

Speed and Speed Management

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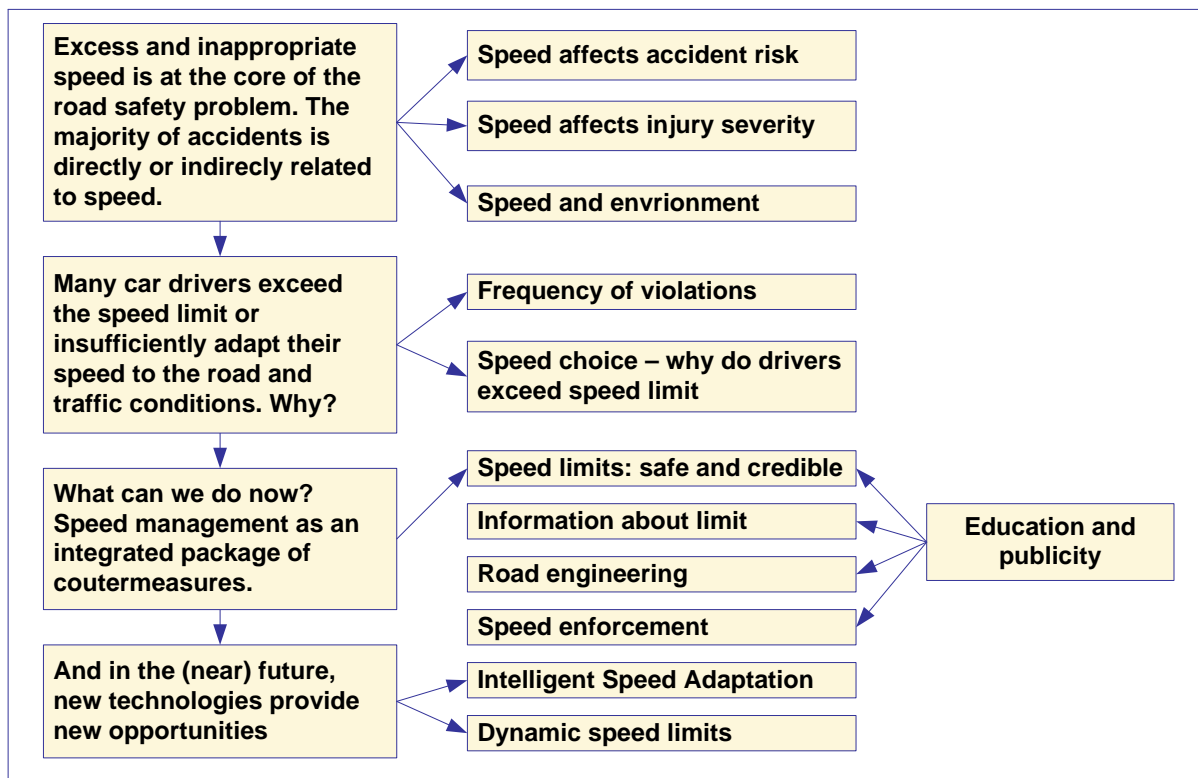
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1 Overview



Speed is at the core of the road safety problem and its management is central to the recommended *Safe System* approach.

Speeding: more and more severe crashes

Speed is involved in all road traffic crashes: no speed, no crashes. In around 30% of the fatal impacts speed is an essential contributory factor. Firstly, speed affects the risk of being involved in a crash. At a higher speed, it is more difficult to react in time and prevent a crash. Secondly, speed affects the injury consequences of a crash. At a higher (impact) speed, more energy is released when colliding with another vehicle, road user or obstacle. Part of this energy will need to be absorbed by the vulnerable human body. Very strong relationships have been established between speed and crash risk and severity.

Excess speed and inappropriate speed are very common

Speed limits provide information to the drivers about the safe speed to travel in average conditions. Exceeding the speed limits is very common. Typically, 40 to 50% of the drivers travel faster than the speed limit. Typically, 10 to 20% exceed the speed limit by more than 10 km/h. Given the strong relationship between speed and crash risk and severity, a large

number of casualties could be saved if all drivers complied with the current speed limits. In addition, drivers adapt their speed insufficiently to local and temporary conditions related to traffic and weather. They often choose a speed that is inappropriate for the prevailing conditions. Speed choice is related to the drivers' motives, attitudes, risk perception and risk acceptance. Furthermore, speed choice is affected by characteristics of the road and the road environment and by characteristics of the vehicle.

Speed management as a package

There is no single solution to the problem of excess and inappropriate speed. A package of countermeasures is necessary, increasing the effectiveness of each of the individual measures. The most appropriate combination of measures will differ with circumstances. A good balance between road design, speed limit, and road user perception of appropriate speed is vital.

At the core of speed management are speed limits. Speed limits must define a safe speed, reflecting the function of the road, traffic composition and road design characteristics. Speed limits must also be credible for drivers, reflecting the characteristics of the road and the road environment. Drivers must be aware of the local speed limit at all times. This can be realized by good and consistent signing as well as consistent application of road markings and delineation, specifically related to particular speed limits.

Road engineering, such as speed humps and narrowings, helps to reduce speed at locations where low speed is essential. If applied in a consistent way, these measures also help drivers to recognize the traffic situation and the corresponding speed limit. Despite these measures, there always will be drivers who exceed the speed limit. For these intentional violators enforcement remains a necessary instrument. Speed management has to be accompanied by education and information to make road users aware of the speed and speeding problem and about the 'why' and 'what' of countermeasures.

New technologies?

New technologies enable in-vehicle systems that support driver compliance with speed limits. These systems provide information about the speed limit in force; warn the driver when the limit is being exceeded; or make excess speed impossible or uncomfortable. Such systems are available and likely to be introduced progressively. New technologies also enable communication between road and vehicle, allowing for full dynamic speed limits, based on the actual traffic and weather conditions. These systems are still under development.

2 Speed is a central issue in road safety

Speed is a central issue in road safety. In fact, speed is involved in all crashes: no speed, no crashes. Speed has been found to be a major contributory factor in around 10% of all crashes and in around 30% of fatal crashes (TRB, 1998; OECD, 2006). Both excess speed (exceeding the posted speed limit) and inappropriate speed (faster than the prevailing conditions allow) are important crash causation factors. In addition, speed generally has a negative effect on the environment, but a positive effect on travel time. The negative effects are mainly a societal problem and are hardly noticed by individual drivers; individual drivers on the other hand, particularly notice the positive effects.

Speed affects the risk of being involved in a crash and the severity of a crash. In general, the higher the speed, the higher the crash risk and the more severe the crash consequences (see Aarts & Schagen, van, 2006, for an overview).

2.1 Speed and crash risk

On any road, increases in speed will lead to the increased likelihood of a crash. Very strong relationships have been established between speed and crash risk. The general relationship holds for all speeds and all roads, but the exact rate of increase in crash risk varies with the initial speed level and the road environment. Large speed differences at a road also increase the likelihood of a crash. In addition, drivers driving much faster than the average driver have a higher crash risk.

Assessing potential effects of speed reduction measures

Based on work by Nilsson in Sweden, and applying the most recent update of Elvik (2009) a change in average speed of 1 km/h will result in a change in serious injury crashes of just over 2% for a 120 km/h road and around 3% for a 50 km/h road.

A similar relationship is assumed in Britain, based on empirical studies by Taylor (2000; 2002), where changes in crash numbers associated with a 1 km/h change in speed have been shown to vary between 1% and 4% for urban roads and 2.5% and 5.5% for rural roads, with the lower value reflecting good quality roads and the higher value poorer quality roads.

The exact relationship between speed and crashes on a particular road or in a particular area will depend on a range of road and traffic characteristics that interact with speed and also on the characteristics and behaviour of the drivers using the road, such as age, gender, drink-driving and seat belt use.

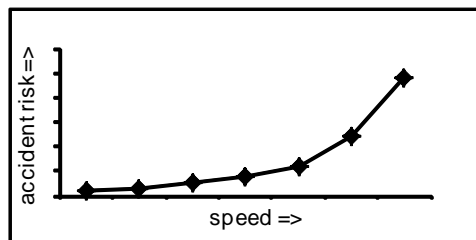
Higher speeds: more crashes

High speeds reduce the possibility to respond in time in critical situations. People need time to process information, to decide whether or not to react and, finally to react. At high speed the distance covered in this period is longer. At higher speeds the distance between starting to brake and a complete standstill is longer as well. The braking distance is proportional to the square of speed (v^2). Therefore, the possibility of avoiding a collision reduces as speed increases.

This is well illustrated at a broad average level by Finch et al. (1994).

1 km/h increase in speed → 3% increase in crashes

In practice the relationship is more complex. The exact relationship depends among many other things on original speed level and road environment. The larger the increase in speed, the steeper the increase in crash risk. The relationship between speed and crash risk is a power function: Given a particular road, with increasing speed, the crash risk increases more as the absolute speed gets higher.



Based on the principles of kinetic energy and validated by empirical data, Nilsson (1982; 2004) developed the following formula:

$$A_2 = A_1 \left(\frac{v_2}{v_1} \right)^2$$

In words: the number of injury crashes after the change in speed (A_2) equals the number of injury crashes before the change (A_1) multiplied by the new average speed (v_2) divided by the former average speed (v_1), raised to the square power.

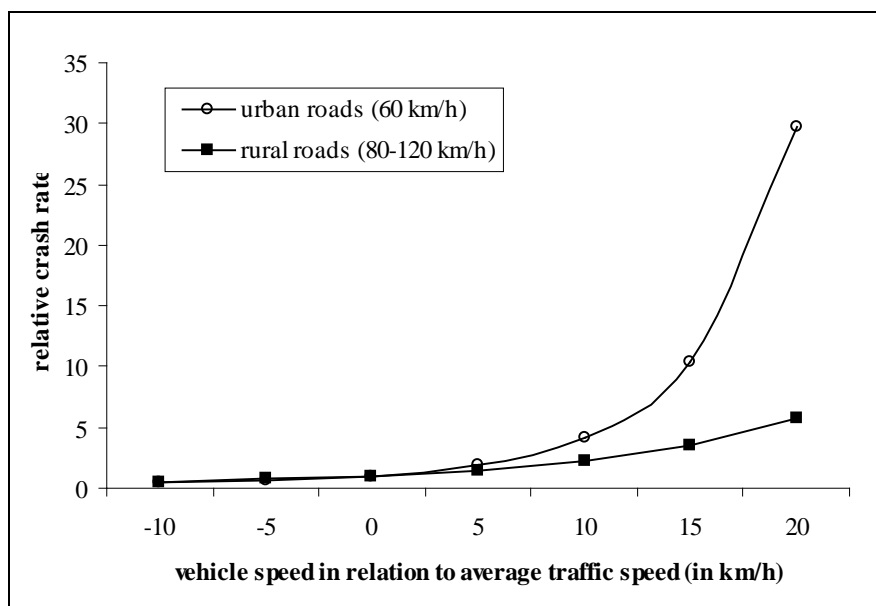
Initial speed and road environment affect the relationship between speed and crash risk. Several recent re-analyses of the speed-crash relationship (Cameron & Elvik, 2010; Hauer and Bonneson, 2006 cited by Elvik, 2009) found that the exact relationship between speed and crash risk depends on the initial speed and the road environment. Given a particular change in speed, the effects are somewhat smaller in urban areas than on rural roads and on urban roads.

Larger speed differences: more crashes

If on a particular road, the speed variance is high, this will result in less predictability, more encounters, more overtaking manoeuvres, etc. Therefore, when speed differences increase, the crash risk increases as well. Hence, a countermeasure that results in lower average speed, but in larger speed differences may not have the expected positive effect on road safety. But, so far, no reliable quantified relationship has been established for this linkage.

Higher crash risk for driving above average speeds

A number of studies have looked at the risk of the individual driver in relation to speed. These studies compared the (estimated) speed of drivers who were involved in a crash with the average speed on that particular road. The first studies date from the 1960 and 1970s in the United States (e.g. Solomon, 1964). They found that driving above and below average speeds had a higher risk of crash involvement. This was known as the U-curve speed-crash relationship. More recent studies, mainly conducted in Australia (Kloeden, McLean & Glonek, 2002) and Great Britain (Taylor, Lynam & Baruya 2000) also found a higher crash risk for driving above average speeds. However, they did not find evidence for a higher crash risk for the driving below average speeds. As an example, the Figure below shows the results of the Australian studies: the relative crash rate on urban roads (Kloeden et al., 1997; Kloeden et al., 2002) and rural roads (Kloeden et al., 2001) for vehicles going above and below the average speed (=0).



2.2 Speed and injury severity

For any given road, there is a clear biomechanical relationship between increased injury severity and increased speed. When the collision speed increases, the amount of energy that is released increases as well. Part of the energy will be 'absorbed' by the human body. However, the human body tolerates only a limited amount of external forces. When the amount of external forces exceeds the physical threshold serious or fatal injury will occur. Hence, higher speeds result in more severe injury. This is particularly true for occupants of light vehicles when colliding with more heavy vehicles, and for unprotected road users, such as pedestrians and cyclists when colliding with motorized vehicles.

Higher speeds: more severe injury

Road safety effects of speed changes are directly related to the change in kinetic energy that is released in a collision. Based on this, Nilsson (1982) developed the following formula to describe the effects of a speed change on the number of injury crashes:

$$A_2 = A_1 \left(\frac{v_2}{v_1} \right)^2$$

With A_2 as the number of injury crashes after a speed change; A_1 as the number of injury crashes before the speed change; v_1 as the average speed before the change, and v_2 as the average speed after.

Subsequently, Nilsson reasoned that the severe injury crash rate would be affected more by a change in speed than the overall crash rate. Based on empirical data of the effects on crashes after a speed limit change on Swedish roads, he increased the power of the function to calculate the number of severe injury (I) and fatal crashes (F) to respectively 3 and 4:

$$I_2 = I_1 \left(\frac{v_2}{v_1} \right)^3$$
$$F_2 = F_1 \left(\frac{v_2}{v_1} \right)^4$$

Most of the empirical data relate to speed changes on motorways and rural roads and they appeared to fit these general formulas very well (Nilsson, 2004; Elvik, Christensen & Amundsen (2004). More recently it was found that the exact relationship between speed and crashes depends on the initial speed and that, in urban areas, speed changes have a somewhat smaller effect than on non-urban roads (see Elvik, 2009).

The relationship between speed and road safety

Empirical data confirms the theory that the relationship between speed and road safety can be described in terms of a power function and that speed changes affect the severe crashes substantially more than the less severe crashes. The Table below shows the power for different crash severities for rural roads/motorways and for urban/residential roads, based on the latest empirical data.

Crash/injury severity	Rural roads/motorways		Urban/ residential roads	
	Best estimate	95% Confidence interval	Best estimate	95% confidence interval
Fatal crashes	4.1	(2.9-5.3)	2.6	(0.3-4.9)
Fatalities	4.6	(4.0-5.2)	3.0	(-0.5-6.5)
Serious injury crashes	2.6	(-2.7-7.9)	1.5	(0.9-2.1)
Serious injuries	3.5	(0.5-5.5)	2.0	(0.8-3.2)
Slight injury crashes	1.1	(0.0-2.2)	1.0	(0.6-1.4)
Slight injuries	1.4	(0.5-2.3)	1.1	(0.9-1.3)

Source: Elvik, 2009

2.3 Speed, injury risk and mass differences

When a heavy and a light vehicle collide, the occupants of light vehicles are far more at risk of sustaining serious injury (Broughton, 2005). This is because the energy that is released in the collision is mainly absorbed by the lighter vehicle. Currently, the differences in mass between vehicles are very large. The difference between a heavy goods vehicle and a passenger car can easily be a factor of 20. But also the mass differences between passenger cars are large and still increasing. A mass difference of a factor of 3 is not exceptional.

Pedestrians, cyclists and moped riders have a high risk of severe injury when colliding with a motor vehicle. The difference in mass is huge and the collision energy is mainly absorbed by the lighter 'object'. In addition, pedestrians, cyclists and moped riders are completely

unprotected: no steel framework, no seat belts, and no airbags to absorb part of the energy. Over thirty years ago, Ashton and Mackay (1979; in ETSC, 1995) found a steep increase of risk with increased impact speed. This was confirmed by a more recent review of Rosén, Stigson and Sander (2011) who also report a steep increase in risk with increased impact speed. However, in an absolute sense the recently reported risks are lower than those reported previously, as indicated in the Table below. One reason, according to Rosén et al., is that older studies have a bias towards severe and fatal injuries, resulting an overestimation of the fatality risks. Other possible reasons may be found in developments in vehicle construction (vehicle front end design – though few models tested by Euro NCAP have yet demonstrated improved performance in the pedestrian tests) and improved post trauma care.

It must be noted however that the distribution of serious and fatally injured pedestrians by impact speed distribution might look a little different from the distribution shown below. While a large proportion of pedestrian deaths might be prevented at 50 km/h it is less likely that as many serious injuries would be avoided.

Impact speed	Indications of percentage fatally injured pedestrians	
	Based on Ashton and Mackay, 1979:	Reported by Rosén, Stigson and Sander, 2011:
30 km/h	5	2
50 km/h	45	8
65 km/h	85	40
80 km/h	--	85

2.4 Speed, environment and travel time

Speed not only affects road safety, but also the environment such as:

- the level of exhaust emissions
- the level of traffic noise
- fuel consumption
- quality of life for people living or working near the road.

In general, high speeds and large speed variation have a negative effect on each of these factors. High speeds and large speed variation also have a negative effect on road safety. Hence, with regard to speed management, road safety aims and environmental aims have much in common. Co-operation between road safety and environmental organizations may increase the political and public acceptability for speed management measures.

Speed also affects travel time. In principle, higher speeds result in a reduction of the travel time. However, higher speeds lead to more collisions which are an important cause of congestion. In addition, in particular on short journeys, the perceived gain of time is much larger than the objective gain of time, which is in fact only marginal:

Extra time taken for a 10 kilometre journey when speed is reduced by 5 km/h (Source: ETSC, 1995):					
Original speed	50 km/h	70 km/h	90 km/h	110 km/h	130 km/h
Extra time taken (minutes)	1.33	0.66	0.39	0.26	0.18

2.5 Speeding: societal vs. individual consequences

The negative road safety outcomes of high speed are evident at an aggregate level. For individual drivers crash risk is very small; at higher speeds the risk is higher, but still very small. Hence, an individual driver will hardly ever experience the safety consequences of excess speed. More or less the same applies for the environmental effects of speeding. These are also noticeable at an aggregate level, but hardly at all at the individual level (possibly with the exception of fuel consumption).

Contrary to the disadvantages, the advantages of higher speeds are experienced at the individual level. Individual advantages include just reaching traffic lights while still green, (subjectively) shorter journey times, thrill and enjoyment of speed or speeding.

This contradiction between societal and individual consequences makes persuading drivers of the value of speed management a difficult mission.

3 Many drivers exceed the speed limit

Many drivers drive faster than the posted speed limit. This is the case for all road types as is evident from both objective observations and self-reported speed behaviour. In addition, people often drive at an inappropriate speed, because they fail to adapt their speed sufficiently to the actual road and traffic conditions. The reasons for speeding are diverse and may relate to temporary motives (e.g. being in a hurry), to more permanent personality characteristics (e.g. risk taking), to human perceptual skills and limitations, as well as to characteristics of the road, the road environment and the vehicle.

3.1 The frequency of speed limit violations

Observed speed limit violations

Speed limit violations are very common. Typically 40% to 60% of the drivers exceed the limit. Typically, around 10 to 20% exceed the speed limit by more than 10 km/h (OECD, 2006). The amount of violations on an individual road depends on many different, local aspects, including:

- the local speed limit
- characteristics of the road and road environment
- traffic density and traffic composition
- the level of enforcement
- the country.

Drivers may intentionally or unintentionally exceed the speed limit, since speed choice and motives for speeding are affected by many factors.

Monitoring vehicle speeds nationally

To assess the extent of speeding violation nationally, countries should carry out speed surveys annually on a representative sample of their roads with different speed limits. Speed survey sites should be at locations where drivers can choose “free-speeds”, if they are not likely to be restricted by congestion or by local speed reducing measures.

Self-reported speeding behaviour

The SARTRE 3 survey (SARTRE, 2004) provides information on self-reported speeding behaviour for different road types. Most self-reported speed violations occur on motorways; least self-reported speed violations occur in built-up areas. The percentage of car drivers who report violating the speed limit often, very often or always on different road types are:
motorways: 24%
main roads between towns: 18%
country roads: 12%
built-up areas: 8%

The percentage of self-reported speed violators is considerably smaller than the observed percentages. In assessing self-reported behaviour and when developing speed campaigns, it is important to recognize that the reasons for socially unacceptable behaviour such as speeding are often understated in relation to the reporting driver and overstated for other drivers (Kanellaidis, Golias & Zafiropoulos, 1995). Another reason could be that a few kilometres faster than the speed limit is not considered a speed limit violation by the drivers themselves.

Potential casualty saving

Given the strong relationship between speed and crash risk and crash severity and the large proportion of drivers exceeding the existing speed limits, a substantial number of casualties could be saved if drivers complied with these limits. For example, for Norway it has been estimated, that the number of fatalities could be reduced by about 22%, if speeding was completely eliminated (Elvik, 2008). For Norway, eliminating speeding would mean an overall speed reduction from 78.5 to 74.3 km/h. For countries with higher levels of speeding a larger fatality reduction can be expected.

3.2 Inappropriate speed

Many drivers exceed the posted speed limits. However, even if they comply with the posted speed limit, their speed may be inappropriate for the prevailing traffic, road or weather conditions. Objective data on the prevalence of inappropriate speed is difficult to obtain. One reason is that there is insufficient knowledge about the appropriate speed for specific conditions.

However, the vast majority of the drivers do adapt their speed to the actual conditions. For example, in rainy conditions the average speed is lower than when it is dry. At the same time the crash risk is higher during rain (SETRA-CSTR, 1990). Similarly, in Norway it was found that speed is reduced considerably when snow is falling or when the ground is covered by snow, but that road users insufficiently adapted their driving speed to offset the adverse effects on the number of crashes (Elvik & Kaminska, 2011). So, it must be concluded that the speed adaptation is often insufficient and the speed still inappropriate for rainy conditions and other adverse conditions.

3.3 Speed choice: why do drivers exceed the speed limit?

The vast majority of drivers consider speed as a very important road safety problem. More than 80% of the European drivers state that *driving too fast* is often, very often or always a contributory factor in road crashes (SARTRE, 2004). At the same time, many drivers exceed posted speed limits. Sometimes this may be intentional, sometimes unintentional. Speed choice is affected by characteristics of the driver, by factors related to human perceptual skills and limitations, by characteristics of the road and the road environment, and by characteristics of the vehicle.

Speed choice and driver characteristics

Many drivers prefer to drive faster than the objective risk justifies, but also faster than what they consider to be a safe speed. Motives for exceeding the speed limit are both rational and emotional and may depend on the temporary state of the driver or the actual situation. There are also more permanent personality characteristics that affect speed choice and explain differences between individual drivers and groups of drivers. These types of driver characteristics are related to speed preferences and speed violations.

People generally prefer to drive faster than is safe

Drivers, who prefer higher speeds, also consider higher speeds to be safe. In addition, almost all drivers want to drive faster than the speed that they themselves consider to be a safe speed (Goldenbeld & Schagen, van, 2007). According to the SARTRE 3 survey, around 20% of the European drivers report driving a little faster or much faster than other drivers. At the same time, only around 5% state that they drive more dangerously than other drivers. Apparently, dangerous driving is not related to speed in the mind of most of these drivers.

What are drivers' motives for exceeding the speed limit?

Most drivers openly admit that they more or less regularly exceed the speed limit. They provide the following reasons for these intentional speed limit violations:

- they adapted their speed to that of the general traffic stream;
- they were in a hurry;
- they generally enjoy driving fast;
- they were bored.

The arguments are both rational and emotional. Enjoying driving fast is a very common argument. According to the SARTRE 3 survey almost 10% of the European drivers agreed that they very much enjoy driving fast.

Another reason for exceeding the speed limit is that the driver is unaware of the speed limit. It may be assumed that this is an unintentional violation. Either a speed limit sign was absent or the driver missed it; in both cases the road characteristics are insufficiently informative about the speed limit in force.

Not all drivers are the same

Not all drivers choose the same speed. First of all, there are differences between individual drivers. These individual differences may have to do with personality characteristics. For example, a clear relationship has been established between preferring to drive fast and a general preference for risky, sensational and challenging activities (Zuckerman & Neeb, 1980; Heino, 1996).

Secondly, it is possible to distinguish different groups in relation to speed preferences. For example, a typical finding in studies is that (Webster & Wells, 2000):

- young drivers prefer to drive faster than elderly drivers;
- male drivers prefer to drive faster than female drivers;
- drivers driving for professional purposes prefer to drive faster than drivers driving for private purposes.

Perceptual skills: underestimation of driving speed

All motor vehicles have a speedometer to allow objective monitoring of driving speed. Nevertheless many drivers seem to rely as well on their subjective perception or 'feeling' of their speed when it comes to speed choice (Haglund & Åberg, 2000). However, human perceptual skills (and limitations) affect the subjective experience of speed and may lead to overestimation or underestimation of the driving speed. Hence, the subjective perception of speed is not very reliable. From a safety point of view, underestimation is the most dangerous.

Three types of situations easily lead to underestimation of driving speed (ETSC, 1995; Martens, Comte & Kaptein, 1997; Elliott, McColl & Kennedy, 2003):

- Situations in which a high speed has been maintained for a long period, for example on long-distance trips on motorways. In these cases, the travel speed will increasingly be underestimated, resulting in higher speeds without the driver noticing.
- 'Transition' situations, where drivers must reduce their speed significantly after a period of driving at a high speed. When entering the lower speed zone, drivers will underestimate their travel speed. This is, for example, the case when leaving the motorway and entering a lower-speed two-lane rural road and when entering a village from a major through road. It may also be the case when a long straight section of road is followed by one or more curves.
- Situations where there is little peripheral visual information. For example, wide roads without points of reference, driving at night or in fog provide little peripheral information and are likely to lead to underestimation of the driving speed.

Speed choice and the road/vehicle characteristics

The road environment may also elicit speed limit violations. There are large differences in the amount of speeding between individual roads of the same category and with the same speed limit. Incompatibility between the posted speed limit and the (implicit) message of the road and the road environment may be the reason. The road is insufficiently 'self-explanatory' and the speed limit may be considered as inappropriate. Either intentionally or unintentionally an imbalance between speed limit and the road characteristics may cause drivers to exceed the speed limit.

The characteristics of the car fleet continue to develop, particularly for cars. Some of these characteristics may affect speed choice:

- Engine power increases: cars can be driven faster;
- Comfort increases: there is less discomfort at high speed;
- Number of Land Rover-type cars increase: SUVs (Sport Utility Vehicles) and other 'Land Rover' type of cars become increasingly popular. This type of cars has high wheels, distorting the perception of speed. Speed will be underestimated.

4 Speed management as an integrated package

There is no single solution to the problem of excess and inappropriate speed. A package of countermeasures is necessary, increasing the effectiveness of each individual measure. (OECD, 2006). The most appropriate combination of measures will differ with circumstances. In principle, effective speed management requires an integrated, systematic and stepwise approach. Within the current system of fixed speed limits, the following steps are important:

Step 1: Setting speed limits

The basis for any speed management policy is setting speed limits. Speed limits need to reflect the safe speed on that particular road, related to road function, traffic composition, and road design characteristics. Furthermore, speed limits need to be credible, i.e. they must be logical in the light of the characteristics of the road and the road environment.

Step 2: Information about the speed limit

The driver must know, always and everywhere, what the speed limit is. The conventional way is to use consistent roadside signing and road markings. In-vehicle systems to inform drivers about the speed limit in force are likely to be introduced progressively.

Step 3: Road engineering measures

At particular locations low speeds may be crucial for safety (perceived or actual). Examples are near schools or homes for the elderly, at pedestrian crossings, at intersections. At these locations, physical speed-reducing measures such as speed humps, road narrowings and roundabouts can help to ensure motor vehicles maintain a safe speed.

Step 4: Police enforcement to control the intentional speeder

If Steps 1 to 3 are applied, it can be assumed that the unintentional speed violations are an exception. Drivers who still exceed the speed limit do so intentionally. Here, police enforcement will remain necessary to enforce compliance with limits and issue penalties.

Information and education for drivers

All of steps 1 to 4 have to be accompanied by information to the driver on the problem of speed and speeding, what the speed limit system is based on and why, what additional measures are taken and why, and preferably also on the (positive) outcomes of these measures.

5 The elements of a speed management policy

In the next five sections of this Chapter the five elements of an integrated speed management policy are discussed separately: setting speed limits, providing information about the speed limit in force, implementing road engineering measures, speed limit enforcement and, last but not least, education and publicity.

5.1 Setting appropriate speed limits

Until not so long ago, a common approach to determine the most appropriate speed limit for a particular road or road section was to set the limit close to the V85. The V85-speed is the speed that is not exceeded by 85% of the vehicles. However, it is increasingly understood that the speed limit should not be based on driver speed choice but on analysis of the road and traffic functions and characteristics as well as the biomechanical limits of road users to make sure that the limit represents a safe speed. In Sweden, for example, a new road classification has been introduced recently with the aim of better matching the road function, speed limit and inherent protective design. Here, the setting of speed limits is determined by the inherent protective quality of the road sections and vehicles concerned, rather than the speed behaviour of road vehicle users.

X-LIMITS approach used in Australia and United States

The computer programme X-LIMITS originally developed by ARRB for use by Australian and New Zealand state road authorities has been further developed as “USLIMITS” in collaboration with FHWA for application in the United States. The programme requires data input on density of development, frequency of access, road function, carriageway characteristics (such as number of lanes and carriageway separation), flow, interchange spacing, existing vehicle speeds, adjoining limits, and any special features such as high local crash rates. On the basis of this data, the program calculates a recommended speed limit.

A balance between safety, mobility and environmental considerations

Safety is only one element that affects what speed limit is applied. Also the effects on travel time, mobility must be considered. Setting limits aims to meet the optimum total cost by balancing safety and mobility consequences. There may be a different optimum for different roads depending on their crash rate and their function for mobility. What the optimum is, is largely determined by the method and assumptions that are applied to calculate the costs of road crashes and mobility loss, and increasingly also the costs of air pollution and noise. This, in the end, is a political decision. Assessment frameworks have been proposed to support these decisions (Kallberg, & Toivanen, 1998; Lynam, Hill, & Barker, 2004).

The *Vision Zero* approach (Tingvall & Howarth, 1999) known generically as *Safe System* proposes that the “balance” between safety and mobility should be judged from a more ethical standpoint. This requires that an upper limit is put on the injury risk that could occur on the road (e.g. virtually eliminating the chance of a fatality occurring). The speed limit and the design of the road infrastructure would then be matched to ensure that the injury risk was not exceeded. The *Safe System* approach is recommended to countries by the OECD and other international organisations (OECD, 2008).

Matching speed limits to human injury tolerance in different potential impacts

In Sweden, the concept of a safe speed, as originally discussed by Tingvall and Howarth (1999), has been adopted as a basis for considering appropriate speed limits. The driver/vehicle/road system should operate such that, in the event of an impact, forces are not exerted on vehicle occupants or other road users which are likely to lead to a fatality. Based on this, the updated Dutch *Sustainable Safety* philosophy presents the following requirements with regard to safe speeds in different traffic situations (Source: Wegman & Aarts, 2006):

Road type/traffic situation	Safe speed (km/h)
Roads with potential conflicts between cars and unprotected road users	30
Intersections with potential side impacts between cars	50
Roads with potential head-on conflicts between cars	70
Roads where head-on and side impacts with other road users are impossible	≥100

Unfortunately, there is not yet sufficient knowledge to define the safe speeds for motorized two-wheelers and heavy good vehicles. Also from a practical point of view this problem is as yet unsolved. The best solution is the separation from other traffic, but it is not clear how to realize that in practice.

Who is responsible for setting speed limits?

Generally, the national government decides on the general, national speed limits for different road types. The national government may also determine which exceptions to the general limits can be applied. It generally is the road authority that decides what speed limit is applied for a specific road or road section in their jurisdiction. This decision, of course, must fit within the national speed limit framework, but in general it means that local or regional road authorities have a large amount of freedom in determining which speed limit would be applied where.

Current general speed limits in EU Member States

Current general speed limits vary across Member States. The general speed limit for motorways in EU Member States is mostly 120 or 130 km/h. Germany does not have a general speed limit for motorways, but a recommended speed of 130 km/h. The general speed limit for rural roads in EU Member States is mostly 80 or 90 km/h and for urban roads 50 km/h.



In most countries speed limits that differ from these general limits are applied. Widespread and well known are the 30 km/h zones in residential areas. In Germany, where there is no general speed limit for motorways, many sections of the motorway have a local posted speed limit which may range from 80 km/h to 130 km/h, related to both safety and environmental considerations. In the Netherlands the general speed limit on motorways is 130km/h, but for safety and/or environmental reasons many sections have a permanent or variable (depending on time of day) lower speed limit (notably 120, 100 or 80 km/h).

EU countries apply a lower speed limit for heavy good vehicles (HGVs) and buses/coaches. The majority of countries only apply an overall maximum speed limit for HGVs (generally 80 km/h) and buses (varying between 80 and 100 km/h). By EU Directive 92/24/EEC and its adaptation (2004/11/EEC), speed limiters are compulsory for HGVs of 3.500 kg and more and for buses of 10.000 kg or more.

Different speed limits in adverse weather and traffic conditions

Also the use of variable speed limits related to weather and traffic conditions vary across EU Member States.

Weather

In the EU, only France applies lower general speed limits for bad weather conditions. In case of rain or snow, the speed limit for motorways changes from 130 km/h to 110 km/h and at rural roads from 90 km/h to 80 km/h. In case of fog (visibility less than 50 meters) the speed limit on all types of roads is 50 km/h. In other countries (e.g. Germany, United Kingdom) matrix signs on motorways provide advisory or compulsory reduced speed limits when weather conditions are bad.

Both Finland and Sweden apply different general speed limits in wintertime. In Finland, the speed limit at motorways changes from 120 km/h to 100 km/h and, on main rural roads, from 100 km/h to 80 km/h; these have been evaluated by Peltola (2000). Similarly in Sweden the speed limits change respectively from 110 km/h to 90 km/h and from 90 km/h to 70 km/h.

In France, it is common to reduce the general speed limit by 20 or 30 km/h on a temporary basis, generally in case of high temperatures, with the aim to reduce air pollution and smog.

Traffic conditions

An increasing number of countries monitor traffic flow and use this information to inform through matrix signs drivers about (the chance of) congestion. This application is generally restricted to motorways and some of the most important rural roads. The information may consist of a general message, that congestion is ahead or may arise, to advisory reduced speed limits and compulsory reduced speed limits.

Speed limits and road function

The speed limit needs to reflect the function of a road. Ideally, a road network consists of a limited number of mono-functional roads. For example, in the Netherlands, Sustainable Safety distinguishes between three road functions (Wegman & Aarts, 2006).

Flow function:

Roads with a flow function allow efficient throughput of (long distance) motorized traffic. All motorways and express roads as well as some urban ring roads have a flow function. The number of access and exit points is limited.

Area distributor function:

Roads with an area distributor function allow entering and leaving residential areas, recreational areas, industrial zones, and rural settlements with scattered destinations. Intersections are for traffic exchange (allowing changes in direction etc.); road links facilitate traffic in flowing.

Access function:

Roads with an access function allow actual access to properties alongside a road or street. Both intersections and road links are for traffic exchange.

In line with human injury tolerance, at roads with a flow function and at the links of roads with a distributor function speeds of motorized traffic can be allowed to be high:
if motorized traffic is physically separated from pedestrians, cyclists, mopeds and slow moving agricultural vehicles; and
if road design standards are good.

At roads with an access function and at intersections of roads with a distributor function speed must be low since here all road users make use of the same space. At these locations road engineering measures may be required to support the low speed requirement.

Speed limits and design speed

In general terms, the design speed of a road can be defined as the highest speed that can be maintained safely and comfortably when traffic is light (ETSC, 1995). More specifically the design speed is used by road engineers to determine the various geometric design features of the roadway (AASHTO, 2001; Fitzpatrick, & Carlson, 2002). The exact definition differs from country to country.

In principle, the required design speed depends on the function of the road and, hence, on the desired speed level. If, because of the road function, high speeds are desired, road quality and roadside protection need to be of an appropriate standard. The alternative to improving road standard is to reduce the speed limit consistent with the standard and risk of the road. The exact values for design standards of different road types differ as well from one country to another.

Clearly, the design speed must never be lower than the speed limit. It is not wise to have a speed limit which is much lower than the design speed of a road. This may damage the credibility of a speed limit.

Furthermore, it is important that the design speed is consistent over a longer stretch of road. A substantial reduction of design speed at a particular site must be supported by more than just a sign with the reduced speed limit. Additional warning signs should preferably be accompanied by a change in road design characteristics and/or road markings.

Credible speed limits: characteristics of the road and road environment

First and foremost speed limits have to be safe, but they also have to be credible. A credible speed limit is a limit that is considered to be logical by (the majority of) drivers for that particular road in that particular road environment. A speed is not credible when, for example:

The speed limit sign for built-up areas is located 'in the middle of nowhere' when actual buildings and town activities are not yet visible.

The same speed limit is applied for a wide, straight rural road and a narrow, winding rural road.

If different limits are applied for motorway sections with a similar cross section and a similar (rural) environment. (If other reasons than safety are the basis of these different limits, e.g. noise protection, environmental pollution, this must be clearly communicated to the road users (compare the German sign 'Lärmschutz', i.e. noise protection).

In general, the principle of credibility implies that any transition from one speed limit to another must be accompanied by a change in the road or road environment characteristics.

Credibility of speed limits can be further enhanced by applying different speed limits for different weather and traffic conditions, i.e. by a system of dynamic speed limits.

5.2 Information about the speed limit in force

Setting the appropriate speed limit is of course the first step. The second step is to ensure that the driver always and in any location knows what the posted speed limit is. The conventional way is the use of roadside signing and road markings. In-vehicle systems to inform drivers about the speed limit in force are being introduced progressively.

5.3 Signing and marking

While most drivers know the general speed limits in their country, there is still often uncertainty about the speed limit in force when driving on a particular road (Silcock et al., 2000). There are several supplementary ways to reduce the uncertainty:

Roadside signing

The conventional way to inform road users about the speed limit at a particular road or road section is roadside signing. The Vienna Convention provides guidelines for roadside signing in general, for example regarding uniformity, consistency, simplicity and legibility. With regard to speed limit signs it is important that they are placed on a regular basis; for example, a sign is usually needed after a junction. As with all other road side signs, speed limit signs need to be placed such that they are very visible. They also need to be maintained adequately. Signs may fade in sunshine or become illegible by dirt or overgrown trees. It must be noted that in many countries, e.g. in Norway and The Netherlands, general speed limits are not signed, only the exceptions.

Road markings

To support the road side signs, a speed limit sign can also be painted on the road surface, for example at speed limit transitions. Furthermore, the speed limit regime at a particular road type can be supported by differential, but consistent longitudinal lines (line present/absent, broken/solid, different colours). The meaning of the differential lines with regard to the required speed must be clearly communicated to the road users. The 'automatic' effect of longitudinal marking on speed behaviour has been found to be very small (Van Driel, Davidse & Maarseveen, van (2004).

Small repeater signs as reminder

In addition to the regular speed signs, small repeater signs can help to remind the drivers of the speed limit in force. For example, in the Netherlands these small repeater signs are used at motorways that have a limit of 100 km/h instead of the general 120 km/h. These signs (with a diameter of 150 mm) are placed every 100m integrated in the hectometre posts (see photograph). In Britain, small repeater signs are required at regular intervals, where roads have speed limits which are not the commonest for that road type.



A hectometre post with speed limit reminder at motorways in the Netherlands

In-vehicle information systems

The development of in-vehicle systems to inform drivers about the speed limit in force continues rapidly and is already often integrated in navigation systems. This type of in-vehicle information systems make use of detailed digital maps that are linked to a speed limit database. These systems enable the driver to get information on the speed limit in force, wherever he or she is. See ERSO [eSafety](#) and [Vehicle Safety](#) texts.

5.4 Road engineering

Overall road design should indicate the function of a road and, in combination with design speed, the appropriate speed limit. At specific locations, additional road engineering measures may be necessary to ensure the safe speed of cars. If applied in a consistent way, this type of measures may also help drivers to recognize the traffic situation and the speed limit. Locations where physical speed reduction measures are often necessary are residential areas, at-grade intersections at main urban and rural roads, high-speed to low-speed transition zones, and midblock pedestrian crossings.

Use of 30 and 60 km/h zones and accompanying measures in the Netherlands

In the Netherlands between 1985 and 1997, about 10-15% of the urban residential roads were converted to 30km/h zones. The roads in these zones were redesigned using road humps, road narrowing's and mini-roundabouts to ensure the 30 limits were respected. Subsequently, as part of the Sustainable Safety initiative, there was a major increase in investment in these zones between 1998 and 2007. In this period, the proportion of urban access roads treated has increased to 90%. Engineering work within the zones was however less extensive than in the earlier zones. According to Sustainable Safety, also rural access roads should have a reduced speed limit of 60 km/h. Between 1998 and 2007, around 75% of these roads categories were redesigned into 60 km/h zones.

In parallel, engineering work has also been used on the urban and rural roads where speed limits were not reduced to 30/60 km/h to maximize separation of vulnerable road users.

Source: Weijermars andnWegman (2011)

Residential areas: 30 km/h + supportive engineering measures

An increasing number of countries apply 30 km/h zones in residential areas, based on the known relationship between speed and the survival limits of vulnerable road users in a collision. In order to ensure that the 30 km/h limit is not exceeded, the limit is best supported by engineering measures such as speed humps, road narrowing's, chicanes and raised areas at intersections. The application of these vertical and horizontal measures has been found to have a substantial effect on speed (e.g. Van Schagen, 2003). In addition, these types of measures make roads less attractive for motorized traffic, resulting in less through traffic. These measures can substantially improve safety. Elvik et al. (2009) report that casualty reductions of up to 60% have been recorded, but that the effects can be smaller depending on the physical changes used. Elvik and colleagues consider 25% to be a more typical average reduction.

Roundabouts and midblock pedestrian crossings

Speed reduction is also particularly appropriate at at-grade intersections at main urban and rural roads. For these locations, the application of roundabouts is a very effective speed reduction measure. In addition, at roundabouts the angle of impact is smaller, resulting in less severe consequences in case of a collision. Based on a meta-analysis (Elvik et al., 2009) it is reported that overall, a roundabout can be expected to reduce the number of injury crashes by 40 to 50%. The effect on fatal crashes is even somewhat larger. The exact effect depends on various factors. The largest effects are found of roundabouts in rural areas, of roundabouts that replace a previous non-signalized intersection and of roundabouts that replace a previous four-legged junction.

At mid-block pedestrian crossings the speed of motorized vehicles should also be kept low. A raised crossing will make high speeds less likely.

Transition zones

When entering the lower speed zone, in particular after a period of driving at a high speed, drivers will easily underestimate their travel speed, and hence insufficiently adapt their speed. Here specific measures help to indicate the transition from one traffic environment to another, to other traffic behaviour, and primarily to another speed (Herrstedt et al., 1993).

Of special concern is the entrance of a village from a major through road. ETSC (1995) describes two principles for measures in such transition zones. The first principle is that complementary measures along the through route within the urban area are required. The second principle is that measures at the transition zone should be such that they achieve a cumulative effect, culminating at the actual gateway to the towns or villages. The latter can be achieved, as the ETSC reports says, by a combination of road narrowing and the introduction of vertical elements, culminating in the gateway. This is an example of a psychological measure that relies on the driver's perception of the appropriate speed: speeds are lower where the height of the vertical elements is greater than the width of the road (Herrstedt et al., 1993).

Taylor and Wheeler (2000) evaluated the effects of 56 traffic-calming schemes in British villages on main interurban roads where the speed on the approach to the villages was typically 90 km/h. It was found that the schemes with only gateway measures resulted in a reduction in fatal and serious crashes within the villages of 43%; the number of slight crashes increased by 5%. The crash reduction was higher for pedestrians and cyclists than for motor vehicles. Higher crash reduction rates were reported for schemes with additional measures inside the villages (chicanes, road narrowing, mini-roundabouts, speed humps and speed cushions). Here, the number of fatal and serious crashes decreased by about 70% and the number of slight injuries by about 37%.

The transition between motorways and the adjacent lower speed zones is another situation where underestimation of speed may result in insufficient speed adaptation. A roundabout at the exit of the motorway may restore speed perception and facilitate choosing the appropriate speed.

Where a long straight stretch of road enters a winding section, physical speed reduction measures are less suitable. Currently, roadside warning signs and advisory speed limits are the most commonly used in this type of situations. Vehicle actuated signs warning of speeds being inappropriate for approaching hazards have proved effective in Great Britain (Winnett & Wheeler (2002). There is also experience with (combinations of) transverse and longitudinal pavement markings at dangerous curves as a perceptual rather than a physical speed reduction measure (Fildes & Jarvis, 1994). Similar pavement markings have been used at village gateways. Evaluation studies generally show a positive effect on driving speed, but there is uncertainty over how long this effect will last over time (Martens, Comte, & Kaptein, 1997).

5.5 Speed enforcement

Speed enforcement aims to prevent drivers exceeding the speed limit by penalizing those who do. This not only affects the speed violators who actually get caught (specific deterrence), but also those who see or hear that others get caught (general deterrence). Speed enforcement will remain an essential speed management measure as long as the speed problem is not solved in a structural way by road design, engineering measures or in-vehicle technology. There are various tools and methods available for speed enforcement. Police enforcement can be a very effective measure but needs to be sustained, given the effects are limited both in time and place. Surveys show that road users are generally fairly positive about speed enforcement activity. See ERSO text on [Speed Enforcement](#).

5.6 Education and publicity campaigns

Road user awareness of the risk of inappropriate speeds to themselves and others can be increased through education and driver training, publicity campaigns and driver (improvement) courses. In addition, these instruments can be used to inform road users about specific speed management measures, in particular about the reasons, the expected benefits and, preferably, also about the realized effects. Education and publicity are conditional on other speed reduction measures, such as speed enforcement and the acceptance of legal changes. On its own, research indicates that the effect of education and publicity in changing actual speed behaviour is limited.

Road user education and driver training

Structural traffic education as part of the school curriculum is generally limited to primary schools. At that age, the possibilities of influencing later speed behaviour of the pupils are very limited. However this introduces children to the 'speed' problem, with the aim of encouraging discussion with their parents about their speed behaviour.

For the young in secondary schools, the (theoretical) preparations for a driver license or, in some countries, a moped certificate may be the right moment to direct their attention to the consequences of driving or riding (too) fast. That driving/riding too fast leads to more and more severe crashes applies to moped riders just as much as to car drivers. However, the extent to which this sort of information influences the actual speed behaviour of the novice moped riders and later on as car driver is not established.

Subsequently, driver training plays a role in helping to create awareness of safe speed and how speed and speeding relate to road safety: the rationale for speed limits, adapting driving speed to the circumstances; anticipating and adapting their speed in time. In total, while contributing to improved driver awareness, the effects of road user education and driver training in isolation on actual speed behaviour must be considered to be limited.

Publicity campaigns

Publicity and information campaigns about speed are very useful in various ways (Delhomme et al., 1999). They can be used to explain the goal, necessity, and effects of measures such as physical speed limiters and 30 km/h zones. They have been found to considerably

increase the effectiveness and acceptance of speed enforcement. Besides this, campaigns can be used to make people aware of the problem of driving (too) fast. The direct effect of publicity campaigns on speed behaviour is limited. A recent meta-analysis of the effects of road safety campaigns in the CAST project (Vaa & Phillips, 2009) showed that, overall, speed campaigns resulted in a reduction of speeding of 16%; however, the effect of mass media campaigns (i.e. using television, radio or newspaper as the communication channel) was not significant. Probably related to this, the same analysis showed that achieving a feeling of intimacy and immediacy increases the effect of a campaign. When using mass media campaigns, Delaney et al. (2004) found that a convincing, emotional approach is more effective than a rational, informative approach.

Publicity campaigns are usually aimed directly at the road user. However, they can also be aimed the driver's social surroundings. The success of this has been shown by campaigns against drink-driving, which is socially unacceptable nowadays. An attempt should be made to discover if the same applies to speeding.

Driver improvement courses

Driver improvement courses generally follow a serious traffic violation or are related to a particular level of demerit points. A course can be compulsory or voluntary, e.g. in combination with a reduction of the fine. Most driver improvement courses are related to drink-driving offences. Driver improvement courses also relate to safe/defensive driving in general. Only a few countries apply driver improvement courses specifically related to speed offences, e.g. Austria, Switzerland, Finland, UK, and Belgium. For methodological reasons, it is very difficult to assess the effectiveness of driver improvement courses. Those studies that did, generally found that the effects on crash risk are small (Ker et al., 2005), or non-existent (Masten & Peck, 2003).

6 New technologies, new opportunities

New technologies that can make speed management more intelligent and flexible are emerging rapidly. They are based on digital maps in relation to vehicle positioning information, e.g. through GPS. They are also based on the possibilities of vehicle-roadside communication and the automatic detection of the actual traffic, road and weather circumstances. Some systems are already available and likely to be introduced progressively. With respect to speed management, there are interesting and promising developments related to ISA and dynamic speed limits.

6.1 Intelligent Speed Adaptation (ISA)

Intelligent Speed Adaptation (ISA) is an in-vehicle system that supports drivers' compliance with the speed limit. ISA is in fact a collective term for various different systems. Field trials and driving simulator studies show positive effects on speed behaviour and imply large safety effects. Some studies report negative side effects of ISA, but there is yet insufficient insight in the size of these possible negative side effects and their consequences. Around

one quarter of European car drivers considers a speed-limiting device like ISA to be very useful; actual experience with ISA seems to increase acceptance.

What is ISA?

Intelligent Speed Adaptation (ISA) is an in-vehicle system that uses information on the position of the vehicle in a network in relation to the speed limit in force at that particular location. ISA can support drivers in helping them to comply with the speed limit everywhere in the network. This is an important advantage in comparison to the speed limiters for heavy good vehicles and coaches, which only limit the maximum speed.

ISA is a collective term for various systems:

- The open ISA warns the driver (visibly and/or audibly) that the speed limit is being exceeded. The driver him/herself decides whether or not to slow down. This is an informative or advisory system.
- The half-open ISA increases the pressure on the accelerator pedal when the speed limit is exceeded (the 'active accelerator'). Maintaining the same speed is possible, but less comfortable because of the counter pressure.
- The closed ISA limits the speed automatically if the speed limit is exceeded. It is possible to make this system mandatory or voluntary. In the latter case, drivers may choose to switch the system on or off.

The currently available ISA systems are based on fixed speed limits. They may also include location-dependent (advisory) speed limits. It will become increasingly possible to include dynamic speed limits that take account of the actual circumstances at a particular moment in time.

How effective is ISA?

In the 1990s, in a number of countries field trials with ISA have been carried out, for example in Sweden, the Netherlands, Germany, and France. In Sweden it concerned large-scale experiments with the open ISA (warning/informing) and the half-open ISA (the active accelerator) in four different town/cities (Biding & Lind, 2002). In the Dutch town of Tilburg, there was an experiment with the closed ISA (Besseling & Boxtel, van, 2001). The field trials generally showed a positive effect of the system. Driving speeds with ISA were slower and more homogenous. In Sweden, no differences were found between a warning and an informing system.

There has also been a lot of research using driving simulators to assess effectiveness of ISA, for example in Britain (Carsten & Fowkes, 2000; Carsten & Tate, 2005). Here, they tested three ISA systems: an open, advisory system; a combination of half-open/closed system on a voluntary basis (on-off switch); and the same system on a mandatory basis (without on-off switch). They also looked at three different types of speed limits: fixed, variable and dynamic. Based on the speed behaviour, the effects on the number of crashes have been estimated. The estimates show that all systems had a positive effect on safety, with the largest effect of the mandatory system based on dynamic speed limits. Besides the safety improvement, the

British studies found ISA also to lead to a reduction in fuel consumption. The most recent UK research has indicated the following benefits:

Expected road safety results from a range of ISA options:

	Advisory % reduction	Voluntary % reduction	Mandatory % reduction
Fatal crashes	5%	21%	46%
Serious injury crashes	3%	14%	34%

Source: Carsten, O. (2012) Personal communication of additional results to study of Lai, F., Carsten, O. & Tate, F., *How much benefit does Intelligent Speed Adaptation deliver: An analysis of its potential contribution to safety and environment*, Accident Analysis and Prevention 48 (2012) 63 - 72.

Does ISA have negative side effects?

No negative side effects of ISA were found in the experiments in Sweden (Biding & Lind, 2002). However, there is still some concern about this point. Issues that have been reported are:

- Compensation behaviour: there are indications that drivers compensate by driving faster on road segments where the ISA system is not active (Persson et al., 1993).
- Diminished attention: ISA can result in reduced attention to the road and traffic situation, when the system is not active. This diminished attention expresses itself in, for example, forgetting to slow down when entering a lower speed zone or to accelerate when entering a higher speed zone, but also in forgetting to use the direction indicator (Comte, 2000; Várhelyi et al., 2002).
- Over confidence: it is possible that using ISA could result in the driver completely relying on the speed limit indicated by the system, and insufficiently observing the real-time circumstances.
- Feeling frustrated: the speed limiting by ISA can produce frustration in the driver and in other traffic (Comte, 2000; Várhelyi et al., 2002).

At present there is insufficient insight into the size of these possible negative side effects and their consequences.

How acceptable is ISA?

According to the SARTRE survey of 2004 around a quarter of the European drivers are of the opinion that it is 'very useful' to have a device in the car that restrains you from exceeding the speed limits. This is a little bit lower than for devices preventing drink-driving and driving when fatigued (for both 32% is of the opinion that it is very useful). The practical experiments in both Sweden and the Netherlands have shown that the acceptance of ISA increases if concrete experience with it has been gained. Looking at policy and legal issues (OECD, 1996), it can be concluded that an informative ISA will not give rise to many problems. In



fact, there are already several products on the market that are very similar to an informative ISA. More intervening systems, however, are still confronted with several legal and policy hurdles.

To assess the political acceptance of ISA systems, the EU-funded PROSPER project performed a survey among different stakeholders (politicians, governmental institutes, research institutes, pressure groups and commercial groups) in eight EU countries. It is reported, that despite differences between countries and between different stakeholder groups, ISA is generally seen as an effective safety measure (PROSPER, 2006). An introduction among all driver groups, on all road types and on a mandatory basis is preferred. A half-open system or the active accelerator was considered to be the best option for now. According to the stakeholders, this scenario would result in the best results for safety, environment and congestion. Barriers to the implementation of ISA that were identified included the technical functioning, applicability to the whole network, benefits for the road users and liability issues (Beyst, 2004).

While there is considerable public support for ISA, an implementation strategy is needed to speed up the process of implementation of ISA in vehicles as recommended by the PROSPER project (PROSPER, 2006). This should include the development of speed limit maps by European, national and regional authorities (to date, Sweden and Finland have established speed limit databases although these are under development in the UK and the Netherlands). Also, awareness of ISA / Speed Alert has to be created. Authorities and organisations (e.g. fleet owners) can act as forerunners by implementing ISA in their vehicle fleets. Further harmonisation activities are needed on the international level. Euro NCAP plans to incorporate Speed Assistance Systems into its rating system in 2013.

See also ERSO [eSafety](#) and [Vehicle Safety](#) texts.

6.2 Dynamic speed limits

Fixed speed limits represent the appropriate speed for average conditions. Dynamic speed limits, on the other hand, are limits that take account of the real time traffic, road and weather conditions. Dynamic limits can better reflect the safe speed. If, for example, 80 is a safe speed in average conditions, 90 km/h may still be safe in optimal conditions, whereas 60 may still be too high in very busy, or dark and slippery conditions. Dynamic limits are also expected to increase the credibility of the speed limit system in general.

A number of countries apply dynamic speed limits on their motorways, related to traffic flow or weather conditions. Increasing technological developments would allow for dynamic speed limits at other road types as well and eventually integrated into intelligent speed adaptation devices.

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