

NCHRP Project 17-101

NCHRP Research Report 1135: A Guide to Applying the Safe System Approach to Transportation Planning, Design, and Operations

August 2024

Project Team

The University of North Carolina Highway Safety Research Center,
with support from the following:

- Burgess & Niple
- Mobycon
- UC-Berkeley SafeTREC
- Centre for Accident Research and Road Safety (CARRS-Q)
- Timothy E. Barnett
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NCHRP 17-101 Project Objectives

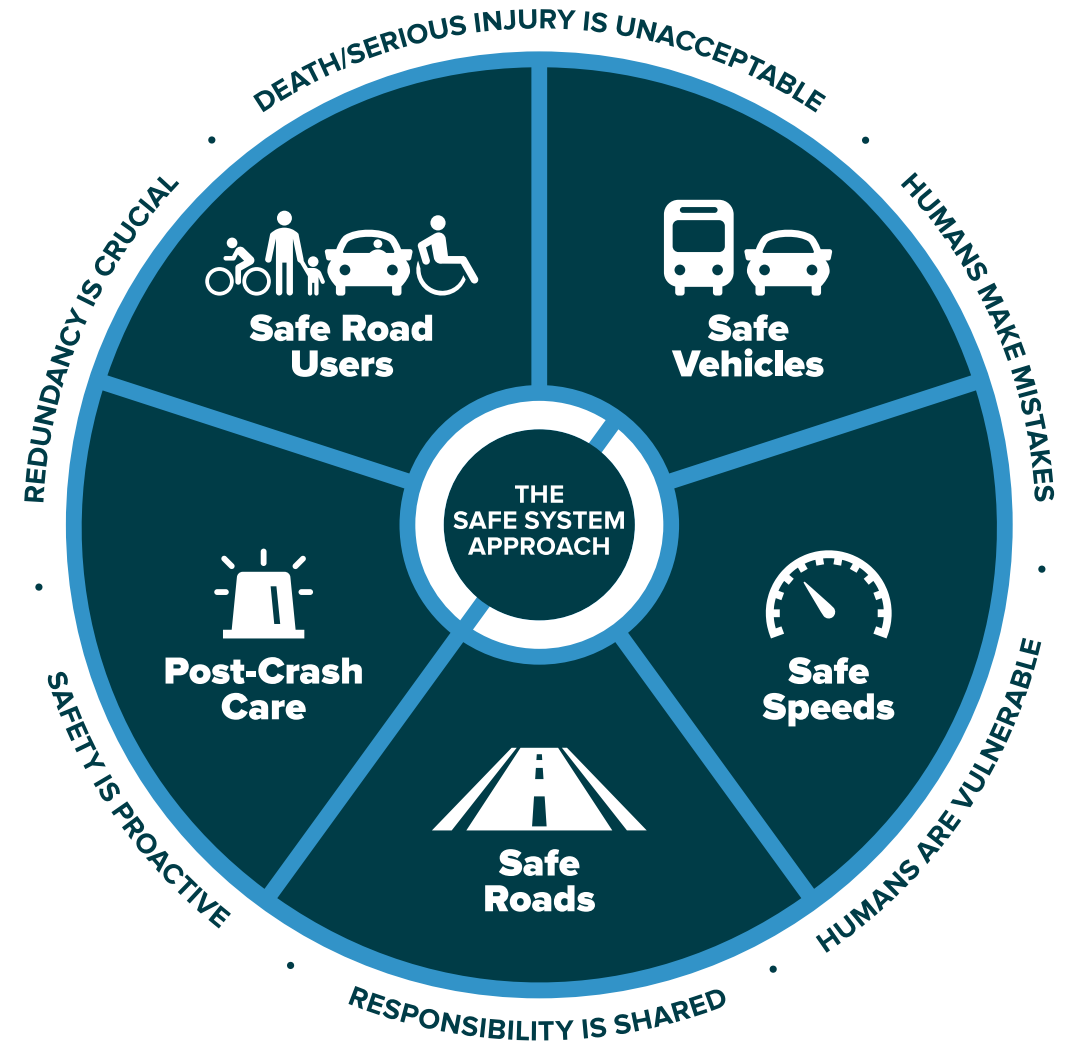
- Identify, contextualize, and modularize strategies, practices, and policies for implementing a Safe System approach in the United States.
- Research products will enable a range of professionals and organizations to adopt and implement a truly Safe System approach in their work.

The Ultimate Safe System

“In road transport, the *Ultimate Safe System* is one in which **road users cannot be killed or seriously injured regardless** of their behavior or the behavior of other road users.” (*Job, Truong, and Sakashita, 2022, p. 6*)

How Safe System Has Been Characterized

- Safe System is **not** an “**approach**,” it is a **desired end state**.
- An “elements first” take on the Safe System (e.g., Safe Road Users, Safe Roads, and Safe Speeds) often **mistakes process** (improved signage to check boxes next to Safe Road Users, Safe Roads, and Safe Speeds) **with value** (protecting road users in the event of inevitable mistakes).



Safe System Principles

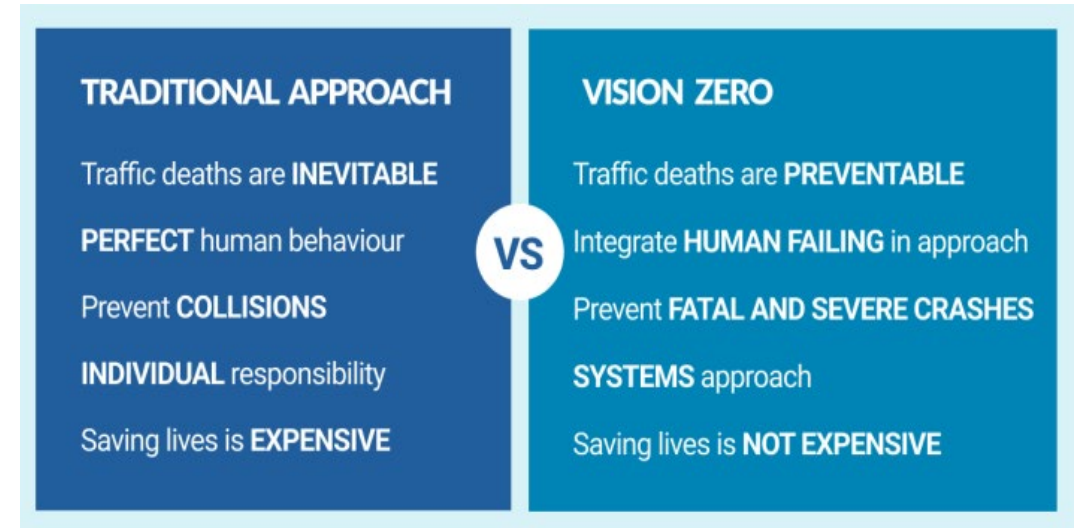
- Death/Serious Injury is Unacceptable.
- Humans Make Mistakes.
- Humans are Vulnerable.
- Safety is Proactive.
- Redundancy is Crucial.
- Responsibility is Shared.
 - Includes system operator accountability



Another Look at Safe System Principles

Death/Serious Injury Is Unacceptable

- This is the moral goal of Vision Zero.
- The desired end state is to realize a future without death and serious injury on our roads.
- This principle requires all transportation plans and projects to be organized around preventing serious road trauma.



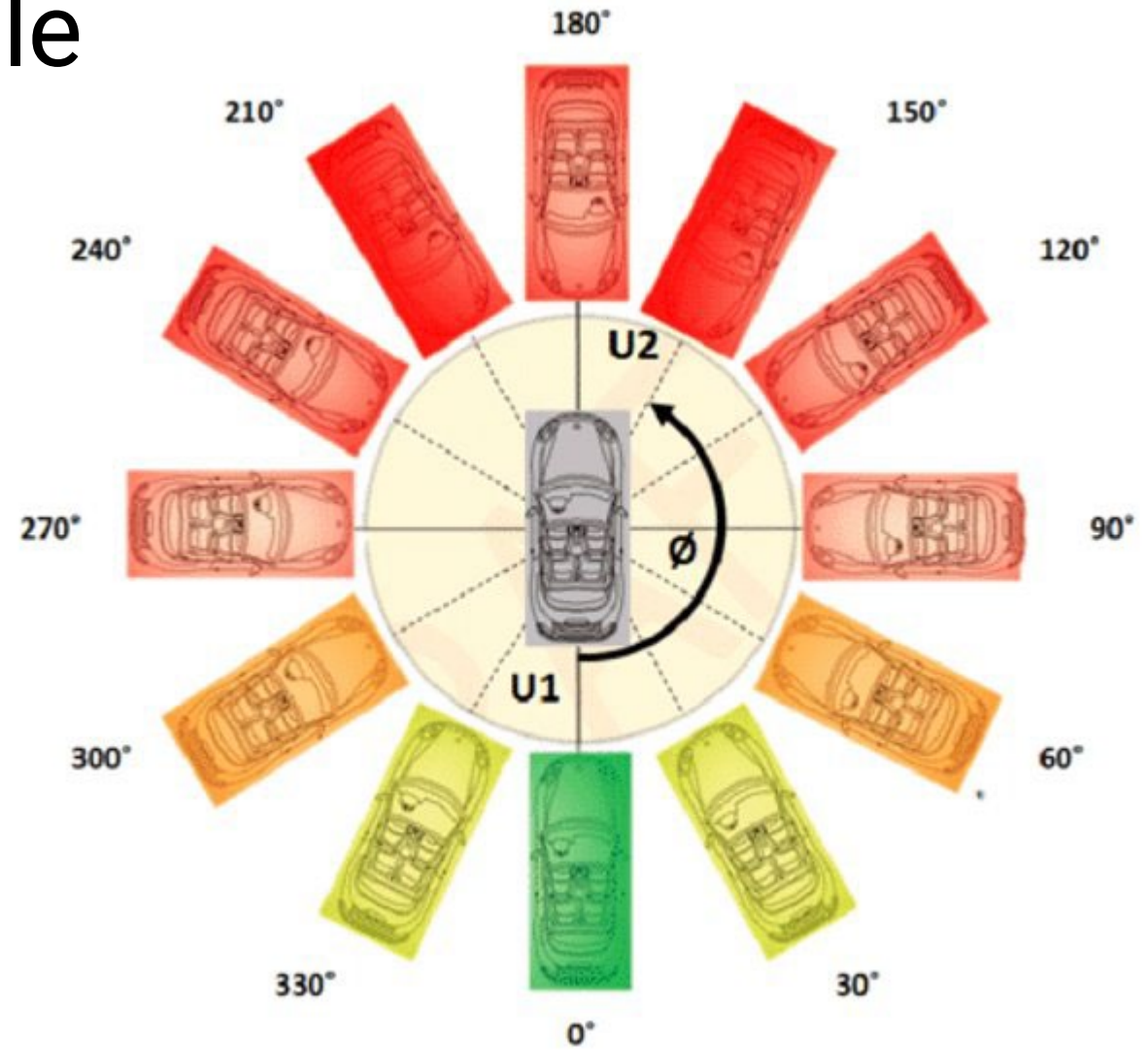
Source: Vision Zero Network (2024).

Humans Make Mistakes

- **Slips** (errors of following through with our intentions), **lapses** (errors of memory storage), and **mistakes** (errors of planning) are endemic to the human population.
- Education and behavior modification programs must take these natural human proclivities into account when designing behavioral interventions (e.g., graduated driver licensing (GDL) works to the extent novice drivers learn by doing—by driving under increasingly more complex conditions over time).
- Knowledge of human fallibility demands the design and operation of a system that accommodates inevitable human error.

Humans Are Vulnerable

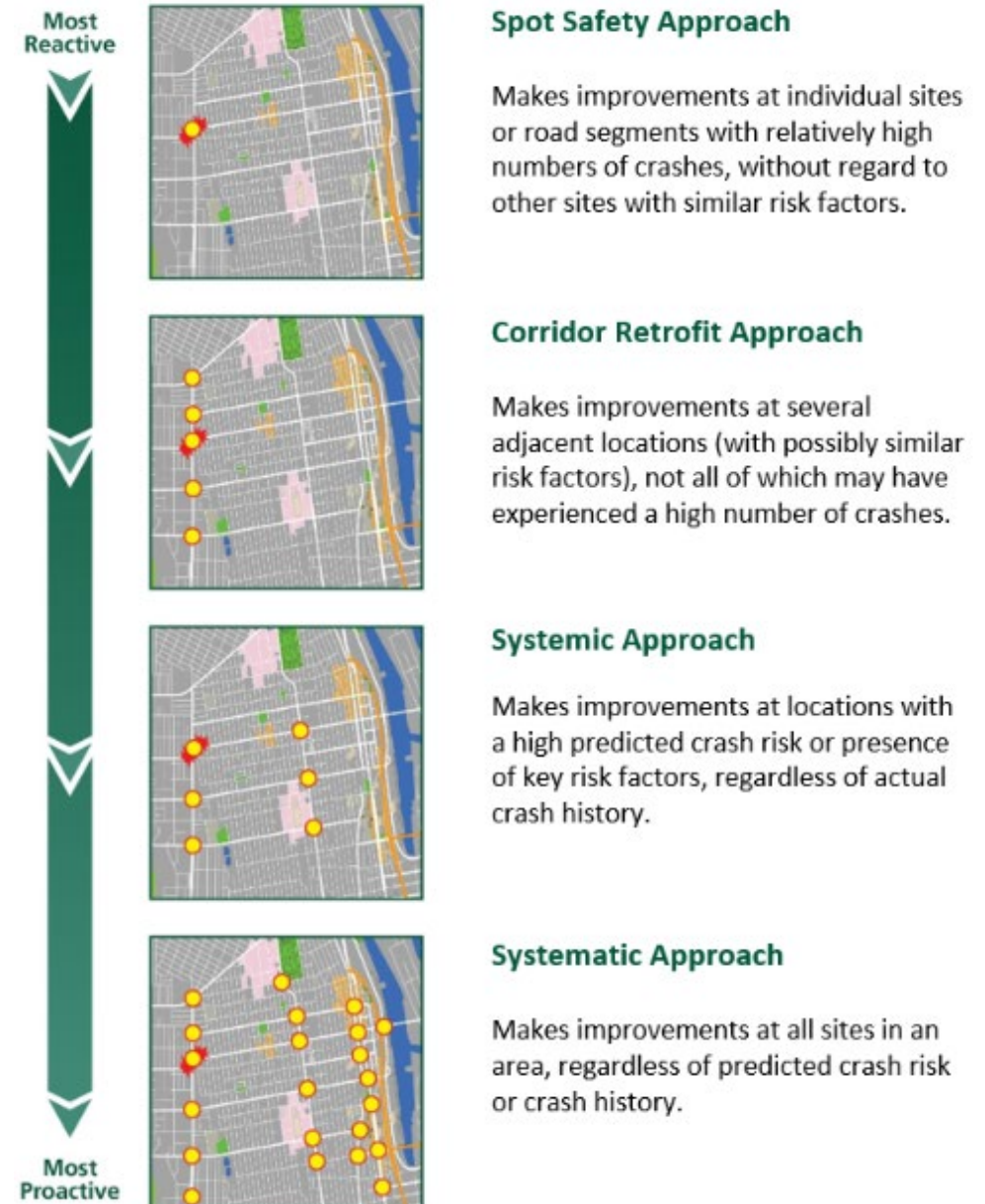
- All users of the road network—even those who deliberately take risks or travel recklessly—must never be exposed to human-intolerable energy forces.



Source: Jurewicz & Sobhani (2016).

Safety Is Proactive

- As with the 'Death/Serious Injury is Unacceptable' principle, the bodily safety of road users provides the foundation for all planning, design, operations, and maintenance decisions.



Source: Thomas et al. (2018).

Responsibility Is Shared

- Preventing serious and fatal road injury is possible and requires involvement from government at all levels, health and education sectors, private industries, and civic organizations. All are vital to preventing fatalities and serious injuries on our roadways (World Health Organization, 2023).

Redundancy Is Crucial

- The focus on this principle must be on those elements of the system that provide **reliable protection** for road users when other elements of the system fail.



Source: Stigson et al. (2022).

NCHRP 17-101 Research Schedule

Phase I



Task 1

Project management,
literature review, &
practitioner survey
design



Task 2

Conduct survey and
develop outline of
guidelines



Task 3

Interim report
& meeting



Task 4

Present outline
of guidelines to
practitioners



Task 5

Prepare
guidelines



Task 6

Final report &
deliverables

Phase II

Literature Review

- The team identified **465 peer-reviewed and trade publications** that described **safety practices and management systems**.
- Team members
 - Summarized study purposes, methods, and findings and
 - **Extracted at total of 75 safety practices**—concrete, visualizable safety-oriented acts that can be routinely carried out or applied over a broad geographic area.

Practitioner Survey

- Consisted of items related to the following:
 - Professional role and tenure (# of years in the field)
 - Organizational culture (normative questions about organization's degree of innovativeness, safety individualism, and fatalism)
 - Demographics (age, gender, race/ethnicity)
 - Practice Areas (Policy, Planning, Design, Operations & Maintenance, Law Enforcement, and Post-Crash Response)

Safety Practice Impact Matrix Instructions

For each of the following questions, click to choose a spot on the matrix that rates practices according to their feasibility and impact.

Feasibility considers practices' technical, political / social, budgetary, and legal constraints.

Impact considers practices' ability to address large, trending, or urgent road safety issues.

Click the matrix for each prompt **once**. When you see the dot on the matrix, your response is automatically saved.

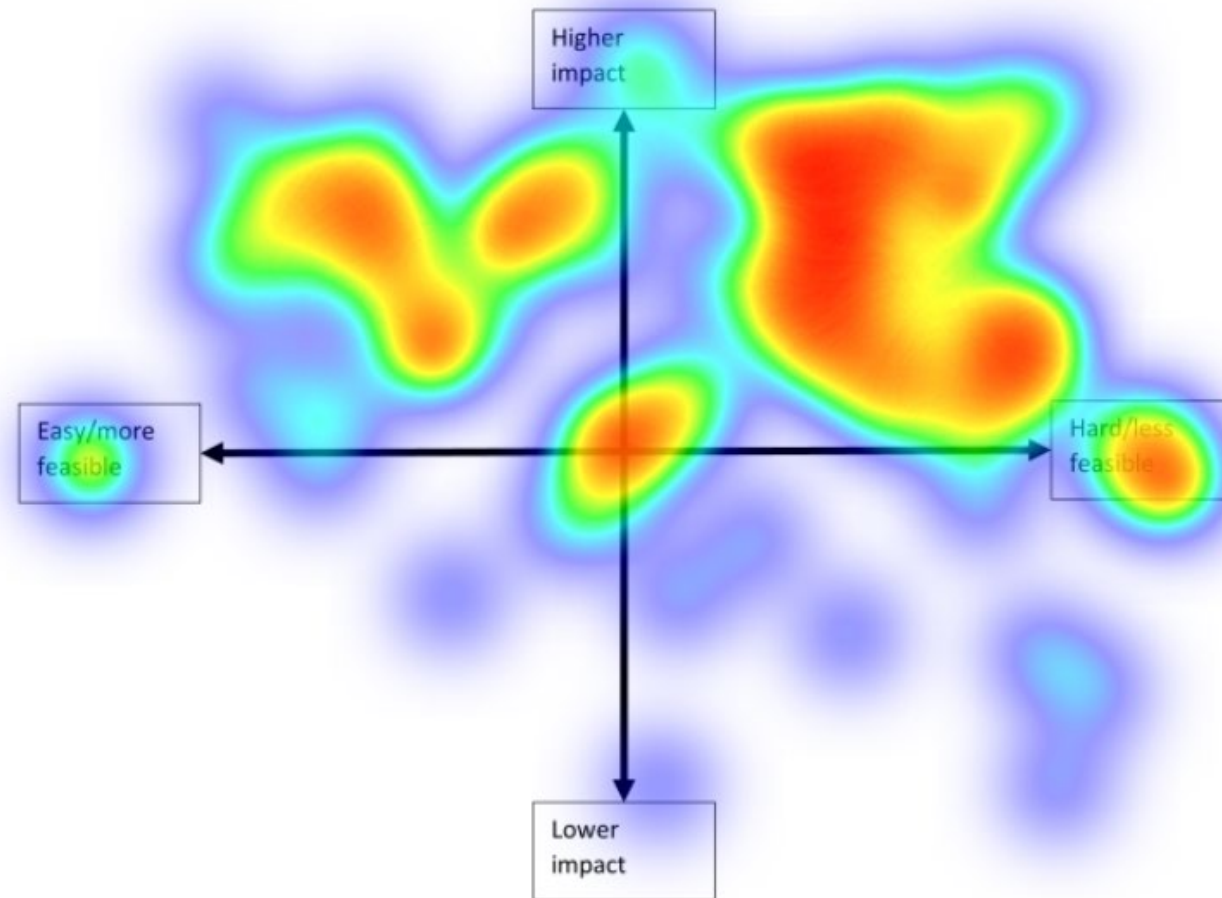
The horizontal axis moves from high feasibility (left) to low feasibility (right). The vertical axis has high impact at the top and low impact at the bottom. The image below shows what type of practice would fit in each quadrant:

Quadrants correspond to following ideas:



Example Impact Matrix Responses

Installing seat belt interlocks in vehicles



Policy Practices

- **Most impactful and feasible**

- Installing leading pedestrian intervals with right-turn-on-red restrictions in areas with high pedestrian activity
- Updating NHTSA's new car assessment program (NCAP) to include pedestrian detection and collision avoidance safety tests.

- **Least impactful and feasible**

- Promoting the installation of technology in private automobiles that records drivers' distraction, drowsiness, and other forms of impairment.
- Establishing maximums in vehicle size (in terms of width, length, height, weight) permitted in areas with high pedestrian activity.



Source: NHTSA's NCAP 5-star rating system (van Ratingen, 2022).

Planning Practices

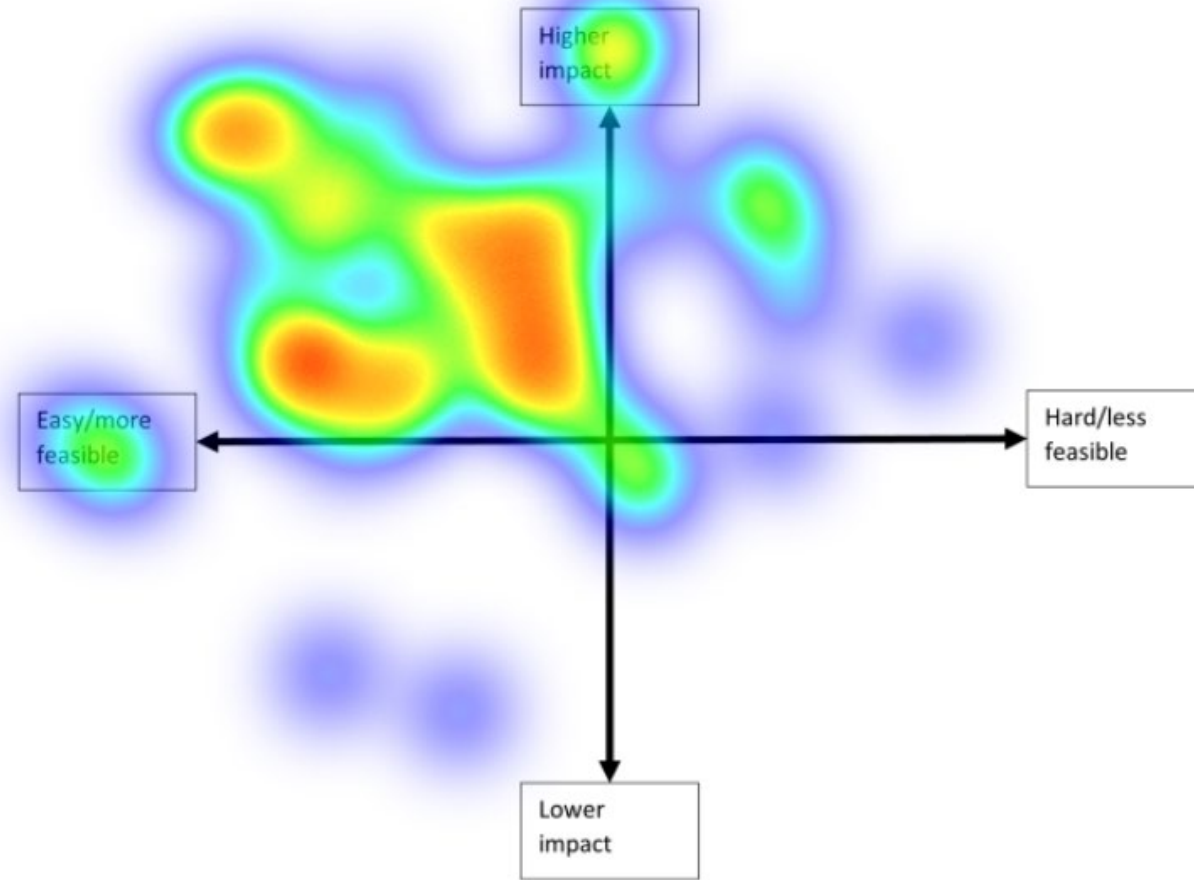
- **Most impactful and feasible**

- Incorporating road safety audits in project scoping/planning phases.
- Prioritizing injury risk-based (systemic) safety assessments over crash “hot spot” or “black spot” approaches.

- **Least impactful and feasible**

- Replacing travel forecasting (“predict and provide”) with backcasting (“decide and provide”, i.e., starting from a vision of desirable travel patterns and working backward to realize the vision).
- Encouraging and facilitating public use of self-reporting (via mobile app or survey) to capture collisions and other events falling outside the scope of traditional crash reporting (e.g., near misses, pedestrian and bicyclist falls).

Road Safety Audits

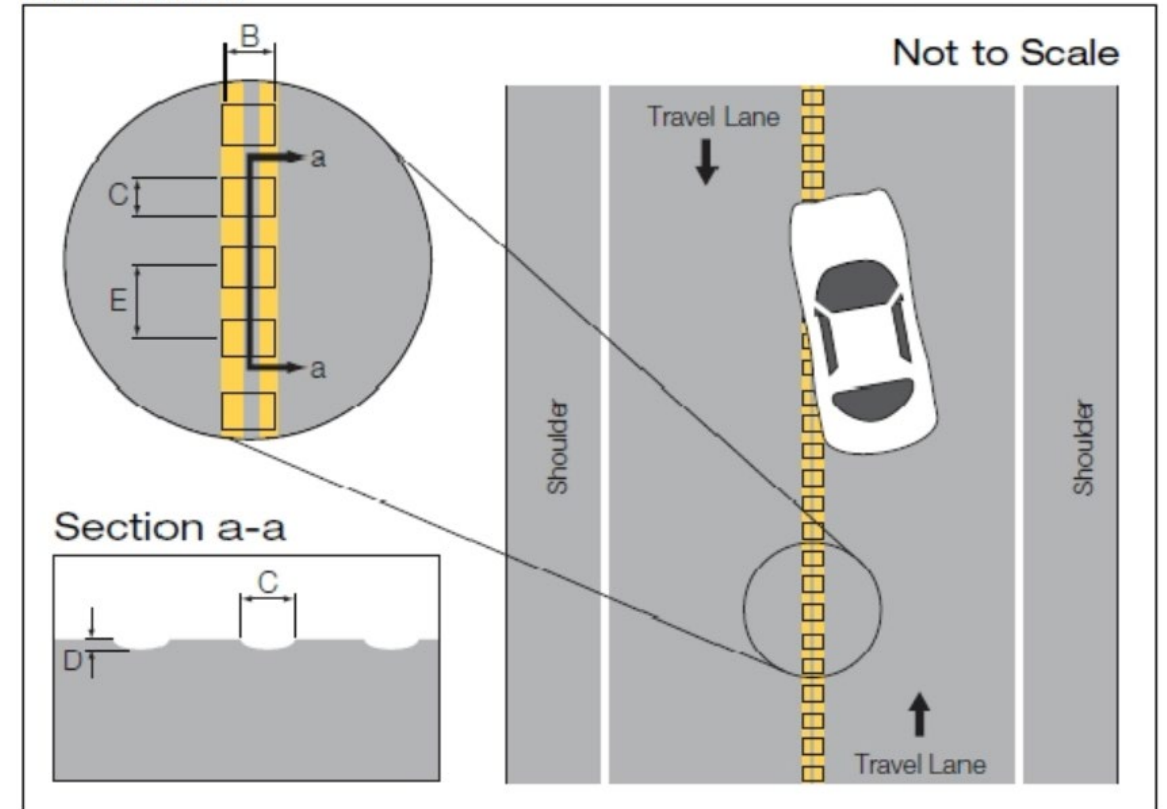


Design Practices

- **Most impactful and feasible**
 - Improving sight distance at intersections by restricting parking at the corners (daylighting).
 - Installing centerline rumble strips on undivided highways.
- **Least impactful and feasible**
 - Employing people with skills in perceptual psychology to help design "self-explaining" roads.
 - Providing pedestrian/bicycle bridges or daylit tunnels at intersections.

Center Line Rumble Stripes

Note: No "A" Distance



Source: FHWA (2011).

Operations and Maintenance Practices

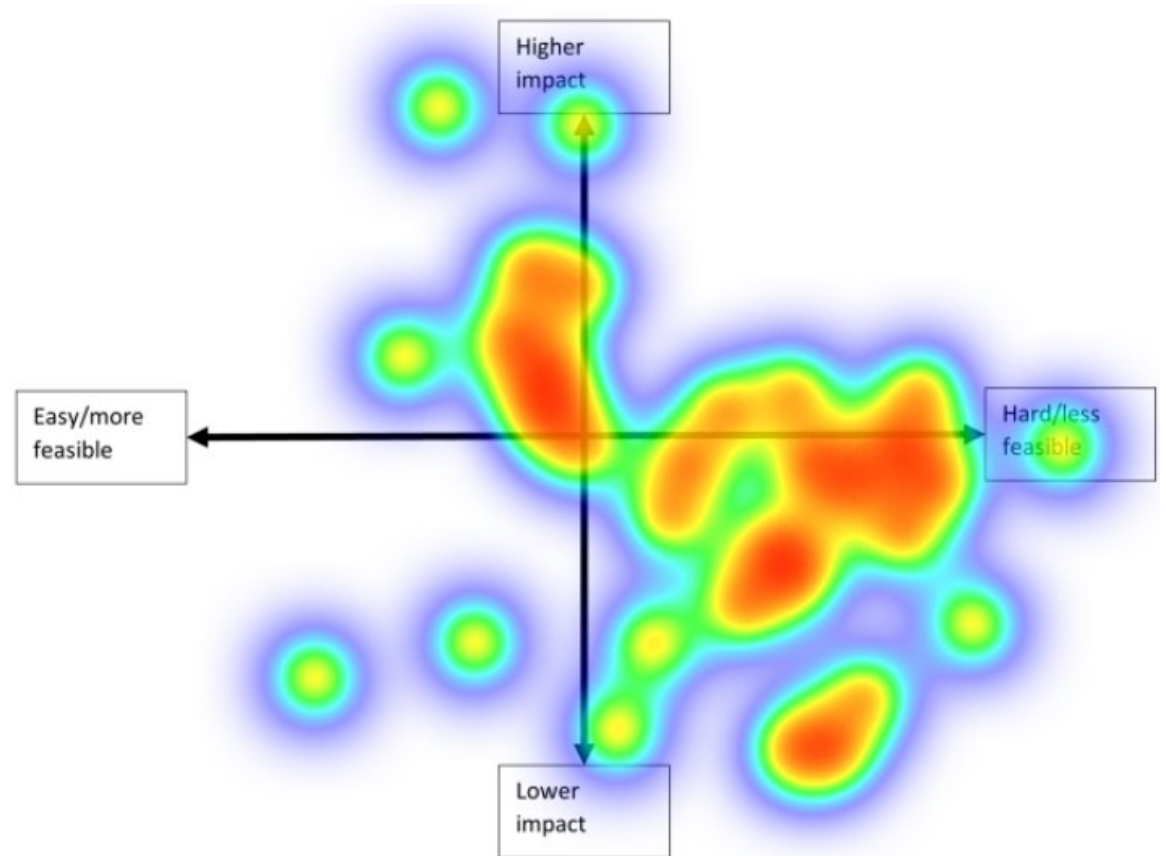
- **Most impactful and feasible**

- Installing leading pedestrian intervals with right-turn-on-red restrictions in areas with high pedestrian activity.
- Removing roadside objects that pose a danger when impacted upon a lane departure.

- **Least impactful and feasible**

- Implementing variable speed limits (VSL) during adverse weather conditions.
- Implementing variable speed limits (VSL) at nighttime in alcohol-serving districts.

VSL at Nighttime in Alcohol-serving Districts



Law Enforcement Practices

- **Most impactful and feasible**

- Instituting immediate administrative license revocation or suspension (ALR/ALS) for alcohol- and drug-impaired-driving offences.
- Instituting or enforcing a statewide primary enforcement seat belt use law.

- **Least impactful and feasible**

- Forming a task force or community coalition of law enforcement, transportation, public health, members of the community, and other partners to investigate serious crashes and report findings and proposed changes to the public.
- Encouraging and facilitating public use of self-reporting (via mobile app or survey) to capture collisions and other events falling outside the scope of traditional crash reporting (e.g., near misses, pedestrian and bicyclist falls).

Post-Crash Response Practices

- **Most impactful and feasible**

- Forming a task force or community coalition of law enforcement, transportation, public health, members of the community, and other partners to investigate serious crashes and report findings and proposed changes to the public.
- Training law enforcement and transportation staff to coordinate post-crash reporting at crash sites.

- **Least impactful and feasible**

- Encouraging and facilitating public use of self-reporting (via mobile app or survey) to capture collisions and other events falling outside the scope of traditional crash reporting (e.g., near misses, pedestrian and bicyclist falls).
- Deploying unmanned aerial systems (UAS) to conduct route monitoring, crash incident verification, secondary crash detection, and response vehicle routing to and from the crash site.

Organizational Climate Measures

Innovativeness

Indicated by 4 items:

1. Senior management like to keep to established, traditional ways of doing traffic safety
2. People in this organization are always searching for new ways of looking at traffic safety problems
3. Management is not interested in trying out new ideas to improve road user safety
4. Management here is quick to spot the need to do traffic safety work differently

Fatalism

Indicated by 3 items:

1. There is talk here about how zero fatalities is impossible to achieve
2. People here believe we can build a system where no one dies
3. Management here often say we can reduce, but never eliminate road deaths

Individualism

Indicated by 3 items:

1. People here know that traffic safety mostly depends on road users being sober and alert
2. People here believe that road users are mostly responsible for their own safety
3. People here are convinced that safe travel is beyond the control of individual road users

Correlation Among Organizational Climate Measures

	Innovativeness	Individualism	Fatalism
Innovativeness	1		
Individualism	-0.076	1	
Fatalism	-0.474*	0.017	1

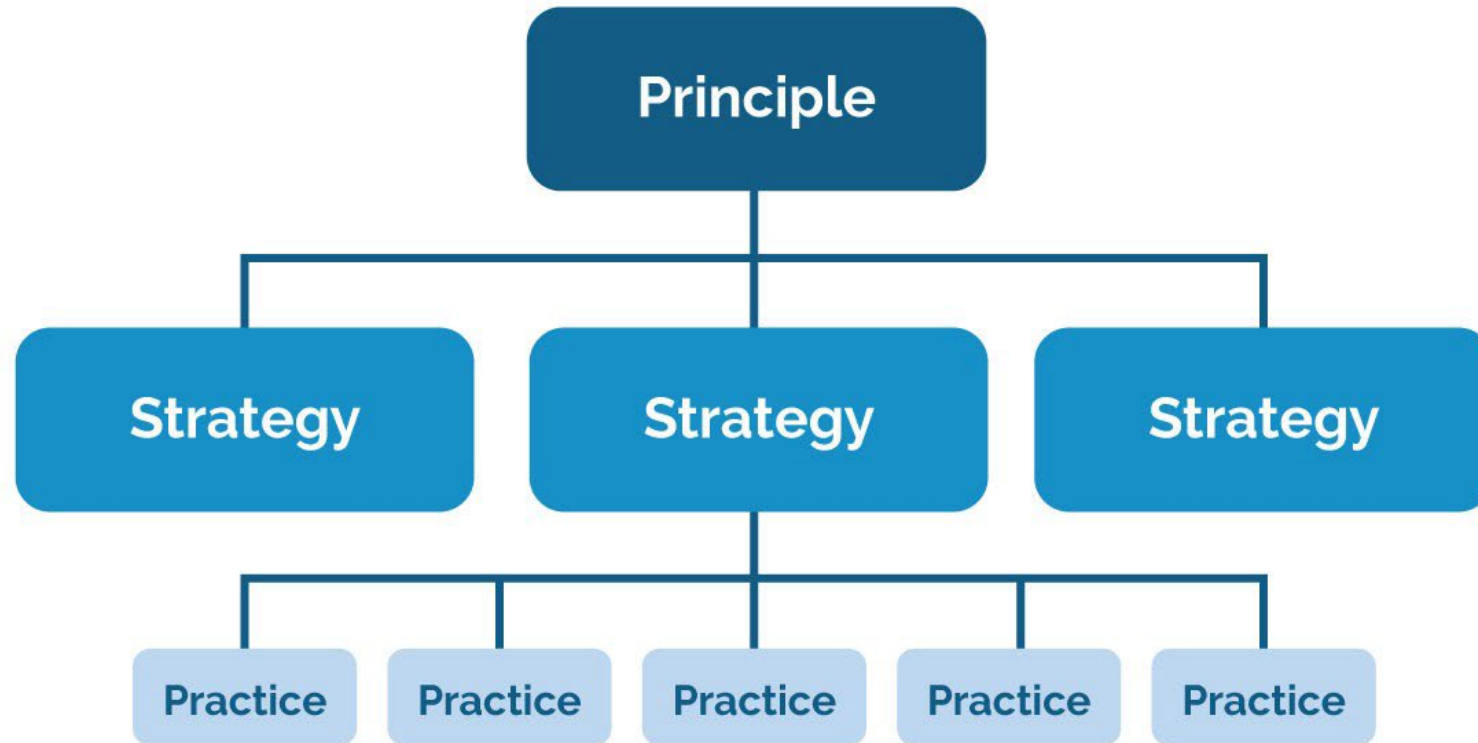
Focus Group Questions

- **What does the term “Safe System” mean to you?** (response is written in chat and presented as a “waterfall” to prompt discussion)
- **What would you say are the “roles” or specific functions of [participants’ discipline] in creating a Safe System for all road users?**
- **How do you think we could begin transitioning toward a Safe System?**
- **Here is a safety practice you and your [participants’ discipline] colleagues rated highly in terms of its potential to improve safety, yet low in terms of its financial, social, and political feasibility.”**
 - **What sorts of barriers or obstacles do you foresee in implementing this practice? and**
 - **What kinds of resources (e.g., data, money, skillsets) would be needed to begin implementing this practice?**
- **Summarize discussion, then ask: Have we missed anything?**

Focus Group Themes and Quotes

- ***Collaborate and coordinate across sectors, disciplines, municipalities, and community members.***
 - “...we need better cross-disciplinary collaboration, especially between transportation and injury, prevention / public health professionals. There's people speaking different languages. and so being able to get those folks on the same page.”
- ***Challenge perceptions that speed management impinge on personal freedoms.***
 - “When we look at these like governing the speed, working with insurance and getting rewards for good behavior and driving within certain speed parameters. Working with the insurance industry to monitor the speeding on apps, on cars, and when drivers don't exceed speed limits, they get discounts on their insurance.”
- ***Streamline, simplify, and enhance access to safety funding.***
 - “...make it as easy for them [smaller communities] to engage and receive that funding by doing the upfront analysis work, the safe analysis work ahead of time.”
- ***Advance proactive safety policies and practices, ones that respond to current and future realities.***
 - “...we've done some preliminary studies about how flooding has impacted fatal and serious crashes. I imagine flooding could be an issue in the future. But something that we must do has to do with the element of post-crash, care. And if we have flooding or something that is impacting navigation to hospitals, we have a lot of scenarios that we can't plan for yet.”
- ***Start small, build support for change, and approach safety differently.***
 - “...one block at a time, one street at a time. Starting at these projects out in getting people familiar with them, whether it's a new bike lane or a pedestrian improvement, or something like that, you know, once people start seeing these and experiencing them that can very, very slowly and incrementally start to potentially change their minds.”

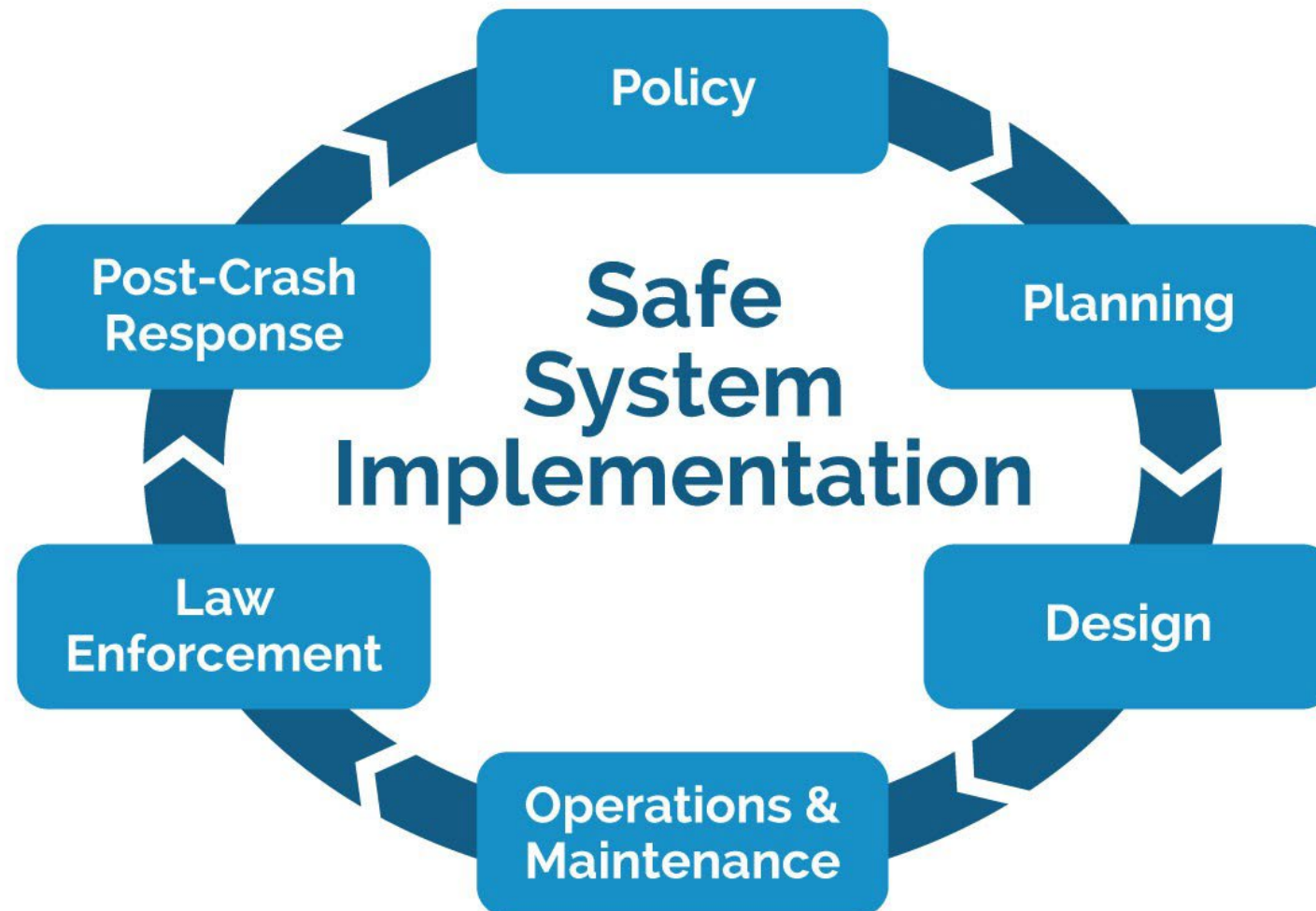
Safe System Implementation Guidance Structure



Example

- **Principle:** Humans are vulnerable
- **Strategy:** Design around human tolerances to crash forces
- **Practices:** Installing permanent barrier-protected bike lanes on arterial roads; Installing cable barriers on the edges and in the medians of rural roads

Safe System Implementation via Domain-related Strategies and Practices



Implementation Guidance Outline

- The **role of a domain** in fostering a Safe System
- The need for a **paradigm shift** within each domain
- Domain-specific Safe System **strategies**
- Domain-specific safety **practices**
- Proposed steps to **implementing** domain-specific safety practices

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