Safe System Assessment Framework

Dr Blair Turner, 25th September 2018

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- The Safe System – a quick recap
- Why an assessment framework?
- How it works
- Outputs and effectiveness

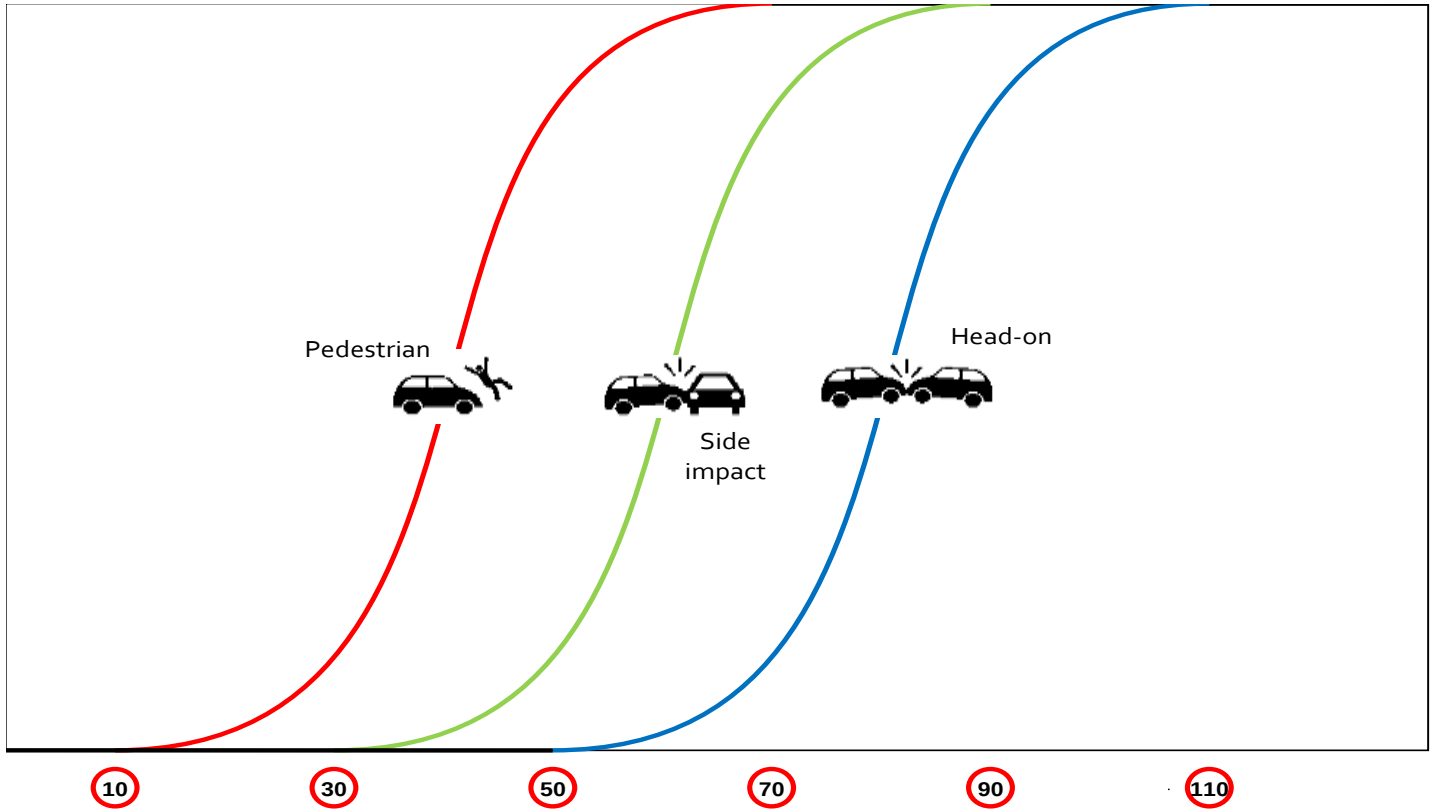
Safe System - Recap

- **Key pillars**
  - **Safe roads, road users, vehicles, speeds, post-crash care**
- Shared responsibility
- Human tolerances

Pillar 1	Pillar 2	Pillar 3	Pillar 4	Pillar 5
Road safety management	Safer roads and mobility	Safer vehicles	Safer road users	Post-crash response

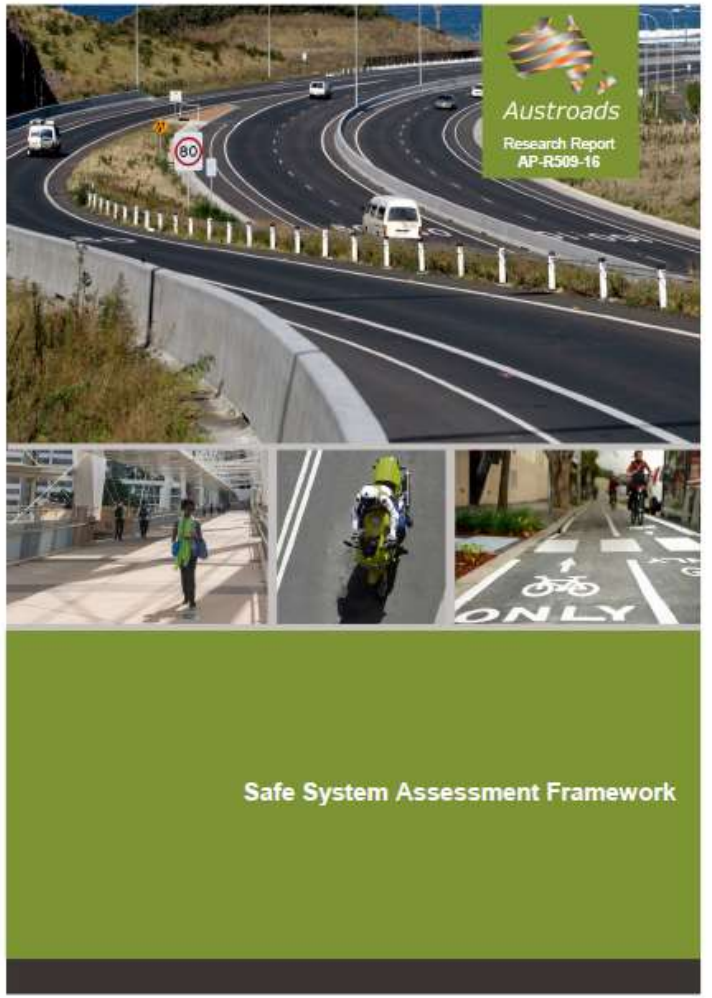
- Key pillars
  - Safe roads, road users, vehicles, speeds, post-crash care
- **Shared responsibility**
- Human tolerances

- Key pillars
  - Safe roads, road users, vehicles, speeds, post-crash care
- Shared responsibility
- **Human tolerances**



Safe System Assessment Framework

- Part of the National Road Safety Strategy
- 10 years of Safe System – how are we progressing?
- Austroads project to:
  - consider Safe System objectives in road infrastructure projects
  - assess alignment with the Safe System objectives
  - advise on improved alignment with Safe System objectives



Core elements of Austroads project

- Include all pillars of the system
- Break down the problem into base elements:
  - Crash types
  - Risk types – exposure, likelihood, severity
- A way to assess
- A way to improve things – Hierarchy of treatment options

Additional Safe System components	
Pillar	**Prompts**
Road user	Are road users likely to be alert and compliant? Are there factors that might influence this? What are the expected compliance and enforcement levels (alcohol/drugs, speed, road rules, and driving hours)? What is the likelihood of driver fatigue? Can enforcement of these issues be conducted safety? Are there special road uses (e.g. entertainment precincts, elderly, children, on-road activities, motorcyclist route), distraction by environmental factors (e.g. commerce, tourism), or risk-taking behaviours?
Vehicle	What level of alignment is there with the ideal of safer vehicles? Are there factors which might attract large numbers of unsafe vehicles? Is the percentage of heavy vehicles too high for the proposed/existing road design? Is this route used by recreational motorcyclists? Are there enforcement resources in the area to detect non-roadworthy, overloaded or unregistered vehicles and thus remove them from the network? Can enforcement of these issues be conducted safety? Has vehicle breakdown been catered for?
Post-crash care	Are there issues that might influence safe and efficient post-crash care in the event of a severe injury (e.g. congestion, access stopping space)? Do emergency and medical services operate as efficiently and rapidly as possible? Are other road users and emergency response teams protected during a crash event? Are drivers provided the correct information to address travelling speeds on the approach and adjacent to the incident? Is there reliable information available via radio, VMS etc. Is there provision for e-safety (i.e. safety systems based on modern information and communication technologies, C-ITS)?

Safe System Assessment Framework

- Crash types that result in death and serious injury:
  - Run-off-road
  - Head-on
  - Intersection
  - Rear end and other
  - Pedestrian
  - Cyclist
  - Motorcycle

- Three components to risk:
  - Exposure
  - Likelihood
  - Severity
- Make estimate of contribution of each for key crash types
- 0 to 4 rating scale
  - 0 = minimal contribution
  - 4 = high impact on poor safety outcome

	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist	
Exposure	1/4	1/4	1/4	1/4	1/4	1/4	1/4	
Likelihood	1/4	1/4	1/4	1/4	1/4	1/4	1/4	
Severity	1/4	1/4	1/4	1/4	1/4	1/4	1/4	
Product	1/64	1/64	1/64	1/64	1/64	1/64	1/64	1/448

Table 4.2: Safe System assessment framework for infrastructure projects

	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist
Exposure	AADT; length of road segment	AADT; length of road segment	AADT for each approach; intersection size	AADT; length of road segment	AADT; pedestrian numbers; crossing width; length of road segment	AADT; cyclist numbers; pedestrians	AADT; motorcycle numbers; length of road segment
Likelihood	Speed; geometry; shoulders; barriers; hazard offset; guidance and delineation	Geometry; separation; guidance and delineation; speed	Type of control; speed; design, visibility; conflict points	Speed; sight distance; number of lanes; surface friction	Design of facilities; separation; number of conflicting directions; speed	Design of facilities; separation; speed	Design of facilities; separation; speed
Severity	Speed; roadside features and design (e.g. flexible barriers)	Speed	Impact angles; speed	Speed	Speed	Speed	Speed

Table 4.4: Safe System matrix scoring system

Road user exposure	Crash likelihood	Crash severity
0 = there is no exposure to a certain crash type. This might mean there is no side flow or intersecting roads, no cyclists, no pedestrians, or motorcyclists).	0 = there is only minimal chance that a given crash type can occur for an individual road user given the infrastructure in place. Only extreme behaviour or substantial vehicle failure could lead to a crash. This may mean, for example, that two traffic streams do not cross at grade, or that pedestrians do not cross the road.	0 = should a crash occur, there is only minimal chance that it will result in a fatality or serious injury to the relevant road user involved. This might mean that kinetic energies transferred during the crash are low enough not to cause a fatal or serious injury (FSI), or that excessive kinetic energies are effectively redirected/dissipated before being transferred to the road user. Users may refer to Safe System-critical impact speeds for different crash types, while considering impact angles, and types of roadside hazards/barriers present.
1 = volumes of vehicles that may be involved in a particular crash type are particularly low, and therefore exposure is low.	1 = it is highly unlikely that a given crash type will occur.	1 = should a crash occur, it is highly unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies must be

Table 4.5: Run-off-road (to left or right) treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Flexible roadside and median barriers (or equally/better performing future equivalent) • Very high quality compacted roadside surface, very gentle to flat side slopes and exceptionally wide run-off areas • Very low speed environment/speed limit.	S S L, S
Supporting treatments which move towards better Safe System alignment (compatible with future implementation of Safe System options)	• Wide run-off areas, with well-maintained shallow drainage and gentle side slopes • Wide sealed shoulders with audio-tactile edgeline • Lower speed limit.	S L L, S
Supporting treatments (does not affect future implementation of Safe System options)	• Non-flexible safety barrier • Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Skid resistance improvement • Improved superelevation • Audio-tactile centreline • Audio-tactile edgeline • Vehicle activated signs.	S L L L L L L L
Other considerations	• Speed enforcement • Rest area provision • Lane marking compatible with in-vehicle lane-keeping technology.	L, S L L

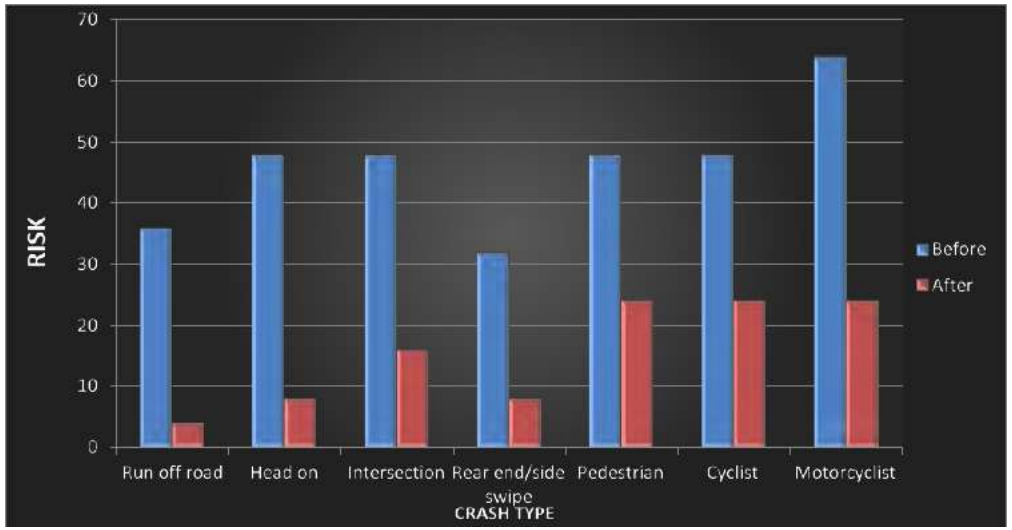
Safe System matrix

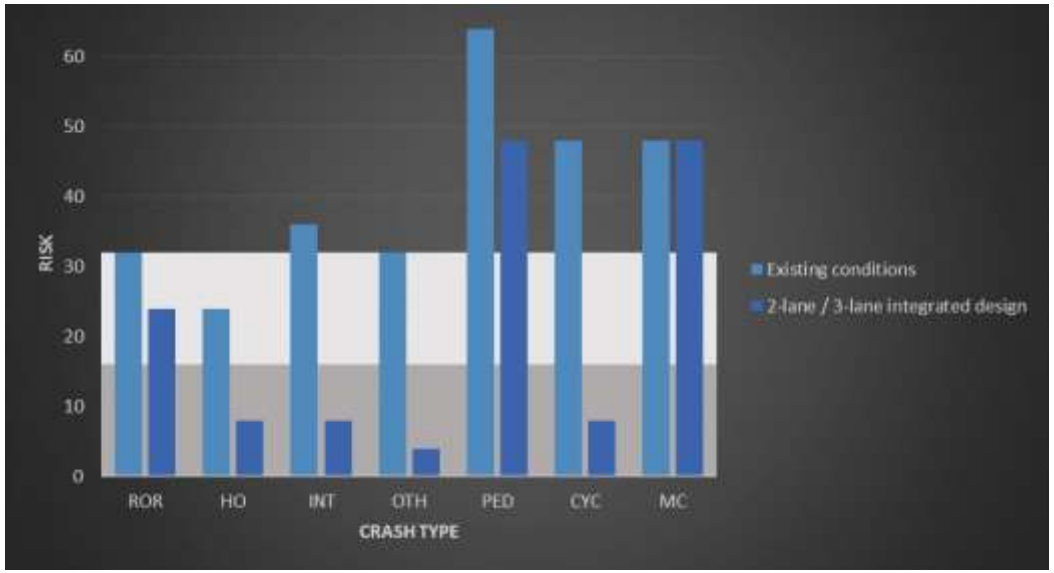
	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	High volume ×	High volume ×	High vol. on Burwood Hwy × Moderate vol. on Terrara Rd –	High volume ×	Low pedestrian volumes ✓	Low cyclist volumes ✓	Low motorcyclist volumes ✓	
	$^4/_4$	$^4/_4$	$^4/_4$	$^4/_4$	$^1/_4$	$^1/_4$	$^1/_4$	
Likelihood	Steep grade × Deceleration lane ✓ Presence of intersection × No shoulders × Moderate clear zone – No barriers ×	Divided, wide/raised median ✓ Intersection movements/conflict points minimal for HO crash ✓	% turning movements × No. of lanes and conflict points × High speed × Poor sight distance × Protected turn lanes ✓	High no. of lanes × Protected turn lanes ✓ Short decel. lanes × Buses stopping ×	Service lane with footpath ✓ No crossing facilities at intersection × Many lanes to cross ×	Service lane – some separation ✓ No crossing facilities at intersection ×	No delineation × Well surfaced ✓ Straight road ✓	
	$^3/_4$	$^1/_4$	$^3/_4$	$^3/_4$	$^4/_4$	$^4/_4$	$^3/_4$	
Severity	High speed × No barriers × Steep grade × Poles and trees to hit ×	High speed × Low speed in side road ✓	High speed × Bad conflict angles ×	High speed ×	High speed × No crossing facilities ×	High speed ×	High speed × Some roadside hazards ×	**Total**
	$^3/_4$	$^3/_4$	$^4/_4$	$^3/_4$	$^4/_4$	$^4/_4$	$^4/_4$	
Product	$4 * 3 * 3 = {}^{36}/_{64}$	$4 * 1 * 3 = {}^{12}/_{64}$	$4 * 3 * 4 = {}^{48}/_{64}$	$4 * 3 * 3 = {}^{36}/_{64}$	$1 * 4 * 4 = {}^{16}/_{64}$	$1 * 4 * 4 = {}^{16}/_{64}$	$1 * 3 * 4 = {}^{12}/_{64}$	$^{176}/_{448}$

Safe System matrix

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	High volume ×	High volume ×	High vol. on Burwood Hwy × Low vol. on Terrara Rd ✓	High volume × Low vol. on Terrara Rd ✓	Low pedestrian volumes ✓	Low cyclist volumes ✓	Low motorcyclist volumes ✓	
	$^{4}/_{4}$	$^{4}/_{4}$	$^{1}/_{4}$	$^{3}/_{4}$	$^{1}/_{4}$	$^{1}/_{4}$	$^{1}/_{4}$	
Likelihood	Steep grade × Deceleration lane ✓ No intersection ✓ No shoulders × Moderate clear zone – No barriers ×	Divided, wide/raised median ✓ Divided, wide/raised median ✓ No intersection movements/conflict points that could result in HO crash ✓	No turning movements ✓ High speed × Protected turn lanes ✓	No. of lanes × Protected turn lanes ✓ Decel. lanes no longer needed ✓ Buses stopping ×	Service lane with footpath ✓ No crossing facilities at intersection ×	Service lane – some separation ✓ No crossing facilities at intersection ×	No delineation required ✓ Good sight distance ✓ Well surfaced ✓ Straight road ✓	
	$^{2}/_{4}$	$^{0}/_{4}$	$^{1}/_{4}$	$^{2}/_{4}$	$^{4}/_{4}$	$^{4}/_{4}$	$^{2}/_{4}$	
Severity	High speed × No barriers × Moderate clear zone –	High speed × Low speed in side road ✓	High speed × Few conflict angles ✓	High speed ×	High speed ×	High speed ×	High speed × Some roadside hazards ×	**Total**
	$^{3}/_{4}$	$^{3}/_{4}$	$^{3}/_{4}$	$^{3}/_{4}$	$^{4}/_{4}$	$^{4}/_{4}$	$^{4}/_{4}$	
Total	$4 * 2 * 3 = {}^{24}/_{64}$	$4 * 0 * 3 = {}^{0}/_{64}$	$1 * 1 * 3 = {}^{3}/_{64}$	$3 * 2 * 3 = {}^{18}/_{64}$	$1 * 4 * 4 = {}^{16}/_{64}$	$1 * 4 * 4 = {}^{16}/_{64}$	$1 * 2 * 4 = {}^{8}/_{64}$	$^{85}/_{448}$

Outputs


70
60
50
40
30
20
10
0
RISK
Run off road
Head on
Intersection
Rear end/side swipe
Pedestrian
Cyclist
Motorcyclist
CRASH TYPE
Before
After


60
50
40
30
20
10
0
RISK
ROR
HO
INT
OTH
PED
CYC
MC
CRASH TYPE
Existing conditions
2-lane / 3-lane integrated design

Effectiveness

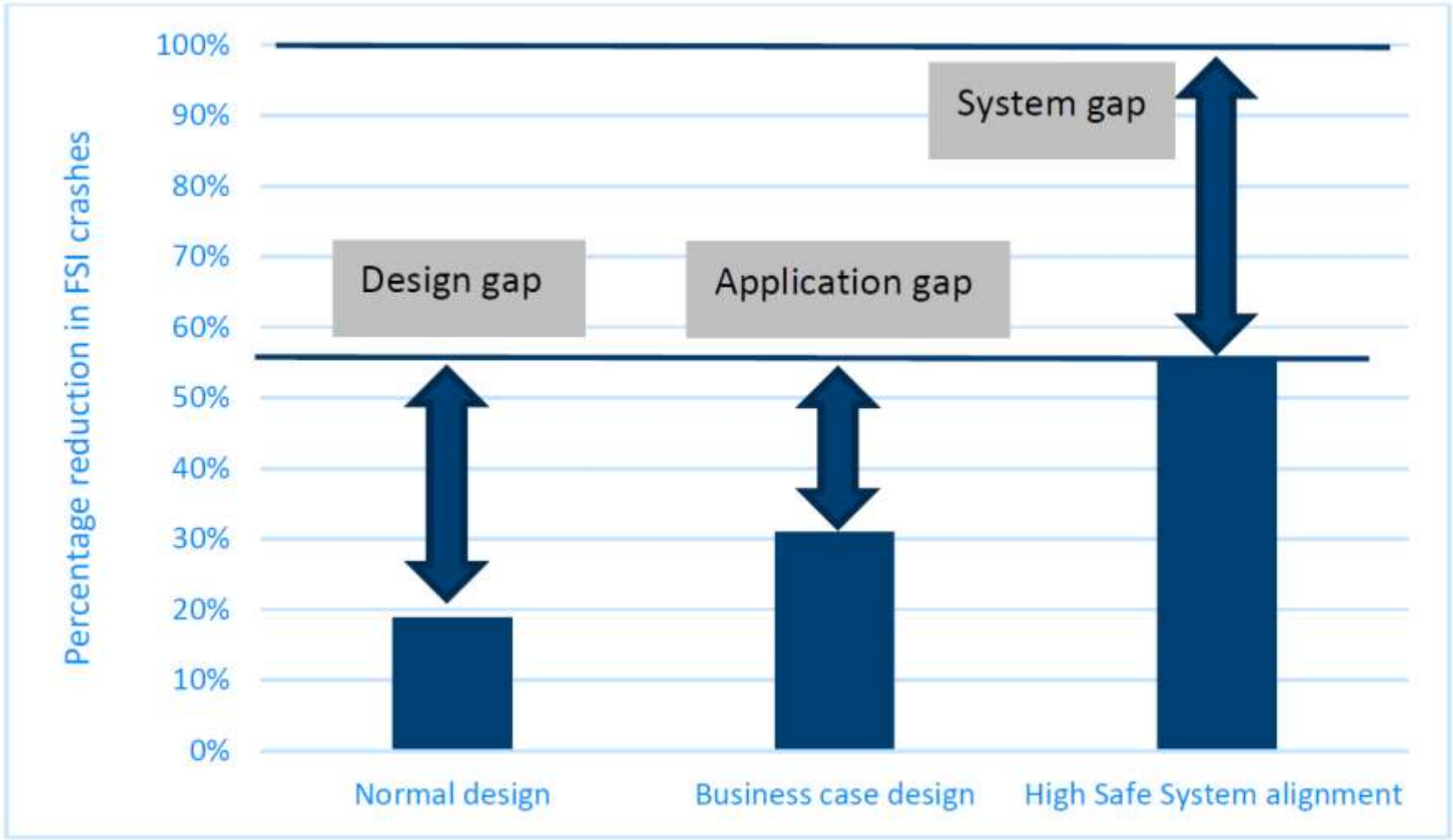


Figure 5: Safe System gaps in infrastructure design


QUESTIONS?

SHAPING OUR TRANSPORT FUTURE