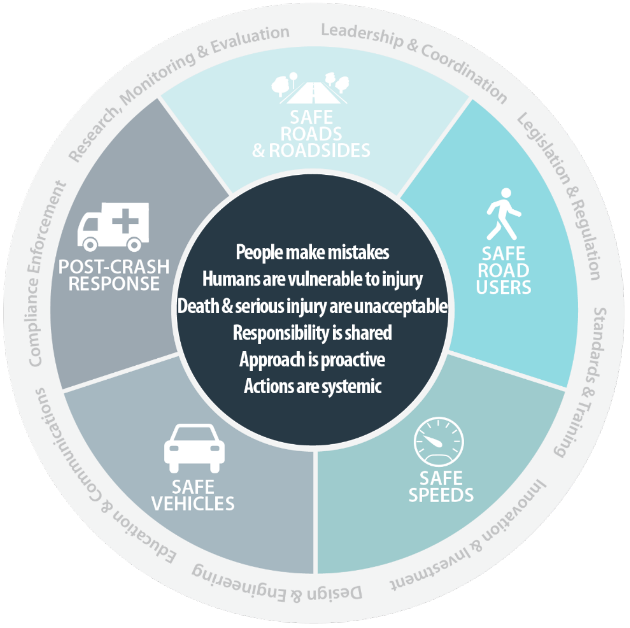
ROAD SAFETY FOUNDATION

Survivability of Speed

What is a Safe System?

It is a system – not an approach

It is a system that is engineered (in the broadest sense) to prevent the possibility of death and serious injury



Safe System Key Principles

Shared Responsibility

To err is human - people make ‘*mistakes*’ but death should not be the penalty from normal human behaviour/processing limitations

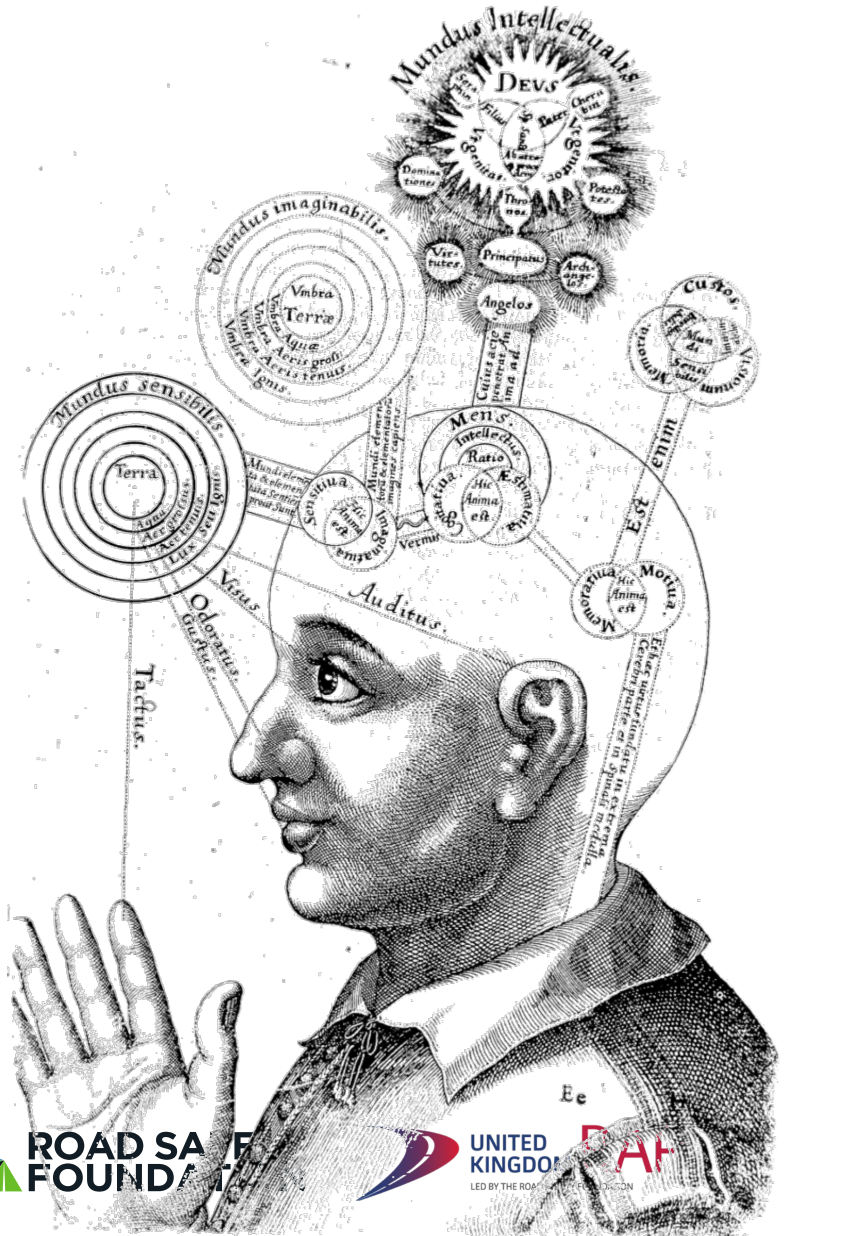
System design that reflects the *fallibility* of humans

The human body has a limited physical ability to tolerate crash forces

System design that reflects the *frailty* of humans

All parts of the road system must be strengthened in combination to multiply the protective effects and if one part fails, the others will still protect people

System design that has *redundancy* built in



What Does this Mean Re: Speeds?

Higher speeds reduce reaction time and increase crash energy

A Safe System demands that we do not allow travelled speeds to exceed human tolerances to crash forces

Energy is managed so that road users are not overwhelmed by crash forces

2 responses

- Manage speeds through enforcement/engineering etc.
- Improve the road environment so you can operate the road at more desirable speeds

A reimagined system, designed around human needs, can ensure collisions remain survivable and increase user confidence and comfort.

Small Changes, Big Rewards

1mph change in speed = 5% change in crashes

Maycock et al, 1998

1kph change in speed = 8% change in fatalities

1kph change in speed = 6% change in injury collisions

Elvik, 2019

Aim of the Research

To make sense of in-depth survivability research (so practitioners do not have to)

To reach a consensus view with experts:

What 'safe' means

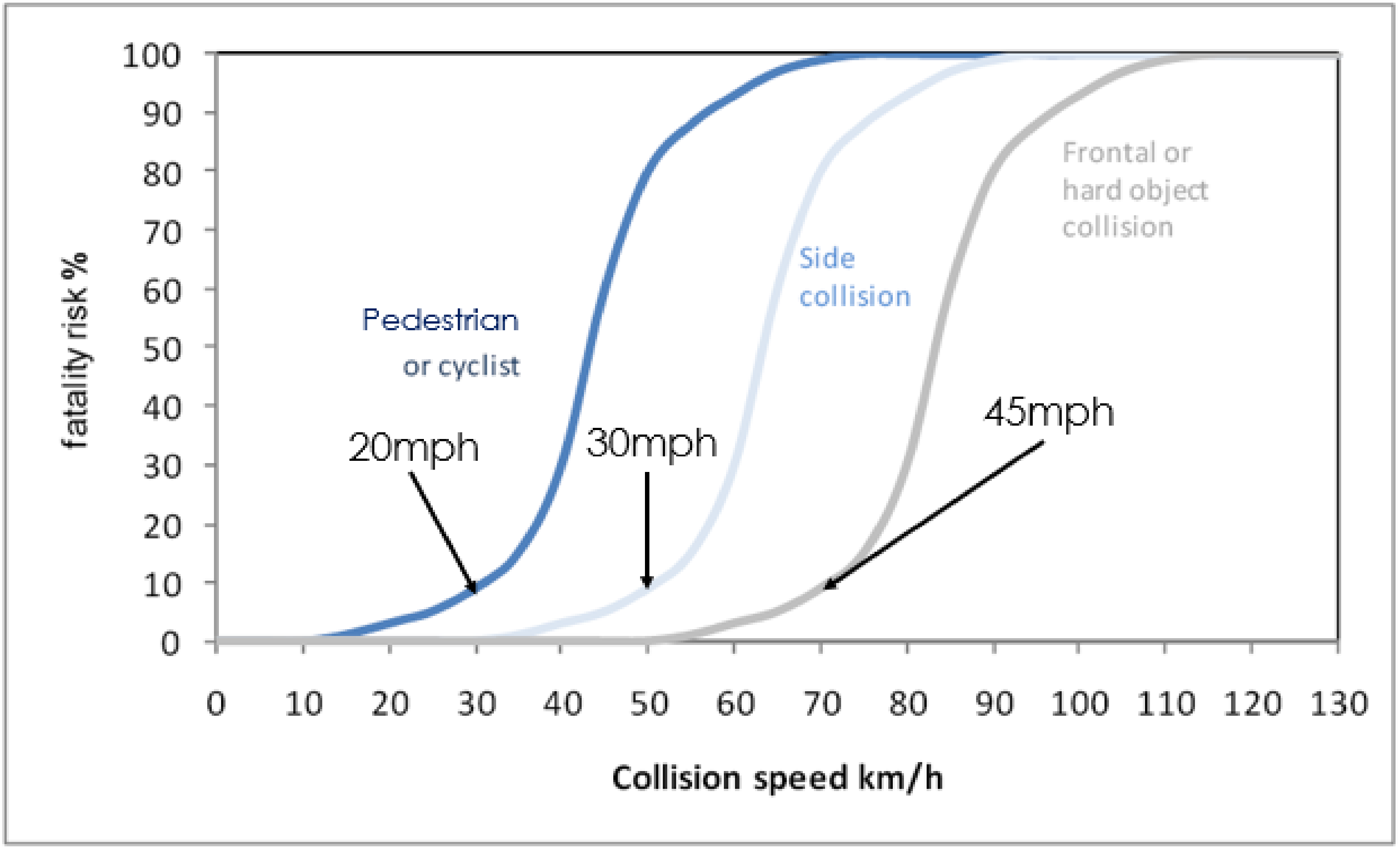
Evidence-based 'safe' speed definitions for different collision types/road types






Steven Reed

Survivability and Safe Speeds (Wramborg, 2005)



Survivability Research – Challenges!

The data will always be a bit old - vehicle safety will continue to improve (though the population will also age too and so get more fragile)

You have to decide your threshold of acceptance: 10% killed, 10% life changing injury, 10% seriously injured …

It is like comparing apples and pears…

- 10% of what?
- Very different vehicle fleets in different parts of the world
- Data set time period
- Delta V vs impact speed vs closing speed vs operating speeds
- Most(but not all) exclude roll overs/unbelted/weird angles/side swipes of pedestrians etc.

What is an Acceptable Level of Risk for a 'Safe System'?

Head on	
Impact Speed (mph)	Serious Injury Risk
20	1%
30	10%
50	50%
60	90%

Ideally it would be elimination of fatal or life changing injury

Injury classifications do not necessarily align to 'life-changing'

After much deliberation, we decided that our 'Safe' speeds would have to '*tolerate*' 10% fatal or serious injury risk

https://www.roadsafetyfacility.org/ai_file_subscribe/file/834

Car to Pedestrian

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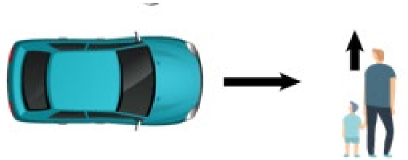

10mph where high concentrations of pedestrians or those that are vulnerable

Richards et al 10% fatal risk = 27mph is within lower bounds of confidence

Truong and Jurewicz 10% MAIS3+ = 12.5mph

Lubbe 10% MAIS3+ = 18mph

Speeds lower for elderly

Car to Cycle

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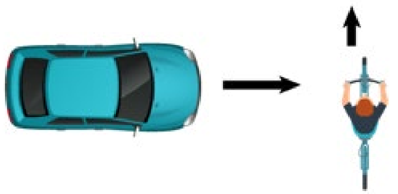

10mph where high concentrations of cyclists

Truong – 10% MAIS3+ risk = 12.5mph

Lubbe (2022) – 10% MAIS3+ risk = closing speeds of 27mph

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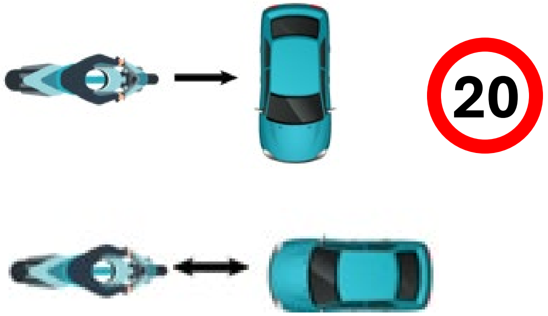
Car to Motorcycle



Head on:

10% fatal = 18mph (Truong)

10% MAIS3+ = 9mph (Truong)

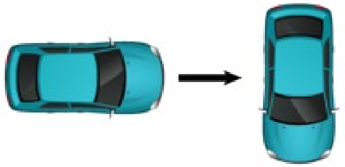
10% MAIS 3+ = 30mph closing speed = 12-16mph (Lubbe)

Side Impact:

10% fatal = 37.5mph (Truong)

10% MAIS3+ = 19mph (Truong)

Vehicle to Vehicle Side Impact



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10% MAIS3+ = Delta V 16-19mph (Jurewicz)

10% MAIS3+ = Delta V 16mph (Richards and Cuerden)

10% MAIS3+ = 37mph impact speed or delta V 19mph (Truong)

10% MAIS3+ = 44-47mph impact speed (Lubbe)

10% MAIS3+ = 19mph (heavier vehicles) (Truong) (extrapolated)

But we need to adjust for the likely imbalance in vehicle masses, as occupants of lighter cars will be more severely injured

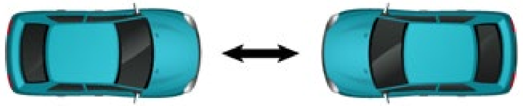
We've chosen to reflect a collision that represents a 75^{th} %tile and 25^{th} %tile mass vehicle colliding

So, for a good proportion of collisions, the delta V for the lighter vehicle has been underestimated by up to 20%

So, adjusting the earlier work by 20% we have the following impact speeds:

- 26-31mph (Jurewicz et al, 2016)
- 27mph (Richards and Cuerden, 2009)
- 31mph (Truong et al, 2022)
- 36-39mph (Lubbe et al, 2024)

Vehicle to Vehicle Head On Impact



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10% MAIS3+ = impact speed or delta v of 19mph (Jurewicz)

10% MAIS3+ = Delta V 18mph (Richards and Cuerden)

10% MAIS3+ = 70mph closing speed (Lubbe) (e.g. both cars with 35mph delta V); a later Lubbe study suggests impact speeds of 44-47mph

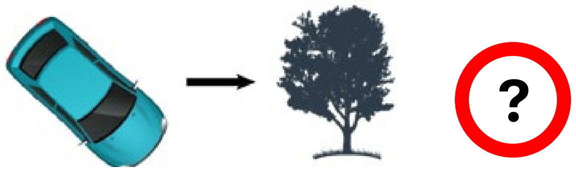
10% MAIS3+ = impact speed or delta v 31mph (Truong)

10% MAIS3+ = 16mph (heavier vehicles) (Truong) (extrapolated)

So, adjusting the earlier work by 20% we have the following impact speeds:

- 16mph (Jurewicz et al, 2016)
- 15mph (Richards and Cuerden, 2009)
- 26mph (Truong et al, 2022)
- 29mph (Lubbe et al, 2022), 36-39mph (Lubbe et al, 2024)

Vehicle run off



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Poor data availability – hasn’t been researched like the other crash types due to there being too many factors … type of obstacle, angles of impact, distances to obstacles …

What About Future Technologies?

The work described assumes that there is no slowing of vehicles prior to impact because this is a worst-case scenario that should be accommodated under a safe system

AEB and other new technologies may mean greater levels of braking before impact

Some suggest AEB could reduce impact speeds by 12mph (Lubbe/Rizzi/Hasegawa)

However, Rizzi noted that such substantial speed reductions will be hard to achieve in some cases such as those with small overlaps (AEB doesn’t work so well for these types of collisions?)

Experts did not feel comfortable to suggest that technology would bring us big wins in terms of increased operating speeds permissible in a Safe System of the future

However emerging vehicle technologies, including passive safety improvements and active collision-avoidance systems, may help a Safe System to be fully realised

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