ROAD SAFETY IMPACT OF REGULAR VEHICLE INSPECTION PROGRAMS

Original version

Prepared by: Jim Langford, Monash University Accident Research Centre
and Nicky Pronk, Monash University Accident Research Centre
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1. A BRIEF STATEMENT OF THE ISSUE

As motor vehicles age, some components will wear (for example, brake linings and tyres) and the structure of the vehicle may deteriorate. When older vehicles are compared to newer vehicles through assorted inspection programs, the former invariably have more technical defects (Elvik and Vaa, 2004). “If action is not taken to replace consumables and deteriorated components or if the vehicle is used beyond a certain level of structural deterioration it will become unsafe” (Gardner, 1995). Regular vehicle inspections are therefore seen by some jurisdictions as a means to reduce the number of unroadworthy vehicles and, thus, to reduce the overall number of crashes.

This paper addresses periodic vehicle inspection programs aimed only at the light vehicle fleet. It excludes inspection issues associated with goods, commercial or passenger service vehicles, road side inspection programs and also excludes inspection programs conducted for non-safety reasons (e.g. control of vehicle emissions).

2. CURRENT POLICIES AND PRACTICES IN AUSTRALASIAN JURISDICTIONS

New vehicles released onto the Australian market are required to meet standards specified in the Australian Design Rules for Motor Vehicles and Trailers, a set of safety requirements that are developed and administered by the Australian Government in consultation with state and territory governments and industry organisations. In New Zealand, new vehicles are required to comply with the standards specified by either the Australian, United States, European or Japanese design rules. New Zealand legislation also requires that all imported used vehicles be inspected and passed as roadworthy before being registered.

Once on the road, vehicles are required by law to remain in a ‘safe’ condition. Currently in Australasia, the policies and practices regarding vehicle inspection programs, as a means to maintain vehicle roadworthiness, vary widely:

- In the Northern Territory vehicles are required to undergo annual inspections alongside renewal of registration.
- In the ACT light vehicles are required to undergo an inspection when application is being made for original registration (never before registered in the Territory or seeking registration after the registration has expired by more than 12 months) in the Territory, on transfer of registration if the vehicle is over six years of age, or when the vehicle is issued with a defect notice. Heavy vehicles are required to undergo inspection for original registration, when the vehicle is 3, 5, 7, 9 etc. years of age, or if a defect notice has been issued.

- In NSW vehicles three years or older are required to undergo annual inspections alongside registration. Vehicles sold privately are also required to have an inspection prior to transfer of ownership.
- In Victoria and Queensland, inspections are required only upon change of ownership.
- In Tasmania, a vehicle is inspected if the registration has expired by three months or more or if police or transport inspectors (through roadside checks) consider the car unroadworthy.
- South Australia and Western Australia do not require periodic vehicle inspection.
- Vehicles in New Zealand are required to be inspected when they are being re-registered, when they have been modified in a way that may impact the safe operation of the vehicle, or following any change of use (such as a private car becoming a taxi). In addition all vehicles have to undergo annual inspections until they are six years old, with inspections required every six months thereafter.

3. A REVIEW OF THE RESEARCH

3.1 The association between vehicle defects and crashes

Research suggests that vehicle defects generally play a relatively minor role in crash causation. Looking at the major factors involved in crashes as judged by police, Gardner (1995) suggested that, generally:

- human factors have major responsibility for 80-95% of crashes
- environmental factors have major responsibility for 10-30% of crashes
- vehicle factors have major responsibility for 2-10% of crashes.

Vehicle defects as a probable contributing factor (based on interpretations of the police accident reports) figured in 10.5% of all fatal crashes and 4% of all other injury crashes in New Zealand in 2000 (LTSA, 2001). However, a general note of caution must be sounded in this context: police are not expert in the detection of vehicle defects and, for a variety of understandable reasons, are likely to under-report the true role of defects in contributing to crashes (Shiner, Treat, & McDonald, 1983; Vaughan, 1993).

Looking beyond conventional police reports, the Victorian Parliamentary Inquiry into Victoria's Roadworthiness System (Road Safety Committee, 2001) was given the following estimates, based on Police Accident Investigation reports for a sample of fatal and serious casualty crashes over the period 1992-1999:

- 1.1% of involved vehicles had defects that caused or contributed to the crash
- this increased to 2.7% if defects that *may* have contributed to the crash were included in the estimates.

The Victoria Police submission to the Inquiry stated that "the relationship between serious collisions causation and vehicle roadworthiness is not significant"[5]. Police also mentioned that over one-third of the 4511 inspected vehicles were deemed unroadworthy. In most cases, however, this had no bearing on the crash - thereby supporting the claim that "vehicle defects, although often present, rarely (play) a role in the causation of accidents" (Environment, Resources & Development Committee, 2001).

The Police submission also indicated that the crash rates attributable to vehicle defects differed according to the type of vehicle involved. Data provided by the Victoria Police Accident Investigation Section for the year 1998 showed the following:

Table 1: Proportion of road crashes attributable to vehicle defects, Victoria 1998.

Vehicle type	Role of vehicle defects in crashes (% of all crashes):			
	Caused	Contributed	May have contributed	Total
Heavy	4.9	1.2	3.7	9.9
Light	0.8	0.4	2.6	3.9
Total	1.4	0.5	2.8	4.7

Source: Data supplied by VicRoads, correspondence reference no. AO72493.11, 21/11/2002.

Other estimates of the role of vehicle defects in crash causation submitted to the Victorian Inquiry were as follows:

- the Victorian Institute of Forensic Medicine, looking at a 10-year collection of vehicles in fatal crashes, claimed that 5.3% had defects and estimated that around one-third of these defective vehicles caused or contributed to the crash – representing less than 2% of all vehicles involved in fatal crashes;
- a Monash University Accident Research Centre report estimated that 1.3% (3/224) of fatal crashes that occurred from 1996-98 were directly attributable to vehicle defects, and in a further 6.7% (15/224) of cases, vehicle defects played a contributory role.

A recent Australian review conducted by Rechnitzer, Haworth and Kowadlo (2002) found considerable variation across studies regarding the extent to which vehicle defects contributed to crashes (see Attachment 1). However, looking only at studies that entailed in-depth inspections and formal investigations, it has been suggested that defects make a major or definite contribution in 2.9% to 4.5% of crashes – and make a possible contribution in around 12% of cases.

In summary, there is considerable variation between studies regarding the possible role of vehicle defects in causing crashes. This variation has a number of sources, particularly the different causal criteria that have been used (*definite* versus *probable* versus *possible* contributions). While it is beyond the scope of this paper to reconcile the different estimates, the weight of research opinion puts any definite role at around 5% of crashes or less, and puts a possible role at around 10%. It also needs to be stressed that these estimates relate to systems which commonly have a number of mechanisms in place to promote proper vehicle maintenance and roadworthiness.

3.2 Are periodic vehicle inspections associated with crash reductions?

Periodic vehicle inspection programs are widespread across both Europe and the US (Elvik and Vaa, 2004), as well as in some Australasian jurisdictions. However these programs vary widely in the stringency of the inspections performed, with the subsequent evaluations particularly of their impact on crashes also varying in quality. Thus, it is difficult to make generalisations from the limited research available, particularly as some of the findings are contradictory.

Looking first to Australasian research, a New Zealand study – based on a fleet of over 16,000 vehicles from a New Zealand township where inspections were conducted exclusively by the Ministry of Transport - found that a vehicle's probability of accident involvement increased over time following inspection (White, 1986). In other words, the evidence supported the hypothesis that a mandatory inspection has immediate safety benefits which diminish over time. The study also could not detect any interaction between age of vehicle and week of accident from last inspection.

Neither this study nor a later one by White (1988) was able to estimate the overall number of accidents averted through this system of vehicle inspections.

These studies were followed up when New Zealand crash data for the period 1991-1998 were analysed, to investigate the possible relationship between age of vehicle, involvement in a defect-related crash and the time since vehicle inspection. As found earlier, for all ages of vehicle, a vehicle's probability of defect-related accident involvement increased over time following inspection. However, these relationships only became significant for vehicles twelve or more years of age (Clough, 1999).

The Victorian Parliamentary Inquiry investigated crash patterns across the various Australasian jurisdictions and reached the following conclusions (Road Safety Committee, 2001):

- Australia States which have annual testing schemes have similar defect-related crash rates to Victoria and Queensland, which do not have annual inspections
- New Zealand, which has a high level of testing, experiences higher rates of vehicle defects in fatal and serious injury crashes than does Victoria.

The Inquiry Committee reported that they could find no compelling empirical evidence to support the introduction of regular inspection programs in Victoria. (In reaching this conclusion, the Inquiry effectively assumed that possible reporting differences across the various jurisdictions did not conceal true differences.)

This conclusion is supported by overseas research. Fosser (1992) conducted one of the more controlled pieces of research in Norway in 1986-90 where 204,000 cars were randomly assigned to one of three conditions: inspected annually over three years, inspected once over the three years or not inspected at all. Results showed that there were no significant differences in crash rates across the three groups, and that periodic inspections had no preventive effect on the technical conditions of vehicles in a system which also had roadside inspections.

As an overall summary of the association between vehicle inspections and safety benefits found in overseas research, Elvik and Vaa (2004, p.803)[1] concluded:

> Periodic vehicle inspection has no effect on the number of accidents for passenger cars and vans, which are up to 12 years old. A possible explanation for this result is that drivers adapt their driving behaviour to the technical conditions of the vehicle, and drive more carefully when they know that the vehicle has technical defects. Such behavioural adaptations are not very well known, but a number of studies indicate that they do occur. Another possible explanation for the result is that some of the technical defects identified by periodic inspections are too trivial to affect safety.

[1] Elvik and Vaa lamented that most of the studies were more than 15 years at the time of their writing. This situation does not appear to have changed: a comprehensive literature search conducted in early 2006 for the purposes of this revision failed to identify any recently published research into the association between light vehicle periodic inspection programs and crashes.

Attachment 1 shows a further overview of the main research activities in this area (Rechnitzer et al. 2002). The results are far from uniform, with vehicle inspections being associated variously with crash reduction, no changes in crash levels and increases in crashes. It has been suggested that these differences may be a result of methodological and statistical shortcomings as well as the influence of jurisdiction-specific factors such as other traffic safety measures, different driving environments and the varying stringency of the inspections (Road Safety Committee, 2001). In total, these results show that at the very least, there is no consistently demonstrable link between periodic vehicle inspections and crash reductions.

4. POLITICAL, SOCIAL AND OTHER FACTORS ASSOCIATED WITH VEHICLE INSPECTION PROGRAMS

Inspection programs inevitably entail substantial costs, the bulk of which are borne by motorists. For example, the Victorian Parliamentary Inquiry into Victoria's Roadworthiness System estimated that for the Victorian community, the annual cost of an annual inspection program for all 3 million light vehicles would be around $304m. It was further estimated that this cost could be offset by a maximum of $5m arising from possible road safety benefits.

Particularly for jurisdictions currently without regular inspection programs, these costs are likely to require clearer evidence of larger safety benefits if the inspections were to be accepted. On the one hand, the New Zealand studies previously cited, which suggest that the benefits are most marked for older vehicles, represent a first step in providing that evidence, particularly given the relatively advanced age of both the Australian and New Zealand light vehicle fleets. On the other hand, the amount of contraindicative evidence from elsewhere suggests that the New Zealand findings need to be corroborated on a more comprehensive scale before they can be used as a basis for introducing tests elsewhere.

It also needs to be recognized that periodic vehicle inspection programs may have other than safety benefits which also need to be included in considerations. For example, one of the main aims of the French vehicle inspection program first introduced in 1986 was to ensure that vehicle emission control systems were functioning effectively – to the point that subsidies were provided to encourage the de-registration of older, less efficient vehicles (Yamamoto, Madre and Kitamura, 2004). However, as noted by Elvik and Vaa (2004), the existing benefit-cost analyses which include both safety and environmental outcomes provide a mixed result: for some studies, the costs substantially outweigh the benefits, for others the benefit-cost ratios at least exceed 1.0.

Given the balance of evidence, jurisdictions with periodic inspection programs in place may find it difficult to dismantle them:

- in part because there is at least some supportive research evidence
- in part because the programs have face validity so far as public perception is concerned
- in part because the programs enjoy the support of some sections of the automobile sales and repair industry.

The most immediate option open to jurisdictions with inspection programs for maximizing safety benefits, seems to be fine-tuning some of the program components. For example:

- determining whether the inspections are to be regular or via roadside checks
- determining the frequency of inspections and for which vehicles
- determining precisely what is to be inspected
- determining who conducts the inspections

- monitoring the inspection system to ensure that road safety benefits are maximised and that disadvantages (e.g. unnecessary replacement of roadworthy components, non-replacement of unroadworthy components) are minimised.

5. CONCLUSIONS

Crash evidence suggests that vehicle defects do not play a major role in crash causation. Research on the efficacy of vehicle inspection programs is sparse and the results varied. The varied results are not surprising given the differences in the quality and stringency of the programs evaluated and in methods of program implementation.

The following assessment made in 1986 seems equally pertinent today:

> In practice, it has been difficult to demonstrate that vehicle inspection programs do in fact reduce the frequency of accidents due to vehicle defects. There are several reasons why this difficulty exists, including the possibility that such programs are ineffective, even to the extent of being counter productive. Another reason is that vehicle defects are thought to account for only a small percentage of all crashes. Hence, even if a vehicle inspection is highly effective in identifying and correcting vehicle defects the net result in terms of an overall reduction in accident frequency will inevitably (be) small (Heyworth & McLean, 1986).

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Attachment 1: Summary of findings from the articles reviewed by Rechnitzer, Haworth and Kowadlo (2002).

Studies examining the contribution of defects to crashes			
Study	Country	Findings in brief	Implications of findings
Vaughan (1993)	Australia	Brake defects have been found to cause accidents.	Vehicle defects can cause crashes.
Grandel (1985)	Germany	In 6.4% of passenger vehicle crashes, and 5% of two-wheeled vehicle crashes, defects may have contributed.	A small proportion of crashes are caused by vehicle defects.
McLean et al. (1979)	Australia	12 out of 68 crashed motorcycles were found to have defects. One was considered as definitely contributing to the crash. 11 out of 386 cars were found to have defects. Three were considered as definitely contributing to the crash.	A small proportion of crashes are caused by vehicle defects.
Treat (1977)	USA	Of all crashes studied in-depth, 4.5% had defects that definitely played a role in causing the crash, and 12.6% had defects that probably played a role in causing the crash.	Vehicle defects can contribute to causing crashes.
Haworth et al. (1997) (single vehicle crashes)	Victoria, Australia	3% of crashes were caused by mechanical defects. 37% of crashed vehicles unroadworthy.	Defects may cause crashes in some cases.
Haworth et al. (1997) (motorcycle crashes)	Victoria, Australia	Mechanical faults contributed to 12% of crashes overall. Mechanical faults contributed to 28% of single vehicle crashes, and 7% of multi-vehicle crashes.	Defects may cause crashes. Mechanical faults may result in more single vehicle motorcycle crashes than multi-vehicle crashes.
Duignan et al. (1996)	Australia	No results yet.	No results yet.
Fosser (1992)	Norway	There was no difference in the crash rate between cars that undergo PMVI (Periodic Motor Vehicle Inspection) and those that do not, in the same jurisdiction.	No difference in accident rate associated with PMVI. However significant level of random testing also occurs.
Asander (1992)	Sweden	There were less defects in the vehicle fleet (7-8% cars with serious defects scrapped), and a 16% decrease in road injury following the introduction of PMVI to Sweden.	PMVI associated with a decrease in the number of defects in the vehicle fleet. PMVI is associated with a decrease the injury rate.
NHTSA (1989)	USA	No difference in fatality rates between states with and without PMVI. Overall crash rate was higher in states without PMVI. This was true for older and newer vehicles. Crashed cars with defects reported as the contributing cause to the accident were higher in states without PMVI.	PMVI is associated with a reduction in the accident (but not fatality) rate, but factors other than PMVI may be affecting the accident rates. PMVI associated with a decrease in the incidence of defects in the vehicle fleet.
White (1986a)	New Zealand	The probability of having an accident is lowest immediately following an inspection, and then increases until the next inspection (10-15% if inspections are biannual).	The probability of having an accident decreases immediately after an inspection, then increases until the next inspection.

Studies examining the effect of inspection programs			
Study	Country	Findings in brief	Implications of findings
Berg et al. (1984, cited in Fosser, 1992)	Sweden	The number of cars in police reported accidents and the number of injury accidents declined after the introduction of PMVI.	The introduction of PMVI is associated with a decrease in accident and injury rates.
Loeb & Gilad (1984)	USA	PMVI reduces fatality rates (around 300 a year) and accident rates (around 38,000 a year), but not injury rates.	PMVI is associated with a reduction in fatalities and accidents, but not injuries.
Crain (1981)	USA	States with PMVI experienced higher accident rates than states without PMVI (not statistically significant). States with random inspections experienced the lowest accident rates.	Random inspections are associated with a decrease in accident rate.
Schroer & Peyton (1979)	USA	Inspected cars had 9.1% fewer accidents than uninspected cars for the first year after inspection. Those who returned for inspections at periodic intervals experienced 21% fewer accidents than those who had never had an inspection, and those that did not return approached the same accident rate as those who had never been inspected.	The probability of having an accident decreases immediately after an inspection, then increases until the next inspection.
Little (1971)	USA	States that introduced PMVI experienced a 5% greater increase in accident rates over time than those that had no PMVI, or those that had well-established PMVI.	Study concluded that other factors must be influencing death rates, and that it could not be seriously argued that vehicle inspections could be associated with increased death rates.