Safety and the Human-Centered Systems Approach

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Federal Highway Administration
Safety R&D

Integrating Safety Into Transportation Planning
June 9-10, 2005
The Relative contributions of major causes of road accidents in the United States.

K. Rumar, 1985
Human Error: A System-Wide Perspective

Human error refers to decisions and/or actions taken by:

- Users
- Designers
- Operations personnel
- Maintenance personnel
- Planners
Drivers and Visually Impaired Pedestrians at a Crosswalk
Pedestrian & Red Light Runner
Red Light Runner
Selected Behavioral Factor Groupings

- Individual characteristics
- Task
- Infrastructure
- Environment
- Traffic considerations
- Vehicle design
Behavior: Individual Characteristics

- Training
- Experience
- Sensory systems capabilities
- Memory capacity
- Mental model
- Physiological state
- Medical status
- Skill/knowledge
- Age
- Emotional state
- Aggressiveness
- Risk perception
- Expectations
- Long-term adaptation
- Social influences
Behavior:
Task & Infrastructure

**Task**
- Task complexity
- Cognitive requirements
- Temporal requirements
- Psychomotor requirements
- Representation by mental model

**Infrastructure**
- Condition of physical roadway
- Roadway geometry
- Roadway lighting
- Traffic control devices
- Signage
Caution Sign?

“Bright Ideas,” Flint Trading Inc.
Misplaced/Misused Chevrons
“Stop” Signs Obscured

“Bright Ideas,” Flint Trading Inc.
### Behavior:

#### Task & Infrastructure

<table>
<thead>
<tr>
<th>Task</th>
<th>Infrastructure</th>
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</thead>
<tbody>
<tr>
<td>Task complexity</td>
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</table>
Behavior: Vehicle Design

- Controls
- Displays
- In-vehicle information systems
- Anthropometry
- Safety belts
- Brake system
- Road noise
- Headlights
- Cell phones
Behavior: Environment & Traffic Considerations

Environment
- Rain
- Snow/ice
- Fog
- Glare
- Time of day/night

Traffic Considerations
- Volume (gaps, headway)
- Speed
- Mix of vehicles
- Hazards
- Construction
What Can We Do About It?

Can We Affect Roadway User Behavior? Yes, if …

- IF we can measure it
- IF we can manipulate it
- IF we can demonstrate it
- IF the effort is cost effective
What We Can Do - Selected Tools

- Education
- Engineering
- Experimental research
- Analytic methods
- Training
- Computer modeling
- Awareness programs
- Enforcement

........... but which tool do we use? .... and how do we know that our efforts are worthwhile?
HCS Research Approach

- Identify Research Needs
- Develop Research Concept
- Develop Detailed Research Requirements
- Develop Work plan
- Institutional Review Board
- Workgroup Review
- White Papers
- Customer
- Outreach
- Workgroup Review
- Prepare Report
- Conduct Study
Turner-Fairbank Highway Research Center HCS Research Capabilities

- Sign Simulator
- Desktop Simulator
- Field Research Vehicle
- Highway Driving Simulator (HDS)
- Field – Tests, Validation
- Photometric Visibility Laboratory
## Proper Fit of Research Tools & Activities

<table>
<thead>
<tr>
<th>Generic Transportation HF Research Activities</th>
<th>Selected Research Tools*</th>
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<tr>
<td></td>
<td>SQ</td>
</tr>
<tr>
<td>Initial user concept acceptance</td>
<td>●</td>
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<tr>
<td>Initial user preferences</td>
<td>●</td>
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<tr>
<td>Initial user requirements</td>
<td>●</td>
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<tr>
<td>Initial evaluation of device parameters</td>
<td>●</td>
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<tr>
<td>Evaluation of rapid prototype(s)</td>
<td>●</td>
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<tr>
<td>Initial evaluation of a procedure</td>
<td>●</td>
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<tr>
<td>Refine user requirements in tasking situation</td>
<td>●</td>
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<tr>
<td>Explore elementary non-driving component</td>
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<tr>
<td>Non-driving subsystem and driving integration</td>
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<tr>
<td>Initial integration of multiple subsystems</td>
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<tr>
<td>Study of complex multiple independent variables</td>
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<tr>
<td>Integration of multiple systems</td>
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<tr>
<td>Full prototype testing and evaluation</td>
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*SQ = Survey/Questionnaire, TA = Task Analysis, CM = Computer Model, PT = Part Task Simulator, LF = Low Fidelity Simulator, HF = High Fidelity Simulator, FT = Field Test
Low Fidelity Simulation

Field Data Collection
HCS Road Research Vehicle
Digital Highway Measurement System
Selected Research Topics

Intersections
- Path and Speed Selection Through Double-Lane Roundabouts
- Access and Usability of Roundabouts for All Users
- Novel Intersection (e.g., jug handle, continuous T, median U)
- Stand-alone Infrastructure Crash Avoidance System

Visibility
- Luminance Tradeoffs among RRPMs and Pavement Markings
- Low-Cost Safety Enhancements for Curves- Field Study
Selected Research Topics (Con’t)

Pedestrians and Bicycles
- Comparison of Pedestrian Crossing Signals
- Memorial Circle Study (Washington, DC)
- Countdown Pedestrian Signal Timing Strategies: Comprehension
- In-Roadway Warning Lights at Crosswalks
- Segway Human Transporter™ Laboratory Study

Speed Management
- Comprehension of Speed Management Signs
- Effects of Urban Street Environment on Operating Speeds
- Speed Management on Main Roads Through Rural Towns
STIP for Driving Simulators: Roadway Design and Visualization

STIP Objectives:

• Make roadway designers aware of the benefits of using driving simulators;
• Establish a mechanism for roadway designers to participate in learning about and promoting the use of driving simulators for design purposes; and
• Demonstrate and document the usefulness of using driving simulators for making decisions on design issues.
Potential Planning Uses for HDS

- Selection of alternative roadway plans
- Estimate driver perceptual, cognitive, and psychomotor overload
- Evaluate driver-infrastructure information interface
- Evaluate emergency or dangerous activities
- Evaluate an expanded number and range of system and scenario parameters
Major Products

- Input to Infrastructure
- Guidance/Rule Making
- Automated Tools
- Guidelines and Handbooks
- Technical Reports & White Papers
- Conference Presentations
- Project/Study Reviews
- Fliers and Tech Briefs
- CDs and Web sites
For More Information:

- Visit us at the Turner-Fairbank Highway Research Center, McLean, VA (outside Washington, DC)
- View our Website at: www.tfhrc.gov
- Contact Tom Granda
  - 202-493-3365
  - thomas.granda@fhwa.dot.gov

www.tfhrc.gov
Braking at a Red Light
Trying To Get Ahead
“T” intersection

“Bright Ideas,” Flint Trading Inc.
To Stop or Not To Stop ....

“Bright Ideas,” Flint Trading Inc.
Construction Ahead?

“Bright Ideas,” Flint Trading Inc.
Intersection Crash Avoidance:
Stand-Alone Infrastructure Solution

Condition 3

Condition 4
Laerdal Tunnel Project: Driver Concerns

SINTEF studies show:

**Norway**
- 20% feel anxiety and uneasiness in tunnels
- 30% feel it is dangerous to drive in tunnels
- 45% of the elderly drivers fear long tunnels
- 6-9% negative to driving in tunnels
- 7% consider driving an extra 5 km to avoid tunnel

**Denmark**
- 52% fear driving in long tunnels

**Sweden**
- Willing to pay to avoid delay in traffic is twice as high in tunnels as compared to open road
Laerdal Tunnel Project: Awards

Winner of Norwegian Lighting Award 2001

Winner of Scandinavian Lighting Award 2002