

# Advantages and disadvantages of reactive (black spot) and proactive (road rating) approaches to road safety engineering treatments: When should each be used?

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## Abstract

A fully funded safe systems approach entails roads being treated with barriers, pedestrian bridges, etc. as well as appropriate speed management to avoid road users being exposed to intolerable physical forces in crashes. The practical reality for most developed as well as low and middle income countries, is that this will not occur for some years. In the interim, we must select works and locations which provide the best road safety gains from limited resources. Significant controversy remains as to how to do this best, with the debate polarising around two alternatives: the reactive or black spots approach based on known crash history versus the proactive approach based on engineering deficiencies identified by various means of audit and road ratings. This paper presents a review of evidence and process analysis to comment on the advantages and disadvantages of each approach. The polarisation of the debate has led to absolutist answers of one option being always superior. The reactive approach works well only if reliable data on crash type, location and severity exist; it has the advantage of accommodating variation of crash history which may depend on non-engineering factors such as being several hours from a major city causing greater fatigue risk or proximity to hotels adding to drink-driving risk. Road assessments have the advantage of not relying on reliable crash data, which for many countries do not exist, and are the only option for new or re-engineered roads. Road assessments are currently more intimately connected to safe systems principles, although it is not clear that this is an inherent rather than historical advantage. This paper suggests that there are circumstances in which each approach is superior, and recommends a decision process for determining which to employ, in addition to consideration of a combined approach.

**Key words:** safe system principles, road safety engineering, black spot treatment, road assessments, proactive treatments

## 1. Introduction

One of the most powerful tools at the disposal of road safety practitioners is road engineering treatment. These can yield strong, demonstrable benefit cost ratios, and they constitute a key plank in the safe systems approach to road safety. The safe systems approach is working well for road safety (Mooren et al., 2009, Tingvall, 1998), and in consequence is increasingly being adopted internationally. The principles are endorsed by Commission for Global Road Safety (2008), and form the explicit basis of the *Australian National Road Safety Strategy 2011-2020* (Australian Transport Council, 2011), the *New Zealand Road Safety Strategy: Safe Journeys* (Minsitry of Transport, 2010), and the *Global Plan for the Decade of Action for Road Safety 2011-2020* (WHO, 2011).

There can be little debate that our roads are designed and built to standards which are unsafe for many groups of road users (Ernst & Shoup, undated;; and see Figures 1 for

examples, and Figure 2 for examples of partial safety treatments in high income countries). Thus, the benefits of well-chosen and well-designed road engineering treatments for safety are repeatedly found to be effective (Austroads, 2009; iRAP, 2012; Job, 2007). However, a critical debate remains in relation to the selection of locations for treatment.

**Figure 1: Unsafe road treatments:**

**(a) No end treatment on guardrail facing into traffic on an 80km/h speed limit road in Eastern Europe;**



**(b) Unprotected trees alongside a major high speed highway in Australia**

**Figure 2: Examples of unsafe road engineering, where solutions are readily identifiable**



**(a) High speed rural highway in the USA, with median barrier but no shoulder barrier despite numerous drop-offs and other hazards**



**(b) High speed rural highway in a Gulf Region country, with median barrier but no shoulder**



**barrier despite trees and other hazards**

**(c) High speed rural highway in NSW Australia, with median barrier but little shoulder barrier despite trees and other hazards**



**(d) High speed motorway (M1) in the UK, with median barrier but no shoulder barrier despite trees and other hazards**

## **1.1. Under-used Opportunity**

Appropriate engineering treatments of roads and roadsides are of indisputable value, and the failures of the transport system to deliver safety have been pushed by road safety advocates for many years in relation to roads (e.g., Job et al., 1989; Tingvall 1998) and vehicles (e.g., Nader 1965; Grzebieta & Reznitzer, 2001). Nonetheless, while improvements have undoubtedly occurred, broadly the problems remain on our roads, and only small percentages of the road networks of even high income countries have been retrofitted for safety to standards even approaching safe systems principles (See Figure 2 for examples of improved roads with median barriers on major highways which remain well short of safe system principles due to lack of shoulder barriers). The critical limiting factor in the deployment of engineering treatments for safety is the funding dedicated to such treatments by governments and often also by internal budget prioritisation given to safety treatments versus maintenance, and network expansion within road agencies.

## **2. Selection of locations for treatment**

Thus, in order to achieve the best road safety outcome, road safety practitioners must select the locations which will be treated. Broadly, there are two conceptually different methods for making these selections: proactive versus reactive analyses.

### **2.1. Proactive versus reactive processes for selection of locations for treatment.**

Proactive treatments involve processes by which the safety of a road is evaluated on the basis of the features of the road and roadside, without recourse to crash records. For example, a wire rope barrier is safer on a high speed road than unprotected trees, well designed round-a-bouts are safer than conventional intersections, and raised medians are safer than no median for locations where pedestrian cross. Various systems exist for evaluating roads on this basis, but the best recognised, best developed international system is the Road Assessment Program in its various guises (iRap, euroRAP, etc.). iRAP is in use in over 70 countries with over 500,000km of road assessed (iRAP, 2012).

Alternatively, the safety of a road may be assessed by its crash performance, though assessment of the number and severity of crashes which occur on that road. This is the basis of black-spot and black-length selection and treatment, common to many high income countries.

There is considerable discussion of the relative merits of these approaches. However, rather than being helpful in creating constructive decision making on the best method for site selection for treatment sensitive to each jurisdiction's circumstances, the debate has polarised to positions of the proactive approach being superior in all circumstances versus similarly strong claims for the reactive approach. The simple fact of being proactive is seen as advantageous because it does not require that crashes occur before a location is treated.

However, if crashes are already occurring, who not use this information, rather than make estimates about where they will occur when there are data showing where they occur? This paper suggests that there may be circumstances in which each approach is more appropriate, and that a combination of the two may deliver even greater benefits by capturing the strengths of both approaches in some circumstances. Table 1 lists the key points of advantage and disadvantage of these two approaches.

Table 1 highlights the key factors to consider in determining a method for assessment, keeping in mind that within a country or state, there may be circumstances where each is appropriate. A simple decision process could involve the steps in Figure 3.

**Table 1: Advantages and Disadvantages of the proactive and reactive approaches to selection of locations and road engineering treatments**

PROACTIVE PROCESS (ROAD ASSESSMENTS)	REACTIVE PROCESS (CRASH DATA BASED)
Relies on a valid assessment process, but does not require accurate crash data	Relies on valid crash data, including accurate location data and severity data
Is dependent on road features alone to predict crashes	Is able to accommodate crash history being affected by behavioural factors as well as road features (such as proximity to a hotel, or a 'fatigue zone' some hours from a major city)
Road engineering features may interact with the safety levels of the vehicle mix to create undetected variations in crash risk and crash severity	Variations in crash risk and severity due to the vehicle fleet are accommodated through the use of actual crash data
may be applied to new or re-engineered roads	Can only be applied to a road after usage when crash data are available
Is independent of statistical variations in crash occurrence	May be vulnerable to variations in crash occurrences
Is seen as more closely connected to safe system principles	Not seen as closely connected to safe systems, since crashes must occur before this process can operate
Evaluations based on re-assessment of the road rely on the validity of the assessment method and its correspondence to crash risk	Evaluations may be biased by category shift and/or regression to the mean, though methods for reducing these risk exist (Elvik, 2006; Job & Sakashita, 2006).

**Figure 3: Steps in determining the best method of assessment for selection of locations and treatment**

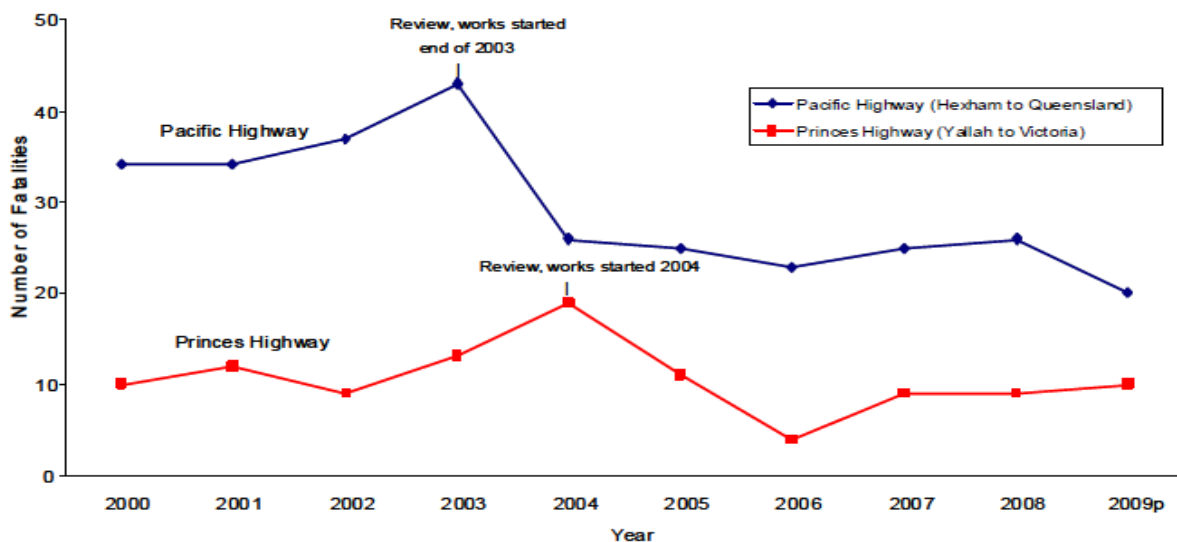
Question 1: Is the road new or in use for some time?	
In use for some time Got to Question 2.	New Use road assessment (e.g., iRAP), and go to Question 3
Question 2: Are sound and sufficient crash data available, including accurate location and severity data?	
In use for some time Use crash data method, or a combined method (see text below).	New Use road assessment, and go to Question 3
Question 3: Is there a significant risk of systematic crash variations through behavioural factors systematically related to location (e.g., stretches of the road near a hotel or licensed premise increasing the risk of drink-driving crashes)?	
Yes Consider these factors as well as road assessment	No Continue with road assessment

## 2.2. Combined processes

Greater benefits may arise from the combined use of crash data analysis and a broader assessment of the state of the road. Such a process has been developed and employed in road safety reviews of major highways in the state of New South Wales (NSW), Australia. These road safety reviews are not safety audits, in that they do not focus on the existing engineering standards and the extent to which the road varies from these, because the standards are often not enough for safety and minor variations from them can be a focus of audits even if these are not proving to be of consequence to safety. Rather, these road safety reviews are an innovative process involving: crash analysis, direct on road assessment of all fatal crash locations over the last 5 years, inspection of the entire highway, and evaluation focussed on the issue of what caused the death or injury not what caused the crash. The review team includes at least one engineer, road designer, psychologist, statistical expert, and police officer (see Roads & Traffic Authority of NSW, 2004 for an example report of a review, and see Job, 2007, 2012 for process details). From this process

of combined review of crash locations and the broader assessment of the entire road, a package of works is developed. From these reviews a package of works is developed and delivered. These reviews have been extraordinarily successful in delivering large and sustained reductions in fatal and all crashes. For example, with four years of post-works data now available, compared with 4 years of pre-works data, the first two reviews (the rural sections of the Pacific Highway and the Princes Highway, NSW) have yielded benefit cost ratios around 12, well above the benefits of the reactive black spot program operating in the same state. Fatalities on the Pacific Highway dropped from 55 per year to 25 per year when the works were complete, and fatalities on the Princes Highway dropped from 24 per year to 4 (see Figure 4 for details of fatality reductions, and see de Roos et al., 2008; Job, 2012). These successes point to the synergistic value of a review process which considers both crash data and a broader review of the entire road- combining the reactive and proactive processes.

**Figure 4: Reductions in fatalities associated with the works from the Highway Safety Reviews in NSW**



### 3. Conclusions and Recommendations

The safety benefits of roadside engineering treatments are substantially under-utilised, even in wealthy countries, due to lack of commitment of resources to road safety. Decisions regarding where to use the limited resources available are critical to delivery of the most safety benefit for the resources expended.

Rather than polarised debate regarding the use of either proactive or reactive processes for selection of works, this paper suggests that there are circumstances under which each is useful, and that processes which combine the two approaches (such as the highway safety review process developed in New South Wales, Australia) may capture benefits of both approaches to yield maximum safety benefits for the resources available.

### Acknowledgement and Disclaimer

Photos 1(b) and 2(c) are from the NSW RTA. All other photos are by the author. The views expressed in this paper are those of the author, and do not necessarily represent the views of the National Road Safety Council or the University of NSW.

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