June 19 - 20, 2025
Hollywood, FL

TRANSPORTATION SYMPOSIUM

Human Factors in Safety Engineering

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Transportation Symposium Website

SCAN ME

1

Human Factors in Safety Engineering

FDOT

TARGET ZERO
FATALITIES & SERIOUS INJURIES

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Our Safety Challenge

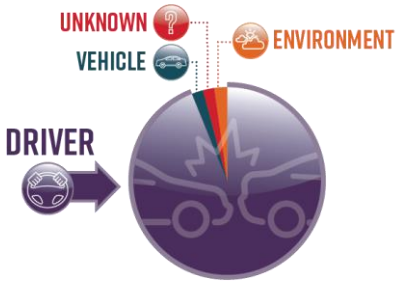
ON FLORIDA'S ROADS...

Daily Fatalities

Daily Serious Injuries

Source:
Florida Strategic Highway Safety Plan, 2021

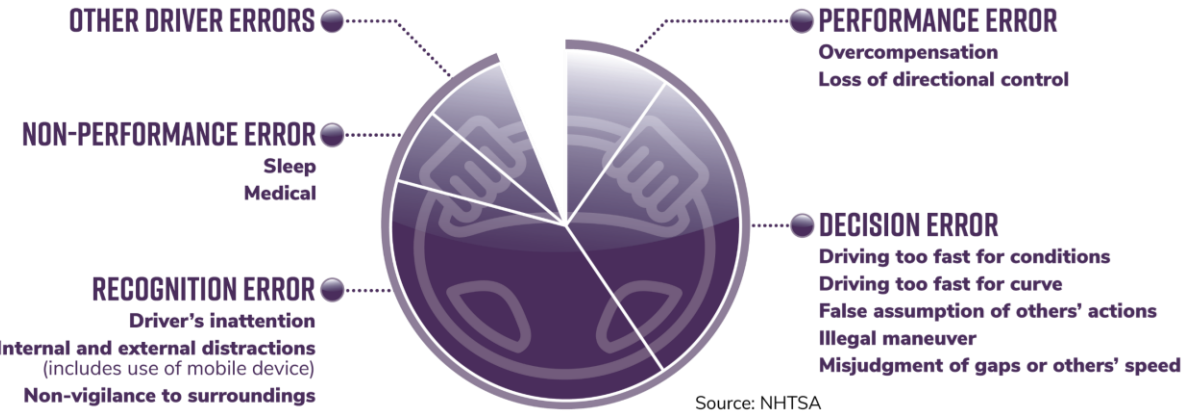
NATIONALLY...



MAJORITY OF CRASHES INVOLVE
DRIVER ERROR
AS A CONTRIBUTING FACTOR

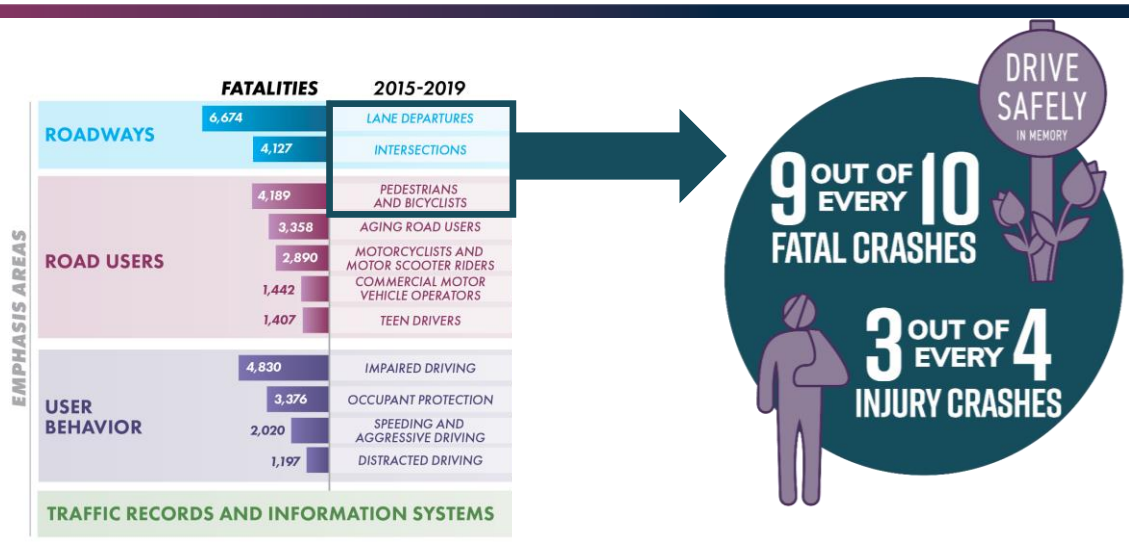
Source: NHTSA

National - Driver Related Factors



Source: NHTSA

Emphasis Areas



What is/are Human Factors?

A. The name of a 1980's rock and roll group

B. The former title of the EIS section describing Community Impacts

C. Exponents used with *Natural* logarithms

D. Study of human traits and behaviors

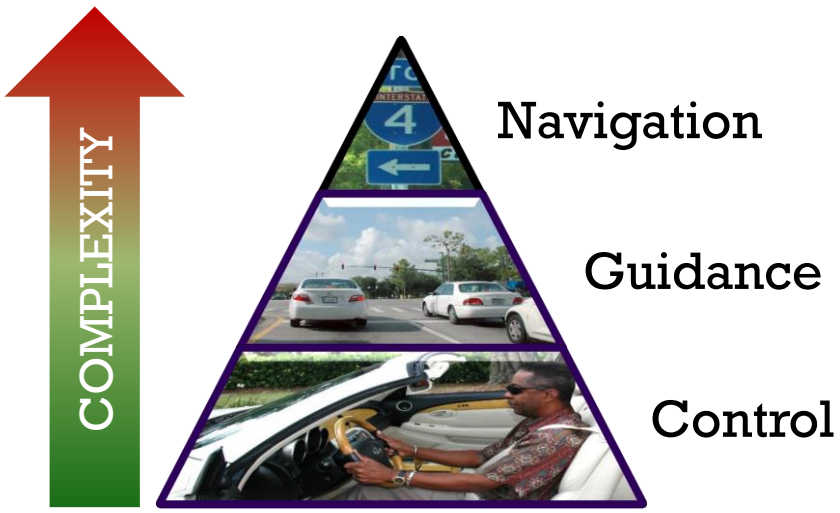
E. Programs to combat distracted and impaired driving

What is/are Human Factors?

- Scientific discipline concerned with the understanding of interactions among humans and other elements of a system
- Profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance

Definitions from the Human Factors and Ergonomics Society

Driving is Multi-Tasking



Driving Comprised of Subtasks

- **Control**: Keeping the vehicle at a desired speed and heading within the lane

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Driving Comprised of Subtasks

- **Guidance**: Interacting with other vehicles (following, passing, merging, etc.) by maintaining a safe following distance and by following markings, traffic control signs, and signals;
- Control: Keeping the vehicle at a desired speed and heading within the lane

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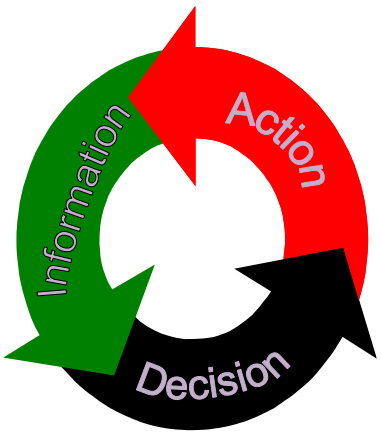
Driving Comprised of Subtasks

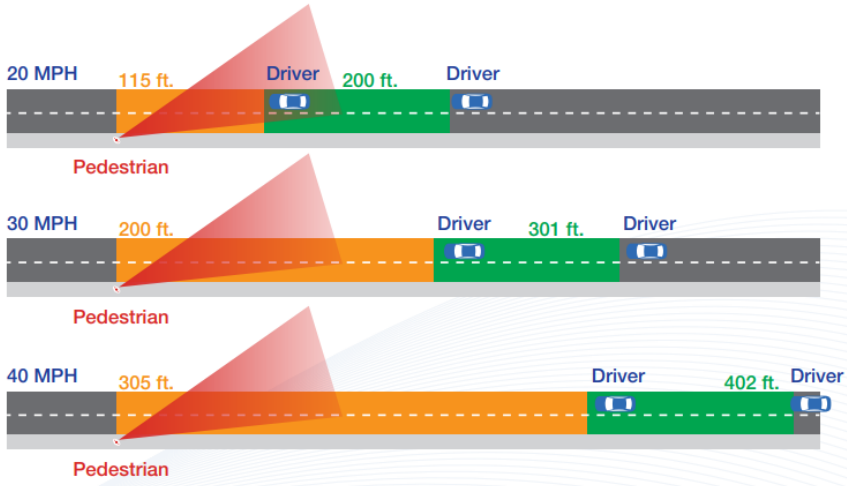
- **Navigation**: Following a path from origin to destination by reading guide signs and using landmarks
- Guidance: Interacting with other vehicles (following, passing, merging, etc.) by maintaining a safe following distance and by following markings, traffic control signs, and signals;
- Control: Keeping the vehicle at a desired speed and heading within the lane

Steps to Successful Task Performance

- Gather and filter available information
- Interpret the relevant information and choose an action
- Execute the action
- All the while, maintaining the pyramid of Control – Guidance – Navigation



Speed, Distance, and Ability to Stop or Yield



Speed and Driver's Vision

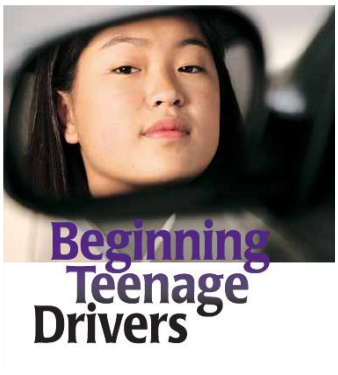
Driver's Peripheral Vision at 10-15 MPH

Driver's Peripheral Vision at 30-35 MPH

Driver's Peripheral Vision at 20-25 MPH

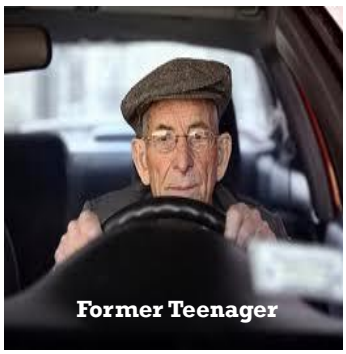
Driver's Peripheral Vision at over 40 MPH

Young Drivers – Undeveloped Abilities



- Less time behind the wheel
  - Tend to overestimate their driving skill
  - Underestimate collision risk
  - Less experience recognizing potential hazards
  - Tend to need longer perception time
  - Underdeveloped vehicle maneuvering and visual scanning skills
- Pressured by Peers

Aging Drivers – Aging Gracefully?



- ✓ Years of experience
- ✓ Well honed skills
- ✓ Driving almost robotic

- ▪ Declining vision
- ▪ Potential cognitive challenges
- ▪ Physical decline

Elements of a System

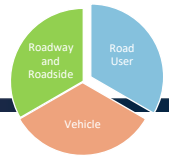
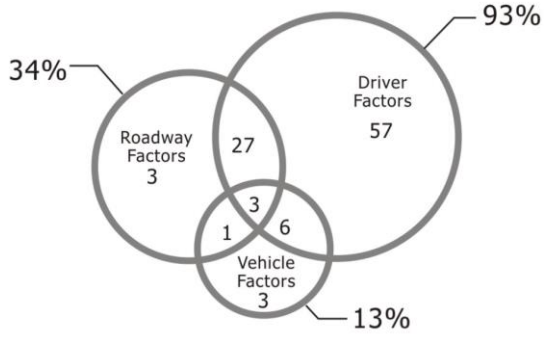


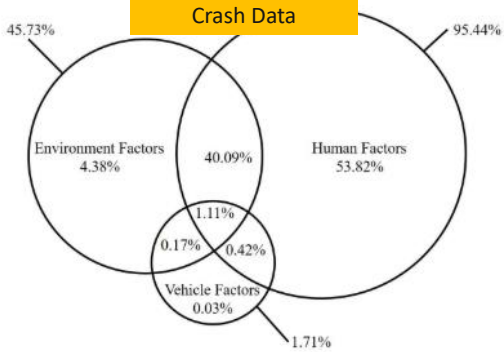
Exhibit 3-3: Contributing Factors to Vehicle Crashes

Based on 1970s Crash Data



Treat, J.R., Tumbas, N.S., McDonald, S.T., Shinar, D., Hume, R.D., Mayer, R.E., *et al.* (1979) Tri-Level Study of the Causes of Traffic Accidents Executive Summary. DOT HS 805-099. Transportation Research Institute (UMTRI)

Based on 2017-2022 Crash Data

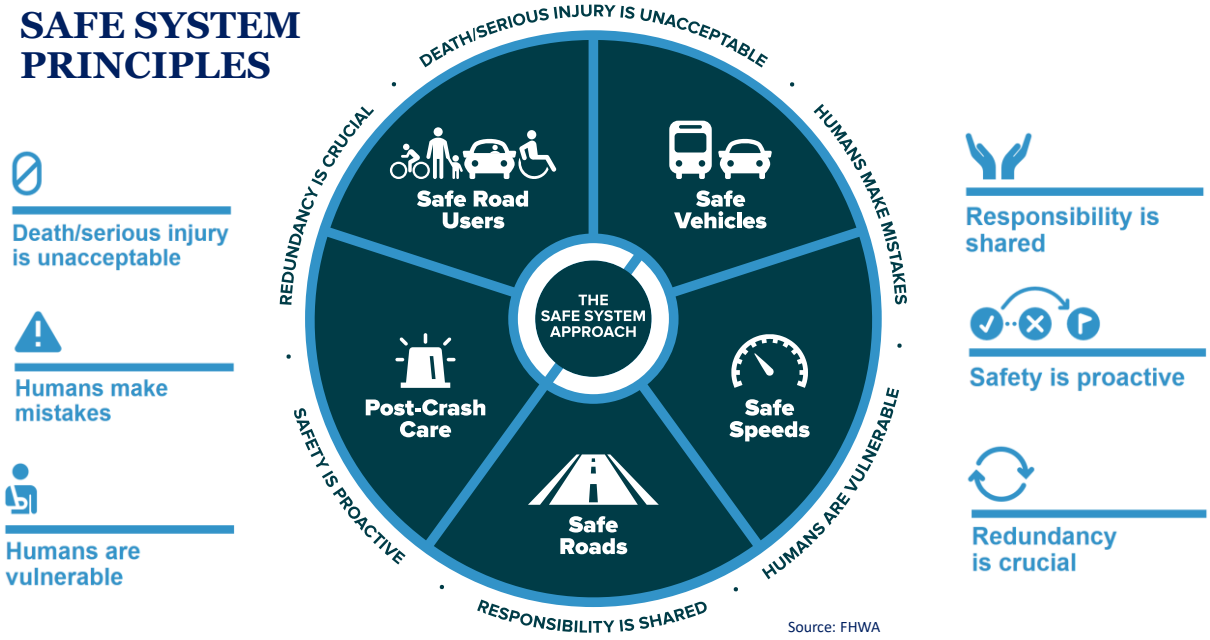


Dong, Y. and Wood, J. (2025) Evaluation of Crash Contributing Factors. *Journal of Transportation Technologies*, **15**, 155-178. doi: 10.4236/jtts.2025.151009.

Human Error and System Failure

- Principle 1:
  - Humans can only do that which is humanly possible
- Principle 2:
  - If the system demands more of the human than is humanly possible, then one or more errors will occur
- Principle 3:
  - If errors occur, the system may fail
- Principle 4:
  - If the system fails, inefficiencies and/or injuries will result

SAFE SYSTEM PRINCIPLES



Source: FHWA

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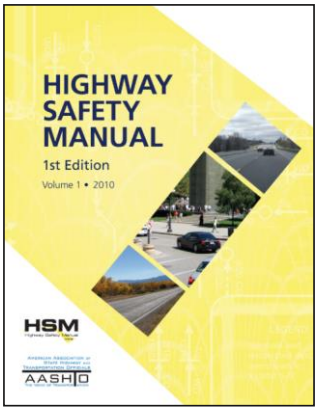
Goal of Understanding Human Factors



"The goal of understanding the effects of human factors is to reduce the probability and **consequences of human error** . . . by designing systems with respect to *human characteristics and limitations*"

AASHTO Highway Safety Manual: www.highwaysafetymanual.org

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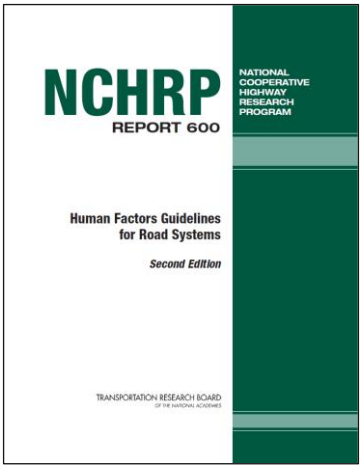
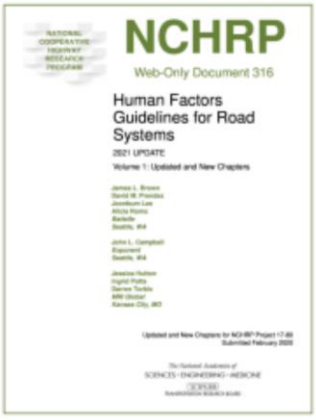
Human Factors Guidelines for Road Systems



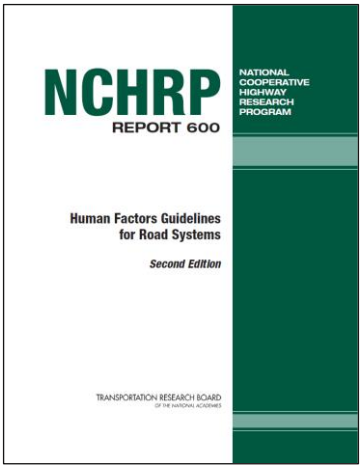
- Intended to provide human factors principles and findings to highway designers and traffic engineers.
- Allows a non-expert in human factors to more effectively bring consideration of the road user's capabilities and limitations into the practice of design, operations, and safety.

HFG 2021 Update



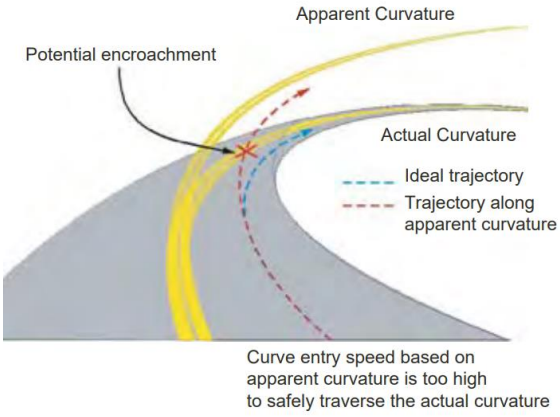
- NCHRP Web-Only Document 316, Volume 1, is an addendum to the HFG Second Edition. It expands upon the 2nd Edition with three new chapters: Pedestrians, Bicyclists, and Roundabouts.
- In addition, it provides updated information to three guideline chapters that are included in the Second Edition HFG

Human Factors Guidelines for Road Systems



- The HFG serves as a complement to other primary design references and standards. It does not duplicate or replace them. It is an additional tool for the engineer to use in designing and operating roadways that are safely usable by the broad range of road users.

INFLUENCE OF PERCEPTUAL FACTORS ON CURVE DRIVING



- Driver's use visual information to assess the degree of curvature of an upcoming curve and use their perception of the curve's radius for making speed and path adjustments.
- The curve radius as seen from the driver's perspective is called the "apparent radius".
- In cases of a vertical sag superimposed on a horizontal curve, the driver's "apparent radius" makes the horizontal curve appear flatter and they may adopt a faster curve entry speed.

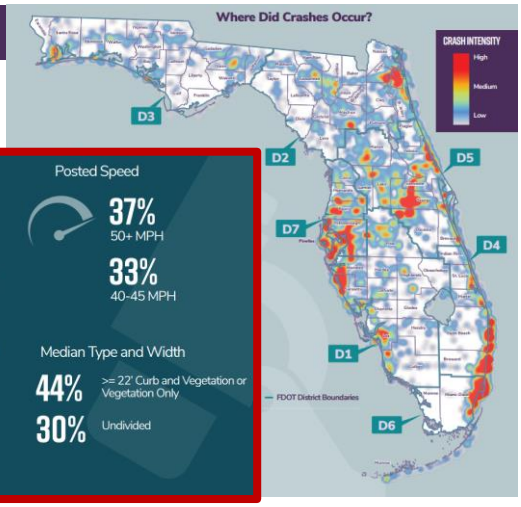
LANE DEPARTURE

33% of Florida's Fatalities and Serious Injuries

Predominant Statewide Risk Factors:

52% Fixed Object / Run Off the Road

79% Non-Limited Access Roadways



Driver

- 69% Male
- 37% Ages 20-34
- 93% FL Residents

Number of Lanes

- 54% 2-3 Lanes
- 29% 4-5 Lanes
- 21% 6+ Lanes

Context Classification

- 32% C2
- 28% C3C
- 16% C4

Posted Speed

- 37% 50+ MPH
- 33% 40-45 MPH

Inside Shoulder Type and Width

- 17% Curb and Gutter

Outside Shoulder Type and Width

- 41% 1-5' Paved

Median Type and Width

- 44% >= 22' Curb and Vegetation or Vegetation Only
- 30% Undivided

FDOT SIGNAL FOUR (S4) ANALYTICS | 2017-2021 FATAL AND SERIOUS INJURY CRASHES TARGET ZERO

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Statewide Rumble Strips Initiative

- Approximately **3,000 Centerline Miles** Statewide
- **$60 Million** of Funding for FY23 through FY26 Design, Construction & CEI

CENTER RUMBLE STRIPS ARE EXPECTED TO REDUCE CROSSES BY 46%

SHOULDER RUMBLE STRIPS ARE EXPECTED TO REDUCE CRASHES BY 51%

THE SINUSOIDAL WAVE DESIGN ENSURES LOWER NOISE LEVELS FOR ADJACENT PROPERTY OWNERS AND SAFER FOR ALL ROAD USERS.

FDOT 26 TARGET ZERO

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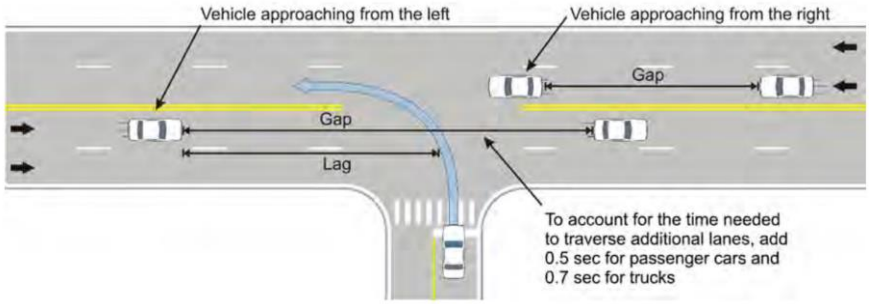
LEFT-TURNS AT UNSIGNALIZED INTERSECTIONS

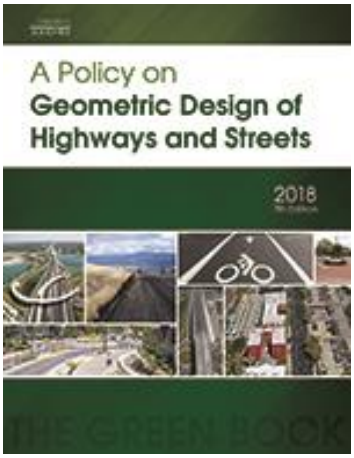


- Most left-turn crashes at unsignalized intersections are caused by misjudged gaps.
- Driver perception of approaching vehicle speed is challenging, which may cause accepting smaller (less-safe) gaps if speeds of oncoming vehicles are higher.

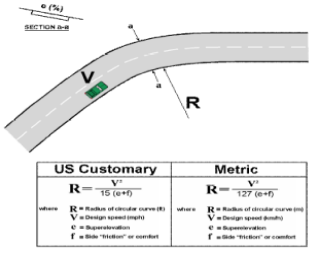
Positive Guidance

- If designs are incompatible with driver attributes, or
- if the information displays are ambiguous or erroneous, or
- if expectancies are violated, drivers will commit errors, and *system failures* may result.

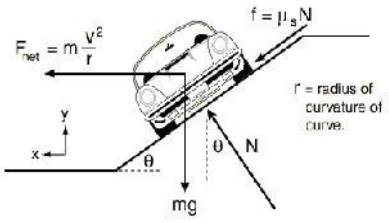
Design Consistency



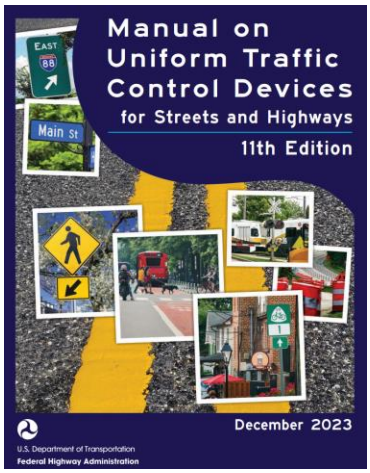
- Familiar, comfortable patterns of cross-section, line and grade, among common roadway types and within specific facilities



US Customary	Metric
$R = \frac{V^2}{15\,(e+f)}$	$R = \frac{V^2}{127\,(e+f)}$
where R = Radius of circular curve (ft), V = Design speed (mph), e = Superelevation, f = Side "friction" or comfort	where R = Radius of circular curve (m), V = Design speed (km/h), e = Superelevation, f = Side "friction" or comfort

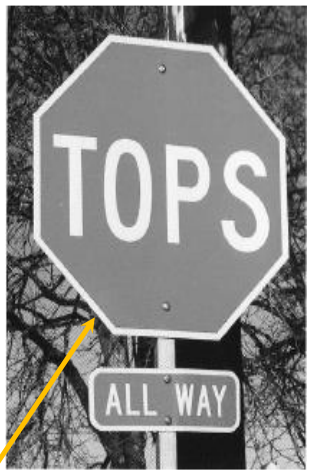


Traffic Control Devices - Uniformity

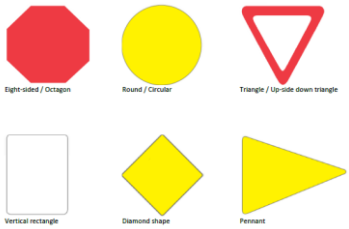


- Uniformity of the meaning of traffic control devices is vital to their effectiveness.
- Uniformity means treating similar situations in a similar way.
- Uniformity of devices:
  - simplifies the task of the road user
  - assists road users, law enforcement officers, and traffic courts by giving everyone the same interpretation
  - assists public highway officials through efficiency in manufacture, installation, maintenance, and administration.

Redundancy in Uniformity



- Shapes and colors alone convey essential information without relying on words



Uniformity in design shall include shape, color, dimensions, legends, letter style, borders, and illumination or retroreflectivity.
MUTCD Section 2A.04 – Design of Signs

Drivers continued to stop; 87% saw nothing unusual

Redundancy in Application

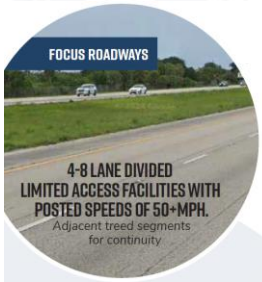
- Say the same thing in <u>more than one way</u>
- How many ways are depicted here?

Statewide Systemic Safety Strategy

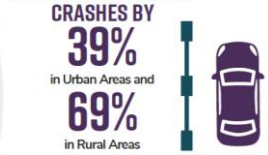
Severe Crashes Are Rare and Random:

Identify common roadway characteristics when crashes are severe → Screen the road network for where those conditions exist → Identify safety infrastructure to deploy statewide → Compare investment options for highest B/C impact → Track deployment and evaluate effectiveness

Statewide Median Barrier Initiative



- Approximately **121 Centerline Miles** Statewide
- **$130 Million** of HSIP and State Funding for FY27 & FY28 Design, Construction & CEI



Leveraging Our Collective Expertise

- Law **E**nforcement
- **E**ngineering
- **E**mergency Medical Services
- **E**ducation
- *Everyone!*

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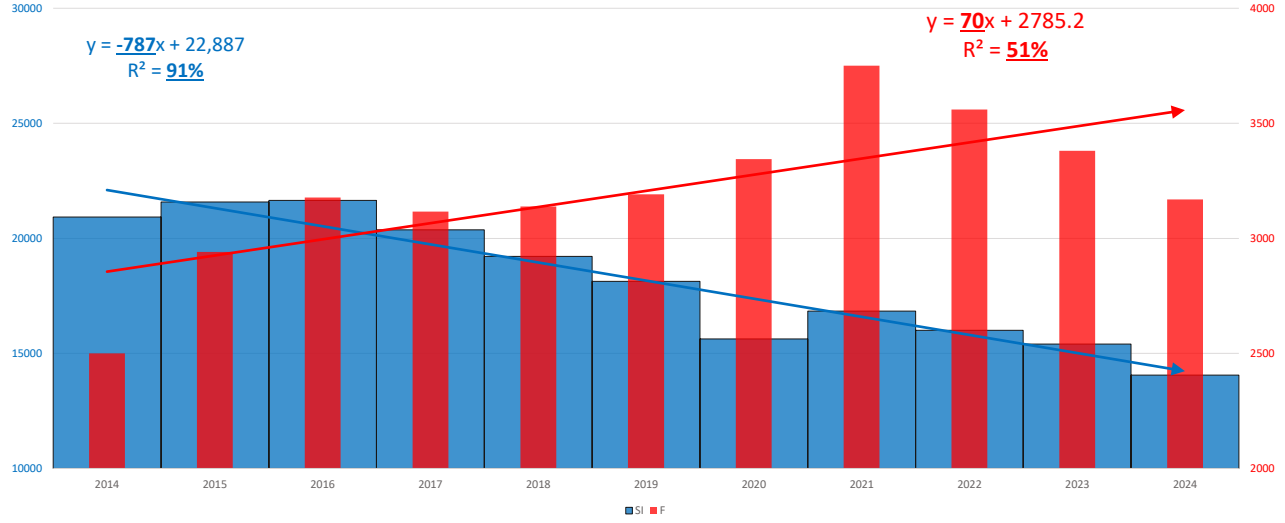
Paradigm Shift

We're Making Progress, but Dichotomy in Trends



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Paradigm Shift

Egregious Fringe

FDOT

TARGET ZERO

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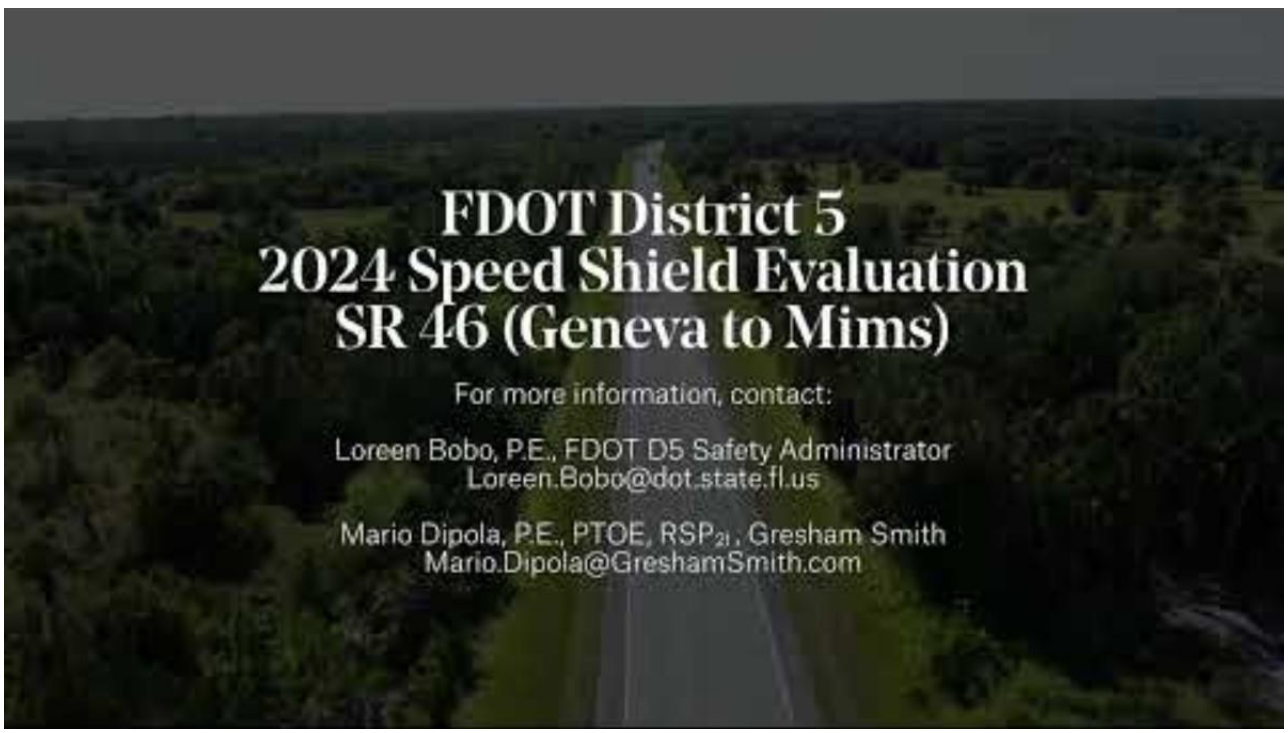

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Speed Shields

SR 46 between Geneva & Mims

- Human Factors Relating to Traffic Control Devices
  - Timing
  - Primacy
  - Expectancy
  - Redundancy

FDOT

TARGET ZERO

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3 Sites

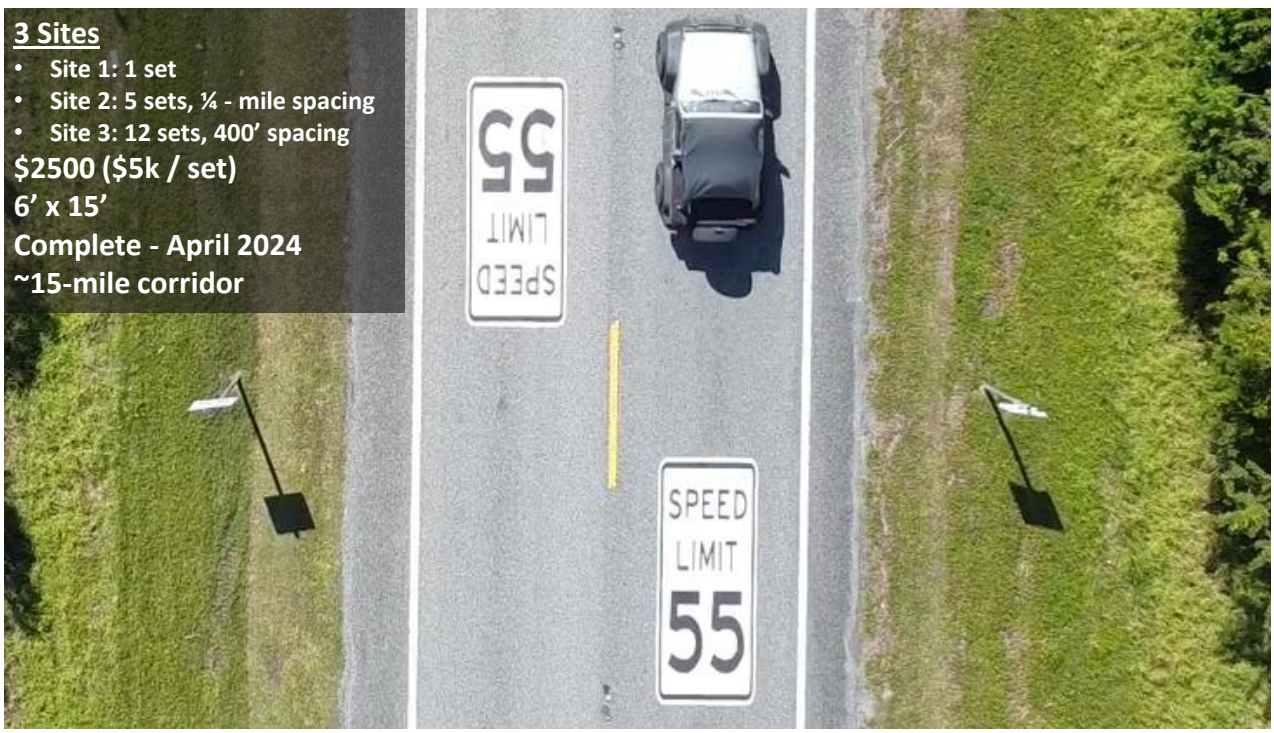
- **Site 1: 1 set**
- **Site 2: 5 sets, ¼ - mile spacing**
- **Site 3: 12 sets, 400’ spacing**

$2500 ($5k / set)

6’ x 15’

Complete - April 2024

~15-mile corridor



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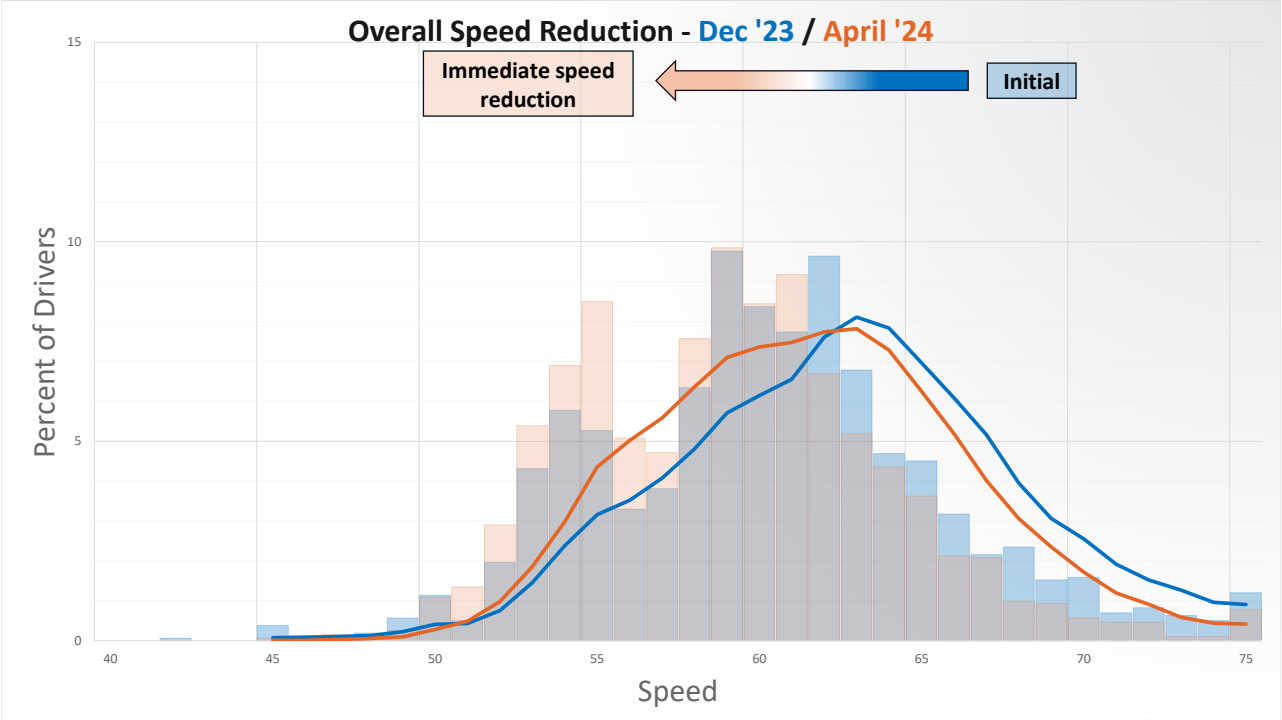
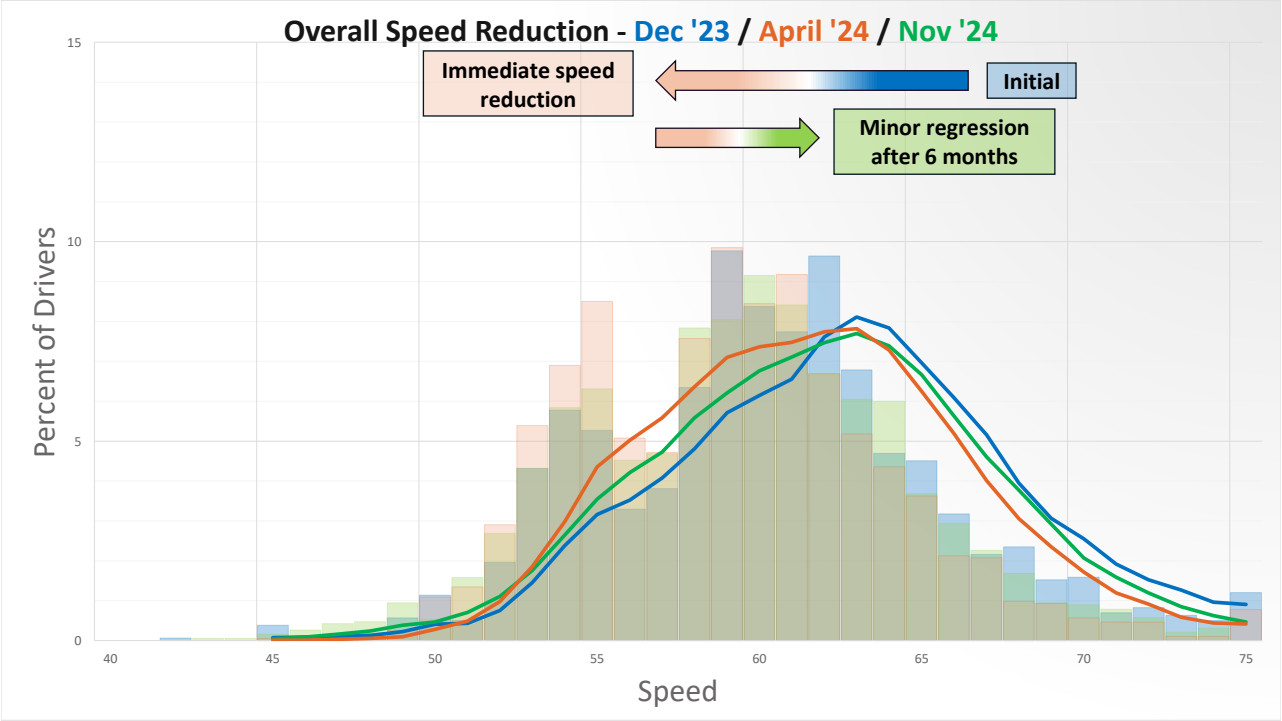

Overall Speed Reduction - Dec '23 / April '24
Immediate speed reduction
Initial
Percent of Drivers
Speed
0
5
10
15
40
45
50
55
60
65
70
75

41


Overall Speed Reduction - Dec '23 / April '24 / Nov '24
Immediate speed reduction
Initial
Minor regression after 6 months
Percent of Drivers
Speed
0
5
10
15
40
45
50
55
60
65
70
75

42

Speed Shields – Results

% Change	Site 1 (1 set)		Site 2 (5 sets @ 1/4 mi)		Site 3 (12 sets @ 400')		Eastbound (all 3 sites)		Westbound (all 3 sites)		Upstream (all 3 sites)		Midpoint (all 3 sites)		Downstream (all 3 sites)		Overall	
	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24	4/'24	11/'24
Average	-1.6%	-2.4%	-0.7%	0.9%	-2.5%	-0.2%	-2.0%	-1.9%	-2.0%	-0.1%	-2.6%	-1.4%	-1.2%	0.5%	-1.5%	-1.4%	-2.0%	-1.0%
50 %ile	-2.6%	-2.7%	-0.6%	0.2%	-2.3%	-0.6%	-1.7%	-1.6%	-2.3%	-0.5%	-2.2%	-1.0%	-1.2%	0.0%	-1.8%	-1.5%	-1.9%	-1.0%
85 %ile	-1.9%	-1.0%	-1.0%	-0.2%	-3.1%	-1.3%	-2.7%	-1.8%	-2.2%	-0.8%	-3.3%	-2.5%	-1.7%	0.5%	-1.8%	-1.4%	-2.4%	-1.4%
95 %ile	-4.6%	-2.9%	-1.7%	-1.5%	-4.5%	-1.7%	-3.7%	-3.1%	-4.0%	-2.4%	-4.8%	-3.7%	-3.0%	-1.1%	-2.5%	-1.7%	-3.7%	-2.4%
10 mph pace	-1.6%	-3.2%	0.0%	3.2%	-3.1%	-1.5%	-1.6%	1.6%	-1.6%	0.0%	0.0%	1.6%	-1.6%	0.0%	-1.6%	0.0%	-1.6%	1.6%
EF (10+)	-39.3%	-26.8%	-17.2%	-0.7%	-40.2%	-21.7%	-39.9%	-31.4%	-33.0%	-12.5%	-44.0%	-36.2%	-27.1%	7.1%	-28.1%	-22.6%	-36.2%	-21.8%
EF (15+)	-57.0%	-48.8%	-29.4%	-19.2%	-63.9%	-30.0%	-56.4%	-45.8%	-53.0%	-27.7%	-63.6%	-52.7%	-52.7%	-13.3%	-36.1%	-28.5%	-54.4%	-36.4%

Over Half of 15+ mph eliminated

Over a third 15+ mph eliminated

43

Foveal Vision = ±4°

44

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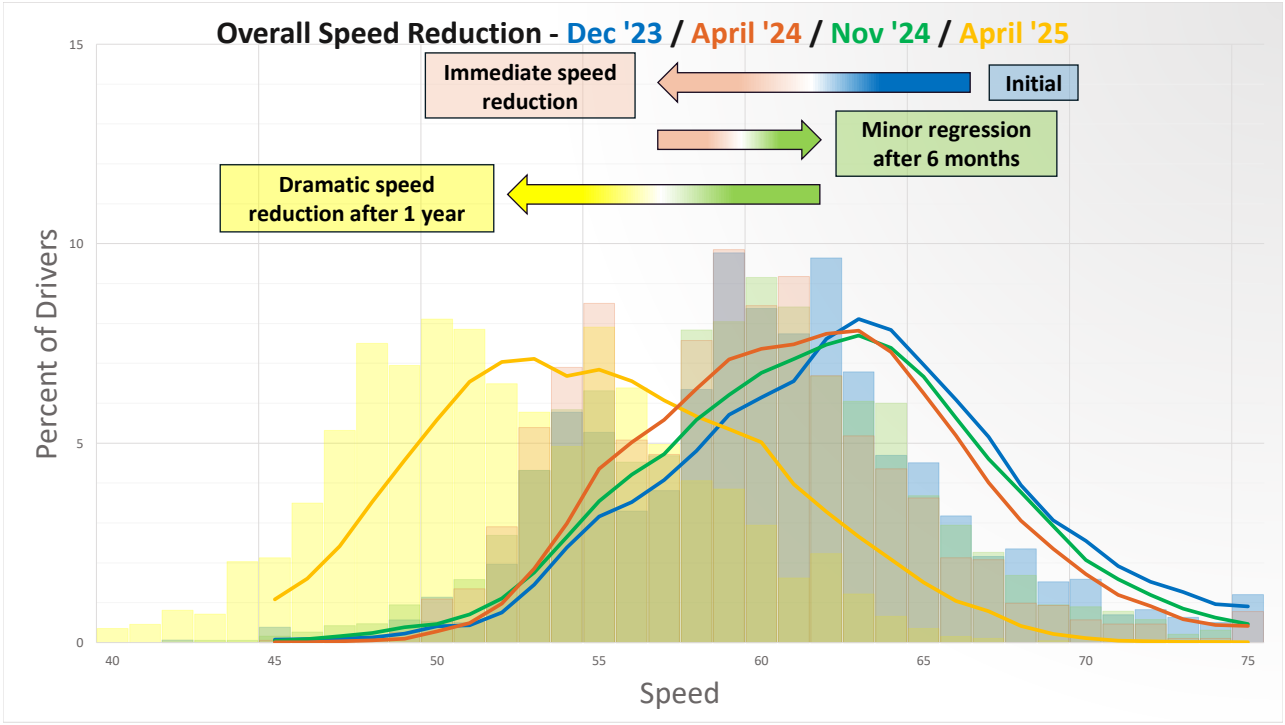
5 Criteria for any Traffic Control Device

1. Fulfill Need
2. Command Attention
3. Convey Clear, Simple Meaning
4. Command Respect
5. Give Adequate Time for Response

45



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Thank You!

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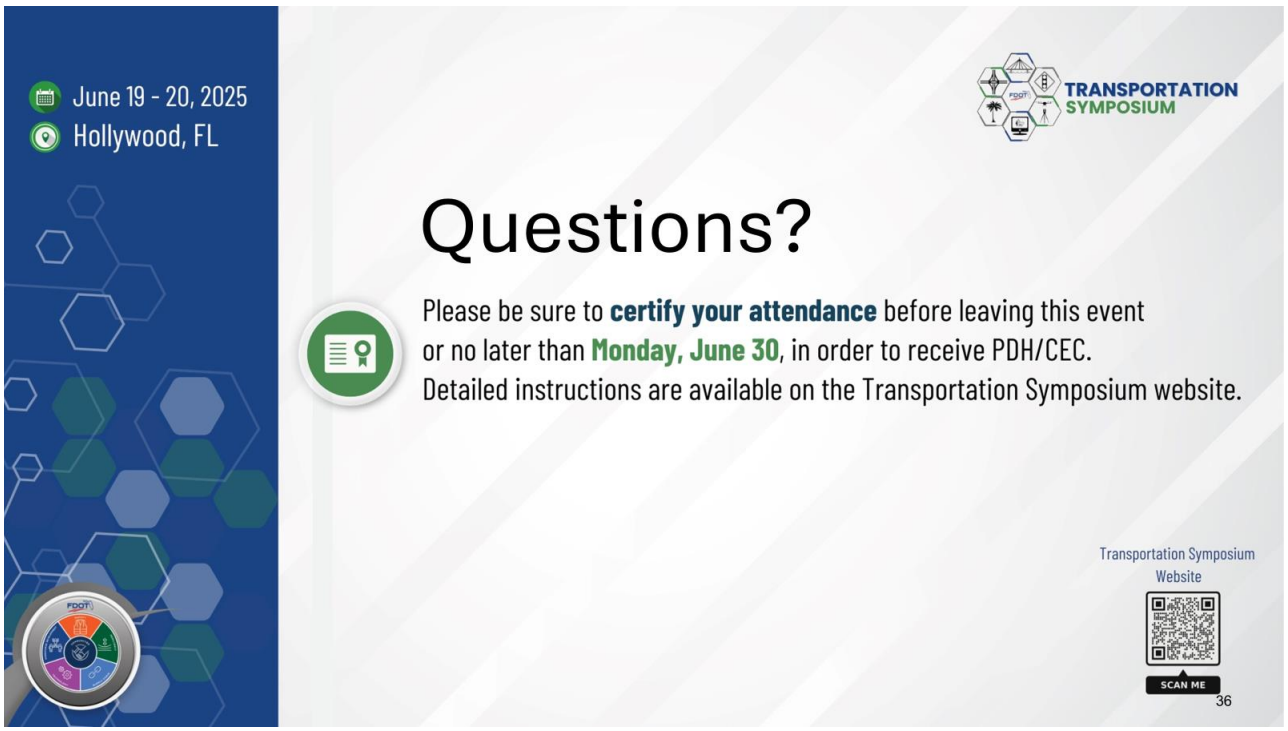

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