "balancing crash risk" overtly creates a new concept of achieving consistency across a road and considers the crash risk of all components in a type cross section in order to maximise benefits. This can be extended to intersections, barriers, batters, and clearing standards also.

Finding 4 - prioritise for delivery efficiency

Economy of location and economy of scale

Delivery efficiency can be gained through both "economy of location" by bundling projects in the same vicinity or "economy of scale" by bundling work of similar type over a larger area. The benefits are realised through contractor practices including production efficiencies, camp establishment, stockpiling, materials supply and workforce travel. There are also benefits to the client and tenderers through reduced effort in contract management and tendering.

Prioritise for delivery efficiency

These delivery benefits consequently meant that the program realised free projects by bundling widening projects which were in close proximity to provide these opportunities for contractor efficiency. While this meant that projects with slightly lower BCRs were elevated in delivery priority, the net result was longer lengths of the highway were treated quicker. The benefits realised from free projects far outweigh the slight deferment of a notionally higher BCR project, given that the degree of accuracy in the economic analysis is limited anyway. It is not worth chasing the marginally higher BCR project at isolated locations and forego a free project through delivery efficiency gains.

This broader discipline of delivery is now mandatory for design engineers and road safety practitioners to integrate as part of the program and project management processes for safety program implementation.

Challenge scope creep

Project scope was challenged to ensure that objectives, treatment, standards and costs were maintained and that well intentioned project managers did not fall victim to the bias of scope creep. Program managers must ensure that properly set standards for the network which are defined in early planning processes align to those developed as part of the project management processes. Any deviation from this will result in an inconsistent network with a consequence of higher crash rates and lost opportunities from potential network-wide influences on driver behaviour.

A strategy used to remove the temptation for project managers to spend project funds (particularly contingency or risk allocation) on improved scope items is to remove budget allocation from projects. A component of the allocation is removed at project milestones during the project lifecycle such as business case, design or contract award when risks have been avoided, managed or mitigated.

Finding 5 - consider risk compensatory influences

Risk compensatory decisions

The reduction in fatalities on the Bruce Highway has been much greater than that expected as the proportion of the highway treated to date:

- is approaching 50% actual reduction over the full length (treated and untreated sections compared against
- a forecast reduction of 16% (for say a 30% reduction of the 50% length treated in two years).

There are three (driver risk compensatory) areas which probably have contributed to this:

- compensatory decisions by providing regular overtaking opportunities (Applied in Strategy)
- compensatory decisions due to reduced freedom from narrower lanes (Applied in Strategy)
- compensation decisions on untreated 150mm centreline sections (Not considered in Strategy Development)

It will be difficult to determine the relative contribution from each of these initiatives in reducing fatalities. Further work could be considered to determine the relative merits of these so that this can be considered for other stereotypes (plus serious injury statistics when data is available).

Overtaking risk compensatory decisions

While there is limited, if any evidence, to support overtaking lanes as a treatment to improve safety, overtaking lanes were a key feature of the Bruce Highway strategy for both travel time and safety benefits. The significant number of cross centreline crashes required treatment which mitigated the potential for head on crashes. This was considered as a possible treatment to reduce the anxiety of drivers who have not been able to find a safe overtaking opportunity when behind a slower driver.

The overtaking frequency (intervention standard) has been applied on the basis of three stereotypes for covering various traffic volume ranges (>4000vpd, >6000vpd, >8000vpd).

Lane width influence on drivers

Another aspect of the approved type cross-section is the reduced lane width. This reduction is thought to have a risk compensatory effect of drivers by providing 250mm

less width for vehicle tracking within the lane and thereby requiring greater attention. ATLMs will be rolled out along all treated sections in 2016 which will also provide feedback to drivers who either inadvertently traverse the lane lines or fall asleep.

WCLT risk compensatory decision by drivers

One of the not readily understood aspects of driving on a high speed, highly trafficked, two-lane single carriageway highway is the actual risk of oncoming traffic. The crash risk of having a head-on crash at 100km/h is the same as driving off the top of a 12 storey building. Drivers are complacent to this risk as no one would consider driving one metre away from the top edge of a 12 storey building at 100km/h.

The one and seemingly only proposition to answer this significant network-wide improvement in safety is that drivers are now perceiving the risk when driving on the untreated sections. This is believed to be due to improved perception of safety on the treated WCLT sections particularly when passing heavy vehicles. Anecdotally, after the first treatments were implemented, drivers could be seen to reduce speed (‘*taking foot off accelerator’*) at the interface between treated and untreated sections. Also, there have been many occasions where drivers have reported on how *“great”* the treated sections are and that they *“feel much safer now”*. The underlying assumption here is that the inverse applies and drivers are now being extra cautious on the untreated (existing) sections because they feel relatively unsafe.

Next steps

Some combination of these three propositions described as risk compensatory behaviour influences are the best explanation for the dramatic reduction in fatalities which is far-greater than the proportional length that has been treated. Crash reductions have occurred on the untreated sections as well as the treated sections.

Also, the Bruce Highway results have been compared with a baseline for comparison. The baseline was established using the performance information on the balance of the network to eliminate any suggestions that other broader Queensland initiatives (for example education or enforcement) were influencing the results across all networks. There has been no discernible change in performance contributed by other factors across the broader network with the only significant step change in performance realised on the Bruce Highway.

ACTION: 1. Assess benefits on untreated sections

Evaluate the network-wide performance of these three factors to understand the relative contributions, if at all, to the risk compensatory influence of drivers and the step change improvement in performance on untreated sections.

If total network risk compensatory behaviour benefits can be realised when significant lengths of a network have been treated (compared with site by site treatments), consideration is being given to retrofitting a 0.5m WCLT by reducing lanes from 3.5m to 3.25m (and leaving edge lines untouched) as the next step change initiative across all applicable rural roads. While narrower (than 1 metre) wide-centreline ‘*project-initiated’* solutions have not directly been seen to offer significant benefits to drivers, a network-wide application may have risk compensatory influences on driving behaviour. The ease of implementing a narrower 0.5m WCLT by simply reline-marking the centre-line is an opportunity for significant benefit.

ACTION: 2. Implement narrower (0.5m) WCLT

The introduction of a 0.5m WCLT should be further evaluated and comprehensively applied over a short timeframe to a specific road and compared to other roads in that stereotype group as a baseline.

There is also an interdependence between crash risk of components in that the crash risk profiles will change as a result of changes to adjacent components. Future research and evaluation is necessary to consolidate emerging thinking in this area and specifically the step change in performance from network-wide implementation for road stereotypes.

ACTION: 3. Establish network-wide planning practices

Develop network-wide practices to support road system planning for road stereotypes. This will include the collation of historic crash reduction forecasts and aligning these to road design practices to balance component risk.

The significant reduction in fatality rates found on the Bruce Highway has been considered as step-change compared with current theory. This relates to both the treated and untreated sections. Metrics for crash modification factors or crash risk deserve a review given these benefits achieved from WCLT.

ACTION: 4. Review WCLT safety risk improvement metrics

The results from the most significant WCLT implementation in the world should be evaluated to confirm historic crash reduction metrics for use by road jurisdictions. An additional output should include advice on risk compensatory influences on drivers when significant lengths are completed.

Finding 6 – focused management of the road system

Integration

One of the most challenging aspect of the earlier planning work was the integration of various disciplines as part of a sequence of planning steps. The integration of asset management, planning management, design management, delivery management and safety management was

necessary to achieve a successful engineering plan. The results would not have been achieved if these elements were not fully considered from the earliest planning phase.

Comprehensive

Analysis of all crash types, previous experience in achieving improved safety and having a focus of "leaving no stone unturned" were critical to getting the most out of every investment and achieving the best total network result.

Understand the complexity

The technology and engineering in road management in the 21st century is complex. It is important that decision makers do not succumb to naïve decision-making because it is seemingly just too difficult. The level of effort in getting the decision right in network-wide planning should not be underestimated. This is a critical ingredient to getting the best outcome.

Alignment over time

The concept of "strategic alignment" between the standards applied in projects to those designed as part of network-wide planning must be maintained. Again, jurisdictions which have complex organisational structures make this difficult and therefore rely on the influence of leaders in the organisation to maintain this alignment over time throughout the road system lifecycle from planning to program to project.

Safety outcome ownership

When the outcome of safety is clearly delegated to a specific team or unit, there is a high level of ownership generated. It is important that a single line of accountability is established so that team members own the result but are also empowered and supported to make the necessary decisions to improve safety. Organisations with complex structures where safety ownership is eroded due to dispersed line reporting arrangements does little to facilitate the meeting of objectives. In the case of the Bruce Highway, consistency of team members was maintained from planning through program management to program delivery for the total network which crossed many Regional and District boundaries.

Recommendations

Given the constraints of potential funding profiles and the variable pre-existing asset condition, the following six key principles have been followed on the Bruce Highway and shown to produce an outstanding step change in reducing fatal crashes: use a network-wide strategy; set realistic network-wide intervention and construction standards; balance crash risk; prioritise for delivery efficiency; consider risk compensatory influences; and focused management of the road system.

The combination of these objectives have facilitated accelerated retrofitting of the network with an unexpected and significant step change in benefits. This has been due to the likely generation of network-wide strategy approach, risk compensatory behavioural influence of drivers and the refinement of safe system complimentary thinking. The presentation of these findings through seminars and other forums is recommended (see Attachment B).

Attachment C summarises the actions requiring evaluation of the Bruce Highway to better inform the benefits of the practice if it is rolled out across Australia or the rest of the world.

In summary, road and transport agencies have a long term asset management accountability which obligates their decisions to be the best for the long term of the asset and the highest benefit to stakeholders. The Bruce Highway approach has delivered on this accountability with the following outstanding results:

- rapidly completing 500km of safety treatment in about two years
- saving approximately 50 lives in the short period from 2013 - 2015
- has delivered a step change in reducing the number of fatalities by 50%
- saving significantly more than $5b in total program costs when compared to traditional standard treatments

This Bruce Highway approach is best described as using an incremental approach to improve the total network, profiling likely future investment to set realistic visions, setting standards through an iterative process, balancing crash risk across significant components and prioritising projects for delivery efficiency. It has generated a step change in safety performance and demonstrated how a change in thinking to a network-wide focus can aid road authorities to move quickly towards *Vision Zero*.

Attachment A – Recent experiences – principles and findings

On face value, the learning from the Bruce Highway could be described as "provocative", however once explained, the reasons supporting this perspective are logical with the opportunity to realise significant benefits. If design engineers and safety practitioners want to save more lives quicker, the following provocative statements and reasons have been designed to change the thinking behind how safe system treatments are designed and developed.

Provocative Statement	Why	Recommendation
Develop a Network-wide Strategy to Balance Crash Risk		
1. Don't focus on providing the safest solution now for a project (similar to Blackspot programs)	• Untreated sections in the network will remain • Non-feasance immunity rule no longer applies • Creates two network inconsistent interfaces • Crashes move to adjacent locations	Apply the network-wide approach to optimise the total outcome and solve all the gaps for a timeframe matched to the asset lifecycle and the likely funding profile
2. Don't think that traditional safety treatment approaches will make a step change in safety performance	• Crash risk will not be balanced • Maximum benefits not realised	The integration of planning, design, safety, asset management and delivery disciplines are needed to maximise benefits (as road system manager)
3. Don't consider solutions through an independent project by project approach	• This misses the opportunity for benefits much larger • Inconsistency • Piecemeal • Reactive rather than Proactive • Inefficient • Not comprehensive	Develop a strategy to provide an aspirational network-wide incremental vision which can also support higher funding profile to complete a total network. The benefit from the whole network outweighs the aggregate benefit of isolated projects • Consistent driver experience • Self-explaining road • Driver risk compensatory benefit
4. Don't automatically attempt to provide the complete solution now	• For every project completed there will be many locations that remain untreated • Chasing the additional treatment (with a lower BCR) is costlier	Improve the total network in stages to match realistic funding profiles and aligned to asset lifecycles so infrastructure is not wasted
5. Don't focus on past crash locations	• Crashes will emerge on the next worst section or latent crash locations	Use network-wide crash risk evaluation to set consistent standards for only the significant and influential components
Set Realistic Intervention and Construction Standards for Road Stereotypes		
6. Don't adopt standards on a project-by-project basis	• Funding will limit what can be achieved • Untreated sections will remain • Inconsistent road will result	Adopt both an intervention standard and a construction standard for the network stereo type. Standards set on a network-wide basis to maximise benefits.

Provocative Statement	Why	Recommendation
7. Don't automatically use the best project standard	• Benefits not maximised across the total network • Higher cost with many untreated sections remaining	Network-wide standards which balance all significant road component crash risks and match the network funding profile through an incremental approach.
8. Don't adopt the same standard for all roads	• Gold plated standards for lower order roads or lower trafficked roads where benefits are difficult to realise	Establish Road Stereotypes (function, characteristic and traffic) where consistent standards are relative to the crash risk and road importance
9. Don't take a short or long term perspective	• Short term approach will not maximise benefits • Long term approach will never realise total network benefits	Develop standards to align treatments with the typical life of the asset components and the likely funding profile
Prioritise Programs for Efficient Delivery		
10. Don't automatically do the highest BCR project first	• Forego opportunity for free projects	Prioritise for improved delivery efficiency via 'economy of location'
11. Don't automatically schedule all work types at a location	• This will be at the expense of more beneficial components on other parts of the network	Consider Delivery Efficiency Delay component treatments with a small incremental BCR until complimentary work types make it cheaper
12. Don't allow scope creep of project standards because it is safer	• This will incur extra cost for the project, reduce opportunities to complete the full network earlier and minimise network benefits.	Maintain strategic fit of project standards during the delivery phases to that defined in the network-wide strategy.

Attachment B – Guideline development activities

Potential project activities for consideration:

1. Check Complimentary Safe System Thinking:
    a. Challenge the concepts contained here from various discipline and jurisdictional perspectives
    b. Reflect on the learning from other jurisdictions since this development in 2012
    c. Harmonise terminologies and approaches for relevance across all jurisdictions for safety and traffic engineers, asset managers, program managers, project managers, and design engineers
    d. Capitalise on any feedback from the safe system workshops being held in 2016/17
    e. Communicate this learning to the ANRAM project team for consideration as part of ANRAM support for network-wide analysis.
2. Develop a Business Case including a plan to develop or update relevant guidance materials in areas such as:
    a. The concept of road stereotypes (function, characteristics and traffic) and associated intervention and vision standards for links and networks
    b. Consider how a consolidated view can be presented for use by practitioners with information held in many different guidelines (such as RP&DM & Road Geometry Study for Improved Rural Safety, Safe System in the Planning Framework, and Safe System Assessment Framework)
    c. Specific learning relating to the wide centreline treatment, the practice of balancing crash risk and consequential risk compensatory behaviour developed through network-wide implementation (reference to Road Geometry Study for improved Road Safety)
    d. Consider the possibility of a consistent set of risk factors and benefit calculation for road designer guidelines and well as that for safety practitioners (ANRAM) and to establish a common, single language to relate design standards and safe system treatments with a risk factor with the level of intelligence supported in road design manuals
    e. Connecting safe system thinking with the practicalities of delivery in terms of the asset life cycle
    f. Engineering designer approval (CPEng, RPEQ) of intervention and construction standards in network planning – project design will need to strategically fit with this.