Speed Cameras: An Effectiveness and a Policy Review

by

David K. Willis
Senior Research Scientist
Center for Transportation Safety
Texas Transportation Institute
Texas A&M University System
3135 TAMU
College Station, Texas 77843-3135

d-willis@tamu.edu
979/862-6707

February, 2005

Revised and Updated May, 2006

Prepared under a FY 2005 grant from the Center for Transportation Safety

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TTI-2006-4		

4. Title and Subtitle	5. Report Date
Speed Cameras: An Effectiveness and a Policy Review	May, 2006
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
David K. Willis	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Center for Transportation Safety Texas Transportation Institute 3135 TAMU College Station, TX 77843-3135	11. Contract or Grant No.

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Center for Transportation Safety Texas Transportation Institute 3135 TAMU College Station, TX 77843-3135	Final Report
	14. Sponsoring Agency Code

15. Supplementary Notes:
This is a revised and updated version of a report originally completed in February, 2005

16. Abstract
The objective of this research was to: review what the research literature has to say about the role of illegal speed in traffic crashes; examine the role of speed cameras in reducing speeding; examine the safety effectiveness of speed cameras; and illuminate implementation issues that can “make or break” a speed camera program by gaining public acceptance for, or generating fierce public opposition to, photographic enforcement of speed limits.

The report concludes that speeding enhances crash risk and severity and that speed cameras reduce both speeding and crash severity. Implementation issues, however, are highly problematical, and a poorly implemented automated speed enforcement program can easily undermine public support.

17. Key Words	18. Distribution Statement
Automated Speed Enforcement, Speed Cameras, Photo Radar, Speeding	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Introduction

This paper has four objectives:

1) To review what the research literature has to say about the role of illegal speed in traffic crashes;

2) To examine the role of speed cameras[1] in reducing speeding;

3) To examine the safety effectiveness of speed cameras[2]; and

4) To illuminate implementation issues that can "make or break" a speed camera program by gaining public acceptance for, or generating fierce public opposition to, photographic enforcement of speed limits.

The Role of Illegal Speed in Traffic Crashes

It is clear from the research literature that driving at a speed that is greater than the average speed of free-flowing traffic increases crash risk (Stuster et al., 1998). Kloeden et al. (2001) found a statistically significant (p=.05) increase in casualty crash risk at every speed above the mean travel speed of traffic on rural roads with an out-of-town speed limit of 80 km/hr or higher in South Australia. Going further, they concluded that "… the risk of involvement in a casualty crash is more than twice as great when traveling 10 km/h above the average speed of non-crash involved vehicles and nearly six times as great when traveling 20 km/h above that average speed." They also opined, under a hypothetical scenario, that if no speed were above mean speed one could expect a 41% reduction in casualty crashes on these roads.

Violating speed limits, regardless of the mean speed of traffic, also increases crash risk. In a project examining crash risk on urban roads Kloeden et al. (1997) concluded that "In a 60 km/h speed limit area, the risk of involvement in a casualty crash doubles with each 5 km/h increase in traveling speed above 60 km/h." Stradling and Campbell (2002) confirm the relationship between speed limit violations and crashes, noting that, in a study of English car drivers, "Drivers who report having been penalized for speeding in the previous three years are

[1] The term "speed camera" applies to speed limit enforcement through photographic means. The term embraces "automated speed enforcement," "photo radar" and "safety cameras" when such cameras are used principally for speed enforcement and not for general security surveillance. Speed cameras include single site measurement devices, multiple cameras used in speed-over-distance (sometimes referred to as "point-to-point") measurement systems, and combined red-light/speed cameras.

[2] "Safety effectiveness" includes not only the reduction in speeding related crashes, if any, but also the effect of speed cameras on non-speeding-related crashes (e.g., rear-end collisions caused by sudden braking in advance of a speed camera).

more likely to report also having been accident-involved during that period" (35% with speeding violations had crashes versus 22% with no speeding violation).

Crash severity also rises with speed. "The relationship between vehicle speed and crash severity is unequivocal and based on the laws of physics. The kinetic energy of a moving vehicle is a function of its mass and velocity squared. … Because kinetic energy is determined by the square of the vehicle's speed, rather than by speed alone, the probability of injury, and the severity of injuries that occur in a crash, increase exponentially with vehicle speed" (Stuster et al., 1998). More recent research has quantified the risk of injury with increased speed through a Power Model (Nilsson, 2004; Elvik et al., 2004):

$$\frac{\text{Fatal crashes after}}{\text{Fatal crashes before}} = \left(\frac{\text{Speed after}}{\text{Speed before}} \right)^{\text{Power}}$$

Nillson suggests a power of 4 for fatal crashes; Elvik 4.5. Using 4 for an example, if the speed limit rises from 55 mph to 70 mph, the Power Model forecasts a 161% increase of fatal crashes (70/55 = 1.27; 1.27 x 1.27 x 1.27 x 1.27 = 2.61). For every 100 fatal crashes before there are 261 fatal crashes after. Lower powers apply for injury crashes of various severities.

Pedestrians are at particular risk of death or serious injury from speeding vehicles, with research estimating that 40% of pedestrians struck at 30 mph will be killed, as compared to 80% at 40 mph and nearly 100% at 50 mph (Leaf and Preusser, 1999).

In the United States, thirty percent of traffic fatalities in 2004 were speeding related (i.e., over the limit or too fast for conditions), with some states, such as Texas, having much higher rates of such fatalities (40%) (U.S. Department of Transportation, 2005(b)).

The Role of Speed Cameras in Reducing Speeding

Properly deployed, speed cameras reduce speeding. A June, 2004 evaluation of the United Kingdom's extensive network of mobile and fixed-site speed cameras concluded that, based on more than 11,600 speed surveys over the three year period from April 2000 to March 2003, "There has been a significant reduction in speeds at camera sites" (Gains et al., 2004). More specifically, this study found that the number of vehicles exceeding the speed limit dropped 71% at fixed-

camera sites and 24% at mobile- camera sites; that speeding 15 mph or more above the limit fell 80% at fixed sites and 28% at mobile sites; and that speed reduction was particularly notable in urban areas with lower speed limits (30 – 40 mph) as compared to rural sites with speed limits above 40 mph. An April, 2006 review by The Cochrane Collaboration (Wilson et al., 2006) of published research found that all but one of the studies reviewed showed reductions in speed after the deployment of speed cameras, with reductions ranging from 5% to 70%. The proportion of vehicles traveling more than 10 mph (15 km/h) over the speed limit fell 50 – 65%.

Similar evidence of the effectiveness of cameras in reducing speeding can be seen in data from the Washington, D.C. speed camera program presented in Table 1. Speeding violations dropped pretty steadily from 25.5% of vehicles monitored in the first month of the program (August, 2001) to 2.2% in March, 2006 (District of Columbia, 2006).

Other evidence of the effectiveness of speed cameras in reducing speeding comes from Australia (Anderson and Edgar, 2003) (New South Wales, 2003), British Columbia (Chen et al., 2002), and New Zealand (Keall et al., 2001, 2002).

Preliminary results from an evaluation of speed camera operation in New South Wales are especially impressive, as shown in Table 2.

Finally, in a 2002 evaluation of a hidden speed camera program in New Zealand, Keall et al. concluded that hidden cameras were significantly more effective at broadly deterring speeding than were visible cameras, but that both caused speeds to drop.

Table 1: Speed Camera Results from the District of Columbia

Changes in Aggressive Speeding
(Percentage of Vehicles Exceeding Program Threshold)

	Total Vehicles Monitored	Total (Potential) Violations	Total Non-Violations	% Vehicles Speeding Aggressively
Mar 2006	**3,108,666**	**69,848**	**3,038,818**	**2.2%**
Feb 2006	**2,735,983**	**55,747**	**2,680,236**	**2.0%**
Jan 2006	**3,052,137**	**78,796**	**2,973,341**	**2.6%**
Dec 2005	**2,606,343**	**81,483**	**2,524,860**	**3.1%**
Nov 2005	**2,509,141**	**76,268**	**2,432,873**	**3.0%**
Oct 2005	**2,159,301**	**53,822**	**2,105,479**	**2.5%**
Sept 2005	**1,764,196**	**55,825**	**1,708,371**	**3.2%**
Aug 2005	**733,743**	**22,324**	**711,419**	**3.0%**
July 2005	**703,346**	**25,843**	**677,503**	**3.7%**
June 2005	**918,115**	**30,113**	**888,002**	**3.3%**

May 2005	**907,299**	**31,016**	**876,283**	**3.4%**
April 2005	**1,123,398**	**34,941**	**1,088,457**	**3.1%**
Mar 2005	**1,452,934**	**44,326**	**1,408,608**	**3.1%**
Feb 2005	**1,231,731**	**41,142**	**1,190,589**	**3.3%**
Jan 2005	**1,153,359**	**38,566**	**1,114,793**	**3.3%**
Dec 2004	**1,388,941**	**55,276**	**1,333,665**	**4.0%**
Nov 2004	**1,281,533**	**51,340**	**1,230,193**	**4.0%**
Oct 2004	**1,296,038**	**51,800**	**1,244,238**	**4.0%**
Sept 2004	**1,290,537**	**54,407**	**1,236,130**	**4.2%**
Aug 2004	**918,702**	**38,450**	**880,252**	**4.2%**
July 2004	**1,397,610**	**61,133**	**1,336,477**	**4.4%**
June 2004	**1,337,262**	**58,243**	**1,279,019**	**4.4%**
May 2004	**1,325,568**	**62,271**	**1,263,297**	**4.7%**
April 2004	**1,395,229**	**65,077**	**1,330,152**	**4.7%**
Mar 2004	**1,428,557**	**80,502**	**1,348,055**	**5.6%**
Feb 2004	**1,005,785**	**63,618**	**942,167**	**6.3%**
Jan 2004	**814,037**	**56,519**	**757,518**	**6.9%**
Dec 2003	**993,811**	**53,174**	**940,637**	**5.4%**
Nov 2003	**951,227**	**56,613**	**894,614**	**6.0%**
Oct 2003	**1,142,354**	**81,229**	**1,061,125**	**7.1%**
Sept 2003	**887,629**	**60,069**	**827,560**	**6.8%**
Aug 2003	**797,084**	**56,717**	**740,367**	**7.1%**
July 2003	**746,075**	**58,125**	**687,950**	**7.8%**
June 2003	**637,317**	**47,530**	**589,787**	**7.4%**
May 2003	**684,370**	**47,306**	**637,064**	**6.9%**
April 2003	**596,249**	**47,500**	**548,749**	**7.9%**
Mar 2003	**626,074**	**44,314**	**581,760**	**7.1%**
Feb 2003	**295,588**	**20,891**	**274,697**	**7.1%**
Jan 2003	**610,878**	**46,056**	**564,822**	**7.5%**
Dec 2002	**558,454**	**47,728**	**510,726**	**8.5%**
Nov 2002	**646,309**	**67,569**	**578,740**	**10.4%**
Oct 2002	**683,067**	**64,886**	**618,181**	**9.5%**
Sept 2002	**513,078**	**40,991**	**472,087**	**8.0%**
Aug 2002	**621,418**	**57,997**	**563,421**	**9.3%**
July 2002	**630,788**	**61,010**	**569,778**	**9.7%**
June 2002	**637,786**	**60,209**	**577,577**	**9.4%**
May 2002	**653,510**	**62,985**	**590,525**	**9.6%**
April 2002	**464,791**	**51,555**	**413,236**	**11.1%**
Mar 2002	**538,470**	**69,503**	**468,967**	**12.9%**
Feb 2002	**369,241**	**60,468**	**308,773**	**16.4%**
Jan 2002	**296,426**	**43,736**	**252,690**	**14.8%**
Dec 2001	**305,435**	**52,173**	**253,262**	**17.1%**

Nov 2001	**289,891**	**63,450**	**226,441**	**21.9%**
Oct 2001	**273,427**	**71,259**	**202,168**	**26.1%**
Sept 2001	**113,947**	**24,962**	**88,985**	**21.9%**
Aug 2001	**163,360**	**41,684**	**121,676**	**25.5%**

Source: District of Columbia, Metropolitan Police Department (2006)

Table 2: Examples of Speed Reductions in NSW

On the M4 Motorway at Greystanes (speed limit 90 km/h)

- The number of speeding motorists has been cut from 12,000 a day to 1,100 a day.
- The number of motorists speeding by more than 20 km/h over the limit has fallen from 3,540 vehicles a day to 12.
- The number of motorists speeding by more than 30 km/h over the speed limit has fallen from 1,100 vehicles a day to 3.

On the Princes Highway at Bulli (speed limit 60 km/h)

- The number of speeding motorists has been cut from 7,500 a day to 1,200 a day.
- The number of motorists speeding by more than 20 km/h over the limit has fallen from 380 vehicles a day to 14.
- The number of motorists speeding by more than 30 km/h over the speed limit has fallen from 63 vehicles a day to 3.

On Delhi Road at Macquarie Park (speed limit 60 km/h)

- The number of speeding motorists has been cut from 4700 a day to 800 a day.
- The number of motorists speeding by more than 20 km/h over the limit has fallen from 212 vehicles a day to 4.
- The number of motorists speeding by more than 30 km/h over the speed limit has fallen from 27 vehicles a day to 0.

On Cowpasture Road at Green Valley (speed limit 70 km/h)

- The number of speeding motorists has been cut from 2,200 a day to 260 a day.
- The number of motorists speeding by more than 20 km/h over the limit has fallen from 76 vehicles a day to 3.
- The number of motorists speeding by more than 30 km/h over the speed limit has fallen from 16 vehicles a day to 1.

Source: New South Wales (2003)

The Safety Effectiveness of Speed Cameras

Logically, if illegal speeds increase the risk of crashing and crash severity and if speed cameras reduce illegal speeds, as shown above, then, all other things being equal, speed cameras should reduce speeding-related crashes and crash severity. That logical conclusion is supported by the research literature, though with some caveats.

Wilson et al. (2006), in their Cochrane review of speed camera research, noted that all the studies they examined that included crash data showed reductions in crashes after the implementation of the automated speed enforcement program, with reductions ranging from 14% to 72% for all crashes within the vicinity of camera site to 8% to 46% for injury crashes and 40 – 45% for crashes involving serious injuries or fatalities. While critical of the methodological limitations of the studies reviewed, the Cochrane authors concluded that speed cameras are "a promising intervention for reducing the number of road traffic injuries and deaths."

Similarly Pilkington and Kinra (2005) critically reviewed 14 speed camera studies and concluded that: "Existing research consistently shows that speed cameras are an effective intervention in reducing road traffic collisions and related casualties. The level of evidence is relatively poor, however, as most studies did not have satisfactory comparison groups or control for potential confounders." Reductions in crashes ranged between 5% and 69%; injuries fell 12 – 65%; and deaths were reduced by 17 to 71% in the vicinity of the cameras. Hidden and unpredictably located mobile cameras produced area-wide reductions in crashes "of a similar order of magnitude" as well.

One "potential confounder" of particular concern is the fact that speed cameras are frequently installed at locations with a recent history of speed-related crashes (so-called "black spots"). Reductions in crashes at these locations after the installation of cameras may simply be due to chance or regression to the mean, the statistical phenomenon by which abnormally high or low numbers of events return to normal rates independent of any intervention (Persaud, 2001).

The 2004 evaluation of the U.K. speed camera program noted earlier (Gains et al., 2004) was not included among the studies reviewed by Pilkington and Kinra. It, too, found reductions in crashes and injuries at sites where cameras were installed – a 40% reduction in persons killed or seriously injured; a 33% reduction in personal injury collisions; and a 35% reduction in the number of pedestrians killed or seriously injured. This report also explicitly addresses the regression to the mean issue and argues that it "does not apply in full measure" because camera siting criteria included factors other than collisions (85^{th} percentile speeds at least 10% above speed limit plus 2 mph; speeding as a factor in some or all collisions at the "black spot"; at least 20% of drivers exceeding speed limit) and because speeds were reduced as well as collisions.

Keall et al. (2002) found statistically significant (p=.05 or better) reductions in crashes and injuries in hidden speed camera areas, as compared to open roads in New Zealand, during a two-year trial of hidden cameras.

Although alleged to happen by camera opponents, no evidence of crashes caused by sudden braking in advance of speed cameras was uncovered.

Implementation Issues

Like red-light cameras, speed cameras face serious implementation issues. There are many ways to implement a speed camera program that offends drivers to such an extent that public opposition leads to the program's demise. Cameron and his co-authors have identified a number of excellent "Strategic Principles" that should be followed when setting up a speed camera program (Cameron et al., 2003), and the list of implementation issues that follows borrows liberally from them:

1. Speed cameras should be used to deter speeding where speeding could be predicted to create high crash risks and consequences. School zones; roads near playgrounds; work zones; streets in retail shopping, dining, and drinking districts with a lot of pedestrian traffic; residential neighborhoods; and high speed roads built to low geometric standards (narrow lanes, no shoulders, no edge markings, sharp curves, poor sight distances, etc.) are all high-risk driving environments where speeding should be vigorously deterred. Using speed cameras in low-risk environments (e.g., on rural freeways with low volumes of traffic and no history of speed-related crashes) generates public skepticism about the motives for their use and leads to accusations that the cameras are being used to generate revenue, not to improve road safety – a frequent accusation (Associated Press, 2005) (Wilber, 2004) (Pilkington, 2003).

2. The purpose of the speed camera program – to improve safety by reducing unsafe speed in high-risk environments – must be clearly and persuasively communicated to the public, and the public must understand the "rules of the game." For example, if a hidden camera program is being implemented, the public must understand that they are at risk of being ticketed anywhere at any time. Signs announcing the possible presence of speed cameras should be prominently posted throughout the enforcement area. To do otherwise is to reinforce the suspicion that cameras are being used primarily for revenue enhancement rather than for safety reasons. As a new red-light camera implementation guide notes: "A red light camera program should not be started without a comprehensive public awareness and information campaign. Research has indicated that public information campaigns are a key to the success of the red light camera programs (U.S. Department of Transportation, 2005(a))." The same holds true for speed cameras.

Similarly, the public needs to understand what enforcement thresholds are being used. Is the posted speed limit the one that is being enforced or is it the "perceived limit?" Many drivers believe, or know from experience, that police do not enforce the exact posted limit but, instead, allow upward deviations in speed to account for inaccurate speedometers, momentary inattention, etc. That tolerance level is often 10% or thereabouts (Johnston, 2004) (Cameron et al., 2003) or, in the case of the U.K. speed camera program 10% plus 2 mph (Department for Transport, 2003). If these same tolerance levels do not apply to enforcement by speed cameras, the public needs to be so informed. Research shows that reduced tolerance levels increase compliance with speed limits (Cameron et al., 2003).

High levels of publicity, especially of a hidden camera program, in and of itself can reduce speeding, even with relatively low levels of enforcement (Cameron et al., 2003)

3. Philosophically, there are two ways of using speed cameras. They can be used to deter speeding at a specific site – typically one with a history of speed-related crashes – or they can be used to obtain speed compliance over a broader area. Highly visible fixed cameras accomplish the first objective while hidden cameras accomplish the second (Cameron et al., 2003). A modified fixed camera strategy that rotates a few expensive cameras among many cheap camera boxes is also a way to obtain wider compliance by creating uncertainty, especially if the empty boxes are armed with speed-sensitive camera strobes (this practice is prohibited in the U.K) (Department for Transport, 2004). Public acceptance of fixed cameras at problem locations is high, but not at lower risk locations (Streff and Molnar, 1995). Hidden cameras tend to be the most controversial (NZCity, 2004).

4. Revenue generated by speed cameras should be used principally to cover the costs of the enforcement program, with any surplus being used only for other traffic safety programs. Diversion of surplus revenues for other purposes will quickly erode public acceptance of the program (Johnston, 2004). Programs that employ revenue sharing with the camera vendor are also often criticized as being too generous to the vendor (International Association of Chiefs of Police, 2003).

5. Speed-over-distance camera systems, while much more expensive than single fixed or mobile cameras, are arguably fairer to drivers. With a single camera a momentary lapse of attention can result in a violation of the enforced speed limit. When speed is measured and then averaged over some distance, say a half mile or more, the driver has the opportunity to drop the vehicle's speed back into compliance. Speed-over-distance camera systems may be prohibitively expensive, however -- ~$75,000 for a single camera versus ~$250,000 for a speed-over-distance system (costs converted from British Pounds cited in Cameron et al., 2003).

6. Speed cameras must be accurate. In Melbourne, Australia, 165,000 speeding fines were issued in 2003 as a result of improperly calibrated speed cameras. As an editorial in *The Age* opined in November, 2004: "The fiasco has ended up costing Victoria's taxpayers $26 million and severely undermined public confidence in the accuracy and even the purpose of speed cameras. More importantly, it cost some motorists their licenses and even their jobs." (*The Age*, 2004). Similarly, operation of a mobile speed camera by an improperly trained operator led to the dismissal of 6,800 speeding tickets in Edmonton, Alberta (Mah and Markusoff, 2005)

7. Speed cameras should not substitute for human enforcement. Motorists' organizations oppose speed camera programs when there is even a hint that they may lead either to reduced levels of conspicuous police patrol or decisions to not increase the police presence on problem-plagued roads (Balazs, 2004). In a policy statement the AA Motoring Trust in the U.K. asserts: "A speed camera should be the last resort to ensure compliance, not the first" (AA Motoring Trust, 2003).

8. Privacy concerns should not be ignored, even though the U.S. Supreme Court has ruled that neither individuals in motor vehicles on public roads nor the license plates on those vehicles deserve privacy protections (Kendall, 2004). In particular, legislators and others are often most sensitive to photographs taken of vehicle occupants, so the decision must be made whether such photos are needed for enforcement of the ticket (depending upon the particular jurisdiction, speed camera tickets may be civil or criminal violations; criminal violations will often require a photograph of the driver while the parking ticket-like civil violations do not). If the driver is photographed there remains the issue of whether to mail the photograph with the ticket or just keep it in the file for reference if the individual cited disputes the ticket (Polk, circa1998).

9. Citations issued as a result of speed camera photos should be severe enough to deter future speeding, with more serious infractions being punished more severely than lesser ones (Cameron et al., 2003). The research literature on general deterrence theory generally concludes that to be effective a deterrence program must 1) create a high probability that the bad behavior will be detected; 2) punish the behavior severely; and 3) punish promptly (Cameron et al., 2003), though there is some question about the severity principle (Williams and Hawkins, 1986; Paternoster, 1987). The research literature generally agrees that principle #1 – certainty of detection – is the most powerful deterrent, regardless of the severity or celerity of the sanction (Pogarsky, 2002). Speed cameras certainly increase the risk of detection.

Arguably, the penalty for a speeding violation detected by a camera should be no less than that for a ticket issued by a police officer; doing otherwise, as is frequently the case, "…further reinforces the public view that enforcement by speed cameras is primarily designed to raise revenue and not to save lives and

injury – because it attracts a 'less serious' penalty." (Johnston, 2004) Unfortunately, many speed camera program tickets are much less costly than tickets issued by a law enforcement officer. For example, the ticket issued under the speed camera program in Charlotte, North Carolina is only $50, with no license points and no effect on insurance premiums (Rubin, 2004); in Denver the ticket is only $40, again with no points or insurance consequences (Denver County Court, 2005). It is hard to imagine that such minimal fines really deter speeding or send a strong message that speeding is a safety concern; instead they lead to public cynicism that speed camera programs are just another way to tax the driving public.

The severity of punishment issue is also complicated by the fact that, in some jurisdictions, speed camera tickets are treated as minor civil infractions (like parking tickets) rather than criminal infractions in order to avoid having to photograph the driver as well as the license plate. Photographing drivers creates invasion of privacy concerns that can help torpedo a speed camera program (see # 8, above).

10. In order to have a better deterrent effect, citations issued as a result of speed camera photos should be sent promptly. As noted in # 9, above, a deterrence program should punish promptly, though the effect of celerity on deterrence is not as well researched as certainity of detection and severity of punishment (Pogarsky, 2002). Getting the ticket to the offender within two weeks after the speeding offense is generally doable and effective in deterring future speeding (Cameron et al., 2003).

11. Finally, the National Committee on Uniform Traffic Laws and Ordinances has developed a "automated traffic enforcement model law," which addresses many of the issues raised above and which is available at http://www.ncutlo.org/autoenforce622.htm

Programs that effectively address the implementation issues outlined above reduce speeding and crashes and enjoy public support. They even have secondary effects on drivers' behavior.

In Australia, for example, the widespread use of speed cameras in many parts of the country has resulted in increased demand for cruise control in new cars. According to a November 2004 article in *The Sydney Morning Herald*, "The impact of fixed-speed cameras can be seen on the cars we drive. Every Australian-made sedan is now fitted with cruise control, a device viewed by buyers as a necessity rather than a luxury" (*The Sydney Morning Herald*, 2004).

In the U.K., the rapid proliferation of speed cameras has led to the marketing of Global Positioning System satellite (GPS)-based detector units with map databases of fixed speed camera locations, which are updated daily, as well as radar or laser detectors to identify fixed and mobile speed cameras (Marston,

2005). U.K car manufacturer Vauxhall has recently announced the availability of a GPS-based speed camera detection accessory through its dealers (Vauxhall, 2005).

Unfortunately, speed camera programs can also incite violence and other forms of civil disobedience. News reports from around the world document these problems:

"An angry motorist is thought to have carried out a revenge attack on a speed camera by dowsing it in petrol and setting it on fire" (Scotland, September, 2004)

"A group of balaclava-clad, pro-motorist campaigners disabled ten speed cameras in north London on Sunday, claiming it was just the start of their campaign" (England, October, 2004)

"A photo radar van was dented and had three windows smashed by rocks yesterday, making it the ninth such van to be vandalized this year, say cops." (Canada, December, 2004)

"Vandals have attacked three speed cameras over the holiday period … and the camera poles were flattened in each case" (United Kingdom, December, 2004)

"Street racing demons in Hong Kong have been zooming past speed cameras and beating red lights without getting caught. They have only to press a red button next to their gear shift, and the rear car licence plates will flip down so that cameras cannot capture their plate numbers." (Hong Kong, February, 2005)

"According to Victoria Police, false, defaced and stolen number plates are being used by more thieves for toll evasion …, road safety cameras and at service stations for theft of petrol." (Australia, October, 2004)

"The offender has so far evaded capture whilst daubing paint over the lenses of the cameras to prevent them from snapping speeding drivers. And as soon as the damage has been fixed by the camera maintenance team, the mystery attacker has struck again and again, rendering the cameras useless." (United Kingdom, April, 2005)

"Rogue drivers are evading thousands of speeding tickets by exploiting a loophole in the law that enables them to ignore roadside cameras. …. The scam involves offenders registering their cars at one of a network of 'mass-mailing' addresses used legitimately by businesses instead of at their own homes. When a driver triggers a camera, a penalty notice is sent to the mass-mailing address. Police seeking the motorist find only a shopfront where nobody lives." (United Kingdom, April, 2006)

Conclusion

The objective of this paper was to review what the research literature has to say about the role of illegal speed in traffic crashes; to examine the role of speed cameras in reducing speeding; to examine the safety effectiveness of speed cameras; and to illuminate implementation issues that can "make or break" a speed camera program by gaining public acceptance for, or generating fierce public opposition to, photographic enforcement of speed limits.

The research literature makes it clear that illegal speed increases both crash risk and crash severity. There is also substantial evidence that speed cameras reduce speeding. Consequently, research finds that speed cameras reduce crashes and crash severity.

Speed cameras are plagued by implementation issues, however. In particular, their use must be well-justified and well-explained to the public, in a convincing manner. Yet even well-founded speed camera programs, with strong public support, such as those in the United Kingdom, can run aground when safety is not perceived to be the sole motivation for their use: "Motorists have conflicting views on speed cameras. A poll by the AA found that 76% of drivers approve of them in principle, although 74% think the present regime is geared more towards raising money than safety" (Clark, 2004). Finally, speed cameras can clearly incite the lunatic fringe.

References

AA Motoring Trust, “Memorandum Submitted by the AAA Motoring Trust to the House of Commons Transport Committee – Traffic Law and Its Enforcement,” October 2003

Anderson R and Edgar AW, “Mobile Speed Cameras in the ACT – Slashing Speeds and Cutting Crashes” at http://www.monash.edu.au/cmo/roadsafety/abstracts_and_papers/081/edgara11.pdf (accessed January 27, 2005)

Associated Press, “AAA Urges Hearings on Red-Light and Speed Cameras,” WTOP Radio Network, January 31, 2005

Balazs D, “AAA Arizona comes out against photo radar,” *The Arizona Republic*, September 14, 2004

Cameron M, Delaney A, Diamantopoulou K, and Lough B, *Scientific Basis for the Strategic Directions of the Safety Camera Program in Victoria*, Monash University Accident Research Centre Report No. 202, June, 2003

Chen G, Meckle W, Wilson J, “Speed and safety effect of photo radar enforcement on a highway corridor in British Columbia,” *Accident Analysis & Prevention*, 34:129-138 (2002)

Clark A, “Darling clamps down on speed cameras,” *The Guardian*, November 5, 2004

Denver County Court, “Frequently Asked Questions – Photo Radar” at http://198.202.202.66/CountyCourt/1848faq882.asp (accessed February 10, 2005)

Department for Transport, *Handbook of Rules and Guidance for the National Safety Camera Programme for England and Wales for 2005/06*, November, 2004 at http://www.dft.gov.uk/stellent/groups/dft_rdsafety/documents/page/dft_rdsafety_032652.pdf (accessed February 3, 2005)

Department for Transport, “Safety Cameras - Frequently Asked Questions,” February 11, 2003

District of Columbia, Metropolitan Police Department, “Photo Radar Historical Monthly Data” at http://mpdc.dc.gov/mpdc/cwp/view,a,1240,q,548075,mpdcNav_GID,1552,mpdcNav,|31886|.asp (accessed on May 11, 2006)

Elvik, R, Christensen, P, and Amundsen, A, *Speed and Road Accidents: An Evaluation of the Power Model,* The Institute of Transport Economics (TOI), TOI Report 740/2004, Oslo, Norway, December, 2004

Gains A, Heydecker B, Shrewsbury, J and Robertson S, *The National Safety Camera Programme: Three-year Evaluation Report*, PA Consulting Group and University College London, June, 2004

International Association of Chiefs of Police, Highway Safety Committee, *Traffic Safety Strategies for Law Enforcement*, August, 2003 at http://www.theiacp.org/documents/pdfs/Publications/TrafficSafetyStrategiesCompleteReport.pdf (accessed February 4, 2005)

Johnston I, "Reducing injury from speed related road crashes," *Injury Prevention* 10:257 -259 (2004)

Keall MD, Povey LJ, and Frith WJ, "Further results from a trial comparing a hidden speed camera programme with visible camera operation," *Accident Analysis and Prevention* 34: 773-777 (2002)

Keall MD, Povey LJ, and Frith WJ, "The relative effectiveness of a hidden versus a visible speed camera programme," *Accident Analysis and Prevention* 33: 277-284 (2001)

Kendall ST, "Is Automated Enforcement Constitutional?" Insurance Institute for Highway Safety, May 2004 at http://www.iihs.org/safety_facts/state_laws/auto_enforce_paper.pdf (accessed February 4, 2005)

Kloeden CN, McLean AJ, Moore VM, and Ponte G, *Travelling Speed and the Risk of Crash Involvement*, *Volume 1 – Findings*, Road Accident Research Unit, Adelaide University, for Australian Transport Safety Bureau, November, 1997

Kloeden CN, Ponte G, and McLean AJ, *Travel Speed and Risk of Crash Involvement on Rural Roads,* Road Accident Research Unit, Adelaide University, for Australian Transport Safety Bureau, July, 2001

Leaf WA and Preusser DF, *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*, National Highway Traffic Safety Administration, Publication # DOT HS 809 021, October, 1999

Mah B and Markusoff J, "6,800 photo radar tickets quashed," *The Edmonton Journal*, March 2, 2005

Marston, P, "Ban proposed on speed camera detectors," Telegraph Group Limited, January 17, 2005 at

http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2005/01/17/nspeed17.xml (accessed February 10, 2005)

National Committee on Uniform Traffic Laws and Ordinances, "automated traffic enforcement model law," undated, at http://www.ncutlo.org/autoenforce622.htm (accessed March 10, 2005)

New South Wales, Roads and Traffic Authority, "Speed cameras save lives," news release dated 21-09-2003 at http://www.driveandstayalive.com/articles%20and%20topics/speed/article_speed-cameras-save-lives-in-australia.htm (accessed January 27, 2005)

Nilsson, G., *Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety*. Bulletin 221. Lund Institute of Technology, Department of Technology and Society, Traffic Engineering, Lund. Sweden, 2004

NZCity, "No more hidden speed cameras," 19 October 2004 at http://home.nzcity.co.nz/news/default.asp?id=44173&c=w (accessed February 3, 2005)

Paternoster R, "The Deterrent Effect of the Perceived Certainty and Severity of Punishment: A Review of the Evidence and Issues," *Justice Quarterly* 4:2 (1987)

Persaud BN, *Statistical Methods in Highway Safety Analysis*, NCHRP Synthesis 295, Transportation Research Board, 2001

Pilkington P, "Speed cameras under attack in the United Kingdom," *Injury Prevention* 9:293-294 (2003)

Pilkington P and Kinra S, "Effectiveness of speed cameras in preventing road traffic collisions and related casualties: systematic review," BMJ, doi:10.1136/bmj.38324.6446574.AE (published 14 January 2005) (accessed January 26, 2005)

Pogarsky, G, "Identifying 'Deterrable' Offenders: Implications for Research on Deterrence," *Justice Quarterly* 19:3 (2002)

Polk AE, "Automated Enforcement of Traffic Laws: How to do it right and why you should care," Jet Propulsion Laboratory, circa 1998 at http://152.99.129.29/its/cdrom/1043.pdf (accessed February 5, 2005)

Rubin, Richard, "Area's speed cameras could stay," *The Charlotte Observer*, September 21, 2004 at http://www.charlotte.com/mld/observer/news/local/9718125.htm?1c (accessed February 10, 2005)

Stradling SG and Campbell M, "The Effects of Safety Cameras on Drivers," RoSPA 67th Road Safety Congress, March, 2002

Streff FM and Molnar LJ, "Developing Policies for Automated Speed Enforcement: A Survey of Michigan Opinions," *Accident Analysis & Prevention* 27: 611-616 (1995)

Stuster J, Coffman Z, and Warren D, *Synthesis of Safety Research Related to Speed and Speed Management*, Federal Highway Administration Publication No. FHWA-RD-98-154, July, 1998

The Age Editorial, "The speed camera fiasco drags on," November 6, 2004 at http://www.theage.com.au/ at http://newsstore.fairfax.com.au/apps/newsSearch.ac?page=1&sy=age&sp=adv&kw=Speed+AND+camera&ax=&dr=1month&dt=enterRange&sd=06%2F11%2F2004&ed=06%2F11%2F2004&pbx=age&sc=&ct=&sfx=headline&so=relevance&rc=10&submit=Search (accessed February 4, 2005)

The Royal Society for the Prevention of Accidents, "The Public's View of Speed Cameras," November, 2004 at http://www.rospa.com/roadsafety/info/speed_cameras.pdf (accessed on February 3, 2005)

The Sydney Morning Herald, "Cameras promote cruise control," November 24, 2004 at http://www.stuff.co.nz/stuff/print/0,1478,3105024a30,00.html (accessed November 24, 2004)

U.S. Department of Transportation, Federal Highway Administration, *Red Light Camera Systems: Operational Guidelines*, January 2005(a)

U.S. Department of Transportation, National Highway Traffic Safety Administration, *Traffic Safety Facts 2004 – Speeding*, 2005(b)

Vauxhall, "Avoid Speeding Fines with New Vauxhall Accessory," News Release dated 02/02/05 at http://vauxhall.co.uk/companyInformation/newsPage.jhtml?indexNo=1063 (accessed February 11, 2005)

Wilber DQ, "Changes in D.C. Radar Program Urged," *The Washington Post*, December 6, 2004, p.B02

Williams KR and Hawkins R, "Perceptual Research on General Deterrence: A Critical Review." *Law & Society Review* 20:4 (1986)
Wilson C, Willis C, Hendrikz JK, and Bellany N, "Speed enforcement detection devices for preventing road traffic injuries," *The Cochrane Database of*

Systematic Reviews, 2006:2 Art. No. CD004607.pub2.
DOI:10.1002/14651858.CD004607.pub2