THE SAFE SYSTEM APPROACH: WHAT IS IT AND WHY IS IT GETTING SO MUCH ATTENTION?

THE **SAFE SYSTEM** APPROACH

Zero is our goal. A Safe System is how we get there.

U.S.Department of Transportation
Federal Highway Administration

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Federal Highway Administration Resource Center
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ZERO IS OUR GOAL
A SAFE SYSTEM IS HOW WE GET THERE

1

THE SAFE SYSTEM APPROACH

What is it?

- It is *not* a slogan
- It is *not* a program

It is a paradigm shift in how we approach safe mobility

2

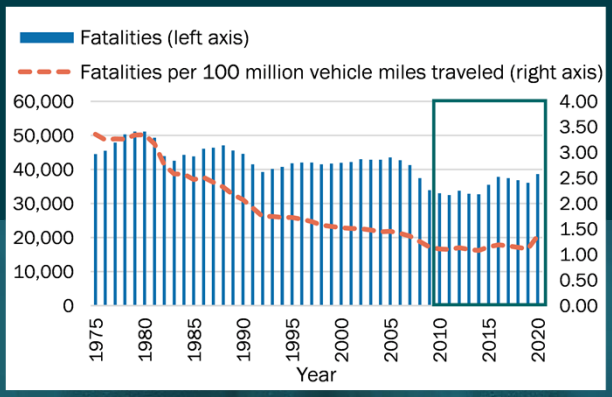
TOP TAKEAWAYS

- A Safe System Approach is **"*Principles Based*"**
- Achieving a Safe System requires strengthening all five elements
  - Safe Roads and Safe Speeds are only parts of a Safe System
- Safe Roads is a continuum, not an absolute

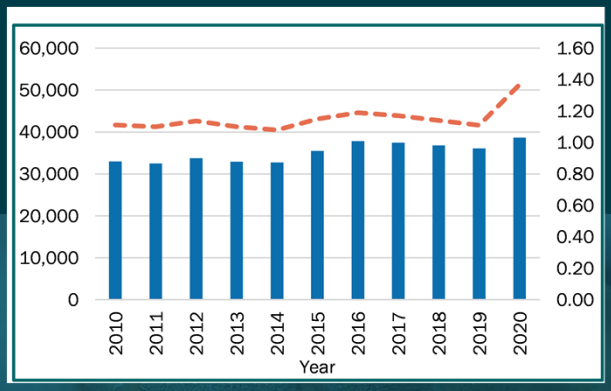
3

We have a National Roadway Safety Problem

Roadway fatalities and the fatality rate was on the decline from 1975-2010



…but progress has stalled over the last decade…

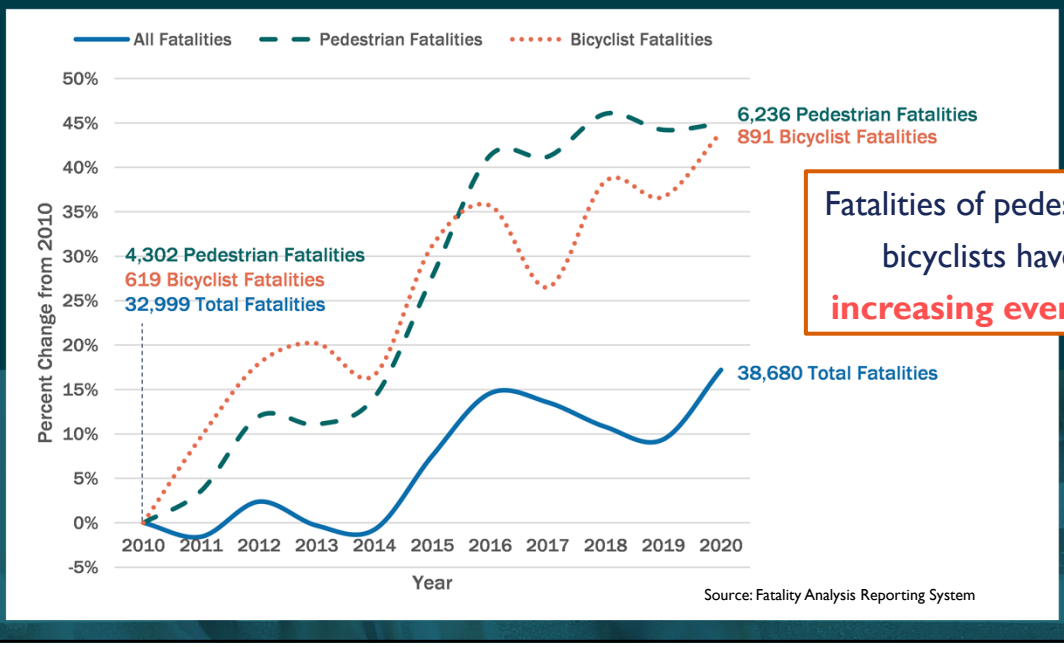


Source: Fatality Analysis Reporting System

4

4

We have a National Roadway Safety Problem



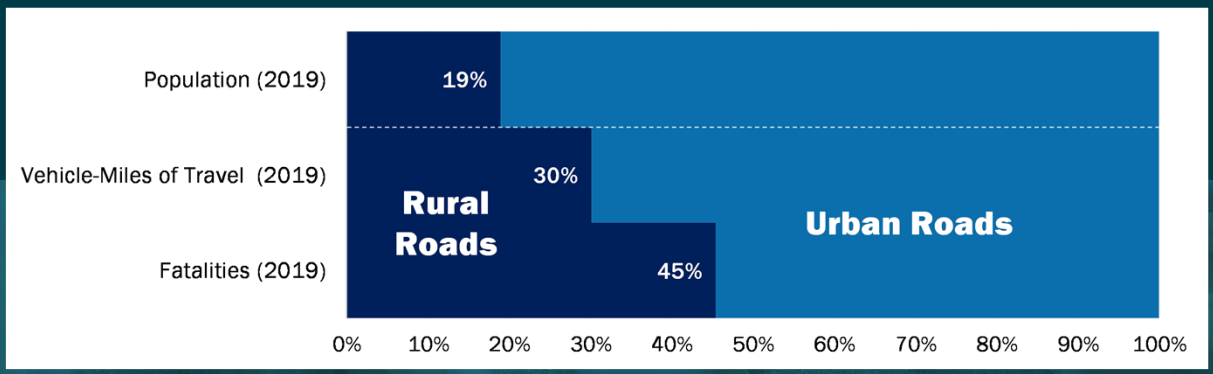
Fatalities of pedestrians and bicyclists have been **increasing even greater**

5

5

We have a National Roadway Safety Problem

Rural Roads: Fatalities and fatal crashes occur disproportionately - by both population and vehicle travel.



https://www.transportation.gov/sites/dot.gov/files/2022-02/USDOT-National-Roadway-Safety-Strategy.pdf

7

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Why are people killed or seriously injured on the roads?

IMPAIRED DRIVING

SPEEDING AND AGGRESSIVE DRIVING

DISTRACTED DRIVING

OCCUPANT PROTECTION

PEDESTRIANS AND BICYCLISTS

MOTORCYCLISTS AND MOTOR SCOOTER RIDERS

COMMERCIAL MOTOR VEHICLE OPERATORS

TEEN DRIVERS

AGING ROAD USERS

People are killed or seriously injured on the roads when collision forces transferred to the human body exceed tolerable thresholds.

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PARADIGM SHIFT

NEW PARADIGM AHEAD

" In road injury epidemiology, kinetic energy is the pathogen "

Robertson LS. *Injury epidemiology.* Oxford: Oxford University Press, 1992

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WHAT IS THE SAFE SYSTEM APPROACH?

A different way of thinking about the road safety problem …

Accommodating human mistakes

Keeping impacts on the human body at tolerable levels

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SUCCESSFUL SAFE SYSTEM ADOPTERS

Sweden
Vision Zero

60-70%
Reduction in fatalities 1994-2015

Netherlands
Sustainable Safety

50-60%
Reduction in fatalities 1994-2015

Australia
Safe System

50-60%
Reduction in fatalities 1994-2015

New Zealand
Safer Journeys

50-60%
Reduction in fatalities 1994-2015

Source: World Resources Institute

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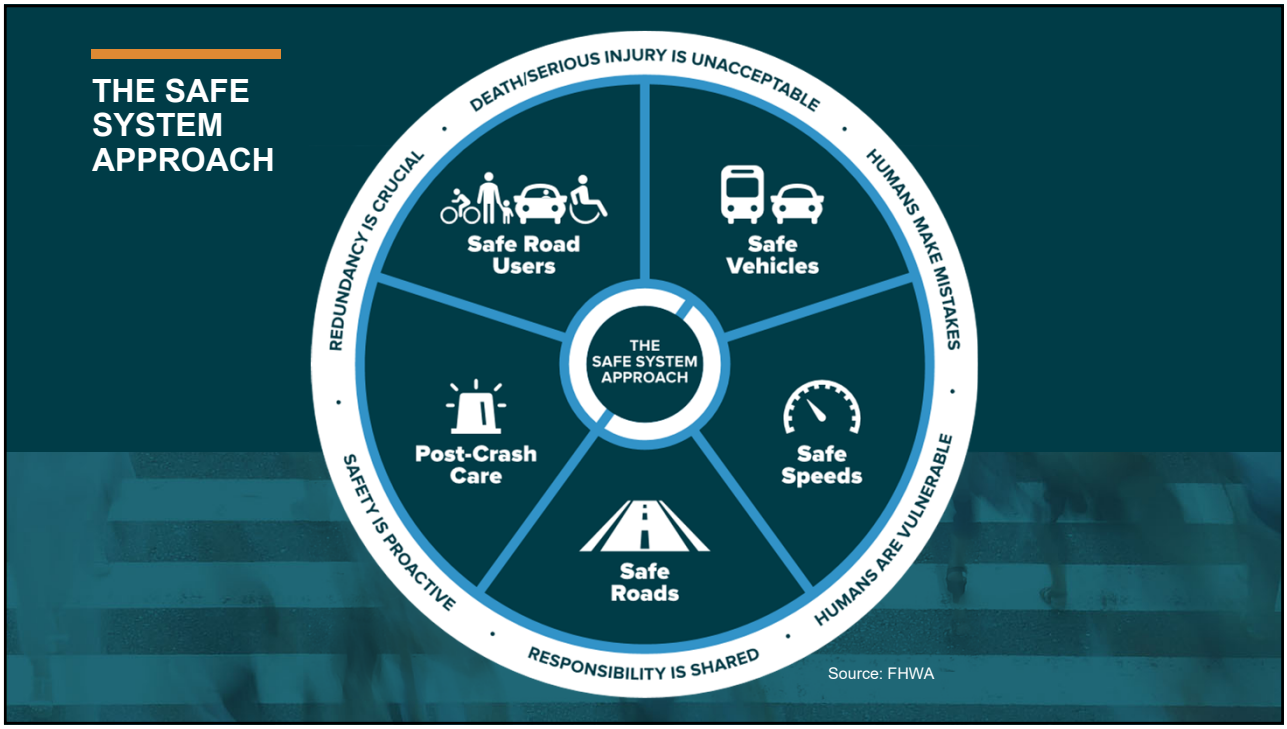
THE SAFE SYSTEM APPROACH
DEATH/SERIOUS INJURY IS UNACCEPTABLE
HUMANS MAKE MISTAKES
HUMANS ARE VULNERABLE
RESPONSIBILITY IS SHARED
SAFETY IS PROACTIVE
REDUNDANCY IS CRUCIAL
Safe Road Users
Safe Vehicles
Safe Speeds
Safe Roads
Post-Crash Care
THE SAFE SYSTEM APPROACH
Source: FHWA

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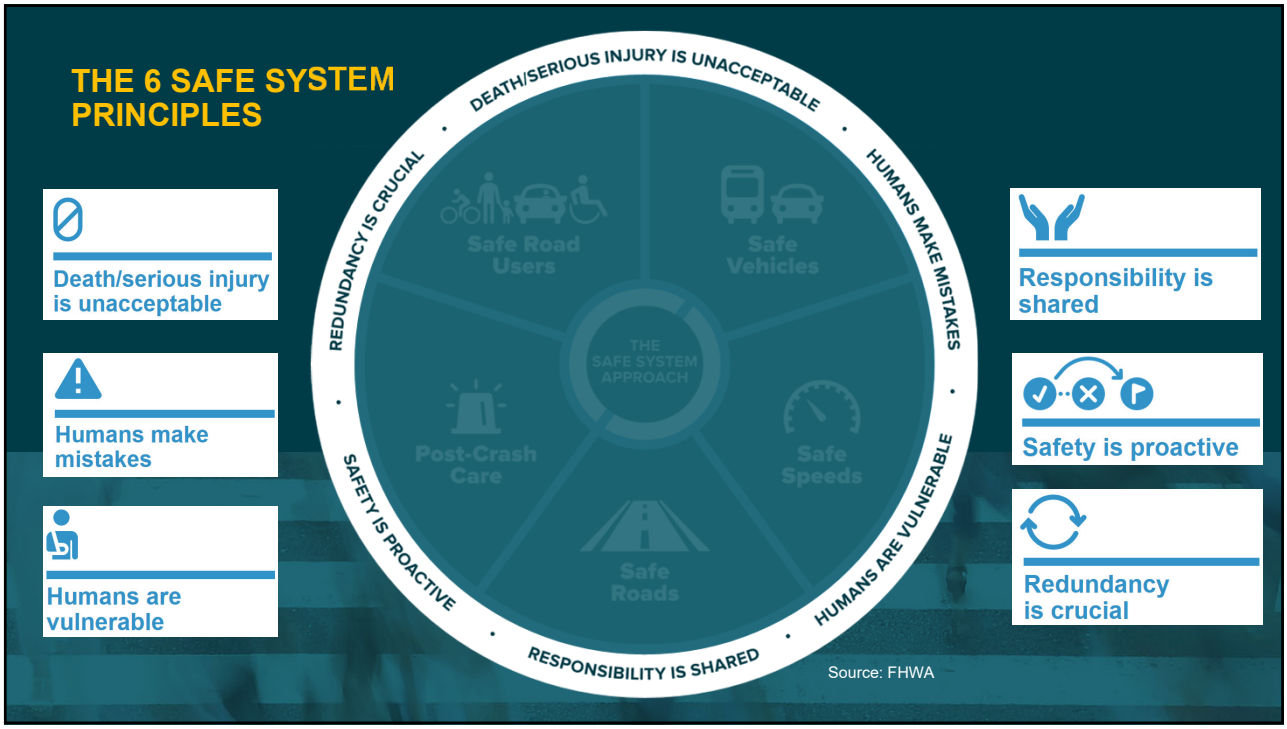
THE 6 SAFE SYSTEM PRINCIPLES
Death/serious injury is unacceptable
Humans make mistakes
Humans are vulnerable
Responsibility is shared
Safety is proactive
Redundancy is crucial
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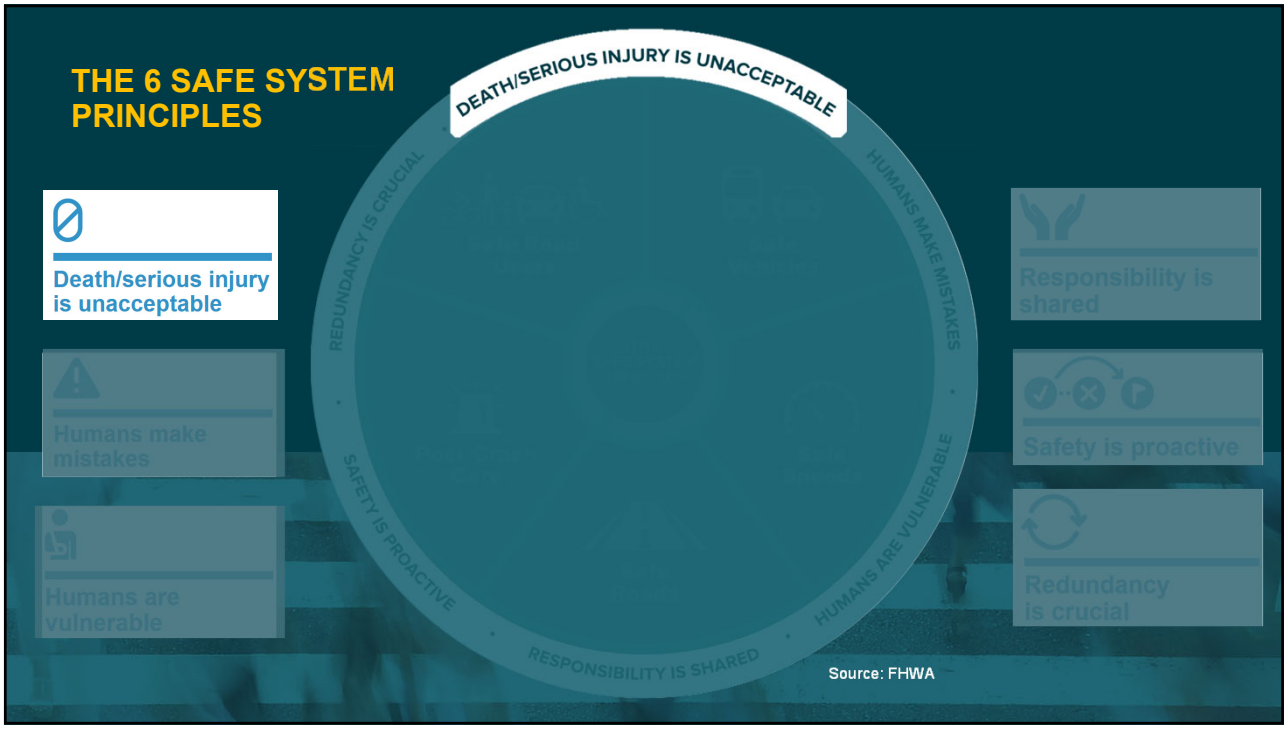
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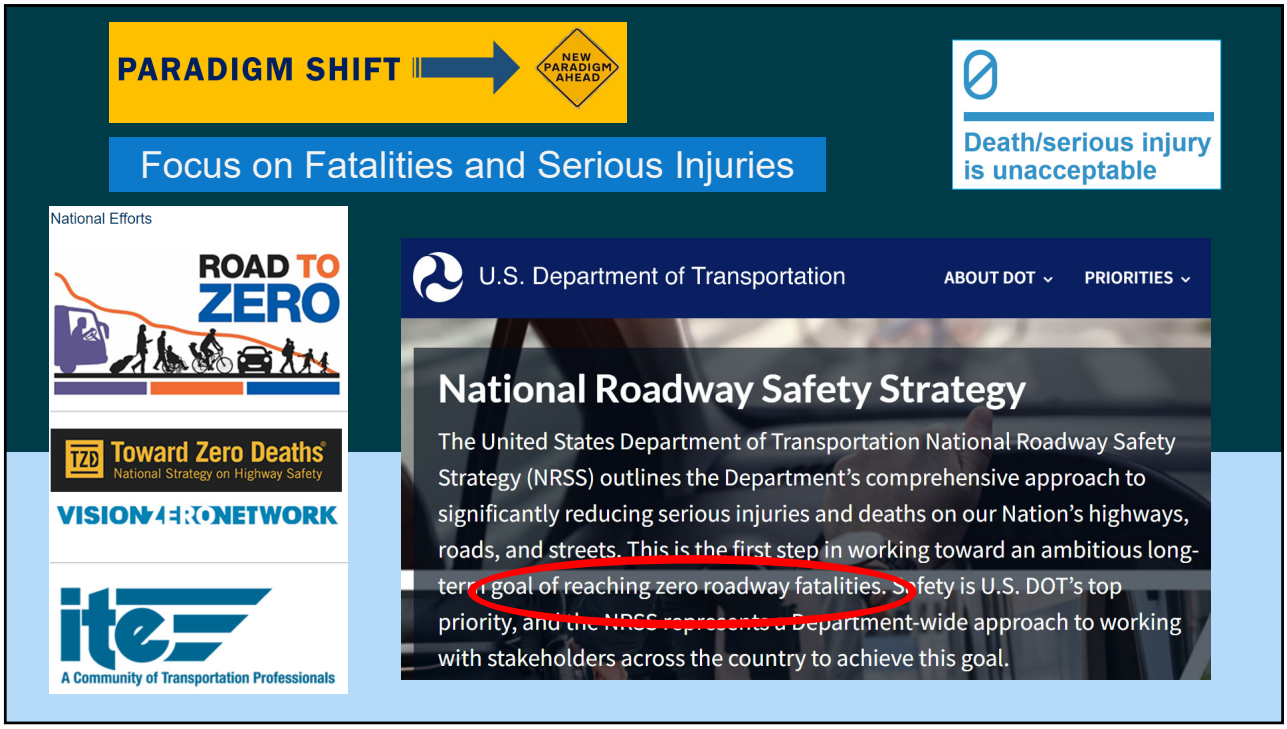
PARADIGM SHIFT
NEW PARADIGM AHEAD
Focus on Fatalities and Serious Injuries
Death/serious injury is unacceptable
National Efforts
ROAD TO ZERO
Toward Zero Deaths
National Strategy on Highway Safety
VISION ZERO NETWORK
ite
A Community of Transportation Professionals
U.S. Department of Transportation
ABOUT DOT
PRIORITIES
National Roadway Safety Strategy
The United States Department of Transportation National Roadway Safety Strategy (NRSS) outlines the Department's comprehensive approach to significantly reducing serious injuries and deaths on our Nation's highways, roads, and streets. This is the first step in working toward an ambitious long-term goal of reaching zero roadway fatalities. Safety is U.S. DOT's top priority, and the NRSS represents a Department-wide approach to working with stakeholders across the country to achieve this goal.

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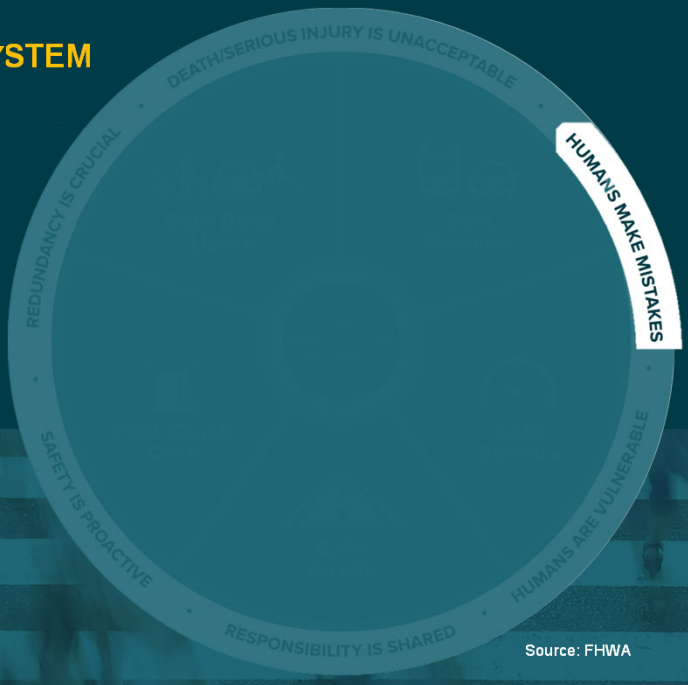
THE 6 SAFE SYSTEM PRINCIPLES



Death/serious injury is unacceptable

Humans make mistakes

Humans are vulnerable

Responsibility is shared

Safety is proactive

Redundancy is crucial

Source: FHWA

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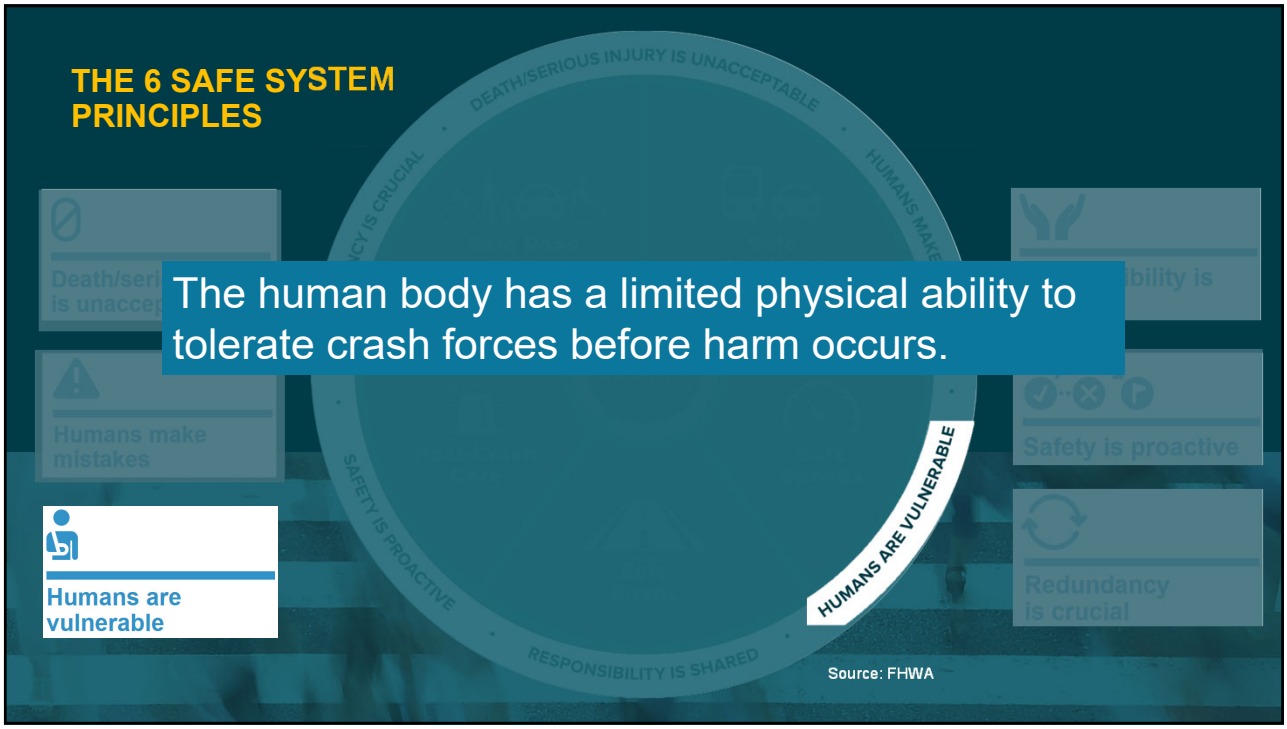
Humans make mistakes

PARADIGM SHIFT → NEW PARADIGM AHEAD

As road users, people will inevitably make mistakes and those mistakes may lead to crashes

In a Safe System approach, owners and operators of the system strive to make it easy for humans to *not* make mistakes by designing roads and vehicles to be in tune with human competences.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Death/seri
is unacce
The human body has a limited physical ability to tolerate crash forces before harm occurs.
Humans make mistakes
Humans are vulnerable
Safety is proactive
Redundancy is crucial
Source: FHWA

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Under a Safe System approach, roadway operating conditions are managed to prevent harmful forces.
Humans are vulnerable
Image: https://www.ocregister.com/2015/05/15/wheeler-dealer-bumper-cars/

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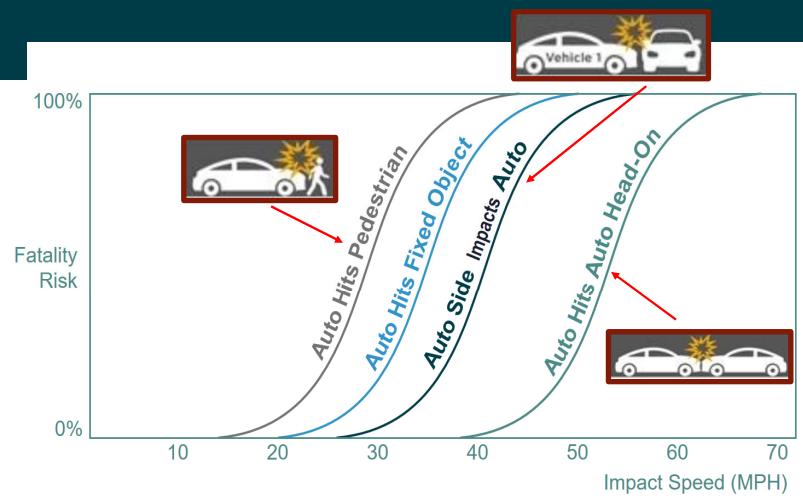
HUMANS ARE VULNERABLE

Humans are vulnerable



Source: FHWA

Designing safer roads is an exercise of managing kinetic energy

$$K = \frac{1}{2}mv^2$$

Velocity is a vector
- Speed
- Direction (angle of impact)

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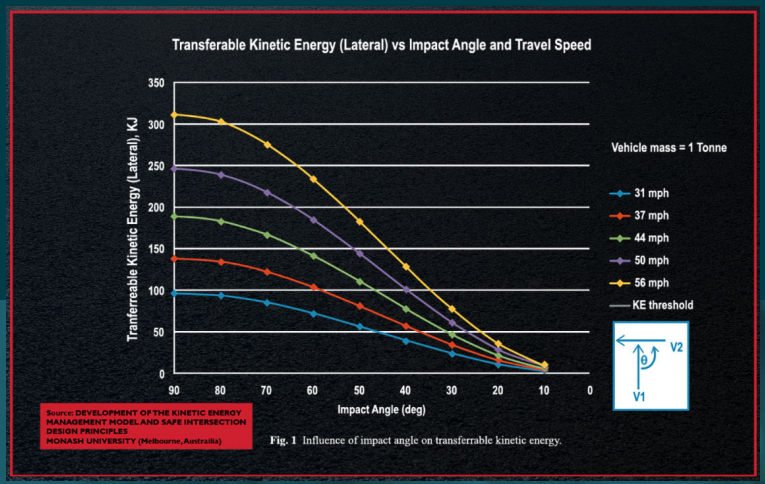
Transferable Kinetic Energy (Lateral) vs Impact Angle and Travel Speed



Changing collision impact angle from 90° to 40° reduces kinetic energy as if vehicle speeds were about 20 mph less

23

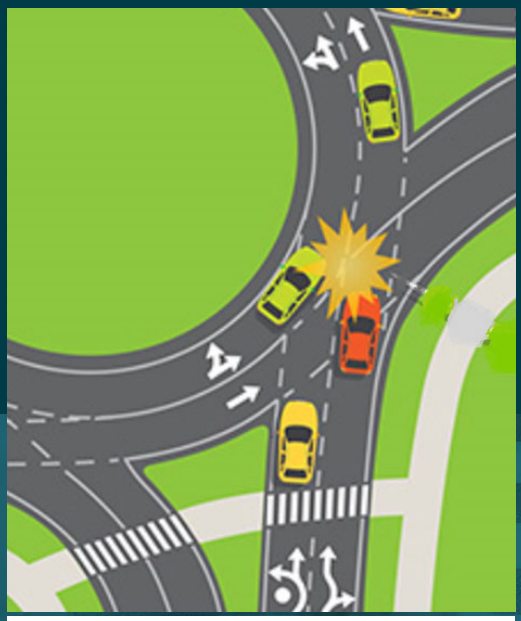


Image derived from: https://dublinohiousa.gov/roundabouts

Example: Roundabouts vs Signalized Intersections

		
Lower Speeds	✓	
Lower Impact Angles	✓	
Fewer Conflict Points	✓	

Is this why roundabouts are so effective at reducing severe crashes?

YES !!!

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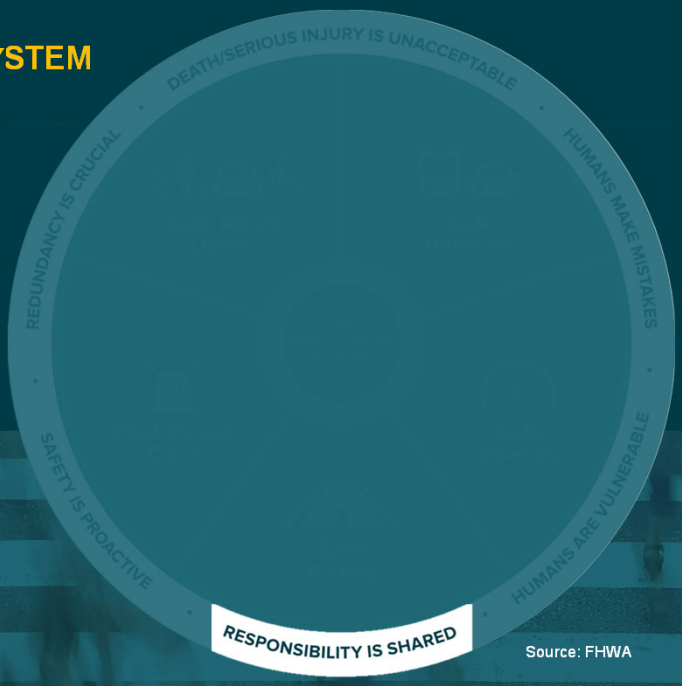
THE 6 SAFE SYSTEM PRINCIPLES



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Source: FHWA

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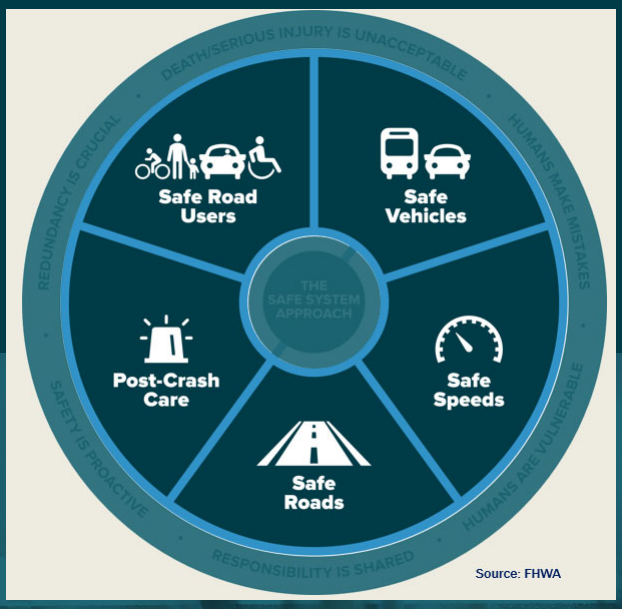
Five Safe System Elements

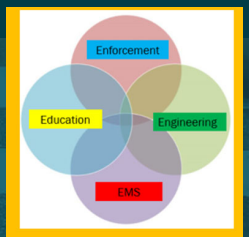


Source: FHWA

Responsibility is shared

Implementing the Safe System approach is a shared responsibility

It cannot be achieved by engineering alone



Source: FHWA Strategic Highway Safety Plans: A Champion's Guidebook to Saving Lives, Second Edition https://safety.fhwa.dot.gov/shsp/guidebook/ovrvw.cfm

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THE 5 SAFE SYSTEM ELEMENTS

Source: FHWA

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Safe Road Users

Walk | Bike | Drive | Transit | Other

Source for all images: Fehr & Peers

- Not distracted or impaired
- Follow rules
- Act within the limits of the road design

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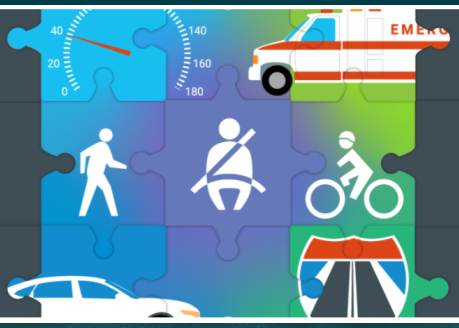
Governors Highway Safety Association
The States' Voice on Highway Safety

https://www.ghsa.org/resources/GHSA/Safe-System-Report21

Putting the Pieces Together

Addressing the Role of Behavioral Safety in the Safe System Approach



Describes the integral role of behavioral safety and road user responsibility in the Safe System approach with actionable recommendations illustrating how organizations and advocates can work together to prevent roadway deaths.

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THE 5 SAFE SYSTEM ELEMENTS

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Safe Vehicles

Active Safety	Passive Safety
Reduces the chance of a crash occurring	Protective systems for when crashes occur
• Lane departure warnings • Lane keeping assist • Forward collision warnings • Autonomous emergency braking • Pedestrian detection • Backup camera • Antilock brakes • Electronic stability control	• Seatbelts • Airbags • Crumple zones • Collapsible steering column

Leveraging connected and automated vehicle (CAV) technology to improve safety

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THE 5 SAFE SYSTEM ELEMENTS

Source: FHWA

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SAFE SPEEDS

Safe Speeds

Source: FHWA

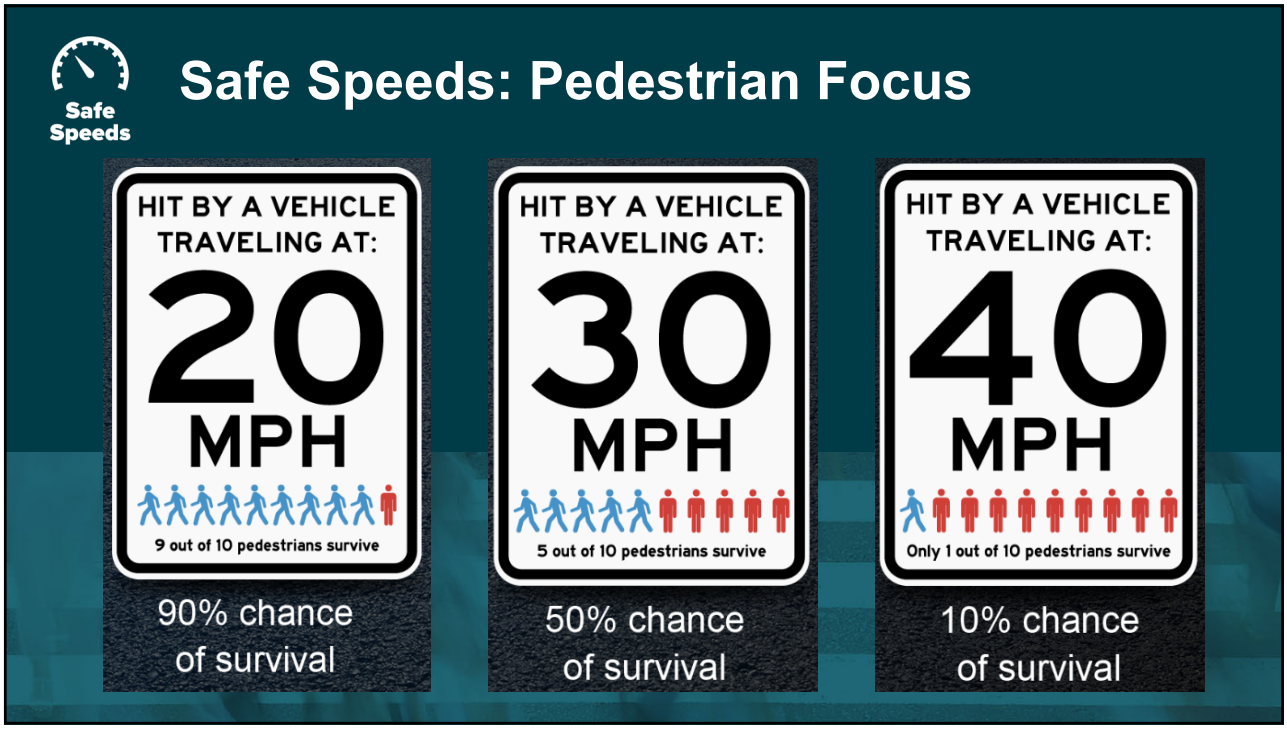
Some roads are engineered to accommodate higher speeds …

Source: FHWA

Source: FHWA

… and others not.

The Safe System approach is not about universally reducing speeds. It's about matching speed appropriate to the road conditions that exist.


Safe Speeds
Safe Speeds: Pedestrian Focus
HIT BY A VEHICLE TRAVELING AT:
20
MPH
9 out of 10 pedestrians survive
90% chance of survival
HIT BY A VEHICLE TRAVELING AT:
30
MPH
5 out of 10 pedestrians survive
50% chance of survival
HIT BY A VEHICLE TRAVELING AT:
40
MPH
Only 1 out of 10 pedestrians survive
10% chance of survival

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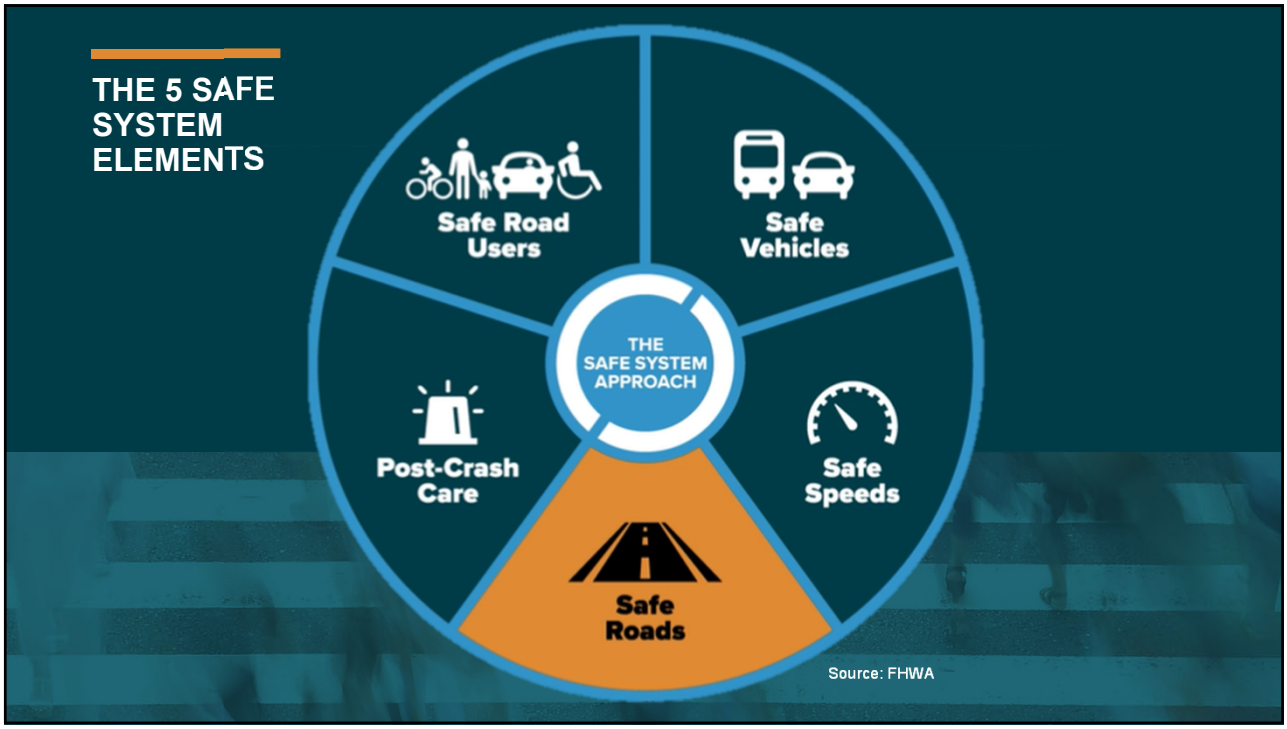
THE 5 SAFE SYSTEM ELEMENTS
Safe Road Users
Safe Vehicles
THE SAFE SYSTEM APPROACH
Post-Crash Care
Safe Speeds
Safe Roads
Source: FHWA

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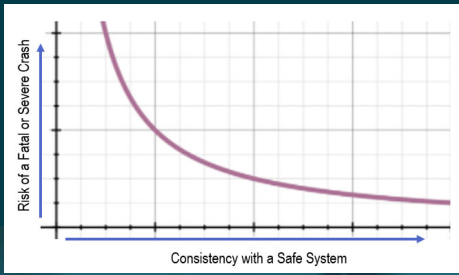
Thoughts on the Safe Roads Element

Safe Roads

Safe Roads is a continuum – not an absolute



- The aim is to design and operate roads to continuously work toward creating a Safe System by implementing features appropriate for the intended and actual road use and speed environment
  - Reduce the likelihood of error
  - Reduce the consequences of error

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Prevention through Design (PtD)

Hierarchy of Control

More Effective

Eliminate
Physically remove the hazard

Substitute
Replace the hazard with option that lowers severity

Engineering Controls
Operate the system to reduce exposure

Administrative Controls
Education, legislation & policies to change behavior

Personal Protective Equipment
PPE, protective gear

Less Effective

Adapted from National Institute for Occupational Safety and Health - https://www.cdc.gov/niosh/topics/hierarchy/default.html

Prevention through Design

Initiative led by the National Institute for Occupational Safety and Health (NIOSH) to prevent or reduce occupational injuries, illnesses, and fatalities through efforts that anticipate and "design out" hazards to workers.

Hierarchy of controls is a PtD strategy.
https://www.cdc.gov/niosh/topics/ptd/

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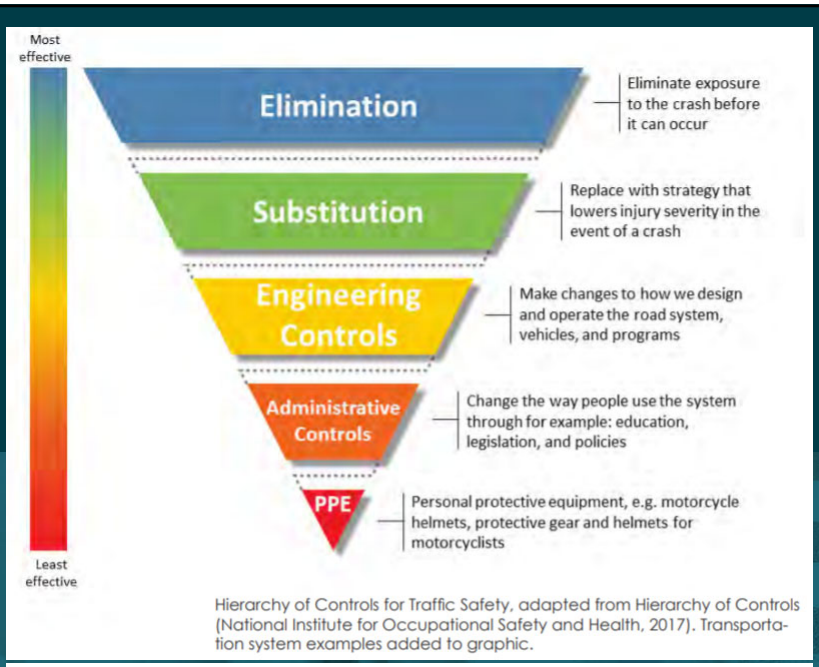

http://targetzero.com/wp-content/uploads/2020/03/TargetZero2019_Lo-Res.pdf

Washington State Strategic Highway Safety Plan:

Target Zero 2019

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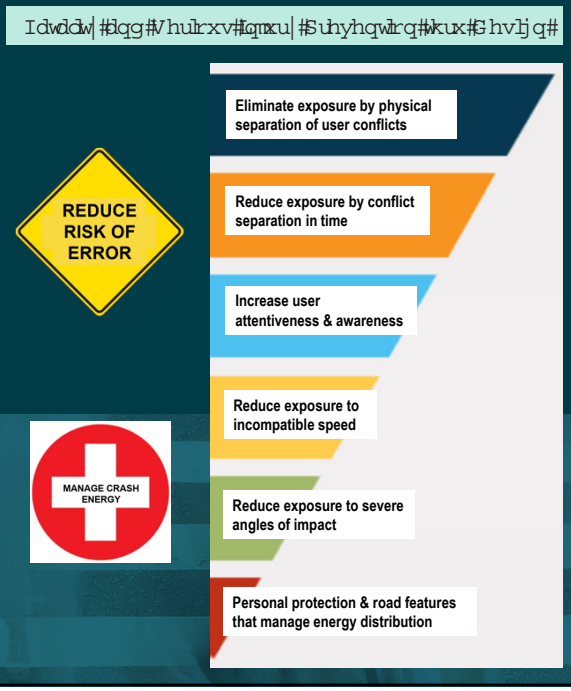

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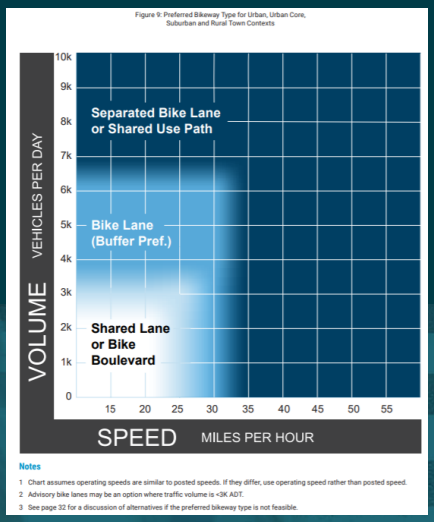
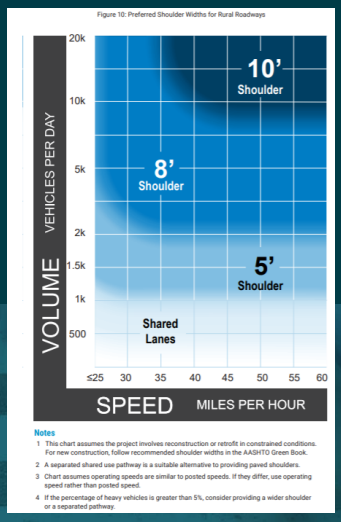
Separating Users in Space





https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf

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Table 14. Recommended Countermeasure Tiers Depending on Traffic Context

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT < 9,000			Vehicle ADT 9,000–12,000			Vehicle ADT 12,000–15,000			Vehicle ADT ≥ 15,000		
	Speed Limit (mph)											
	≤30	35	≥40*	≤30	35	≥40*	≤30	35	≥40*	≤30	35	≥40*
2 Lanes	1	1	2	1	1	2	1	1	3	1	2	3
3 Lanes	1	1	2	1	2	2	2	3	3	2	3	3
4 Lanes with raised median**	1	1	2	1	2	2	2	3	3	3	3	3
4+ Lanes without raised median	1	2	3	2	2	3	3	3	3	3	3	3

Legend:

1 ***Tier 1:*** Traffic context generally supports motorist yielding; countermeasures are generally less expensive and require less process than other two tiers to implement

2 ***Tier 2:*** Traffic context generally requires intervention to induce motorist yielding; countermeasures are generally less expensive and require less process than Tier 3 to implement

3 ***Tier 3:*** Traffic context generally requires intervention to require motorist to stop or to physically separate pedestrians and bicyclists from traffic; often the most expensive and may require extensive public process

* Where the speed limit exceeds 40 mph, Tier 3 should be considered.

** Raised medians must be at least 6 feet wide to serve pedestrians. See the AASHTO *Bicycle Guide* for lengths to serve bicyclists. Where median width is less than these values, review category of 4+ lanes without raised median.

Table adapted from AASHTO *Bicycle Guide* and the FHWA *STEP Guide*

Source: Guidance to Improve Pedestrian and Bicyclist Safety at Intersections (2020); National Cooperative Highway Research Program (NCHRP) Report 926 - http://www.trb.org/Main/Blurbs/180624.aspx

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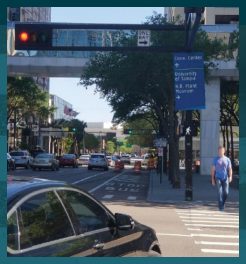
Separating Users in Time

Pedestrian Hybrid Beacons

Leading Pedestrian Interval



All Images
Source: FHWA

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Increasing Users Attentiveness & Awareness

ROADWAY DEPARTURE

- Wider Edge Lines
- Longitudinal Rumble Strips and Stripes on Two-Lane Roads
- Enhanced Delineation for Horizontal Curves

INTERSECTIONS

- Backplates with Retroreflective Borders
- Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections

PEDESTRIANS/BICYCLES

- Rectangular Rapid Flashing Beacons (RRFB)
- Crosswalk Visibility Enhancements

CROSSCUTTING

- Lighting

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Brookline Ave
TURNING VEHICLES
TO
SEPARATE
SLOW
INCREASE AWARENESS

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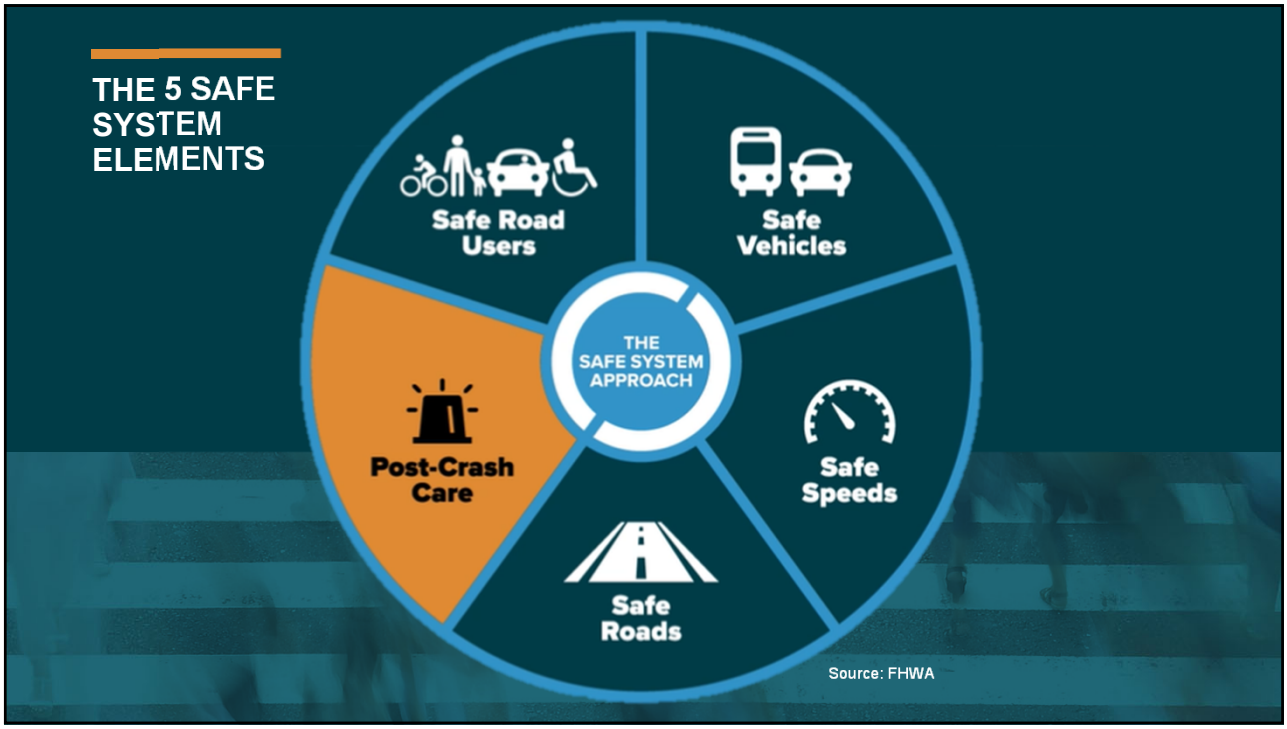
THE 5 SAFE SYSTEM ELEMENTS
Safe Road Users
Safe Vehicles
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Post-Crash Care
THE SAFE SYSTEM APPROACH
Source: FHWA

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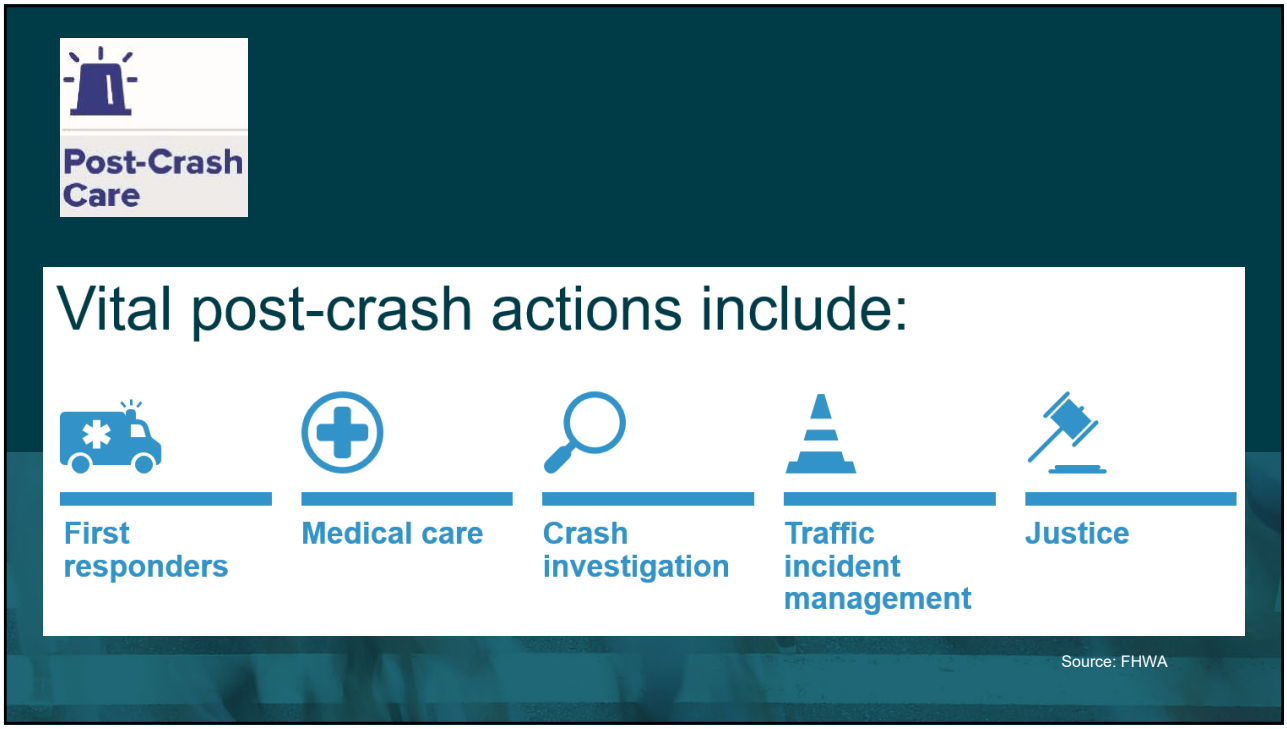
Post-Crash Care
Vital post-crash actions include:
First responders
Medical care
Crash investigation
Traffic incident management
Justice
Source: FHWA

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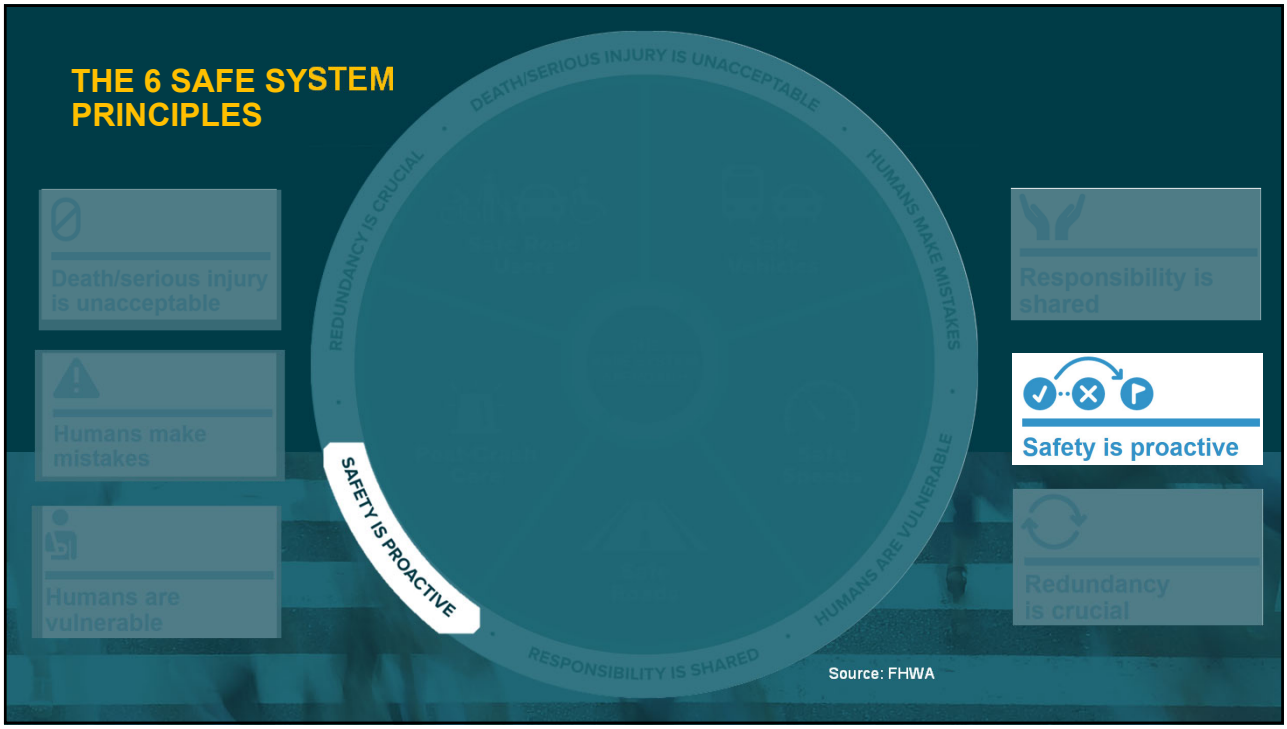
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Source: FHWA

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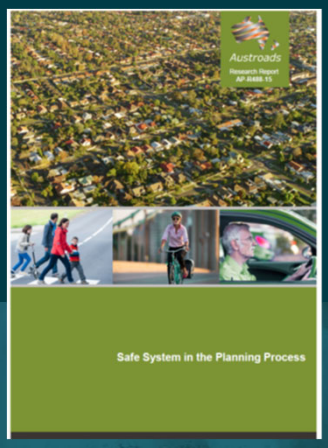
Safe System in the Planning Process

Safety is proactive



"This report aims to promote the consideration of Safe System principles in planning decisions."

Austroads Research Report AP-R488-15

"By applying Safe System principles early in the development process, transport and land-use planners may effectively contribute to the Safe System and address road user safety across all modes. Land-use and transport planning can primarily contribute to this through the built environment (including the road network) and speed management."

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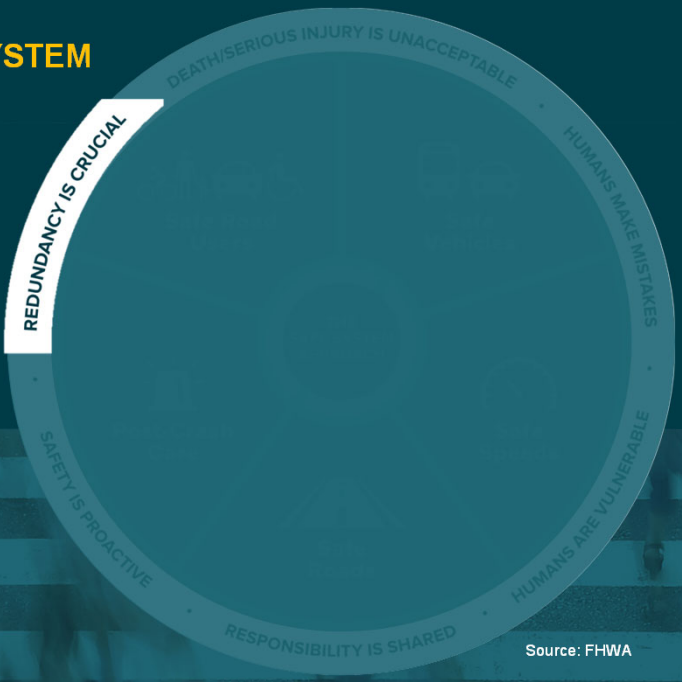
THE 6 SAFE SYSTEM PRINCIPLES



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Humans are vulnerable

Responsibility is shared

Safety is proactive

Redundancy is crucial

Source: FHWA

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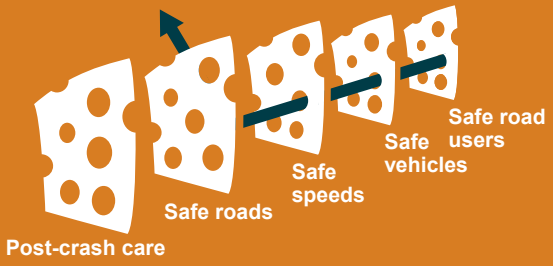
SAFE SYSTEM ELEMENTS CREATE REDUNDANCY

Redundancy is crucial

The "Swiss Cheese Model" of redundancy creates layers of protection



Death and serious injuries only happen when all layers fail

Adapted from James Reason's model for analyzing accident causation
https://royalsocietypublishing.org/doi/10.1098/rstb.1990.0090

Image Source: FHWA

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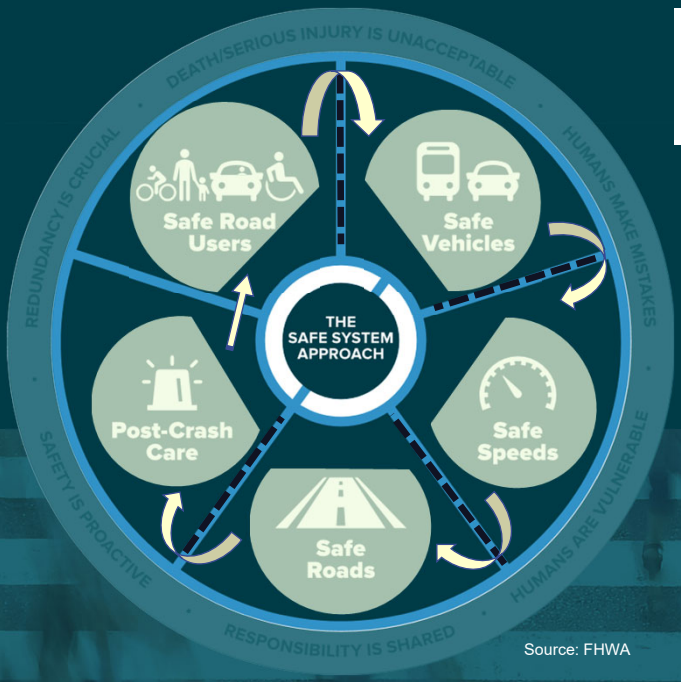
THE 5 SAFE SYSTEM ELEMENTS



Redundancy is crucial

Source: FHWA

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What's Different?

PARADIGM SHIFT

Traditional Approach		Safe System Approach
Reduce Crashes	→	Eliminate Fatalities & Serious Injuries
Speed Management	→	Kinetic Energy Management
Safety "Four E's"	→	Five Safe System Elements
Apply Countermeasures at High Crash Locations	→	Proactively Apply Countermeasures in a "Systemic" Approach
Examine crash records to identify causes or "deficiencies"	→	Strengthen all elements to reduce "system failures"
"Balance" Safety vs. Mobility	→	Only "Safe Mobility"

- Death/serious injury is unacceptable
- Humans make mistakes
- Humans are vulnerable
- Responsibility is shared
- Safety is proactive
- Redundancy is crucial

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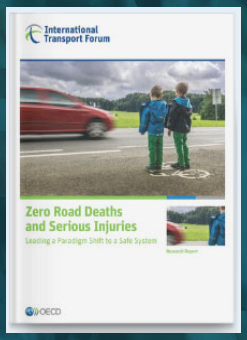
Safe System Approach – What's Next?

"There is no single pathway for the adoption, establishment and implementation of a Safe System. Moving to a Safe System is a learning-by-doing process best described as a journey which presents opportunities, hazards and challenges along the way. The experiences of the pioneering countries show that each follows its own journey, shaped by the cultural, temporal, and local context, but guided by the underlying principles."



Source: Zero Road Deaths and Serious Injuries: Leading a Paradigm Shift to a Safe System; OECD (2016)

http://www.oecd.org/publications/zero-road-deaths-and-serious-injuries-9789282108055-en.htm

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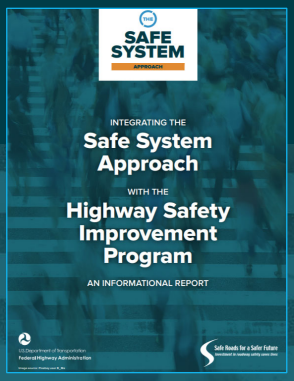
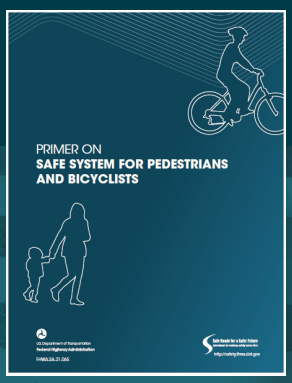
For More Information

FHWA Resources: https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm

ITE Resources: https://www.ite.org/technical-resources/topics/safe-systems/





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WHAT IS THE SAFE SYSTEM APPROACH?

Image: FHWA

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TOP TAKEAWAYS

- A Safe System Approach is **"*Principles Based*"**
- Achieving a Safe System requires strengthening all five elements
  - Safe Roads and Safe Speeds are only parts of a Safe System
- Safe Roads is a continuum, not an absolute

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THE **SAFE SYSTEM** APPROACH

Zero is our goal. A Safe System is how we get there.

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FHWA Resources: https://safety.fhwa.dot.gov/zerodeaths/zero_deaths_vision.cfm

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