SPEED Fact Sheet

NUMBER 03

DECEMBER 08

Downsizing and speed:

Towards a new philosophy of designing cars?

Introduction

'Why do Drivers Speed?', on 25th of September 2008 at an international Forum on Speed Management held in Berne, transport and traffic psychologist Steve Stradling started his contribution by offering this straightforward answer: 'because they can'! Indeed, while traffic crashes are often explained by human behaviour and error, the fact that our road traffic system is designed in a way that allows individuals to drive at excessive speeds remains an undeniable contributor to road crashes. Cars are of course a key component of our road traffic system, and virtually all cars on our roads are able to be driven at speeds that are well above the permitted limits. This Fact Sheet investigates how issues of speed and safety impinge upon the debate about downsizing vehicles.

The impact of car characteristics on drivers' choices of speed

Over the last 15 years the top speed and more importantly the acceleration capabilities of cars have increased significantly. Almost every new car sold today is capable of reaching or exceeding a speed of 130 km/h - the upper legal limit on virtually all of Europe's roads. The majority of new cars today can exceed 130 km/h by at least an additional 40 km/h.
More importantly from a safety perspective, the ability of today's cars to accelerate rapidly to any speed the driver chooses leads to these capabilities being used. Thus for today's traffic conditions the great majority of cars are greatly over-powered for the conditions in which they are actually used.

In actual fact the top speed of vehicles should only determine the speed choice on roads where this top speed is also consistent with the layout of the road (e.g. some stretches of motorway). However, there are indications that drivers of cars with high power engines also drive faster on other roads than motorways. This not only reflects the fact that 'speeders' choose to purchase faster cars, but also that a car's greater power intrinsically leads drivers to choose higher speeds, which is something that should have implications for vehicle design (Horswell & Coster, 2002). However, fast cars and high power engines are only part of the problem: many speeders drive quite ordinary cars.

Other vehicle characteristics lead to excessive and inappropriate speed too. As all cars have a speedometer, in principle driving speed and speeding offences are the result of deliberate choice. However a number of vehicle characteristics induce drivers to speed. To start with, the driving comfort has increased a lot during the past decades. The noise level and vibrations inside the car have considerably decreased. This especially applies to larger and heavier cars, but also to smaller ones. Such signals of driving fast are thus becoming much less common. This has important consequences since drivers rely on their awareness of speed and not only on speedometers. This subjective speed perception is not reliable, and often leads to underestimating the actual speed. We can distinguish four situations that can easily lead to underestimating the driving speed:

1. Motorists who have been driving for a long time at a high speed, e.g. on a motorway, underestimate their speed more as time goes by and they drive faster without noticing it.

2. In transitional situations, i.e. when speed must be reduced considerably, drivers often do not decelerate as much as they should. For example, this is the case after exiting a motorway or when driving into an urban area, but also if a long stretch of straight road is followed by a series of bends.

3. When there is little peripheral information (e.g. at nighttime, in fog, but also on 'open' roads in flat rural areas) motorists easily underestimate their speed.

4. When a car driver is seated at a considerable height above the road surface. This is of serious concern given that during the last few years, Sport Utility Vehicles (SUVs) have become increasingly popular. In one study involving a driving simulator without a speedometer, subjects drove an average of 7 km/h faster when driving at the height of a SUV than at the height of a sports car. Two-thirds of the subjects were not aware that at SUV height they drove faster, and some even thought they were driving more slowly (Rudin-Brown, 2004).

While many of such factors can be addressed through infrastructure measures, providing road users with vehicles that deliver a better match between their top speed capabilities and speeds at which they can be driven safely on public roads would also contribute to addressing these problems.

Speed, Weight, Compatibility and Newton's Laws

Injuries to car occupants are caused by the forces applied to them in a collision. Those forces are generated by the energy of the impact. The energy of a moving car increases in relation to the square of the car's speed. Thus the energy in a 66 km/hr impact is some 70% greater than a 50 km/hr impact. The risk of injury increases accordingly.

If two cars collide head-on, each travelling at 50 km/h, and one car is twice as heavy as the other, then the heavier car has an impact with a change in speed of some 33 km/h. The lighter car however has a much higher severity impact with a speed change of 66km/h. There is no appeal against Newton's laws of motion, although clever crashworthiness in the design of cars can and does reduce the risks regardless of weight.

In an ideal world we would be better off if all road vehicles had the same weight. That is clearly impossible, but in recent years the compatibility between different types of vehicles has got worse. This is especially so with the introduction of SUVs into the vehicle fleet.

Some car manufacturers are now addressing the concept of partner protection. This involves designing the car not just for a barrier impact such as is used in EuroNCAP. That sort of test involves self protection of the occupants in one car striking a barrier. Partner protection involves designing for car to car collisions in which the safety characteristics of small versus large cars are optimised to reduce the risk of injuries to all the people involved. (Backaitis, S.H. (Ed) Vehicle Compatibility in Automotive Crashes. Soc. Automotive Engrs. 2005).

Downsizing vehicles but how? Engine Power, Size, Weight?

It is clear that vehicle size, weight and engine power all have an impact on road safety and should be considered together. Cutting weight alone for example, with other vehicle characteristics remaining unchanged, increases a vehicle's acceleration and top speed performance and consequently does not improve safety. Reduced speed capability is not inherent in downsizing. One then should consider vehicle downsizing in terms of a philosophy of designing vehicles that integrates many parameters, including engine power, vehicle weight, size, and other design characteristics including the protection of occupants and pedestrians.

The question of vehicle weight in particular has generated debate over whether 'heavy' safety equipment is responsible for deterring manufacturers from producing lighter vehicles. However this argument is deceptive. Claes Tingvall, Chairman of the European New Car Assessment Programme (EuroNCAP), stated that: "Blaming safety is unfair, incorrect and just hides the fact that there are other issues responsible for industry's failure to meet its contract with society. The performance of smaller and lighter cars at EuroNCAP clearly shows that improved safety does not need additional weight". Heavier vehicles are mostly the result of an increase in size for comfort, more luxury features and more powerful engines to achieve higher speeds (see ETSC 2006 press release: http://www.etsc.be/documents/CO2_emissions_speed.pdf).

It is clear that occupant protection is one of the most crucial requirements for safety, and downsizing should not impair occupant protection. In that context a crucial aspect of a safe road transport system would be to have a fleet with most vehicles of about the same weight, with as few as practicable being much heavier or lighter than average (though of course there will always be good reasons for some to be so to serve particular purposes). That indeed is even more important than the average mass of the fleet. Unfortunately we are moving away from the partial homogeneity we have had as manufacturers tend to offer ever wider ranges of vehicle types (spanning from small urban cars to SUVs and pick-up trucks).

SUVs and Vulnerable Users

Apart from being likely to induce drivers to drive faster because of higher sitting heights (as mentioned above), this category of vehicles is of particular concern regarding collisions involving vulnerable road users.

In the US, Gabler and Lefler (2004) have shown that for the same collision speed, the likelihood of a pedestrian being killed is nearly doubled in the event of a collision with a large SUV compared to a passenger car. Several more studies have been added to this study, consistently showing a higher rate (up to four times greater) of severe injury and death for pedestrians in collisions with SUVs (Roudsari & al, 2004; Henary & al, 2005).

As Simms and O'Neill (2005) from Dublin's Trinity College write, ''it is now clearly established that SUVs represent a significantly greater hazard to vulnerable road users than ordinary cars." Collisions between SUVs and pedestrians are particularly severe because of the bonnet height of SUVs, resulting in a more severe primary impact which involves the critical central body regions of the upper leg and pelvis. Furthermore, this risk is likely to be exacerbated by the greater physical vulnerability of an ageing population.
In fact if one looks at the EuroNCAP ratings, all large off-road 4X4 vehicles, regardless of the manufacturer, perform rather poorly in terms of pedestrian safety performance ratings. http://www.euroncap.com/large_off_road_4_4.aspx

Another group of vulnerable users are small children. Particularly striking is the fact that SUVs and light trucks are overrepresented in collisions with children in driveways. This may well be the result of the increased height of SUVs and poor visibility design.

Downsizing vehicles: Public Opinion

The fuel efficiency debate cannot be left out of the picture. This is a topic that is generating considerable public involvement and concern, and in this context downsizing vehicles might fit into the general desire to reduce fuel use and save money. A survey on fuel efficiency by TNS-Opinion conducted in five EU countries concluded that 72% of respondents feel fuel prices currently affect the financial situation of their household. Sixty-four percent of them also responded that their number one criterion in buying a car (after its price) is fuel consumption. The production of lighter and less powerful vehicles would do much to address that concern.

Opinion polls can also show that safety concerns might also favour the production of lighter and less powerful vehicles. According to one recent large scale opinion poll in France, when asked what should be done to improve road safety, the 2nd most cited measure out of 10 proposed measures was 'downsizing engine power' with 43% of respondents in favour of such a solution (TNS-Sofres 2008). It therefore seems that downsizing vehicle engine power does not necessarily prove itself an unpopular measure, at least in France.

Conclusion

The public debate about downsizing vehicles is mainly the result of concerns over sustainability. However, safety and speed issues have important implications too in this debate and we have tried to present here how they can be taken into account.

Limiting cars' top speed and engine power, in the light of existing speed limits, seems to be a sensible way of improving road safety. Limiting top speed only would not necessarily have an impact on collisions in urban and rural areas where it would remain highly feasible to travel at speeds well beyond permitted limits on more local roads. On such roads, fitting vehicles with devices such as Intelligent Speed Assistance systems is also a highly efficient and proven measure that should be pursued (ETSC, 2006a). However downsizing engine power as a means to lower the top speed of vehicles (as opposed to just fitting cars with speed limiters) might also have repercussions on how drivers behave on local urban and rural roads, and further research on that would be welcome.

Downsizing vehicles should be regarded as a design philosophy geared towards the production of vehicles that fit customer needs while ensuring better safety of all road users (car occupants and pedestrians alike). Recent vehicle design improvements have shown that 'small' cars can well achieve very good safety ratings.

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Speed Fact Sheets

Editor and circulation

Gabriel Simcic
gabriel.simcic@etsc.be

For more information about ETSC's activities, and membership, please contact
ETSC
Avenue des Celtes 20
B-1040 Brussels
Tel. + 32 2 230 4106
Fax. +32 2 230 4215
E-mail: information@etsc.be
Internet: www.etsc.be

ETSC is grateful for the financial support provided for the Speed Fact Sheets by KeyMed