Automated vehicle Services for People with disabilities – Involved Responsive Engineering (ASPIRE Center)

Quarterly Progress Report #7

Grant Number:	69A3552047140
Topic:	Implications of Accessible Automated Vehicles and Mobility Services for People with Disabilities
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Report Period:	1/1-3/31/2022
Prepared for:	University Transportation Centers Program, Office of the Assistant Secretary for Research & Technology, U.S Department of Transportation

1. Accomplishments

Aim 1: Systematic Review: We will conduct a comprehensive review of the literature to more clearly understand the current trends and implications for future travel related to accessible automated vehicles and services.

- **Specific Objectives and Major Activities:**

Nothing to report this quarter as we have successfully completed Aim 1 as mentioned in previous reports. Please refer to the below mentioned manuscript publication:
https://doi.org/10.1016/j.neulet.2021.136103

Dicianno, Brad E., Sivashankar Sivakanthan, S. Andrea Sundaram, Shantanu Satpute, Hailee Kulich, Elizabeth Powers, Nikitha Deepak, Rebecca Russell, Rosemarie Cooper, and Rory A. Cooper. "Systematic Review: Automated Vehicles and Services for People with Disabilities." Neuroscience Letters (2021): 136103.

Aim 2: **Understand the needs of Users and Providers:** We will conduct surveys, focus groups, and journey mapping of stakeholders, including individuals with disabilities, their travel companions and/or caregivers, designers, medical providers, and mobility service experts (e.g., vehicle manufacturers and modifiers, as well as adaptive driving training instructors). The survey will be refined using pilot surveys, focus groups and journey mapping and then distributed broadly to all key stakeholders.

- **Specific Objectives:**

  1. Enroll research participants for Journey Mapping
  2. Recruit and enroll research participants for AV Focus Group
  3. Survey development in REDCap
  4. IRB protocol development for pilot/nationwide survey
  5. Recruit and enroll research participants for Survey

- **Major Activities:**

  Journey Mapping- This quarter, we successfully completed this phase of the study protocol (IRB#: STUDY20090111). **N= 20 participants** (8 female, 12 male) were enrolled. Please see below:

Subject ID #	Gender (M/F)	Disability category (from socio-demographic survey)	Interviewer's notes on diagnosis/AT
DOTJM01	F	DPHY	SCI/ UE/ PWC
DOTJM02	M	DEYE, DPHY, DDRS	CP/UE/PWC
DOTJM03	M	DDRS, DOUT	SCI /UE/PWC
DOTJM04	M	DPHY, DDRS, DOUT	SCI / PWC
DOTJM05	F	DPHY	CP/ MWC w/Power assist
DOTJM06	M	DEYE	Blind
DOTJM07	M	DPHY	MS/ MWC w/Power assist
DOTJM08	M	DEYE	Blind
DOTJM09	M	DEYE	Blind
DOTJM10	M	DREM	Autism
DOTJM11	M	DEAR, DPHY	CVA

DOTJM12	F	Survey incomplete	Blind
DOTJM13	M	DREM	TBI/PTSD
DOTJM14	F	DPHY, DOUT	SB/BKA/Obese
DOTJM15	F	Survey incomplete	BKA (left)
DOTJM16	M	DPHY	80+ years/CVA/MWU
DOTJM17	F	DEAR, DPHY	Hearing loss
DOTJM18	F	DEAR	Hearing loss
DOTJM19	M	DREM	Cognitive impairment
DOTJM20	F	DEAR, DREM	Down Syndrome

A good representation of individuals with varying disabilities who use personal and/or public transportation at least once a week were interviewed over Zoom. Participants also self-reported their disability categories *(as defined by American Community Survey (ACS)* in a socio-demographics survey. A few individuals belonged to multiple categories mentioned below:

- Hearing difficulty, deaf or having serious difficulty hearing (DEAR).
- Vision difficulty, blind or having serious difficulty seeing, even when wearing glasses (DEYE).
- Cognitive difficulty. Because of a physical, mental, or emotional problem, having difficulty remembering, concentrating, or making decisions (DREM).
- Ambulatory difficulty. Having serious difficulty walking or climbing stairs (DPHY).
- Self-care difficulty. Having difficulty bathing or dressing (DDRS).
- Independent living difficulty. Because of a physical, mental, or emotional problem, having difficulty doing errands alone such as visiting a doctor's office or shopping (DOUT).

The purpose of this research study was to better understand current transportation related experience during a complete trip (planning, locating, entering, riding, exiting, arriving). Discussions involved motivations and reasons for taking or not taking trips, experience taking trips outside home using transportation, understanding what decisions and steps one takes when setting up transportation, and any problems faced when doing so, etc. All twenty Zoom interviews were recorded and made sure their transcriptions were de-identified for data analysis purposes.

Focus Groups- During the quarter, we enrolled a total of **19 participants**. We conducted multiple online focus groups over Zoom with individuals with disabilities (N=5), their travel partners/caregivers (N=4) and accessible transportation service providers (N=10) to obtain perceptions around Automated Vehicle (AV) transportation & systems such as self-driving cars, automated ridesharing (e.g., Ubers without drivers), etc. These discussions were also recorded, and their transcriptions are currently being de-identified for data analysis purposes.

Survey- The 'Voice of the Consumer' and 'Voice of the Provider' surveys were built in REDCap with appropriate branching logics. IRB related to the survey was submitted and subsequently approved this quarter.

Study title: Automated vehicle Services for People with disabilities – Involved Responsive Engineering (ASPIRE Center): Voice of Consumer-Provider survey
IRB #: STUDY20120052
Review Type: Exempt - Approved
Approval date: 3/4/2022

Voice of Consumer (VOC): Individuals with disabilities/older adults, travel partners like caregivers or spouse; Voice of Provider (VOP): Transportation Provider, Expert or Designer

Survey links: **Automated vehicle Services for People with disabilities – Involved Responsive Engineering (ASPIRE Center) | Human Engineering Research Laboratories | University of Pittsburgh**

To date, we have received over 250 survey responses.

A recruitment video was put together and outreach efforts are on-going.

Aim 3: **Data synthesis, extrapolation, analysis and modeling**: We will synthesize the data obtained to understand the current and future needs of potential stakeholders of accessible automated transportation and services. This will involve presenting summary survey findings, extrapolating findings to the greater population of potential automated vehicle users, combining our data with publicly available datasets to understand factors that influence travel, displaying clusters of users based on their characteristics and needs, and ideation and development of solid models that illustrate key features and parameters for implementing automated vehicles and mobility services.

- **Major Activities:**

This quarter, all transcripts from Zoom recordings of 'Journey Mapping' interviews were de-identified for data analysis purposes to extract common themes. Transcripts from Zoom recordings of 'AV Focus Groups' are currently being de-identified for the same purpose. We summarized our first participant's (DOTJM-01) trip in a flowchart. *The individual reported having a spinal cord injury, is of short stature and uses a power wheelchair.*

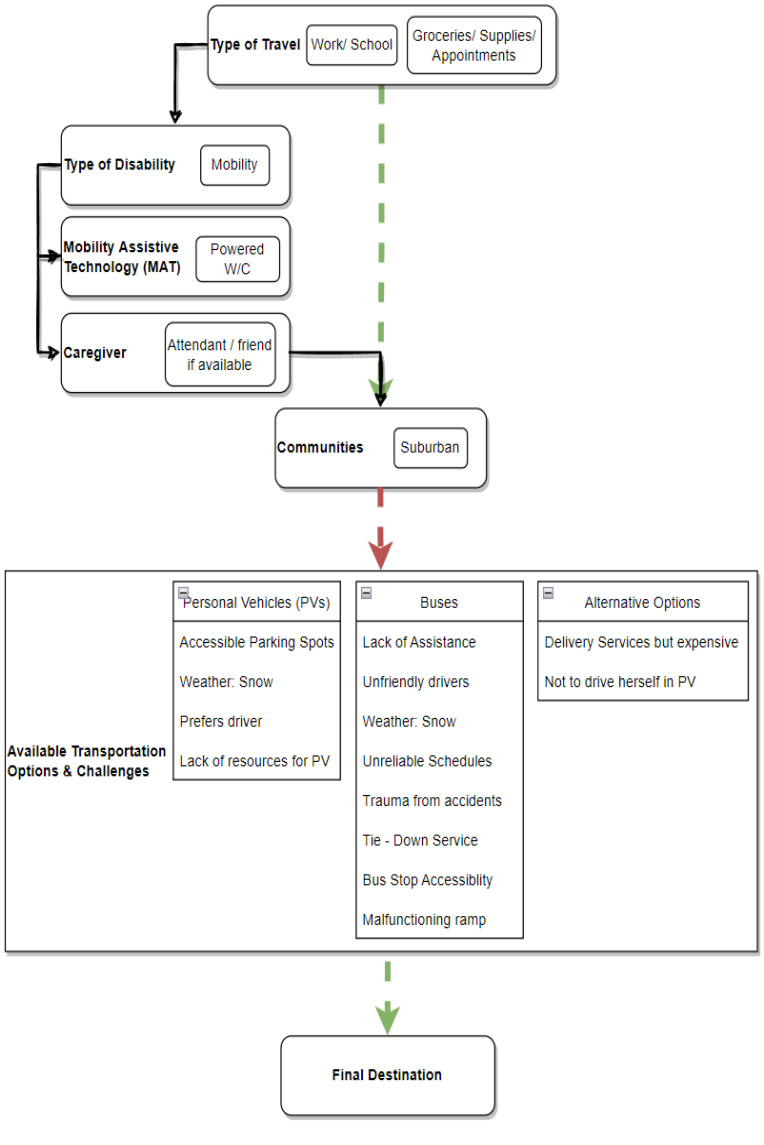
Participant ID: DOTJM-01

Age: 61

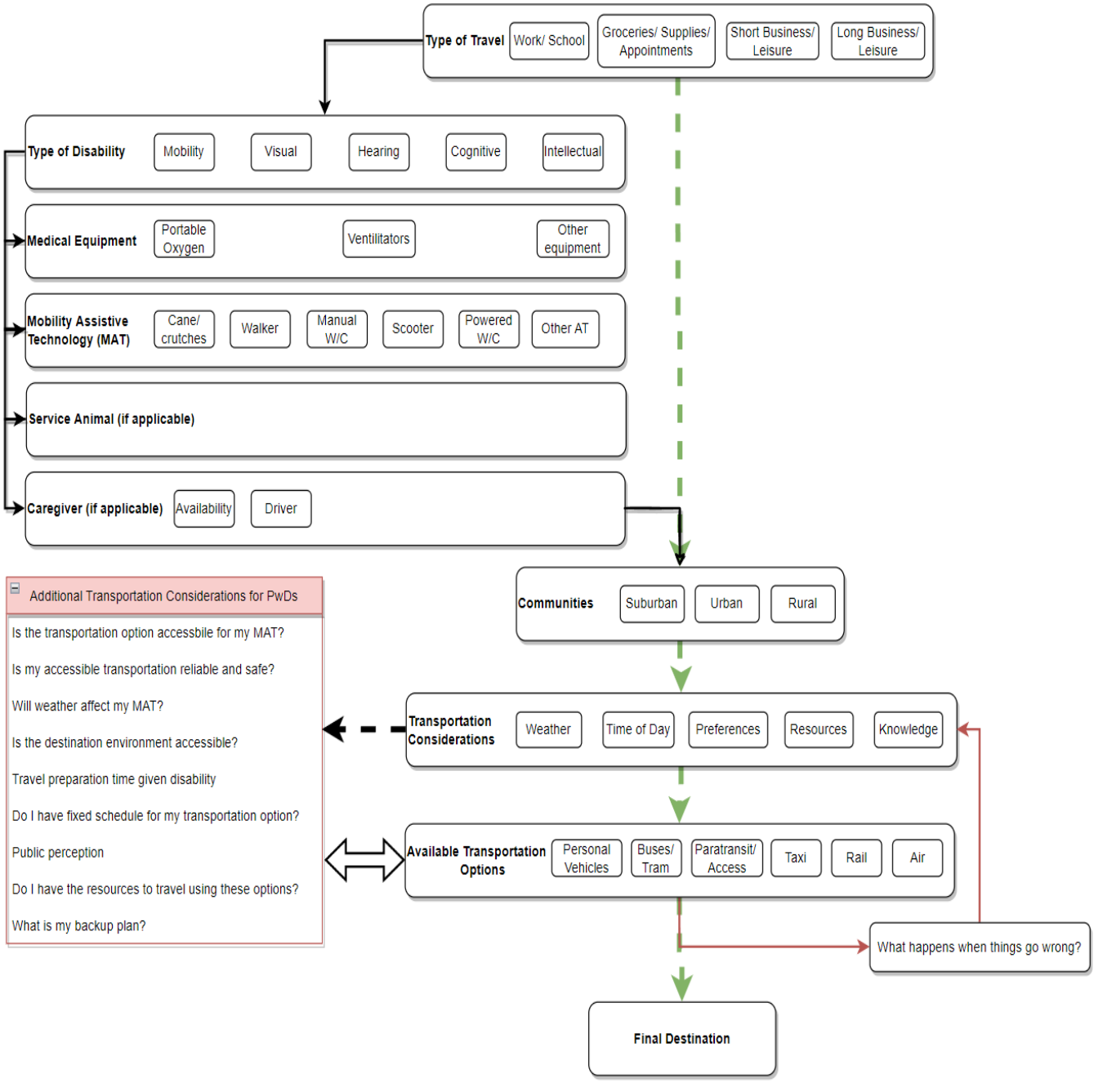
Gender: F

Disability: DPHY

Ambulatory difficulty. Having serious difficulty walking or climbing stairs (DPHY)



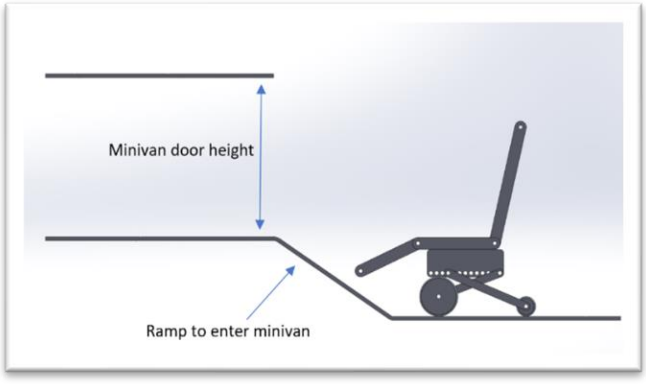
Based on a preliminary analysis of all twenty interviews, a person's typical journey can be mapped in the following flowchart. Note that the green line assumes a path for able bodied individuals. The left-hand side of the flowchart depicts the complexity of a trip for an individual with a disability.

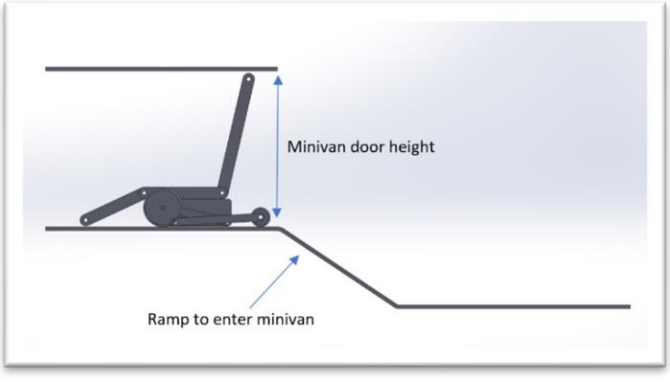


This quarter, the process of analyzing the Journey Mapping data were also finalized; We have selected three members to be coders. Before starting the analysis, all three coders were trained on the analysis process. Currently, each transcript is being independently analyzed by each coder. Conflicts regarding extracting significant statements and coding the statements between coders will be resolved through discussion.

New sub-project: Wheelchair Accessible Autonomous Vehicle Concept

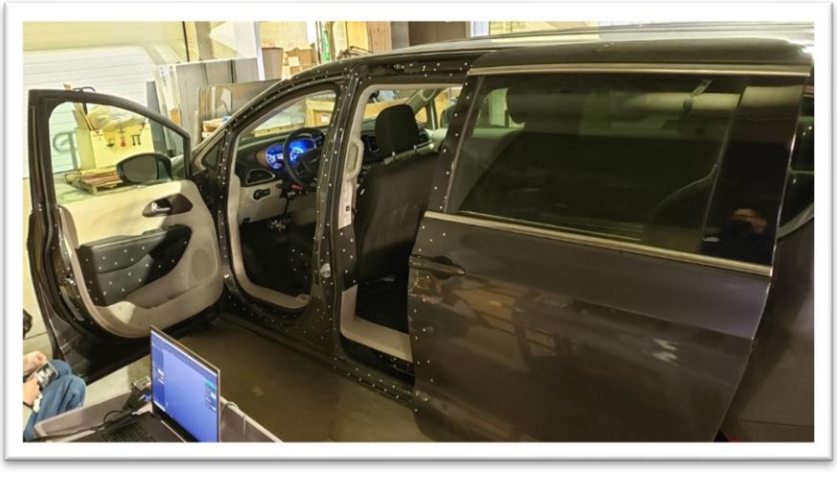
Modifications to vehicles to allow for wheelchair access is substantial, often requiring major modifications to the vehicle's frame to allow for entry of a power wheelchair into the vehicle. Most commonly, the height of the power wheelchair is too tall thus requiring the floor of the vehicle to be lowered to allow entry of the wheelchair. Our concepts (as shown) removes the need for major vehicle modifications with the development of a wheelchair that is able to decrease its height and allow for entry into the vehicle through the regular door opening.





The physical measurements of the interior of a minivan were taken to determine the design criteria of the robotic wheelchair. A 3D CAD mockup of the minivan interior was created using the measurements. Several concepts of the robotic wheelchair were developed using 3D CAD to determine whether it would be feasible for a power wheelchair to be able to fit into the minivan without major modifications such as lowering of the floor or raising of the roof. The developed concepts proved it is feasible for a power wheelchair to enter a minivan. However, additional concepts need to be generated as well as take into consideration how they will function mechanically.

This quarter, we also started 3D laser scanning critical areas of a minivan to get precise measurement to help aid in power wheelchair concept designs. We used Creaform HandySCAN BLACK™ | Elite 3D Scanner system to capture the exact geometric features of the mini-van. The scanner has 11 blue lasers and an accuracy of 0.0009 inch. The scanner is hand-held and relies on an array of randomly placed reflective dot (as shown in below images) to triangulate its position as it moves. Once the scan was captured a scanner data processing software called VXmodel was used to trim scans, patch holes, and turn scanned shells into 3D solids that can be edited in our SolidWorks CAD software.



This quarter, we also hosted our partners from the School of Architecture & Planning (CUA) at HERL to collaborate further on project activities. We are working with Prof. Fici Pasquina and their team of students and consultants on developing graphical illustrations for various phases of the grant. They are currently studying and evaluating background material from HERL, preparing to design visual communication from HERL's research data, researching and evaluating examples of graphical visualizations of similar data sets. More details will be reported in the next quarter as we continue to work together on analyzing de-identified data from Journey Mapping and AV Focus Groups.

2. **Changes/Problems**

   a. **Actual Problems or delays and actions to resolve them**
   Nothing to report.

   b. **Anticipated Problems/Issues**
   Nothing to Report.

3. **Collaborations**

This quarter, we have continued to engage advisory board members in project activities such as survey dissemination, etc. In addition, we worked with Toyota Mobility Foundation (TMF) and an Assistant Professor in the Physical Therapy Department at the University of Rhode Island on the data analysis of 'Journey Mapping' study. We have also initiated collaborations with BraunAbility on future accessible autonomous vehicle design. This involves ingress/egress, in vehicle mobility, docking, and occupant restraints.

Another DoT-ASPIRE Center Advisory Board meeting has been scheduled and we will continue to hold these bi-monthly meetings.

4. **Education and Workforce Development**

In this quarter, we continued to engage PhD and Postdoctoral students in activities such as data transcription and data analysis. In addition, we will have summer interns and co-ops working on project activities.

Over the quarter, Dr. Cooper and team have presented/conducted outreach activities at the below events:

- 37th CSUN Assistive Technology Conference, March 14-18, 2022
- The Miami Spinal Cord Injury SUMMIT March 10-12, 2022
- State of the Science Symposium: "Accessible Autonomous Vehicle Design and Considerations", March 09, 2022.
- CATM Virtual Research Symposium Feb 07, 2022
- ADED Conference "Accessible Autonomous Vehicles", Columbus, Ohio, January 16, 2022
- National Mobility Equipment Dealers Association (NMEDA) Conference Keynote "Rolling Disruptors" panel, Columbus, Ohio, January 15, 2022

5. **Performance metrics**

Please refer to the ASPIRE Center website:
Tier 1 University Transportation Center (UTC) grant | Human Engineering Research Laboratories | University of Pittsburgh

Media:
Veterans' Health Administration Chief of Staff's "Chats with the Chief"
Chat with Dr. Rory Cooper: Making the world more accessible for disabled Veterans