

Synthesis title: Signing and marking

Observatory main category: Roads

Other relevant syntheses to be consulted:

- Distraction (Drivers)

Keywords:

- Traffic Signs; Advertising Signs; Road Markings; Distraction; Clutter.

Key facts

- Traffic signs and road markings are used to control and guide traffic and to promote road safety. Markings also provide road space for cyclists, indicate road type (e.g. whether a road is single or dual carriageway, and slow drivers via “psychological traffic calming”. It is important that signs and markings giving effect to traffic regulation orders, and intended to be read from a moving vehicle, are of sufficient size to enable drivers to recognise them and assimilate the information in time. Signs and markings should only be used where they can usefully serve these functions.

(DfT et al, 1982)

- Recent trials have shown that the simplification of road signs and markings can reduce RTI numbers, traffic flow and average traffic speeds. A 48.6 per cent annual reduction in RTIs was seen following one improvement scheme.

(A. Quimby and J. Castle, 2006)

- Evidence is mounting that roadside advertising, particularly video advertising, also causes driver distraction.

(V.L. Neale et al., 2005)

- Research indicates that the rates of return from road safety schemes involving improved road markings and signage, in all types of location on the highway, lead to a safer travelling environment for road users.
- In a study of the impacts of the implementation of 250 new 20 mph zones in residential areas it was found that average speeds had fallen by nine miles per hour and that the annual number of RTIs had fallen by 60 per cent. However, the use of 20 mph signs alone, without associated traffic calming methods, only led to speed reductions, on average, of about one mile per hour.
- Too many signs and markings are thought to cause cluttering and mental overload. Poorly designed and placed signs and their over-provision detract from the environment, and affect road safety by distracting the road user. The unnecessary or over use of warning signs is also thought to result in driver disrespect for signs and markings and so therefore should be removed.

(AECOM, 2009)

- Repeater and vehicle activated signs and signals are a way of making drivers aware of the road environment and the speed at which they are driving. Vehicle activated signs have been used for speed limit indication and to inform drivers of an upcoming hazard or restriction.

(DfT, 2002)

- There is thought to be a correlation between the quality and condition of signs and markings and the number of RTIs occurring on UK roads.

(RSMA, 2007)

Summary

Clear and efficient signing and marking is an essential part of highway and traffic engineering. Signs and markings are used to control and guide traffic and to promote road safety. Great Britain is thought to have one of the safest road networks in the world and the quality of its traffic signs and markings make a significant contribution to this.

Signing and carriageway markings should comply with the Traffic Signs Regulations and General Directions (TSRGD). Any signs that are not prescribed in the TSRGD must be authorised by the Secretary of State.

To be effective, signs and markings must be designed and implemented in a way that the messages they convey are clear, unambiguous, visible and legible. Maintenance of signs and markings is important.

Whilst one of the primary objectives of road signs, signals and markings is to provide useful information to the driver so that the resulting appropriate behaviour will prevent RTIs, they also indicate legally enforceable speed regulations at specific locations. However, road signs and signals that are intended to moderate speed will generally lose all their effectiveness if infrastructure operators fail to ensure the messages conveyed are enforced and are consistent with the actual road conditions at any given time.

Research shows that inadequate and poorly maintained road signs and markings are often cited as a significant contributing factor to RTIs. Approximately 30 per cent of drivers involved in an RTI report some sort of distraction. Around a third of these RTIs are thought to be caused by external distractions. This includes signs, signals, billboards and commercial signs. Distraction can also be caused by looking for a sign that may be missing. Therefore, continuity of directional signing is important. Young (aged 17-21) drivers are particularly prone to external-to-vehicle driver distraction caused by signs. The risk factor associated with sign clutter is also shown to be highest at junctions and on long monotonous roads (such as motorways).

There is increasing interest and research into traffic management schemes aimed at simplifying the road environment, through methods such as the removal of unnecessary signs to reduce complexity and driver confusion. However, too few signs and markings can cause driver confusion, poor traffic management and inappropriate speeding. Conversely, too many signs and markings are thought to cause cluttering and mental overload. Poorly designed and placed signs and their over-provision detract from the environment, and affect road safety by distracting the road user.

Methodology

A detailed description of the methodology used to produce this review is provided in the methodology section] of the Observatory website at <http://www.roadsafetyobservatory.com/Introduction/Methods>.

This synthesis was compiled during July 2012.

The majority of research referred to in this synthesis is identified as relating to signs and markings as defined by the DfT Traffic Signs Manual. However, some research relating to traffic signals and advertising signs was also consulted. This was deemed appropriate where the focus is on safety issues and RTI prevention.

The steps taken to produce this synthesis are outlined below:

- **Identification of relevant research** – searches were carried out on pre-defined research (and data) repositories. However, some additional information sources were consulted at the suggestion of a subject matter expert.
 - A total of 67 relevant pieces of research were identified.
 - Of these, 49 pieces of research originate from the UK.
- **Initial review of research** – primarily involved the sorting and ranking of the 66 research items, to ensure the most relevant and effective research was identified and went forward for inclusion in the synthesis. Key criteria included:
 - Relevance – there has been a conscious effort to focus on work relevant to road signs and markings and not to duplicate research included in other syntheses (traffic calming, safe route planning and crash mitigation etc), so far as possible.
 - Transparency and author type – whether the research was produced by a governmental, academic, trade association or other source and the extent to which referencing and data sources within the research are clear and transparent.
 - Age of research – whether the research has been published within the last 10 years (exceptions are made for noteworthy items which are older).
 - Interventions – whether the research proves (or disproves) effective interventions to improve road safety and the magnitude of the impact on road safety.
- **Detailed review of research** – key facts, figures and findings were extracted from each piece of research to highlight relevant topic issues.
- **Compilation of Synthesis** – the output of the detailed review was analysed for commonality and a synthesis written in the agreed format. Note that the entire process from identifying research to compiling the synthesis was a time-bound exercise.
- **Review** – the draft synthesis was subjected to extensive review by a subject matter expert, proof reader and the DfT's Evidence Review Panel.

Please note that the terms Great Britain and UK have been reproduced in this synthesis as they have been used in the associated references.

Key statistics

This section collates key statistics relating to signs and markings.

Clutter and distraction

- Driver distraction constitutes an important factor of increased risk of road RTIs worldwide. It is thought that RTIs caused by distraction are underestimated and underreported.
- Percentage estimates of driving time when a driver's attention is directed to roadside scenery (including signs) vary from less than 20 per cent to 50 per cent.

(D. Crundall, 2006)

- Up to 30 per cent of all RTIs are thought to have driver distraction as a contributory factor, and that, of these, roughly a third are thought to be specifically caused by external-to-vehicle driver distraction (including signs, signals and markings). Young (aged 17-21) drivers are particularly prone to external-to-vehicle driver distraction.

(B. Wallace, 2003)

- Research syntheses developed by the European Transport Safety Council (ETSC) revealed that external distractions are thought to cause 2 per cent of fatal road RTIs and 1 per cent of total road RTIs. Visual impairments (which could include those caused by signs) are thought to account for 27 per cent of fatal RTIs and 24 per cent of total RTIs associated with external distractions.

(ETSC, 2011)

Simplified schemes

- Too many signs are shown to cause cluttering and mental overload. Too few signs can cause confusion and uncertainty.
- The simplification of road markings and the removal of unnecessary signs on Kensington High Street in London contributed to a 48.6 per cent annual reduction in total RTIs (compared to a 37.2 per cent reduction for the borough on average). An improvement in pedestrian facilities is also thought to have contributed to this improvement.
- A trial in the village of Starston in Norfolk found that the removal of unnecessary central white lines reduced average speeds by 7 mph. A similar study in Wiltshire showed a 35 per cent reduction in RTIs following the removal of unnecessary central white lines.

(A. Quimby and J. Castle, 2006)

Roadside advertising

- There is growing concern that roadside advertising presents a real risk to driving safety. A recent National Highway Traffic Safety Administration (NHTSA) study into the effects of roadside advertising in the USA found distraction (internal or external to the vehicle) to be a factor in 78 per cent of RTIs and in 65 per cent of near-RTIs in areas where roadside advertising is prevalent.

(V.L. Neale et al., 2005)

- 22 per cent of questionnaire respondents in a trial by King Saud University (Saudi Arabia) state that they have experience of being put in a dangerous driving situation due to distraction by advertising signs.

(S. Bendak and K. Al-Saleh, 2010)

- In a 2005 survey by Privilege Insurance, over a quarter of drivers admitted to having experience of losing concentration due to roadside adverts, with 41 per cent reporting that they had been distracted for up to five seconds.

(A.S Wikman et al., 1998)

Speed limits and speed management

- In a study of the impacts of the implementation of 250 new 20 mph zones in residential areas it was found that average speeds had fallen by nine miles per hour and that the annual number of RTIs had fallen by 60 per cent (67 per cent reduction in RTIs involving children and 29 per cent reduction in RTIs involving cyclists).
- However, the use of 20 mph signs alone, without associated traffic calming methods, only led to speed reductions, on average, of about one mile per hour.

(AECOM, 2009)

- Vehicle Activated Signs (VAS) are a way of making drivers aware of the road environment and the speed at which they are driving. VAS have been used for speed limit indication and to inform drivers of an upcoming hazard of restriction.
- Trials by TRL for the DfT on the use of VAS to manage traffic speed has shown that the installation of speed limit roundel signs can reduce mean traffic speeds by up to 14 mph on some rural roads.
- VAS at bends and junctions have shown to reduce mean speeds by up to 7 mph, and safety camera repeater signs have shown to yield a reduction of up to 4 mph.
- A one-third reduction in RTIs across trial sites in Norfolk has been experienced following the installation of VAS.

(M. A. Winnett and A. H. Wheeler, 2002)

Signals and crossings

- The main types of RTI at signal-controlled junctions are single vehicle, rear shunts and lane changing RTIs on the approach to the junction, principal right turn RTIs and pedestrian RTIs.
- On average, signalisation reduces RTIs by 15 per cent at 3-arm junctions and 30 per cent at 4-arm junctions.

(J. Kennedy and B. Sexton, 2009)

Improved layouts

- A scheme by Durham County Council to enhance road markings to improve junction clarity has seen a 50 per cent reduction in RTIs and a reduction of speed in a study by a road markings trade association.
- Investigations in the 1970s and 1980s into whether the use of edge lines on rural UK roads reduces the level of night-time RTIs saw a 22 per cent RTI reduction in a trial in East Sussex and a 13 per cent reduction in a trial in South Yorkshire following the addition of white edge lines.

(RSMA, 2007)

Quality of signs and markings

- Research in Canada has shown that inadequate and poorly maintained road markings are often cited as a significant contributing factor to fatal RTIs.

(TRL, 2010)

- Research by a UK road markings trade association has found a correlation between the quality and condition of signs and markings and the number of deaths and serious injuries occurring at locations on UK roads.
- Surveys of UK single-carriageway A-roads and motorways show that road markings in 20 per cent of sections fall below the minimum specifiable standard and should be scheduled for replacement while 8 per cent have centre line markings so worn that they are barely visible.

(RSMA, 2011)

- Using cost benefit analysis, road marking improvements are shown to be amongst the most effective road safety mechanisms available to highways engineers. In the first year rate of return from these schemes can exceed 500 per cent and can frequently be in excess of 1,500 per cent. This is as a direct result of the relatively low level capital cost of road markings and the relatively high level safety gains from their utilisation.

(RSMA, 2007)

Research findings

Summaries of key findings from several research reports are given below. Further details of the studies reviewed, including methodology and findings, are given in the References section.

Purpose of signs and markings

- Clear and efficient signing and marking is an essential part of highway and traffic engineering. Road users depend on signing for information and guidance; highway authorities depend on signing for the efficient working and the enforcement of traffic regulations, for traffic control, to inform road users of local information (tourist attractions etc) and as an aid to road safety.
- Signing and carriageway markings should comply with the Traffic Signs Regulations and General Directions (TSRGD). Any signs that are not prescribed in the TSRGD must be authorised by the Secretary of State.
- Highway authorities are responsible for ensuring correct standards of signing on their roads; only they can erect traffic signs or permit their erection. The Police also have certain rights and responsibilities.
- Signs are used to control and guide traffic and to promote road safety. They should only be used where they can usefully serve these functions.
- It is important that signs giving effect to traffic regulation orders, and intended to be read from a moving vehicle, are of sufficient size to enable drivers to recognise them and assimilate the information in time.

(DfT, 1982)

- A review of direction signs used on Great Britain's roads by the Department for Transport in 1987 led to the recommendations that there should be an increased use of warning and regulatory signs to give drivers advanced information on hazards and restrictions ahead, thereby improving road safety.

(R.T. Stirland *et al.*, 1987)

- Trials in Guildford carried out for the DfT in 1989 into how direction signs on Great Britain's roads could be improved to be more informative and effective led to recommendations for an increased use of warning and regulatory signs and measures to improve consistency and reduce sign clutter.

(R. Ball and T. Doherty, 1989)

- Warning signs are used to alert drivers to potential danger ahead. This may include obstructions, two-way traffic, pedestrians, water on the road and bridges and other structures. They indicate a need for special caution by road users and may require a reduction in speed or some other manoeuvre.

(DfT, 1982)

- Regulatory signs indicate requirements, restrictions and prohibitions. Most are erected to give effect to a traffic regulation order or other statutory provision.
- It is essential that drivers have an unobstructed view of traffic signs. The distance which should be kept clear of obstructions to the sight line, whether caused by vegetation, other signs or street furniture, is known as the clear visibility distance. The higher the prevailing traffic speeds and the higher number or complexity of signs or markings in a particular location, the greater the clear visibility distance needs to be.

(DfT, 2008)

- Negative impacts of signs include street clutter, maintenance liabilities and cost, and driver distraction and roadside hazards. Positive impacts of signs include accident prevention, observation of laws and traffic flow smoothing.
- Fixed road signs provide permanent information about conditions that occur at a particular place. In reality, conditions are often changing: hazards may arise due to weather conditions (i.e. fog, rain, ice), traffic conditions (i.e. tail-backs, heavy traffic) or to the unexpected (i.e. accident, fallen trees, subsidence).

(DfT, 2011)

- In the last decade changes to European product standards have allowed road markings to be more clearly specified in a manner to define their performance requirements for safety and delineation on the highway.

(RSMA, 2007)

Clutter and distraction

- Poorly designed and placed signs and their over-provision detract from the environment, and affect road safety by distracting the road user.
- Visual clutter is thought to impact driver safety in three ways; through distraction from the driving task, through impairing visual search and through increasing mental workload.

(DfT, 2011)

- Research has shown that the greater the number of signs which drivers are presented with simultaneously, the greater the difficulty they are likely to have in assimilating the information and will experience information overload.
- The problem in dealing with information overload has shown to typically be highest in older drivers and in younger, inexperienced drivers.
- Generally, not more than two signs should be erected on any one post when intended to be read from an approaching vehicle.

(DfT, 1982)

- Evidence suggests that there are two specific situations where the risk factor of sign clutter is at its highest: at junctions, and on long monotonous roads (such as motorways).
(B. Wallace, 2003)
- Visual clutter can hinder sign acquisition and can confuse drivers through increasing the time required to process the information given.
(G. Ho *et al.*, 2001)
- The Australian Transport Accident Commission states that the amount of external information presented to drivers is increasing and finding a sign in highly cluttered scenes is difficult, especially at junctions.
- It is thought that advertising signs that include movement or flashing lights are likely to be more distracting, and there is some evidence that signage of this type near junctions is a particular problem.
(Parliament of Victoria Road Safety Committee, 2006)
- Analysis of eye movement demonstrated that glances away from the road for more than two seconds significantly increase the risk of being involved in a RTI, or near-RTI.
- There are few published studies on distractions caused by Variable Message Signs (VMS) and advertising. These studies have shown that drivers attempt to compensate for the visual demands of VMS displaying messages by driving more slowly, thereby keeping the sign in view for longer.
- VMS placed at street level appear to have a larger distracting effect in potentially hazardous situations.
(D. Basacik and A. Stevens, 2008)

Simplified schemes

- In recent years there has been an increasing interest in traffic management schemes aimed at simplifying the road environment. Some of these schemes include the removal of unnecessary signs to reduce complexity and driver confusion.
- RTI and casualty data does not yet provide a sufficient safety case for simplified streetscapes. However, there is a lack of full analysis of existing trials.
- There is some concern that over-simplifying streetscapes may lead to some motorists abusing the lack of signs and instructions, for example, by speeding or ignoring priority norms (such as turning priorities at junctions).
(A. Quimby and J. Castle, 2006)

Roadside advertising

- Roadside advertising signs can affect drivers by:
 - Directly distracting or confusing them while driving.
 - Indirectly distracting drivers from the driving task by moving or giving the appearance of motion.
 - Taking drivers' eyes off the road, which will give them a slower reaction time to road hazards.
 - Obstructing visibility, e.g. at intersections or driveways.
 - Presenting a physical obstruction to vehicles moving.
 - Diverting their attention from important roadside warning signs which might, in turn, put them and other road users at risk.
- Driver simulator experiments show that two driving performance indicators, drifting from lane and accidentally crossing dangerous intersections, are particularly worse when advertising signs are present than when they are not.

(S. Bendak and K. Al-Saleh, 2010)

- Whilst the risk of roadside advertisements on driver attention is not nearly as great as that from in-car distractions, evidence is mounting that roadside distractions (and advertising in particular) present a 'small but significant' risk to driving safety.

(V. L. Neale, 2005)

- Reviews of RTI rates associated with advertising signs seem to show that these signs are correlated with higher RTI rates, particularly in certain situations such as at junctions, when driver workload is very high or very low.

(J. Edquist et al., 2011)

- A Finnish Road Administration study found that all recorded RTIs in which advertisements had in one way or another contributed to the occurrence of an RTI had occurred at a junction.

(Finnish Road Administration, 2004)

- Trials carried out by TRL for TfL show that video-based advertising signs attract driver attention for longer periods of time and have a greater impact on driver behaviour than static advertising signs.

(M. Chattington et al., 2009)

- Street-Level Advertisements (SLAs; predominantly on bus shelters) are shown to cause greater driver distraction and fixation than Raised-Level Advertisements (RLAs).

(D. Crundall, 2006)

- A more consistent and stringent approach to the position, location, installation, use and content of static and scrolling, moving and video-style roadside advertising is required.

(Parliament of Victoria Road Safety Committee, 2006)

Quality of signs and markings

- Great Britain is thought to have one of the safest road networks in the world and the quality and clarity of its traffic signs (including traffic signals and road markings) make a significant contribution to this.
- A nationally consistent traffic sign system has been delivered through legislation and guidance which ensures traffic signs can be seen and readily understood under all common road conditions.

(DfT, 2011)

- Road markings have their limitations. They may be completely obliterated by snow. Their conspicuity is impaired when wet or dirty, and their effective life is reduced if they are subjected to heavy trafficking.
- Road markings in 20 per cent of sections of major A-roads and motorways fall below the minimum specifiable standard and should be scheduled for replacement while 8 per cent have highly worn and barely visible centre line markings.

(RSMA, 2011)

Visual capacity and conspicuity

- The visual capacity of the human eye at night-time is only 5 per cent of its visual capacity during daytime. Visual errors play an important role as a cause of RTIs.
- Coherent, clear and conspicuous traffic signs are an integral part of a traffic system. To be effective, signs must be designed, built and displayed in such a way that the messages they convey are clear, unambiguous, visible and legible.
- The lack of traffic sign conspicuity is often cited as a contributing factor by drivers who are involved in RTIs at junctions. Increasing the conspicuity of safety critical traffic signals will therefore lead to improved safety performance.
- The conspicuity of road signs can be improved by either using retro reflective materials or incorporating internal or external lights into the sign.
- Studies have shown that road markings should be visible during the night to a degree that allows the driver an absolute minimum of 2.5 seconds reaction time. This can be achieved by an adequate width and retro reflectivity specifications.

(ESTC, 2006)

Speed limits and speed management

- While one of the primary objectives of road signs and signals is to provide useful information so that the resulting appropriate behaviour will prevent RTIs, they also indicate legally enforceable speed regulations at specific places.
- Clear and prominent road signs and markings in appropriately spaced sequences make the driver aware, subconsciously but effectively, of the speed at which he is travelling. This leads to the implementation of perceptual countermeasures by drivers, such as reducing travelling speed. Measures shown to effectively lead to effective subconscious speed management and reduction include centre hatching, and changing the colour of the road surface.
- The position and prominence of road signs for speed management are crucial from both a preventive and legal standpoint.
- Particularly for the motorway network, advances in information collection and transmission and communications technologies have made Variable Message Signing (VMS) a feasible option for proactive speed and traffic management.
- Good infrastructure design can induce drivers to reduce speed “instinctively”, i.e. independently of speed limit signs or rules of the road. This is seen on self explaining roads where the design of the road itself effectively informs the driver of the appropriate and legal speed to travel without the need for extensive signage.
- Innovative marking schemes have been shown to encourage compliance with speed limits and with appropriate speeds by, for example, creating the illusion of road narrowing.
- Road signs and signals that are intended to moderate speed will generally lose all their effectiveness if infrastructure operators fail to ensure the messages conveyed are consistent with actual road conditions at any given time.
- Inappropriate speed limits ultimately destroy the credibility of the signs and signals.

(OECD and ECMT Road Safety Group, 2009)

- The 2002 Traffic Signs Regulations and General Directions leaflet states that for 30 mph lit roads, no repeaters are permitted. On lit roads subject to any other speed limit (other than 20 mph limit zones), repeaters must be used.
- A road with regular street lighting has a default speed limit of 30 mph unless signs indicate otherwise. The entry to a 30 mph zone must be marked with a “30” sign on both sides of the road. Where there is no street lighting, the default speed limit is 60 mph for single-carriageway and 70 mph for dual carriageway roads. This is referred to as the National Speed Limit (NSL). Entry to NSL zones are marked with a sign with a diagonal black stripe on a white background.

- These regulations have arguably led to some confusion over what the correct speed limit for a road might be, particularly when there is no street lighting. Such confusions may lead to inadvertent speeding.

(DfT, 2002)

- Vehicle Activated Signs (VAS) are a way of making drivers aware of the road environment and the speed at which they are driving. VAS have been used for speed limit indication and to inform drivers of an upcoming hazard or restriction.

(M. A. Winnett and A. H. Wheeler , 2002)

- The Department for Transport have proposed strengthening guidance on the use of 20 mph speed limits and for encouraging the use of zones and limits in the vicinity of town centres, schools, shops and playgrounds.

(AECOM, 2009)

Traffic calming

- Traffic calming features generally need supporting by traffic signs to ensure the features are clearly visible to approaching drivers at all times.
- Traffic calming schemes, particularly when introduced in rural situations where the aim is to reduce speeds, sometimes result in a significant increase in the number of warning signs in advance of the traffic calmed area.
- VAS devices are particularly useful on the approaches to bends and junctions where motorists may be unable to judge a safe speed until they are in the bend, or are unaware of side road visibility restrictions.
- White lining can have a significant part to play in traffic calming schemes and can bring about driver behavioural change, although benefits are likely to be greatest when used in combination with other techniques.
- Experience has indicated that the clearer the road marking layout, the more positive will drivers be in their actions and general behaviour.
- However, clear markings can sometimes lead to more aggressive driving as drivers “claim” their priority, with a resulting increase in speeds. Additionally, wider, clearly defined lane widths, with their feeling of spaciousness, can promote a feeling of comfort and create a road environment considered suitable for higher speeds.

(IHT and the County Surveyors’ Society, 2005)

Engineering interventions

- Research indicates that the rates of return from road safety schemes involving improved road markings and signage, in all types of location on the highway, lead to a safer travelling environment for road users.

(RSMA, 2007)

- The Department for Transport has identified a series of engineering interventions as being effective at delivering road safety. This includes:
 - Traffic-calming features – to control vehicle speeds;
 - Signs and lines (including hazard warnings) – to educate and inform road users, influencing their behaviour such as adjusting speeds to match prevailing road conditions;
 - Speed limit review (including signage) – to ensure that prevailing speed limits are appropriate to the network conditions and to influence road user behaviour; and,
 - Vehicle activated signs (VAS) – to provide drivers with feedback as to their speed or potential risks, such as sharp bends or poor forward visibility.

(AECOM, 2011)

- Improved road safety can also be achieved by improving road layout to assist drivers at bends and junctions. This can be achieved by consistency of design and siting of road markings and signs.

(OECD and ECMT Road Safety Group, 2009)

- Self-explaining roads encourage the driver to naturally adopt behaviour consistent with the design and function. Different classes of roads should be distinctive, and within each class features such as width of carriageway, road markings, signing, and use of street lighting should be consistent throughout the route. Drivers can thereby perceive the type of road and "instinctively" know how to behave. The environment effectively provides a "label" for the particular type of road and therefore there is less of a need for separate traffic control devices such as additional traffic signs to regulate traffic behaviour.

(IHT and the County Surveyors' Society, 2005)

- The use of warning signs and markings should be kept to a minimum as their unnecessary use may breed disrespect for all signs and markings. Warning signs should be removed where the danger or hazard is seasonal or temporary.

(CTC & Associates LLC, 2010)

- Road markings provide continuous information to road users related to the roadway alignment, vehicle positioning, and other important driving-related tasks. Effective road markings can therefore contribute to road safety.
- Effective roadway design and operation practices that improve traffic safety in general, such as edge line and centreline rumble strips, can

warn distracted drivers or can mitigate the consequences of distracted driving.

(G.Yannis, 2011)

- Research in Texas has found that edge-line treatments on rural roads may reduce RTI frequency with the highest safety impacts occurring on curved road segments.
- Greater longitudinal pavement marking retroreflectivity levels have shown to increase drivers' visibility and detection distance. However, increased visibility may also cause drivers to feel too comfortable during night-time conditions and drivers may then pay less attention and/or operate at unsafe speeds. This is defined as 'risk compensation'.
- Solar-powered actively illuminated studs (active studs) could make rural A and B roads safer by improving the delineation of the road layout ahead at night and in poor visibility conditions.

(TRL, 2010)

- DfT research has found that road signs and markings (such as hatchings and VAS) generally achieve better speed reduction results if there is a reason for drivers to slow down (e.g. a sharp bend or a junction) or clearly defined change of speed limit (e.g. a village entry).
- Peripheral hatching and VAS on rural roads and hazard marker posts at rural bends are found to be particularly successful in lowering speeds.
- Peripheral hatching has shown to achieve greater speed reductions than central hatching. It is thought that this is due to drivers being guided towards the centre of the carriageway, thus affecting their safety margin.
- Signs and markings with high contrast in relation to their environmental setting play a role in capturing drivers' attention and facilitating speed perception.

(S. Jamson et al., 2008)

- Transverse road markings most commonly used are transverse bars and transverse chevrons. These marking patterns may be an effective measure for reducing speeds when placed at decreasing distances so the spacing between markings is continuously reduced in the direction of movement.
- Reductions in mean driving speed have been reported in studies that implemented transverse markings on the approach to curves. Besides reductions in mean driving speed, reductions in speed variance have also been reported.

(MassSAFE, 2004)

How effective?

- A major improvement scheme carried out in 2000 on Kensington High Street (London) included the simplification of road markings and the removal of street clutter and unnecessary signs. Before and after studies have found that there was a 48.6 per cent annual reduction in total RTIs (compared to a 37.2 per cent reduction for the borough on average). The highest reduction was seen in RTIs involving pedestrians and motorcyclists.
- A trial in Bury St. Edmunds to reduce the visual intrusion of traffic signs found that as a result, traffic flow reduced by 13 per cent and the 85th percentile speed reduced by 2 mph to 20 mph.
- A trial in the village of Starston in Norfolk found that the removal of central white lines reduced average speeds by 7 mph. A similar study in Wiltshire showed a 35 per cent reduction in RTIs and a 5 mph reduction in average speeds.

(A. Quimby and J. Castle, 2006)

- Trials show that at standard roundabouts there was a 28 per cent decrease in total RTIs after the installation of signals. There were significant casualty reductions in most categories, with the largest reduction seen in RTIs involving a pedal cycle which reduced by 80 per cent.

(TfL, 2005)

- Durham County Council have undertaken extensive improvement work to junction layouts throughout the county. This includes enhanced road marking to improve layout clarity. These improvements have seen a 50 per cent reduction in RTIs and a reduction of speed in the 85th percentile.
- Throughout the 1970s and 1980s several studies were undertaken to identify whether the use of edge lines on rural UK roads reduced the level of night-time RTIs. In East Sussex a 22 per cent reduction in total RTIs was seen following edge line application, with a 13 per cent reduction seen in South Yorkshire.

(RSMA, 2007)

Gaps in the research

- Signage may contribute to driver distraction, but the extent to which this is so and the types of signs that are potential problems are uncertain. There is a need for further research to understand the role of signs in distracting drivers.

(Parliament of Victoria Road Safety Committee, 2006)

- Estimates of the role of driver distraction in RTI causation can vary widely due to the lack of a standardised definition and inconsistencies in RTI reporting.

(D. Basacik and A. Stevens, October 2008)

- Most research into external driver distraction originates in the USA or Australia. It is recommended that further research is carried out in the UK.

(B. Wallace, 2003)

- The OECD recommends that the gathering and processing of RTI data is improved so that, on a comparable basis, the causes and impacts of RTIs can be accurately identified and adequate measures taken and subsequently evaluated, particularly from the standpoint of cost-effectiveness.

(OECD and ECMT Road Safety Group, 2009)

- There is research pointing to the effectiveness of warning signs in reducing RTIs but there is a distinct lack of research on the effectiveness of regulatory and guidance signs.

(CTC & Associates LLC, 2010)

- There is a lack of research into white lining on road works scenarios and their impact of RTIs (i.e. through causing driver confusion).
- The impact of age and driver experience on distraction and problems in dealing with information overload has not yet undergone significant investigation.
- There is a lack of research on the potential for simplified schemes to lead to some motorists abusing the lack of signs and instructions, for example, by speeding or ignoring priority norms.

References

Department for Transport research and statistics

Title: Traffic Signs Policy Paper, Signing the Way
Author / organisation: Department for Transport
Date: October 2011
Format: pdf
Link: http://assets.dft.gov.uk/publications/signing-the-way/signing-the-way.pdf
Free / priced: Free
Objectives: Sets out a policy framework for ensuring the traffic sign system in Great Britain meets the future needs of all road users, while building upon the existing and established traffic sign system. It sets out recommendations for improving the information that traffic signs communicate to road users by providing more freedom for decisions about signing at the local level.
Methodology: Collation of traffic signs policy in Great Britain.
Key findings: <ul style="list-style-type: none">• Great Britain has one of the safest road networks in the world and the quality and clarity of our traffic signs (including traffic signals and road markings) make a significant contribution to this.• Poorly designed and placed traffic signs and their over-provision detract from the environment, and affect road safety by distracting the road user.• Traffic signs can clutter the highway network if used to excess. Traffic sign clutter is unattractive and is a potential distraction to road users.• Recommends that a clear policy context for only placing traffic signs where they are required is set and that local authorities take a wider policy approach to designing and delivering traffic signs which positively impact on the local environment.
Themes: Signs, policy, legislation
Comments: Robust government document

<p>Title: Delivery of Local Road Safety (Road Safety Research Report No. 124)</p>
<p>Author / organisation: AECOM in association with Tavistock Institute prepared for the Department for Transport</p> <p>Date: September 2011</p> <p>Format: pdf</p> <p>Link: http://assets.dft.gov.uk/publications/rsrr-124/rsrr-124-report.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: In 2008 the Department for Transport commissioned AECOM, in association with the Tavistock Institute, to design and deliver a three-year independent evaluation of local road user safety. This report presents a summary of the main findings. The evaluation was commissioned to consider the following objectives:</p> <ul style="list-style-type: none"> • To evaluate the different strategies and plans for delivering road user safety; • To assess what is being delivered, the key processes and how efficient Local Highway Authority (LHA) practices are; and, • To identify lessons and areas of good practice in road user safety investment.
<p>Methodology: The evaluation methodology consisted of a series of integrated activities, focused around the use of case study local authorities. The evaluation approach incorporated the key 'policy stages' commonly adopted in local road safety:</p> <ul style="list-style-type: none"> • Strategic level assessment of policies and plans, designed to generate road safety improvements as well as wider economic, social and environmental benefits (the rationale for investment); • Authority-level review of 'the road safety function' (i.e. how the objectives and scope of road safety are derived from the overarching rationale); • Evaluation of delivery practices and programmes (how local authorities deliver local road safety, the money invested (inputs) and interventions delivered (outputs); and • Detailed evaluation of individual interventions (the outcomes and impacts of investment).
<p>Key Findings:</p> <ul style="list-style-type: none"> • Interviewees identified a series of engineering interventions as being effective at delivering rural road safety. This included: <ul style="list-style-type: none"> ○ Traffic-calming features – to control vehicle speeds; ○ Signs and lines (including hazard warnings) – to educate and inform road users, influencing their behaviour such as adjusting speeds to match prevailing road conditions; ○ Anti-skid and carriageway surface colouring – to address an identified risk factor and potential cause of RTIs/casualties; ○ Pedestrian and cycle crossings – to provide safe crossing points for vulnerable road users, reducing the risk of mode conflicts; ○ Cycle paths – to provide for vulnerable road users, where network capacity exists; ○ Speed limit review (including signage) – to ensure that prevailing speed limits are appropriate to the network conditions and to influence road user behaviour; ○ Vehicle activated signs (VAS) – to provide drivers with feedback as to their speed or potential risks, such as sharp bends or poor forward visibility; ○ Gateway features – to demarcate different network environments and to influence road user behaviours; and, ○ Junction enhancements (site-specific engineering) – to directly address potential risks.
<p>Themes: Road user safety, interventions, signs</p>
<p>Comments: Robust government document</p>

Title: Road Safety Research Report Findings: Review of 20 mph Zone and Limit Implementation in England
Author / organisation: AECOM in association with Tavistock Institute prepared for the Department for Transport Date: 2009 Format: pdf http://webarchive.nationalarchives.gov.uk/20090417002224/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme4/20mphzoneresearch.pdf
Free / priced: Free
Objectives: AECOM, in association with the Tavistock Institute, was commissioned by the DfT to undertake a review of the implementation of 20 mph zones and limits in England. This work was part of the wider Local Road User Safety Evaluation and Action Learning commission. The objective was to enhance the understanding of the different approaches to 20 mph zone and limit use and implementation, and identify the characteristics of recently implemented schemes.
Methodology: The review considered where and when zones and limits are being implemented, the rationale for their use and the characteristics of supporting traffic calming measures. The study findings were derived using a combination of DfT databases and primary data collated from a selection of case study Local Highway Authorities (LHA). In-depth interviews were undertaken with road safety officers at each case study LHA, to explore their strategies and progress to 20 mph and limit delivery.
Key Findings: <ul style="list-style-type: none"> • A review of 250 residential areas where 20 mph zones had been implemented found that average speeds had fallen by nine miles per hour and that the annual number of RTIs had fallen by 60 per cent (67 per cent reduction in RTIs involving children and 29 per cent reduction in RTIs involving cyclists). • However, the use of 20 mph signs alone, without associated traffic calming methods, only led to speed reductions, on average, of about one mile per hour. • DfT have proposed strengthening guidance on the use of 20 mph speed limits and encouraging the use of zones and limits in the vicinity of town centres, schools, shops and playgrounds.
Themes: Safety, speed, signs
Comments: Robust government document. Focuses on speed management.

<p>Title: Interaction between speed choice and road environment (Road Safety Research Report No. 100)</p>
<p>Author / organisation: S. Jamson, F. Lai, H. Jamson, A. Horrobin and O. Carsten, Institute for Transport Studies, University of Leeds prepared for Department for Transport.</p> <p>Date: November 2008</p> <p>Format: pdf</p> <p>Link: http://webarchive.nationalarchives.gov.uk/20110504093109/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme4/interaction/</p> <p>Free / priced: Free</p>
<p>Objectives: To identify the most effective, low-cost speed-reducing measures for a selection of urban and rural environments.</p>
<p>Methodology: The overall approach consisted of three steps: Stage 1 - a review of previous experience with speed-reduction treatments; Stage 2 - applying expert judgement to the information gathered in Stage 1 to design a range of treatments for each of the problem areas and road types; and Stage 3 - simulator experiments to identify the most promising treatments.</p>
<p>Key Findings:</p> <p>The review focused on how engineering design contributes to speed reduction. Findings from the consultation of research literature, analysis of existing data local authority survey, and simulator experiments include:</p> <ul style="list-style-type: none"> • Treatments generally achieved better results if there was a reason for drivers to slow down (e.g. a sharp bend or a junction) or clearly defined change of speed limit (e.g. a village entry). • Physical treatments, including those that featured sensory feedback, achieved the lowest spot speed on urban roads, while rural roads were found to be amenable to peripheral hatching and vehicle-activated signs. Hazard marker posts at rural bends were also found to be successful in lowering speeds. • Peripheral hatching achieved superior results compared to central hatching, presumably due to the fact that drivers were guided towards the centre of the carriageway, thus affecting their safety margin. • Treatments with high contrast in relation to their environmental setting also played a role in capturing drivers' attention and hence facilitating speed perception.
<p>Themes: Signs, policy, legislation</p>
<p>Comments: Robust government document</p>

<p>Title: Scoping Study of Driver Distraction (Road Safety Research Report No. 95)</p> <p>Author / organisation: D. Basacik and A. Stevens, Transport Research Laboratory prepared for the Department for Transport</p> <p>Date: October 2008</p> <p>Format: pdf</p> <p>Link: http://webarchive.nationalarchives.gov.uk/20090417002224/http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/report95.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: This report was commissioned to understand the state of knowledge on driver distraction and lay some groundwork for future distraction research efforts, with the strategic aim of improving safety through policy interventions. The main objectives of the project were:</p> <ul style="list-style-type: none"> • to prepare a definition of driver distraction and secure at least UK agreement on its adoption; • to summarise and critically review research on driver distraction from sources both within and outside the vehicle and to identify gaps in knowledge; and • to provide recommendations for future research and for monitoring changes in the impact of driver distraction.
<p>Methodology: A core and wider reference group of scientists who are research-active in the area of driver distraction were identified at the beginning of the project to review the work and participate in workshops. A distraction definition discussion document was then produced, along with a distraction review document. These were circulated among the reference groups and discussed during two workshops.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • Estimates of the role of driver distraction in RTI causation can vary widely due to the lack of a standardised definition and inconsistencies in RTI reporting. Nevertheless, a study of naturalistic driving behaviour found that inattention contributed to 78 per cent of RTIs (Neale et al., 2005). • External distractions (e.g. from outside persons, objects, events) are the most frequently reported cause of distraction-related RTIs (Stutts et al., 2001). • A small number of US studies have shown that advertising billboards have led to an increase in RTI rates. • Analysis of eye movement demonstrated that glances away from the road for more than two seconds significantly increase the risk of being involved in a RTI, or near-RTI, while those less than two seconds do not appear to significantly increase risk beyond baseline driving (Klauer et al., 2006). • There are few published studies on distractions external to the vehicle, such as variable message signs (VMS) and advertising. These studies have shown that drivers attempt to compensate for the visual demands of VMS displaying messages by driving more slowly, thereby keeping the sign in view for longer. • Signs and advertisements placed at street level appear to have a larger distracting effect in potentially hazardous situations.
<p>Themes: Signs and markings, distraction, safety, RTI causation</p>
<p>Comments: Robust government document, However, the report focuses more on psychological reasons behind distraction.</p>

Title: Traffic Signs Manual – Chapter 3 – Regulatory Signs
Author / organisation: Department for Transport, Department for Regional Development (Northern Ireland), Scottish Executive and Welsh Assembly Government
Date: 2008
Format: pdf
Link: http://assets.dft.gov.uk/publications/traffic-signs-manual/traffic-signs-manual-chapter-03.pdf
Free / priced: Free
Objectives: This manual sets out the codes to be followed in the use, siting, and illumination of regulatory signs both on all-purpose roads and motorways. It also covers temporary signs for use in connection with road works.
Methodology: Collation of UK legislation, policy and guidance on the use of regulatory signs on all-purpose roads and motorways.
Key Findings: <ul style="list-style-type: none"> • Regulatory signs indicate requirements, restrictions and prohibitions. Most are erected to give effect to a traffic regulation order or other statutory provision. • Regulatory signs either give positive instructions or indicate a prohibition. • It is important that signs giving effect to traffic regulation orders, and intended to be read from a moving vehicle, are of sufficient size to enable drivers to recognise them and assimilate the information in time. • It is essential that drivers have an unobstructed view of traffic signs. The distance which should be kept clear of obstructions to the sight line, whether caused by vegetation, other signs or street furniture, is known as the clear visibility distance. The higher the prevailing traffic speeds, the greater this distance needs to be.
Themes: Signs and markings, policy, legislation
Comments: Robust government document

Title: Traffic Signs Manual – Chapter 4 – Warning Signs
Author / organisation: Department for Transport, Department for Regional Development (Northern Ireland), Scottish Executive and Welsh Assembly Government
Date: 2004
Format: pdf
http://assets.dft.gov.uk/publications/traffic-signs-manual/traffic-signs-manual-chapter-04.pdf
Free / priced: Free
Objectives: This manual sets out the codes to be followed in the use, siting, and illumination of warning signs both on all-purpose roads and motorways. It also covers temporary signs for use in connection with road works.
Methodology: Collation of UK legislation, policy and guidance on the use of warning signs on all-purpose roads and motorways.
Key Findings:
<ul style="list-style-type: none"> • Warning signs are used to alert drivers to potential danger ahead. They indicate a need for special caution by road users and may require a reduction in speed or some other manoeuvre. • Appropriate warning signs can greatly assist road safety. To be most effective, however, they should be used sparingly. Their frequent use to warn of conditions which are readily apparent tends to bring them into disrepute and detracts from their effectiveness. Unjustified signing should not be used at individual locations simply in response to complaints from the public. Care should be taken to ensure a route is treated consistently, especially where it crosses the boundary between two traffic authorities. • Warning signs warn drivers of hazards. This includes junctions, two-way traffic, traffic signals, pedestrians, water on the road and bridges and other structures.
Themes: Signs and markings, policy, legislation
Comments: Robust government document

Title: Traffic Signs Manual – Chapter 5 – Road markings
Author / organisation: Department for Transport, Department for Regional Development (Northern Ireland), Scottish Executive and Welsh Assembly Government
Date: 2003
Format: pdf
http://assets.dft.gov.uk/publications/traffic-signs-manual/traffic-signs-manual-chapter-05.pdf
Free / priced: Free
Objectives: This manual sets out the codes to be followed in the use of road markings both on all-purpose roads and motorways.
Methodology: Collation of UK legislation, policy and guidance on the use of road markings on all-purpose roads and motorways.
Key Findings:
<ul style="list-style-type: none"> • Road markings serve a very important function in conveying to road users information and requirements which might not be possible using upright signs. They have the advantage that they can often be seen when a verge-mounted sign is obscured, and, unlike such signs, they can provide a continuing message. • Road markings have their limitations. They may be completely obliterated by snow. Their conspicuity is impaired when wet or dirty, and their effective life is reduced if they are subjected to heavy trafficking. • Road markings make a vital contribution to safety, e.g. by clearly defining the path to be followed through hazards, by separating conflicting movements and by delineating the road edge on unlit roads at night.
Themes: Signs and markings, policy, legislation
Comments: Robust government document

Title: The Traffic Signs Regulations and General Directions (TSRGD) 2002
Author / organisation: Department for Transport Date: 2002 Format: pdf Link: http://www.legislation.gov.uk/ukxi/2002/3113/pdfs/ukxi_20023113_en.pdf Free / priced: Free
Objectives: The TSRGD 2002 prescribes the designs and conditions of use for traffic signs to be lawfully placed on or near roads in England, Scotland and Wales.
Methodology: Collation of regulations and legislation for the design, siting and enforcement of traffic signs.
Key Findings: <ul style="list-style-type: none"> • Traffic signs are essential for the implementation of traffic management schemes and for the enforcement of road traffic law. • For 30 mph lit roads, no repeaters are permitted. On lit roads subject to any other speed limit (other than 20 mph limit zones), repeaters must be used. • A road with regular street lighting has a default speed limit of 30 mph unless signs indicate otherwise. The entry to a 30 mph zone must be marked with a “30” sign on both sides of the road. Where there is no street lighting, the default speed limit is 60 mph for single-carriageway and 70 mph for dual carriageway roads. This is referred to the National Speed Limit (NSL). • Entry to NSL zones are marked with a sign with a diagonal black stripe on a white background.
Themes: Signs and markings, policy, legislation
Comments: Robust government document

<p>Title: Vehicle-activated signs – a large scale evaluation</p> <p>Author / organisation: M. A. Winnett and A. H. Wheeler, TRL prepared for the Department for Transport</p> <p>Date: 2002</p> <p>Format: pdf</p> <p>Link: https://trl.co.uk/reports/TRL548</p> <p>Free / priced: Free</p>
<p>Objectives: To assess the impact of vehicle activated signs on driver speed, RTI numbers and driver understanding of signs (including any regional differences).</p>
<p>Methodology: Vehicle activated signs were installed at 62 trial sites, mainly on rural single carriageway roads. This includes speed limit roundels, bend warnings, junction warnings and safety camera repeater signs. The effectiveness of these installations was assessed through:</p> <ul style="list-style-type: none"> • Review of before and after collection of speed data • Review of before and after RTI data <p>Nearly 450 drivers took part in opinion surveys at three locations in Norfolk and one in Wiltshire. Opinions were sought about the four sign types.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • At the speed limit roundel signs, mean speeds of the traffic as a whole were reduced by between 1 mph and 14 mph • The junction and bend warning signs reduced mean speeds by up to 7 mph, and the safety camera repeater signs yielded a reduction of up to 4 mph. • There has been a one-third reduction in RTIs across all of the Norfolk sites combined when compared with the number of RTIs that would have been expected without the signs. • Safety camera repeater signs appear to give small additional RTI reductions over safety cameras alone. • There was overwhelming approval of the signs. Most drivers had made the connection between their own speed and the signs being triggered.
<p>Themes: Safety, speed, signs</p>
<p>Comments: Robust government document. Focuses on speed management.</p>

Title: Guildford Direction Signs Demonstration Project
Author / organisation: R. Ball and T. Doherty, Highways and Transportation Volume 36, Institution of Highways and Transportation. Date: 1989 Format: pdf Link: http://trid.trb.org/view.aspx?id=313241 Free / priced: Available for a fee
Objectives: A trial of new sign designs in Guildford to demonstrate how direction signs can be improved to be more informative and effective.
Methodology: Arising from the 1987 DfT Direction Signs Review, this demonstration project by Surrey County Council and Guildford Borough Council trialled various new sign designs and collated comments and feedback on the proposed new designs prior to recommending them for incorporation into a revision of the Traffic Signs Regulations.
Key Findings: <ul style="list-style-type: none"> • The review recommended a series of measures to improve the quality of direction signing in Britain. Many of the techniques demonstrated were taken forward into a revision of the Traffic Signs Regulations. • Measures trialed included changes to the colouring of some direction signs, increased use of warning and regulatory signs and the introduction of junction name signs on all-purpose roads. • The new measures provided a greater emphasis on route status, reduces the risk of inconsistency in signing and reduces sign clutter.
Themes: Signs and markings, policy, legislation
Comments: Robust government document but dated (1991)

Title: Report on the Direction Signs Review
Author / organisation: R.T. Stirland, B.R.A Blaxall and B.J.Bennett, TRRL. Date: 1987 Format: pdf Link: http://trid.trb.org/view.aspx?id=280136 Free / priced: Available for a fee
Objectives: To review the system of directional traffic signs on all types of road and to consider whether additional information or changes to directional signing would be useful for road users.
Methodology: Review of the system of directional signs in the 1980s and the identification and formation of recommendations for how the system could be changed or improved to enhance the efficiency of these signs. Undertaken through an extensive consultation process with a wide range of representative bodies and organisations (including local authorities, police and road user bodies).
Key Findings: <ul style="list-style-type: none"> • The review led to a number of changes to the system of directional signs in the UK. This includes: <ul style="list-style-type: none"> ○ Updated advice on sign design, siting, consistency and continuity ○ The use of junction nameplates on all-purpose roads ○ Investment into new technologies for variable message traffic signs ○ Increased use of warning and regulatory signs on directional signs to give drivers advanced information on hazards and restrictions ahead
Themes: Signs and markings, policy, legislation
Comments: Robust government document but dated (1987)

Title: Traffic Signs Manual - Chapter 1 - Introduction
<p>Author / organisation: Department for Transport, Department for Regional Development (Northern Ireland), Scottish Executive, Welsh Assembly Government</p> <p>Date: 1982 (updated in 2004)</p> <p>Format: pdf</p> <p>Link: http://assets.dft.gov.uk/publications/traffic-signs-manual/traffic-signs-manual-chapter-01.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: This manual sets out the codes to be followed in the use, siting, and illumination of signs both on all-purpose roads and motorways. It also covers temporary signs for use in connection with roadworks, in emergency by the Police, and temporary route signing by motoring organisations and highway authorities.</p>
<p>Methodology: Collation of UK legislation, policy and guidance on the use of signs on all-purpose roads and motorways.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • Clear and efficient signing is an essential part of highway and traffic engineering. Road users depend on signing for information and guidance; highway authorities depend on signing for the efficient working and the enforcement of traffic regulations, for traffic control, and as an aid to road safety. Signing includes not only signs on posts but also carriageway markings, beacons, studs, bollards, traffic signals and other devices. • Signs must give road users their message clearly and at the correct time. The message must be unambiguous and speedily understood; it must be given not too soon for the information to have been forgotten before it is needed, and not too late for the safe performance of consequent manoeuvres. • Highway authorities are responsible for ensuring correct standards of signing on their roads; only they can erect traffic signs or permit their erection. The Police also have certain responsibilities. • Signs are used to control and guide traffic and to promote road safety. They should only be used where they can usefully serve these functions. Warning signs will not, for instance, promote road safety if used widely where there is no unusual degree of danger.
<p>Themes: Signs and markings, policy, legislation</p>
<p>Comments: Robust government document</p>

Other Works

Title: Distracted Driving, European Transport Safety Lecture (Athens, 7 November 2011)
Author / organisation: G. Yannis, European Safety Transport Council (ESTC)
Date: November 2011
Format: Powerpoint presentation in pdf
Link: http://www.etsc.eu/documents/ETSL-Yannis17.pdf
Free / priced: Free
Objectives: Presentation on driver distraction and RTIs. Based on a study conducted in Greece to identify the causes of driver distraction (internal and external distractions) and methods of reducing driver distraction and therefore RTIs.
Methodology: The presentation provides a summary of findings from a study carried out in Greece on distractions during driving. The study consisted of a comprehensive international literature review (90+ studies) and a series of experiments into driver distraction in Greece (including roadside and in-vehicle observation, questionnaires and driver simulation exercises). The focus of the study is distraction due to mobile phone use (internal distraction) and distraction due to advertising signs (external distraction).
Key Findings: <ul style="list-style-type: none">• Driver distraction constitutes an important factor of increased risk of road RTI worldwide.• In existing research, it was revealed that approximately 30 per cent of drivers that were involved in a road RTI reported some source of distraction before the RTI occurred.• External distractions are thought to cause 2 per cent of fatal road RTIs and 1 per cent of total road RTIs. Visual impairments (which could include those caused by signs) are thought to account for 27 per cent of fatal RTIs and 24 per cent of total RTIs).• Research on labels and advertising signs is not conclusive so far as regards their impact on RTI risk.• The location and position of labels and advertising signs might have different impact to the distraction of driver attention.• Labels and advertising signs resembling (in size and form) to traffic signs or other traffic indicators create confusion.• Many effective roadway design and operation practices that improve traffic safety in general, such as edge line and centreline rumble strips, can warn distracted drivers or can mitigate the consequences of distracted driving.
Themes: Distraction, signs, advertising signs, safety, RTI
Comments: Powerpoint presentation only but fairly robust. Signs only form a small part of the analysis. Based on findings of a large number of international studies. Referencing is adequate.

Title: A survey into the quality of road safety markings on Britain's roads
Author / organisation: Road Safety Markings Association (RSMA) Date: March 2011 Format: pdf Link: http://www.roadsafetyknowledgecentre.org.uk/issues/other-issues/knowledge/492.html Free / priced: Free
Objectives: Ninth national investigation conducted by the RSMA into the quality of road safety markings. The objective is to survey and monitor the quality and maintenance of safety markings to see if minimum standards are being met and whether the most cost-effective road safety measure is being applied and maintained adequately to save lives.
Methodology: Road safety markings were surveyed using the Ecodyn System, which measures the reflectivity of centre and lane lines. Ecodyn is installed on a specially equipped vehicle and includes measurement equipment fitted to the outside of the vehicle. The findings relate to site surveys carried out in the autumn of 2010. The survey covers a total of 2,462km of roads.
Key Findings: <ul style="list-style-type: none"> • Britain's most dangerous roads are rural single-carriageway A-roads, where two-thirds of all road deaths and serious injury RTIs take place. • Road users need guidance to tell them what is coming next and where to position the car. Roads without centre lines are like roads without signs: without them, drivers lose vital information to guide them safely. • There is a correlation between the quality of the centre lines and the number of deaths and serious injuries. • On more than 60 of the single-carriageway A-roads surveyed, totalling more than 1,000 miles, on average 14 per cent of road markings are completely worn out; and 29 per cent fall into the "amber" zone and should be scheduled for replacement. Just 29 per cent of lines reach the acceptable level of visibility. • Road markings in one in five sections of major A-roads and motorways fall below the minimum specifiable standard and should be scheduled for replacement while eight per cent have centre line markings so worn that they are barely visible • An amendment to the Specification for Highways Works (SHW) to promote the use of higher specification materials laid 150mm wide is recommended.
Themes: Markings, quality, safety, RTIs
Comments: Fairly robust document produced by an industry body. Statements based on primary research.

Title: Effects of advertising billboards during simulated driving
Author / organisation: J. Edquist, T. Horberry, S. Hosking, and I. Johnston, Monash University, Applied Ergonomics, Volume 42, Issue 4. Date: February 2011 Format: pdf Link: http://www.sciencedirect.com/science/article/pii/S0003687010001274 Free / priced: \$31.50
Objectives: Simulator trials to examine the effects of billboards on drivers, including older and inexperienced drivers who may be more vulnerable to distractions.
Methodology: The experiment examined a range of driver performance measures using a driving simulator. The simulator experiment examined speed and lane change behaviours and also examined visual behaviour. A combination of road types (with varying levels of complexity) were presented to drivers, containing different types and numbers of advertising billboards and different hazard types and warnings. The study assessed how these billboards affected eye movement, visual attention and driver behaviour and also looked at how the effects on young novice drivers and older drivers compare with drivers who were neither old, young nor inexperienced (comparison drivers).

Key Findings:

- Simulator trials show that the presence of billboards changed drivers' patterns of visual attention, increased the amount of time needed for drivers to respond to road signs, and increased the number of errors in this driving task.
- Reviews of RTI rates associated with advertising signs seem to show that these signs are correlated with higher RTI rates, particularly in certain situations such as junctions, when driver workload is very high or very low.
- The presence of billboards in the simulator experiment distracted eye movements away from the road ahead and delayed responses to other road signs. Responses to other road signs were delayed by an average of 0.5 to 1 second in the presence of billboards, in which time a car travelling at 70 km/hour will have travelled almost 20m.
- Eye scanning patterns for novice and older drivers were both more affected by billboards than eye scanning for comparison drivers. Older drivers made more lane change errors overall, but particularly when billboards were present.
- The simulator trials demonstrated that even simple billboards can affect drivers' attentional allocation and performance, therefore having the potential to lead to potentially dangerous driving situations.

Themes: Advertising signs, distraction, RTIs, safety

Comments: Robust academic document.

Title: Current Topics in Transport: Carriageway Marking (2006-2009)

Author / organisation: TRL

Date: February 2010 **Format:** pdf. **Free / priced:** £20
unavailable online

Objectives: To provide a summary of key research carried out between 2006 and 2009 into carriageway marking design and application methods, maintenance and benefits.

Methodology: The report includes over 65 abstracts of reports, conference papers, books and journal articles which focus on the installation, maintenance and effects of carriageway markings including lane markings, rumble strips, warning messages and road studs. The topics covered include visibility at night and on wet roads, types of materials used, correct application, retroreflectivity, design, durability and condition. These items have been selected from the material added to the Transport Research Laboratory's Library Database between 2006 and 2009.

Key Findings:

- One of the most important aspects of a safe and efficient roadway is the uniform application of pavement markings to delineate the roadway path and specific traffic lanes. Markings provide continuous information to road users related to the roadway alignment, vehicle positioning, and other important driving-related tasks.
- It is estimated that in the United States alone, approximately \$2 billion is spent annually on pavement markings. Despite these annual expenditures, there is a general void in terms of a consolidated effort that attempts to quantify proven benefits of pavement markings.
- Research in Texas has found that edge-line treatments on rural two-lane roadways may reduce RTI frequency with the highest safety impacts occurred on curved roadway segments.
- Research in Canada has shown that inadequate and poorly maintained pavement markings are often cited as the most contributing factor to fatal RTIs.
- It has been shown in previous research that greater longitudinal pavement marking retroreflectivity levels increase drivers' visibility and detection distance. However, increased visibility may also cause drivers to feel too comfortable during night-time conditions and drivers may then pay less attention and/or operate at unsafe speeds.

Themes: Markings, quality and maintenance, safety, RTIs,

Comments: Robust but provides summary abstracts only. Safety only part of the analysis.

Title: Transportation Research Syntheses: Effectiveness of Traffic Signs on Local Roads
Author / organisation: CTC & Associates LLC prepared for the Minnesota Department of Transportation Date: January 2010 Format: pdf Link: http://www.lrrb.org/pdf/trs1002.pdf Free / priced: Free
Objectives: The Minnesota Department of Transportation is reviewing whether the removal of ineffective traffic signs may be part of an overall sign management strategy and asked CH2M Hill to prepare a best practice guide for removing traffic signs. This is in response to the 2009 edition of the Manual on Uniform Traffic Control Devices which includes requirements for the management and maintenance of all roadway signs.
Methodology: A literature search and synthesis of research demonstrating the effectiveness or lack of effectiveness of various types of traffic signs on local roads, including low-volume roads was performed.
Key Findings: <ul style="list-style-type: none"> • There is research pointing to the effectiveness of warning signs in reducing RTIs but there is a distinct lack of research on the effectiveness of regulatory and guide signs. • The use of warning signs should be based on an engineering study or on engineering judgment. • The use of warning signs should be kept to a minimum as the unnecessary use of warning signs tends to breed disrespect for all signs. In situations where the condition or activity is seasonal or temporary, the warning sign should be removed or covered when the condition or activity does not exist. • Despite the extensive use of static warning signs in the highway system, the effectiveness of these signs in improving traffic safety has hardly been investigated. • A study by the Mendocino County Transportation Board has shown that RTIs reduced by 42.1 per cent from 1992 to 1998 due to the installation of more traffic signs. • This article describes the success Mendocino County, Calif., had in reducing traffic RTIs by installing more traffic signs. According to the article, the Mendocino County Transportation Board reduced RTIs by 42.1 per cent from 1992 to 1998 at a cost of \$79,260 over the same period. The money was spent on installing traffic warning signs on county roads.
Themes: Signs, local roads, safety, RTIs
Comments: Fairly robust. Provides a summary of other reports.

Title: The role of roadside advertising signs in distracting drivers
Author / organisation: S. Bendak and K. Al-Saleh, King Saud University, International Journal of Industrial Ergonomics, Volume 40, Issue 3.
Date: 2010
Format: pdf Link: http://www.sciencedirect.com/science/article/pii/S0169814109001449
Free / priced: \$31.50
Objectives: To assess the effects of advertising signs on driving performance and distraction.
Methodology: The effects of advertising signs were assessed through driving performance experiments using a driving simulator and the collection of driver opinion on distraction caused by such signs using a questionnaire. Twelve volunteers participated in the driving simulator study on two identical paths with one difference. One had roadside advertising signs and one had none. 160 drivers responded to the questionnaire.
Key Findings: <ul style="list-style-type: none"> • Driving simulator results revealed that two driving performance indicators, drifting from lane and accidentally crossing dangerous intersections, were significantly worse with advertising signs present as compared with performance without advertising signs. • The number of tailgating times, overspeeding occurrences and turning or changing lanes without signaling were also worse in the presence of advertising signs but the difference was not statistically significant. • Half of the questionnaire respondents indicated being distracted at least once by roadside advertising signs. • 22 per cent of questionnaire respondents indicated being put in a dangerous situation due to distraction caused by such signs. • Suggestions are made as to the positioning of advertising signs and the need for more research in this area. For example, it is recommended that advertising signs are banned on dangerous bends, areas where high RTI rates are recorded (i.e. black spots) and intersections.
Themes: Advertising signs, distraction, RTIs, safety
Comments: Robust academic document.

Title: Literature review of road safety at traffic signals and signalised crossings (Published Project Report PPR436)
Author / organisation: J. Kennedy and B. Sexton, TRL prepared for Transport for London Date: November 2009 Format: pdf Link: http://www.tfl.gov.uk/assets/downloads/literature-review-of-road-safety-at-traffic-signals-and-signalised-crossings.pdf Free / priced: Free
Objectives: To undertake a literature review of road safety studies at traffic signals and signalised crossings in London or other urban areas. The review is intended to inform TfL policy and practice. The aim is to identify, integrate and synthesise the existing evidence concerning road safety at traffic signals and signalised crossings and to identify gaps where robust evidence may not yet exist.
Methodology: The review included literature back to 1980 in the UK and 1990 elsewhere. The literature mainly comprised before-and-after studies with small numbers of sites.
Key Findings: <ul style="list-style-type: none"> • The main types of RTI at signal-controlled junctions are single vehicle, rear shunts and lane changing RTIs on the approach to the junction, principal right turn RTIs and pedestrian RTIs. • Between 2004 and 2006, 19 per cent of all RTIs in London occurred at signal-controlled junctions. • On average, signalisation reduces RTIs by 15 per cent at 3-arm junctions and 30 per cent at 4-arm junctions
Themes: Signals and crossings, safety, RTIs
Comments: Focus is on signals, rather than signs and markings

Title: Investigating driver distraction: the effects of video and static advertising (Published Project Report PPR409)
Author / organisation: M. Chattington, N. Reed, D. Basacik, A. Flint, A. Parkes, TRL prepared for Transport for London, June 2009 Format: pdf. Free / priced: Free https://trl.co.uk/reports/PPR409
Objectives: A study to compare driver behaviour across a number of experimental conditions with differing levels of roadside advertising present.
Methodology: The study was conducted using a driving simulator and integrated eye-tracking system to compare driving behaviour across a number of experimental advertising conditions. 48 participants took part in the trial, with three factors examined; advert type, position of adverts and exposure during adverts.
Key Findings: <ul style="list-style-type: none"> • Trial results indicated that when passing roadside adverts, drivers: <ul style="list-style-type: none"> ○ Spent longer looking at video adverts than static adverts and glanced at them more frequently ○ Tended to show greater variation in lateral lane position with video adverts ○ Broke harder on the approach to video adverts ○ Drove more slowly past video adverts • Participants were more aware that their driving was impaired by the presence of video adverts than static adverts.
Themes: Advertising signs, distraction, RTIs, safety
Comments: Robust document produced for Transport for London.

Title: Recommendations/ Conclusions on Speed Moderation (CEMT/CM(96)1/FINAL)
Author / organisation: OECD (Organisation for Economic Cooperation and Development), ECMT Road Safety Group
Date: 2009
Format: pdf
Link: http://www.internationaltransportforum.org/Pub/pdf/09CDsr/PDF_EN/16RecommSpeed_EN.pdf
Free / priced: Free
Objectives: The Road Safety Group has reviewed recent developments in Member Countries and to study, from the various technical, social and regulatory standpoints, European-wide approaches to, and future action on, traffic-calming policy, which is now a permanent feature of road safety policy in the various ECMT Member States.
Methodology: This report consists of a series of policy and standard recommendations for the harmonisation of speed limit legislation and implementation across Europe. It has been developed through a review of the current situation across ECMT Member States, and the formation of suggested methods of harmonisation, efficiency and consistency to improve road safety through speed management.
Key Findings: <ul style="list-style-type: none"> • It is recommended that general speed limits be introduced for all categories of vehicle in all networks. It is also recommended that general speed limits' harmonisation be promoted at national and European level on homogeneous networks, which have similar physical characteristics and traffic conditions and which have equivalent functions, in order to improve safety on the road. • Good infrastructure design can induce drivers to reduce speed "instinctively", i.e. independently of speed limit signs or rules of the road. • The tools available for influencing driver behaviour are: narrowing of the carriageway, provision of parking space on the verges, road markings, staggerings, road humps, rough bands, edge markers, road design, choice of materials, landscaping, roundabouts, etc. They have proved to be effective provided that they are used in accordance with specific standards. When they are not used properly they impair efficiency. • Fixed road signs provide permanent information about structural conditions or conditions that occur frequently at a particular place. However, in reality, conditions are often changing. Particularly for the motorway network, advances in information collection and transmission and communications technologies have made variable message signing a feasible option for proactive traffic management.
Themes: Speed, safety, RTIs, signs and markings, design, policies and standards
Comments: Robust government document. However, there is a lack of quantitative data and research findings.

<p>Title: Recommendations on Road Transport Safety on Rural Roads in Europe (CM(2002)11/FINAL)</p>
<p>Author / organisation: OECD (Organisation for Economic Cooperation and Development), ECMT Road Safety Group Date: 2009 Format: pdf Link: http://www.internationaltransportforum.org/Pub/pdf/09CDsr/PDF_EN/21RecRural%20Roads_EN.pdf Free / priced: Free</p>
<p>Objectives: Developing and implementing a policy strategy specifically targeting rural roads is an integral part of a comprehensive road safety policy and is completely in keeping with the approach currently being taken by the ECMT. The objectives of the report are to:</p> <ul style="list-style-type: none"> • Show the scale and human cost of the road safety problem across the 41 countries of the ECMT. • Make concern with road safety an issue of national importance for politicians, roads administrators, enforcement agencies, private companies, and individual road users. • Encourage road safety policy to be part of general transport policy. • Show the benefits of a strategic approach to road safety which takes into account the vehicle, road infrastructure, and the road users as equally important parts. • Highlight the particular safety problems associated with rural roads and to present a framework for their improvement. • Produce recommendations for improving road safety for consideration by European Ministers for Transport.
<p>Methodology: This report consists of a series of policy and standard recommendations for improving rural road safety across Europe. It has been developed through a review of the current situation across ECMT Member States, and the formation of suggested methods of harmonisation, efficiency and consistency to improve rural road safety through interventions to improve behaviour, infrastructure and vehicles.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • It is recommended that the gathering and processing of RTI data is improved so that, on a comparable basis, the causes and impact of RTIs can be accurately identified and adequate measures taken and subsequently evaluated, particularly from the standpoint of cost-effectiveness. • Improving road safety by improving road layout to assist drivers at bends and junctions. Along lengths of road measures should include those to reduce head-on RTIs. This can be achieved by consistency of design including those road markings and signs.
<p>Themes: Rural roads, safety, RTIs, signs and markings</p>
<p>Comments: Robust government document. However, there is a lack of quantitative data and research findings and signs and markings only form a minor part of the analysis.</p>

Title: White Lines Save Lives – Road markings, road safety and efficient road utilisation in 21st century Britain
Author / organisation: Road Safety Markings Association Date: April 2007 Format: pdf Link: http://www.google.co.uk/url?sa=t&rct=j&q=road%20markings%2C%20road%20safety%20and%20efficient%20road%20utilisation%20in%2021st%20century%20britain&source=web&cd=1&ved=0CCIQFjAA&url=http%3A%2F%2Fwww.rsma.co.uk%2Findex.php%2Fresources%2Fpublic-documents%2Fdoc_download%2F26-white-lines-saves-lives.html&ei=UISqUNtO0ZTRBfOVgJgF&usq=AFQjCNGpXwQw-6ciSX6E3iawHJczqV_wnw
Free / priced: Free
Objectives: This report has been produced to highlight the clear road safety and economic benefits that would be achieved through enhanced budgets to national and local road authorities for investment in road marking based safety schemes.
Methodology: The report has been developed through a review of real life case studies where new or improved road marking have been implemented and have had an impact on RTIs numbers.
Key Findings: <ul style="list-style-type: none"> • Road markings have always been a critical part of the safety infrastructure of the UK highways network, in addition to providing the foundation of congestion relief, as the principle tool for delineation and traffic direction. • In the last decade changes to European product standards have allowed road markings to be more clearly specified in a manner to define their performance requirements for safety and delineation on the highway. • Research indicates that the rates of return from road safety schemes involving improved road markings, in all types of location on the highway, lead to a safer travelling environment for road users. Under cost benefit analysis the first year rate of return from these schemes will exceed 500 per cent and will frequently be in excess of 1,500 per cent making road-marking improvements amongst the most effective road safety mechanisms available to highways engineers. This is as a direct result of the relatively low level capital cost of road markings and the relatively high level safety gains from their utilisation. • Durham County Council, having undertaken extensive improvement work to junction layouts throughout the county has compiled data that identifies range of road safety improvement as a result of using improved and enhanced road marking to improve layouts, these improvements include a 50 per cent reduction in RTIs, associated with improved marking layouts and a reduction of speed in the 85th percentile. • Various research projects have been undertaken into the effectiveness of audible or profile roadmarking systems commonly found on the nearside carriageway of high-speed roads (dual carriageways and motorways). Such markings provide a profiled surface that emits a 'rumble' or similar audible warning when a vehicle travels across it, providing an alert for drivers who may be sleeping or similar. • Throughout the late 1970s and early 1980s many studies were undertaken to identify whether the use of edge lines on rural UK roads reduced the level of RTIs, with particular reference to night-time RTIs. In East Sussex a 22 per cent reduction in total RTIs was seen following edge line application, with a 13 per cent reduction seen in South Yorkshire.
Themes: Markings, safety, RTIs,
Comments: Robust document produced by an industry body. Clear and transparent case studies

<p>Title: Inquiry into driver distraction</p> <p>Author / organisation: Parliament of Victoria Road Safety Committee</p> <p>Date: August 2006</p> <p>Format: pdf</p> <p>Link: http://www.parliament.vic.gov.au/images/stories/committees/rsc/driver_distraction/Distraction_Final_Report1.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: To review, consider and make recommendations on the role of driver distraction in causing RTIs and, in particular to report to Parliament on:</p> <ul style="list-style-type: none"> • the prevalence of mobile telephone use by drivers and its impact on RTI causes; • the prevalence of in-car video devices, their effect on drivers and impact on RTI causes; • the types of other devices and activities, both inside and outside the vehicle, that may distract a driver's attention from the driving task and lead to unsafe driving; • the suitability and enforceability of existing laws concerning the use of mobile telephones and other electronic devices by drivers; and • the possible need for change to legislation or statutory requirements to implement any recommendations made as a result of the inquiry.
<p>Methodology: Invitations to participate in the study were advertised in the major daily Melbourne metropolitan newspapers on 17 September 2005. The Committee also wrote to relevant Government departments, key stakeholders and community groups, inviting written submissions. In response to the Committee's advertisements and invitations, 44 written submissions were received. In addition to the receipt of written submissions, the Committee held a series of public hearings and briefings.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • Many poorly considered road signs can create visual clutter, resulting in one form of driver distraction. There is a need for the relevant authorities to develop appropriate guidelines to regulate the location, size and content of all road authority and other signs within road reserves to minimise potential driver distraction. • Driver distraction can also be caused by advertising signs. Advertising within or near road reserves can come in many forms. Various forms of advertising are also placed on vehicles, including public buses, trams and taxis. Video-type signs, also referred to as electronic billboards, provide moving graphical material, sometimes combining news headlines and news/film clips with an accompanying advertisement. • A more consistent and stringent approach to the installation, use and content of scrolling, moving and video-style advertising within and adjacent to road reserves is required. • According to MUARC, visual clutter impacts driver safety in three ways; it distracts from driving task; it impairs visual search; and it increases workload.
<p>Themes: Distraction, safety, RTIs, clutter, signs</p>
<p>Comments: Robust government document. However, more focussed on distraction from mobile phones and other in-car devices and applications than external distractions (such as signs).</p>

Title: Conspicuity and Road Safety (Fact Sheet)
Author / organisation: European Safety Transport Council (ESTC) Date: February 2006 Format: pdf Link: http://www.etsc.eu/documents/FINAL_Fact_Sheet_Conspicuity.pdf Free / priced: Free
Objectives: This Fact Sheet considers the impact on sign placing, lighting and design on RTI reduction at night. The objective is to present ways to improve the conspicuity of traffic signals, road markings, trucks, people being unexpectedly exposed on roads, pedestrians and cyclists.
Methodology: The Fact Sheet summarises the findings from various studies and trials carried in countries including Canada, the UK, Norway, Spain and Finland.
Key Findings: <ul style="list-style-type: none"> • The visual capacity of the human eye is only 5 per cent of its visual capacity during daytime. Visual errors play an important role as a cause of RTIs. • The lack of conspicuity of signs and markings is often cited as a contributing factor by drivers who are involved in RTIs at intersections. • There are two measures to improve the conspicuity of road signals: signs which retro reflect the light of vehicle headlamps, or signs which are lit by fixed auxiliary lighting -- either internal lamps or external luminaries. When fixed auxiliary lighting is not an option, signs should be made from high brightness retro reflective materials that maximise the amount of light returned to the drivers. • Together with adequate road markings, traffic signs have proven to be a low cost measure with high ratios of benefit to cost. • Studies have shown that safe pavement markings should be visible during the night to a degree that allows the driver an absolute minimum of 2.5 seconds reaction time. This can be achieved by an adequate width and retro reflectivity specifications.
Themes: Signs placing, markings, RTIs, conspicuity
Comments: Robust document. Based on international case study findings

<p>Title: A Review of Simplified Streetscape Schemes (Report Ref PPR292)</p> <p>Author / organisation: A. Quimby and J. Castle, TRL prepared for Transport for London</p> <p>Date: January 2006</p> <p>Format: pdf</p> <p>Link: http://www.tfl.gov.uk/assets/downloads/review-of-simplified-streetscape-schemes.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: To undertake a review of simplified streetscape scenes and their underlying design philosophy, and to consider the applicability of their use in London. It includes a review of such schemes that have been implemented in Europe and evaluates their impact on safety, access and public attitudes.</p>
<p>Methodology: TRL undertook a study to research into the impact of the simplification of streetscape schemes. Information was collated from:</p> <ul style="list-style-type: none"> • Published research materials • Internal TRL review of unpublished research • Internet searches • A survey of known practitioners • A general local authority survey
<p>Key Findings:</p> <ul style="list-style-type: none"> • In recent years there has been an increasing interest in traffic management schemes aimed at simplifying the road environment. Some of these schemes imply remove unnecessary signs to reduce complexity and driver confusion. • RTI and casualty data reviewed did not provide safety case for simplified streetscapes. However, there is a lack of full analysis of existing trials. • Too many signs are shown to cause cluttering and mental overload. Too few signs can cause confusion and uncertainty. • A major improvement scheme carried out in 2000 on Kensington High Street (London) included the simplification of road markings and the removal of street clutter and unnecessary signs. Before and after studies have found that there was a 48.6 per cent annual reduction in total RTI on Kensington High Street (compared to a 37.2 per cent reduction for the borough on average). The highest reduction was seen in RTIs involving pedestrians and motorcyclists. • A trial in Bury St. Edmunds to reduce the visual intrusion of traffic signs found that as a result, traffic flow reduced by 13 per cent and the 85th percentile speed reduced by 2 mph to 20 mph. • Recent studies show that under certain conditions, for example, where there is a 30 mph speed limit, the removal of white line removal can reduce free flow driving speeds. A trial in the village of Starston in Norfolk found that the removal of central white lines reduced average speeds by 7 mph. A similar study in Wiltshire showed a 35 per cent reduction in RTIs and a 5 mph reduction in average speeds. • There is some concern that over-simplifying streetscapes may lead to some motorists abuse the lack of signs and instructions, for example, by speeding or ignoring priority norms.
<p>Themes: Signs and markings, clutter, distraction, safety, RTIs</p>
<p>Comments: Robust government document based on primary and secondary research.</p>

Title: Attraction and distraction of attention with roadside advertisements
Author / organisation: D. Crundall, E. Van Loon, G. Underwood, University of Nottingham, Accident Analysis and Prevention, Volume 38. Date: 2006 Format: pdf Link: http://www.sciencedirect.com/science/article/pii/S0001457505002149 Free / priced: Free
Objectives: To investigate the effect of the positioning of roadside advertisements on attracting the attention of passing drivers and therefore having the potential to contribute to RTI causation.
Methodology: This study compared street-level advertisements (SLAs; predominantly bus shelters) with raised-level advertisements (RLAs) of the same size that were suspended 3m above the ground, on their ability to attract driver attention under different task conditions. Participants were split into two groups and watched video clips of driving, rating them for hazardousness while their eye movements were recorded. One of the groups was additionally primed to attend to advertisements.
Key Findings: <ul style="list-style-type: none"> • Percentage estimates of driving time where drivers' attention is directed to scenery and other irrelevant items vary from 20 per cent or less, to 50 per cent. • SLAs received the most fixations when participants were solely looking for hazards, and the fewest fixations when primed to look for advertisements. • SLAs attract and hold attention at inappropriate times compared to raised-level advertisements. • Such distractions have the potential to increase the probability of being involved in an RTI. Assuming that drivers' propensity to search for hazards is positively correlated with the actual likelihood of a hazard (which is the aim of hazard perception training), then a real hazard is more likely to occur while a driver is fixating an SLA than an RLA.
Themes: Advertising signs, distraction, RTIs, safety
Comments: Robust academic document.

Title: Do traffic signals at roundabouts save lives?
Author / organisation: Transport for London Date: April 2005 Format: pdf Link: http://www.tfl.gov.uk/cdn/static/cms/documents/signalsatroundabouts-transportationprofessional-article.pdf Free / priced: Free
Objectives: A study to measure the effect of traffic signals at roundabouts on safety.
Methodology: The study analysed the casualty data at selected roundabouts 'before' and 'after' signal control was implemented. A total of twenty sites were selected, equally divided between at grade (standard) and grade separated junctions. For each of the twenty sites the casualty data was obtained for the 36 month period 'before' and for the same length of time 'after' the date of signal implementation. When signals were implemented as part time operation, the 'before' and 'after' data were re-examined and casualty data analysed for the specific times of operation.
Key Findings: <ul style="list-style-type: none"> • Signal control is usually installed at a roundabout to improve traffic capacity and to balance a junction at high flows. Supporting reasons may include reducing RTIs or provide surface level crossings for pedestrians. With the increasing vehicle demand, signal control at roundabouts is becoming a common measure in traffic management. • At standard roundabouts there was a good decrease in total RTIs after the installation of signals of 107 (28 per cent), which is an average reduction of 10.7 RTIs at each site for a 36 month period. This is a saving of just over 3.5 RTIs per site each year. • There were significant casualty reductions in most categories. The largest was in RTIs involving a pedal cycle which reduced by 56 RTIs (80 per cent).
Themes: Signals, safety, RTIs, roundabouts
Comments: Robust government document. However, the focus is on signals, rather than signs and markings.

<p>Title: Traffic calming techniques: Experience and practical advice with 80 case studies</p> <p>Author / organisation: The Institution of Highways and Transportation and the County Surveyors' Society</p> <p>Date: January 2005</p> <p>Format: pdf</p> <p>Link: http://products.ihs.com/cis/Doc.aspx?AuthCode=&DocNum=275609</p> <p>Free / priced: Free (subject to subscription to IHS)</p>
<p>Objectives: To provide an update ten years after the publication of the County Surveyors' Society's publication entitled Traffic Calming in Practice. The report updates the work started in TCiP and extends it to demonstrate how traffic calming techniques have changed. The objectives of the report are to describe the context within which traffic calming measures should be considered and provide guidance on design and implementation and how traffic calming techniques may develop in the future.</p>
<p>Methodology: The report has been developed through a review of:</p> <ul style="list-style-type: none"> • Design and implementation of traffic calming measures • Public consultation and participation processes • Relevant legislation, standards, guidance and advice, • National policy background, design procedures and quality • Case studies looking at a longer term view of some of the schemes introduced in the past
<p>Key Findings:</p> <ul style="list-style-type: none"> • Traffic calming features generally need supporting by traffic signs. Signing and lighting are subject to the requirements of the regulations and advice, which aim to ensure that traffic calming features are clearly visible to approaching drivers at all times. • As well as using signing, markings and lighting to meet the requirements of regulations, they can also be used to provide information to ensure appropriate warning of traffic calming features is given to approaching drivers at all times. Traffic calming measures need to be visible both day and night and in adverse weather conditions. • Traffic calming schemes, particularly when introduced in rural situations where the aim is to reduce speeds to 40, or perhaps 30 mph, sometimes result in a significant increase in the number of warning signs in advance of the traffic calmed area. Along with carriageway markings and other features, they are used to alter the drivers' perception of the road on which they are travelling and hence bring about a change in behaviour leading to slower speeds. • White lining can have a very significant part to play in many traffic calming schemes and can in itself bring about significant benefits, although these are likely to be greatest when used in combination with other techniques. • Vehicle activated sign devices are particularly useful on the approaches to bends and junctions where motorists may be unable to judge a safe speed until they are in the bend, or are unaware of side road visibility restrictions.
<p>Themes: Signs and markings, safety, RTIs, legislation, policies and standards</p>
<p>Comments: Robust document. However, it is slightly dated (7 years old) and signs and markings only form part of the analysis.</p>

Title: Driven to Distraction: An overview of the 100-car naturalistic driving study and findings
Author / organisation: V. L. Neale, T.A. Dingus, S. G. Klauer, J. Sudweeks (Virginia Tech Transportation Institute) and M. Goodman (National Highway Traffic Safety Administration)
Date: 2005
Format: pdf
Link: http://www-nrd.nhtsa.dot.gov/pdf/esv/esv19/05-0400-W.pdf
Free / priced: Free
Objectives: Findings from an experiment designed to assess the effects of roadside advertising on driver attention and performance in different road types.
Methodology: The report presents the findings from a simulator study quantifying the effects of billboards on driver attention, mental workload and performance in Urban, Motorway and Rural environments. The study used the Brunel University Driving Simulator (BUDS) to conduct a rigorous test in a safe, controlled environment.
Key Findings: <ul style="list-style-type: none"> • There is growing concern that roadside advertising presents a real risk to driving safety, with conservative estimates putting external distractors responsible for up to 10 per cent of all RTIs. • The results demonstrate that roadside advertising has a clear detrimental effect on lateral control, increases mental workload and eye fixations, and on some roads can draw attention away from more relevant road signage. • There is evidence that drivers' visual attention is often attracted by adverts or other irrelevant objects, and if this should occur when the driver's visual workload is already high (such as at a complex junction or on a busy motorway), the driver could fail to detect more relevant signage, hazards, or potentially lose proper control of their vehicle. • Whilst the risk of roadside advertisements on driver attention is not nearly as great as that from in-car distractions, evidence is mounting that roadside distractions (and advertising in particular) present a 'small but significant' risk to driving safety.
Themes: Distraction, safety, RTIs, advertising signs
Comments: Robust US government document based on laboratory experiments. Focus on advertising signs.

<p>Title: Report on Passive Speed Control Devices - Task 20: Speed and Traffic Operations Evaluation</p>
<p>Author / organisation: MassSAFE, University of Massachusetts prepared for Governor's Highway Safety Bureau. Date: August 2004 Format: pdf Link: http://www.ecs.umass.edu/masssafe/PDFS%20for%20Site/Speed%20Management/Passive%20Speed%20Control%20Devices.pdf Free / priced: Free</p>
<p>Objectives: This document highlights various passive speed control measures used in the U.S. and around the world. Divided into two sections, the report includes research on longitudinal and transverse pavement markings.</p>
<p>Methodology: Collation of case study evidence and research into the effectiveness of longitudinal and transverse road markings on traffic speeds.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • Instead of regulatory measures, such as signing and traffic calming measures, an alternative way to reduce excessive speeds is to target speed perception. This includes the implementation of road markings. • Perceptual countermeasures, or passive speed control measures, serve to alter drivers' perceptions of the correct speed for a particular road so drivers may assume a lower speed is more appropriate. While regulatory measures require enforcement, traffic calming and passive speed control measures are intended to be self-enforcing. • Transverse markings most commonly used are transverse bars and transverse chevrons. These marking patterns may be an effective measure for reducing speeds when placed at decreasing distances so the spacing between markings is continuously reduced in the direction of movement. • Reductions in mean driving speed have been reported in studies that implemented transverse markings on the approach to curves. Besides reductions in mean driving speed, reductions in speed variance have also been reported.
<p>Themes: Markings, safety, RTIs,</p>
<p>Comments: Robust academic report</p>

<p>Title: Effects of Roadside Advertisements on Road Safety (Internal Reports 25/2004)</p> <p>Author / organisation: Finnish Road Administration</p> <p>Date: 2004</p> <p>Format: pdf</p> <p>Link: http://alk.tiehallinto.fi/julkaisut/pdf/4000423e-veffectsofroadside.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: The report was compiled to provide background material for different levels of policies, instructions and decisions concerning advertisements. The report contains two separate sections on the effects of advertisements on road safety commissioned by the Finnish Road Administration. The objective was to conduct a general assessment of studies of the effects of roadside advertisement on road safety and to determine whether the effects of advertisements are apparent as the cause of fatal RTIs.</p>
<p>Methodology: The assessment includes a summary of existing research findings on the effects of roadside advertisements on road safety, a review of the development needs of policies on advertisements, and a description of problems related to studies of safety effects. The report also includes the findings of a study of fatal RTIs that occurred in 2000 and 2001 to determine whether there was evidence that advertisements or deficiencies in the crossfall of roads were partial causes of the RTIs.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • The effects of roadside advertising that targets road users is a topic of discussion globally. • It is difficult to assess the extent to which advertising plays a role in RTIs. • In general, the number of RTIs occurring near roadside advertisements has not been observed to be higher than at reference sites. The negative effects of advertisements are, however, visible in RTI statistics if they are focused on limited conditions (junctions) • The effects of advertisements are apparent in driver behaviour, but the effects measured in normal traffic are small • Advertisements along main roads distract the detection of traffic signs and possibly also other objects relevant to the driver's task. • Six cases were found in the investigation committee material from 2000- 2001 in which advertisements had in one way or another contributed to the occurrence of an RTI. All of the RTIs had happened at an intersection. In four cases the effect was obstructed visibility, in one case obstructed visibility and disturbance of the driver's concentration, and in one case only disturbance of the driver's concentration. • Junctions of high speed routes have shown to be a problem, particularly for older drivers.
<p>Themes: Distraction, advertising signs, safety, RTIs</p>
<p>Comments: Robust government document. Focus is on advertising signs. Slightly dated.</p>

<p>Title: External-To-Vehicle Driver Distraction (Research Findings No. 168/2003)</p> <p>Author / organisation: B. Wallace, Human factors Analysts Ltd prepare for the Scottish Executive</p> <p>Date: 2003</p> <p>Format: pdf</p> <p>Link: http://www.scotland.gov.uk/Resource/Doc/47133/0029641.pdf</p> <p>Free / priced: Free</p>
<p>Objectives: The Scottish Executive commissioned a literature review on driver distraction to explore in more depth whether external driver distraction is a significant factor in road RTIs and to examine existing knowledge and gaps on the relevant external factors that cause vehicle RTIs, with a view to identifying where further research might be carried out.</p>
<p>Methodology: The research was carried out by Human Factors Analysts Ltd. (HFAL) a 'spin-out' company from the University of Strathclyde, between December 2002 and March 2003. It consisted of a literature review of all relevant material relating to external-to-driver distraction published since 1945 in English. However, it was necessary to also obtain literature relating to general theories of driver distraction and general studies of driver distraction, to provide a contextual background.</p>
<p>Key Findings:</p> <ul style="list-style-type: none"> • Information from RTI databases suggests that external-to-vehicle driver distraction is a major contributory factor to road RTIs. However it is likely that these incidents are under-reported. The real risks may therefore be greater than official statistics suggest. • The evidence suggests that there are two specific situations where the risk factor of billboards and signs is at its highest: at junctions, and on long monotonous roads (such as motorways). • Overall the literature review found that advertising/billboards can function as distractors in specific situations. However, more research is needed to discover in what particular situations they pose most of a threat, and the precise extent of the risk. • The general conclusion is that between 10 per cent and 30 per cent of all RTIs have driver distraction as a contributory factor, and that, of these, roughly a third are specifically caused by external-to-vehicle driver distraction. Young (aged 17-21) drivers are particularly prone to external-to-vehicle driver distraction. It is, however, thought that these figures are an underestimate. • External distraction is thought to be caused by one of two factors: visual 'clutter' (occurring mainly at junctions); and 'low arousal' during monotonous situations when the driver is 'surprised' by a billboard or sign and fixates on it after a long period of driving. • Most research into external driver distraction originates in the USA or Australia. It is recommended that further research is carried out in the UK.
<p>Themes: Distraction, RTIs, safety, signs, advertising signs, clutter.</p>
<p>Comments: Robust government summary document. However, signs only form part of the analysis. Slightly dated.</p>

Title: Visual search for traffic signs: The effects of clutter, luminance and aging
Author / organisation: G. Ho, C.T. Scialfa, J.K. Caird and T. Graw, University of Calgary, Human Factors, Volume 43, No.2.
Date: 2001
Format: pdf
Link: http://www.psych.ucalgary.ca/pace/pca-lab/pdf/signs.pdf Free / priced: Free
Objectives: To determine if observers could reliably estimate visual clutter in driving scenes and if these estimates of clutter would predict the efficiency of visual search for traffic signs by younger and older drivers.
Methodology: Digitised images of driving schemes were presented to 14 older and 14 younger drivers covering both day and night-time scenarios and examples of high and low levels of clutter. Participants were asked to judge whether the images were low or high in visual clutter.
Key Findings: <ul style="list-style-type: none"> • Visual clutter can hinder sign acquisition and can confuse drivers through increasing the time required to process the information given. This is a particular problem for older drivers. • Scenes classified as high in clutter required longer latencies and more fixations to acquire specific sign, were associated with more errors, and had longer fixations durations than those low in clutter. • Older drivers were shown to be less accurate and slower than younger adults and executed more eye movements to acquire signs.
Themes: Signs, safety, RTIs, clutter, distraction
Comments: Fairly robust academic paper. Based on laboratory experiments.

Title: Conflicts of interest: Driving experience, and time-sharing during in-car tasks on roads of different width
Author / organisation: A.S. Wikman, T. Nieminen, and H. Summala.
Date: 1998 Format: pdf
Link: http://www.tandfonline.com/doi/pdf/10.1080/001401398187080
Free / priced: Priced
Objectives: To present the findings of a simulator study quantifying the effects of billboards on driver attention, mental workload and performance in urban, motorway and rural environments.
Methodology: The intention of this study was to determine the effects of roadside advertising (billboards) on driver attention and performance in different road environments. The Brunel University Driving Simulator (BUDS) was used to create driving scenarios for urban, rural, and motorway conditions. Participants drove each of these routes both with and without billboards. Driver attention was assessed in a number of ways.
Key Findings: <ul style="list-style-type: none"> • Conservative estimates putting external distractors responsible for up to 10 per cent of all road traffic RTIs. • In a 2005 UK survey by Privilege Insurance, over a quarter of drivers admitted losing concentration due to roadside adverts, with 41 per cent of those reporting that they had been distracted for up to 5 seconds. • Findings indicate that more RTIs occurred in the presence of billboards. • Evidence from this study suggests that roadside advertising can adversely influence driver attention, increasing visual demand. The presence of billboards increased overall number of eye fixations, although not total duration of glances, suggesting a change in drivers' visual attention strategies towards more but shorter glances.
Themes: Advertising signs, distraction, RTIs, safety
Comments: Robust academic document.