Human Factors: Unknowns, Knowns and the Forgotten

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2018 SIP-adus Workshop: Human Factors

Outline

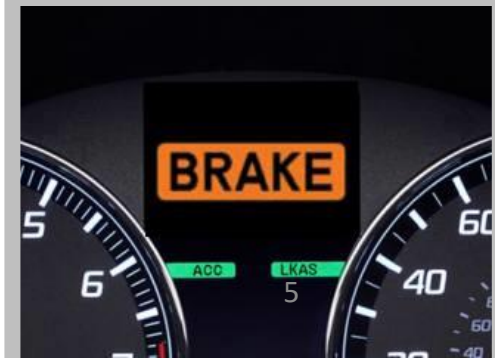
- Examples of bad design
- Expert evaluations of assisted driving systems
- Human Factors (HF) body of knowledge
- Process requirements and safety assurance
- Canadian on-road testing guidelines
- Summary

Bad Human Factors Design Example 1

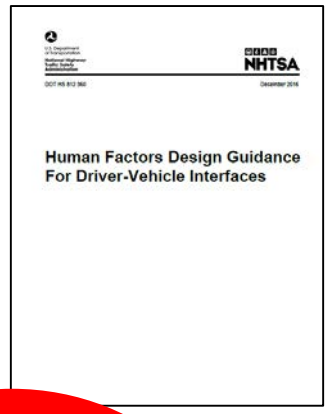
Bad Human Factors Design Example 2

Relevance to Automated Vehicles

- Bad HMI is already pervasive
- Opportunities for inadequate design will increase with:
  - Novel and complex automated driving systems
  - Vague operational design domains (ODD)
  - Miscalibrated trust (disposition, situation and experience)
  - Assisted/ shared/ conditional automation with transition HMI (requests to intervene and fallback behavior)
  - Driver state issues (inattention, fatigue, sleep inertia, confusion and overload) and their detection
  - Signaling and interaction with passengers and other road users.



Toolkit of human factors design procedures and assessment methods



Design Process Requirements

Expert Audit

Lab Testing

Field Operational Trials

Expert Audit – Methodology

- 2 human factors experts evaluated the safety and usability of assisted driving functions on 3 different vehicles
- Drove a set test route in traffic with assisted driving functions
- One expert was familiar with the HMI and operation of the vehicle being tested, while the other was not
- They used a detailed checklist that focused on:
  - **Detection** (e.g., find controls, monitor displays)
  - **Judgement** (e.g., choose setting, determine system status),
  - **Operation** (e.g., press button, grab steering wheel to override system)

umtri DRIVER INTERFACE

HUMAN FACTORS NORTH

Green & Rudin-Brown, 2018

Expert Human Factors Audit – Results

Numerous design issues created challenges for the drivers:

- Finding the controls and displays and identifying functions
- Less accessible / hidden locations for controls
- Easily confused with other controls
- Wrong control design for required action

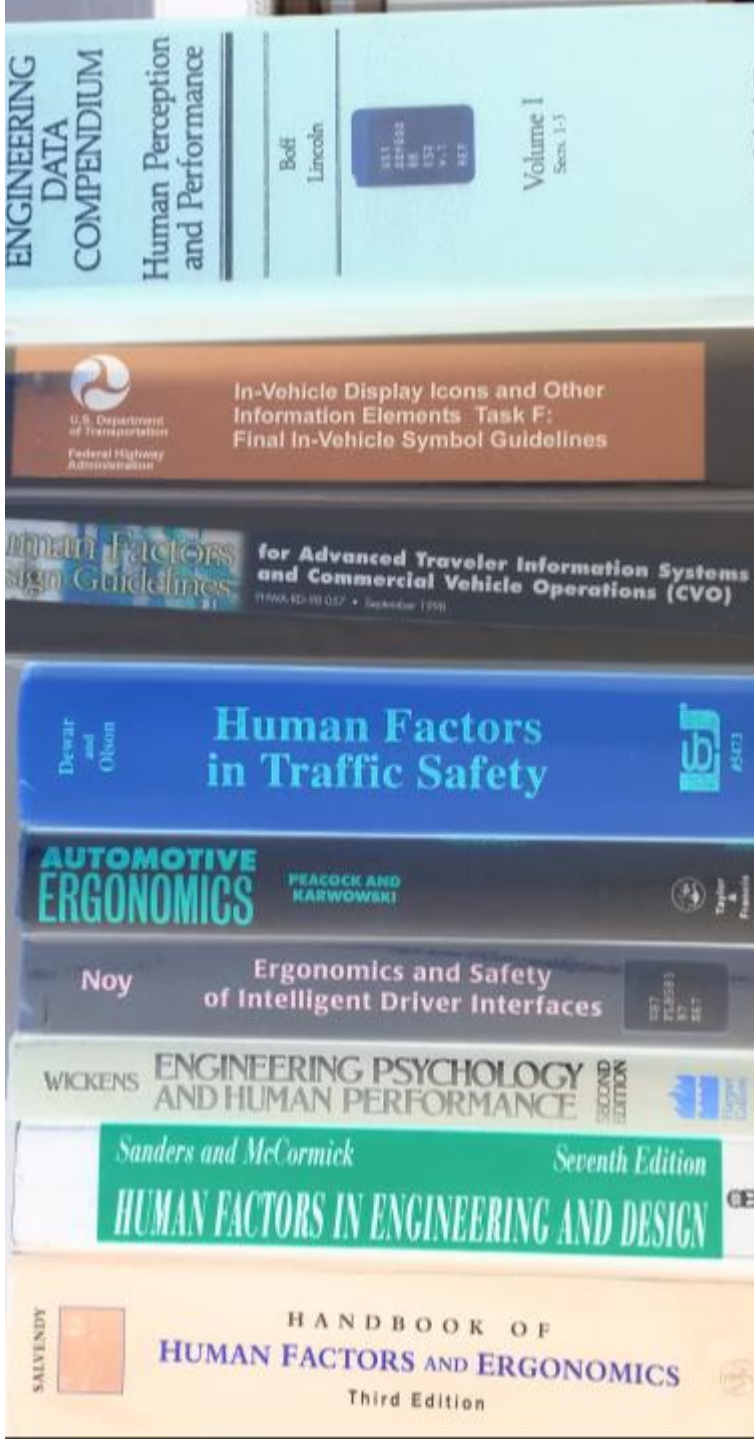
Expert Audit – Results continued

Confusing, unpredictable and distracting

- Unknown functionality
- Unknown operational design domain (ODD)
- Current system status, or change in status, never clear
- Takeover requests are only implied
- Requires drivers to look away from the road

Established Body of Human Factors Knowledge

- Human-Machine Interface (HMI) design
  - Displays – optimal fonts, symbols, colour contrasts, coding, grouping…
  - Controls – shape, operation, stereotypes and conventions…
- Labelling and warnings design
- Human-systems integration/ User-centred design
- Physical ergonomics (anthropometry and biomechanics, forces, comfort, reach envelops, eye- ellipse, H-point etc)…
- Human error, workload, situation awareness, psychophysiology and operator state…
- Research tools and methods



Recent Knowledge - Examples

- Human Factors Design Guidance for Level 2 and Level 3 Automated Driving Concepts https://www.nhtsa.gov/document/human-factors-design-guidance-level-2-and-level-3-automated-driving-concepts

- Guidelines and verification methods for automated vehicle HMI (Transportation Research Part F, Naujoks et al., 2018)

- The challenge of advanced driver assistance systems assessment (Transportation Research Record, Biondi et al., 2018)

- 2017 & 2018 Forum on the Impact of Vehicle technologies and Automation on Users (AAA Foundation for Traffic Safety) https://aaafoundation.org/2017-forum-impact-vehicle-technologies-automation-users-summary-report/

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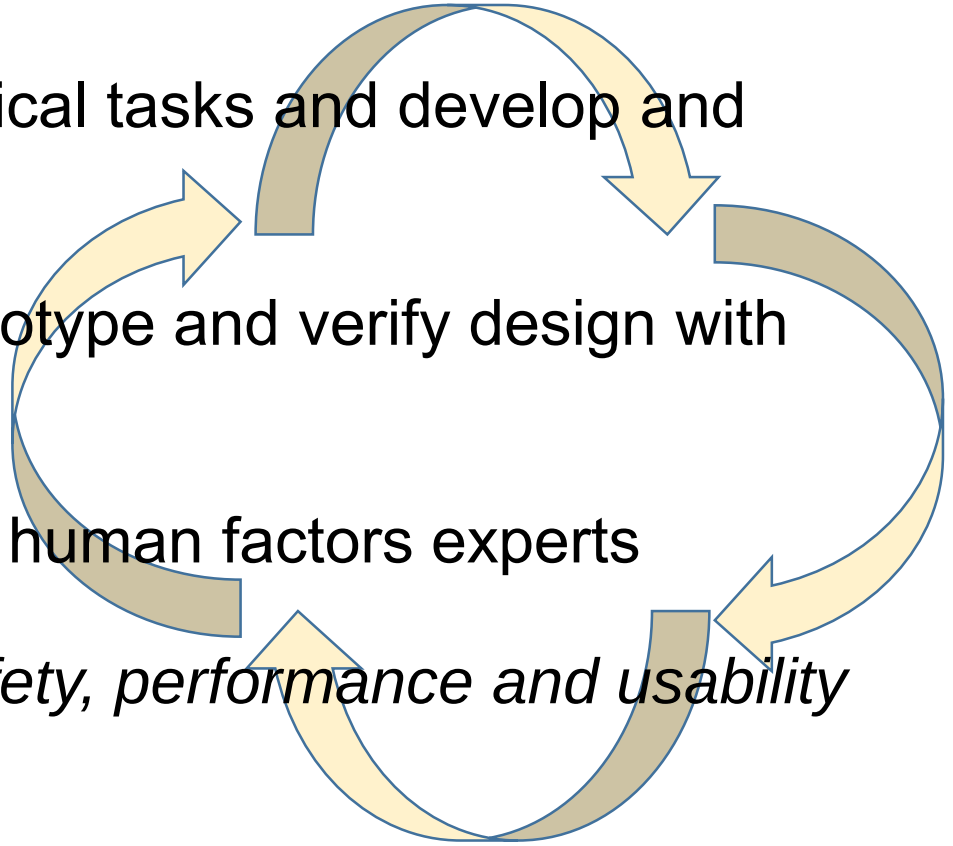
Human Factors (HF) Process Requirements

HF knowledge exists but it must be a priority and applied more effectively

- Established procedures to define intended users, user needs, use cases and interfaces
- Identify use-related hazards and categorize critical tasks and develop and implement risk mitigation or control measures
- Consult relevant guidelines and standards, prototype and verify design with user testing (real users) … **repeat**
- Document the whole process with sign-off from human factors experts



User experience (UX) design does not address safety, performance and usability

Safety Assessment for ADS in Canada

- A tool developed by Transport Canada to assist ADS developers in reviewing the safety of SAE level 3 to 5 automated vehicles they manufacture, import, operate and/or intend to sell in Canada

- Aligned with similar US policy measures to provide guidance while ADS technology is evolving and it is not yet appropriate to consider conventional regulatory approaches

- ADS Vehicles will still be required to comply with existing Canadian Motor Vehicle Safety Standards or obtain regulatory exemptions as necessary

- ADS equipped vehicles will also be subject to defect and compliance provisions of the Canadian Motor Vehicle Safety Act

To be published in the coming months

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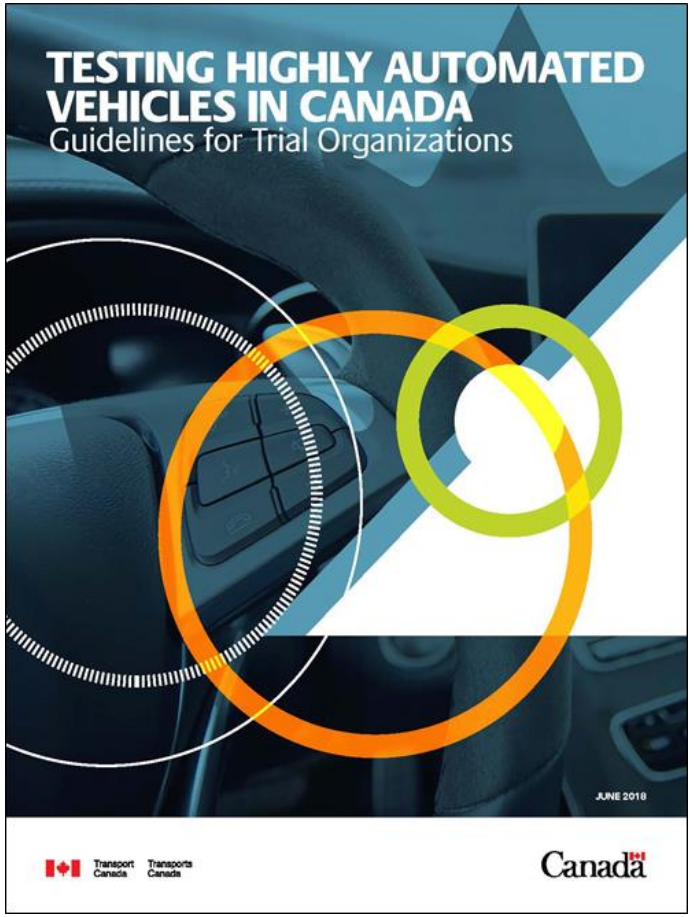
Testing Highly Automated Vehicles in Canada: Guidelines for Trial Organizations

Include several statements relevant to human factors:

- Apply to temporary trials of ADS and set minimum safety practices organizations are expected to follow in Canada.
- Recommendations:
  - Drivers be adequately trained and remain attentive during the trial operations, incorporating measures to manage fatigue and mitigate driver distraction
  - ADS is equipped to facilitate safe human-machine interactions; including clear and effective communication with passengers and other road-users
  - Safe transitions between automated and non-automated modes
  - Safely managing interactions with other road users, including vulnerable road users such as pedestrians and cyclists and protection of onboard users.



Published in June 2018

http://www.tc.gc.ca/en/services/road/safety-standards-vehicles-tires-child-car-seats/testing-highly-automated-vehicles-canada.html

Canadian Jurisdictional Guidelines for the Safe Testing and Deployment of Highly Automated Vehicles

- Recommendations on policy, legislative and regulatory issues for provinces and territories to consider to facilitate ADS testing and deployment.
- Key topics covered include:
  - Guidance on administration of testing and deployment
  - Vehicle credentialing
  - Driver licensing
  - Law enforcement and crash/incident reporting

Published in October 2018

https://ccmta.ca/en/ccmta-research-canadian-jurisdictional-guidelines-for-the-safe-testing-and-deployment-of-highly-automated-vehicles-now-available

Summary

- Bad design remains an issue and risks will likely increase with more complex automated driving systems
- A substantial body of knowledge already exists to address many of the human factors design needs for automated driving systems but a process is needed to ensure it is applied more effectively
- On-road testing with real users is an essential part of development
- International harmonized research efforts are needed to address the numerous research questions for automated vehicles.