CONNECTING HUMAN FACTORS AND ROAD SAFETY

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Definitions

**Human Factors**
- Aims to increase comfort, safety and efficiency through consideration of how human performance is affected by engineering design

**Road Safety**
- Aims to reduce the harm resulting from crashes of road vehicles
  - Implicit – uses standards to build in safety
  - Explicit – uses analysis of crash data to determine effectiveness of countermeasures
Understand the specific human limitations that lead to particular crash types
Help identify the most appropriate countermeasures
Quickly determine potential effectiveness of new traffic control devices
Provide road user-based road design standards standards
Assist in design where no standards are available or standards can’t be met
UNDERSTAND HUMAN LIMITATIONS
Perceptual Cue for Closing Velocity:
Movement in Depth

![Graph showing the relationship between Vehicle Image Size and Viewing Distance](image)
Movement in Depth

Can begin to distinguish difference
Rear-End Crashes

- 2/3 involve a stopped lead vehicle
- As speed differential increases, exponential rise in rear end crash risk
  - for > 20 mph, 6.7 times higher
  - for 30-35 mph, 30 times higher
(Solomon, 1964)
SELECT APPROPRIATE COUNTERMEASURES
Countermeasures For Rear-End, Closing Velocity Crashes

- Left turn bays
- 2-way left turn lanes
- VMS warning of stalled vehicles lanes or traffic queues
Safety Analyst

- FHWA Software tool

- Modules:
  - Network Screening
  - Diagnostic and Countermeasure Selection
    - Based on analysis of road user limitations and error
  - Cost-benefit analysis of Countermeasures
  - [www.safetyanalyst.org](http://www.safetyanalyst.org)
Policy Implications

- Human factors input should be sought when road safety countermeasures are developed and selected
QUICKLY DETERMINE IF COUNTERMEASURES ARE LIKELY TO WORK
Problem: Right-turning drivers fail to detect bicyclists on a bike path coming from the right
Summala et al., 1996
Countermeasures Tested

- Signs
- Painted warnings
- Speed humps
- Elevated crossings
Results

- Drivers looked to the right more often when forced to slow by speed humps and elevated crossings
- Signs and painted markings had no effect on visual search
  - Summala et al (1996)
Policy Implications

- When new countermeasures are implemented, before and after driver behavior should be monitored to ascertain likely effectiveness
We assume that better performance means fewer crashes **BUT** we need to ensure all aspects of performance are measured – especially adaptive behaviors.
Post-Mounted Delineators: Performance & Safety

- After PMDs implemented, higher speeds at night on 50 mph roads
- 40 – 60% increase in nighttime injury crash rates on 50 mph roads

(Kallberg 1993)
PROVIDE ROAD USER
BASED STANDARDS
Inadequate Delineation

- Older, tired and unfamiliar driver
- Roadway freshly paved with temporary delineation
- RPMs spaced 130 ft apart
- Jurisdiction own standard 80 ft spacing on curves
- Research shows 40 ft spacing on curves
Inappropriate stop sign placement
Policy Implications

- Human factors input is a must if TCD and road design standards are truly to build in safety.
SUPPORT DESIGN DECISIONS WHERE THERE ARE NO STANDARDS
Untreated Transition Zone
Human Factors Issues

- **How speed is perceived**
  - Streaming of objects in peripheral vision \( (Salvatore, 1968) \)
  - Closeness of objects to the roadway \( (Shinar et al., 1974) \)

- **Driver adaptation to high speeds**
  - Occurs within seconds
  - Persists for 5 to 6 minutes \( (Schmidt and Tiffin, 1969) \)

- **Influence of driving task**
  - More effort = lower speed

- **Influence of road message**
Countermeasures

- How speed is perceived
  - Lateral markings
- Driver adaptation to high speeds
- Influence of task demand
- Influence of road message
Lateral Pavement Markings

- Full transverse lateral markings alert speed-adapted drivers

- Peripheral markings are sufficient to sensitize them to their speed

(Godley et al, 1999)
Countermeasures

- How speed is perceived
  - Lateral markings
- Driver adaptation to high speeds
  - Speed drop 1.5 miles in advance
- Influence of task demand
  - Gentle curves
- Influence of road message
  - Changes to median, cross-section, lighting
WHAT IS THE MINIMUM SPACING BETWEEN INTERCHANGES
Section for Analysis of Weaving Distances
Basis for Interchange Spacing?

- Driver workload: one task at a time
- Crash experience
Driver Tasks and Interchange Spacing

- Bullnose
- Acceleration Lane Ends
- 500 m
- Merging
- Sign Reading
- Guide Sign
- Deceleration Lane Begins
- 345 m
- Bullnose

Lane Changing
Minimum Lane-Changing Distance

- Based on driver gap search and lane change time requirements:
  - 10 – 13 seconds for 1 lane change
  - 17 seconds for 2 lane changes
  - 24 seconds for 3 lane changes

(McGee et al, 1978; Smiley, 2001; McNees, 1982)

- Time converted to distance using design speed
Driver Tasks and Interchange Spacing

- Bullnose
- Acceleration Lane Ends
- Guide Sign
- Deceleration Lane Begins
- Bullnose

- Merging: 4 sec
- Sign Reading: 9 sec
- Lane Changing: 10 sec
- Deceleration: 345 m
Interchange Separation

- Minimum of 1 mile based on driver workload of one task at a time
- Supported by safety analysis showing a 50% increase in crash rates as interchange spacing drops below 1 mile

(Cirillo, 1967; Cirillo, 1968)
Minimize risk for a complex road design for an intersection involving

- An at-grade skewed rail crossing where traffic and train volume indicated a separated crossing should be built
- A bus transitway
Fallowfield Rail Crossing
Findings:

- Amber onset 2.2 s from stop bar
- 75% ran light prior to wait of 94 s
- 83% ran light after wait
- No jumping light after train passed despite priority given to transitway
Policy Implications

- Human factors can support design decisions when standards are missing or can’t be met, by means of
  - Analysis
  - Simulation and testing
Summary: Human Factors Contribution to Road Safety

- Understand the specific human limitations that lead to particular crash types
- Help identify the most appropriate countermeasures
- Quickly determine effectiveness of new traffic control devices
- Provide road user-based road design standards
- Assist in design where no standards are available or standards can’t be met
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