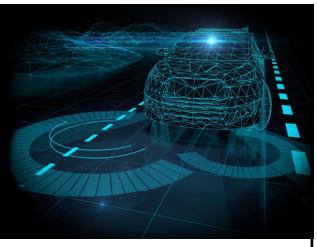
Inclusive Design of Autonomous Vehicles: Summary Presentation

Prepared for Great Lakes ADA Center



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About the Event

Four-part series:

- March 10, 2021
- March 24, 2021
- April 7, 2021
- April 21, 2021

AV Portal Page:
https://www.access-board.gov/av/

Accessibility for Passengers with Mobility Disabilities: Part 1
- Entering and exiting autonomous vehicles

Accessibility for Passengers with Mobility Disabilities: Part 2
- Maneuvering and securement in vehicles and continued discussion of entering and exiting autonomous vehicles.

Accessibility for Passengers with Sensory and Cognitive Disabilities: Part 1
- Ride hailing and on-board communication for passengers with hearing, visual, or cognitive disabilities.

Accessibility for Passengers with Sensory and Cognitive Disabilities: Part 2
- Continue discussion of communication accessibility in hailing and interacting with autonomous vehicles for passengers with hearing, visual, or cognitive disabilities.

Online Dialogue

Summary Report

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Opening Remarks

"We have an opportunity to incorporate access, equity and accessibility for all from the beginning of our coming major policy and technology decisions."

- United States Secretary of Transportation

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Other Opening Remarks

Gregory S. Fehribach,
Chair of the U.S. Access Board

Robin Hutcheson,
DOT Deputy Assistant Secretary for Safety Policy

Jennifer Sheehy,
DOL Deputy Assistant Secretary of Office of Disability Employment Policy

Dr. Victor Pineda,
U.S. Access Board Public Member
Professor of Urban Planning at UC Berkley

Karen Tamley,
U.S. Access Board Public Member
CEO of Access Living

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Accessibility for Passengers with Mobility Disabilities

- Randall Duchesneau, U.S. Access Board
- Dr. Victor Paquet, University at Buffalo
- Kevin Frayne, BraunAbility
- Scott Windley, U.S. Access Board
- Bryan Brilhart, Robotic Research
- Dr. Kathleen D. Klinich and Miriam A. Manary, University of Michigan
- Dr. Jordana Maisel, University at Buffalo

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Randall Duchesneau, U.S. Access Board

Links:

ADA for Transportation Vehicles (1991, 1998)
Updated guidelines for buses and vans (2016)
https://www.access-board.gov/ada/vehicles/

- Boarding and alighting using a ramp or lift capable of deployment to the roadway
- Slip resistant surfaces, openings less than 5/8" sphere, max. changes in level 1/4" vertical or 1/2" beveled
- Level boarding easiest; coordinate vehicle floor heights with boarding platforms
  - Gap no greater than 2" horizontally and 5/8" vertically, otherwise use ramp to span gap
  - Adjustable vehicle ride height
- Doorways – 32" min. clear width, contrasting color stripe,
- Vertical clearance – 56" for smaller vehicles, and 68" for larger vehicles
- Ramps – permitted to fold or telescope, designed to support 600 pounds, capable of manual operation in case of power failure, clear width of 30" min., edge guards 2" high min., visual contrast striping along perimeter of ramp
- Lifts – comply with NHTSA's FMVSS, permit boarding toward or away from the vehicle
- Shielded lights to illuminate ramps, doorways, boarding areas

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Dr. Victor Paquet, University at Buffalo

Study 1: Effects of ramp slope on human performance during ramp ascent and descent.

Study 2: Effects of a different multi-segmented ramp configurations on human performance during boarding and exiting a simulated vehicle environment

- Ramp slopes of 1:8 and 1:12 were easiest for all users groups
- 33% could not independently complete a 1:4 slope, and 15% could not independently complete a 1:6 slope
- Power wheelchair, visual, and ambulation aid users rated descent more difficult than ascent
- Recommend **Maximum slope for vehicle ramps of 1:6**, with less severe slopes preferred

- Ramp deployment to street level, 3.3", 4.5", 6", and 8" curb.
- Ramp ascent times for manual wheelchair and scooter users were lower as slope decreased, Ramps deployed to the curb had lowest ascent times
- 6" and 8" curbs rated as moderately easy, 20% of manual wheelchair users required assistance even for 4.5" curb
- Ramps that created uneven floor surfaces within the vehicle during deployment could create trip and fall hazards and reduce clear floor space for turning and maneuvering inside the vehicle.
- **Use of curbs will support easier entry and exit.**

- Ramp storage areas in the floor compete with batteries – consider incorporating automated ramps into vehicle design
- **Use pickup/drop off location with curb or elevated platform to reduce ramp slopes**, provide adequate space to maneuver on/off ramp within pedestrian right-of-way

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Kevin Frayne, BraunAbility

The ideal solution is to get a step-in design on an AV that can support a ramp angle that is going to work for wheelchair users.

Geometry defines what accessible solutions you can go with (lift vs. ramp)

- Vehicles that can achieve **8" - 10" step-in height** can use ramp
- Wheelchair users and advocate community asking for ramps
- **Vehicle interior height 59" to 61"**
- Underfloor batteries
  - Challenging to achieve step-in height of 8" - 10" suitable for ramp
  - Tend to preclude easily attaching lifts, ramps or wheelchair securement systems because critical components under floor that you need to stay away from.

- BraunAbility Solutions
  - 20mm bondable flooring solutions, stays above batteries and gives new surface to attach lifts, ramps, and wheelchair securement solutions
  - Folding ramps
  - 50mm ultrathin in-floor ramp solution above the battery but below the floor.

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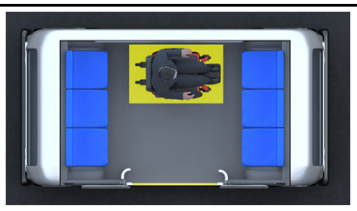
Scott Windley, U.S. Access Board

Maneuvering & Securement:

Providing a passenger access route with sufficient clearance to permit a wheelchair user to get from the door of the vehicle to the wheelchair space for securement, and then back to the door for exiting



- Wheelchair space 30" min. in width by 48" min. in length
- One unobstructed side of each wheelchair space must adjoin or overlap passenger access route
- Securement system that is front-facing
- Recommended to provide turning space inside the vehicle

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Bryan Brilhart, Robotic Research

Robotic Research is an autonomy provider, technology company, and developer of unmanned systems for both military and commercial applications

Ex. autonomy in Local Motors low speed shuttle

New Flyer Excelsior AV

- Automated electric bus released in 2021
- Precision docking - Bus can pull up to boarding platform with very close tolerances, repeatable process, level, safe boarding at every stop

Paralift

- Automatic loading and securement system
- Intuitive design, wheelchair user can enter and exit vehicle with out aid from another person
- Sensors, automatic door opener, powered wheelchair lift, automatic securement, phone app, buttons, voice control

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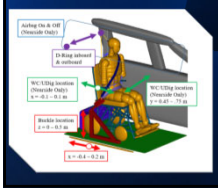
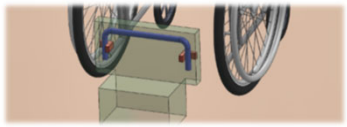
Dr. Kathleen D. Klinich and Miriam A. Manary, University of Michigan

Automated wheelchair tiedown and occupant restraint system





- Transfer from wheelchair seat to vehicle seat if possible
- Wheelchair should be WC 19 crash tested
- Secure wheelchair, and separately secure occupant
- **Universal Docking Interface Geometry (UDIG)** – truck trailer hitch for wheelchairs
- Goal: safe, automated wheelchair docking station
- Currently evaluating front and side impacts
- Placement of UDIG in relation to wheelchair, and occupant in relation to seatbelts
- "Center airbag" to protect during side impacts

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Jordana Maisel, University at Buffalo

Maneuvering and securement on fixed route buses

- Keep the entire travel chain in mind
- Interior seating layout/configuration
  - Ramp at front only, ramp at front and rear, ramp at rear
  - Front facing or side facing seats
  - Challenges with narrow turning space
  - Side facing seats less desirable (wheelchair)
  - Side facing seats preferred (blind)
- Securement systems and securement time (lab)
  - Four-point (slowest), three-point, semi automated rear facing (fastest, most preferred)
- Field testing securement systems for different wheelchair users
  - **Semiautomated preferred by manual and power wheelchair users, but rated more difficult by scooter users**
  - Safe, easy, but difficult to identify where bus is going and where to get off; not preferred by scooter users

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Accessibility for Passengers with Communication Disabilities

- Dr. Cecilia Feeley and Andrea Lubin, Rutgers University
- Dr. Robin Brewer, University of Michigan
- Anil Lewis, National Federation of the Blind
- Dr. Christian Vogler, Gallaudet University
- Dr. Aaron Steinfeld, Carnegie Mellon University
- Dr. Gregg Vanderheiden, University of Maryland
- Darryl Cooper, Disability Rights Office, Federal Communications Commission
- Ted Guild, World Wide Web Consortium (W3C)
- Bruce Bailey, U.S. Access Board

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Dr. Cecilia Feeley and Andrea Lubin, Rutgers University

Feedback from focus groups of persons with developmental and visual disabilities after taking an AV shuttle ride

- Majority of participants do not use personal assistance for current modes of transportation
- DD – Want option to have **family member** along while getting used to new technology, would not need personal assistance long term
- VD – Would like **assistance** to operate doors, guide to available seats, manage luggage, and to secure mobility devices
  - Want steps with contrasting texture and color, handrails, non-slip finish, and short distance between the floor of the AV and the ground
- Prefer to schedule trips and indicate destinations with **personal smart phone**
- Should be several options for paying, cash, smart cards, paying via smart phone
- Safety concerns and questions most discussed
  - On-board cameras to capture safety-related issues
  - Remote assistance similar to AIRA, (app that allows remote assistance via a smart phone camera)
  - Access to call center with live operator assistance in case of emergency.
  - Might need personal onboard attendant to handle emergencies.
- Conversational engagement with vehicle (weather etc.)

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Dr. Robin Brewer, University of Michigan

Feedback about designing AVs and ridesharing experiences from focus groups of persons who are visually impaired

- Some expressed preference for semi-autonomous vehicles (having control equates with independence)
- Concerns about having **control** over the vehicle if vehicle malfunctions or misinterprets actions
- Suggested solutions based on existing AT, screen readers, refreshable braille displays
- Passengers with VI currently help drivers find them and must direct drivers to pick-up or drop-off locations because GPS accuracy insufficient
- Drivers often help passengers to destinations once the vehicle has arrived and are asked to help with luggage
- Drivers expressed preference to know about passengers' disabilities ahead of time but understood passengers might not want to disclose for fear of discrimination
- Replacing humans with algorithms that use AI may not solve the problem of discrimination.

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Anil Lewis, National Federation of the Blind

Take an imaginary virtual trip in an AV as a passenger who is blind

- **Accessible App** for requesting ride; telephone option for less tech-savvy.
- To locate the correct AV, the **app could have the AV sound its horn/chirp**, or use **haptic vibrations** that change frequency as person moves toward/away from correct AV; less tech-savvy may need personal assistance
- Consideration needed for entering AV if shape is different from current cars/buses
- Passenger could be provided **orientation** description for the inside of the AV ahead of time, or there could be **audio description on demand**
- Accessible controls - **tactile knobs or buttons w/ tactile symbols**; touch screens (good for those familiar with using them); speech commands w/ verbal feedback
- All functions and information provided by AV to passengers must be accessible to passengers who are blind; Controls and information provided should be **customizable**; if don't want to hear points of interest should be able to turn off
- Don't base research solely on persons who have not had mobility training
- Getting passenger from AV to final destination might not be responsibility of the AV; passengers could use AIRA or Be My Eyes, apps allowing sighted assistance remotely via a smart phone camera.

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Dr. Christian Vogler, Gallaudet University

Research considerations for providing functionally equivalent service in AVs for persons who are deaf or hard of hearing

GALLAUDET UNIVERSITY
TECHNOLOGY ACCESS PROGRAM

- Voice command interface systems will not work for deaf/hard of hearing, Gallaudet researching using a limited set of gestures, signs, and tactile methods to replace voice control
- Appropriate visual information must be provided, but don't want visual modality to be overloaded/too distracting
- Display **relevant** information, **prioritize** visual information, and provide functionally **equivalent** service
- Monitors could be used, consider screen real estate - Too many controls? Which can be hidden?
- Consider how hearing aids and cochlear implants can get an effective, clean feed from the AV; **Direct connections** should be considered, but user may have to choose between communication from AV or people around them
- Future design must fully integrate the idea of **multiple audio output** options and support them in parallel
- Communication systems for communicating with outside world must provide **audio alternatives** such as video and text capabilities and cannot be voice activated only

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Dr. Aaron Steinfeld, Carnegie Mellon University

Communication Accessibility in Hailing and Interacting with Autonomous Vehicles

- Core issue: getting vehicle to come and pick you up
- **Use best practices in smartphone apps, websites, kiosks**
- Users often don't know what features are available
- Requesting service via conversational agents still need key advances to be practical (complex time)
- Challenges navigating from and through **crowded transportation hubs** to the correct curb location and rendezvous with AV
- Advances being made by AI, with learning commonly used destinations and services, and with learning personal interaction preferences.
- Still unresolved ethical and legal concerns for privacy and data retention with sharing preferences shared with third-party systems.
- Communication to passenger and bystanders (Ex. AV pulling over because of rain)
- **AI assistant jumping** from phone to vehicle, unintentional disclosure of information to other passengers in a shared ride

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Gregg Vanderheiden PhD, University of Maryland

Cognitive Access to Autonomous Vehicles

- Addressing the needs of cognitive disabilities will result in much more useable products for everyone
- Cognitive disabilities often in combination with physical/vision/hearing/speech disabilities, need a **spectrum** of interface solutions
- Problems occur en-route (change mind/panic), best solution will involve people (sign language, "on-call person" familiar with rider)
- Accents, no English (foreign language or ASL), unfamiliar with apps, easily confused, no ability to give instructions, too much noise
- Solutions: use **ultra simple interfaces**, layered interface, no reading required, everything presented in voice/text/sign, cue and respond approach, able to silence features, **able to request human assistance**
- "**Trip Tags**" (physical token or electronic device) might be used to facilitate communication between passenger and AV, send ride updates to someone monitoring , restrict ride changes etc
- Concerns for privacy and potential for data abuse

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Darryl Cooper, FCC

- Communication: two-way interaction, in real or near real time, between 2 or more people
- Phones, VoIP, email, text messaging, Internet browsers
- Service providers have flexibility in coming up with solutions
- Voice activation, automatic speech recognition, real-time text
- Accessibility solutions for interacting with AV could be the same ones to meet FCC requirements for Communication services
  - Ex. Interface to make a call could be same interface to vehicle
- In car entertainment: closed captioning, audio description, emergency broadcast, user interfaces devices and program guides

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Ted Guild, World Wide Web Consortium (W3C)

W3C leadership in codifying website accessibility is being leveraged in other areas of ICT

- "Internet of things" (IoT), and the implications for automotive and transportations industries
- Automotive Working Group and Web Accessibility Initiative (WAI)
- Now is the right time to be factoring accessibility into the data model design
- Geospatial data considerations must include granular location, building drop-off and pickup considerations, accessible routes, and accessible means of egress

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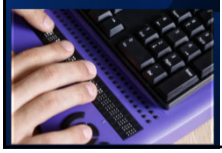
Bruce Bailey,
U.S. Access Board

Link:
https://www.access-board.gov/ict/



- Section 508 definition of ICT and how it builds on the Clinger-Cohen definition for IT
- Section 508 requires ICT be accessible to individuals with disabilities
  - Establishes base metrics for accessibility
  - Addresses information kiosks and other hardware
- Could be used to assess accessibility of AV

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Questions?

duchesneau@access-board.gov
https://www.access-board.gov/av/

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National Network
Information, Guidance, and Training on the Americans with Disabilities Act

August ADANN 30th Anniversary Session

Webinar: ADA National Network 30th Anniversary Series: Spotlight on Webinars and On-Line Courses

Tuesday – August 24, 2021
2:00 PM - 3:30 PM [Eastern Time]

Register & More:
www.ada-audio.org

Celebrating 30 Years! National Network
Americans with Disabilities Act Guidance and Training

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Audio Conference Series

Next Session:

Tuesday, September 21, 2021

Best Practices for Ensuring Students with Food Allergies have the same Opportunities in Higher Education

Registration available at: www.ada-audio.org

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