Collaborative Sciences Center for ROAD SAFETY

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Implementing Safe Systems in the United States

Guiding Principles and Lessons from International Practice

September 18, 2019

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Education and information
Innovation
Standards
Coordination
Data, research and evaluation
Road rules and enforcement
Licensing and registration
SAFE ROADS
SAFE SPEEDS
SAFE VEHICLES
SAFE PEOPLE
Work to prevent crashes that result in death or serious injury
HUMAN TOLERANCE OF CRASH IMPACTS

Conventional Wisdom:

Table 1. Driver-, Vehicle-, and Environment-Related Critical Reasons

Critical Reason Attributed to	Estimated	
	Number	Percentage* ± 95% conf. limits
Drivers	2,046,000	94% ±2.2%
Vehicles	44,000	2% ±0.7%
Environment	52,000	2% ±1.3%
Unknown Critical Reasons	47,000	2% ±1.4%
Total	2,189,000	100%

*Percentages are based on unrounded estimated frequencies
(Data Source: NMVCCS 2005–2007)

Source: NHTSA, 2015

Driver Error

- **Recognition error**, which may include driver inattention or distraction, as well as inadequate surveillance for oncoming hazards before entering an intersection of making a lane change.
- **Decision error**, such as driving too fast for conditions or misjudging gaps in oncoming traffic.
- **Performance error**, such as poor directional control over the vehicle prior to a crash, a factor most often attributable to drowsy driving.

Rethinking “Critical Factors”

Counterfactual Reasoning: A form of logic that falsifies antecedents to determine whether they negate consequences.

Antecedent → Consequence

The Simulation Heuristic

Outcome Closeness: We focus on antecedents that are immediately proximate to consequences.

Outcome Normality: Exceptional outcomes are presumed to follow from exceptional antecedents. We construct counterfactuals that shift the exceptional antecedent to its “normal” value.

Extant Norms: Counterfactual content is based on social norms of expected behavior (which are modifiable and socially constructed).

Source: Roese, 1997

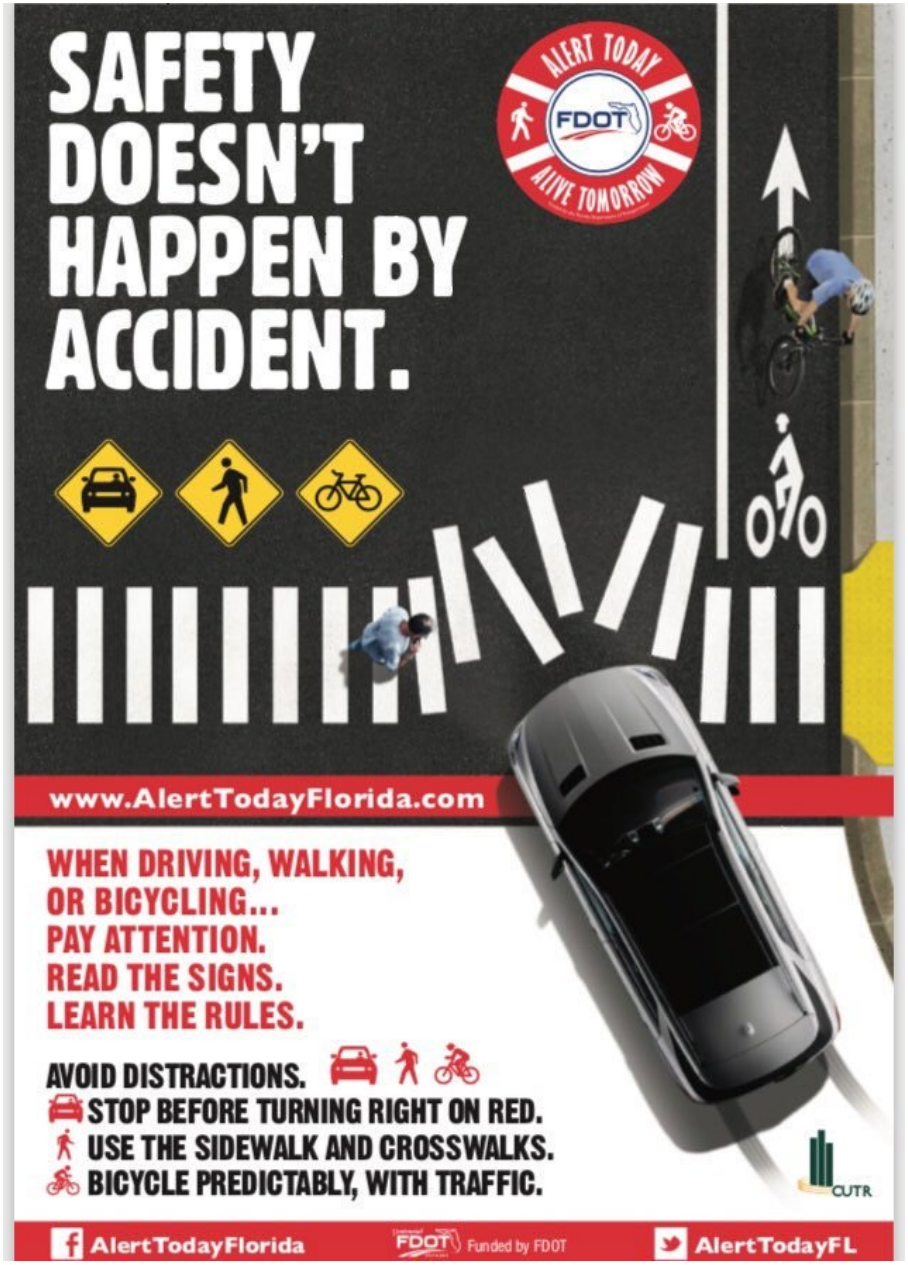
The Simulation Heuristic: Blame the Victim

Pedalcyclists Killed, by Related Factors

Factors	Number	Percent
Failure to yield right of way	216	25.7
Not visible (dark clothing, no lighting, etc.)	87	10.4
Failure to obey traffic signs, signals, or officer	83	9.9
Under the influence of alcohol, drugs, or medication	53	6.3
Making improper turn	43	5.1
Improper crossing of roadway or intersection	39	4.6
Operating without required equipment	31	3.7
Wrong-way riding	31	3.7
Failure to keep in proper lane or running off road	22	2.6
Riding on wrong side of the road	20	2.4
Inattentive (talking, eating, etc.)	17	2.0
Darting or running into road	16	1.9
Improper or erratic lane changing	15	1.8
Failing to have lights on when required	8	1.0
Physical impairment	7	0.8
Vision obscured (reflected glare, parked vehicle, sign, etc.)	6	0.7
In roadway improperly (standing, lying, working, playing)	5	0.6
Making improper entry or exit from trafficway	4	0.5
Ill, blackout	3	0.4
Improper passing	3	0.4
Traveling on prohibited trafficways	2	0.2
Erratic, reckless, careless, or negligent operation	1	0.1
Passing with insufficient distance	1	0.1
Other factors	26	3.1
None reported	163	19.4
Unknown	204	24.3
Total Pedalcyclists	**840**	**100.0**

Notes: The sums of the numbers and percentages are greater than total pedalcyclists killed as more than one factor may be present for the same pedalcyclist.

Source: NHTSA, 2016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READ THE SIGNS.
LEARN THE RULES.
AVOID DISTRACTIONS.
STOP BEFORE TURNING RIGHT ON RED.
USE THE SIDEWALK AND CROSSWALKS.
BICYCLE PREDICTABLY, WITH TRAFFIC.
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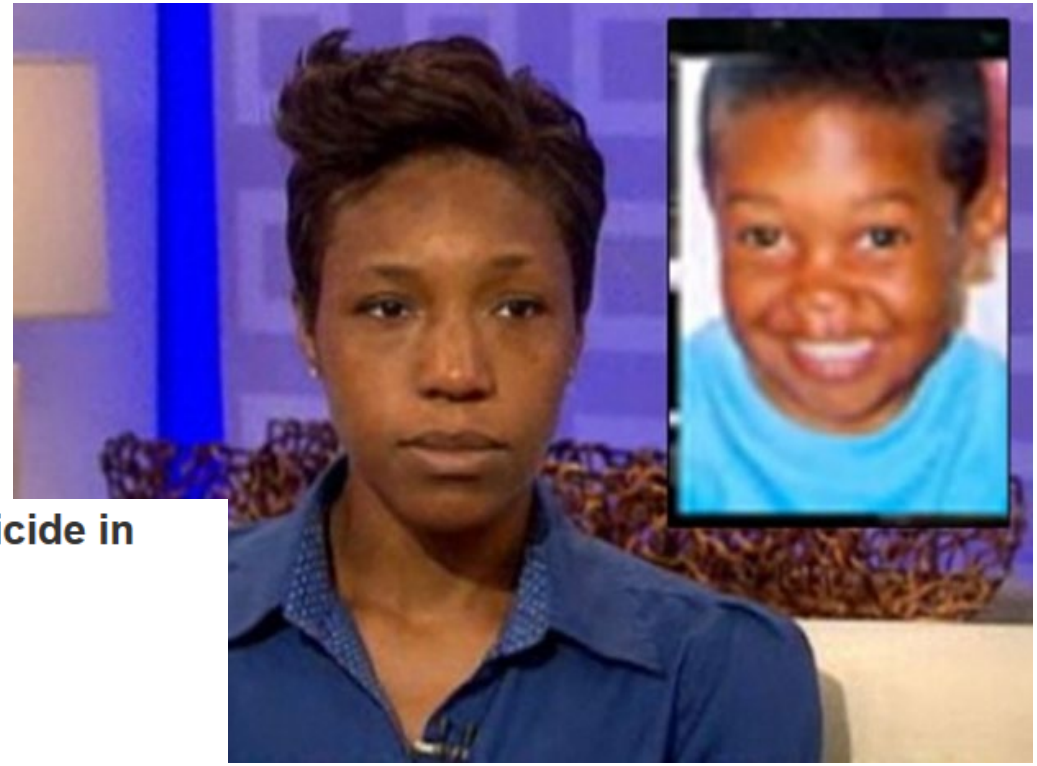
FOCUS
ON DRIVING
A SAFER
FLORIDA
HIGHWAY SAFETY AND MOTOR VEHICLES
HIGHWAY PATROL
FLORIDA
#FocusOnDrivingFL
Surname Name
Hi. How are you doing?
Hi! Thanks. I'm fine. How are you?
I'm fine too, thanks. Do you want to go to Chinese for lunch today?
Today, I have lunch with clients. How about tomorrow?
Sounds good. Meet as usual at 12:30 in front of the office?
Enter Message
Send
EYES ON THE ROAD
DON'T DRIVE DISTRACTED


A SAFER
FLORIDA
HIGHWAY SAFETY AND MOTOR VEHICLES
FLORIDA HIGHWAY PATROL
ARRIVE ALIVE
DON'T DRINK & DRIVE
ENJOY SPRING BREAK RESPONSIBLY
#SPRINGBREAKFL

Anatomy of a Crash:
The Case of Raquel and A.J. Nelson



Pedestrian convicted of vehicular homicide in own child's death

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By Elise Hitchcock
The Atlanta Journal-Constitution

A Marietta mother may serve more time than the driver who hit and killed her 4-year-old son.

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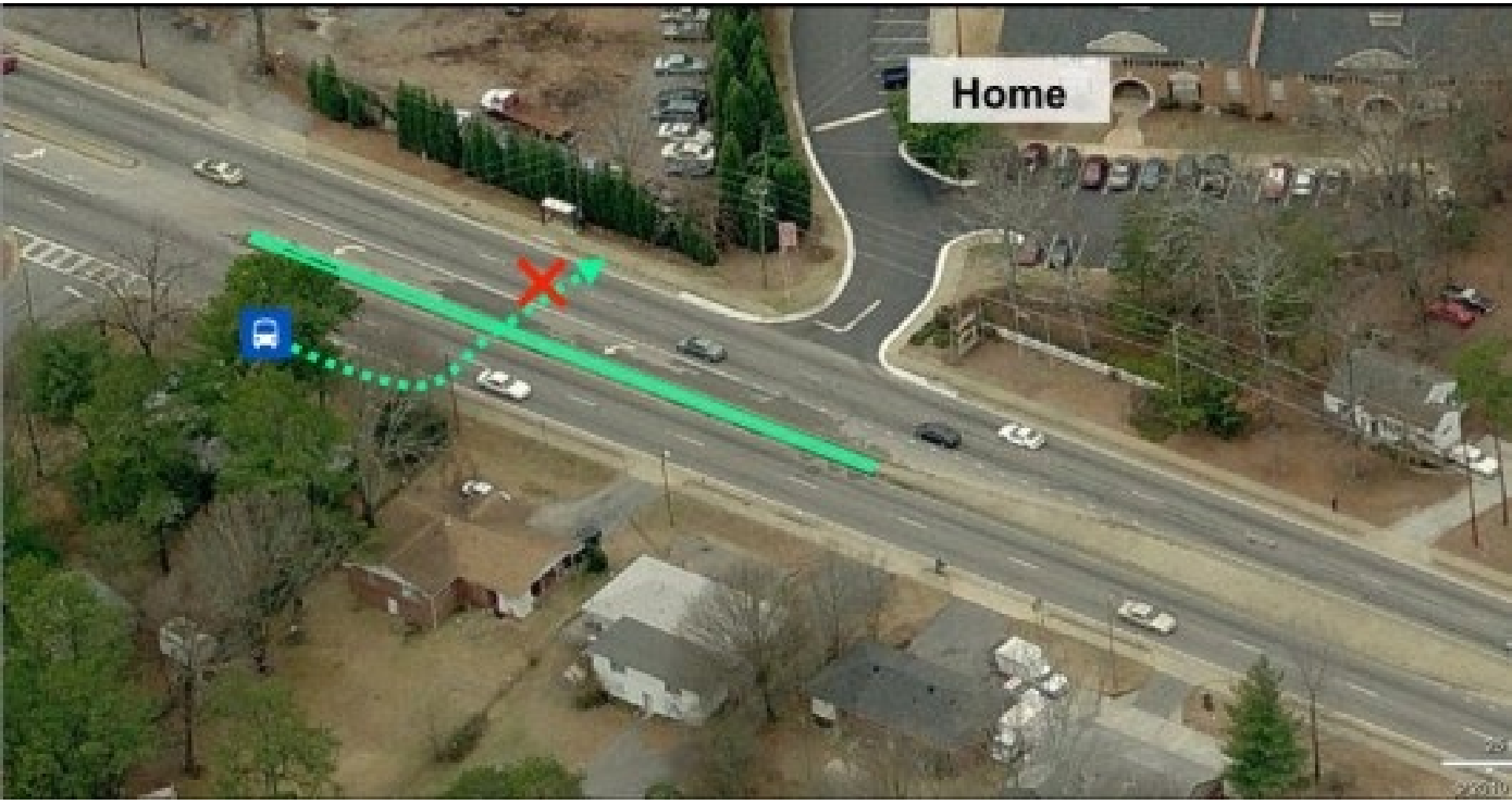
Raquel Nelson, 30, could be sentenced to up to 36 months at a hearing July 26, said David Savoy, her attorney. She was convicted Tuesday of homicide by vehicle in the second degree, crossing roadway elsewhere than at crosswalk and reckless conduct, said Savoy.

Jerry L. Guy, the driver who admitted hitting the child when pleading guilty to hit-and-run, served a 6-month sentence. He was released Oct. 29, 2010, and will serve the remainder of a 5-year sentence on probation, according to Cobb court records.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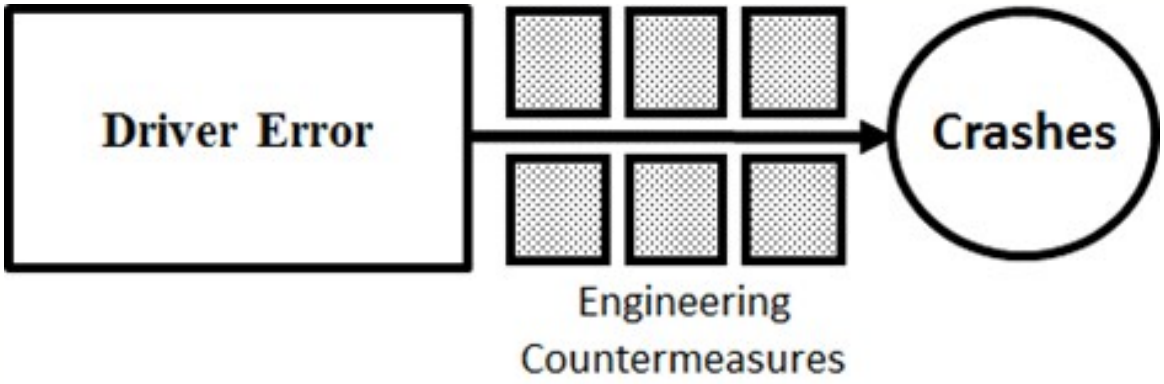
Conventional Safety Practice

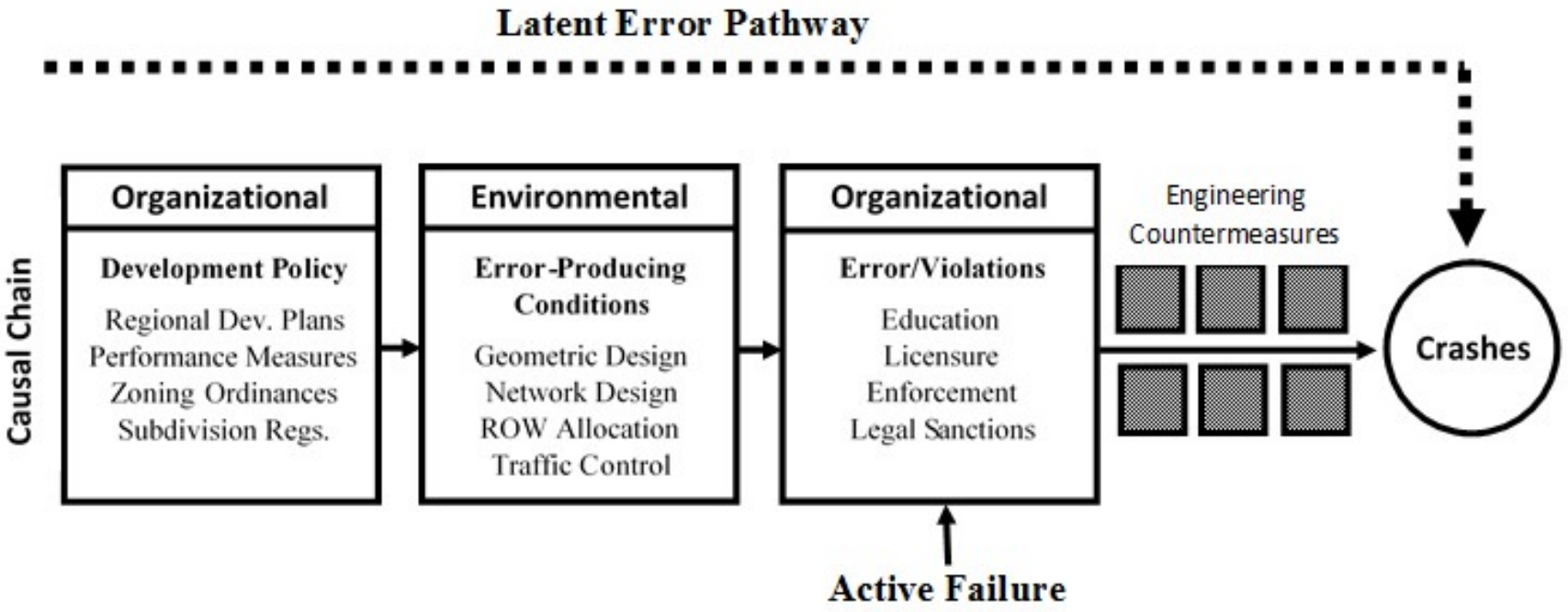


A Safe Systems Perspective

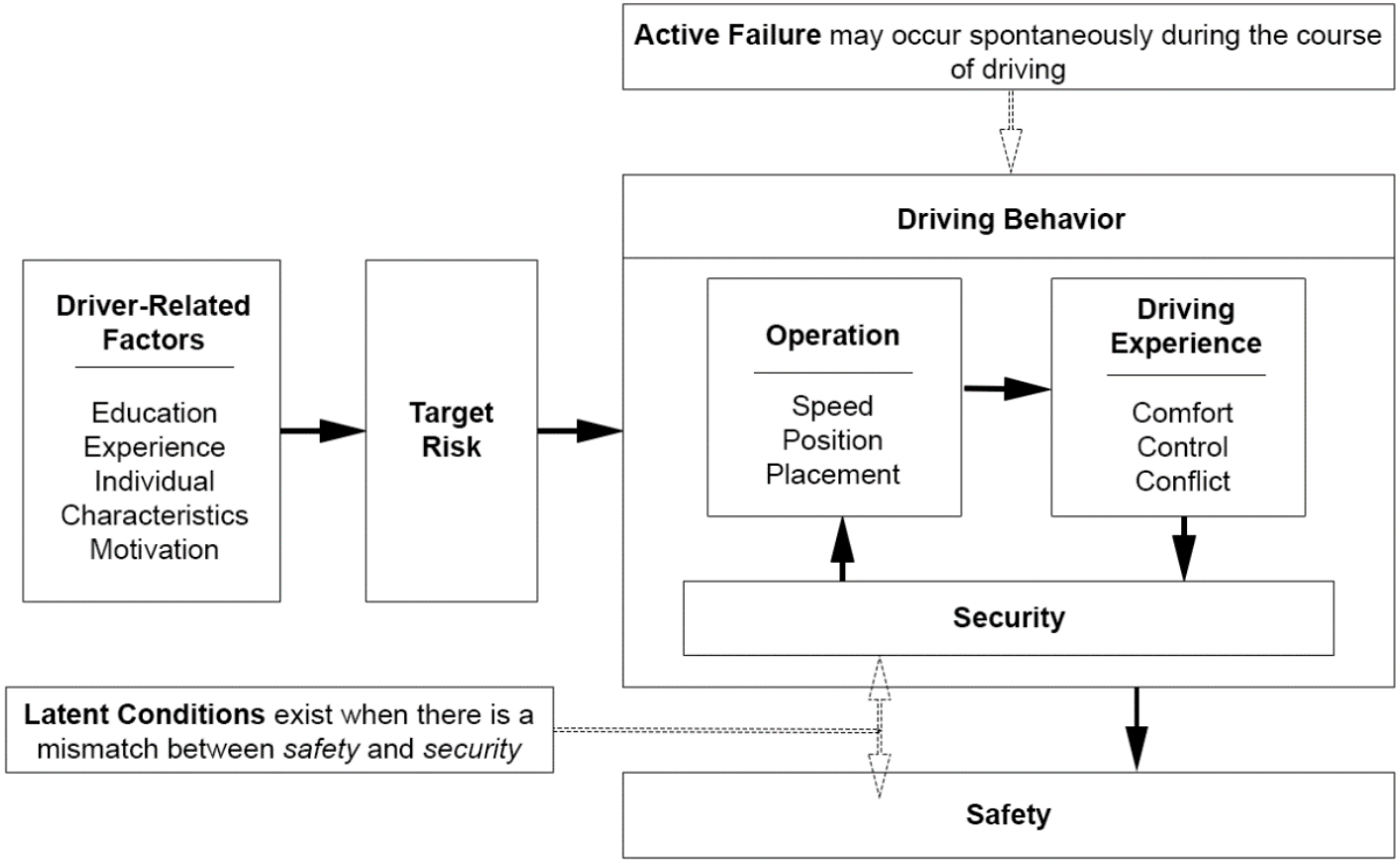
Active Failure: Actions taken by individuals that result in crashes.

Latent Error: Dormant conditions that, when combined with active triggers, lead to crashes. These are the “resident pathogens” in the system.

A Safe Systems Perspective



Cognition, Behavior, and Error Production



The Recognition Heuristic

Cognition and Driving Behavior

- **Scripts:** Behavioral routines adopted in response to our understanding of our operating environment
- **Schema:** Expectancies regarding the existence and location of hazards

Self-explaining Roads

- There is a **communicative process** between the driver and behavior.
- Roadways should **clearly convey desired behavior**.
- This requires a deeper understanding of **behavioral scripts and schema**, and mechanisms for influencing them.

The Netherlands' Self-Explaining Roads

- Adapt the structure and function of the transportation system to the complexities of human behavior.
- The Netherlands: Self-explaining roads (SWOV, 2012)
  - Limit speeds and promote mass homogeneity on roads
  - Strictly control access and mobility
  - Match roadway design to land development

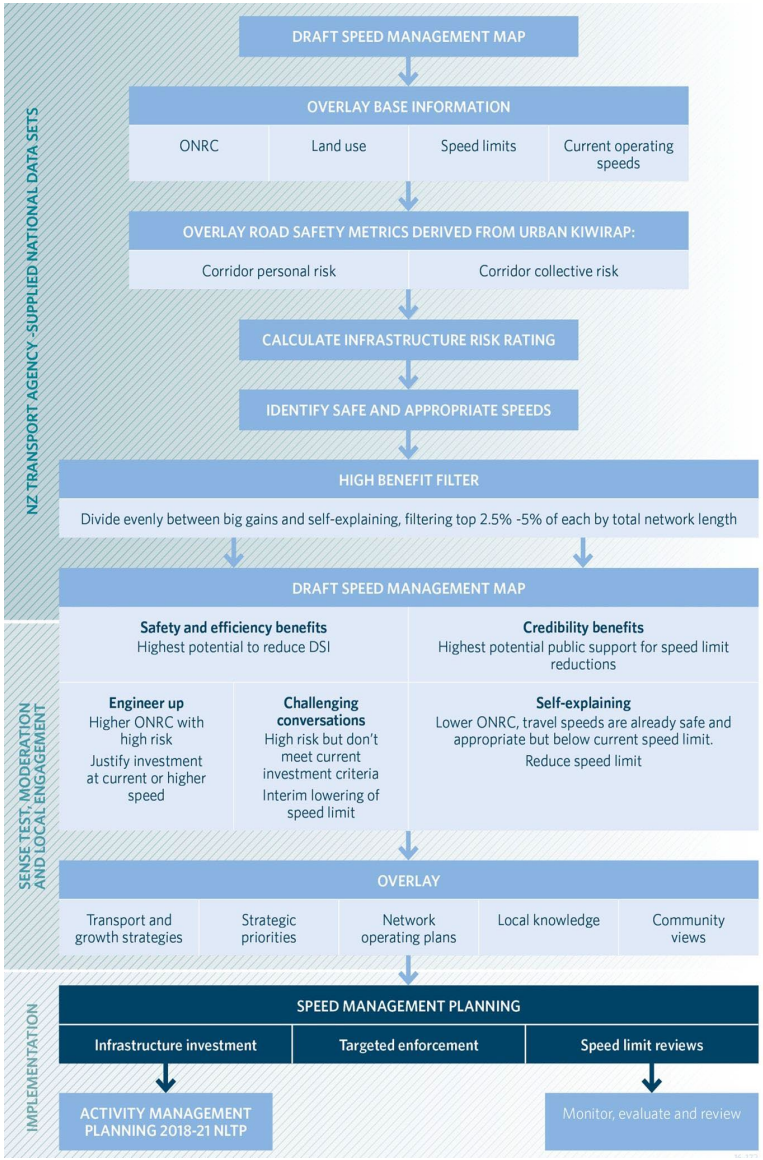
Figure 1 shows how the different road types make up a road network.

Figure 1. *Three functional road types as the basis of a sustainably safe road traffic*

New Zealand's One Network Road Classification

Classification	Straight open road /urban motorways	Curved open road	Winding open road	Urban (not motorway)
Class 1 High volume national	**100–110km/h**[4] Depends on design and safety risk (e.g. divided 4–5 star, grade separated intersections, safety barriers) and factoring in enforcement thresholds			
Class 2 National, Regional, Arterial **Class 3** Primary and secondary collector	**80–100km/h** Depends on safety risk and whether volumes justify investment to bring the road up to 3 star equivalent, also enforcement thresholds		**60–80km/h**	50km/h 60–80km/h where safety risk allows, e.g. fewer intersections, mode separation for active users 30–50km/h
Class 4 Access and low-volume access All winding/tortuous	**60–80**km/h Depending on roadside development, pedestrian and cyclist volumes, whether sealed or not			30km/h if high volumes of cyclists/pedestrians Recognise access and place 10km/h for Shared Spaces

New Zealand's Speed Management Program



New Zealand's Speed Management Program

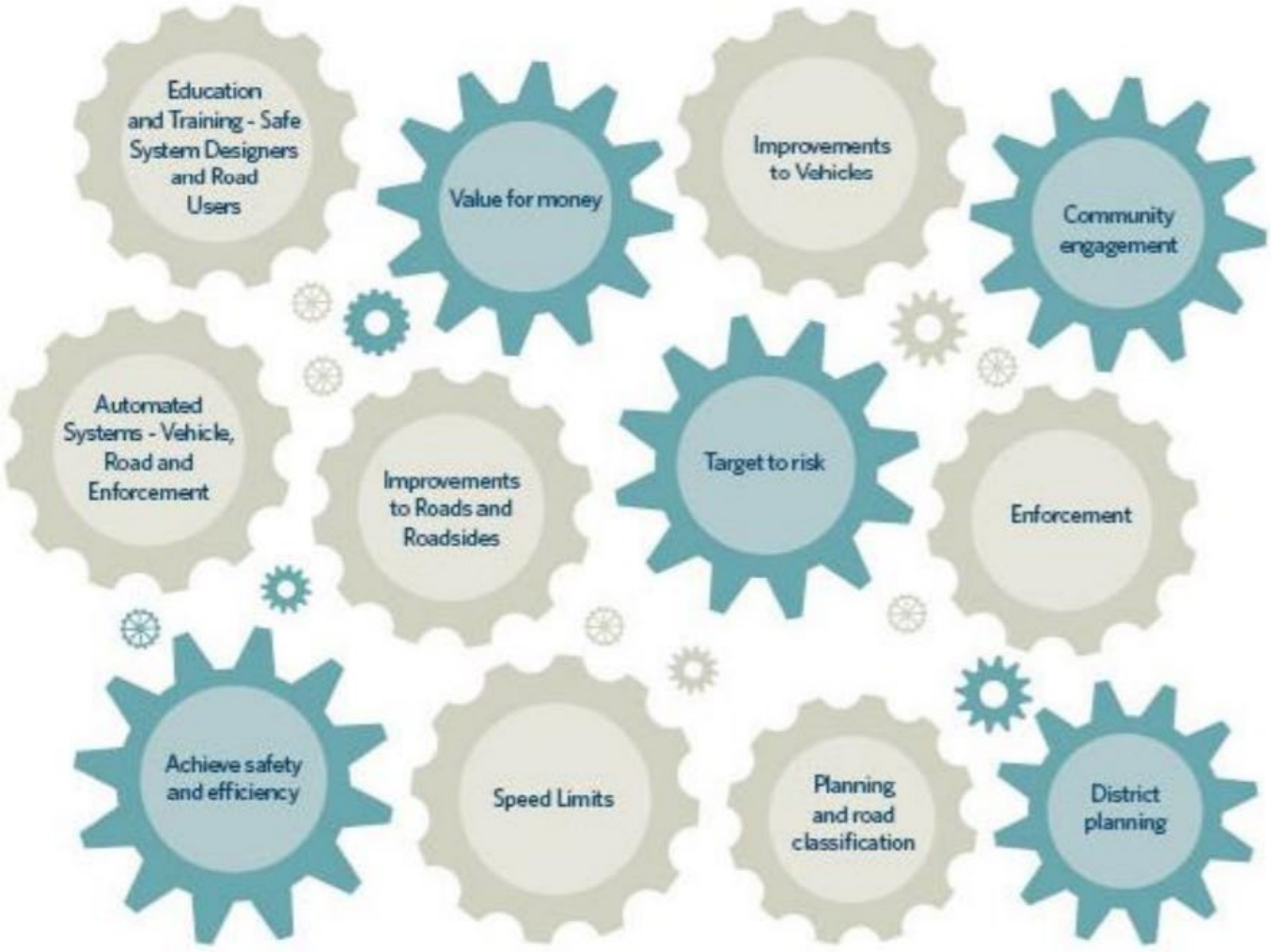
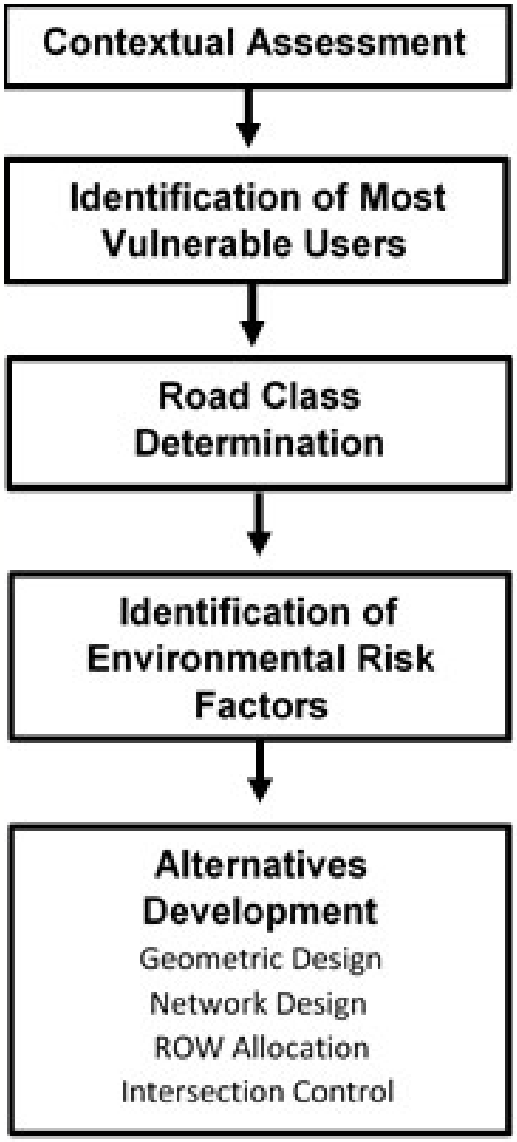


Figure 1.1: Key elements to be considered in speed management

A Safe Systems Approach to Project Planning and Design



Principles of Safe Systems

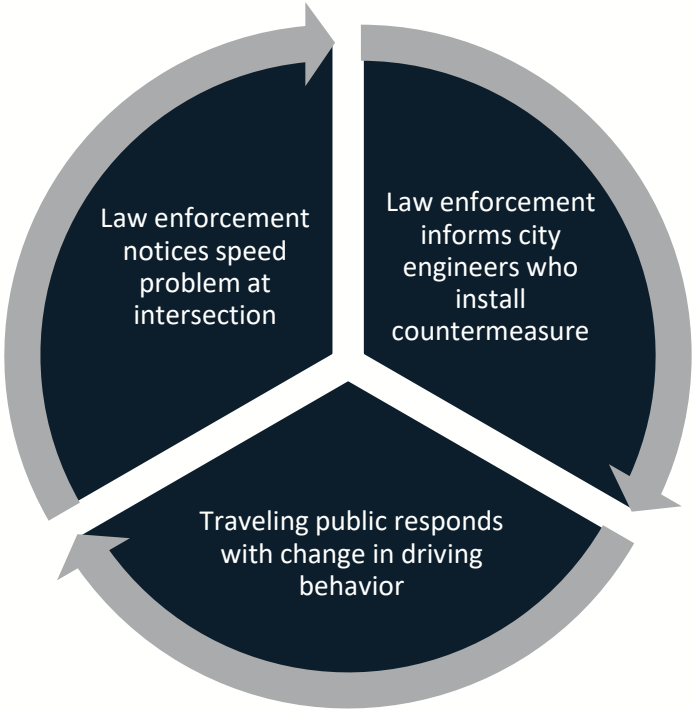
1. Human error should not be viewed as the primary cause of crashes.
2. Transportation facilities should be designed for the safety of the most vulnerable user.
3. A shared responsibility exists amongst those who design, build, manage and use roads and vehicles.
4. All parts of the system must be strengthened to multiply their effects; and if one part fails, road users are still protected.

Safe Systems: A Different Approach

- Transportation safety management in the United States has followed a series of paradigms (Norton, 2015)
  - Safety First (1900s-20s): Drivers bear responsibility for the safety of others
  - Control (1920s-60s): Expert control through the "3 Es"—Engineering, Education, and Enforcement
  - Crashworthiness (1960s-80s): Cars redesigned for greater occupant protection
  - Responsibility (1980s-today): Drivers responsible for their own safety and the safety of others
  - Is Safe Systems the 5th paradigm?

Safe Systems: A Different Approach

- Safe Systems differs by:
  - Emphasizing management of latent risk over high-crash locations.
  - Considering kinetic energy, not design standards, the key consideration in roadway design.
  - Aligning functional classification with design and speed.
  - Leveraging feedback loops and shared funding streams to create change.



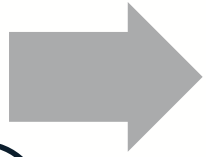
Source: ITE

Safe Systems: A Different Approach

- Safe Systems requires a move to systems thinking.

Traditional Approach

- Characterized by linear thinking
  - Design speed and speed limits
  - Intersection design and throughput
  - Crashes and hot spot treatment



Safe Systems

- Characterized by systems thinking
  - Self-explaining roads and access control
  - Intersection design and kinetic energy
  - Severe crashes and systemic treatments

Safe Systems: The International Experience

- Sweden
  - Center guardrails to eliminate fatal crashes
  - Speed limit reductions
  - “2+1” roads
- The Netherlands
  - Self-explaining roads
  - Bicycle facilities in rural areas
  - Buy-in from non-government partners and communities to adopt safe road policies
- New Zealand
  - Flexible road safety barriers
  - Side and median barriers
  - Rumble strips
  - Widening centerlines
  - Widening shoulders
  - Speed management

Source: Dumbaugh et al., 2019
NZ Transport Agency, 2019