THE SAFE SYSTEM

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

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How does the US reach zero deaths?

Total US Traffic Fatalities 2009-2018
Source: NHTSA

Total US Pedestrian Fatalities 2009-2018
Source: Fehr & Peers
The Safe System approach aims to eliminate fatal and serious injuries for all road users by:

- Accommodating human mistakes
- Keeping impacts on the human body at tolerable levels
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

Source: FHWA
THE 6 SAFE SYSTEM PRINCIPLES

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

Source: FHWA
THE 6 SAFE SYSTEM PRINCIPLES

- DEATH/SERIOUS INJURY IS UNACCEPTABLE
- RESPONSIBILITY IS SHARED
- HUMANS ARE VULNERABLE
- REDUNDANCY IS CRUCIAL
- SAFETY IS PROACTIVE
- SAFE RoADS

Source: FHWA
Five Safety Measures

- Number of Fatalities
- Fatality Rate
- Number of Serious Injuries
- Rate of Serious Injuries
- Number of Non-Motorized Fatalities and Serious Injuries

Transportation Performance Management (TPM) is a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals.
THE 6 SAFE SYSTEM PRINCIPLES

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

Source: FHWA
HUMAN CENTRIC DESIGN

What is Human Factors?

The field of human factors applies what we know about the capabilities and perceptual limitations of people to better design the environments in which they function. It is an interdisciplinary area of research that focuses on a number of real-world applications, including product design, workplace safety, ergonomics, human-machine interfaces, and transportation. The goal is to maximize performance and safety by creating products, equipment, machines, and environments that complement human capabilities.

THE 6 SAFE SYSTEM PRINCIPLES

- **REdundancy is crucial**
  - Safe Road Users
- **Death/serious injury is unacceptable**
- **Humans make mistakes**
- **Humans are vulnerable**
  - Post-Crash Care
  - Safe Roads
  - Safe Speeds
  - Safe Vehicles

**Responsibility is shared**

**Safety is proactive**

**Redundancy is crucial**

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)

Source: FHWA
Changing an impact angle from 90° to 40° reduces kinetic energy about the same as if speeds were about 30kph (20 mph) less.
Is this why roundabouts are so effective at reducing severe crashes?

YES !!!
THE 6 SAFE SYSTEM PRINCIPLES

1. REDUNDANCY IS CRUCIAL
   - Death/serious injury is unacceptable

2. HUMANS MAKE MISTAKES
   - Humans make mistakes

3. SAFETY IS PROACTIVE
   - Humans are vulnerable

4. RESPONSIBILITY IS SHARED

5. Safe Users

6. Safe Vehicles

DEATH/SERIOUS INJURY IS UNACCEPTABLE
HUMANS ARE VULNERABLE
Safe Roads
Safe Speeds
Post-Crash Care
Responsibility is shared
Safety is proactive
Redundancy is crucial

Source: FHWA
Implementing the Safe System approach is a shared responsibility. It cannot be achieved by engineering alone.
THE 6 SAFE SYSTEM PRINCIPLES

1. REDUNDANCY IS CRUCIAL
   - Safe Roads
   - Safe Vehicles
   - Safe Users

2. DEATH SERIOUS INJURY IS UNACCEPTABLE
   - Post-Crash Care
   - Safe Speeds

3. HUMANS MAKE MISTAKES
   - Responsibility is shared

4. HUMANS ARE VULNERABLE
   - Safety is proactive
   - Redundancy is crucial

Source: FHWA
Proactive vs. Reactive

Crash occurrence

Crash countermeasure

Identify risks

Mitigate risks

Systemic Approach - using data and roadway characteristics to identify patterns of risk and proactively implementing targeted safety measures at locations with those risk characteristics (irrespective of past collision history).
A systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types. The approach helps agencies broaden their traffic safety efforts at little extra cost. Find out how (read more).

A Way to Manage Risk
https://safety.fhwa.dot.gov/systemic/

Systemic In Practice
https://safety.fhwa.dot.gov/systemic/
Highway Safety Improvement Program (HSIP)

The HSIP is the projects, activities, plans, and reports carried out under 23 U.S.C. 148. FHWA has developed a wide variety of resources to help States plan highway safety improvement projects using a performance-driven process, implement those projects, evaluate the effectiveness of past projects and report annually on the status of HSIP implementation efforts.

Resources

https://safety.fhwa.dot.gov/hsip/hsip.cfm

THE 6 SAFE SYSTEM PRINCIPLES

1. Death/serious injury is unacceptable
2. Humans make mistakes
3. Humans are vulnerable
4. Safety is proactive
5. Responsibility is shared
6. Redundancy is crucial

Source: FHWA
SAFE SYSTEM ELEMENTS CREATE REDUNDANCY

The “Swiss Cheese Model” of redundancy creates layers of protection.

Death and serious injuries only happen when all layers fail.

Post-crash care
Safe roads
Safe speeds
Safe vehicles
Safe road users

Source: FHWA
### SAFE ROADS

**1st AVERT CRASH**

Avoiding crashes involves reducing the opportunity for error:

- Separating users in space
- Separating users in time
- Increasing attentiveness and awareness

**2nd MANAGE CRASH ENERGY**

Managing crash kinetic energy involves:

- Manage speed
- Manage impact angles
- Manage impact energy distribution

*Source: Fehr & Peers*
Separating Users in Space
Separating Users in Time

Leading Pedestrian Intervals

https://safety.fhwa.dot.gov/provencountermeasures/lead_ped_int/
SAFE SYSTEM APPROACH TO INTERSECTION PLANNING & DESIGN

First step towards the development of objective analysis approaches that capture key Safe System concepts and are implementable by intersection planners and designers in the U.S.

Assessment of Exposure-Severity-Complexity

\[ E_t = \sum_{i=1}^{n_i} (1 + P(FSI)_{1i} \times k_{1i} \times k_{2i}) \]

Equation 7. Sum of exposure-severity-complexity products for all conflict points of type t.

Conflict point severity serves as an estimate of the probability of fatality or serious injury (P(FSI))

Movement complexity considers Human Factors

- \( \text{SSI}_t = 100 \times \exp\left(\frac{-1}{c} \times E_t\right) \)

Equation 8. SSI score for all conflict points of type t.

Table 19. SSI score results for Scenario 1.

<table>
<thead>
<tr>
<th>Intersection Type</th>
<th>Intersection SSI Score</th>
<th>Pedestrian</th>
<th>Crossing</th>
<th>Merging</th>
<th>Diverging</th>
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<tbody>
<tr>
<td>2x1 Roundabout</td>
<td>79</td>
<td>40</td>
<td>95</td>
<td>100</td>
<td>100</td>
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<tr>
<td>2x2 Roundabout</td>
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<td>32</td>
<td>93</td>
<td>100</td>
<td>100</td>
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<tr>
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<td>2</td>
<td>20</td>
<td>91</td>
<td>100</td>
</tr>
<tr>
<td>Signalized RCUT</td>
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<td>86</td>
<td>100</td>
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<tr>
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<td>100</td>
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<tr>
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<td>1</td>
<td>98</td>
<td>100</td>
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<tr>
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<td>2</td>
<td>96</td>
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<tr>
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<td>0</td>
<td>1</td>
<td>94</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: FHWA
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)
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