STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

Technology Transfer Final Report

STRIDE Project A5

Barriers & Facilitators of People with Disabilities in Accepting & Adopting Autonomous Shared Mobility Services

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THE STRIDE CENTER

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1.   Project Overview

The first phase of this project (D2) assessed older drivers' (>65 years old; N=104) perceptions of autonomous vehicles (AVs) before and after riding in an autonomous shuttle (AS) and driving simulator operating in autonomous mode (Society of Automotive Engineering; SAE, Level 4). The second phase (A3) of this project (i.e., Phase II) used the same method to assess younger and middle-aged drivers' (18-64 years old; N=106) perceptions of AV technology (shuttle and simulator). The current study (i.e., Phase II Extension; A5) used same method but used only the shuttle to assess people with disabilities' (PWD; 20-77 years old; N=42) perceptions of AV technology.

The first task was to quantify and qualify PWDs' perceptions, values, beliefs, and attitudes before and after riding in an AS (SAE, level 4). The quantitative results showed that after riding the AS, PWDs indicated higher *intention to use*, and *acceptance* of AVs and lower *perceived barriers* compared to their baseline. The qualitative results generated seven themes from four open-ended Automated Vehicle User Perception Survey (AVUPS) questions: *safety*, *ease of use*, *cost*, *availability*, *disability*, *AV information*, and *experience with AV*. A few of PWDs raised concerns about safety and trust when there is no shuttle safety operator, as well as accessibility issues if public demand for shuttle use increases.

The second task was to use the data obtained from STRIDE D2 (Phase I; older drivers, N=50), A3 (Phase II; younger and middle-aged drivers, N=51), and this project (Phase II Extension; A5, PWD, N=42) and create a model of the AS facilitators and barriers. Regression analyses results showed that *optimism* and *ease of use* negatively predicted *perceived barriers* and positively predicted *intention to use*, *well-being*, and the *acceptance* score. Driving status (i.e., active driver) negatively predicted *intention to use*, *well-being*, and *acceptance*. Results of a regression analysis showed that *optimism*, perceived *ease of use*, *driver status*, and *race/ethnicity* were all significant predictors of user *acceptance* of AV technology, accounting for 30.7% of the variance in *acceptance*.

To conclude, our findings provide crucial foundational knowledge regarding *acceptance* of AVs, *intention to use* AVs, *perceived barriers* to AVs, and *well-being* associated to AV technology use. From the qualitative responses, seven themes were identified from adults across the lifespan with and without disabilities.

2.   Research Goals

- Quantify people with disabilities' perceptions of autonomous vehicles after exposure to an autonomous shuttle operating in autonomous mode (SAE, level 4) to determine if disability status impacted perceptions
- Qualify people with disabilities' perceptions of autonomous vehicles via four open-ended Automated Vehicle User Perception Survey questions
- Build a predictive model of facilitators and barriers of autonomous shuttle from the data collected from older drivers (N=50), younger and middle-aged drivers (N=51), and people with disabilities (N=42)

3.   Findings

Using the validated AVUPS, we assessed the perceptions of 42 people with disabilities in Florida before and after being exposed to an autonomous shuttle operating in autonomous mode (SAE, level 4). People with disabilities expressed increased *intention to use* and *acceptance* of AVs, decreased *perceived*

barriers, and no change in *well-being* after riding the autonomous shuttle, compared to baseline. AVUPS four open-ended questions generated themes: *safety, ease of use, cost, availability, aging, disability, AV information,* and *Experience with AV*. Modeling results showed that *intention to use*, *well-being*, and *acceptance* were rated more favorable when *optimism* and *ease of use* were rated higher and more favorable. Not surprisingly, *perceived barriers* was rated lower when *optimism* and *ease of use* were rated higher.

4. Performance Metrics

Metric	# Completed
OUTPUTS	
Product(s): Number of new or improved tools, technologies, products, methods, practices, and processes created or improved	1
Technical Report: Number of client-based technical reports published	STRIDE Final Report
OUTCOMES	
Body of Knowledge: Number of trainings for transportation professionals	3
Professionals Trained: Number of professionals participating in trainings	127
IMPACTS	
Stakeholders: Number of stakeholders you met with to encourage adoption or implementation of product(s)	10
Adoption/Implementation: Number of incidences outputs of research have been implemented or adopted	0 (In process of doing so)

5. Product

1) Two Continuing Education Courses

- Classen, S. Autonomous & Connected Vehicles (ACV): Introduction to the Health Care Professional. 2020; updated in 2022. https://ot.phhp.ufl.edu/category/online-education/ceu-courses/dr-classen-courses/
- Classen, S., & Mason, J. Invited Presenters. STRIDE Webinar. Demonstration Study: Older Driver Experiences with Autonomous Vehicles, May 26th, 2021. See, https://www.youtube.com/watch?v=HW-dTDK00Uc

6. Who benefits/will benefit from your product(s)?

- Findings of this project provide foundational information to people with disabilities pertaining to AV technologies, particularly on autonomous ridesharing services.
- Information from our products will inform engineers, city planners, and policy makers to enhance deployment of AV technologies.
- Our products and findings will also be useful for healthcare professionals seeking alternative mobility options for the transportation disadvantaged. For example, people who cannot drive due to transient conditions (i.e., dilated pupils after vision testing) or who want to supplement driving with autonomous shared services, such as the autonomous shuttle.

- The general public may be educated to have a more sensitive understanding of facilitators and barriers pertaining to PWDs.
- This information is also useful to industry and developers of the shuttle—to ensure that the Americans with Disabilities Act (ADA) and the Rehabilitation Act of 1973 is adhered to for increasing access for PWDs.

7. Body of Knowledge & Professionals Trained

1) Online presentation delivered at the Transportation Research Board: Automated Road Transportation Symposium (ARTS), Washington DC, USA – "Automated Shuttles and Buses for All Users (Session B210): Older Drivers and Persons with Disabilities Experiences with Automated Shuttles" presented by Justin Mason and Sherrilene Classen, University of Florida, on July 13, 2021. (57 Attendees)

2) In-person podium presentation delivered at the University Transportation Centers annual conference, Boca Raton, FL, USA – "Connected and Autonomous Vehicles (Session 1B): Experience of Drivers of All Age Groups in Accepting Autonomous Vehicle Technology" presented by Sherrilene Classen, Justin Mason, Seung Woo Hwangbo, from University of Florida, and Wencui Yang, Virginia Sisiopiku, from University of Alabama at Birmingham on March 24, 2022. (30 Attendees)

3) A research presentation was presented at the University of Florida Institute for Learning in Retirement at Oak Hammock, Gainesville, FL, USA – "Simulator Sickness in Younger, Middle-Aged, and Older Drivers After Exposure to an Autonomous Driving Simulator" presented by Seung Woo Hwangbo, Justin Mason, and Sherrilene Classen, University of Florida, on March 25, 2022. (40 Attendees)

4) A research presentation was presented at the annual Association for Driver Rehabilitation Specialists Conference, Charlotte, NC, USA – "Autonomous Vehicle Revolution & Drivers' Perceptions of AVs" presented by Seung Woo Hwangbo and Sherrilene Classen, University of Florida, on October 3, 2022. (40 Attendees)

8. Journal Publications, Conference Presentations, & Posters

Nine publications, three final reports, 20 presentations, and one media exposure were produced.

- Among nine publications, seven have been published, one is accepted, and one is under review.
- Among 20 presentations, two have been presented locally, seven state-wide, nine nationally and one internationally at conferences and/or meetings. One will be presented on April 22, 2023.

Journal Publications
- Classen, S., Mason, J., Hwangbo, S. W.*, Wersal, J., Rogers, J., & Sisiopiku, V. P. (2021). Older drivers' experience with automated vehicle technology. Journal of Transport and Health, 22, 101107. https://doi.org/10.1016/j.jth.2021.101107
- Classen, S., Sisiopiku, V., Mason, J., Wersal, J., Hwangbo, S-W., & Rogers, J. (2021). UF & UAB's Phase I Demonstration Study: Older Driver Experiences with Autonomous Vehicle Technology (Project D2). Final Report to the Southeastern Transportation Research, innovation, Development, and Education Center (STRIDE). https://rosap.ntl.bts.gov/view/dot/57395
- Classen, S., Sisiopiku, V., Mason, J., Hwangbo, S. W., McKinney, B., Li, Y., Yang, W., & Rogers, J. (2022). UF & UAB's Phase II Demonstration Study: Developing a Model to Support

Transportation System Decisions Considering the Experiences of Drivers of All Age Groups with Autonomous Vehicle Technology (Project A3). Final Report to the Southeastern Transportation Research, innovation, Development, and Education Center (STRIDE). https://stride.ce.ufl.edu/wp-content/uploads/sites/153/2022/08/STRIDE-Final-Report-Project-A3-Classen-S..pdf

- Classen, S., Mason, J., Hwangbo, S. W.*, & Sisiopiku, V. (2021). Predicting autonomous shuttle acceptance in older drivers based on technology readiness, life space, driving habits, and cognition. Frontiers in Neurology – Neurorehabilitation, 12. IF = 4.00. https://doi.org/10.3389/fneur.2021.798762
- Classen, S., Li, Y.*, Giang, W., Winter, S.M., Wei, R., Patel, B., Jeghers, M. Gibson, B., Rogers, J., & Ramirez, A. (2022). RCT Protocol for driving performance in people with Parkinson's using autonomous in-vehicle technologies. Contemporary Clinical Trials Communications, 28, 100954, 1-7. IF=2.226. https://doi.org/10.1016/j.conctc.2022.100954
- Hwangbo, S. W., Classen, S., Mason, J., Yang, W., McKinney, B., Kwan, J., & Sisiopiku, V. (2022). Predictors of Simulator Sickness Provocation in a Driving Simulator Operating in Autonomous Mode. Safety, 8(4), 73. https://doi.org/10.3390/safety8040073
- Mason, J., Classen, S., Hwangbo, S. W., & Sisiopiku, V. P. (2023). Age and Technology Readiness Influences on Adults' Experiences with Highly Automated Vehicles. Transportation Research Record, 03611981221145128. https://doi.org/10.1177/03611981221145128
- Classen, S., Sisiopiku, V.P., Mason, J. R., Yang, W., Hwangbo, S. W.*, McKinney, B. & Li, Y. (Accepted). Experience of drivers of all age groups in accepting autonomous vehicle technology. Manuscript re-submitted on 5/26/2022 to Journal of Intelligent Transportation Systems. IF = 4.277

Conference Presentations & Posters

- Hwangbo, S. W., Classen, S., Mason, J., Wersal, J., Rogers, J., & Sisiopiku, V. (2021). Older Drivers' Motion Sickness and Simulator Sickness After Automated Vehicle Exposure. The Virtual Occupational Therapy Summit of Scholars on June 23-25, 2021.
- Mason, J., & Classen, S. (2021). Automated Shuttles and Buses for All Users (Session B210): Older Drivers and Persons with Disabilities Experiences with Automated Shuttles. Virtually presented at the TRB: Automated Road Transportation Symposium (ARTS) on July 13, 2021.
- Hwangbo, S. W., Classen, S., Mason, J., Wersal, J., Rogers, J., & Sisiopiku, V. (2021). Older Adults' Motion Sickness and Simulator Sickness after Riding in an On-road Automated Shuttle and Simulated Drive in Autonomous Mode. Florida Occupational Therapy Association's Virtual Live Conference on November 13-14, 2021.
- Kimberly, B. (2021, September 2). Exposing older adults to self-driving technology improves perceptions on safety, usefulness: study. McKnight's Senior Living. https://www.mcknightsseniorliving.com/home/news/exposing-older-adults-to-self-driving-technology-improves-perceptions-on-safety-usefulness-study/
- Classen, S., Sisiopiku, V., Mason, J., McKinney, B., Hwangbo, S. W., & Yang, W. (2022). Users' Perceptions and Attitudes toward Autonomous Vehicle Technologies after Simulation Exposure – A Study across the Lifespan. 8th Road Safety and Simulation – RSS 2022 Conference at Athens, Greece, June 8-10, 2022.
- Manjunatha, P., Mason, J., Classen, S., Elefteriadou, L., & Srinivasan, S. (2022). Public Perception and Lessons Learned from Autonomous Shuttle Demonstration Studies. Transportation Research Board (TRB), Washington D.C., January 9-13, 2022.

- Hwangbo, S. W., Mason, J. R., & Classen, S. (2022). Simulator sickness in younger, middle-aged, and older drivers after exposure to an autonomous driving simulator. Abstract submitted to the 35th Annual University of Florida College of Public Health and Health Professions Research Day on February 10th, 2022.
- Sisiopiku, V.P., Yang, W., Mason, J., McKinney, B., Hwangbo, S. W., Classen, S. (2022). Users' perceptions and attitudes toward autonomous vehicle technologies after simulation exposure – A study across the lifespan. Proceedings of the 2022 Road Safety and Simulation International Conference, Athens, Greece.
- Mason, J. R., Burns, H. C., Joseph, J. L., Hanson, C. S., Fox, E. J., DeMark, L. A., Snyder, H., Horwitz, H. M., & Classen, S. (2022). Perceptions of adults with Spinal Cord Injury or disease before and after riding in an autonomous shuttle. American Occupational Therapy Association Annual Conference & Expo on March 31- April 3, 2022, San Antonio, Texas & Virtual.
- Classen, S., Manjunatha, P., Stetten, N., Mason, J., & Elefteriadou, L. (2022). Perceptions of older road users before and after the exposure to an autonomous shuttle. ROAM (Research on Older Adults' Mobility), Invited Presentation, Residence Inn by Marriot, Washington D.C., 09 January 2022.
- Classen, S., Manjunatha, P., Mason, J. & Elefteriadou, L. (2022). Public perceptions and lessons learned from autonomous shuttle demonstration studies. Association for Unmanned Vehicle Systems International (AUVSI) Exponential All Things Unmanned Conference, Orlando, Florida, 25-28 April 2022.
- Mason, J., Classen, S., & Sisiopiku, V. (2022). Automated Vehicle User Perception Survey: A brief tool to assess intention to use and acceptance of automated vehicles. Association for Unmanned Vehicle Systems International (AUVSI) Exponential All Things Unmanned Conference, Orlando, Florida, 25-28 April 2022.
- Classen, S. (2022). Track: Crossroads: Progress through Specialized Workshops. Session Title: Accelerating Innovation Through Diversity of Thought. Presentation Title: Perspectives on Older drivers and Individuals with Spinal Cord Injury using Autonomous Vehicles. Session ID: XPO22-WK07AUVSI XPONENTIAL 2022, Orlando Florida, 28 April 2022, Room S220D, 10:30-12:00 noon.
- Classen, S., Sisiopiku, V., Yang, W., Mason, J., Hwangbo, S-W., & McKinney, B. (2022) Autonomous vehicle revolution and drivers' perceptions of autonomous shuttles. ADED 46th Annual Conference in Charlotte, NC, Monday, October 3, 2022, 2:00 PM - 5:15 PM.
- Classen, S., Sisiopiku, V.P., Yang, W., & Mason, J. (2022). Experiences of drivers of all age groups in accepting autonomous vehicle technology. Consortium of University Transportation Centers Annual Conference, Boca Raton, FL, March, 2022.
- Hwangbo, S. W., Mason, J., & Classen, S. (2022). Simulator sickness in younger, middle-aged, and older drivers after exposure to an autonomous driving simulator. Robert Levitt Awards for Student Research on Aging, Oak Hammock, Gainesville, FL, March 25, 2022.
- Hwangbo, S. W., Mason, J., & Classen, S. (2022). Predictors of simulator sickness in a driving simulator in autonomous mode. Occupational Therapy Summit of Scholars, Madison, WI, June 16-18, 2022.

9. Stakeholder Engagement

MEETING DETAILS		NARRATIVE DESCRIPTION
STRIDE rep.	Justin Mason	Justin Mason has been in constant communication with the City of
Date of Activity	Every other Tuesday (on a bi-weekly basis)	

Type of Activity	other - please describe	Gainesville, I-Street, and Transdev to plan and organize data collection. Stakeholders have been providing us with updates related to the automated shuttle and their policies reflecting COVID-19.
Location	Online Zoom Weekly Meeting	
Stakeholder(s)	Derrick Breun, VP of Operations at Transdev, Jesus Gomez, City of Gainesville, I-Street	
STRIDE rep.	Seung Woo Hwangbo	Seung Woo Hwangbo has been in constant communication with Transdev on participants' schedules for data collection. Seung Woo has been meeting with Michelle and Jack (Transdev, EZ10 shuttle safety operator) for data collection at Lot 10 (100 SW 1 Ave, Gainesville, FL 32601), and they provided feedback on how the shuttle rides are completed, and managed all the troubleshooting issues of the shuttle. Depending on participants' responses, communication methods varied using direct phone calls, text messages, and emails. Stakeholders have been providing us with updates related to the automated shuttle and their policies reflecting COVID-19.
Date of Activity	Weekly basis depending on participants' responses	
Type of Activity	other - please describe	
Location	In-Person Meeting (100 SW 1 Ave, Gainesville, FL 32601), Phone and Email	
Stakeholder(s)	Derrick Breun, VP of Operations at Transdev, Jason Perez, Michelle, Jack, Transdev	
STRIDE rep.	Seung Woo Hwangbo	Seung Woo Hwangbo had a meeting with UF Health Street study navigator, Sara Marsh, to enroll the study within the system for the potential participant recruitment.
Date of Activity	2/25/2021	
Type of Activity	other - please describe	
Location	Online Zoom Meeting	
Stakeholder(s)	Sara Marsh, Study Navigator, Health Street at the University of Florida	
STRIDE rep.	Justin Mason	Justin Mason participated in the Safe Mobility for Life Transitioning from Driving Team Meeting and presented on the update of the AV/CV survey and the phase II outreach. The agenda was titled, "Transportation survey and FL shuttle deployments".
Date of Activity	7/22/2021	
Type of Activity	demonstration	
Location	Safe Mobility for Life Transitioning from Driving Team Meeting	
Stakeholder(s)	Sheri Coven from Cambridge Systematics, Inc.	

STRIDE rep.	Justin Mason	Justin Mason was invited, participated, and presented in the Florida/Ohio/Texas Transportation Consortium Meeting on the topic of the Impact of Technology on Disabled, Vulnerable, and Elder Road Users.
Date of Activity	9/15/2021	
Type of Activity	demonstration	
Location	Florida/Ohio/Texas Transportation Consortium Meeting: Impact of Technology on Disabled, Vulnerable, and Elder Road Users	
Stakeholder(s)	Cynthia Jones from Ohio Department of Transportation	
STRIDE rep.	Sherrilene Classen	Sherrilene Classen was invited, participated, and presented this study in the Gainesville Parkinson's Support group meeting on Friday, November 19th, at 12:30 pm.
Date of Activity	11/19/2021	
Type of Activity	demonstration	
Location	Online Zoom meeting	
Stakeholder(s)	Bhavana Patel from UF Health Norman Fixel Institute for Neurological Diseases, Gainesville Parkinson's Support group	
STRIDE rep.	Justin Mason	Justin Mason met with the CEO of the Oak Hammock to discuss shuttle and research findings: Autonomous Vehicles for Older Adults Living with Disabilities on March 31st, 2022.
Date of Activity	3/31/2022	
Type of Activity	demonstration	
Location	Oak Hammock	
Stakeholder(s)	Kevin Ahmadi from Oak Hammock at UF, President and CEO	
STRIDE rep.	Justin Mason	Justin Mason presented study findings at the Rehabilitation Psychology Seminar: Autonomous Driving Research on April 7th, 2022.
Date of Activity	4/7/2022	
Type of Activity	demonstration	
Location	Veterans Affairs, Tampa	
Stakeholder(s)	Ronald Rivera from James A. Haley Veterans Hospital in Tampa, Resident	
STRIDE rep.	Justin Mason	Justin Mason, Jesus Gomez, and Pruthvi Manjunatha virtually presented for the N-CATT on April 19, 2022.
Date of Activity	4/19/2022	
Type of Activity	demonstration	
Location	Virtual Webinar	

Stakeholder(s)	Andrew Carpenter from National Center for Applied Transit Technology (N-CATT), Director at N-CATT	
STRIDE rep.		
STRIDE rep.	Justin Mason	Justin Mason and Beth Gibson presented at the annual conference on topic "Where is my Flying Car? Current Technology to Support Independent Mobility" on April 22, 2022.
Date of Activity	4/22/2022	
Type of Activity	demonstration	
Location	Virtual Expo	
Stakeholder(s)	David Jones from SportsAbility, Founder/Past-president	
STRIDE rep.		
STRIDE rep.	Seung Woo Hwangbo	Seung Woo Hwangbo presented at Oak Hammock at UF of research projects on autonomous vehicle technologies on April 26th, 2022.
Date of Activity	4/26/2022	
Type of Activity	demonstration	
Location	Oak Hammock	
Stakeholder(s)	Kevin Ahmadi from Oak Hammock at UF, President and CEO, Oak Hammock residents	

10. Adoption/Implementation

1) The FDOT, Office of Safety, has funded a new project, using the survey developed with this STRIDE funding—to enhance the survey (Phase 1) and extend it to adults (i.e., 50+ years old) (Phase 2) who are using a variety of autonomous mobility services, including: ride hailing services, ride sharing services, taxis, shuttles and buses. FDOT (Classen) Phase I Total Award: $203,947. FDOT (Classen) Phase II Total Award: $269,442. Barriers and facilitators pertaining to older drivers' perceptions on the use of autonomous vehicle technology inform engineers, city planners, policy makers and health care professionals.

2) The North Florida/South Georgia Region Veterans Administration has funded a new project using a survey developed with this STRIDE funding—to quantify, qualify, and integrate rural Veterans' acceptance and adoption perceptions pertaining to automated vehicle technologies—and inform future planning and policy for ubiquitous accessible Veteran Transportation. In 2022, the North Florida/South Georgia Region Veterans Administration Total Award: $200,000. Promoting Veteran Centric Rural Transportation Options via Automated Shuttle Exposure.

11. Broader Impacts

National Leadership:
Sherrilene Classen: Member of Conference Planning Committee: AUVSI Exponential All Things Unmanned Conference, Orlando, Florida, 25-28 April 2022. Close collaboration with Kealy Griffith, Director of Conference Planning, AUVSI.

National Leadership:

Sherrilene Classen: Scientific Peer Reviewer: AUVSI Exponential All Things Unmanned Conference, Orlando, Florida, 25-28 April 2022.

National Leadership:
Sherrilene Classen: Chair of the Research Committee, Association for Driver Rehabilitation Specialists (ADED), Term May 2022-Dec 2024.

The University of Florida's Institute for Driving, Activity, Participation, and Technology (I-DAPT) is one of the national leaders in understanding users' acceptance practices related to autonomous and connected vehicles. As a result of our unique collaboration with the TREND lab at UAB, we will be able to disseminate information so that: a) industry partners and policy makers may benefit from learning about perceptions of adults with and without across the life span and their intention to use AVs, and b) the general public can be benefitted from a broader understanding of facilitators and barriers of accepting AV technology, especially for serving people with disabilities and those with mobility needs.