DESIGN RESEARCH TOWARDS VIABLE BUS USE FOR AN AGING POPULATION

Trygve Faste, Corresponding Author
University of Oregon
Department of Product Design
5282 University of Oregon, Eugene, OR 97403-5282
Tel: 541-346-4377 Fax: 541-346-3626; Email: trygve@uoregon.edu

Kiersten Muenchinger
University of Oregon
Department of Product Design
5282 University of Oregon, Eugene, OR 97403-5282
Tel: 541-346-6891 Fax: 541-346-3626; Email: kiersten@uoregon.edu

Word count: 5,336 words text + 5 figures

Submission Date: December 2nd, 2016

ABSTRACT
Older Americans are increasing in numbers and addressing their needs through better public transportation design will improve their quality of life. This study sought to increase understanding of the obstacles faced by people with impairments in vision, hearing and/or mobility, which are common issues for older people, and generate physical product solutions. The research was conducted to conceptualize products, structures, and services to reduce or eliminate these obstacles.

With a focus on the Eugene, Oregon public bus system, elderly riders were surveyed and interviewed. Designers rode on buses noting what worked well and where problems arose. Five ride-along observations of older and disabled persons who had mobility, hearing and/or vision impairments were conducted. Two focus groups at Lane County Independent Living Alliance (LILA) with experts on public transportation and disabilities were conducted.

This research shows that aging riders face conceptual, physical, and social barriers that impact their willingness to use buses. Using the bus was seen as inconvenient, time consuming, physically draining and potentially frustrating. Priority seating areas designated for older and disabled users fill quickly. People with mobility challenges may use bulky walkers and require the availability of grab bars, and users of wheeled mobility devices need different device security. Several situations noted in the study show that physically challenged riders are subject to awkward, uncomfortable social dynamics more than other bus users. Innovation in easy access seats and secure WhMD stations at the front of the bus are critical for older users, as it makes riding the bus less draining and more safe.

Keywords: Bus use, Public Transportation, Senior Citizen, Aging, WhMD, WTORS, Walker

INTRODUCTION

As the number of older Americans increases, so does the number of opportunities to design our built environment to better the lives of older Americans. Because older persons have limitations with vision, hearing and mobility with greater frequency and magnitude than the general population, focusing on designs that aid vision, hearing and mobility in environments directed toward the public will provide older people greater facility to engage in their communities. Environments that support active transportation modes not only allow older people to maximize their physical activity but also their use of public transportation and, in turn, their engagement within the wider community. (*1*) This study of the needs of people with vision, hearing and mobility issues in a public bus transportation system was instigated to synthesize existing research, discover new insights, and generate new designs that enhance the common use of public bus transportation.

The number of older people who are reliant on public transportation is increasing. There are jumps up in the number of public transportation users as people hit ages 65, 75 and 85. (*2,3*) A growing number of older Americans implies there will be a greater number of individuals relying on public transportation for a longer time period. (*4*) Disabled persons and people with medical conditions, who may have similar vision, hearing and mobility issues to those of older persons, also use public transportation more than the general population. (*5,6*)

Nearly 20% of Americans ages 65-74 identify themselves as having a condition that makes it difficult to travel, and that number increases to nearly 30% for ages 75-84 and increases again to 50% for individuals aged 85 and above. (*5*) Medical conditions may impose physical constraints to travel but they often do not curb people's desire to travel out of the home. (*7*) While Americans want to drive their own cars as long as possible for the independence and flexibility personal car travel gives them, the likelihood that a person with a medical condition would give up driving increases significantly with age, from 28% of those 19-64 to 62% of those 85 or older. (*5*)

Difficulty with public transportation

However, adults aged 65 and older find that using public buses is difficult for them, with problems including walking to and from bus stops and getting on and off a bus. (*8*) The ability to use one's personal mobility equipment throughout a journey is another problem noticed by disabled people. (*6*) Disabled persons cite the physical difficulties of using public transportation as a reason that travelling outside of home is not merely difficult, but is impossible. (*9*) These findings would no doubt be very different in dense urban areas where parking is more challenging and more public transit options exist.

Secure space on the bus

Once on the bus, finding a seat or spot can be both physically and emotionally threatening to older and disabled people. Open seats, seats with reachable grab bars, and accessible spaces for walkers and wheelchairs may not be available on a given bus. The possibility of a seat not being available and needing to stand on the bus discourages some older people from attempting to ride the bus. (*8*) The seating areas that are designated for older and disabled persons may not be available or relinquished by other riders. For users of wheeled mobility devices (WhMD), including wheelchairs and motorized scooters, the strap systems available to secure the devices are not liked and are frequently not used. (*3,10*) This is understandable since these devices are not designed for securement in transit (*11*), but there is a need for the development of Wheelchair Tiedown and

Occupant Restraint Systems (WTORS) with improved usability. (*3*) As most of the reports of injuries to WhMD users are from non-collision incidents in which a WTORS user was inappropriately secured or an unrestrained rider was injured (*10*), restraints that provide security without meeting current collision standards may be appropriate for reducing typical rider injuries.

Asking others for help

Proud and independent people also don't necessarily want to ask for help using the bus, finding a seat on the bus, or having their WhMD secured on a bus. Older people note that one of the benefits of using a bus is that they don't need to bother someone to get a ride. (*2*) Finding additional ways bus transportation can provide moments of independence for older people may help their emotional health. Disabled persons cite not wanting to ask others for help as a reason that travelling outside of home is impossible (*9*), so helping the disabled traveler may also help her or his emotional health. Buning et al. reported that 39% of WhMD users never requested to have their WhMD secured during transit and 49% of respondents said they did not ask because either they or the bus driver did not want to take the time to secure the restraints. (*11*) A majority, 78%, of participants would prefer to secure their own WhMD. (*11*) Creating WTORS that can be operated independently by WhMD passengers is needed (*3, 12*) and is a way to provide moments of independence to all WhMD users.

OBJECTIVE

This study sought to increase understanding of the unique obstacles that people with impairments in vision, hearing and/or mobility face in using public bus transportation. These findings were used to aid the design of products, structures, and services that can reduce or eliminate these obstacles. By focusing on vision, hearing and mobility impairments, design solutions are applicable to older users, users with disabilities and any other users that may have impairments or be in environments that cause impairments, like darkness or loud urban spaces. The driving goal is to improve bus transportation for our aging population, but the resulting ideas and services provide better public transportation for all.

MATERIALS & METHODS

This project applied product design methodology to generate qualitative research that can be used to better understand the complex dynamic around bus use and the elderly in a small city environment. The particiipants in this study include individuals who are aging and/or have mobility, vision and hearing challenges that use the public bus system in Eugene, Oregon.

Nineteen surveys and seven one-on-one interviews conducted at the Campbell Center, a center for older citizens supported by Eugene Recreation Services, were conducted to document how bus riders aged 58 and older felt about public buses.

User observations while on a trip that utilized the bus were conducted to see how the current bus designs functioned for our sample population. Fifteen designers rode the Eugene bus system for three hours each, noting various challenges that arose for the elderly and disabled riders. Five ride-along observations, in which designers accompanied physically challenged older people, were subsequently conducted and documented.

In addition, two one hour-long focus group sessions were conducted with active participants in the Lane County Independent Living Alliance (LILA). The sixteen participants in these sessions were either public bus users with physical challenges, or professionals who help people with disabilities

live independently.

Three experts on accessible public transportation in the Lane County Transit District (LTD), Eugene's public transportation authority, discussed their most pressing issues in interviews and during progress presentations for this project.

RESULTS

Difficulty with public transportation: the conceptual challenges to bus usage

People drive themselves as long as possible. They appreciate the convenience of being able to travel more quickly and comfortably via car. Survey participants stated: "[My car is] convenient, faster, [and] better for running lots of errands." (77-year-old, Campbell Center Survey) "[Cars are] door to door all the way...car takes 7 minutes, and bus takes 35 to 50 minutes" (62-year-old Campbell Center Survey) and "The bus can take 1 hour to go a 15-minute trip." (Campbell Center Survey) Though use of the bus was felt to be time consuming, of the surveyed riders 63% use the bus for running errands. This suggests that other factors make the inconvenience of the bus worthwhile.

Car preference goes beyond time efficiency. One 76-year-old participant shared that medical conditions complicate bus usage, and driving is easier. "I have fibromyalgia and having a car means I don't have to walk so much. I know at some future time I am going to have to give up driving but I'm not looking forward to it." (Campbell Center Survey) Eventually people do stop driving when they have developed physical impairments. "I no longer drive [for] medical reasons." (Campbell Center Survey) Similarly, one participant in Zeitler's research stated, "You can see why I push for a bus three/four times a week. There will come a time where I cannot drive anymore. How do I get to the shopping centre?" (*1*) Users who have always driven in their own cars may develop new disabilities forcing them to become new to riding public transportation. Physical impairments also complicate getting to and from bus stops. "I walk from the bus stop home 1200 steps up hill."(Campbell Center Survey)

There were some aspects of riding the bus considered to be positive. "Comfortable - Safe - Good place to read a book" were some of the reasons a 69-year-old bus rider listed. (Campbell Center Survey) In general people considered the bus to be a safer than driving. One rider uses the bus "...when there is snow and ice." (66-year-old, Campbell Center Survey) Perceptions of safety and time are important considerations for older patrons when contemplating bus usage.

Secure space on the bus: the physical barriers to bus usage

People stop driving for medical reasons, so the accessibility of buses for the physically impaired is critical. In our survey of riders over the age fifty-eight, 47% of riders use the bus due to impairments. Loss of mobility, sight and hearing are challenges to overcome and physical environment within the bus becomes a critical component to its function as an enjoyable and viable transportation solution. Moving around the bus, sitting and standing are difficult for older bus riders. One 76-year-old rider who has trouble getting on and off the bus due to balance issues states: "[The] driver should not start the bus until I'm seated." (76-year-old rider Campbell Center Survey) While balance may be the most easily noticed issue, time is also a factor. One UK study found that older people walk slower than the 1.2m/s that UK Department for Transport recommends as a baseline for crosswalk design. Only 11% of older people kept this pace or above. (*13*) Due to this slow rate of walking, the area in the front of the bus, most visible to the driver and

shortest distance to travel from the front bus entrance, is desirable territory for older people.

Crowding can complicate the ability to quickly sit. One rider answered the question of how they felt about riding the bus stating: “it’s too crowded” (72-year-old, Campbell Center Survey) An elderly rider noted that one annoyance is “people who put stuff on an adjacent seat when it could be in their lap.” (Campbell Center Survey) Built-in features of the bus can prevent an older riders from accessing sections of the bus. It was found that the steps between seating zones were too steep and that to enter the bus they had to use the front ramp. (Campbell Center Survey) One rider stated “I have fallen before boarding the bus because steps are too high.” (Campbell Center Interview) Most buses have priority seating at the front as this area is quicker and easier to access. This zone is often full of people without disabilities because it affords space for bulky objects like luggage and baby strollers. (Ride-along Observation) One man and his young child folded his stroller and sat in the priority seating area for people with disabilities with the stroller under the seat and the child on his lap when riding a small bus, but when he transferred to a larger bus with plenty of room in the back (a non priority seating area where bicycles are usually stored), he kept the stroller unfolded in the aisle with the child sitting next to him. (Ride-along Observation)

It was observed that the priority area in the front of the bus fills quickly with walkers that people do not fold up. The walker is needed for stability all the way to the rider’s seat. (Ride-along Observation) The front of the bus is also the only place for riders using WhMD’s as it is designed such that they can be properly secured. On the observed buses, seats that could be used for elderly passengers often fold out of the way to fit wheelchairs: typically two attached seats fold up to make space for one wheelchair. (Ride-along Observation) If the two wheelchair bays are full, additional wheelchair users need to wait for another bus and elderly riders have four less priority seats to utilize. (Ride-along Observation) Bus riders may not be able to raise and lower the seats on their own due to the weight of the seat, or complexity of the latching mechanism. (Ride-along Observation) It is very hard to move the seats in the priority seating area up or down. (Ride-along Observation) This creates even more demand on an already burdened area of the bus. Beter seat designs do exist but were not present on these observations, highlighting the challenges of implementing good solutions.

While the front of the bus is designed for highest priority seating availability, one rider stated: “I don’t actually sit in the handicapped spot, I like to sit next to a certain seat with better railings.” (Campbell Center Interview) Another older rider who prefers a particular seat on the bus as it is the only seat with a near-by slanted grab bar that she likes. “I always want to sit here because then I can lower myself into the seat, it is way better. I wish every seat had a way to lower like this.” (Ride-along Observation) Prior research has shown that “[t]he greatest problem and safety hazard within independent home environments for the elderly with limited mobility is the absence of grab bars.” (*14*) This research confirms the need for well placed grab bars in moving environments, as it was noticed that many people with varying levels of disabilities were using the ramps and rails for supports. (Ride-along Observation)

Asking others for help: social complications and barriers to bus usage

Older and disabled bus patrons need to interact with other passengers or the bus driver more frequently and in different ways than other riders. A diagram showing four overlapping areas of social interaction between various bus occupants can be seen in Figure 1.

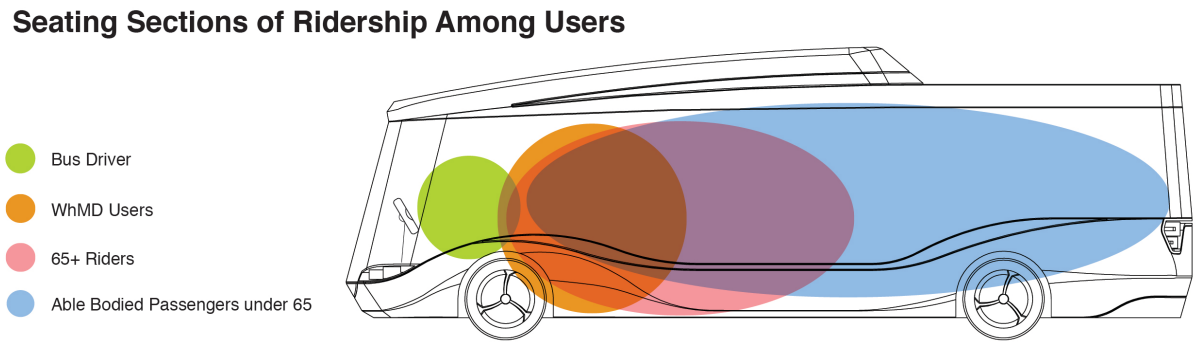

FIGURE 1 Seating sections of ridership among users.

One contributing factor to increased interaction is the crowded reserved seating area. (Ride-along Observation) If the seats are being used by non-disabled riders who do not move of their own accord, an older or disabled rider must ask them to move if they wish to sit. People expressed frustration with bus etiquette during the LILA focus group sessions. It was also found that though people with disabilities are willing to accept help, they like to feel self-sufficient and would rather be able to board and exit the bus without assistance. (LILA Focus Group) Bus users conveyed that they enjoyed the freedom from their caretakers that the bus provides and that asking others to move is counterproductive to feeling independent. (LILA Focus Group)

Other ways that riders who are older and/or disabled may be forced to ask for special assistance involves knowing when they have reached their destination. One user with vision impairments stated: “I have to memorize all of my routes because the speakers don’t announce every stop so I can’t hear them at all sometimes.” (LILA Focus Group) When this rider loses count they have to ask where they are. (LILA Focus Group) Other riders find it difficult or impossible to reach the pull cord or button to indicate their desire to disembark at the next stop. This requires that they call attention to themselves by either yelling to the bus driver that they would like to stop, or by asking a stranger to pull the cord. (Ride-along Observation) On the buses observed, the button designed for wheelchairs to request a stop is actually very difficult to reach, so people in wheelchairs often have to remind the bus driver help them get unstrapped or to get the ramp out. (LILA Focus Group) Catching the right bus is also difficult. “I can’t see my bus and so I just have to memorize my stops and hold this card and hope that the driver can see me.” (LILA Focus Group) This user is blind, and the cards with numbers indicate which bus she needs to catch when she is waiting at a stop that multiple buses pass.

These observations indicate that the bus driver is asked to assist in many situations. Drivers have a lot of other factors to consider, including driving the bus, collecting bus fares, answering questions, noticing when people have reached their seat, and helping strap in/out wheelchairs. (Ride-along Observation) The straps used to secure wheelchairs don’t work on all wheelchairs, are low and out of reach. (LILA Focus Group) The messy appearance of these straps doesn’t help riders feel safe, and many times require driver assistance to use properly. (LILA Focus Group) One bus driver waited to help strap in and unstrap a wheelchair user in the hope that some other rider would do so voluntarily. (Ride-along Observation) He was thankful to the person who did help, suggesting he really appreciated having his workload lightened. (Ride-along Observation) Drivers also don’t always want to stop and do the work required to strap in a wheelchair. (LILA Focus Group) The drivers will typically release people from the straps more often than helping them put on the straps. (LILA Focus Group) This leads to a potentially awkward social situation where, if

the driver does not engage with the WhMD user, the WhMD user has to ask a stranger for help. In this situation, riders would have to notice that nobody else is helping, and then work together to figure out what to do. While this is a seemingly plausible solution to the problem of an overly burdened driver, it has a few potential drawbacks. One is that the person being helped may feel self-conscious about their reliance on the kindness of strangers, a potential blow to selfesteem. Another is that the person helping may not know the safe and correct way to operate the equipment. Instructions on how to strap in wheelchair are difficult to read. (Ride-along Observation) On the other hand, social interactions can be a positive experience and 26% of the survey participants mentioned that they enjoyed interacting with friendly bus drivers. (Campbell Center Survey) Similarly, successful transportation programs for older people in some communities are considered to include the driver's kindness and general demeanor with older persons. (*15*) The various and complex social expectations of the bus driver, riders under 65, riders older than 65 and WhMD users is summarized in Figure 2, and shows the great potential for awkward or frustrating interactions.

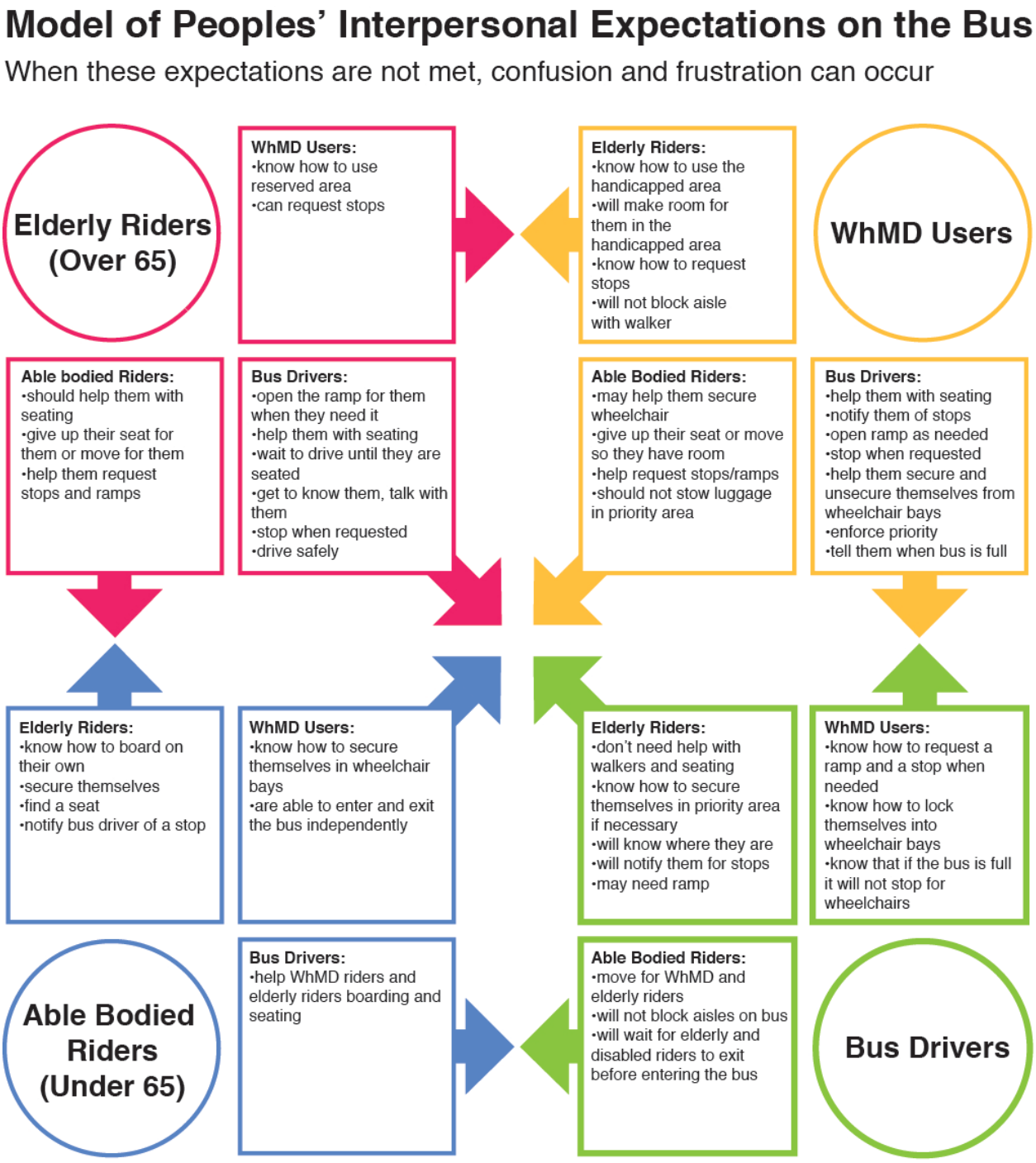

FIGURE 2 Model of Peoples' Interpersonal Expectiations on the Bus.

DISCUSSION AND CONCLUSION

This research shows that as people age they face conceptual, physical, and social barriers that impact their willingness to use buses as a viable means of transportation. While people born with disabilities were motivated to use public transportation and the independence that it provided, (LILA Focus Group), aging people saw their cars as supplying more independence, and the bus to

be limiting. (Campbell Center Survey & Campbell Center Interview) As a result, the needs of elderly riders, which may be less physically obvious than those of WhMD users or riders with product clues to their disabilities, must be successfully addressed through thoughtful design to increase ridership.

Convenience to easy access seats and secure WhMD stations at the front of the bus is critical for older users, as it makes riding the bus less draining and more safe.

Many older riders use walkers to help them all the way to their seats. (Ride-along Observations) Currently, walkers block aisles and do not otherwise integrate with bus seating. Because the front of the bus is also used for large objects like luggage and strollers, (Ride-along Observations) there is a concentration of non-secured, wheeled, bulky objects localized where people with physical impairments sit. It is highly likely that increased obstacles like this make moving more challenging for people who need to sit in this area and may lead to an increased risk of accidents.

Designing walkers that can comfortably traverse the variety of terrains an elderly person would encounter from their doorstep to a bus seat has great potential. If walkers also took into account bus seat design and the interior architecture of the bus, they could provide user stability and minimize aisle obstruction to create a safer and more efficient use of the priority seating space. In addition, if the interior of the bus were re-designed in concert with the walker, the walker-user would have a more harmonious bus-riding experience. (Figure 3)

FIGURE 3 Walker designed to integrate with bus seating.

The many different types of riders in priority seating areas pose a wide array of competing needs. One such conflict is that an older person wants an empty chair **to** be there when they enter the bus, whereas a person in a wheelchair wants chair **not to** be there when they enter the bus. (Ride-along

Observations) Both needs should be met in better ways than the current folding systems offers. As each bus is different, figuring out how to operate the heavy folding seats, different types of latches and the wheelchair restraints can be confusing. (Ride-along Observations) Negotiating between all of the user needs to ensure reliable seating for prioritized passengers is another area where thoughtful design can make a significant impact.

Currently, the WTORS and the seats are two separate designs. Integrating WTORS and seats into one design that transitions seamlessly from seat to wheelchair mount would be a powerful innovation. One study found that low-g events from the bus braking or turning occur frequently and account for half of onboard passenger injuries and, in the study, account for all of the wheelchair rider's fatal and nonfatal injuries. This result implies that WTORS that sacrifice high-g protection for improved ease of use could reduce injury risk significantly. (*16*) A system of seats that flip up (as in a movie theater) in order to offer a secure wheelchair locking bracket is one strategy. (Figure 4) With this concept any seat could potentially secure a wheelchair, which adds flexibility to the bus layout. Each Wheeled Mobility Device would have standard latches, like those found inside car doors, that mount into the existing WhMD hitches. (Figure 5) This concept builds on the device of Hunter-Zaworski who's research concluded that though there are engineering challenges to overcome, a self-latching system for WhMD's on public buses is viable. (*17*) The WhMD user may attach herself by backing up to the bracket until the latch mechanism locks to the seat bar, and detach through a release switch mounted on her WhMD. The ease of use of a universal wheelchair coupling system could increase overall bus capacity for WhMD's , increase the number of secured wheelchairs on buses and potentially lower the number of low-g accidents.

FIGURE 4 Fold-up bus seat with secure wall bracket.

FIGURE 5 WhMD latch to wall bracket for fold-up bus seat.

Folding priority seats could be “smart” programed to lock in the closed position until a senior citizen rider enters the bus. The senior citizen bus pass could have an RFID tag that would wirelessly communicate with the seat, similar to a security tag and detector system at a department store. A reserved seating system affords an older rider some of the convenience they lost when they stopped using their own car. Such a system could be optimized to take into account ridership patterns, and would know when older riders need more seating reserved. While this system could be controlled by software, the bus driver could also have an override if needed. This coordinated system ensures that a seat is already flipped up, out of the way, when a WhMD user enters the bus and comes to clip into the seat bar.

A system similar to the one described above that can supply seats when needed and remove them when not needed would also address the social awkwardness elicited by the current system. It addresses the availability, flexibility, security, convenience and spontaneity attributes noted by Coughlin to be desired in transportation to service older persons. (*18*) Bus drivers would no longer need to help buckle in users of WTORS, eliminating an extra responsibility and giving them more time to focus on other tasks. Older people would no longer need to ask other bus patrons to move so that they can sit, and able-bodied people would not be confused as to where they should sit. All riders would have a heightened sense of independence, and understanding of bus etiquette.

Simple designs could also aid independence for people with visual and auditory impairments. A small fob (such as a keyfob for a car) could tap into a GPS system on the bus and at the touch of a button could inform riders of their position via text or voice recording, or signal the bus driver that

a stop is requested. A product like this would also greatly assist users who can't reach the stop request cable, reducing the need for them to shout to the driver. The product could be supplied by the bus system on request, and returned when no longer needed. Though the cost could be an initial barrier, the added efficiency could help to improve the riding experiences for both passengers and the driver.

As discussed, this project generated many potentially viable design solutions to the conceptual, physical and social aspects of riding public buses encountered by persons who are older or disabled. These design concepts illustrate the importance of synthesizing research with creative process. The prototype designs require further testing and refinement. With appropriate development, innovations that take into account the needs of vision, hearing and mobility challenged people can make bus riding more intuitive and enjoyable for the aging bus riders and the community as a whole.

ACKNOWLEDGEMENTS

This study was funded by the National Institute for Transportation and Communities (NITC). The student design researchers involved in this project include Cara Anthieny, Elias Burch, Ching-Lu Chueh, Maleah Cooper, Andrew Eldredge, Kevin Elliott, Nathan Hemphill, Kinsey Johnson, Carly Keyes, Jack Koby, Brittany Lang, Sam Selbie, Connor Shimamoto, Morgan Snook, and James Tuttle. Kate Scott, the Community Program Analyst & OAA Contract Manager for Senior and Disability Services arranged meetings with the Disability Services Advisory Council and the Senior Services Advisory Council of the Lane Council of Governments. Andy Fernandez and Diane Sconce with the Campbell Center in Eugene Recreation and Cultural Services enabled survey research with the 50+ age group of users. Tim Shearer and the staff and community at Lane Independent Living Alliance (LILA) contributed to this research by organizing individual ride-along observation sessions and providing final project feedback. Susan Hekimoglu and Cosette Rees from Lane Transit District (LTD) arranged a tour of buses at the central station and provided final project feedback.

REFERENCES

1. Zeitler, E., Buys, L., Aird, R., Miller, E. Mobility and Active Ageing in Suburban Environments: Findings from In-Depth Interviews and Person-Based GPS Tracking. *Current Gerontology and Geriatrics Research*, Volume: 2012, p 10.
2. Frith, W., Mara, M K., Langford, J. Demand for transport services: impact on networks of older persons' travel as the population of New Zealand ages. New Zealand Transport Agency, 2012.
3. Gorti, R. K. An analysis of travel trends of the elderly and zero-vehicle households in the United States. MSci thesis. Civil Engineering, Department of Civil and Environmental Engineering, University of South Florida, Tampa, FL. 2004.
4. Shaheen, S., Allen, D., Liu, J., Public Transit Training: A Mechanism to Increase Ridership Among Older Adults. *Journal of the Transportation Research Forum*, Volume: 49, Issue 2, 2010, pp. 7-28.
5. Mattson, J. Travel Behavior and Mobility of Transportation-Disadvantaged Populations: Evidence from the National Household Travel Survey. Upper Great Plains Transportation Institute, 2012. http://www.ugpti.org/pubs/pdf/DP258.pdf. Accessed Apr. 14, 2015.
6. Penfold, C., Cleghorn, N., Creegan, C., Neil, H., and Webster, S. Travel behaviour, experiences and aspirations of disabled people. Report for Dept. of Transport, United Kingdom, National Centre for Social Research (NatCen), London. 2008.
7. Sikder, S., Pinjari, A. R. Immobility Levels and Mobility Preferences of the Elderly in the United States: Evidence from 2009 National Household Travel Survey. *Transportation Research Record: Journal of the Transportation Research Board*, Issue Number: 2318, 2012, pp. 137–147.
8. Jansuwan, S., Christensen, K., Chen, A. Assessing the Transportation Needs of Low-Mobility Individuals: Case Study of a Small Urban Community in Utah. *Journal of Urban Planning and Development*, Volume: 139, 2013, Issue 2, pp. 104-114.
9. Bureau of Transportation Statistics (BTS). Transportation difficulties keep over half a million disabled at home. *BTS Issue Brief No. 3*., Dept. of Transportation, Washington, DC, 2003, p.1.
10. Shaw, G., & Gillispie, T. Appropriate protection for wheelchair riders on public transit buses. J*ournal of Rehabilitation Research and Development*, 40, 2003, pp. 309–319.
11. Buning, M. E., Getchell, C. A., Bertocci, G. E., & Fitzgerald, S. G. Riding a bus while seated in a wheelchair: A pilot study of attitudes and behavior regarding safety practices. *Assistive Technology*, 19, 2007, p.166–179.
12. Frost, K L, Bertocci, G, Salipur, Z. Wheelchair securement and occupant restraint system (WTORS) practices in public transit buses. *Assistive Technology*, vol 25, 2013, pp 16-23.
13. Musselwhite, C. Environment–person interactions enabling walking in later life. *Transportation Planning and Technology*, Volume 38, Issue 1, 2015, pp. 44-61.
14. Chappell NL, Cooke HA. 2010. Age Related Disabilities - Aging and Quality of Life. In: JH Stone, M Blouin, editors. International Encyclopedia of Rehabilitation. Available online: http://cirrie.buffalo.edu/encyclopedia/en/article/189/
15. Berliner, R., Swansen, E., Knodler Jr., M. A., Tupper, S., Peabody, D., Collura, J. The Complex Web of Senior Mobility Services. TRB 93rd Annual Meeting Compendium of Papers, 2014.
16. Shaw, G. Investigation of large transit vehicle accidents and establishing appropriate protection for wheelchair riders. *Journal of Rehabilitation Research and Development*, 45, 2008, pp. 85-108.
17. Hunter-Zaworski, K., Zaworski, J., Clarke, G. The Development of an Independent Locking Securement System for Mobility Aids on Public Transportation Vehicles. US Department of Transportation, 1992.
18. Coughlin, J. Transportation and Older Persons: Perceptions and Preferences. A Report on Focus Groups. Centre for Transportation Studies and Age Lab, AARP, 2001.