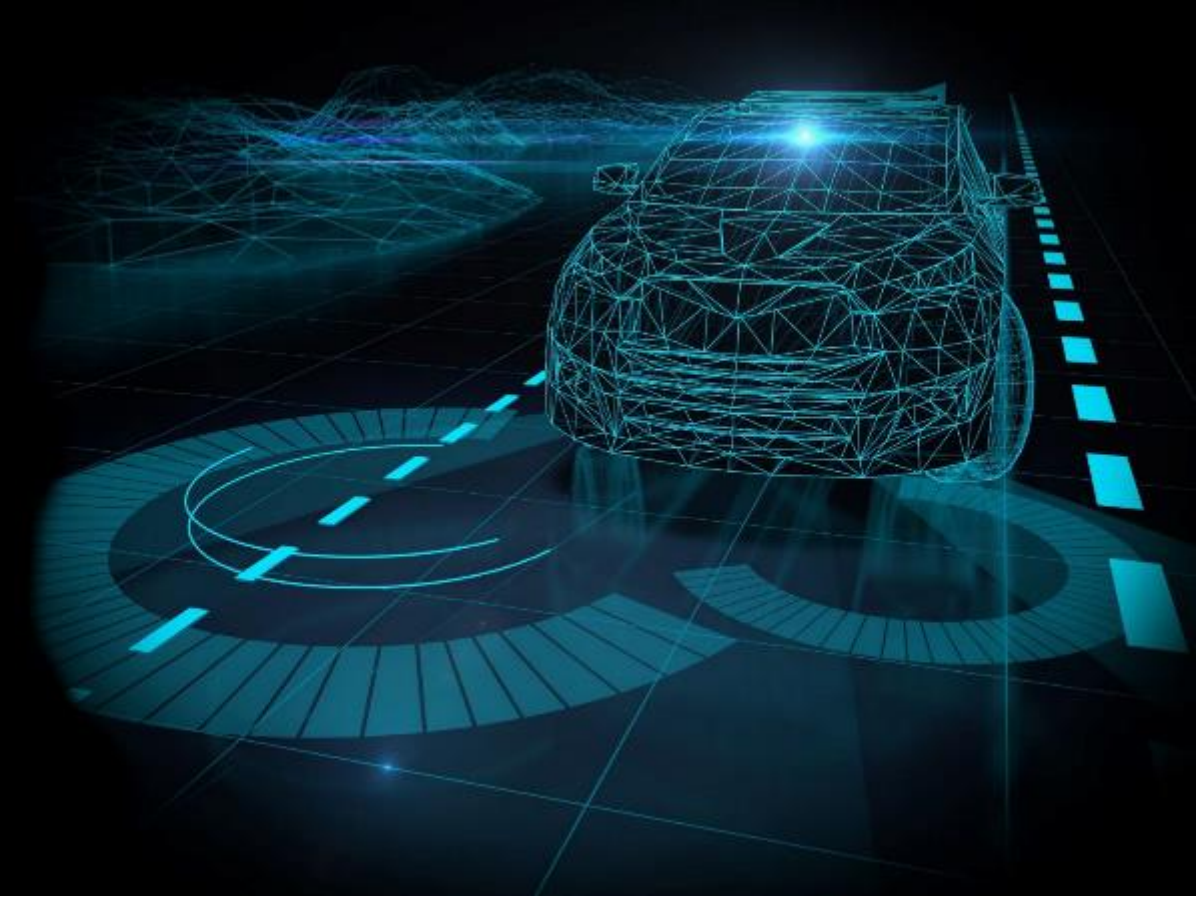
The event will begin momentarily.

- This event is being recorded
- Captions are available by clicking the CC icon in the Zoom toolbar below
- ASL is provided
- For more information and to download presentation materials visit: www.access-board.gov/av

Inclusive Design of Autonomous Vehicles: A Public Dialogue



Accessibility for Passengers with Mobility Disabilities: Part 2
Maneuvering and Securement

Agenda

- Presentations
  - U. S. Access Board – Scott Windley
  - Robotics Research – Bryan Brillhart
  - Q & A
  - University of Michigan – Dr. Kathleen D. Klinich and Miriam A. Manary
  - Q & A
  - University at Buffalo – Dr. Jordana Maisel
  - Q & A
- Open Dialogue
- Dialogue continues online
  - https://transportationinnovation.ideascale.com/

PowerPoint slides available for download at:
www.access-board.gov/av

How to Participate

- Ask Questions to Presenters
  - Submit questions using Zoom's Q & A feature throughout the event
    - Ex. "Question - What are wheelchairs?"
    - Ex. "Question for Presenter 1 – Did your study look at scooters?"
  - Moderator will read question
  - May not get to all questions
  - Alternative: Email events@access-board.gov
- Contribute to Open Discussion
  - Request to speak using Zoom's Q & A feature
    - Ex. "Microphone - I'm Beth from XYZ Company and would like to talk about automated doors"
    - Ex. "Microphone - I'm Alex and I'd like to share my experience using an AV"
  - Host will enable your microphone
  - Moderator will call on you to unmute and speak
  - ASL – if you wish to be visible for signing, indicate in request
- Online dialogue
  - http://transportationinnovation.ideascale.com/
  - For assistance, email: ePolicyWorks@dol.gov

Existing Accessibility Guidelines

- ADA Accessibility Guidelines for Transportation Vehicles (1991, 1998)
  - www.access-board.gov/ada/vehicles

- Updated Guidelines for Buses and Vans (2016) (not yet adopted by DOT)
  - www.access-board.gov/guidelines-standards/vehicles/update-buses-vans/guidelines-text

For technical assistance on these guidelines:

- 800-872-2253 (v)
- 800-993-2822 (tty)
- ta@access-board.gov

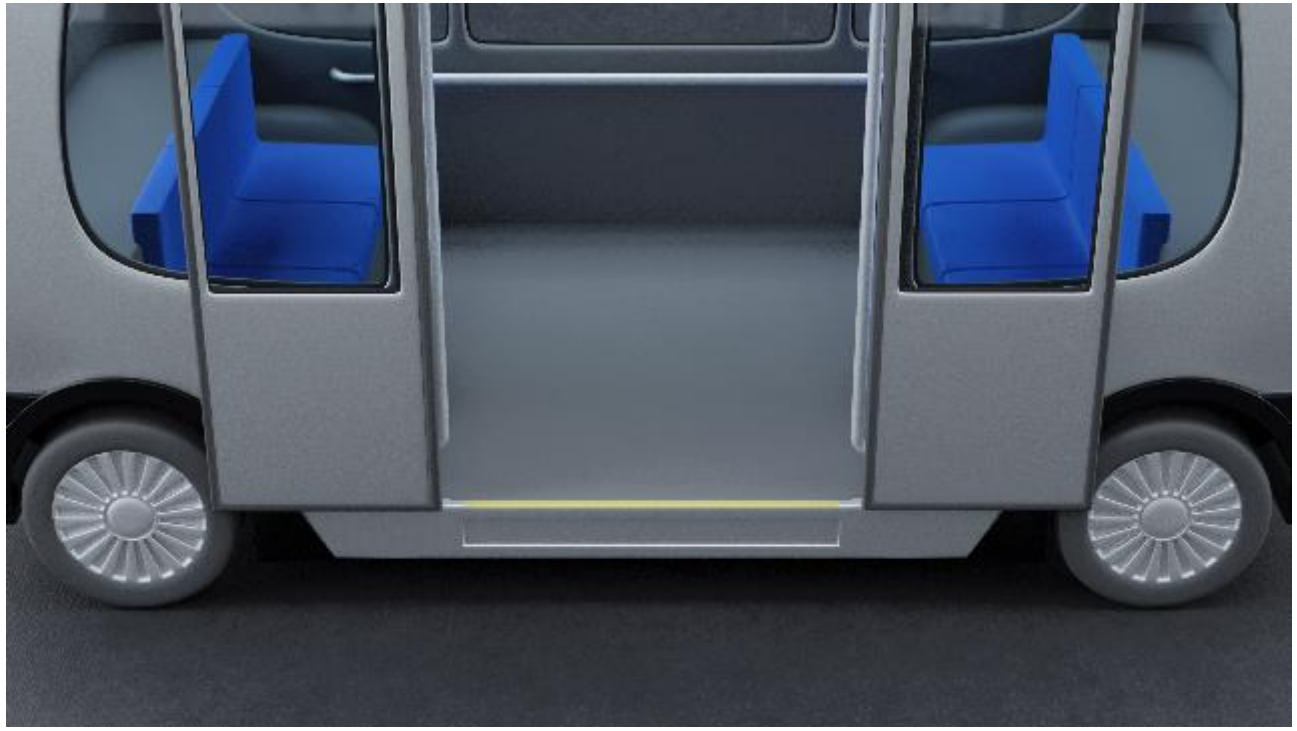
U. S. Access Board: Accessibility Guidelines for Buses and Vans

Scott Windley, Accessibility Specialist

Boarding and Exiting

Technical Criteria

- Walking Surfaces
- Passenger Access Route
- Maneuvering Through Vehicle
- Securement Location Size
- Means of Securement



Maneuvering and Securement

- Maneuvering so that wheelchair users can get from door to securement space.
- Means of securement.

Maneuvering

Passenger Access Route

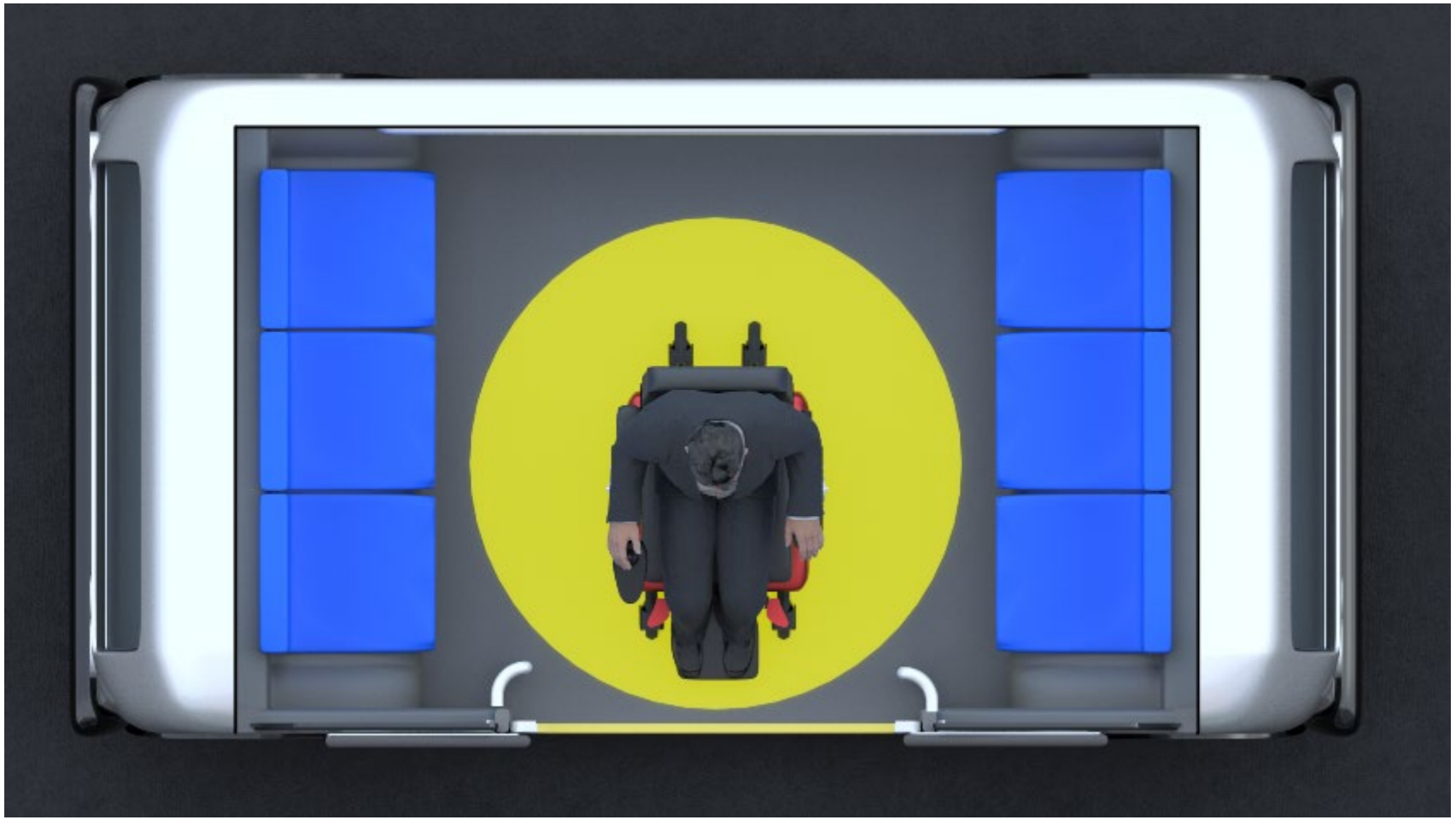
Sufficient clearances to permit passenger using a wheelchair to:

- **Get from doors to wheelchair space**
- **Position for securement.**
- **Back to doors for exit.**

Recommendation

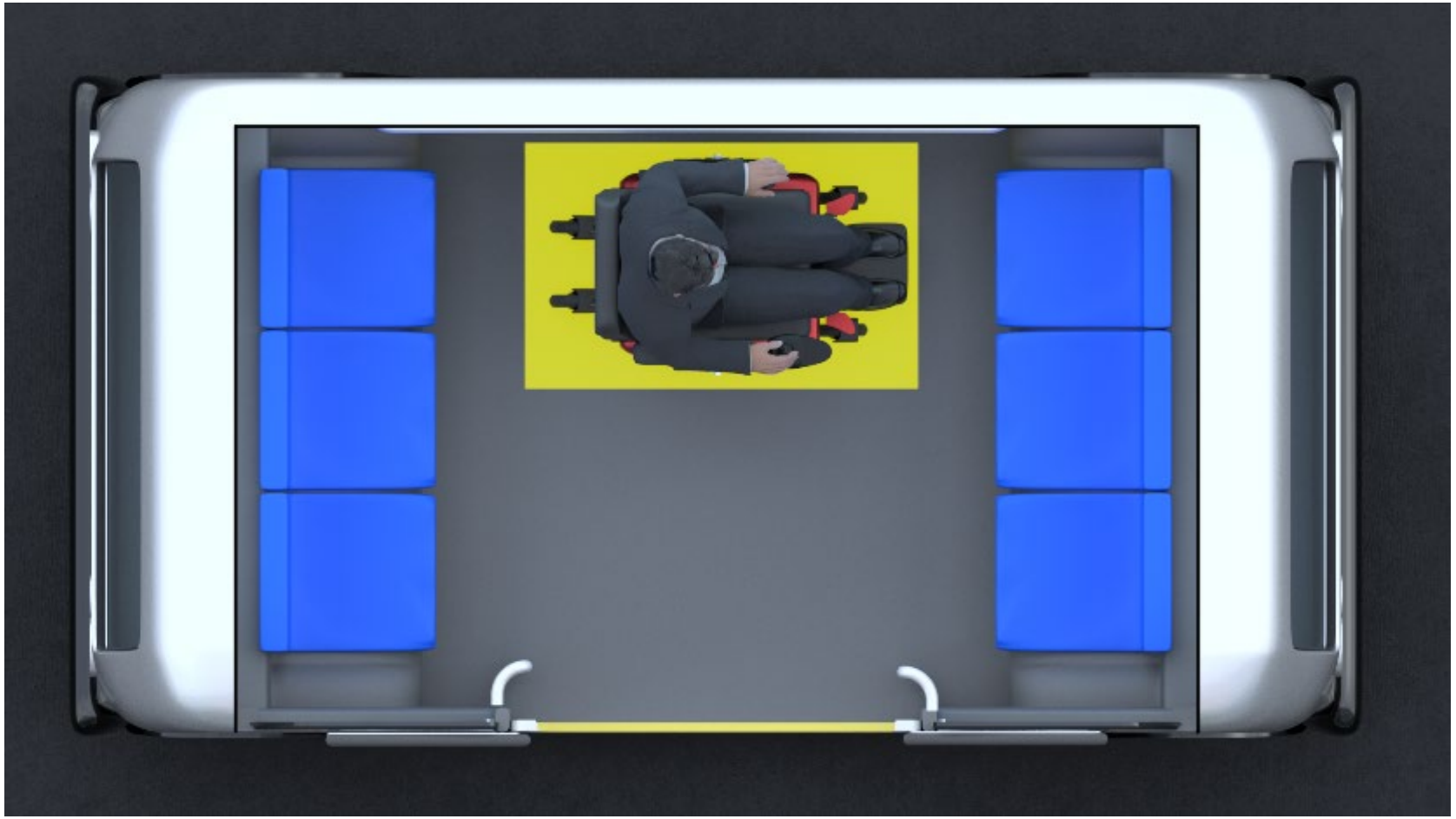
Turning Space

If there is room a turning space would provide greater maneuvering ability.



Wheelchair Location and Securement

- One unobstructed side of each wheelchair space shall adjoin or overlap a passenger access route.
- Wheelchair spaces shall be 30 inches min. width and 48 inches min. length.
- Securement System (front facing).



Maneuvering & Securement

Bryan Brillhart

Robotics Research


ROBOTIC RESEARCH
PARALIFT®
PARATRANSIT TRANSPORTATION
WITH AUTOMATED WHEELCHAIR ACCESSIBILITY

ROBOTIC RESEARCH

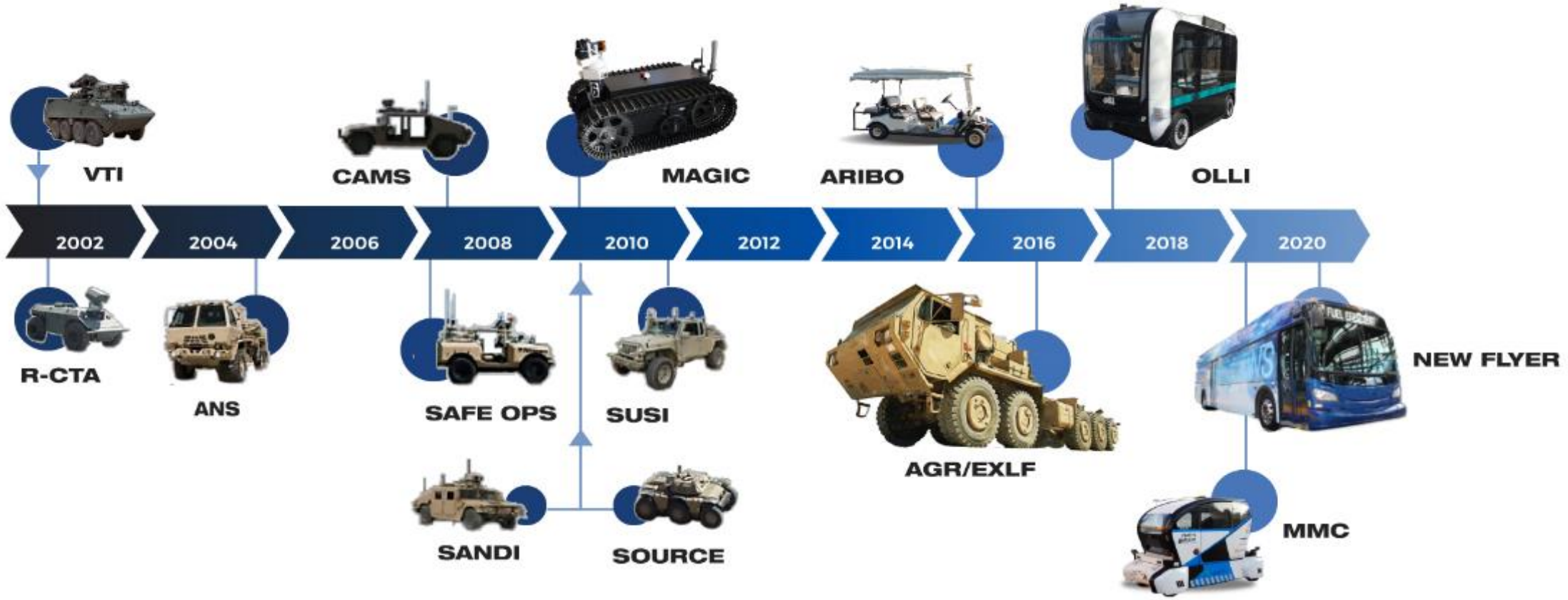
Robotics company with **over 20 Years of experience** in Unmanned Systems

Robotic Research has integrated autonomy on **well over 20 different commercial and military vehicles for air, ground, and sea applications.**

Since its founding in 2002, Robotic Research has been involved in most of the Army's major autonomous vehicle programs and currently is the **Autonomy Kit Prime Contractor for the largest Army autonomous vehicle projects, AGR and ExLF.**

Robotic Research is leveraging its military technology for autonomous commercial transportation by teaming up with **Local Motors**, a leading innovator in Smart Mobility, and with **New Flyer**, the largest bus manufacturer in North America, and with **Pratt & Miller**, also known as Corvette Racing.

Robotic Research History



Shuttles Operating on 4 Continents

Adelaide, Australia
Copenhagen, Denmark
Mechelen, Belgium
Seoul, South Korea
Thuwal, Saudi Arabia
Tokyo, Japan
Turin, Italy

ROBOTIC RESEARCH
DRIVEN™

Akron, OH
Baltimore, MD
Buffalo, NY
Chandler, AZ
Chicago, IL
Clarksburg, MD
Concord, CA
Fort Myer, VA
Greenville, SC
National Harbor, MD
Peachtree Corners, GA
Phoenix, AZ
Sacramento, CA
San Diego, CA

New Flyer - Transit Bus & Coach

Increased Throughput & Efficiency

Traditional Mass Transit
in City

First AV Bus in North America

Precision Docking

Yard Applications

BRT

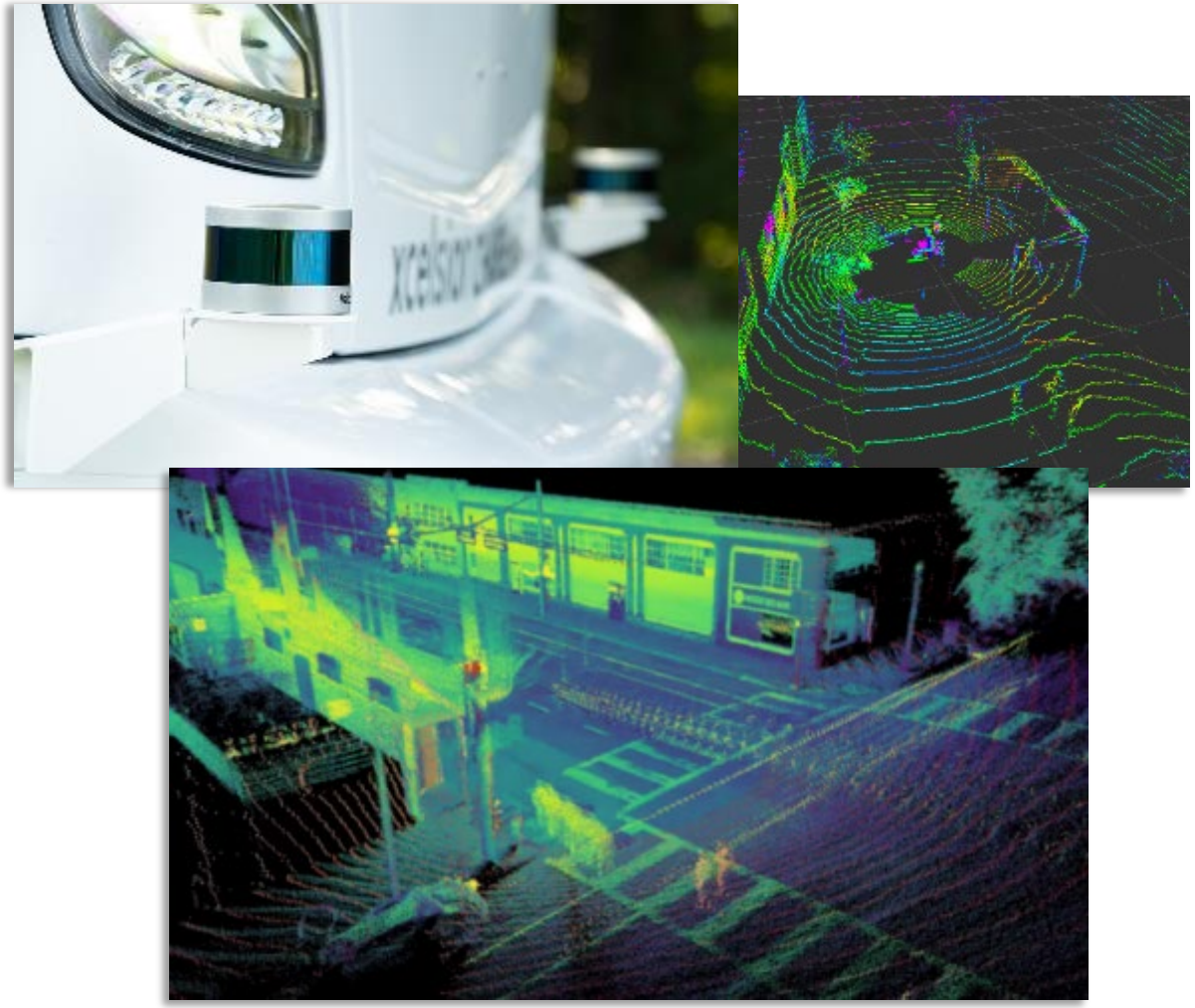
Accessibility in Automated World

- Operate without human interaction
- Maintain safety of system and surroundings
- Accommodate a variety of wheelchair configurations
- Perform operations faster than current loading systems
- Detect curb/platform

ParaLift Overview

- Automatic loading and securement system
- Wheelchair passengers enter and exit vehicle with no aid from another person
- Intuitive design provides wheelchair passengers with further independence and autonomy in their lives
- Features:
  - Sensing to ensure clear space
  - Automatic door opener
  - Powered wheelchair lift
  - Securement system
  - Safety system
  - Announcement system

Sensing and Detection

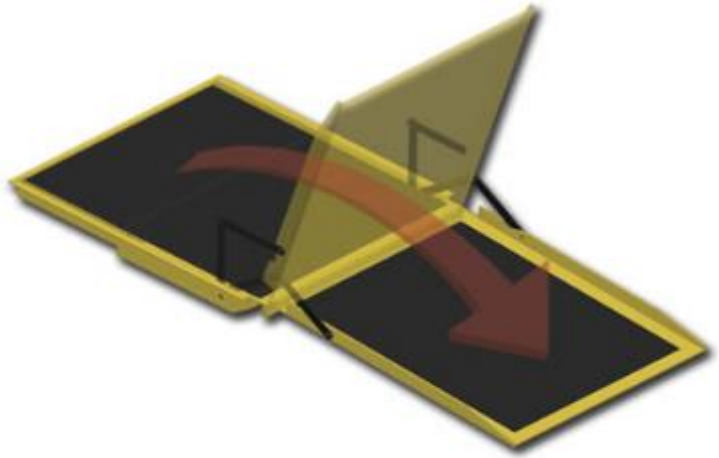


- LIDAR sensor generates 3D map of surroundings
- Detects the presence of passenger and position of ramp or lift
- Ensures area under ramp or lift if clear before lowering
- Stops ramp or lift if obstruction
- Detect curb and vehicle position
- Currently developing camera-based detection system

Platform Agnostic

- Quantum wheelchair securement system uses a pair of arms to clamp onto wheels of the wheelchair to secure it in place
- Three-point seat belt system integration designed to rapidly secure the passenger
- Compatible with wheelchairs of various types and sizes
- NHTSA crash tested

Adaptability



- ParaLift can be installed on a variety of commercial vans
  - Can use existing ramp systems
- ParaLift automated system is adaptable to transit buses
  - Automate control of existing bus ramp and door

ROBOTIC RESEARCH

Questions

Dr. Kathleen D. Klinich

University of Michigan

Miriam A. Manary

University of Michigan

Development of an Automated Wheelchair Tiedown and Occupant Restraint System: Initial Progress

Kathleen Klinich, Jingwen Hu, Miriam Manary, Kyle Boyle, Nichole Orton, Yushi Wang, Laura Malik, Brian Eby

March 24, 2021

UMTRI TRANSPORTATION RESEARCH INSTITUTE UNIVERSITY OF MICHIGAN

Wheelchair Transportation Safety (WTS)*

- Best practice recommendation is to transfer from a wheelchair to a vehicle seat
- Wheelchairs used as motor vehicle seats should be crash tested to verify performance (per WC19).
- Method to secure the wheelchair to the vehicle. (wheelchair tiedown)
- Method to restrain the occupant.
- Wheelchair Tiedowns and Occupant Restraint Systems (WTORS)
- Ultimate goal of equal level of safety for those who remain seated in wheelchairs.

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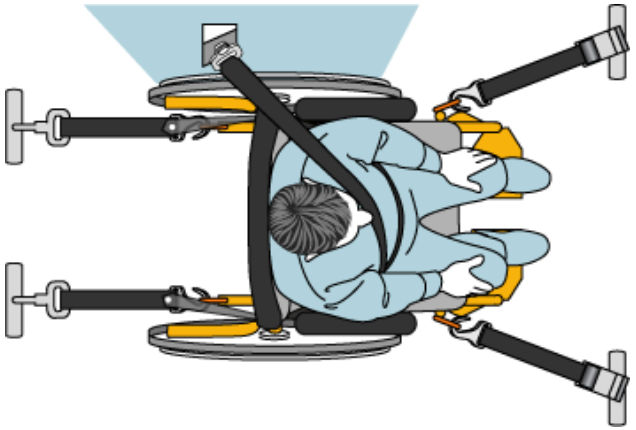
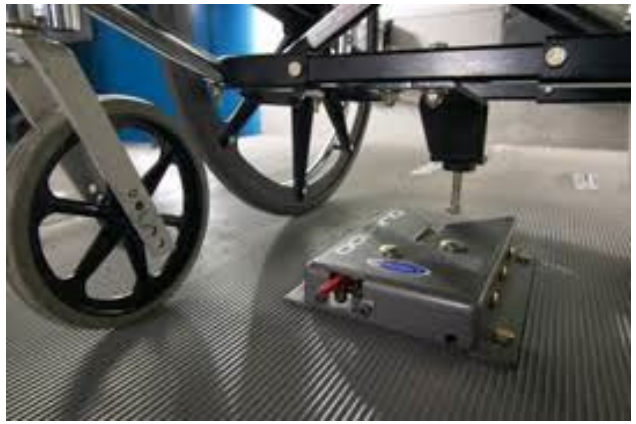
*Buning, Mary Ellen et al. 2012. "RESNA's Position on Wheelchairs Used as Seats in Motor Vehicles." *Assistive Technology* 24(2).

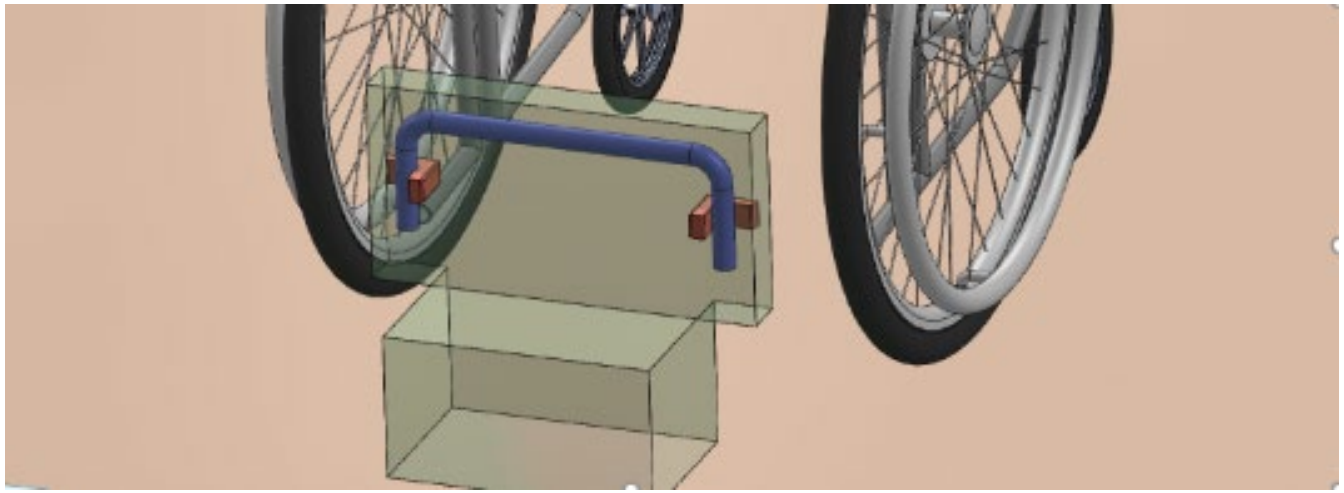
Current WTORS Systems

WTORS Type	Independent Use	Protection in High g and Low g crashes	Any combination of wheelchair and vehicle?
4-pt strap tiedown paired with seatbelt	No	Yes	Yes
Docking station paired with seatbelt	Yes	Yes	No
Rear-facing stations	Yes	No	Yes





Universal Docking Interface Geometry



- Common geometry for connection interface between wheelchairs and vehicles. Akin to standardization of truck trailer hitch.
- As long as geometry is met, actual hardware can take any design.
- Allows a wheelchair (manual, power, scooter) to dock in any vehicle.
- Geometry defined and field tested.
- Requires both WC and WTORS manufacturers to work together.
- Already implemented in standards, but no commercial use yet.

Project Goals and Tasks

- Develop an automated wheelchair docking station that would allow safe, independent docking of occupants seated in wheelchairs.
- Develop an automated belt-donning system.
- Evaluate in front and side impacts.

- Computational Modeling
- Volunteer Usability Assessment
- Sled Testing

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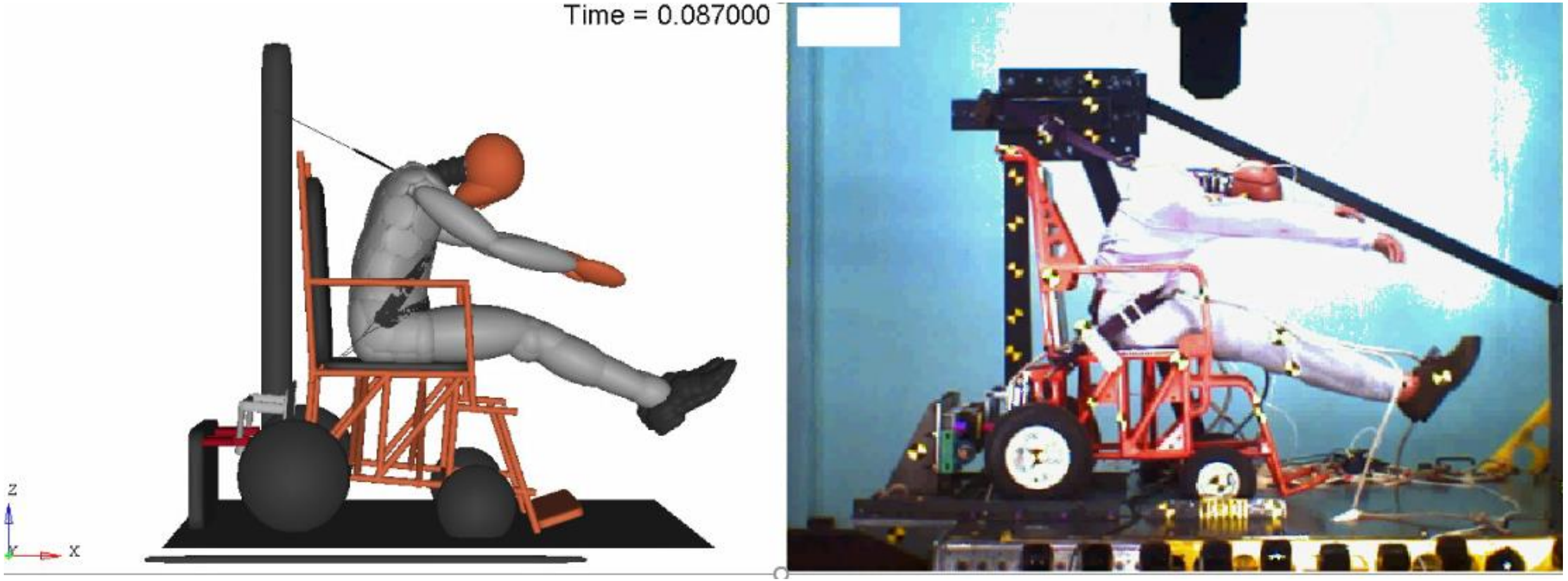
Frontal model validation: surrogate wheelchair fixture



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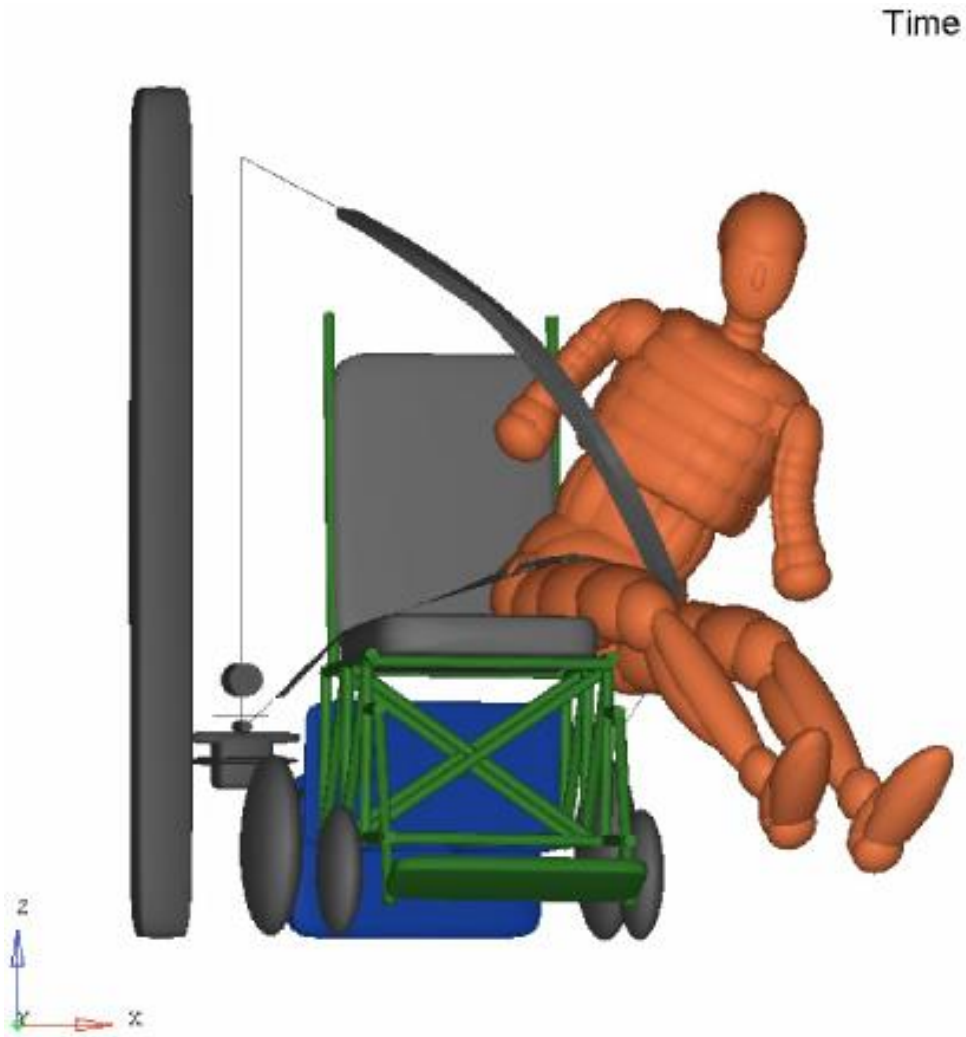
Side model validation



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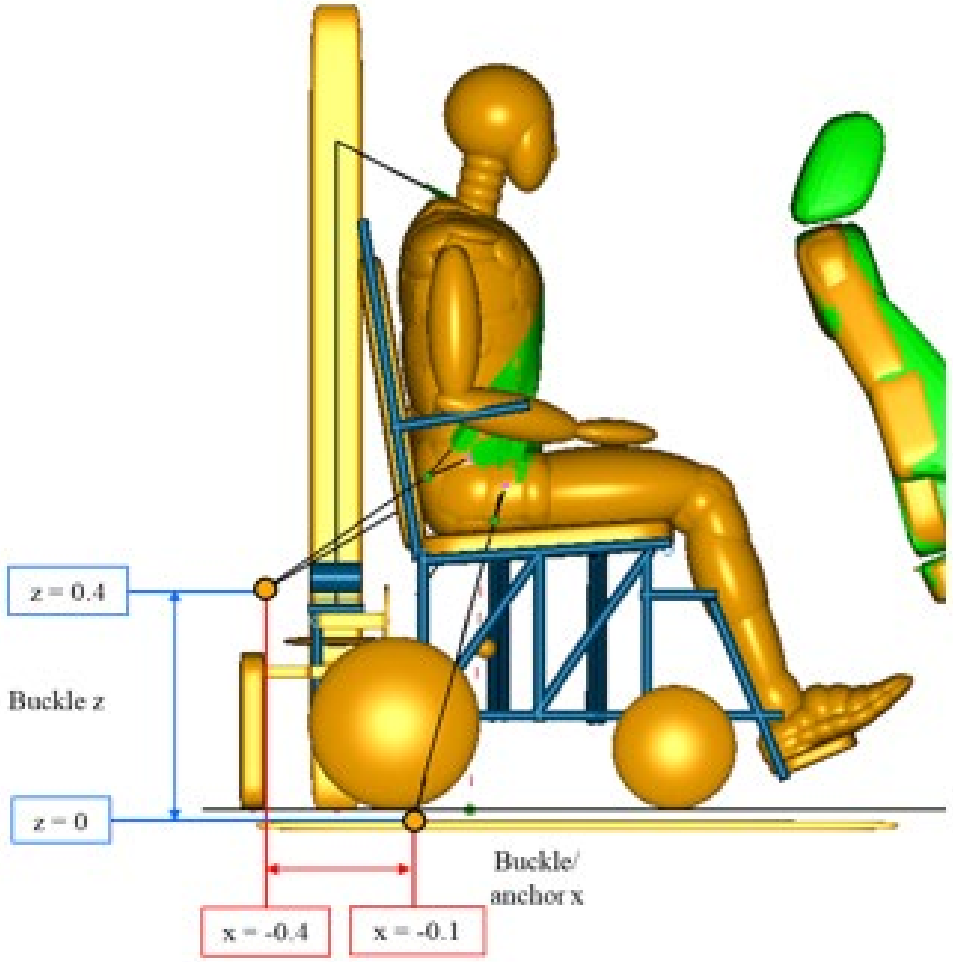
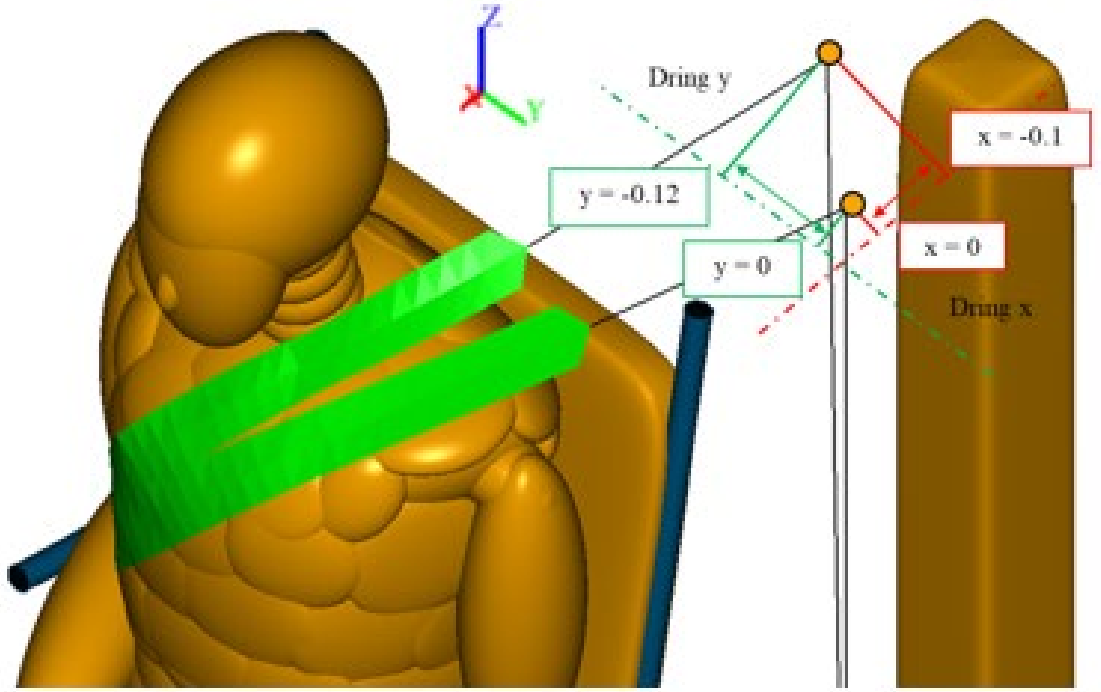
Frontal optimization parameter ranges





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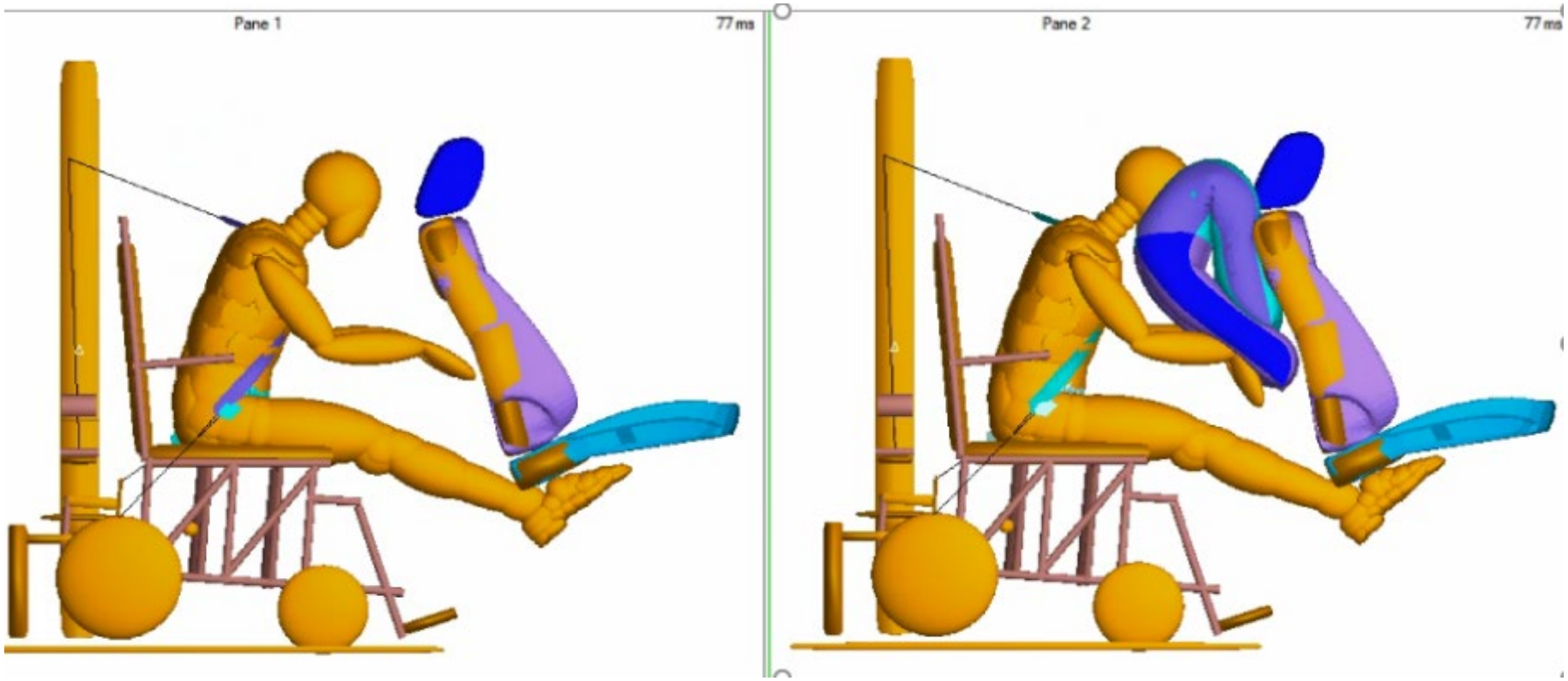
SCARAB airbag



- Airbag provides benefit for suboptimal geometry
- Providing sufficient space to maneuver wheelchair may reduce potential for head contact

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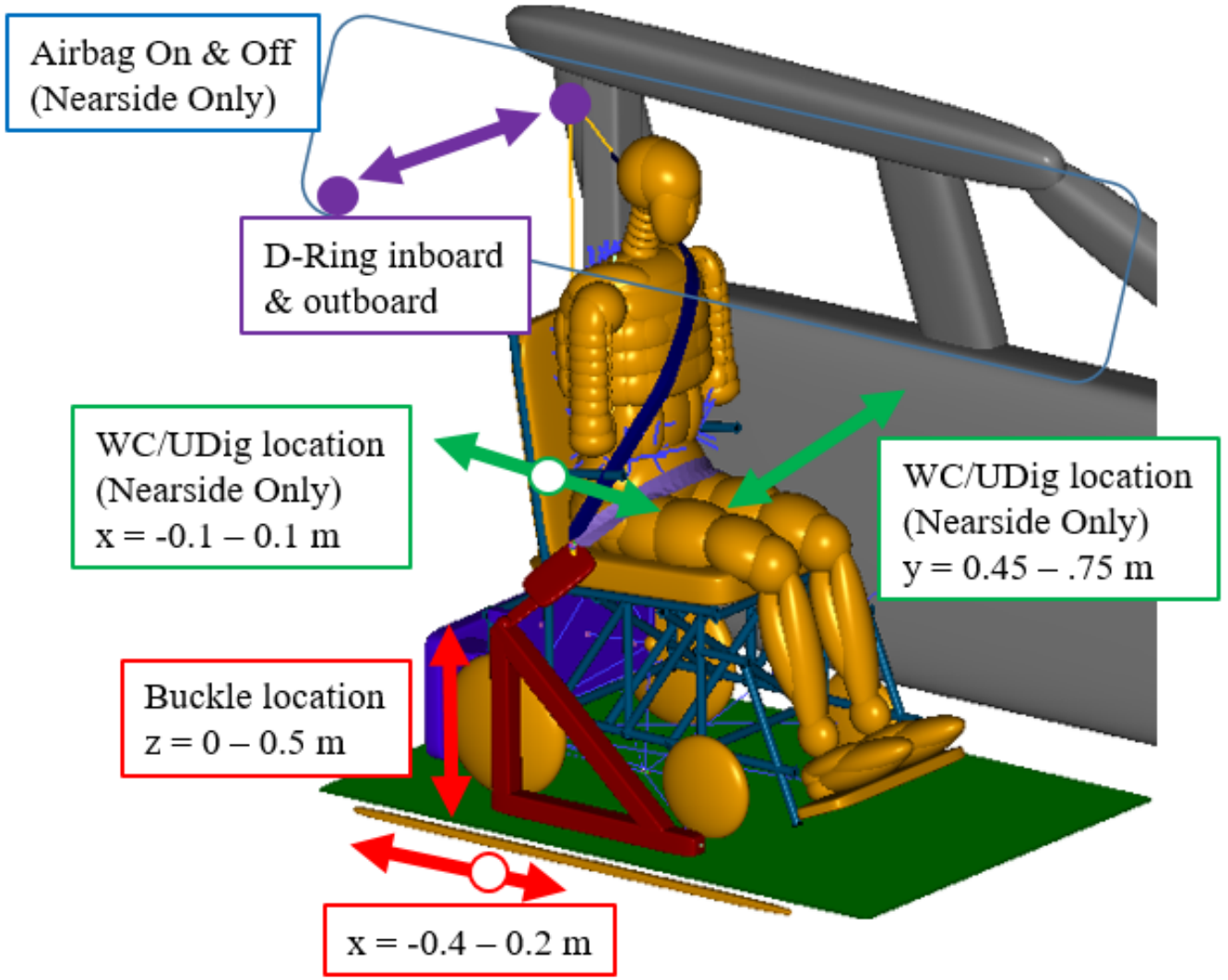
Side impact optimization



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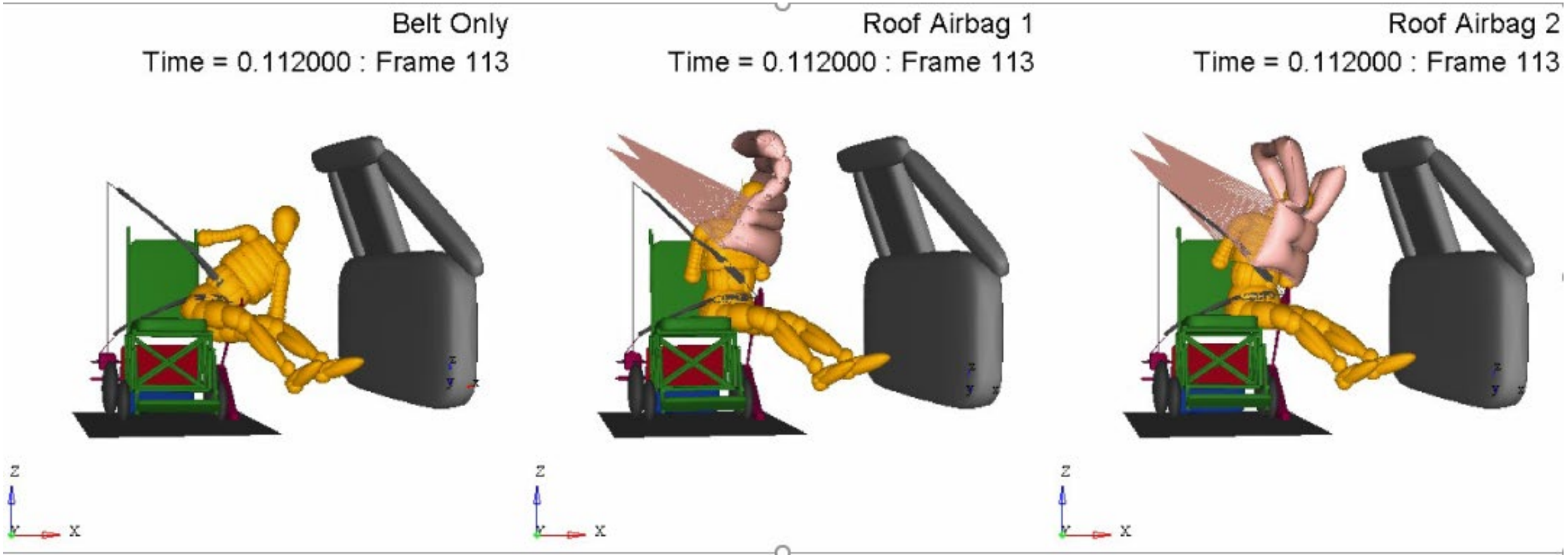
Concept: Center Airbag To Contain Humans (CATCH)



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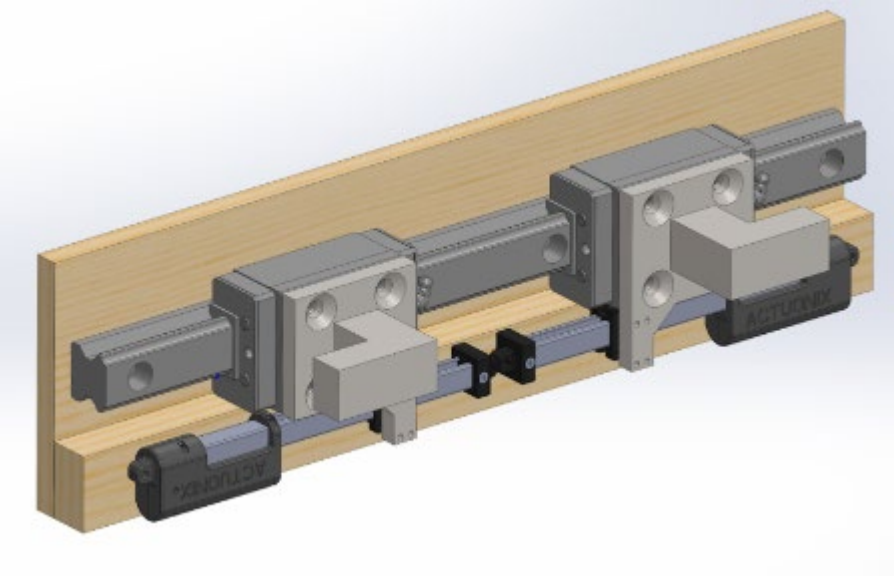
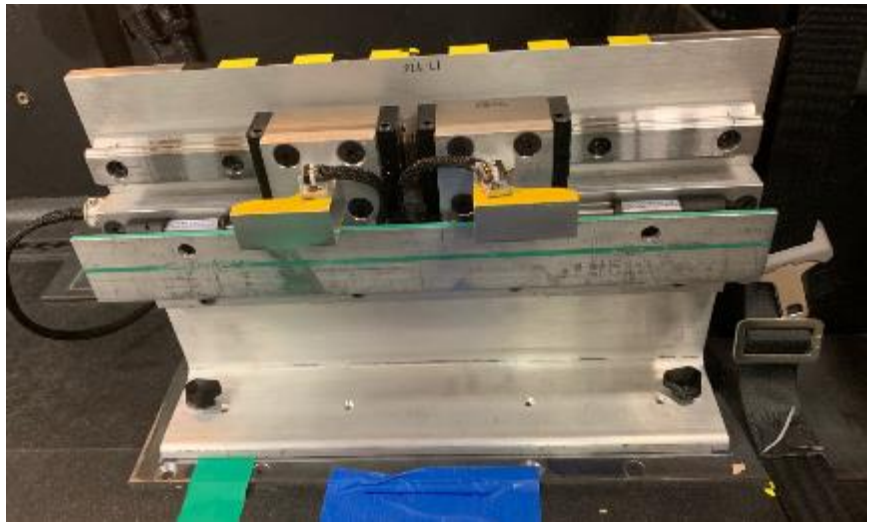
UDIG Anchorages





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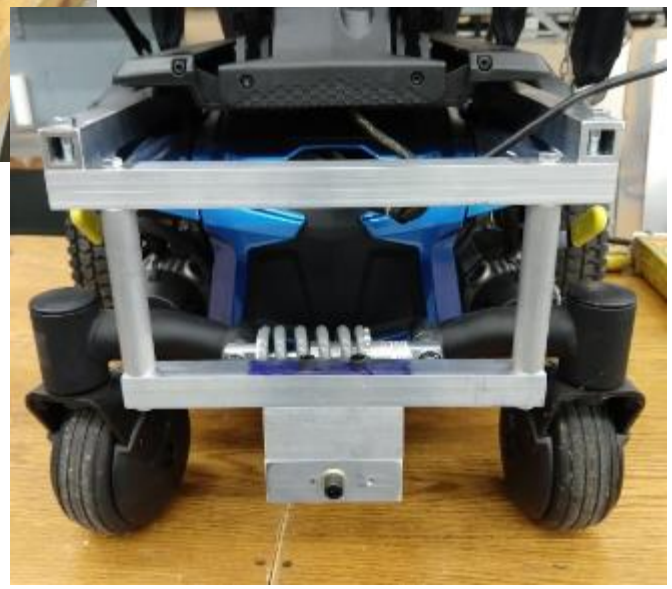
Wheelchair UDIG attachments



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Key goals of volunteer testing

- How do different seating station configurations affect accessibility?
- How do different belt geometries affect fit, comfort, and usability?
- How much variation in belt fit do we get between power and manual wheelchairs in the same condition?
- Feedback from regular wheelchair users on usability.

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Pilot testing

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More information coming

- Project finishing up in June
- Save the date-Thursday August 5, 2021 1-4 pm
- Virtual Open House to share findings from this research
- umtri.umich.edu for more information this summer

We would like to thank the National Highway Traffic Safety Administration for sponsoring this project.

Thank you for your attention.

Kathleen D. Klinich kklinich@Umich.edu
Miriam A. Manary mmanary@umich.edu

Questions?

Dr. Jordana Maisel

University at Buffalo

ACCESSIBILITY FOR PASSENGERS WITH MOBILITY DISABILITIES: PART 2

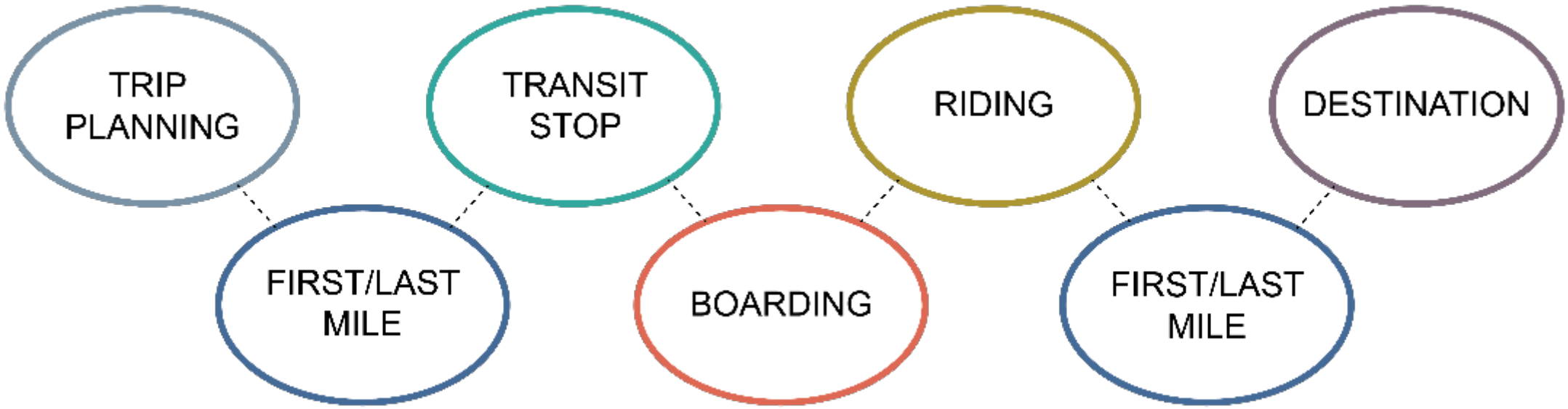
MANEUVERING AND SECUREMENT

Jordana L. Maisel, PhD

U.S. Access Board Public Forum on Autonomous Vehicles

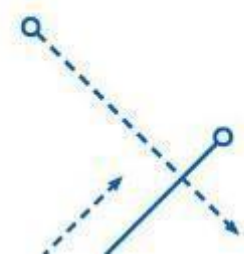
University at Buffalo
Center for Inclusive Design and Environmental Access
School of Architecture and Planning

Travel Chain

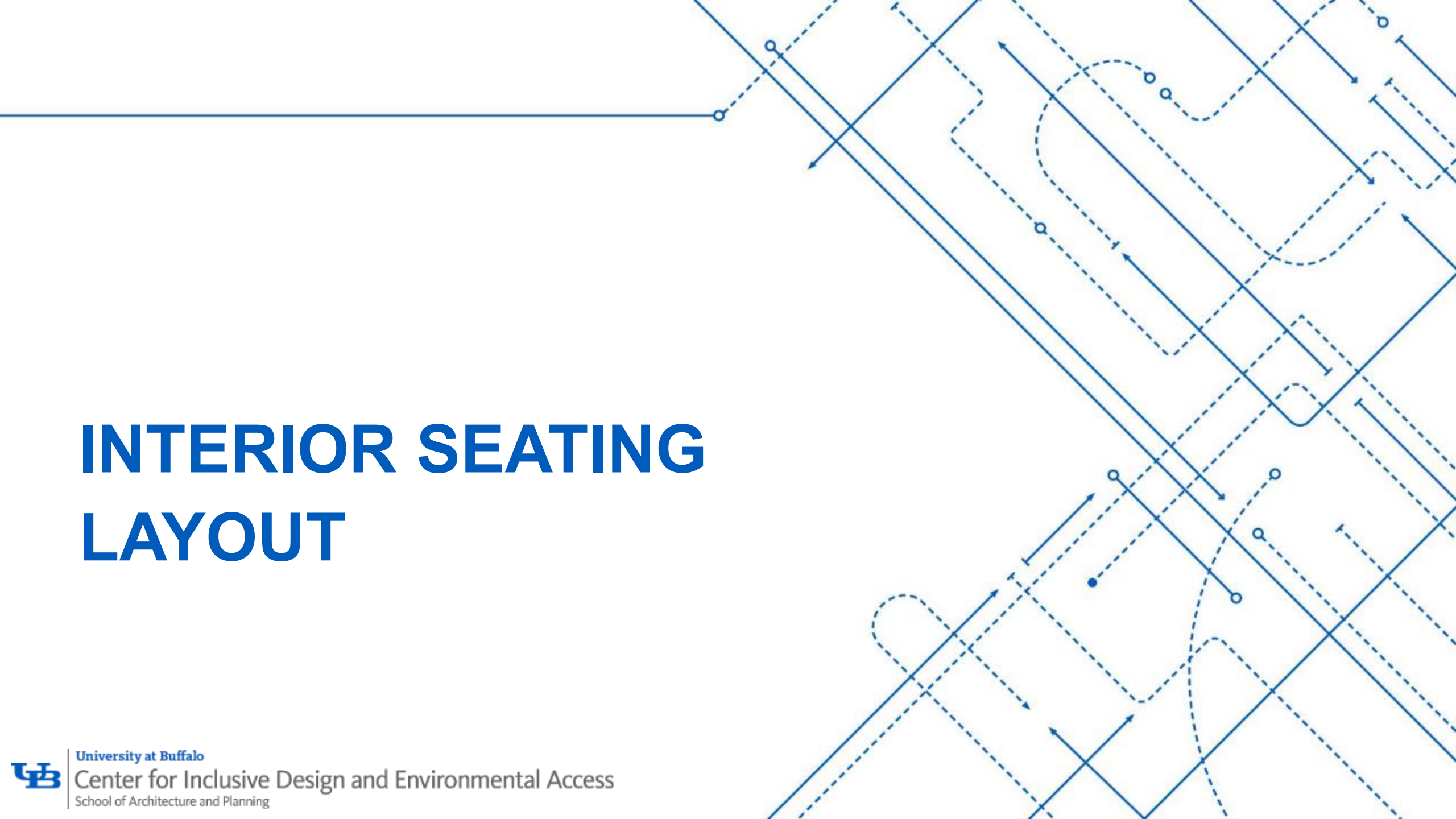


Research Questions

- How does seating configuration impact interior movement and usability for individuals who use wheeled mobility devices, are blind and/or visually impaired, and who use walking aids?
- How do different securement systems affect securement time and usability for people who use different types of wheeled mobility devices?
- How does field testing newer (i.e., 3-point, forward-facing and semi-automated, rear-facing) securement systems impact usability for manual wheelchair users, power wheelchair users, and scooter users?



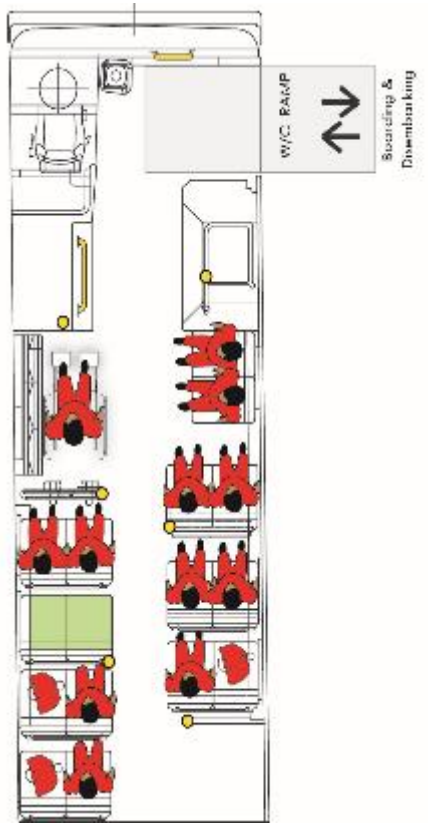
INTERIOR SEATING LAYOUT



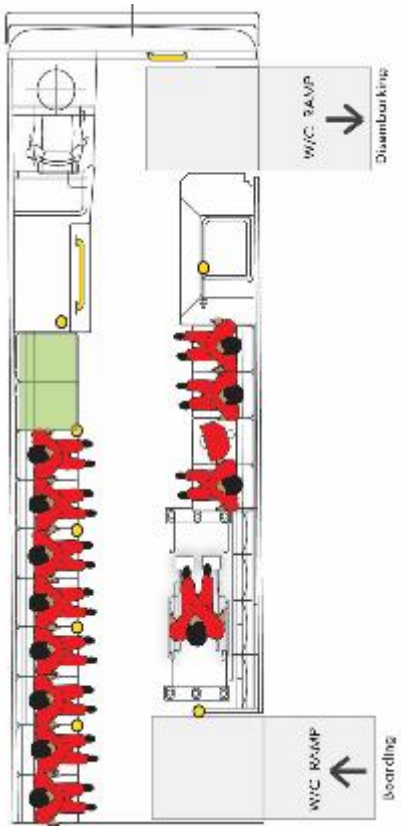
University at Buffalo
Center for Inclusive Design and Environmental Access
School of Architecture and Planning

Research Design — Layouts

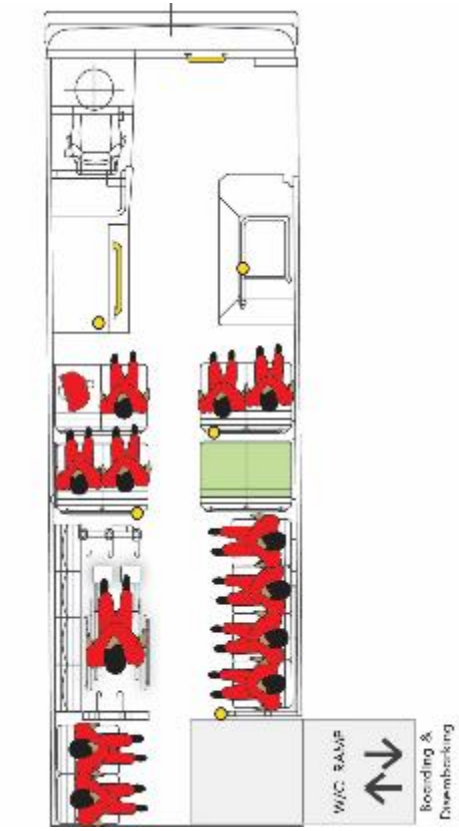
Layout 1:
Front Entry/Exit
Forward Seating



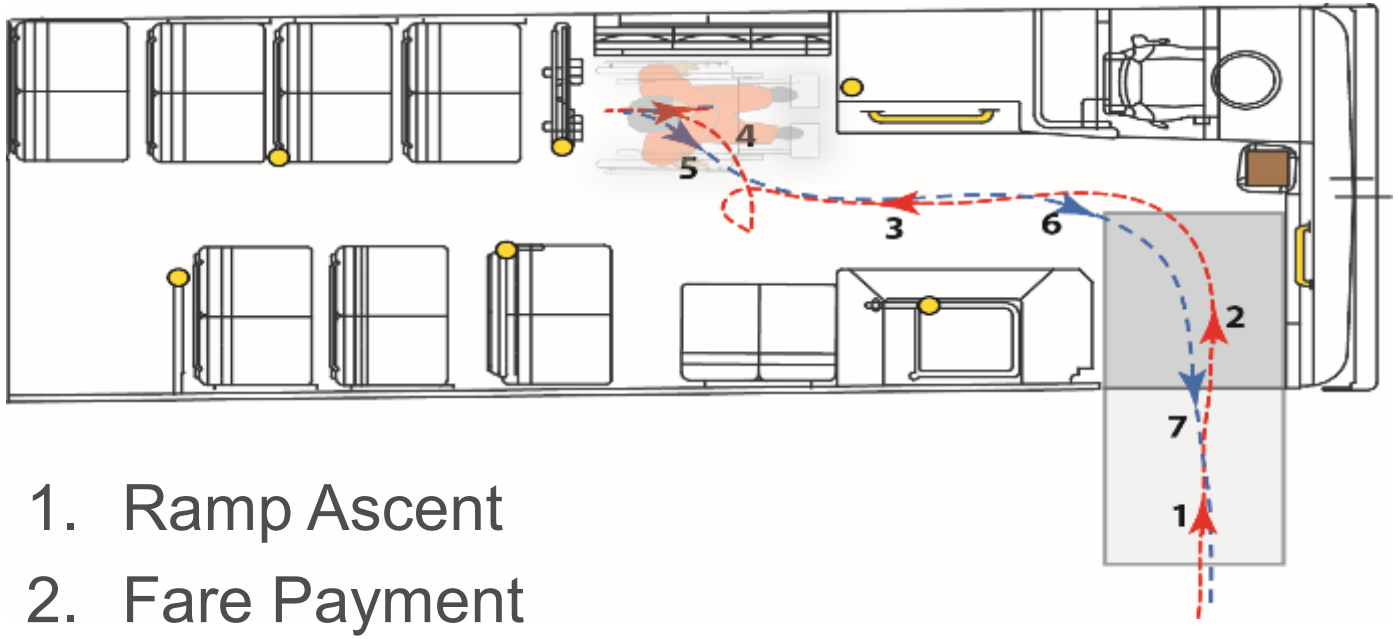
Layout 2:
Mid Entry, Front Exit
Side Seating



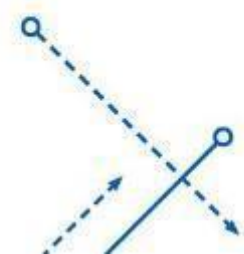
Layout 3
Mid Entry, Mid Exit
Mixed Seating



Research Design — Task Description

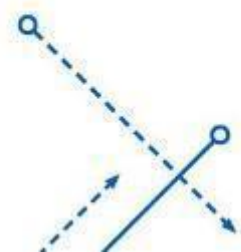


1. Ramp Ascent
2. Fare Payment
3. Moving to the Seat/Wheelchair Securement Space (WSC)
4. Entering and Positioning
5. Exiting the Seat/WSC
6. Moving to the Exit Door
7. Ramp Descent

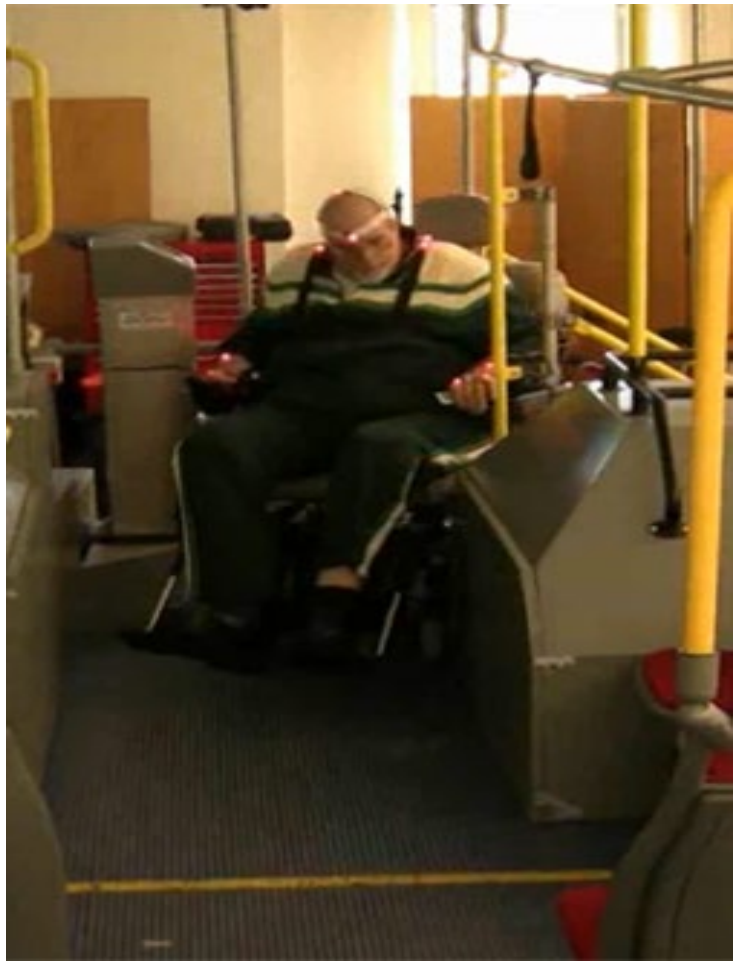


Study Sample (n=90)

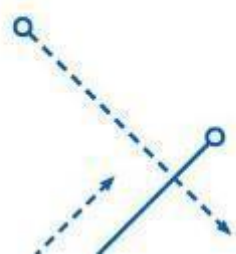
Participant Group	n
Wheeled Mobility Device Users	48
Blind, Visual Impairment	18
Walking Aid Users	24



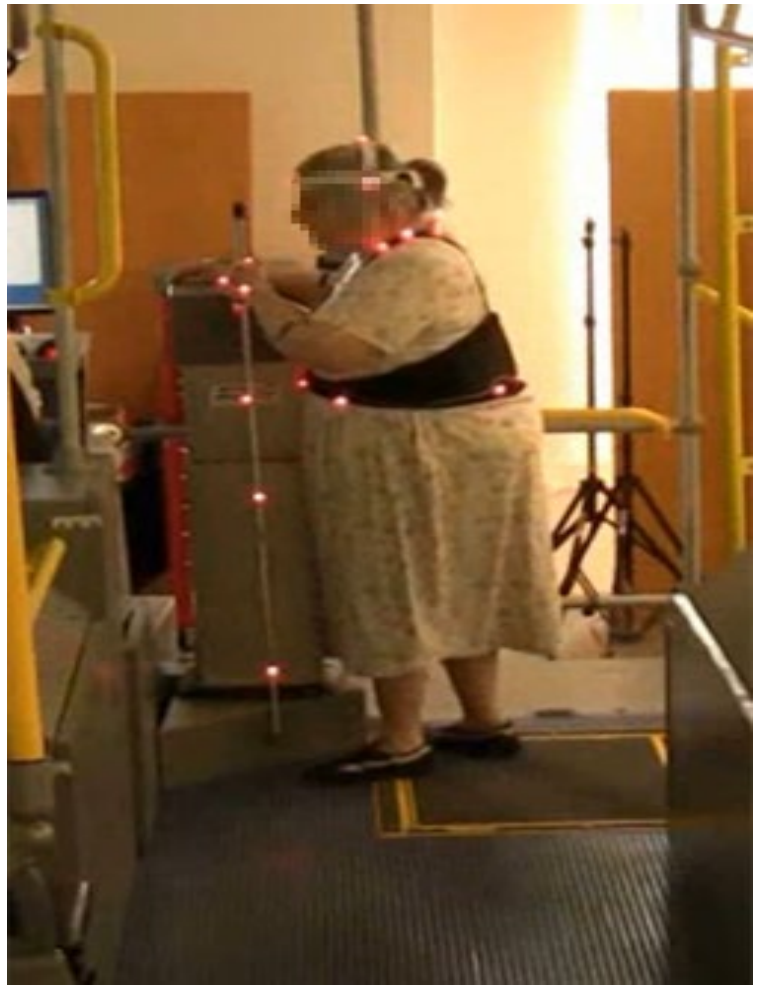
Findings — WhMD Users (n=48)



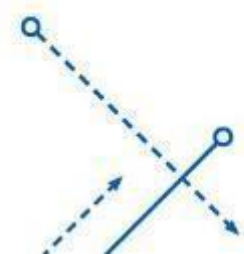
- Narrow turning space near the front of the bus.
- Inadequate turning space with second wheelchair on board.
- Side-facing seats less desirable; increased risk of injuring others.
- Limited reach capability among wheeled mobility users.



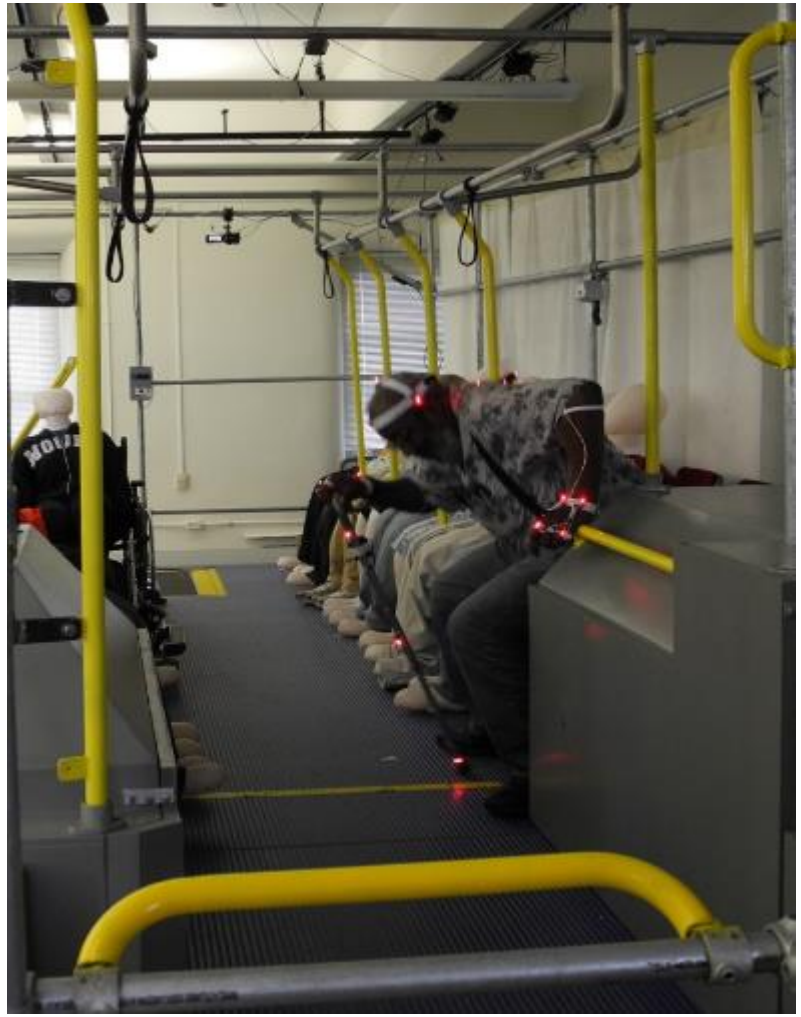
Findings — BVI (n=18) and WA Users (n=24)



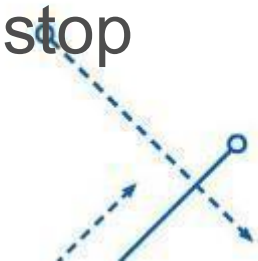
- Side-facing seats preferred.
- Challenges locating features in the environment, e.g., fare payment, vacant seat.
- Risk of collisions, trip hazards.
- Use of assistive supports during sitting and rising.



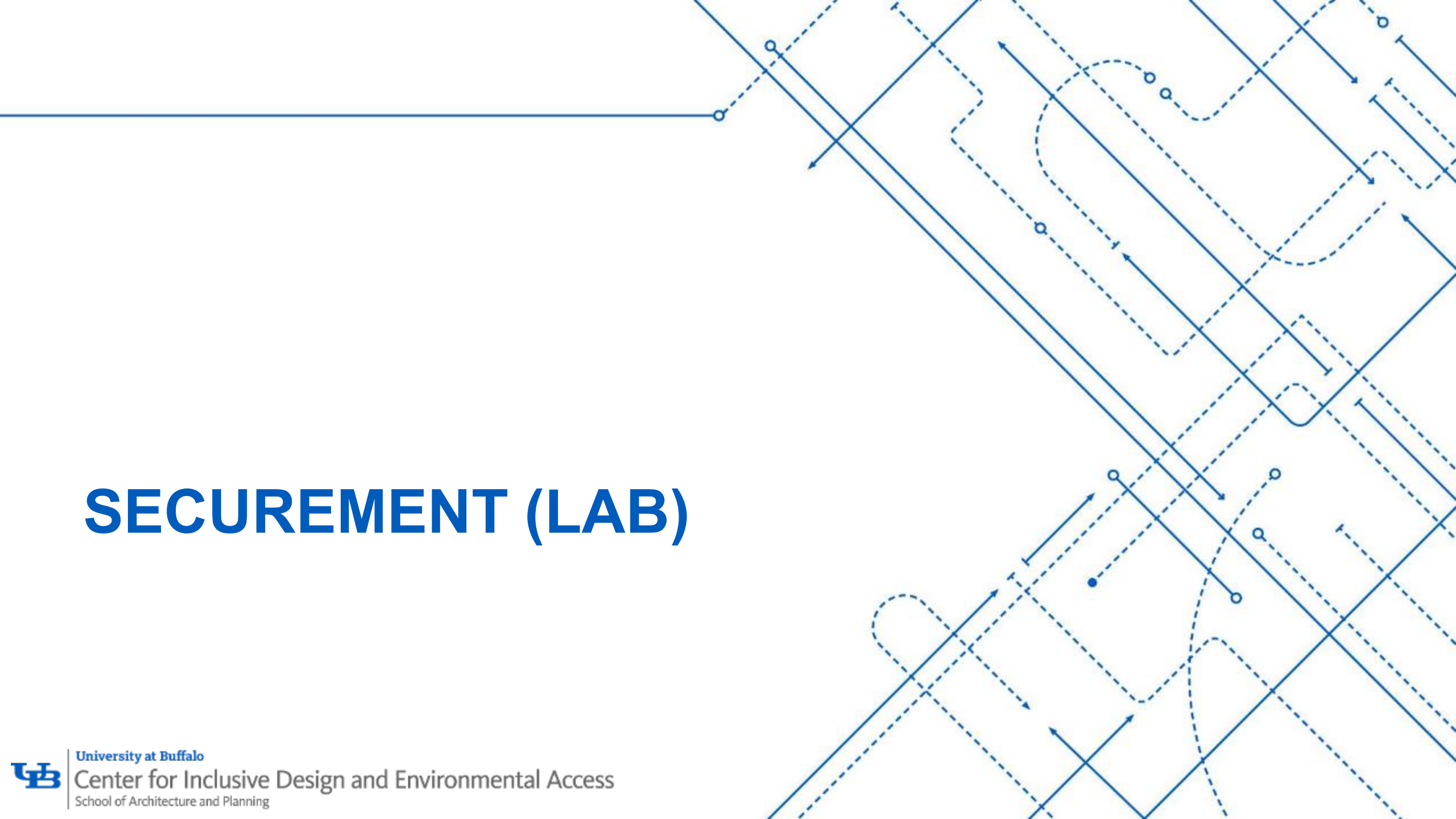
Summary



- Environment design impacted performance.
- Space requirements for walking aid users.
- Increasing minimum clearances by small amount will increase the percentage of people accommodated, particularly wheeled mobility users.
- There will not be “one best solution” to accessibility.
- Everything is interrelated, e.g. fare location and maneuvering, entry location, and stop design.

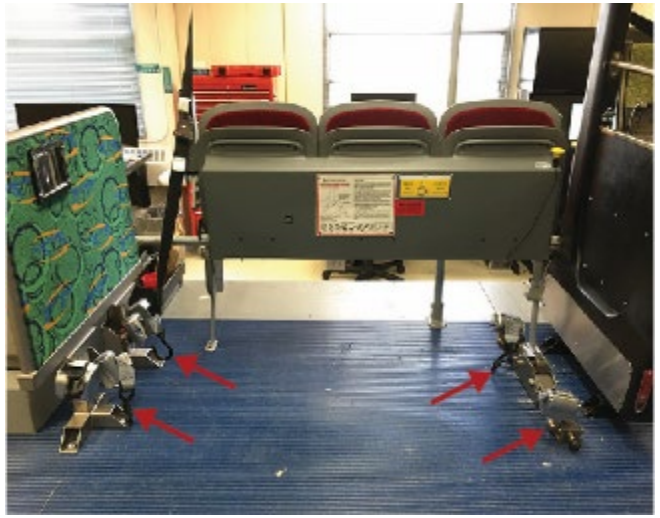


SECUREMENT (LAB)



Research Design — Securement (n=36)

Participant Group	n
Manual Wheelchair	15
Power Wheelchair	15
Scooter	6



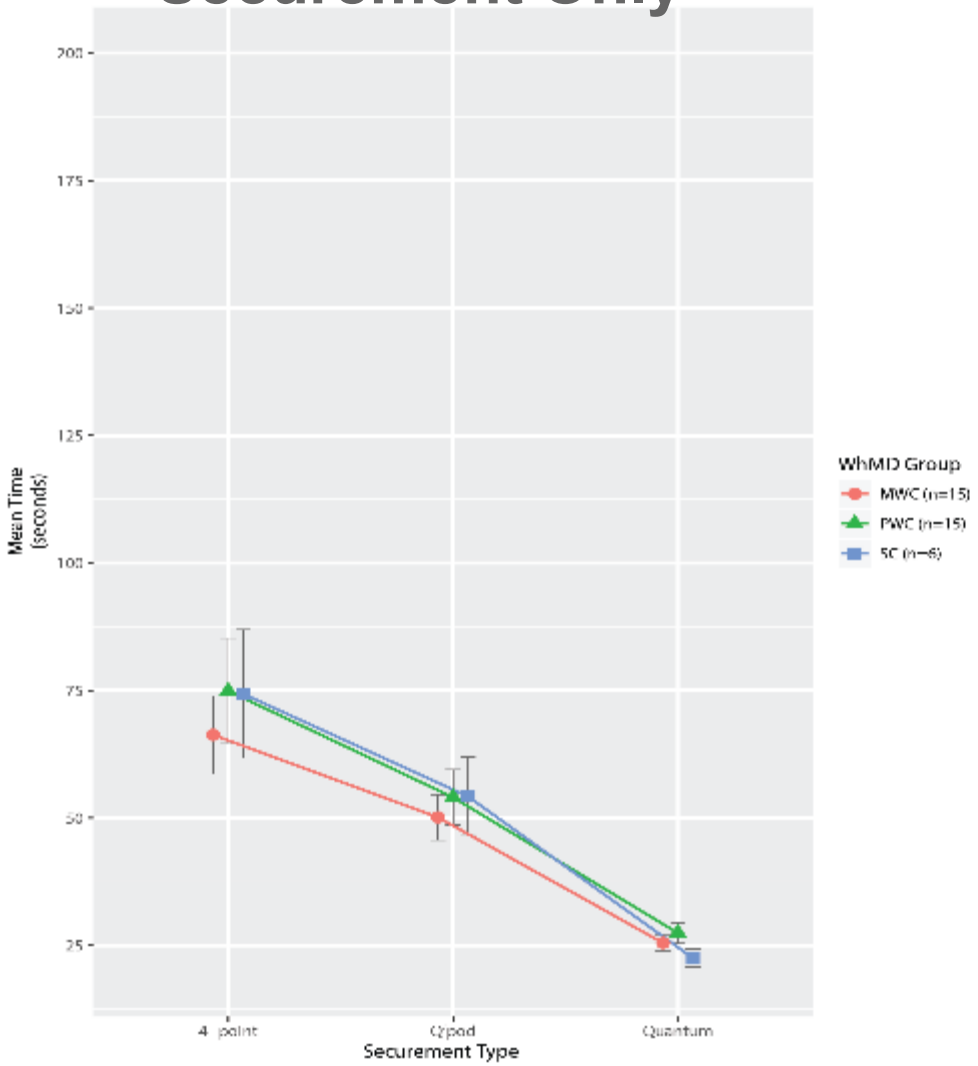
4-Point

3-Point Forward-Facing (3P-FF)

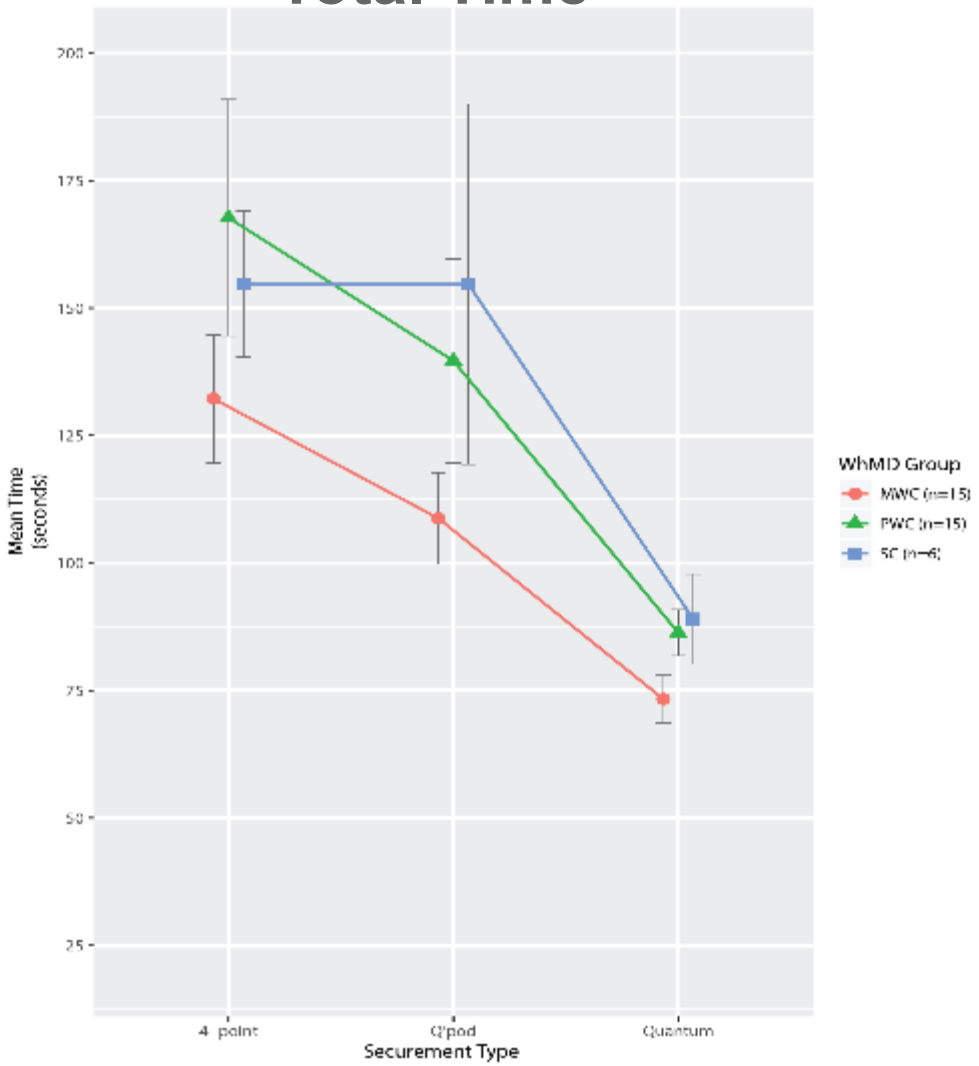
Semi-Automated Rear-Facing (SA-RF)

Findings — Time, All Participants

Securement Only



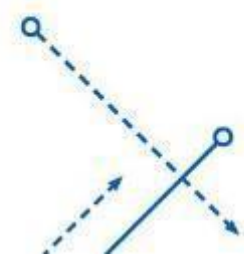
Total Time

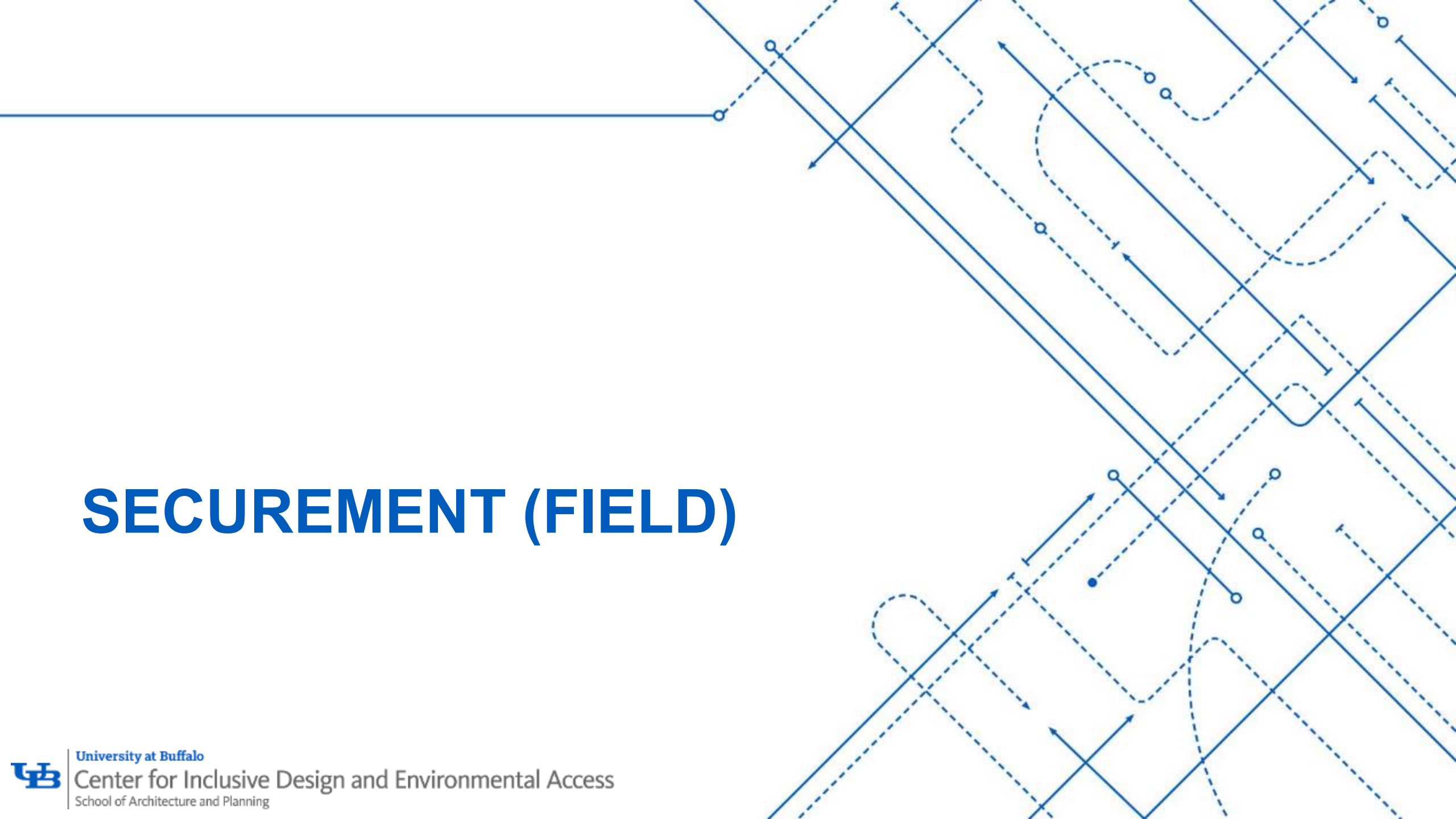


Preferences

Groups	N	Participant Preference		
		4-Point	3P-FF	SA-RF
MWC	15	3	3	9
PWC	15*	2	2	10
Scooter	6	0	0	6

*Note: One PWC did not specify a preference for a single securement system.





SECUREMENT (FIELD)

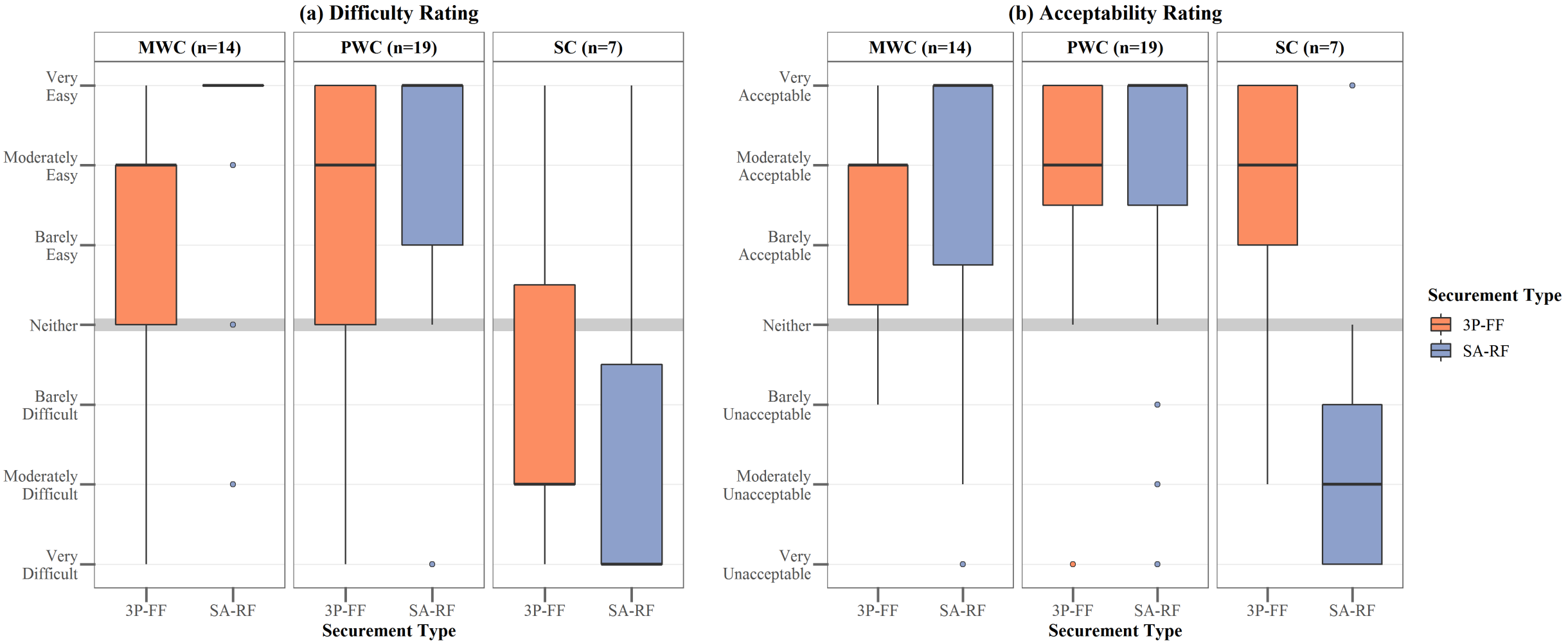
Research Design (n=40)

Participant Group	n	Age Range
Manual Wheelchair	14	28-71
Power Wheelchair	19	32-74
Scooter	7	38-65

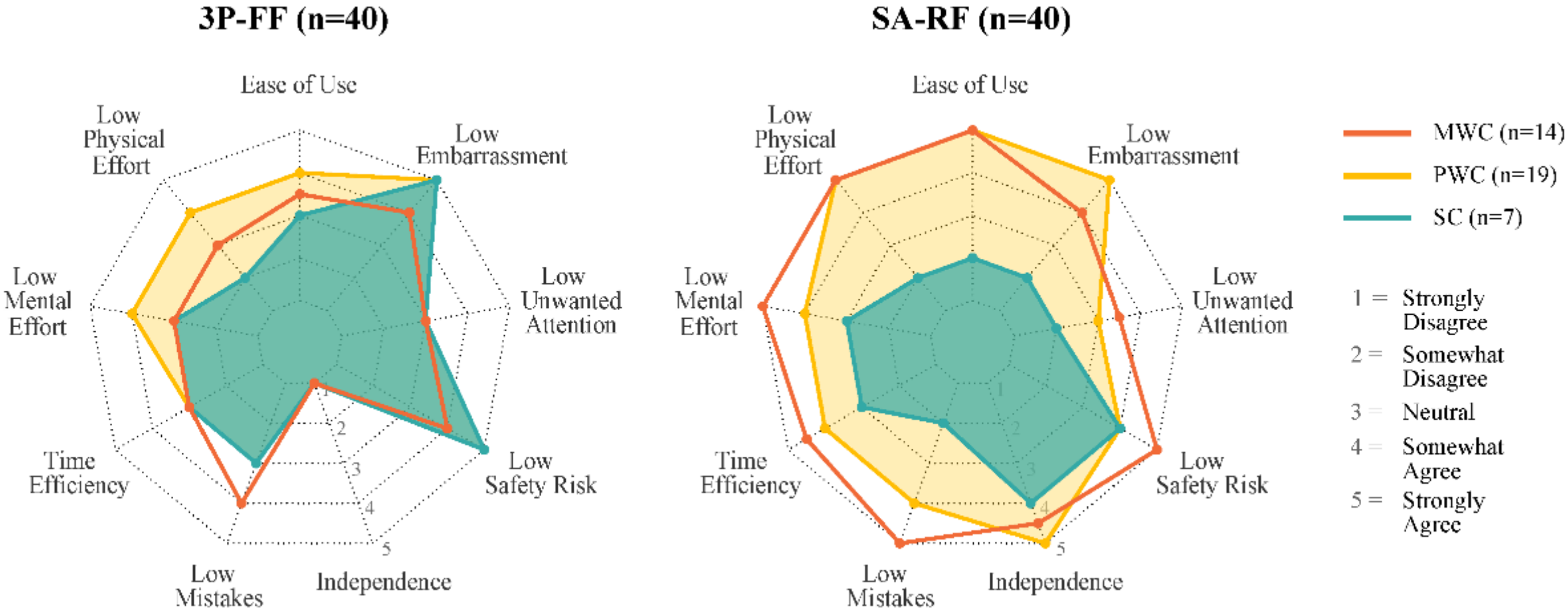
3P-FF

SA-RF

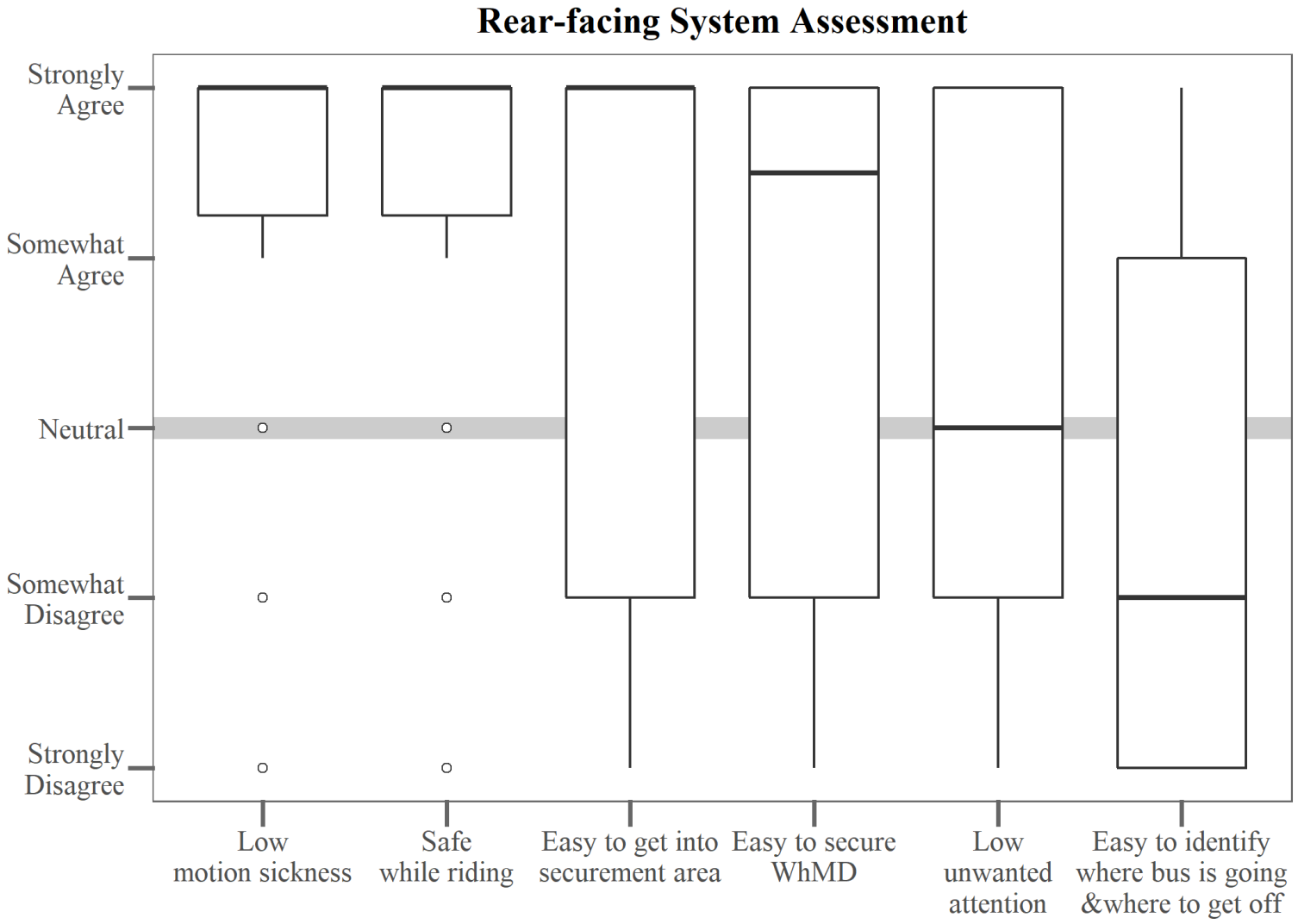
Findings — Difficulty/Acceptability

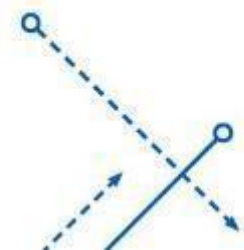


Findings — RAPUUD, Securement Device



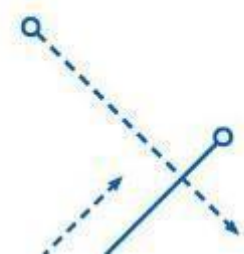
Findings — Rear-Facing





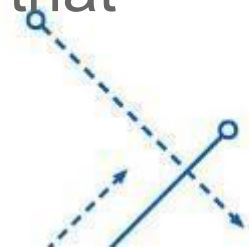
Summary of Findings

- A slight majority preferred the SA-RF system to the 3P-FF system.
- Although MWC and PWC users rated the use of the SA-RF favorably on many measures, participants in this field study were less likely to prefer the SA-RF.
- SC users consistently rated both securement systems as more difficult to use and requiring greater physical effort than MWC and PWC users.
- PWC and SC users were almost evenly divided between using fixed-route more or less often due to the presence of the SA-RF.
- Design research is needed to explore the capacity for scooters to be secured (rear-facing) safely in public transportation vehicles.



Research Implications for Self-Driving Vehicles

- Maneuvering and securing in public transportation are challenging for individuals with mobility and sensory impairments.
- Need for greater clearances for maneuvering and securement as evidenced by changing wheelchair dimensions.
- Reconfigurable spaces/seating will need to accommodate a wide range of rider needs and preferences.
- Fare payment tasks add to the challenges and should be eliminated during trips.
- Audio and tactile communication may assist those who are blind or have visual impairments more effectively way find within the vehicles.
- Sensing of passenger status (located properly, secured, etc.) will be important.
- Independent wheelchair securement requires significant space and designs that accommodate diverse mobility devices.



SPONSOR

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Center for Inclusive Design and Environmental Access
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QUESTIONS/COMMENTS

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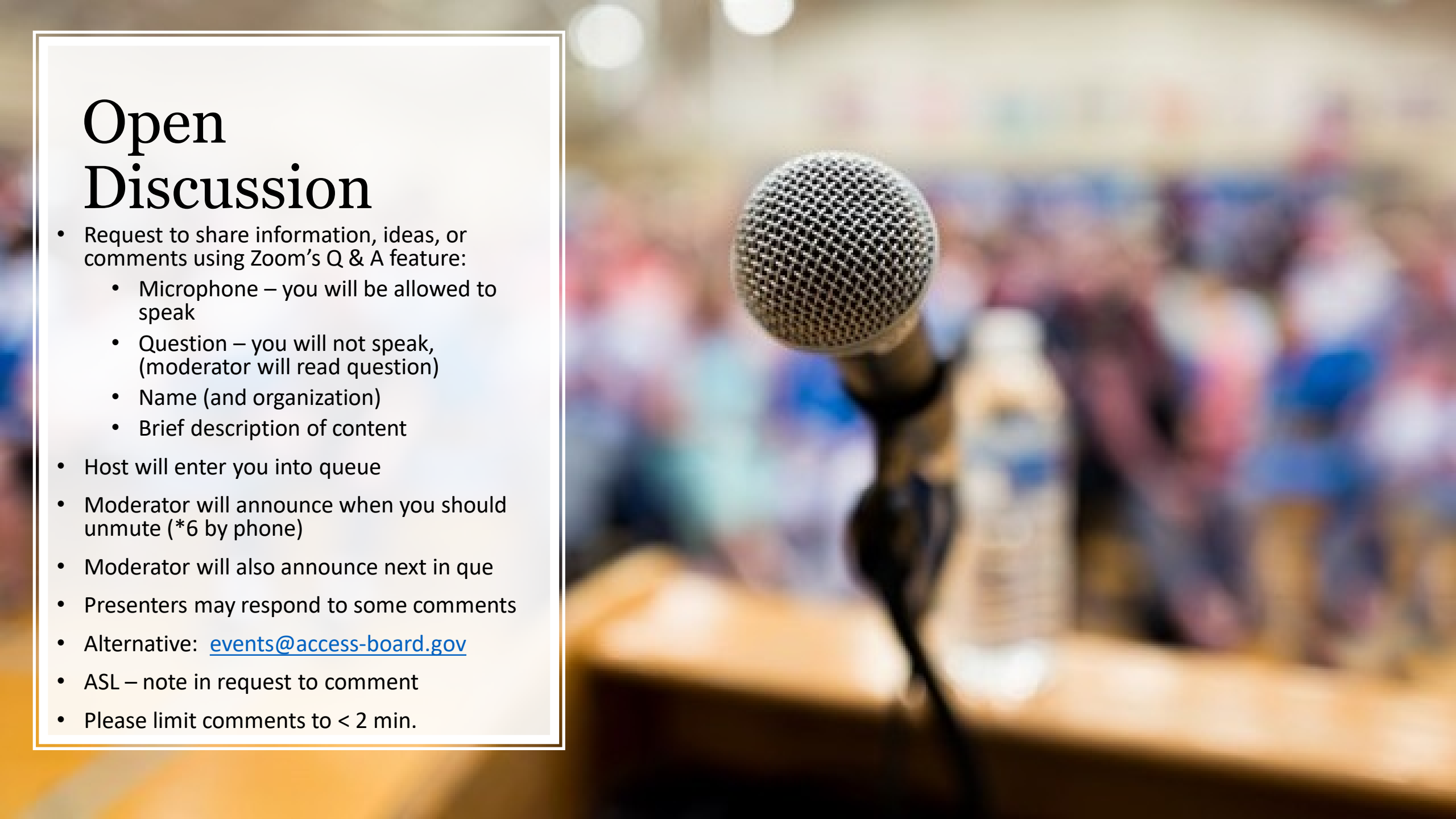
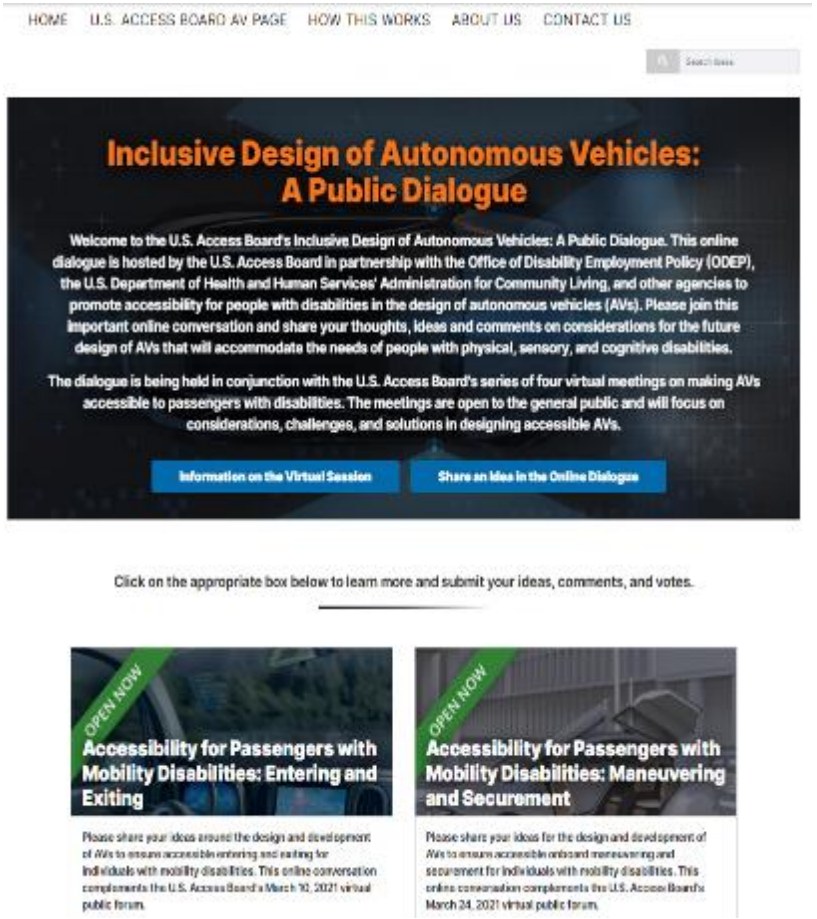
Open Discussion

- Request to share information, ideas, or comments using Zoom's Q & A feature:
  - Microphone – you will be allowed to speak
  - Question – you will not speak, (moderator will read question)
  - Name (and organization)
  - Brief description of content
- Host will enter you into queue
- Moderator will announce when you should unmute (*6 by phone)
- Moderator will also announce next in que
- Presenters may respond to some comments
- Alternative: events@access-board.gov
- ASL – note in request to comment
- Please limit comments to < 2 min.



Online Dialogue

- Continue the conversation Online
  - http://transportationinnovation.ideascale.com
  - Share ideas, comment, vote
  - For assistance, email: ePolicyWorks@dol.gov



Next Session

Accessibility for Passengers with Sensory and Cognitive Disabilities: Part 1

This session will address ride hailing and on-board communication for passengers with hearing, visual, or cognitive disabilities.

April 7, 2021, 2:00 – 3:30 (ET)

Presenters:

- Hendrik Opstelten – Federal Transit Administration (FTA)
- Anil Lewis – National Federation of the Blind (NFB)
- Dr. Robin Brewer, University of Michigan
- Dr. Christian Vogler, Gallaudet University