# Designing for Human Mistakes

## Shifting from changing behavior to changing design

# Why?

# The incomprehensible word

To *understand*:

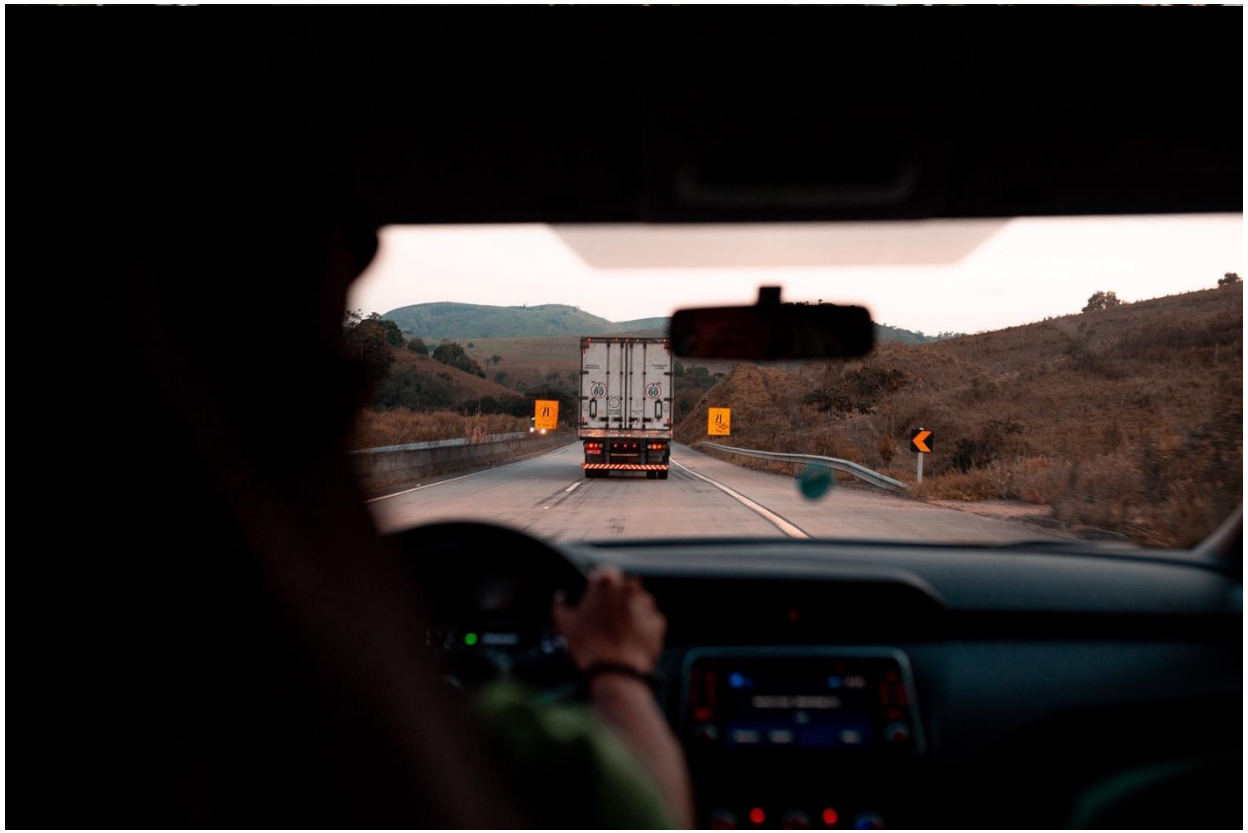
> "must originally have referred to the process of observation and learning rather than the result."

https://blog.oup.com/2022/02/the-incomprehensible-word-understand/

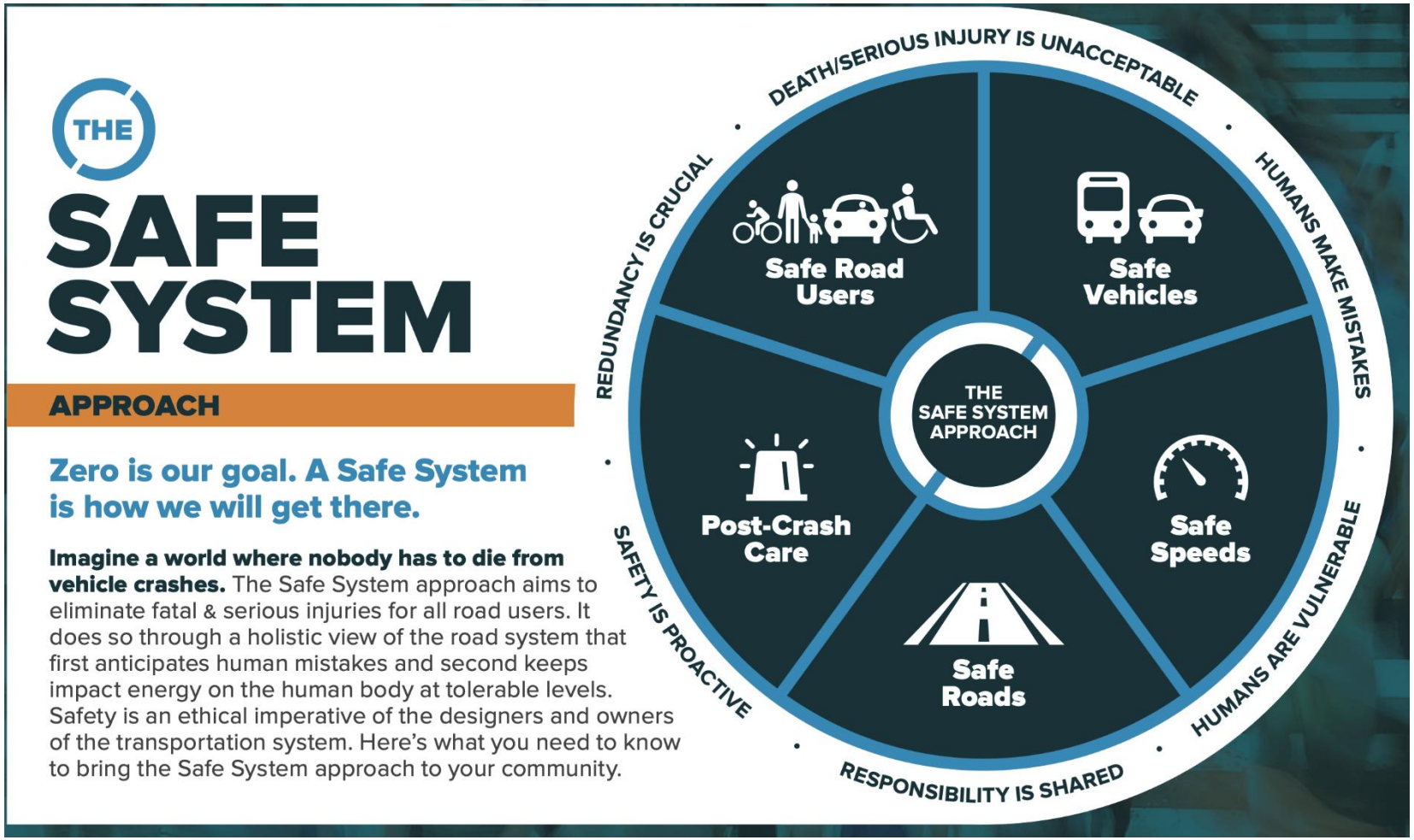
# Human *factors*

Performance

Behavior

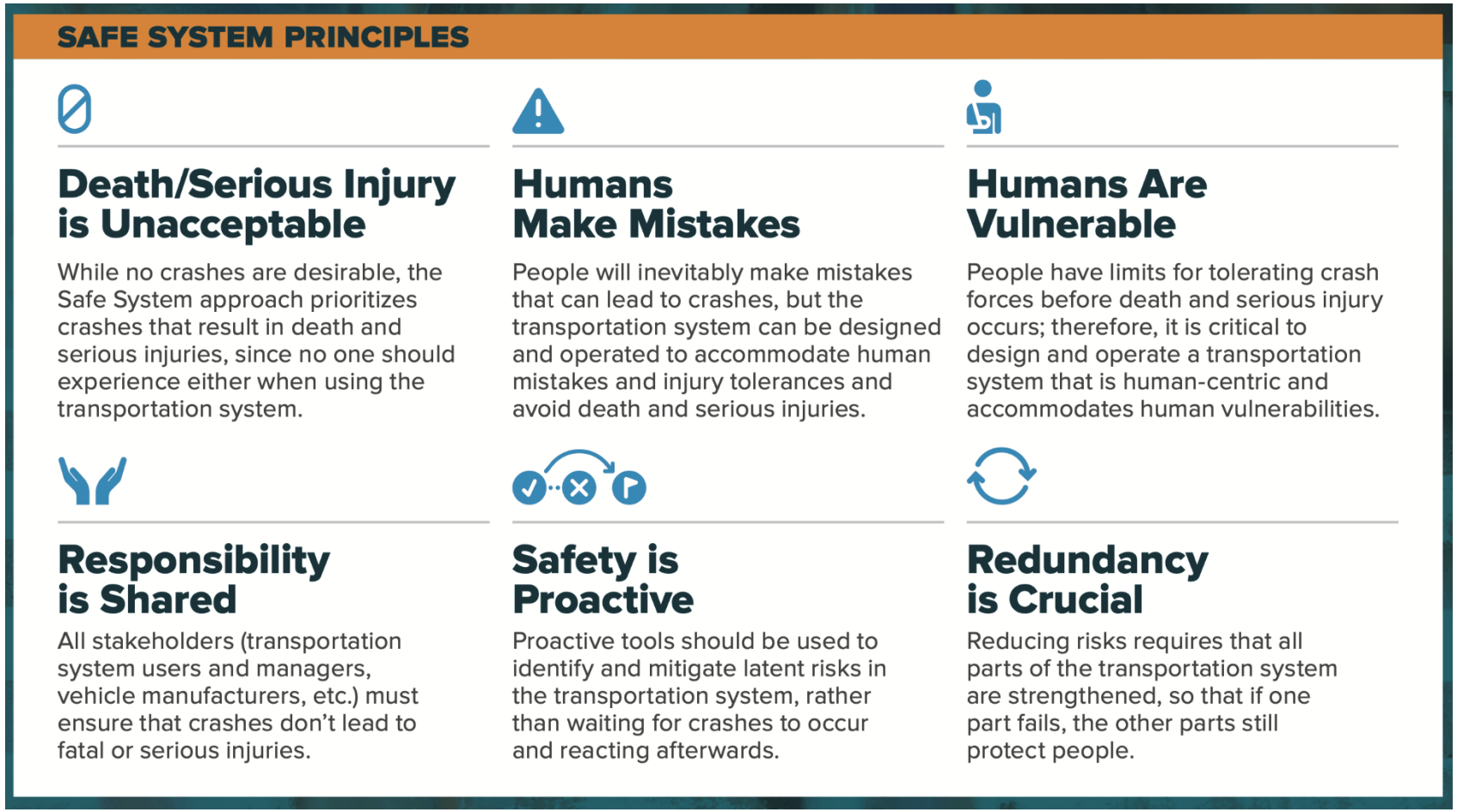


# Safe System Approach




https://safety.fhwa.dot.gov/zerodeaths/docs/FHWA_SafeSystem_Brochure_V9_508_200717.pdf

# Safe System Principles



# Accept reality


**Humans will error**

a slip

a lapse

a mistake

or a *volitional act*.

To err is human, to forgive design.
(Alphonse Champanis)

# The safe system approach

"*It involves a paradigm shift to improve safety culture, increase collaboration across all safety stakeholders, and refocus transportation system design and operation on anticipating human mistakes and lessening impact forces to reduce crash severity and save lives*."

"*The Safe System Approach requires a culture that places safety first and foremost in road system investment decisions*."

https://highways.dot.gov/public-roads/winter-2022/01
https://highways.dot.gov/safety/zero-deaths/safe-system-approach-presentation-0
https://highways.dot.gov/safety/zero-deaths

# Paradigm shift

| Traditional | | Safe System |
| --- | --- | --- |
| Prevent crashes | → | Prevent deaths and serious injuries |
| Improve human behavior | → | Design for human mistakes/limitations |
| Control speeding | → | Reduce system kinetic energy |
| Individuals are responsible | → | Share responsibility |
| React based on crash history | → | Proactively identify and address risks |

# Two possible paths

## Judgment *versus* Observation

# Needs and Feelings

## Needs

- Autonomy
- Ease
- Efficiency
- Connection
- To be seen
- Belonging
- Self-Expression
- Security
- Stimulation
- Space
- Adventure

## Feelings

- Engaged
- Excited
- Exhilarated
- Grateful
- Happy
- Sanguine
- Stimulated
- Peaceful
- Calm
- Relaxed

# We observe Strategies

Feeling(s) due to unmet need(s)

- Frustrated
- Irritated/Agitated
- Disconnected
- Lonely
- Tired
- Fearful
- Confused
- Bored
- Overwhelmed
- Uncomfortable

Strategy (Action)

- Speeding
- Following too close
- Distracted driving
- Passing in no passing zone
- Aggressive driving
- Improper turn
- Unsafe lane change
- Mid-block crossing
- Sidewalk cycling counterflow

Needs

- Autonomy
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# The safe system approach

"*Safe Roads is a continuum, not an absolute*"

"*Applying a Safe System Approach has no one right answer. Instead, it starts with one critical question.* ***How can we design the roadway system around all users and make safety the default choice?*** *In short, a safe system is built around people, and it's built for saving lives*."

https://highways.dot.gov/public-roads/winter-2022/01
https://highways.dot.gov/safety/zero-deaths/safe-system-approach-presentation-0
https://highways.dot.gov/safety/zero-deaths

# Dekker et al (2011)

When injury events "*are seen as complex phenomena, there is no longer an obvious relationship between the behavior of parts in the system (or their malfunctioning, e.g. "human errors") and system-level outcomes. Instead,* ***system-level behaviors emerge from the multitude of relationships and interconnections deeper inside the system, and cannot be reduced to those relationships or inter-connections***."

Dekker, S., Cilliers, P., & Hofmeyr, J. H. (2011). The complexity of failure: Implications of complexity theory for safety investigations. Safety science, 49(6), 939-945.

# Shinar (2019)

*“The prevalent notion that approximately 90 percent of the crashes are due to human errors or failures is due to a threshold bias, and the implied notion that 90 percent of the countermeasures should be directed at changing these behaviors is based on an erroneous assumption that the cure must be directly linked to the stated cause.”*

***“the impetus to greater safety is not necessarily to identify the underlying (human) cause (e.g., fatigue) but to focus on the descriptive situation that preceded the crash and then try to change the complete context***.”

Shinar, D. (2019). Crash causes, countermeasures, and safety policy implications. Accident Analysis & Prevention, 125, 224-231.

# A tale of two approaches

- Behavior based approach
  1. Identify Critical Behaviors
  2. Observe Compliance using a Critical Behavior Inventory
  3. Warn, Coach, Punish
- System based approach
  1. Identify hazards
  2. Estimate level of risk for each hazard
  3. Control hazards according to a hierarchy

# Assessing hazards

Hazard: A condition, entity, or event that presents a potential for injury or harm.

- What conditions are reasonably foreseeable?
- Where do conflicts exist?
- How could a person experience injury?

# Reasonably foreseeable

- an act or practice that must meet three necessary conditions
  - must be possible;
  - must be a use pattern that enables the prediction of an occurrence;
  - must occur with reasonable frequency.

# Risk Matrix

| FREQUENCY RATING | SEVERITY RATING | | | |
|---|---|---|---|---|
| | *Low* | *Moderate* | *High* | *Extreme* |
| *Frequent* | C | D | E | F |
| *Occasional* | B | C | D | E |
| *Infrequent* | A | B | C | D |
| *Rare* | A | A | B | C |

*Crash Risk Ratings:*

*A: lowest risk level*
*B: low risk level*
*C: moderate-low risk level*
*D: moderate-high risk level*
*E: high risk level*
*F: highest risk level*

# Hierarchy of Controls

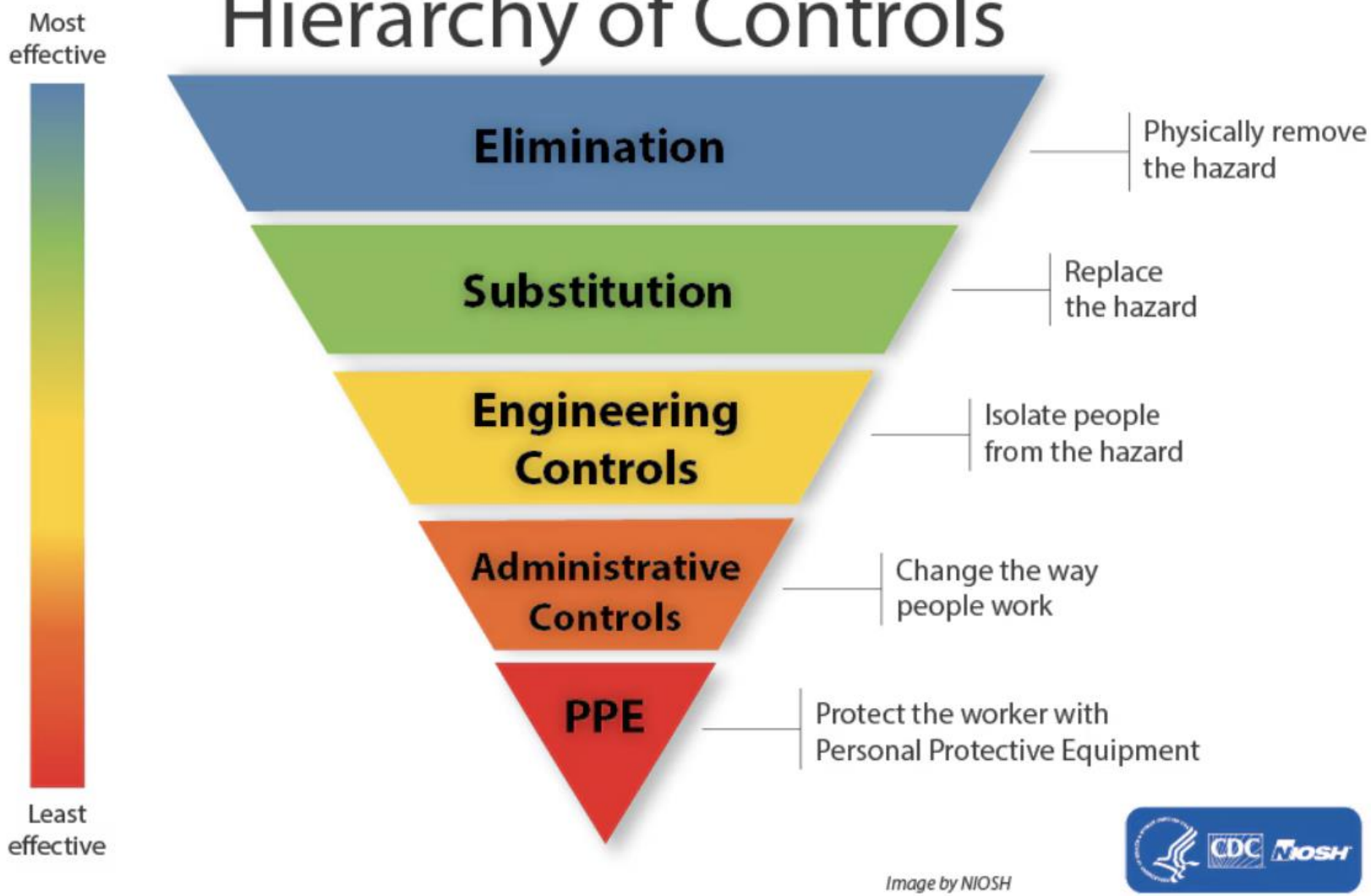



*Image by NIOSH*

# Road Safety Assessments

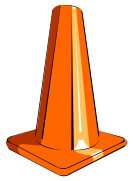
## When should an RSA be conducted?

Pre-construction:

- Scoping and Planning
- Preliminary through Detailed design

Construction:

- Work zones
- Pre-opening

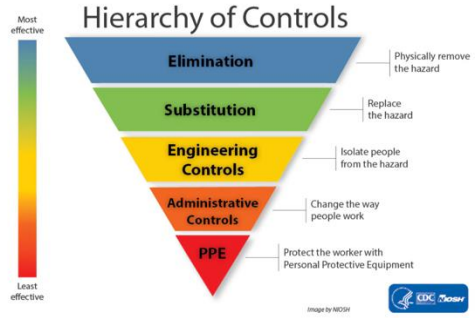


Existing Roadways:

- Post-construction
- Proactive safety
- Reactive safety

Cost of improvements

**Least**




**Most**

https://highways.dot.gov/safety/data-analysis-tools/rsa/road-safety-audits-rsa

# A case study

- Recognize judgments and observations
- Distinguish behavior vs system based issues
- Categorize mitigation measures using safety hierarchy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# Discussion of case study

# Thank you for your time and attention

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