

CHAPTER 1

INTRODUCTION

1.1 Road Traffic Safety

Road traffic safety refers to the methods and measures used to prevent road users from being killed or seriously injured. Typical road users include pedestrians, cyclists, motorists, vehicle passengers, and passengers of on-road public transport (mainly buses and trams).

Best-practices in modern road safety strategies focus on preventing serious injury and death from vehicle crashes despite human fallibility.^[1] Safe road design is now about implementing a Safe System approach:

The basic strategy of a Safe System approach is to ensure that in the event of a crash, the impact energies remain below the threshold likely to produce either death or serious injury. This threshold will vary from crash scenario to crash scenario, depending upon the level of protection offered to the road users involved.

As sustainable solutions for all classes of road have not been identified, particularly low-traffic rural and remote roads, a hierarchy of control should be applied, similar to classifications used to improve occupational safety and health. At the highest level is sustainable prevention of serious injury and death crashes, with sustainable requiring all key result areas to be considered. At the second level

is real time risk reduction, which involves providing users at severe risk with a specific warning to enable them to take mitigating action. The third level is about reducing the crash risk which involves applying the road design standards and guidelines (such as from AASHTO), improving driver behaviour and enforcement.

Road traffic crashes are one of the world's largest public health and injury prevention problems. The problem is all the more acute because the victims are overwhelmingly healthy before their crashes. According to the World Health Organization (WHO), more than 1 million people are killed on the world's roads each year. A report published by the WHO in 2004 estimated that some 1.2 million people were killed and 50 million injured in traffic collisions on the roads around the world each year and was the leading cause of death among children 10–19 years of age. The report also noted that the problem was most severe in developing countries and that simple prevention measures could halve the number of deaths.

Vehicle speed within the human tolerances for avoiding serious injury and death is a key goal of modern road design because impact speed affects the severity of injury to both occupants and pedestrians. For occupants, Joksch (1993) found the probability of death for drivers in multi-vehicle accidents increased as the fourth power of impact speed (often referred to by the mathematical term δv ("delta V"), meaning change in velocity). Injuries are caused by sudden, severe acceleration (or deceleration); this is difficult to measure. However, crash

reconstruction techniques can estimate vehicle speeds before a crash. Therefore, the change in speed is used as a surrogate for acceleration. This enabled the Swedish Road Administration to identify the KSI risk curves using actual crash reconstruction data which led to the human tolerances for serious injury and death referenced above.

According to a 2004 report from the World Health Organisation a total of 22% of all 'injury mortality' worldwide were from road traffic injuries in 2002 and without 'increased efforts and new initiatives' casualty rates would increase by 65% between 2000 and 2020. The report identified that the speed of vehicles was 'at the core of the problem and said that speed limits should be set appropriately for the road function and design along with physical measures related to the road and the vehicle and effective enforcement by the police. Road incidents are said to be the leading cause of deaths among children 10 – 19 years of age (260,000 children die a year, 10 million are injured). They are also occasionally set to reduce vehicle emissions or fuel use.

Maximum speed limits place an upper limit on speed choice and if obeyed can reduce the differences in vehicle speeds by drivers using the same road at the same time. Traffic engineers observe that the likelihood of a crash happening is significantly higher if vehicles are traveling at speeds faster or slower than the mean speed of traffic; when severity is taken into account the risk is lowest for

those traveling at or below the median speed and "increases exponentially for motorists travelling much faster".

It is desirable to attempt to reduce the speed of road vehicles in some circumstances because the kinetic energy involved in a motor vehicle collision is proportional to the square of the speed at impact. The probability of a fatality is, for typical collision speeds, empirically correlated to the fourth power of the speed *difference* (depending on the type of collision, not necessarily the same as *travel speed*) at impact, rising much faster than kinetic energy.

Typically motorways have higher speed limits than conventional roads because motorways have features which decrease the likelihood of collisions and severity of impacts. For example, motorways separate opposing traffic and crossing traffic, employ traffic barriers, and prohibit the most vulnerable users such as pedestrians and bicyclists. Germany's crash experience illustrates the relative effectiveness of these strategies on crash severity: on autobahns 22 people died per 1000 injury crashes, a lower rate than the 29 deaths per 1,000 injury accidents on conventional rural roads; however, the rural risk is five times higher than on urban roads – speeds are higher on rural roads and autobahns than urban roads, increasing the severity potential of a crash.^[107] The net effect of speeds, crash probability, and impact mitigation strategies may be measured by the rate of deaths per billion-travel-kilometers: the autobahn fatality rate is 2 deaths per billion-travel-kilometers, lower than either the 8.7 rate on rural roads or the 5.3

rate in urban areas; the overall national fatality rate was 5.6, slightly higher than urban rate and more than twice that of autobahns.

The 2009 technical report *An Analysis of Speeding-Related Crashes: Definitions and the Effects of Road Environments* by the National Highway Traffic Safety Administration showed that about 55 percent of all speeding-related crashes in fatal crashes had "exceeding posted speed limits" among their crash factors, and 45 percent had "driving too fast for conditions" among their crash factors. However, the authors of the report did not attempt to determine whether the factors were actually a crash cause, contributor, or an unrelated factor.^[109] Furthermore, separate research finds that only 1.6% of crashes are "caused" by drivers that exceed the posted speed limit. Finally, exceeding the posted limit may not be a remarkable factor in crash analysis as there exist roadways where virtually all motorists are in technical violation of the law.^[111]

The speed limit will also take note of the speed at which the road was designed to be driven (the design speed) which is defined in the US as "a selected speed used to determine the various geometric design features of the roadway" However traffic engineers recognize that "operating speeds and even posted speed limits can be higher than design speeds without necessarily compromising safety" since design speed is "based on conservative assumptions about driver, vehicle and roadway characteristics".

Vision Zero, which envision reducing road fatalities and serious injuries to zero by 2020, suggests the following "possible long term maximum travel speeds related to the infrastructure, given best practice in vehicle design and 100% restraint use":

Possible Maximum Travel Speeds	
Type of Infrastructure and Traffic	Possible travel speed (Km/h)
Locations with possible conflicts between pedestrians and cars	30 km/h (19 mph)
Intersections with possible side impacts between cars	50 km/h (31 mph)
Roads with possible frontal impacts between cars, including rural roads ^[115]	70 km/h (43 mph)

"Roads with no possibility of a side impact or frontal impact" are sometimes designated as Type 1 (motorways/freeways/Autobahns), Type 2 ("2+2 roads") or Type 3 ("2+1 roads"). These roadways have crash barriers separating opposing traffic, limited access, grade separation and prohibitions on slower and more vulnerable road users. Undivided rural roads can be quite dangerous even with speed limits that appear low by comparison. For example, in 2011, Germany's 100 km/h (62 mph)-limited rural roads had a fatality rate of 8.7 deaths per billion travel-km, over four times higher than the autobahn rate of 2 deaths. Autobahns accounted for 31% of German road travel in 2011, but just 11% (453 of 4,009) of traffic deaths.

1.2 Fuel Efficiency

Fuel efficiency sometimes affects speed limit selection. The United States instituted a National Maximum Speed Law of 55 mph (89 km/h) as part of the Emergency Highway Energy Conservation Act in response to the 1973 oil crisis to reduce fuel consumption. According to a report published in 1986 by The Heritage Foundation, a Conservative advocacy group, the law was widely disregarded by motorists and hardly reduced consumption at all. In 2009 The American Trucking Associations called for a 65 mph speed limit and also national fuel economy standards claiming that the lower speed limit was not effective at saving fuel. European studies have claimed that, whereas the effects of specific speed reduction schemes on particulate emissions from trucks are ambiguous, lower maximums speed for trucks consistently result in lower emissions of CO₂ and better fuel efficiency.

Environmental considerations

Speed limits can also be used to improve local air quality issues or other factors affecting environmental quality for example the "environmental speed limits" in the United States including one in an area of Texas. The European Union is also increasingly using speed limits as in response to environmental concerns.

Advocacy

Speed limits, and especially some of the methods used to attempt to enforce them, have always been controversial. There are a variety of notable organisations and individuals who, for a variety of often passionately held views, oppose or support the use of speed limits or the way they are enforced.

Opposition

Speed limits, and their enforcement have been opposed by various groups and for various reasons since their inception. Historically, the AA was formed in 1905, initially to warn members about speed traps. In more recent times some advocacy groups seek to have certain speed limits as well as other measures removed. For example, automated camera enforcement has been criticised by motoring advocacy groups the Association of British Drivers, the North American National Motorists Association, and the German Auto Club.

Arguments used by those advocating a relaxation of speed limits or their removal include:

- A 1994 peer-reviewed paper by Charles A. Lave et al. titled *Did the 65 mph Speed Limit Save Lives?* stated that evidence that a higher speed limit may be positive on a system wide in the United States by shifting more traffic to these safer roads.^[128]

- A 1998 report in the *Wall Street Journal* title 'Highways are safe at any speed' stated that when speed limits are set artificially low, tailgating, weaving and speed variance (the problem of some cars traveling significantly faster than others) make roads less safe.
- In 2010, German Auto Club (a major motoring organisation) argued that an autobahn speed limit was unnecessary because numerous countries with a general highway speed limit had worse safety records than Germany, for example Denmark, Belgium, Austria, and the United States.
- In 2008, the German Automobile Manufacturer's Association called general limits "patronizing", arguing instead for variable speed limits. The Association also stated that "raising the speed limits in Denmark (in 2004 from 110 km/h to 130 km/h) and Italy (2003 increase on six-lane highways from 130 km/h to 150 km/h) had no negative impact on traffic safety. The number of accidental deaths even declined".
- Safe Speed, a UK advocacy organisation campaigns for higher speed limits and to scrap speed cameras on the basis that the benefits were exaggerated and that they may actually increase casualty levels; their ePetition to the UK government in 2007 calling for speed cameras to be scrapped received over 25,000 signatures.

Support

Various other advocacy groups press for stricter limits and better enforcement. The Pedestrians Association was formed in the United Kingdom in 1929 to protect the interests of the pedestrian. Their president published a critique of motoring legislation and the influence of motoring groups in 1947 title 'Murder most foul' which laid out in an emotional but detailed way the situation as they saw it and called for tighter speed limits. Historically, the Pedestrians' Association and the Automobile Association were described as "bitterly opposed" in the early years of United Kingdom motoring legislation. More recently organisations such as Road Peace, Twenty is Plenty, and Vision Zero have campaigned for lower speed limits in residential areas.

Signage

In most of the world speed limit signs display the limitation within a red circle. This design follows the style set out by the Vienna Convention on Road Signs and Signals, with the exception of United States and Canada. All countries globally worldwide (except the United Kingdom and United States) use metric speed limits in kilometres per hour. Metric signs are optional in the United States though less commonly seen, while Samoa uses both units. In Ontario, Canada, the type, location, and frequency of speed limit signs is covered by regulation 615 of the Ontario Highway Traffic Act.

Unique speed limit sign in the United States on evacuation routes requiring drivers to maintain the maximum safe speed

1.3 Speed Limit Derestriction

In some countries, derestriction signs are used to mark where a speed zone ends. The speed limit beyond the sign is the prevailing limit for the general area, for example the sign might be used to show the end of an urban area. In the United Kingdom, the sign means that the national speed limit applies (60 mph on open roads, 70 mph on dual carriageways and motorways). In New Zealand it means you are on an open road, but the maximum legal speed of 100 km/h still applies. On roads without a general speed limits, such as German Autobahn, a portion of Stuart Highway, and rural areas on the Isle of Man, it really means end of all quantitative speed limits.

Advisory Speed Limit

Advisory speed limits may provide a safe suggested speed in an area, or warn of the safe maximum speed for dangerous curves. **Traffic** on roads may consist of pedestrians, ridden or herded animals, vehicles, streetcars, buses and other conveyances, either singly or together, while using the public way for purposes of travel. **Traffic laws** are the laws which govern traffic and regulate vehicles, while **rules of the road** are both the laws and the informal rules that may have developed over time to facilitate the orderly and timely flow of traffic.

Organized traffic generally has well-established priorities, lanes, right-of-way, and traffic control at intersections.

Traffic is formally organized in many jurisdictions, with marked lanes, junctions, intersections, interchanges, traffic signals, or signs. Traffic is often classified by type: heavy motor vehicle (e.g., car, truck); other vehicle (e.g., moped, bicycle); and pedestrian. Different classes may share speed limits and easement, or may be segregated. Some jurisdictions may have very detailed and complex rules of the road while others rely more on drivers' common sense and willingness to cooperate.

Organization typically produces a better combination of travel safety and efficiency. Events which disrupt the flow and may cause traffic to degenerate into a disorganized mess include: road construction, collisions and debris in the roadway. On particularly busy freeways, a minor disruption may persist in a phenomenon known as traffic waves. A complete breakdown of organization may result in traffic congestion and gridlock. Simulations of organized traffic frequently involve queuing theory, stochastic processes and equations of mathematical physics applied to traffic flow.

The word *traffic* originally meant "trade" (as it still does) and comes from the Old Italian verb *trafficare* and noun *traffico*. The origin of the Italian words is unclear. Suggestions include Catalan *trafegar* "decant", an assumed Vulgar Latin verb *transfricare* 'rub across', an assumed Vulgar Latin combination of *trans-* and

facere 'make or do', Arabic *tafriq* 'distribution', and Arabic *taraffaqa*, which can mean 'seek profit'.

1.4 Rules of the Road

Traffic control in Rome, Italy. This traffic control podium can retract back to road level when not in use.

Rules of the road and driving etiquette are the general practices and procedures that road users are required to follow. These rules usually apply to all road users, though they are of special importance to motorists and cyclists. These rules govern interactions between vehicles and with pedestrians. The basic traffic rules are defined by an international treaty under the authority of the United Nations, the 1968 *Vienna Convention on Road Traffic*. Not all countries are signatory to the convention and, even among signatories, local variations in practice may be found. There are also unwritten local rules of the road, which are generally understood by local drivers.

As a general rule, drivers are expected to avoid a collision with another vehicle and pedestrians, regardless of whether or not the applicable rules of the road allow them to be where they happen to be.

In addition to the rules applicable by default, traffic signs and traffic lights must be obeyed, and instructions may be given by a police officer, either routinely (on a busy crossing instead of traffic lights) or as road traffic control around a construction zone, accident, or other road disruption. These rules should be

distinguished from the mechanical procedures required to operate one's vehicle. See driving.

Directionality

Traffic going in opposite directions should be separated in such a way that they do not block each other's way. The most basic rule is whether to use the left or right side of the road.

Traffic Regulations

In many countries, the rules of the road are codified, setting out the legal requirements and punishments for breaking them. In the United Kingdom, the rules are set out in the Highway Code, which includes obligations but also advice on how to drive sensibly and safely.

In the United States, traffic laws are regulated by the states and municipalities through their respective traffic codes. Most of these are based at least in part on the Uniform Vehicle Code, but there are variations from state to state. In states such as Florida, traffic law and criminal law are separate, therefore, unless someone flees a scene of an accident, commits vehicular homicide or manslaughter, they are only guilty of a minor traffic offense. However, states such as South Carolina have completely criminalized their traffic law, so, for example, one is guilty of a misdemeanor simply for travelling 5 miles over the speed limit.

1.5 Organized Traffic

Priority (Right of Way)

Vehicles often come into conflict with other vehicles and pedestrians because their intended courses of travel intersect, and thus interfere with each other's routes. The general principle that establishes who has the right to go first is called "right of way", or "priority". It establishes who has the right to use the conflicting part of the road and who has to wait until the other does so.

Signs, signals, markings and other features are often used to make priority explicit. Some signs, such as the stop sign, are nearly universal. When there are no signs or markings, different rules are observed depending on the location. These default priority rules differ between countries, and may even vary within countries. Trends toward uniformity are exemplified at an international level by the Vienna Convention on Road Signs and Signals, which prescribes standardized traffic control devices (signs, signals, and markings) for establishing the right of way where necessary.

Crosswalks (or pedestrian crossings) are common in populated areas, and may indicate that pedestrians have priority over vehicular traffic. In most modern cities, the traffic signal is used to establish the right of way on the busy roads. Its primary purpose is to give each road a duration of time in which its traffic may use the intersection in an organized way. The intervals of time assigned for each road may be adjusted to take into account factors such as difference in volume of traffic, the needs of pedestrians, or other traffic signals. Pedestrian crossings may

be located near other traffic control devices; if they are not also regulated in some way, vehicles must give priority to them when in use. Traffic on a public road usually has priority over other traffic such as traffic emerging from private access; rail crossings and drawbridges are typical exceptions.

Uncontrolled Traffic

Uncontrolled traffic comes in the absence of lane markings and traffic control signals. On roads without marked lanes, drivers tend to keep to the appropriate side if the road is wide enough. Drivers frequently overtake others. Obstructions are common.

Intersections have no signals or signage, and a particular road at a busy intersection may be dominant – that is, its traffic flows – until a break in traffic, at which time the dominance shifts to the other road where vehicles are queued. At the intersection of two perpendicular roads, a traffic jam may result if four vehicles face each other side-on.

Turning

Drivers will often want to cease to travel a straight line and turn onto another road or onto private property. The vehicle's directional signals (commonly known as "blinkers" or "indicators") are often used as a way to announce one's intention to turn, thus alerting other drivers. The actual usage of directional signals varies greatly amongst countries, although its purpose should be the same in all countries: to indicate a driver's intention to depart from the current (and natural)

flow of traffic well before the departure is executed (typically 3 seconds as a guideline).

This will usually mean that turning traffic will have to stop in order to wait for a breach to turn, and this might cause inconvenience for drivers that follow them but do not want to turn. This is why dedicated lanes and protected traffic signals for turning are sometimes provided. On busier intersections where a protected lane would be ineffective or cannot be built, turning may be entirely prohibited, and drivers will be required to "drive around the block" in order to accomplish the turn. Many cities employ this tactic quite often; in San Francisco, due to its common practice, making three right turns is known colloquially as a "San Francisco left turn". Likewise, as many intersections in Taipei City are too busy to allow direct left turns, signs often direct drivers to drive around the block to turn.

Turning rules are by no means universal. For example, in New Zealand (a drive-on-the-left country) between 1977 and 2012, left turning traffic had to give way to opposing right-turning traffic wishing to take the same road (unless there were multiple lanes, but then one must take care in case a vehicle jumped lanes). New Zealand abolished this particular rule on 25 March 2012, except at roundabouts or when denoted by a Give Way or Stop sign. Although the rule caused initial driver confusion, and many intersections required or still require

modification, the change is predicted to eventually prevent one death and 13 serious injuries annually.

On roads with multiple lanes, turning traffic is generally expected to move to the lane closest to the direction they wish to turn. For example, traffic intending to turn right will usually move to the rightmost lane before the intersection. Likewise, left-turning traffic will move to the leftmost lane. Exceptions to this rule may exist where for example the traffic authority decides that the two rightmost lanes will be for turning right, in which case drivers may take whichever of them to turn. In certain parts of the world traffic will adapt to informal patterns that rise naturally rather than by force of authority; for example, it is common for drivers to observe (and trust) the turn signals used by other drivers in order to make turns from other lanes. For example, if several vehicles on the right lane are all turning right, a vehicle may come from the next-to-right lane and turn right as well, doing so in parallel with the other right-turning vehicles.

Intersections



A diagram of movement within a roundabout in a country where traffic drives on the right. A roundabout is a type of road junction, or traffic calming device, at which traffic streams circularly around a central island after first yielding to the circulating traffic. Unlike with traffic circles, vehicles on a roundabout have priority over the entering vehicle, parking is not allowed and pedestrians are usually prohibited from the central island.



Diagram of an example intersection of two-way streets as seen from above (traffic flows on the right side of the road). The East-West street has left turn lanes from both directions, but the North-South street does not have left turn lanes at this intersection. The East-West street traffic lights also have green left turn arrows to show when unhindered left turns can be made. Some possible markings for crosswalks are shown as examples.

In most of Continental Europe, the default rule is to give priority to the right, but this may be overridden by signs or road markings, and does not apply at T-shaped junctions in some of these countries, such as France. There, priority was

initially given according to the social rank of each traveler, but early in the life of the automobile this rule was deemed impractical and replaced with the *priorité à droite* (priority to the right) rule, which still applies. At a traffic circle where *priorité à droite* is not overridden, traffic on what would otherwise be a roundabout gives way to traffic entering the circle. Most French roundabouts now have give-way signs for traffic entering the circle, but there remain some notable exceptions that operate on the old rule, such as the Place de l'Étoile around the Arc de Triomphe. Priority to the right where used in continental Europe may be overridden by an ascending hierarchy of markings, signs, signals, and authorized persons.

In the United Kingdom, priority is generally indicated by signs or markings, so that almost all junctions between public roads (except those governed by traffic signals) have a concept of a major road and minor road. The default give-way-to-the-right rule used in Continental Europe causes problems for many British and Irish drivers who are accustomed to having right of way by default unless otherwise indicated. A very small proportion of low-traffic junctions are unmarked - typically on housing estates or in rural areas. Here the rule is to "proceed with great care" i.e. slow the vehicle and check for traffic on the intersecting road.

Other countries use various methods similar to the above examples to establish the right of way at intersections. For example, in most of the United

States, the default priority is to yield to traffic from the right, but this is usually overridden by traffic control devices or other rules, like the boulevard rule. This rule holds that traffic entering a major road from a smaller road or alley must yield to the traffic of the busier road, but signs are often still posted. The boulevard rule can be compared with the above concept of a major and minor road, or the priority roads that may be found in countries that are parties to the Vienna Convention on Road Signs and Signals.

Perpendicular Intersections Also known as a "four-way" intersection, this intersection is the most common configuration for roads that cross each other, and the most basic type. If traffic signals do not control a four-way intersection, signs or other features are typically used to control movements and make clear priorities. The most common arrangement is to indicate that one road has priority over the other, but there are complex cases where all traffic approaching an intersection must yield and may be required to stop.

In the United States, South Africa, and Canada, there are four-way intersections with a stop sign at every entrance, called four-way stops. A failed signal or a flashing red light is equivalent to a four-way stop, or an all-way stop. Special rules for four-way stops may include:

1. In the countries that use four-way stops, pedestrians always have priority at crosswalks – even at unmarked ones, which exist as the logical

continuations of the sidewalks at every intersection with approximately right angles – unless signed or painted otherwise.

2. Whichever vehicle first stops at the stop line – or before the crosswalk, if there is no stop line – has priority.
3. If two vehicles stop at the same time, priority is given to the vehicle on the right.
4. If three vehicles stop at the same time, priority is given to the two vehicles going in opposite directions, if possible.
5. If four vehicles stop, drivers usually use gestures and other communication to establish right-of-way.

In Europe and other places, there are similar intersections. These may be marked by special signs (according to the Vienna Convention on Road Signs and Signals), a danger sign with a black X representing a crossroads. This sign informs drivers that the intersection is uncontrolled and that default rules apply. In Europe and in many areas of North America the default rules that apply at uncontrolled four-way intersections are almost identical:

1. Rules for pedestrians differ by country, in the United States and Canada pedestrians generally have priority at such an intersection.
2. All vehicles must give priority to any traffic approaching from their right,

3. Then, if the vehicle is turning right or continuing on the same road it may proceed.
4. Vehicles turning left must also give priority to traffic approaching from the opposite direction, unless that traffic is also turning left.
5. If the intersection is congested, vehicles must alternate directions and/or circulate priority to the right one vehicle at a time.

Pedestrian Crossings

Pedestrians must often cross from one side of a road to the other, and in doing so may come into the way of vehicles traveling on the road. In many places pedestrians are entirely left to look after themselves, that is, they must observe the road and cross when they can see that no traffic will threaten them. Busier cities usually provide pedestrian crossings, which are strips of the road where pedestrians are expected to cross.

The actual appearance of pedestrian crossings varies greatly, but the two most common appearances are: (1) a series of parallel white stripes or (2) two long horizontal white lines. The former is usually preferred, as it stands out more conspicuously against the dark pavement.

Some pedestrian crossings also accompany a traffic signal which will make vehicles stop at regular intervals so the pedestrians can cross. Some countries have "intelligent" pedestrian signals, where the pedestrian must push a button in order

to assert his intention to cross. The traffic signal will use that information to schedule itself, that is, when no pedestrians are present the signal will never pointlessly cause vehicle traffic to stop. In some countries, approaching traffic is monitored by radar or by electromagnetic sensors buried in the road surface, and the pedestrian crossing lights are set to red if a speed infringement is detected. This has the effect of enforcing the local speed limit without the necessity of issuing speeding citations, etc. See Speed Limits below.

Pedestrian crossings without traffic signals are also common. In this case, the traffic laws usually states that the pedestrian has the right of way when crossing, and that vehicles must stop when a pedestrian uses the crossing. Countries and driving cultures vary greatly as to the extent to which this is respected. In the state of Nevada the car has the right of way when the crosswalk signal specifically forbids pedestrian crossing.

Some jurisdictions forbid crossing or using the road anywhere other than at crossings, termed *jaywalking*. In other areas, pedestrians may have the right to cross where they choose, and have right of way over vehicular traffic while crossing. In most areas, an intersection is considered to have a crosswalk, even if not painted, as long as the roads meet at approximate right angles. Examples of locations where this rule is not in effect are the United Kingdom and Croatia.

Pedestrian crossings may also be located away from intersections.

Level Crossings

A level crossing is an at-grade intersection of a railway by a road. Because of safety issues, they are often equipped with closable gates, crossing bells and warning signs.

Speed Limits

The higher the speed of a vehicle, the more difficult collision avoidance becomes and the greater the damage if a collision does occur. Therefore, many countries of the world limit the maximum speed allowed on their roads. Vehicles are not supposed to be driven at speeds which are higher than the posted maximum.

To enforce speed limits, two approaches are generally employed. In the United States, it is common for the police to patrol the streets and use special equipment (typically a radar unit) to measure the speed of vehicles, and pull over any vehicle found to be in violation of the speed limit. In Brazil, Colombia and some European countries, there are computerized speed-measuring devices spread throughout the city, which will automatically detect speeding drivers and take a photograph of the license plate (or number plate), which is later used for applying and mailing the ticket. Many jurisdictions in the U.S. use this technology as well.

A mechanism that was developed in Germany is the *Grüne Welle*, or *green wave*, which is an indicator that shows the optimal speed to travel for the synchronized green lights along that corridor. Driving faster or slower than the

speed set by the behavior of the lights causes the driver to encounter many red lights. This discourages drivers from speeding or impeding the flow of traffic. See related traffic wave and Pedestrian Crossings, above.

Overtaking

Overtaking (or *passing*) refers to a maneuver by which one or more vehicles traveling in the same direction are passed by another vehicle. On two-lane roads, when there is a split line or a dashed line on the side of the over taker, drivers may overtake when it is safe. On multi-lane roads in most jurisdictions, overtaking is permitted in the "slower" lanes, though many require a special circumstance. See "Lanes" below.

In the United Kingdom and Canada, notably on extra-urban roads, a solid white or yellow line closer to the driver is used to indicate that no overtaking is allowed in that lane. A double white or yellow line means that neither side may overtake. In the United States, a solid white line means that lane changes are discouraged and a double white line means that the lane change is prohibited.

Lanes

When a street is wide enough to accommodate several vehicles traveling side-by-side, it is usual for traffic to organize itself into *lanes*, that is, parallel corridors of traffic. Some roads have one lane for each direction of travel and others have multiple lanes for each direction. Most countries apply pavement markings to clearly indicate the limits of each lane and the direction of travel that

it must be used for. In other countries lanes have no markings at all and drivers follow them mostly by intuition rather than visual stimulus.

On roads that have multiple lanes going in the same direction, drivers may usually shift amongst lanes as they please, but they must do so in a way that does not cause inconvenience to other drivers. Driving cultures vary greatly on the issue of "lane ownership": in some countries, drivers traveling in a lane will be very protective of their right to travel in it while in others drivers will routinely expect other drivers to shift back and forth.

1.6 Designation and Overtaking

The usual designation for lanes on divided highways is the fastest lane is the one closest to the center of the road, and the slowest to the edge of the road. Drivers are usually expected to keep in the slowest lane unless overtaking, though with more traffic congestion all lanes are often used.

When driving on the left:

- The lane designated for faster traffic is on the right.
- The lane designated for slower traffic is on the left.
- Most freeway exits are on the left.
- Overtaking is permitted to the right, and sometimes to the left.

When driving on the right:

- The lane designated for faster traffic is on the left.

- The lane designated for slower traffic is on the right.
- Most freeway exits are on the right.
- Overtaking is permitted to the left, and sometimes to the right.

Countries party to the Vienna Convention on Road Traffic have uniform rules about overtaking and lane designation. The convention details (amongst other things) that "Every driver shall keep to the edge of the carriageway appropriate to the direction of traffic", and the "Drivers overtaking shall do so on the side opposite to that appropriate to the direction of traffic", notwithstanding the presence or absence of oncoming traffic. Allowed exceptions to these rules include turning or heavy traffic, traffic in lines, or situation in which signs or markings must dictate otherwise. These rules must be more strictly adhered to on roads with oncoming traffic, but still apply on multi-lane and divided highways. Many countries in Europe are party to the Vienna Conventions on traffic and roads. In Australia (which is not a contracting party), traveling in any lane other than the "slow" lane on a road with a speed limit at or above 80 km/h (50 mph) is an offence, unless signage is posted to the contrary or the driver is overtaking.

Many areas in North America do not have any laws about staying to the slowest lanes unless overtaking. In those areas, unlike many parts of Europe, traffic is allowed to overtake on any side, even in a slower lane. This practice is known as "passing on the right" in the United States (where it is common) and "overtaking on the inside" and "undertaking" in the United Kingdom. When

referring to individual lanes on dual carriageways, one does not consider traffic travelling the opposite direction. The inside lane (in the British English sense, i.e. the lane beside the hard shoulder) refers to the lane used for normal travel, while the middle lane is used for overtaking cars on the inside lane. The outside lane (i.e. closest to oncoming traffic) is used for overtaking vehicles in the middle lane. The same principle lies with dual carriageways with more than three lanes.

U.S.-State-Specific Practices

In some US states (such as Louisiana, Massachusetts and New York), although there are laws requiring all traffic on a public way to use the right-most lane unless overtaking, this rule is often ignored and seldom enforced on multi-lane roadways. Some states, such as Colorado, use a combination of laws and signs restricting speeds or vehicles on certain lanes to emphasize overtaking only on the left lane, and to avoid a psychological condition commonly called road rage.

In California, cars may use any lane on multi-lane roadways. Drivers moving slower than the general flow of traffic are required to stay in the right-most lanes (by California Vehicle Code (CVC) 21654) to keep the way clear for faster vehicles and thus speed up traffic. However, faster drivers may legally pass in the slower lanes if conditions allow (by CVC 21754). But the CVC also requires trucks to stay in the right lane, or in the right two lanes if the roadway has four or more lanes going in their direction. The oldest freeways in California, and

some freeway interchanges, often have ramps on the left, making signs like "TRUCKS OK ON LEFT LANE" or "TRUCKS MAY USE ALL LANES" necessary to override the default rule. Lane splitting, or riding motorcycles in the space between cars in traffic, is permitted as long as it is done in a safe and prudent manner.

One-way Roadways

In order to increase traffic capacity and safety, a route may have two or more separate roads for each direction of traffic. Alternatively, a given road might be declared *one-way*.

High-Speed Roads

In large cities, moving from one part of the city to another by means of ordinary streets and avenues can be time-consuming since traffic is often slowed by at-grade junctions, tight turns, narrow marked lanes and lack of a minimum speed limit. Therefore, it has become common practice for larger cities to build roads for faster through traffic. There are two different types of roads used to provide high-speed access across urban areas:

- The controlled-access highway (*freeway* or *motorway*), is a divided multi-lane highway with fully controlled access and grade-separated intersections (no cross traffic). Some freeways are called *expressways*, *super-highways*, or *turnpikes*, depending on local usage. Access to freeways is fully

controlled; entering and leaving the freeway is permitted only at grade-separated interchanges.

- The limited-access road (often called *expressway* in areas where the name does not refer to a freeway or motorway) is a lower-grade type of road with some or many of the characteristics of a controlled-access highway: usually a broad multi-lane avenue, frequently divided, with some grade separation at intersections.

Motor vehicle drivers wishing to travel over great distances within the city will usually take the freeways or expressways in order to minimize travel time. When a crossing road is at the same grade as the freeway, a bridge (or, less often, an underpass) will be built for the crossing road. If the freeway is elevated, the crossing road will pass underneath it.

Minimum speed signs are sometimes posted (although increasingly rare) and usually indicate that any vehicle traveling slower than 40 mph (64 km/h) should indicate a slower speed of travel to other motor vehicles by engaging the vehicle's four-way flashing lights. Alternative slower-than-posted speeds may be in effect, based on the posted speed limit of the highway/freeway.

Systems of freeways and expressways are also built to connect distant and regional cities, notable systems include the Interstate highways, the Autobahnen and the Expressway Network of the People's Republic of China.

One-way Streets

In more sophisticated systems such as large cities, this concept is further extended: some streets are marked as being *one-way*, and on those streets all traffic must flow in only one direction, but pedestrians on the sidewalks are generally not limited to one-way movement. A driver wishing to reach a destination he already passed must use other streets in order to return. Usage of one-way streets, despite the inconveniences it can bring to individual drivers, can greatly improve traffic flow since they usually allow traffic to move faster and tend to simplify intersections.

Congested Traffic



In some places traffic volume is consistently, extremely large, either during periods of time referred to as *rush hour* or perpetually. Exceptionally, traffic upstream of a vehicular collision or an obstruction, such as construction, may also be constrained, resulting in a traffic jam. Such dynamics in relation to traffic

congestion is known as traffic flow. Traffic engineers sometimes gauge the quality of traffic flow in terms of level of service.

In measured traffic data, common spatiotemporal empirical features of traffic congestion have been found that are qualitatively the same for different highways in different countries. Some of these common features distinguish the wide moving jam and synchronized flow phases of congested traffic in Kerner's three-phase traffic theory.

Rush Hour

During business days in most major cities, traffic congestion reaches great intensity at predictable times of the day due to the large number of vehicles using the road at the same time. This phenomenon is called *rush hour* or *peak hour*, although the period of high traffic intensity often exceeds one hour.

Rush Hour Policies

Some cities adopt policies to reduce rush-hour traffic and pollution and encourage the use of public transportation. For example, in São Paulo, Manila and in Mexico City, each vehicle has a specific day of the week in which it is forbidden from traveling the roads during rush hour. The day for each vehicle is taken from the license plate number, and this rule is enforced by traffic police and also by hundreds of strategically positioned traffic cameras backed by computerized image-recognition systems that issue tickets to offending drivers.

1.7 Policy and Institutional Arrangements

Ensuring road safety is one of the priority areas receiving Government's constant attention. Tamil Nadu is the first state in the country to have brought out a Road Safety Policy. This policy has been brought out with a vision to stop and reverse the increasing trend in the number of accidents, through adoption of comprehensive measures covering engineering, education, emergency care and enforcement measures.

In order to translate the objectives of road safety policy into reality, the Government have taken steps to create necessary institutional arrangements. The State Road Safety Committee has been constituted under the Chairmanship of Honourable Minister for Transport, to advise the Government on all policies and programmes relating to Road Safety at the State level. This council seeks to review the implementation of various programme of different departments and suggests policy initiatives to Government. The committee has been expanded with additional members this year.

The Government have also established the District Road Safety Committee functioning in each District under the Chairmanship of the District Collectors. This Committee has been entrusted with the job of considering various measures needed to promote road safety, prepare road safety plans with special attention to the accident prone spots/stretchers, maintenance of roads, driver training, accident analysis, publicity initiatives, traffic planning, highway patrol, passenger amenities

etc., in the districts. These Committees are required to meet at least once in a month. The District Road Safety Committee has since been reconstituted by including new members namely Commissioner of Police, reputed NGOs and consumer action Groups. The Government have also now, constituted a "District Road Safety Committee for Chennai" under the Chairmanship of the Commissioner of Police, Chennai, to function from this year to address various Road Safety related issues in Chennai City.

1. Sending proposals to the Government on Road Safety Policies to be implemented in the State;
2. Overseeing the functioning of the District Road Safety Councils;
3. remedial measures to avert accidents; the Districts and various other agencies including Non- Government Organizations engaged in the task suitably assisted;
4. Controlling the vehicular pollution by involving the Tamilnadu Pollution Control Board, Police and other Agencies.

In order to analyze every fatal accident taking place in this State an Inter-Departmental team of officers comprising Police, Transport and Highways departments has been constituted. This Inter-departmental team visits the accident spot, makes a comprehensive study from different angles, prepares a detailed report after critically analyzing the data and offers specific information and suggests suitable measures, preventive remedial and punitive that may have to be

initiated to avert such incidents in future. This newly set up information system is expected to provide useful inputs for policy initiatives by Government.

The Government have constituted "The Road Safety Fund" from out of the receipts of compounding fees and spot fines collected by Transport/Police departments to finance road safety activities. The Road Safety Fund is administered by an Inter-Departmental Committee headed by the Home Secretary. The allocations made to this fund by the Government were Rs.3.75 crores in 2001-2002, Rs.5.00 crores in 2002-2003 and Rs.6.00 crores each during the years from 2003-04 to 2007-2008. The allocation to the fund has been further increased to Rs.10 crores in 2008-09. An additional amount of Rs.6.8 crores has been sanctioned by Government for carrying out the improvement works at the intersection points where the Districts Roads, intersects the National Highway.

1.8 Defensive Driving and Making Roads Safer

The biggest cause of road crashes in South Africa is driver error. It is generally accepted that 85-90% of road crashes can be attributed to driver error. This includes not only the honest mistake or error in judgement, but also driver recklessness, driver inattention and many other factors. It is important that we strive both to reduce these errors on our side and adjust our driving to be more attentive and defend ourselves against the threats from errors by other road users. These skills and techniques required are called defensive driving.

When driving defensively, we're aware and ready for whatever happens. We are cautious, yet ready to take action and not put our fate in the hands of other drivers.

In this section we will provide advice on how defensive driving behaviour can make our roads safer. Defensive driving is the practice of maintaining an awareness of road and weather conditions, other vehicles, road users and potentially hazardous situations and then taking steps to prevent becoming the cause of or becoming involved in a road crash.

The description of defensive driving also refers to the following:

- Reducing the risk of collision by anticipating dangerous situations, adverse conditions or the mistakes of others.
- Implementing driving techniques that enable drivers to address identified hazards in a predictable manner.
- Driving with an increased awareness of everything happening around you while driving.
- Driving characterized by prudence, diligence and reasonable cautiousness with the goal of making the road a safe place not only for a defensive driver but also for other road users.

1.9 Defensive Driving and Preparedness

Defensive driving is not merely using a set of driving skills when on the road. It starts with preparedness on the side of the driver and an awareness of abilities, challenges, restraints etc. Sometimes the best way to defend oneself against dangers is to avoid confrontation with the danger. The elderly driver who avoids peak hour traffic and the driver avoiding late night driving are both applying alertness to identified hazards through defensive driving!

Preparedness for Defensive Driving includes an Awareness of the following:

Your Own Driving Ability:

We have to drive within our ability. Elderly drivers are good at using their experience to compensate for lack of physical strength, reduced eyesight, hearing etc. They drive defensively by adjusting their time of travel and where they drive.

Vehicle Fitness:

- The defensive driver will be aware of vehicle capabilities and limitations. This would include going onto the road and towing a trailer, awareness of the ability to overtake etc.
- Defensive drivers will ensure that their vehicles are well maintained and in roadworthy condition with properly inflated tyres, clean windshields and wipers, reliable engine and suspension.

- Vehicles will not be overloaded and vehicle components will allow them opportunity for effective response to a threat on the road!

The Road and Traffic Conditions

- Defensive driving is also an awareness of when not to drive, when to delay travel and when and where to remain stationary inside the vehicle. This is discussed in more detail on the Arrive Alive website in the section on safe driving in bad weather conditions.
- It is important to stay alert to weather and traffic reports and to avoid the threats posed by heavily congested traffic and conditions such as snow and ice, mist and fog, heavy winds, veld and forest fires etc.
- By effectively planning the journey and route to the destination the defensive driver is avoiding risks such as driver fatigue, getting lost etc.

Readiness to adjust to Road and Weather Conditions

- The driver must always be willing and able to adapt to road conditions. Safe road conditions cannot be assumed and chances should never be taken. When in doubt -Don't!
- Even light rain can produce dangerous conditions, particularly early in the season when the water picks up oil from the road surface, making it slippery. Tyres lose their grip at higher speeds, so slowing down in inclement weather is a fundamental defensive-driving technique.

Knowledge of Rules of the Road

The defensive driver will be aware of the rules of the road and rights of way, road signs, road markings, load restrictions, etc. This awareness will also alert and remind him of the many who do not know how to drive at intersections, at roundabouts, in mountain passes, etc.

Awareness of protection from Injury

Awareness of accident types and types of injury leads to informed decision making on how to prevent severity of injury in road crashes. Don't start the engine without securing each passenger in the car, including children and pets. Safety belts save thousands of lives each year. Secure any loose objects inside your vehicle.

Sharing the Roads Safely and Defensively

We need not guard only against our own mistakes but also those of others sharing the roads with us! Defensive driving requires that we share the roads safely with others who might not be as cautious as we are!

Techniques on sharing the roads safely

- Continuously look in your mirrors and scan the road ahead, checking for hazards and slowing traffic so you can anticipate problems before they develop.
- Try to see what is happening in front of the car ahead of you.
- Always be aware of what is on your right, your left and behind you.

- Look at the front wheels of the cars parked on the side of the road. If you see a car with the wheels turned to the right, is it going to suddenly pull out?
- Follow the flow of traffic. Driving too slow can be dangerous, too. Drive at speeds that most other vehicles are going [within the speed limit, of course].
- Watch out for the other guy. Part of staying in control is being aware of other drivers and road users around you (and what they may suddenly do) so you're less likely to be caught off guard.
- Do not assume safety from other drivers or make assumptions as to their sobriety, alertness and intentions with regards to safety.
- Do not assume another driver is going to move out of the way or allow you to merge.
- Anticipate what another driver might do wrong [worst case scenarios] and make the appropriate adjustment to reduce your risk.
- Assume that drivers might run through stop signs or red lights and be prepared to react.
- Defensive drivers approach intersections with caution, regardless of green or red lights.

- They anticipate light changes, lane changes and vehicles and pedestrians entering from either side, as well as drivers moving off before the light has changed to green.
- Follow the rules of the road but do not try to “enforce” them by contesting the right of way or trying to race another car, or deliberately driving very slowly to make your point to the driver behind you.
- Do not depend on other drivers. Be considerate of others but look out for yourself.
- Be courteous, kind and respectful to other motorists.
- Learn to make eye to eye contact with drivers and pedestrians. That way you know they see you. Be prepared for the unexpected.
- Also, keep an eye on pedestrians, bicyclists, and pets along the road.
- Be extra careful where a vehicle has darkly tinted glass and you cannot see whether the driver has noticed your approach, particularly at intersections.
- The defensive driver will develop a pattern of observation looking ahead, to the rear view mirror, ahead, to a side mirror, ahead, to the other side mirror, ahead, to the dashboard instruments, ahead and so on.
- At night it is good advice to follow safely behind another vehicle and use their headlights to look well up ahead. As long as the brake lights work on the vehicle in front of you, you will get early warning of trouble.

- Check your blind spot before changing direction, making lane changes or merging and avoid driving in the blind spot of another driver.

Avoiding others who are driving aggressively

Resist getting involved in incidents of road rage. Take a passive approach in dealing with road rage. Sometimes the other driver may have a medical condition that causes unreasonable or uncontrollable anger, and where confrontation can be most dangerous.

- Tailgaters: If the driver behind you is driving right on your bumper, tap the brakes a few times to let the driver know that he's not maintaining a safe distance. If he stays on your tail, slow down gradually and he will most likely overtake. Avoid making gestures.
- Speedsters: If you see a car speeding or aggressively changing lanes behind you, stay in your lane while maintaining your speed. Do not hog the fast lane. Where appropriate, fall back to allow more space behind the driver ahead of you so that the speedster can safely overtake you and move into that gap without feeling the need to overtake several vehicles at once.
- Taking evasive measures: If you observe signs of aggressive driving, slow down or pull over to avoid it. If the driver is driving so dangerously that you're worried, try to get off the roadway by turning left or taking the next exit if it's safe to do so.

Defensive Driving and Driver Alertness

For the defensive driver to be able to respond swiftly and effectively he has to be able to apply all his senses to the vehicle and the environment:

- Defensive driving requires thoughtful and informed, timely decision making.
- The driver must be mentally prepared and ready for the journey.
- Stay focused, keeping both hands on the steering wheel.
- Defensive drivers concentrate on the road and avoid all driver distractions.
- Distractions make a driver less able to see potential threats and properly react to them.
- The defensive driver controls his emotions and is not easily affected by other drivers who may exhibit bad driving behaviour.
- To remain alert it is important not to drive when fatigued or under the influence.
- Fatigue, alcohol or drugs (including prescription and over-the-counter drugs) affect a driver's reaction time and judgment.
- The defensive driver will avoid late night driving where possible or ensure that he takes regular breaks.

Defensive Driving and Allowing Time and Space

Even the driver who is alert cannot do much to avoid a collision if he does not allow himself the time and space to react:

- Use the 2-3 second rule to maintain a safe following distance from the vehicle ahead of you.
- This should be increased to 4-6 seconds in bad weather conditions, driving at night, on gravel or when towing a trailer.
- Reduce your speed to the road, traffic and weather conditions. Remember that posted speed limits apply to ideal conditions.
- To maintain control of your vehicle, you must control your speed to be appropriate for the road, traffic and weather conditions.
- Maintain a safe constant speed and avoid weaving in and out of lanes.
- Always have an escape route. Always leave yourself an out - a place to move your vehicle if your immediate path of travel was suddenly blocked.
- Having an alternate path of travel is essential, so take the position of other vehicles into consideration when determining an alternate path of travel.
- Do not “overdrive” your headlights at night – too many drivers are driving too fast for the distance in which they can stop. They cannot stop in the distance they can see on dipped beam and end up hitting pedestrians, potholes or tyre casings.

- Always be ready to adjust your speed so that you can stop in the distance you can see.

Making yourself Visible

On the Arrive Alive website and in social media we continuously advise pedestrians “To Be Visible is To Be Seen”. The defensive driver will ensure that his vehicle and his intentions are also visible on the road:

- Drive with the headlights on (dipped beam) whenever visibility is not ideal! By law you must drive with the headlights on between sunset and sunrise and when visibility is not clear for at least 150 metres ahead.
- Use indicators /turn signals to let other drivers know where you intend going.
- Operational brake lights are a safety ‘must’. They warn cars behind you that you're slowing down, signalling them to reduce speed, too.
- Don't linger in areas where the driver in front of you can't see you (i.e. that driver's ‘blind spots’). Either safely increase speed or slow down to avoid this scenario.
- Consider whether the driver ahead is aware of you. Some trucks have a warning sign saying – “If you cannot see the mirror of the truck the truck driver also cannot see you!”

- Do not sneak up on the heavy vehicle before overtaking – ensure that you can be seen!

Defensive Driving and Safe Driving Techniques

It is only appropriate that we also share some other defensive driving techniques not shared in the above sections:

- Overtaking cautiously: Apply "acceleration sense" by leaving some additional following distance behind the vehicle to be overtaken. This enables you to accelerate in this lane to gain speed before moving out to overtake. This makes the overtaking manoeuvre much quicker and safer.
- Consider power loss when overtaking at altitude and also when overtaking uphill. Remember that a vehicle may lose 15 to 17% of power in the thinner air at higher altitude.
- Avoid sudden movements and lane changes by planning ahead of your turn or off-ramp.
- Drive predictably
- Remain alert to quieter more vulnerable road users such as bikes or cyclists who might be lane-splitting.
- Allow cyclists the recommended 1.5m of space when overtaking them.

- Avoid driving too close to trucks or behind them for prolonged times. Stay alert to the reduced visibility and the risk of debris projected from their tyres.
- Consider why other vehicles might have come to a standstill. Don't just speed past- If others are hitting the brakes, then something's going on, so be alert.
- Do not make it difficult or impossible for others to overtake - allow them to overtake safely by rather slowing down a bit.
- Avoid changing lanes in intersections. (a rule of the road).
- Do not assume perfectly maintained roads. Stay alert to potholes, fallen tree branches, debris etc., especially after storms.
- Pay attention to warning signs warning of criminal activity in specific areas such as hijacking and smash-and-grab hotspots.

1.10 Courses on Defensive Driving

We advise drivers to continually improve their driving skills. The better driver is the driver who knows his limitations and strives to improve all the time! Attending defensive driving courses can go a long way towards increased defensive driving awareness and skills.

Through defensive driving classes, drivers learn to improve their driving skills by reducing their driving risks, anticipating situations and making safe and

well-informed decisions on vehicle handling. Defensive driving courses vary in implementation but mostly contain similar information. They address the issue of vehicle crashes through careful analysis of the theory and by illustrating how the forces of impact can be avoided or limited with crash prevention techniques.

On-road training in a controlled environment and under the supervision of experienced trainers allows drivers to be shown, and to experience, the correct methods for safer driving. We encourage all drivers, especially the younger, less experienced drivers, to improve their driving skills through defensive driver training.