AV Exterior Communications ISO TC 22/SC 39

GTB meeting

Lisbon, Portugal

November 28, 2018

John Shutko, chair ISO TC 22/SC 39

Outline

Introduction to ISO

Description of ISO TC 22/SC 39

AV Exterior Communication projects

National delegation work

Q & A

Introduction to ISO

22 000* International Standards

100 new standards each month

245* technical committees

We are an independent, non-governmental organization.

We are a global network of national standards bodies with one member per country.

Our job is to make International Standards.

We are coordinated by a Central Secretariat in Geneva, Switzerland.

We are not for profit: selling our standards allows us to finance their development in a neutral environment, to maintain them and to make new ones.

What is an International Standard?

An International Standard is **a document containing practical information and best practice.**

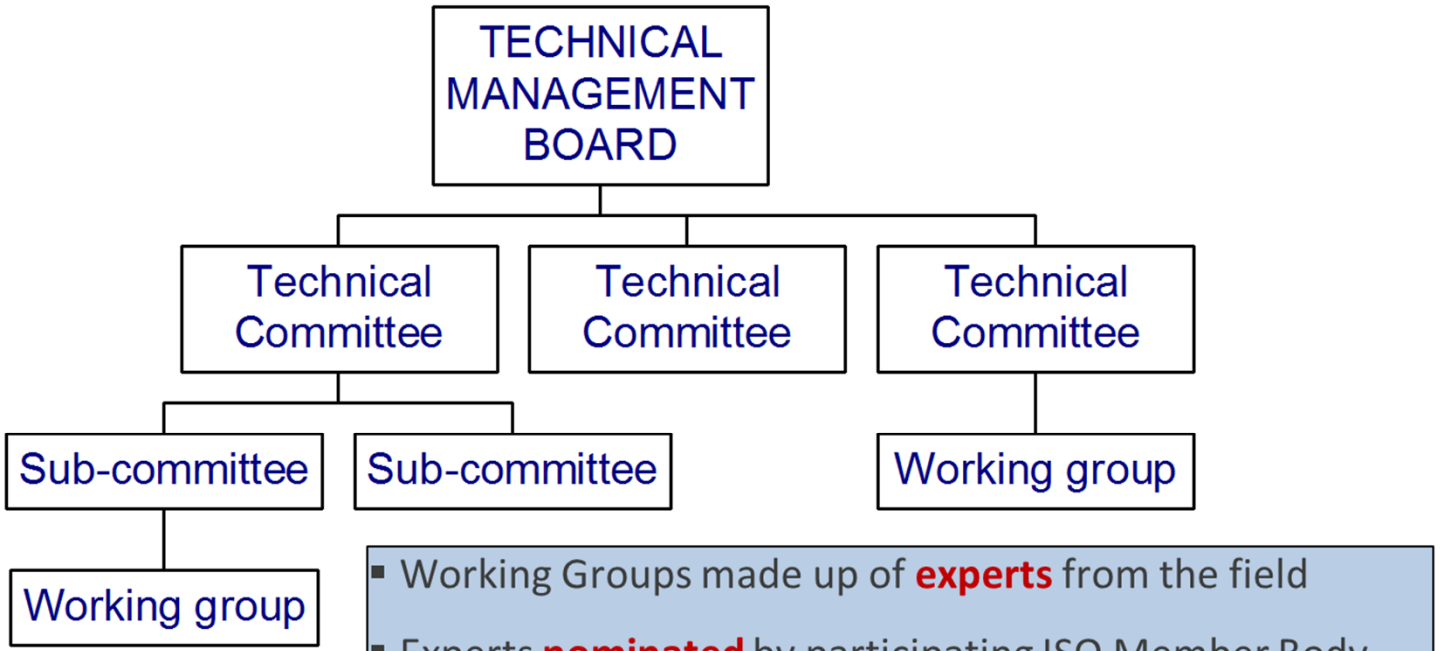
It often describes **an agreed way of doing something or a solution to a global problem.**

In short, ISO standards help:

- Make products **compatible**, so they fit and work well with each other
- Identify **safety issues** of products and services
- Share **good ideas** and **solutions**, technological know-how and best management practices

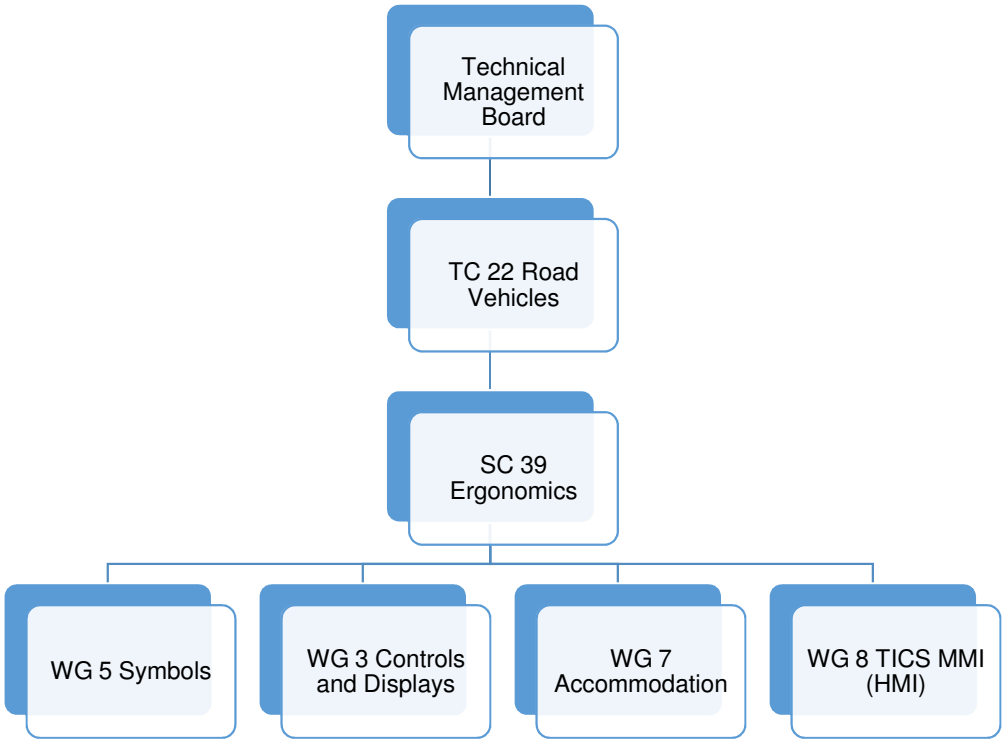
ISO TC 22 / SC 39

ISO Structure



- Working Groups made up of **experts** from the field
- Experts **nominated** by participating ISO Member Body
- Act in a **personal capacity** & expected to input know-how
- Can also be appointed by Liaison organizations

ISO TC 22 / SC 39



WG 8 Participants

Active Countries - 11

- Canada
- Czech Republic
- France
- Germany
- Israel
- Italy
- Japan
- Netherlands
- Portugal
- Sweden
- US

AV Exterior Communications Projects

Recently published

- ISO / TR 23049:2018, **Road Vehicles -- Ergonomic aspects of external visual communication from automated vehicles to other road users**

https://www.iso.org/standard/74397.html

Contents

New work item proposals

- Technical Report - Road Vehicles - Methods for evaluating other road user behavior in the presence of automated vehicle external communication.
  - 14 Approve
  - 0 Disapprove
  - 6 countries agreed to work on the document

Road Vehicles - Methods for evaluating other road user behavior in the presence of automated vehicle external communication.

- Research Approaches
  - Approach Introduction
  - Controlled Environment
  - Uncontrolled Environment
  - Future research approaches
- Independent Variables
  - Road User Types
  - Environment
  - Use Cases
- Dependent Variables
  - Encounter Classification
  - Environment
  - Encounter Partner Action
- Subjective Evaluation

New work item proposal

- Technical Specification - Road Vehicles – Ergonomic design guidance for external visual communication from automated vehicles to other road users.
  - 12 Approve
  - 7 Disapprove
  - 7 countries that agreed to work on the document
- Did not have 2/3 majority
- Plan to move forward as a Technical Report

Road Vehicles – Ergonomic design guidance for external visual communication from automated vehicles to other road users.

Outline

- Regulatory or standards considerations
- Cross-industry benchmarking
- Type of message
  - Intent
  - Visual
- Implementation
  - Message design
  - Location
  - Color

National Delegation Work

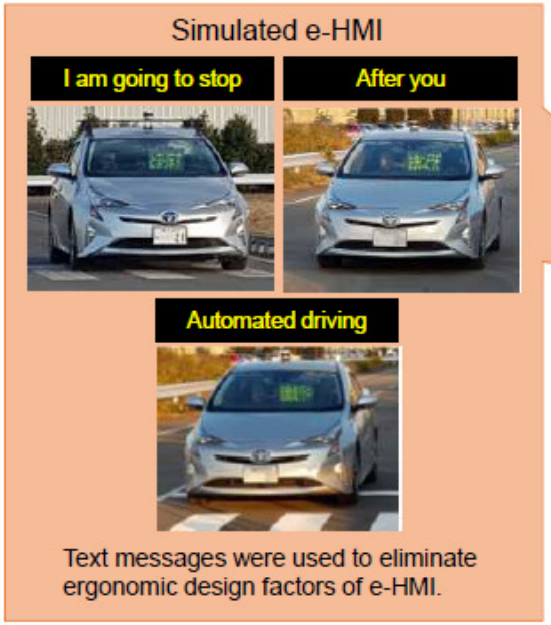
Japan

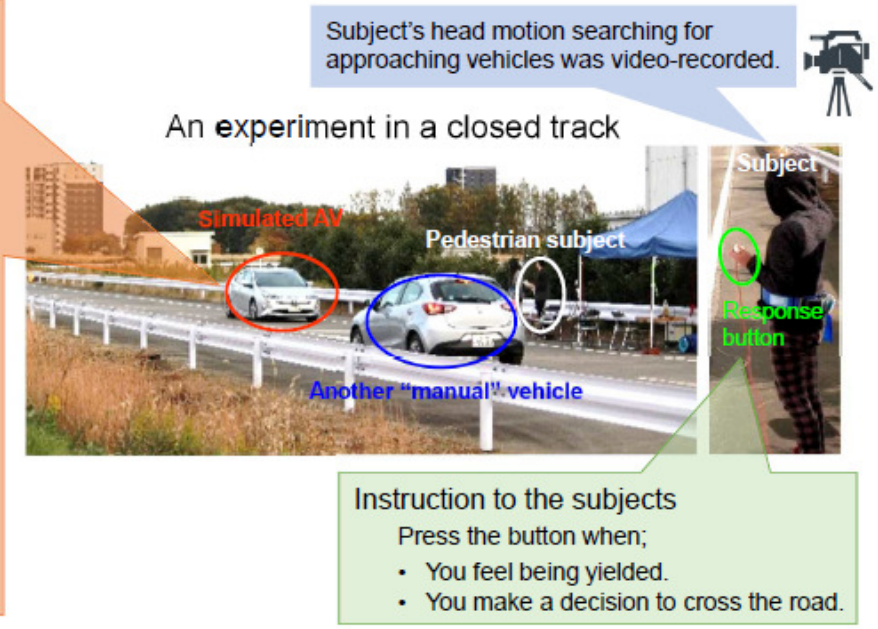
Satoshi Kitazaki

【JAPAN】 Pilot study: Negative outcomes of external communication

EXPERIMENTAL METHOD

- Simulated AV with a simulated external HMI approached an unsignalized crosswalk.
- There was another “manual” vehicle approaching the crosswalk from the other side.
- The subjects stood near the crosswalk and pressed a button when he/she felt being yielded and when he/she made a decision to cross.
- Subject’s head motion searching for other approaching vehicles was video-recorded.





RESULTS AND CONCLUSIONS

- The external HMI negatively influenced 14 subjects out of 56.
- The negative influence was defined as reduced number of checking for possible approaching vehicles before making a decision to cross (NB: the baseline was checking behavior without AV).
- Some subjects did not check the other side of the road at all.
- The subjects may have paid too much attention to the AV sending a message, resulting in poorer attentional allocation to other vehicles.
- No correlations to message meanings and pedestrian types have been found so far.
- Experiments with more subjects are being conducted.

★No check at all for the other direction

Sub No.	Age	Attributes	Gender	eHMI
15	10	School child	M	Automated driving
16	10	School child	M	Automated driving
37	8	School child	F	After you
				Going to stop
35	73	Older, non-licensed	F	Automated driving
25	46	Younger, Licensed	F	Automated driving
31	44	Younger, Licensed	F	Going to stop
46	29	Younger, Licensed	F	After you

★Reduced number of checking (only once for each direction)

Sub No.	Age	Attributes	Gender	eHMI
09	10	School child	M	After you
				Going to stop
23	77	Older, non-licensed	F	After you
24	68	Older, non-licensed	F	Automated driving
52	77	Older, non-licensed	F	Going to stop
45	21	Younger, non-licensed	F	After you
				Going to stop
20	31	Younger, Licensed	M	After you
54	35	Younger, Licensed	M	Automated driving

Portugal

Carlos Silva

ANPEB - Analysis of pedestrians-vehicle interaction in simulated urban environments

- The **main goal** of project **AnPeb** is to describe pedestrian and vehicle interaction at ***un-signalized crossings*** (no traffic lights), based on the analyses of the behavior of those agents (cars/pedestrians) at specific situations

- **Outputs:**

  1. Models describing pedestrian-vehicle crash risk (function individual characteristics and perceived risk, road geometry and type of pavement, vehicle traffic, pedestrians traffic);

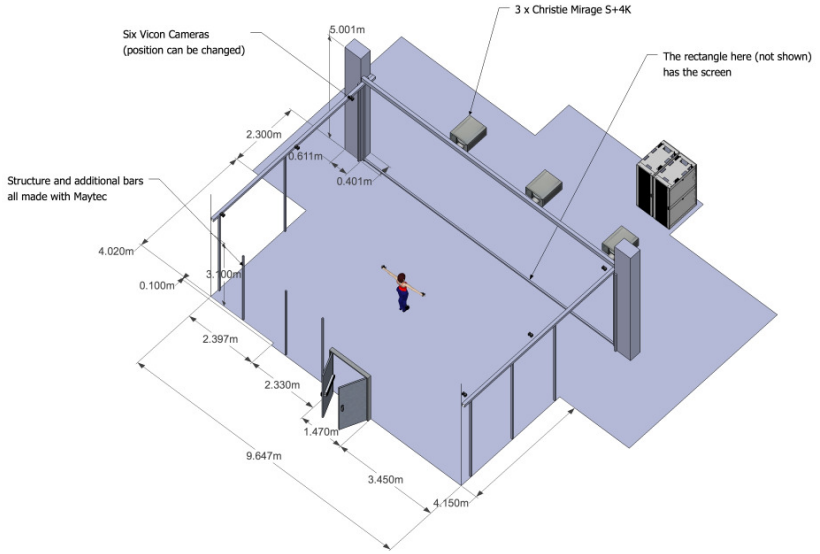
  2. A simulation tool to be used by technician and researchers.

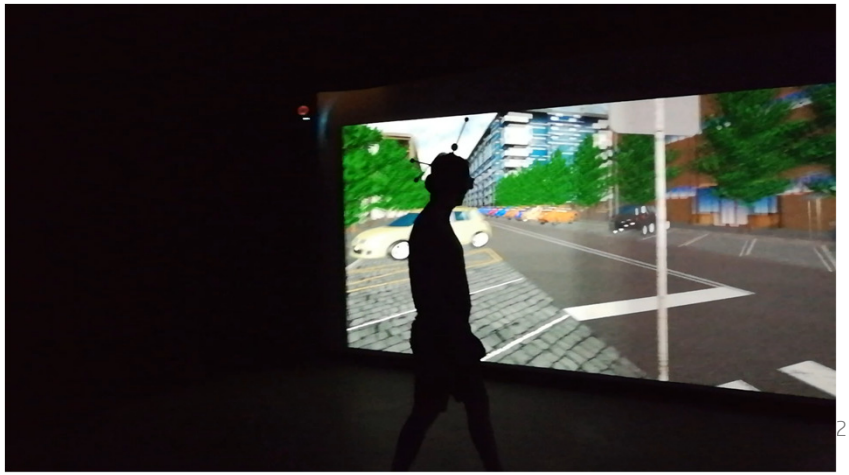
Behavior assessment in Simulated Scenarios

Condition Static – Comparison Test Environment

- Behavior measured in the VR scenario is similar to the one measured in the real-environment (when we analyze mean Time-to-contact at the moment of crossing)

With this result we assured ***relative validity***





Germany

Klaus Bengler

- There is a dilemma of consistency of eHMI of the near future and the existing knowledge for their design and usage
- The consistency between brands and the consistency of HMI on one vehicle has to be taken in to account
- Current research (e.g. Interact, IMAGINE, DFG, …) and discussion at conferences (IEA, HFES, …) has to be taken in to account
  But does currently not give clear guidance for designs
- It should be elaborated what has to be avoided
  signals conflicting with existing signals/regulations
- eHMI should not be the remedy for insufficient realization of AV function
- Proposed steps of action -> next slide

Topics – ISO WG8 Discussion

1. Legal Aspects (type approval, signaling)

2. Communicative needs, acts and messages
   - Who communicates what to whom, when for which reason

3. Technical realisations and requirements
   - Locations
   - Visualisation and Requirements

4. Evaluation methods
   - Scenarios
   - Setups (Laboratory, Simulator, Field)

5. Metrics
   - Measurements or Assessments
   - Statistical Procedures

Which existing (also international) legal aspects must be taken into account for eHMI?

Eventually methods and metrics have to be clarified in parallel order ahead of technical aspects.

Sweden

Patrik Blomdahl

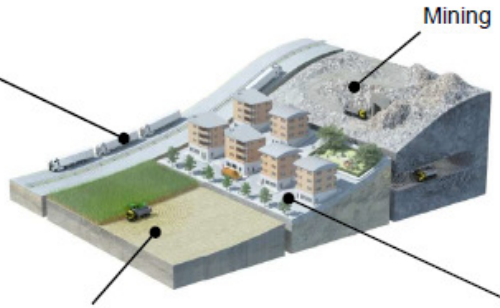
Transports with Automated Vehicles with need for External Communication

Long haulage with Platooning & Hub to Hub

Use cases & Statistics from Volvo Trucks Accident Research Team (ART)

Logistic centers

Vehicle types:



City distribution

Trucks

Buses

Construction Equipment

Use cases & Swedish research related to Automated Vehicle communication

Habibovic et al 2018 -Communicating Intent of Automated Vehicles to Pedestrians

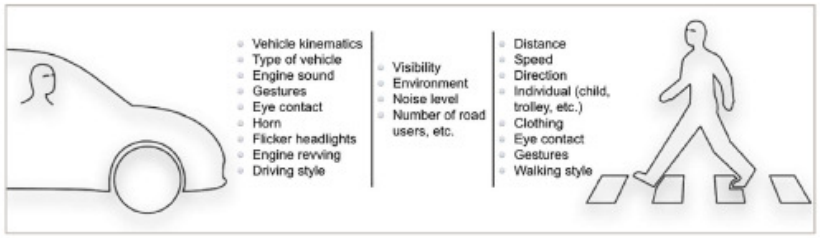
Exterior (A) & interior (B) of the test vehicle, and the test environment in Experiment 1 (C) 2 (D).

Pedestrians' needs in interaction with AVs	Functional requirement
• Pedestrians should be able to easily distinguish if a vehicle is in manual or automated driving mode. This will keep the positive effect of eye contact in manually driven vehicles, and avoid possible dangerous situations due to a mismatch between the "driver's" and the AV's behavior.	Show when a vehicle is in automated driving mode
• Pedestrians need to obtain information about AVs future state (i.e., their intent and plans) rather than their current state. This, since the current state is directly observable from the vehicle's movement, while the future state may be difficult to predict due to the lack of driver-centric cues.	Show future state of the AV
• Pedestrians should be provided with information that eliminates the need of seeking eye contact in encounters with AVs. This, since it may be difficult for them to deduce any accurate/useful information from the eye contact with the "drivers" in AVs.	Replace the eye contact
• Pedestrians should not be told explicitly when/where to cross the street in encounters with AVs. This, since other road users might pose a risk to the pedestrians that is not known by the AV.	Not urge pedestrians when/where to cross (i.e., just communicate the AVs intentions)
• Pedestrians should experience encounters with AVs as calm and not stressful. Calm pedestrians are more likely to make safe and predictable decisions.	Enable a calm interaction

Pedestrian needs in interaction with AVs

In addition, different signal characteristics such as frequency, area, color, and intensity have been explored. By changing the frequency and area of a signal, it is possible to make pedestrians aware of changes in the intention of AVs. In the traffic environment, several colors are already used for certain types of signals. To avoid a mix up, the following colors were excluded: red (prohibited to use in the front of the vehicle), green (strong connection to traffic signal light), blue (used by emergency vehicles, least suitable wavelength for human eyesight), and amber (used by service vehicles). Taking this into account, the choice was to use a white/yellow color for communicating all messages.

Recommended signal characteristics



Cues that are important for pedestrian interaction

France

Laurette Guyonvarch

Benefits of rear E-HMI for MRM scenarios

Objectives

- Evaluate benefits of rear E-HMI in mixed traffic, high speed scenario
- Evaluate understanding of AV intent and behavior during MRM
- Assess drivers' acceptance of external HMI

Results

- E-HMI decreased reaction time
- Early understanding of situation emergency with E-HMI
- E- HMI preferred to current HMI

Study

- Comparison of driver behavior with and without specific HMI in a driving simulator
- Interviews + questionnaires on drivers acceptance

Without E-HMI

With E-HMI

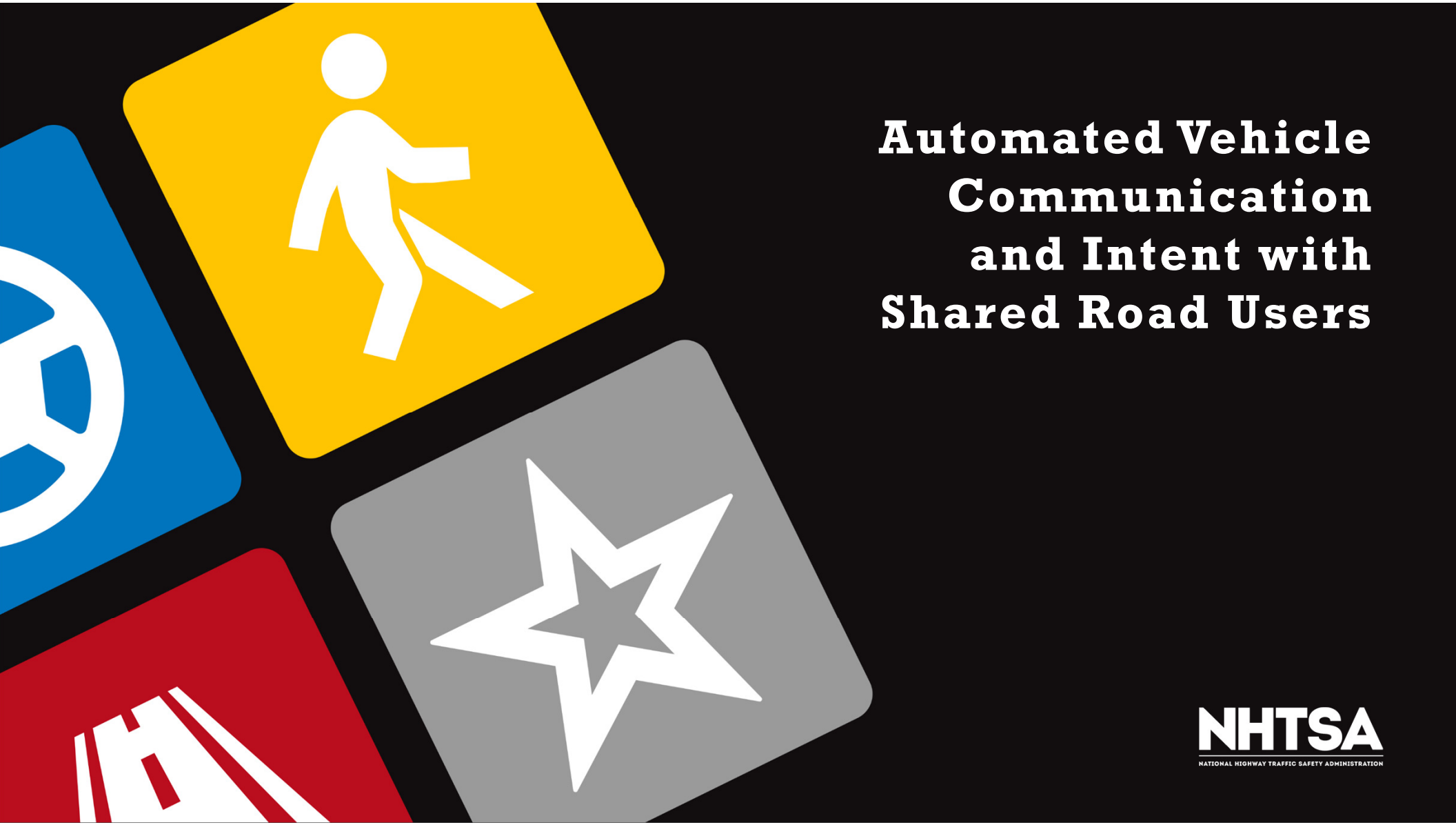
Contacts

arnaud.koustanai@lab-france.com
laurette.guyonvarch@lab-france.com

LAB
ACCIDENTOLOGIE, BIOMÉCANIQUE, COMPORTEMENT HUMAIN

US

John Shutko



Automated Vehicle Communication and Intent with Shared Road Users

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Objectives

- Identify key pieces of information for the AV to communicate to shared road users
- Identify ways to measure communication effectiveness between the AV and shared road users
- Provide research to inform human factors guidance regarding communication of AV intent

UMTRI / Westat project team

Project to be completed: July, 2019

Studies

- Study 1: Structured Interviews of Driver Evaluation Experts – [completed]
- Study 2: Shared Road Users' Determination of Intent of Other Vehicles (Field Study of drivers, pedestrians, bicyclists) – [data collection complete, analysis in progress]
- Study 3: Testing Concepts for Communication of Intent (Lab Study) – [set up in progress, using projected dynamic video images]

Contact

JamesJenness@Westat.com

Recent VR Study

- Goals
  - Can previous VR study results hold with more complex scenarios?
  - Do light bar signals enable more 'trust/acceptance' of AVs?
  - Can these signals be learned?
- Trust
  - Positive impact
- Learnability
  - ~ 2 exposures for single signal
  - 5-10 exposures for all signals
  - The signals are comforting, help people understand what the vehicle will do

Q & A

John Shutko
jshutko@ford.com