Management of speed: the low-cost, rapidly implementable effective road safety action to deliver the 2020 road safety targets

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Introduction

Delivery of road safety is an urgent global priority, as recognised by key events over recent years. The establishment of the United Nations (UN) Decade of Action for Road Safety and the subsequent development of the UN *Global Plan for the Decade of Action for Road Safety 2011-2020* (UNRSC, 2011) provided global impetus to focus on eliminating the pandemic of deaths and injuries from our roads. This has been followed by the Global Status Report 2015 (WHO, 2015) mid-way through the decade, inclusion of road safety in the Sustainable Development Goals (SDG), and the 2nd Global High-Level Conference on Road Safety hosted by the Government of Brazil and co-sponsored by World Health Organisation (WHO) where the Brasilia Declaration was adopted by 52 ministers/vice ministers to escalate road safety actions towards achieving SDGs.

One of the particularly ambitious SDGs to halve the number of global deaths and injuries from road traffic crashes by 2020 is an enormous challenge - in five years, the annual deaths must drop to approximately 600,000 from well over 1.2 million currently. While ambitious targets assist delivery and the above noted events provide a unique opportunity for road safety, road trauma is vulnerable to the perception that it is uncontrollable and unmanageable. This paper offers a global action to deliver the justifiably ambitious global road safety targets and rationale for the proposed action.

The proposed action to deliver global road safety targets

The proposed action to meet the ambitious global road safety targets is to make speed the global focal point for coordinated action and advocacy. A globally committed focus on speed management allows for a consistent targeted set of priorities and a valid rallying point for advocacy and increased understanding from global and local stakeholders, governments, and the community across different countries, thereby delivering the much needed reductions in deaths and injuries on our roads worldwide. Importantly, this does not imply excluding non-speed related activities. The speed reductions needed to meet the targets can be a motivating bargaining chip in which road safety leaders may manage for less reduction of speed if other actions of established success are undertaken (such as increasing helmet or seatbelt use).

Management of speed is more than management of speeding which is restricted to only addressing those behaviours above the legal speed limit (or in certain jurisdictions defined to also include inappropriate speed for prevailing conditions). However, deaths can still occur without speeding if the speed limit is too high for human bodies to survive the force in the event of a crash. Management of speed therefore also includes setting limits to the speed of travel which are forgiving of inevitable human errors to prevent deaths and injuries in the event of a crash, as well as facilitating compliance with the speed limit.

Rationale for the proposal

Speed is the single element of road safety that, with management, can drive down the number of deaths and serious injuries sufficiently to allow a chance to deliver the global road safety targets within the existing time frames and budgets. This is because speed uniquely has *all* the following features:

1. Speed is the toxic element of road crashes, contributing to both crash occurrence and crash severity;
2. The laws of physics apply in all countries and thus there is no country, state, province, obelisk, or municipality to which the problem of speed does not apply;
3. For management purposes, the benefits of speed reductions on deaths and injuries are well enough quantified by research to allow the prediction of the level of change in travel speed required to deliver the road safety targets;
4. Speed reductions provide strong benefits for all road users including the essential targeting of vulnerable road users (pedestrians, cyclists, motorcyclists), allowing for advocacy by a wide range of NGOs and advocacy groups;
5. A focus on speed management is consistent with the successful Safe System approach to road safety, which is the basis of the *UN Global Plan for the Decade of Action on Road Safety 2011-2020* and many national and state/provincial road safety strategies and action plans;The management of speed entails all the pillars of the road safety management system, allowing for multiple targeted effective actions by all stakeholders;
6. Substantial reductions in speed are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets;

7. The capture of the benefits of speed management are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets;
8. Reduced speeds will provide synergistic benefits in other arenas of global priority (reducing fossil fuel use, reducing emissions, reducing climate change effects of transport, and reducing noise pollution), which (especially climate change) are capturing political will and funding priority.

These features are considered in turn.

1. Speed is the toxic element of road crashes, contributing to both crash occurrence and crash severity

Speed is the toxin in crashes: damage is caused by impacts of objects traveling at differential speeds (strictly velocities) and via the associated sudden decelerations. The force of impact is proportional to the speed squared, and thus the greater the speed the greater the impact and damage. For instance, a crash at 60km/h has 300% of the energy of a crash at 30km/h. For this reason, even small reductions in speed generate substantial reductions in death and suffering.

Relatively small differences in speed at the beginning of an incident can produce surprisingly large differences in severity of the outcome. For example, based on accepted times for drivers to assess hazards and respond; and known vehicle deceleration rates under braking; one driver traveling at 100km/h versus another driver traveling at 110km/h can end with the first driver braking in time and having no crash versus the second driver with the same judgment, reaction times, and braking as the first driver still traveling at over 55km/h, where the first driver stopped, and most likely having a fatal or very serious crash. Thus, a 10km/h difference at the start can result in a 55+km/h difference at the end.

Not only does speed increase crash severity through increased impact and energy, but it can also cause crashes. Speed can contribute to occurrence of crashes by reducing the capacity to stop in time; reducing manoeuvrability in evading a problem; making it impossible to negotiate curves and corners at speeds above those which simple physics will allow for the friction available; and causing others to misjudge gaps. For example, a vehicle travelling above the speed limit allows pedestrians less gap to cross the road than expected.

The toxic effect of speed is demonstrated by an extensive analysis of many studies over many countries showing a strong increasing relationship between average speed and the risk of injury and of death (Nilsson, 2004). Sound evidence also exists to show that driving at 5km/h above the limit in an urban environment is equal in risk of death and injury to driving at the blood alcohol concentration of .05 (Kloeden CN, McLean AJ, Glonek G, 2002). A summary synthesis of many studies in various states of the USA also shows large increases in crashes and deaths with speed limit increases across many states of the USA (Stuster, J Coffman, Z & Warren, D 1998). By definition of crashes speed contributes to 100% of road deaths and serious injuries.

2. The laws of physics apply in all countries and thus there is no country, state, province, obelisk, or municipality to which the problem of speed does not apply

Speed is not a unique problem for specific countries, or specific regions but a common problem that applies to all parts of the world. While much of the evidence comes from high income countries because good crash and other data are often not available in low and middle income countries, the evidence for the toxic effect of speed and benefits from speed reductions applies to all countries and regions due to the ubiquitous laws of physics.

3. **For management purposes, the benefits of speed reductions on deaths and injuries are well enough quantified by research to allow the prediction of the level of change in travel speed required to deliver the road safety targets**

Ample evidence exists for the benefits of speed reductions via speed enforcement on deaths and injuries (WHO, 2008; OECD, 2006, Wilson C, Willis C, Hendrikz JK, Le Brocque R, Bellamy N., 2010). Studies have also shown the benefits of different forms of speed enforcement including fixed cameras, mobile cameras, and point-to-point or average speed cameras (Goldenbeld, C., van Schagen, I., 2005, Cameron, MH, Cavallo, A & Gilbert, A. 1992, Job 2012, Keall, MD., Povey, LJ. & Frith, WJ., 2001, Gains A, Heydecker B, Shrewsbury J, Robertson S., 2004). Independent evaluation of fixed speed cameras in the state of New South Wales (NSW) in Australia revealed that at treated locations, the cameras resulted in a 71% reduction in speeding and an 89% reduction in fatalities (Job, 2011). Because speed cameras only address speeding as a crash factor, clearly these results suggest that speeding was contributing to most fatalities. This is in contrast to the official estimates (based on Police reports) indicating that speeding contributed to around 35% to 40% of fatal crashes in NSW. Often the real extent of contribution of speed is significantly underestimated in most police statistics, because in many crashes where speed was a factor this is not apparent after the crash has occurred. Thus benefits of reduced speeds can be larger than expected based on data on speeding (traveling above the speed limit) only. What is clear is that real benefits of speed reductions on deaths and injuries exist and, though underestimated, they are quantifiable.

Direct evidence for the benefits of reducing speed limits on deaths and serious injuries also exists. A before and after evaluation study of a speed limit reduction from 110km/h to 100km/h on a rural highway in NSW showed a 26.7% reduction in casualty crashes (Bhatnagar Y., Saffron D., de Roos M. and Graham A., 2010). Similarly in the state of South Australia reduction in speed limit from 110km/h to 100km/h showed benefits of crash and injury reductions by around 27% compared to roads which remained 110km/h (Mackenzie, J.R.R., Kloeden, C.N., Hutchinson T.P., 2014). In the state of Victoria casualty crash rate increased by 25% when the speed limit was increased from 100km/h to 110km/h and decreased by almost 20% when the speed limit was decreased back to 100km/h (Sliogeris J., 1992).

Speed enforcement tolerances create *de facto* speed limits which allow speeds that are more dangerous than the intended speed limit, and often result in travel speeds which are simply too high for safety and even for the road design by which the speed limit was determined (without consideration of the *de facto* limit). Drivers learn (sometimes incorrect) tolerances through rumour, media, and knowledge of tickets issued, even if the tolerance is not officially disclosed. States and countries are typically reluctant to reveal enforcement tolerances and thus studies of the effects of reduced tolerances are rarely published. An exception is the analysis presented in the Victoria Auditor General report, which provides an assessment of the impact of changes in speed camera policies in Victoria including the lower enforcement tolerance, though the tolerance used by Police is deliberately not disclosed. The greatest benefits of reduced travel speeds from lowered speed enforcement tolerances were shown in Melbourne's 40km/h, 50km/h and 60 km/h zones (where enforcement is common) - fatalities decreased by around 40% from over 100 per year for 1999-2001 to 64 in 2005, and serious injuries by around 7% from 6,379 in 2004 to 5,916 in 2005 (Auditor General Victoria, 2006).

The predictable benefits of speed reductions identified above is key for management and action as the predictability allows the identification of intermediate target speed reductions required to deliver the global road safety targets and therefore better action plans. As above, the strong increasing relationship between average speed and the risk of injury and of death provide quantifiable substantial benefits (Nilsson, 2004). From Nilsson's synthesis we can estimate what speed reduction is required to achieve target reduction in deaths. (Alternatively, in some locations a lesser reduction in mean speed accompanied by the right increase in helmet wearing or median separation of the road may also deliver the same saving of lives, suffering and economic costs).

4. **Speed reductions provide strong benefits for all road users including the essential targeting of vulnerable road users (pedestrians, cyclists, motorcyclists), allowing for advocacy by a wide range of NGOs and advocacy groups**

The strong relationship between speed and the risk of injury and of death applies to all road users involved in crashes. Speeds of impact create large differences in survivability for all road users, with death likely at much lower speeds for vulnerable road users. A large scale evaluation study of 820 locations where speed limits were reduced to 40km/h at school zones in NSW showed impressive reductions in crashes for all road users not just school aged pedestrians—pedestrian casualties aged 5 to 16 decreased by 46% while all pedestrian casualties decreased by 45% (Graham A., & Sparkes P., 2010). Speed management is thus an inclusive solution for all road users globally. This allows for advocacy by a wide range of NGOs and advocacy groups.

5. A focus on speed management is consistent with the successful Safe System approach to road safety, which is the basis of the *UN Global Plan for the Decade of Action on Road Safety 2011-2020* and many national and state/provincial road safety strategies and action plans

The Safe System approach has been successful in multiple jurisdictions (Mooren, L, Grzebieta, R., Job, R.F.S. Williamson, A. 2011), and is the basis of the UN *Global Plan for the Decade of Action on Road Safety* and multiple national and other level strategies and action plans (Australia and many of its states, Ireland, New Zealand, Poland, Qatar, and many others). It is based on the assumptions that humans will inevitably make mistakes and thus road safety will not be achieved by fixing the human. Rather we must work from the known limits of the human body to survive forces and ensure that we provide a transport system in which humans, in spite of their errors, are not exposed to forces beyond those which we can survive.

The management of speed is directly consistent with Safe System approach - forces can be reduced to survivable levels by reducing speeds of travel and thus impact forces (though of, course, many other road safety activities work this way). Thus management of speed is in line with strategies and action plans in many different countries worldwide.

6. **The management of speed entails all the pillars of the road safety management system, allowing for multiple targeted effective actions by all stakeholders**

The management of speed entails actions from all the transport pillars of the road safety management system: safe road and roadsides; safe vehicles; safe road users. Post-crash care is the exception, though supporting advocacy from this highly credible sector can be expected. This allows for all sectors of road safety to play a role in delivery of global road safety targets.

Road and roadside infrastructure are critical elements of the system in the management of speed. Speed reduction via road and roadside infrastructure is especially applicable to pedestrian crashes as well as crashes more generally (WHO, 2013). Examples include well-designed roundabouts; the narrowing of apparent lane width through use of lane lines; rumble strips; speed humps and speed cushions though only for around 120m (Huang, J., Liu, P., Zhang, X., Wan, J., and Li, Z., 2011); chicanes or pinch points. Critically, many of the road engineering treatment options (e.g. speed humps and lane marking) are relatively inexpensive and can be implemented quickly.

Speed governing vehicles can assist with management of speeding, and the technology exists to achieve this cheaply. Intelligent speed adaptation can be inexpensive if introduced on mass, and the evidence shows clear benefits even for warning (advisory systems) but much larger benefits for direct speed limiting systems (Carsten OMJ**,** Fowkes M, Lai F, Chorlton K, Jamson S, Tate FN, Simpkin R, 2008). However, the lead time for substantial safety benefits from vehicle safety features is significant.

Use of legislation to reduce travel speed via appropriate speed limit setting and to reduce speeding are necessary for effective enforcement and norm setting. Experience in NSW shows benefits of targeting high risk groups with higher penalties for speeding. Following research showing over-representation of young drivers in serious speeding

crashes (Sakashita C, Graham A, de Roos M, Croft S, Elliot M., 2007) changes to novice driver license conditions were made including that any speeding offence by a Provision 1 licence holder would result in loss of licence for three months in addition to other penalties. This produced an immediate 34% reduction in speeding fatalities involving Provisional 1 drivers (Job, 2013), demonstrating that the large role of speeding in young driver serious crashes can be managed by effective enforcement and penalties.

Education and promotion also play important roles in speed management. There is value in explaining to the community why the change in speeds is being made and promoting the changes before they are enforced. First, people are more accepting of the change if they feel that they were informed rather than it was unfair, and political will can be sustained. Second, compliance is greater if people change their behaviour before any enforcement takes effect rather than waiting on enforcement. Nonetheless, once the education and warning of change processes have occurred enforcement is an important follow-up activity to increase compliance of drivers/riders who continue to deliberately exceed speed limits.

Speed enforcement, especially a mix of covert and overt enforcement rather than overt alone (Keall, MD., Povey, LJ. & Frith, WJ., 2001), is a crucial element of speed management. Speed camera programs can be utilised to deliver more enforcement in priority locations in terms of death and injury risk. Although there is the possibility of a contribution from a regression to mean effect following an increase in deaths in 2011 in Poland, a revamped speed camera program in 2012 along with extensive publicity has been attributed for the reduction in deaths by almost 15% from 4189 in 2011 to 3,571 in 2012 (Czapski R., Job, RFS, McMahon, K. Giemza, J., 2013; IRTAD, 2013). Speed enforcement tolerance must also be appropriately managed because a small tolerance is seen as socially necessary to allow the view that enforcement is fair. The key issue to be resolved is the setting of a tolerance which facilitates safety as far as possible rather than creates a *de facto* higher speed limit yet allows some margin for error and social acceptability.

7. **Substantial reductions in speed are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets**

In order to achieve the ambitious SDG to halve the number of global deaths and injuries from road traffic crashes by 2020, extremely cost-effective interventions which will deliver the required large reductions with the limited resources likely to be available must be considered and adopted. As identified above, speed reductions bring about large reductions in deaths and injuries, and relatively low cost speed reduction interventions are readily available. Speed humps are cheaper and faster than many other treatments and take minimal maintenance; speed limits signs can be changed cheaply (though the total cost will add up); and speed cameras commonly raise more money than they cost.

Less than five years remain before 2020 when the target to halve the number of global deaths and injuries from road traffic crashes is due. Interventions which can be quickly implemented and which can quickly deliver large gains are therefore essential. The processes of changing speed limit signs or increasing enforcement are much faster than most other areas of change in road safety, which also have the capacity to deliver large gains but are unlikely to deliver most of the gains within the timeframe remaining. For example, assessments and engineering treatments take time to roll out; while vehicle safety improvements are faster than they were, the vehicle fleet changeover in low and middle income countries is slow, and the newest vehicles tend not to start in the hands of those who need them the most— young and novice drivers who cannot generally afford a safe new car; coordination and capture of benefits of school education programs also tend to take time. These types of interventions accrue their benefits over a longer-term than interventions such as changing speed limit signs, reducing enforcement tolerances, and increasing enforcement or penalties.

8. **The capture of the benefits of speed management are possible within the extremely limited budgets likely to be available and within the tight timeframe of the 2020 targets**

Speeds are readily and rather cheaply measurable compared with other baseline performance measures for road safety. Speeds measures can be collected automatically and inexpensively with simple robust technology which allows for continuous data collection over days or weeks, with minimal effort. Such technology is readily available and in common use now in many countries. This affords effective objective baseline setting, monitoring of progress towards the target speeds, and demonstrating the benefits of speed management interventions.

9. **Reduced speeds will provide synergistic benefits in other arenas of global priority (reducing fossil fuel use, reducing emissions, reducing climate change effects of transport, and reducing noise pollution), which (especially climate change) are capturing political will and funding priority**

At the Paris climate conference (COP21) in December 2015, the climate change agenda (rightly) achieved a strong mandate for action which will absorb and attract considerable resources. Aligning road safety activity to this agenda and other agenda such as fossil fuel consumption, air pollution and noise pollution through identified synergies may increase support. Open road travel time increases are generally smaller than expected with speed limit reductions and economic gains can follow reduced speeds due to the reduced costs of crashes, fuel use, and road maintenance (Cameron, M., 2003). The economically ideal speed for trucks is lower than the 100 km/h or higher speed limits on many motorways, though this varies slightly with fuel costs and other factors (Cameron, M., 2003). Reduced open road speeds also reduce noise and air pollution, and emissions and thus negative impacts of transport on climate change, life quality and health (Job, RFS. 1996; WHO Regional Office for Europe, 2012).

Reducing urban speeds on arterial roads especially also creates synergistic benefits with these other agenda, due to reduced fuel consumption and reduced congestion.

Counter-intuitively, traffic is not simply congested by reduced speeds. Maximum traffic flow is achieved at 50km/h compared to 70km/h and above (OECD 2006). The OECD report, based on analysis of thousands of real world locations, shows that the number of vehicles passing through a given point decreases for speeds of 70km/h and above compared with 50km/h. In addition, congestion arises because there are too many cars for the road space and in this circumstance the speed limit becomes irrelevant.

Challenges for the proposed action and how to address them

The extensive evidence cited above shows that speed reductions clearly deliver road safety gains. However, some speed reduction interventions are not popular (though many are sought or directly implemented by the community: see Figure 1) and challenges in implementation will exist, including persuading governments and communities of the value of this approach. While a minority of people may make misinformed claims regarding speed limit reductions, speed enforcement, and speed management, sound arguments to address such views are also available (Job, RFS., Sakashita, S., Mooren, L., Grzebieta, R., 2013; Mooren, L. Grzebieta, R. & Job, S., 2013). It is worthwhile to anticipate a few common ill-informed arguments and address them:

1. Lower speed limits do not work for road safety because they increase travel times and thus increase fatigue;

2. Lower speed limits do not work for road safety because drivers spend more time watching their speedo instead of the road;

3. Lower speed limits are just for revenue raising.

All three claims are clearly erroneous as shown by the many scientific evaluations which show overall benefits of reduced speed limits (see brief review above). The first two are theoretical claims whereas the evidence for benefits of speed reduction is entirely practical based on real world outcomes of reduced speed limits. The practical evidence includes any supposed dis-benefits of the first two hypothetical concerns, yet resoundingly shows safety benefits of speed limit reductions.

If drivers are unable to manage both the scanning of their environment for safety and the monitoring of their speed, then perhaps they should reconsider their ability to drive safely or slow down to a point where they are capable of conducting both these required processes. Most modern cars offer warning systems of speed limits which can be applied to assist the driver know if they are above the prevailing speed limit.

The third claim is important to consider even if dismissed by the evidence for the safety value of reduced speed limits. It is true that speed enforcement collects revenue, but this is after all a voluntary tax which can be avoided entirely by sticking to the speed limit. The collection of revenue by speed enforcement is analogous to the scar created by life-saving surgery: the scar and the revenue are the most visible outward signs though the surgery and the enforcement serve greater purposes.

Figure 1: A rope placed across the road acts as an effective speed hump in a local residential street (Photo by Job RFS)

Conclusion

The presently proposed strategy to deliver the justifiably ambitious road safety targets is to make speed the focal point for coordinated action and advocacy, but not to exclude non-speed related activities. The approach may be presented as options: speed limit reductions to a certain required level; or lesser speed limit reductions if combined with other interventions with known benefits. The presentation of the approach with such realistic options provides choices and may incentivise addition of alternative actions in order to adopt lesser speed reductions. However, we need to manage a risk that optimistic assumptions about the benefits of alternative activities may limit net road safety gains. A globally committed focus on speed reductions is particularly attractive because of its low-cost, rapidly implementable nature, allowing a chance to deliver the required large reductions in deaths with the limited budget and time available. While some speed management interventions may be politically challenging to introduce, effective communications will be of significant assistance and there is no better time to strengthen speed management actions than now with the globally heightened agenda for road safety.

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