Efficacy of Radar Speed Monitoring Displays in Reducing Vehicle Speeds

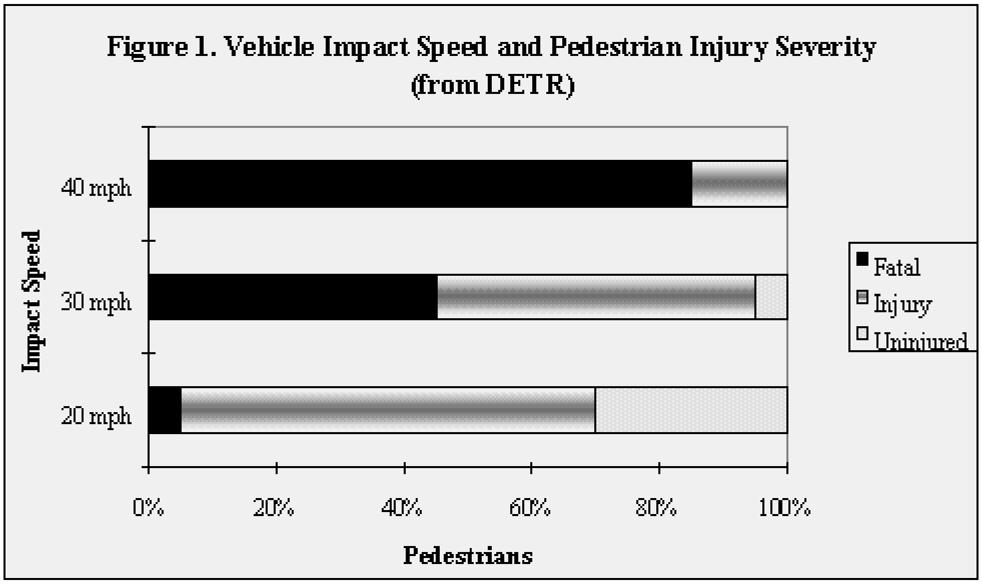
Overview

Speed monitoring displays are radar-activated signs that dynamically display approaching vehicle speeds. Studies show that speed monitoring displays with radar have a statistically significant effect in reducing mean speeds[1,2,3] and the percentage of drivers exceeding the posted speed limit.[4,5,6] In addition, it is expected that displays with radar will also cause some drivers using radar detectors to slow down. Recent studies have proven the long-term effectiveness of radar speed monitoring displays.[7] Portable trailer-mounted displays are appropriate for temporary speed reduction needs such as work zones. However, long-term speed management needs are better served with a permanently mounted speed monitoring display, as vehicle speeds increase once the sign is removed.[8,9,10,11] Several independent studies are reviewed and end-user field studies are examined in this paper. A speed-monitoring device (Driver Feedback Sign) manufactured by 3M will also be detailed.

Introduction

Safety of the traveling public and pedestrians is a major concern of transportation agencies and legislators. Overall pedestrian accident rates per 100,000 people have steadily dropped since the 1970s, but during 1995 there were still 5,585 pedestrian fatalities and about 84,000 pedestrian injuries in the United States.[12] Children under the age of 14 and adults over 65 are the most likely age demographic to be killed in a pedestrian/vehicle collision. Excessive speed is among the contributing circumstances most often reported. The Federal Highway Administration (FHWA) estimates that each 1 mile per hour (1.6 kph) reduction in speed may reduce injury crashes by 5 percent.[13]

The concept that a pedestrian struck by a vehicle traveling at a higher speed will have a more catastrophic effect than if the vehicle were traveling slower is almost too obvious to require proof. Yet the relationship has been documented in a number of studies. A researcher named Pasanen reviewed three studies relating collision speeds and pedestrian injury severity.[14] Pasanen estimates that about 5 percent of pedestrians would die if struck by a vehicle traveling 20 mph. The pedestrian fatality percentage rises to about 40 percent for vehicles traveling 30 mph, about 80 percent for vehicles traveling over 40 mph, and nearly 100 percent for speeds over 50 mph. Pasanen goes on to conclude that a significant number of crashes would be eliminated entirely if vehicle speeds were reduced.



Studies show that most drivers do not take note of, or slow down, in response to standard regulatory or advisory speed signs that are customarily used to regulate speeds.[15]
In contrast, studies indicate that speed monitoring displays with radar have a statistically significant effect in reducing mean speeds and the percentage of drivers exceeding the posted speed limit. Advances made through the combination of dynamic display technology and radar result in a sign that represents an excellent application of intelligent transportation systems as it provides credible, real-time information. A speed monitoring display is a dynamic speed control measure which studies have proven to be more effective than static MUTCD signs in altering driver behavior.

This paper will examine the results of multiple independent studies and reports and three end user field tests utilizing 3M Driver Feedback Signs.

Speed Monitoring Displays

Speed monitoring displays raise driver consciousness of their speed, thereby encouraging drivers to slow down if they are traveling above the speed limit. The objective of the system is to reduce traffic speed and increase speed limit compliance. Speed monitoring displays are also known as Driver Feedback Signs, Radar Signs, and Speed Signs. The advancement of display and detection technologies and recent research on technology effectiveness has increased the successful deployment of these signs in the United States and abroad.

Speed Monitoring Displays are Effective at Reducing Mean Speeds and the Percentage of Speed Drivers

McCoy, Bonneson and Kallbaum[1] placed speed monitoring displays in work zones on a South Dakota interstate. The intention was to make drivers slow down by informing them how fast they were traveling. The radar sign utilized 9-inch high digits, a static work zone sign, an advisory speed plate, and a "YOUR SPEED" guide sign. The mean speeds reduced by 4 to 5 mph and the percentage of vehicles exceeding the advisory speed limit of 45 mph was reduced by 20 to 40 points. The speed reductions documented were greater than those reported for the use of radar alone.[16,17,18]

A traffic control plan was executed according to MUTCD principles and a typical South Dakota DOT interstate highway long-term lane closure plan. Tape switches collected speed, volume, headway and vehicle classification data. The first display location was about 650 feet (200m) downstream of the ROAD CONSTRUCTION AHEAD signs and 4,000 feet (1,220m) in advance of the lane closure taper. The second location was at the beginning of the lane closer taper and the final location was at the end of the taper.

The work area under study was not visible to approaching traffic. Therefore, activity in the work zone did not influence approaching traffic speed. The after study was not conducted until seven days following display installation, in an effort to reduce chances of simply observing the novelty effects of the displays,. Only "free flowing" vehicles (where the headway between it and the vehicle ahead was more than 4 seconds) were used for speed analysis.

McCoy, Bonneson and Kollbaum concluded statistically that the displays did reduce mean speeds. In all vehicle axle classes, mean speeds observed at display locations were lower in the after study than in the before study.

- Mean speeds of two-axle vehicles were reduced by about 4 mph.
- Mean speeds of vehicles with more than two axles were reduced about 5 mph.

In the McCoy, Bonneson, and Kollbaum study, vehicles exceeding the speed limit by more than 10 mph (16 km/hr) reduced speed by a greater percentage:

- 20 to 25 percentage points for two-axle vehicles
- 40 percentage points for vehicles with more than two axles.

Reductions with speed monitoring displays were greater than with radar alone (studied previously).

Previous studies[19,20,21] found that speed reduction measures involving radar have a more pronounced effect on vehicles exceeding the speed limit. These studies also found that truck speeds are usually reduced more than passenger car speeds, attributed to a higher percentage of trucks using radar detectors.

Speed Monitoring Displays Proven to Have Long-Term Efficacy

Geza Pesti and Patrick T. McCoy evaluated long-term effectiveness of speed monitoring displays[7] as part of the Midwest States Smart Work Zone Deployment Initiative, a pooled-fund study sponsored by Iowa, Kansas, Missouri, Nebraska, and FHWA.

Three speed monitoring displays were deployed for a 5-week period along a 2.7 mile (4.35 km) section between two work zones on I-80 near Lincoln, Nebraska. The mean, 85th percentile, standard deviation of vehicle speeds, and the percentage of vehicles complying with the speed limit and speed thresholds were used as measures of effectiveness.

Average daily traffic volume on the test site road section was approximately 38,000 vehicles per day, of which 22 percent was commuting traffic. The normal posted speed was 75 mph (120 km/h), but the speed limit in the study area was 55 mph (89 km/h).

Traffic speeds were measured once before deployment, five times during the 5-week deployment, and once after the removal of the speed monitoring displays. The before studies were conducted four days before the signs were deployed. The speed monitoring displays operated continuously for the next five weeks, during which traffic was measured once each week at 1-week intervals. Finally, one week after the removal of the speed monitoring displays another set of speed measurements were taken to determine the displays produced any residual speed-reduction effects. During congested flow conditions vehicle speeds are primarily influenced by the density of traffic; therefore, speed data was collected only during non-congested conditions.

Results from location 3 were as follows:

Mean Speeds:	3-4 mph reduction (4.8-6.4 kph)
85th Percentile:	2-7 mph reduction (3.2-11.3 kph)
Passenger Cars	
% of vehicles complying with the speed limit:	Before 3.09% After 14.17-30.07%
% of vehicles complying with the speed limit + 5 kph:	Before 38.66% After 62.2-75.82%
% of vehicles complying with the speed limit +16 kmp:	Before 68.04% After 89.76-96.83%
Other Vehicles	
% of vehicles complying with the speed limit:	Before 8.33% After 24.18-39.56%
% of vehicles complying with the speed limit + 5 kph:	Before 55.56% After 76.92-91.75%

% of vehicles complying with the speed limit +16 kmp: Before 92.59%
After 93.88-100%

Speed monitoring displays were found to be effective in lowering speeds, increasing the uniformity of speeds, and increasing the speed-limit compliance over the entire length of the test.

A different study by Bowie, Saito & Burns[22] examined driver opinions of speed monitoring devices. The majority of drivers expressed positive feelings toward the use of speed monitoring devices on highways. For example, 59 percent believed that speed monitoring displays are accurate and 75 percent believed displays are not distracting or difficult to read. Most drivers (95 percent) reported they would slow down if they passed a speed monitoring display that showed they were traveling faster than the speed limit. Seventy-eight (78) percent of respondents indicated they believed the displays conveyed the message, “Check your speed and slow down.”

The Effects of Speed Monitoring Displays are Negated When Removed—Areas Requiring Recurring Speed Management Need Permanent Solutions

The U.S. Department of Transportation’s National Highway Traffic Safety Administration published a report entitled *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries.*[23] This report analyzed methods used to reduce vehicle speeds and evaluated crash data from available databases (Transportation Research Board with 310,000 records, U.S. TRANSDOC with 40,000 records, and the International Road Research Documentation with 285,000 records), from Institute of Transportation Engineers and Federal Highway Administration articles, and from discussions with research organizations in the U.S. and abroad.

The report looked at speed reduction methods such as reduced speed limits, enforcement, installation of stop signs or traffic signals, public education, engineering roadway traffic calming approaches such as road humps, round-abouts, and horizontal traffic deflections (“chicanes”), and traffic control devices such as speed monitoring displays.

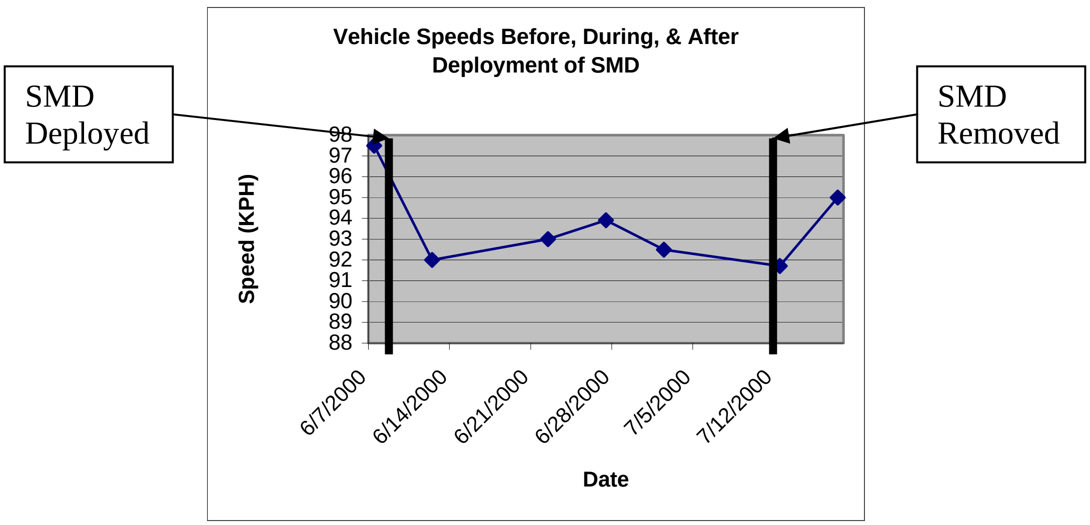
The report listed numerous examples of successful speed reduction tests, both short-term and long-term, for speed monitoring displays. In the UK, where signs were used at entrances to villages, speed reductions were sustained into the middle of villages and speed reductions appeared to be maintained over time. A recurring theme throughout the multiple studies examined was that speeds went back up when portable displays were removed. Some quotes from the report:

> In a Casey and Lund[8] study in California; “When speed boards were deployed, speeds decreased by about 10 percent next to the boards and about 7 percent about one-half mile downstream, but effects rapidly disappeared when the boards were removed.”

In a Bloch[9] study in Riverside California; “Speed decreases had vanished by one week later, and in fact were absent during the treatment week during the hours when the treatments were not present.”

In a Eagle and Winter[10] test of speed warning signs in the UK; “They found that the speeds declined throughout the 12-week test period, more so when enforcement was added, but the effects disappeared when the signs were removed.”

In the previously noted Pesti and McCoy study on long-term effectiveness of speed monitoring displays, they found that speeds went up again after the speed monitoring device was removed as illustrated below:



Portable speed monitoring displays are useful in situations where temporary speed reductions are necessary, such as work zones. Areas with recurring speed management needs such as schools zones, residential areas, and speed transition zones require a permanently mounted solution.

Field Studies

Field tests utilizing 3M’s Driver Feedback Signs and were conducted by:

1. City of Clarksville, Tennessee
2. Maine Department of Transportation
3. Netherlands Department of Transportation.

The Equipment

All three studies utilized Driver Feedback Signs manufactured by 3M, headquartered in St. Paul, Minnesota. Driver Feedback Signs monitor and display the speeds of approaching vehicles. The vehicle speed is displayed to the driver on a sign containing the legend "YOUR SPEED" with the actual speed reading shown below the legend. The speed of the approaching vehicle is provided by a K-band radar detection device integrated within the sign. The location of the radar is not apparent to the driver. The speed display can be set to flash when a vehicle exceeds a speed threshold setting, most often the posted speed limit.

3M Driver Feedback Sign with LED hybrid display technology

The legend or static portion of the display utilizes white Type 9 Diamond Grade retroreflective sheeting and the speed display (or dynamic portion of the display) utilizes a combination of Type 9 fluorescent yellow-green retroreflective sheeting and light emitting diodes (LEDs) to form a hybrid pixel. Under photocell control, the LEDs typically operate only for nighttime illumination or for a violator alert (when a vehicle is detected traveling over the preset speed threshold).

Field Tests

All three field studies showed positive speed reduction results. In each study, speed was measured before the deployment of Driver Feedback Signs and at various times after the deployment. All were permanently mounted signs.

The City of Clarksville, Tennessee tested speeds before and after deployment of the Driver Feedback Sign. The signs were deployed in residential areas on two arterials, Kirby Street and S. Jordon Drive.

Each location achieved similar results in reducing the mean speeds and the percentage of speeding drivers.

Clarksville, Tennessee
Evaluation sign.

Kirby Drive

- **62%** Reduction in Vehicles Traveling Over 6+ mph
- **15%** Reduction in 85th Percentile Speed (34 to 28 mph)
- **19%** Reduction in Mean Speed (27 to 22 mph)

S. Jordan Drive

- **52%** Reduction in Vehicles Traveling Over 6+ mph
- **18%** Reduction in 85th Percentile Speed (34 to 28 mph)
- **19%** Reduction in Mean Speed (27 to 22 mph)

The Maine Department of Transportation conducted a similar test. Again, the test results were positive.

Maine DOT
Evaluation Sign

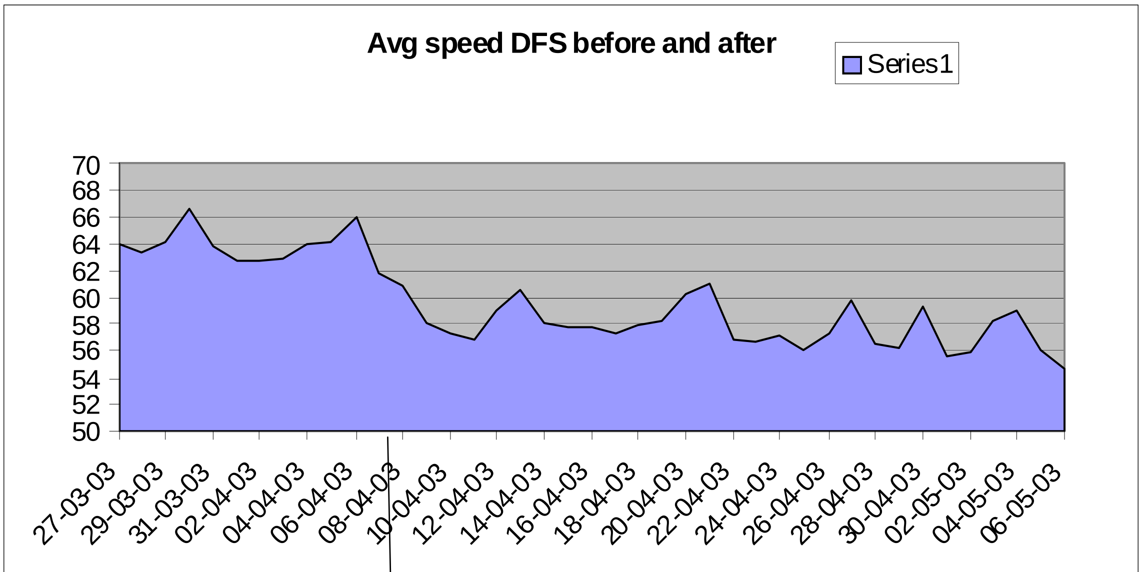
- **56%** Reduction in Vehicles Speeding Over 6+ mph
- **17%** Reduction in 85th Percentile Speed (34 to 28 mph)
- **23%** Reduction in Mean Speed (32 to 25 mph)

A long-term evaluation was conducted on Driver Feedback Signs in Heesch, Netherlands from March 27 to July 13, 2003. The location of the Driver Feedback Sign was at the entrance of a village where the speed limit is reduced from 80 to 50 kph. The sign was placed just before the entrance of the village where the speed limit was still 80 kph. The speed limit lowered to 50 kph 100 meters further down the road. The problem was that many cars entered the village at a very high speed. By alerting drivers to their speed, the county hoped to influence driver behavior. The desired result was to reduce average speed for cars entering the village and a second desired result was to reduce the number of vehicles with excessive speeds (vehicles passing the sign over 80 kph).

The measurement device was a pneumatic tube and the data logged was average speeds and excessive speeds (speeds higher than 80 kph). Speeds were measured between March 27 and April 8, 2003 (before the Driver Feedback Sign was installed). When the Driver Feedback Sign was installed, speeds were again measured (between April 9 and May 6). For measuring long-term effect on driver behavior, speeds were measured again (between June 20 and July 13, 2003).

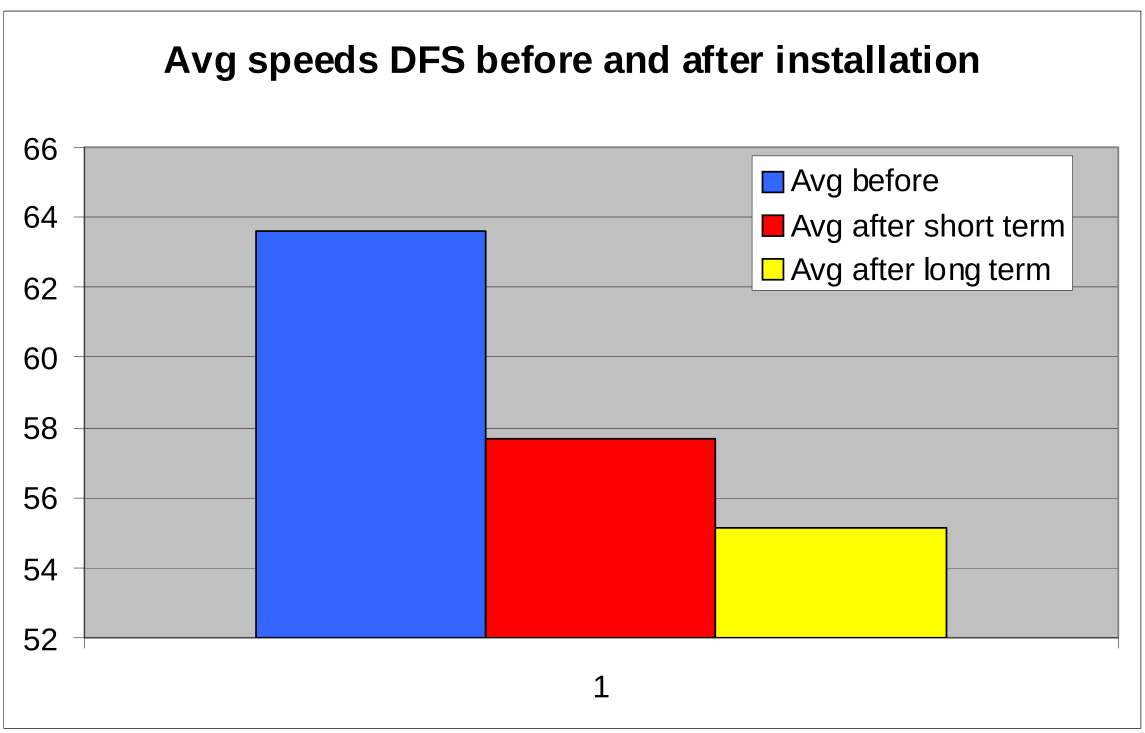
Heesch, Netherlands
Evaluation Sign

The graph below illustrates speed reductions before and after the Driver Feedback Sign was installed.

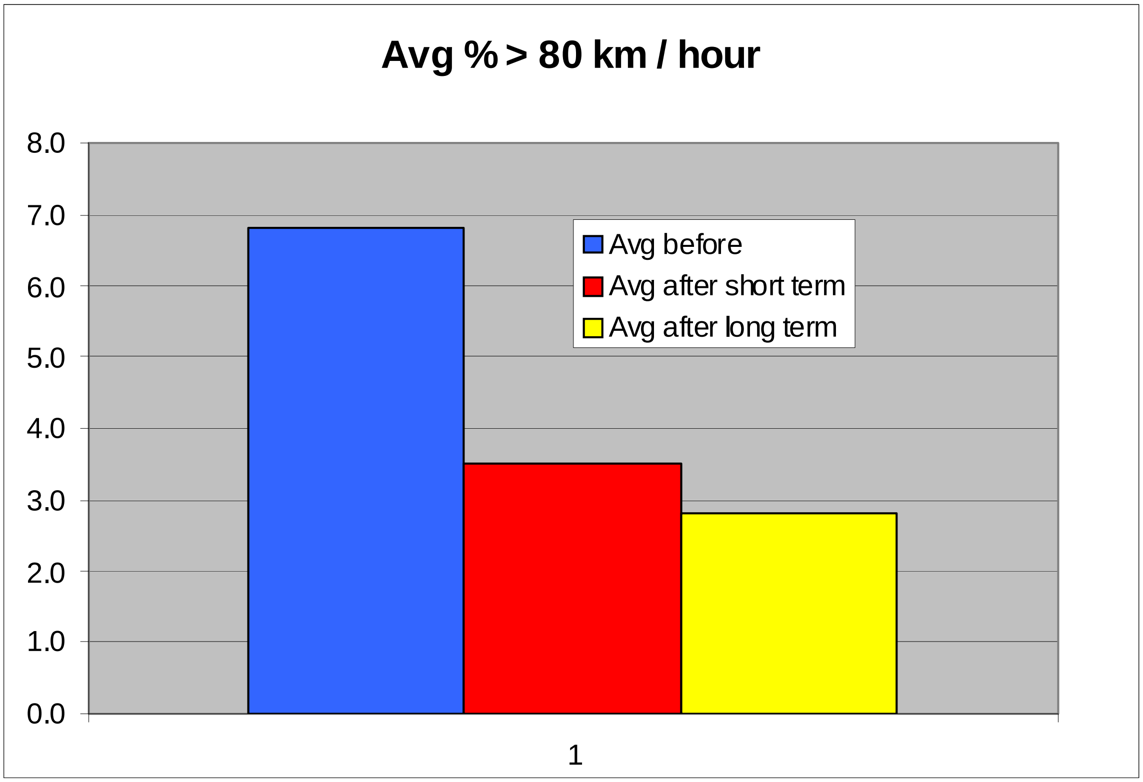


Driver Feedback Sign Installed

The Driver Feedback Signs had an immediate impact with mean speed reduction and further reduction longer term.



The same long-term results were achieved with the reduction in the percentage of speeding drivers (those exceeding the posted speed limit of 80 km/h).



Conclusion

Results of studies and field tests referenced herein show that speed monitoring displays have a statistically significant affect of reducing mean speeds and reducing the percentage of speeding drivers. Speed reductions--even minor ones--may reduce accidents and increase pedestrian safety. Positive long term effects have of speed monitoring displays have also been demonstrated. Portable displays are appropriate for temporary speed reduction needs such as work zones, but areas requiring ongoing speed management require a permanently mounted solution, as vehicle speeds will increase if the speed monitoring displays are removed. The advent of radar and variable message sign integrated technology presents a low-cost, easy to implement solution for reducing speeds and increasing pedestrian safety.

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