



U.S. Department  
of Veterans Affairs



University of  
Pittsburgh

# HERL

HUMAN ENGINEERING RESEARCH LABORATORIES



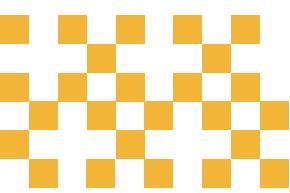
## HERL A.I. AT THE **UNITED NATIONS**

ON PAGE 2

VOLUME 24, NO. 3 | JULY - SEPTEMBER 2025

### IN THIS ISSUE

ACCOLADES	2
PUBLICATIONS	4
HIGHLIGHTS	7
STUDIES	8
PHOTOS	11
NEWS	14



# AI FOR GOOD Summit

## RORY COOPER SPEAKS AT THE UNITED NATIONS

Excerpt from *PittWire* by Nick France - July 15, 2025

The University of Pittsburgh's Rory Cooper spoke at the United Nations as part of the AI for Good Global Summit in Geneva, Switzerland, on July 9. The esteemed Pitt innovator discussed how artificial intelligence is being deployed to fuel collaboration and improve the lives of people with disabilities, along with the challenges and ethical considerations of using AI in rehabilitation engineering.

Cooper's talk highlighted several pieces of technology developed in the Human Engineering Research Laboratories (HERL), a joint venture between Pitt and the U.S. Department of Veterans Affairs. Cooper is the founding director and VA Senior Research Career Scientist at HERL and serves as Pitt's assistant vice chancellor for research for STEM-health sciences collaborations.

The presentation featured a wheelchair that can traverse bumps, curbs and icy surfaces while keeping its user upright, a board game that teaches players about community mobility for mobility device users, a virtual coach that helps teach wheelchair users to use powered seat functions in real time, and the affordable, light-weight and fashionable Kirigami wheelchair.

Cooper has been using applied science to aid disabled veterans and other wheelchair users — both groups in which he counts himself — for more than 30 years. In addition to directing HERL, Cooper was elected to the National Academy of Engineering Class of 2024 and named to the U.S. Olympians and Paralympians Association's Executive Committee the same year. In 2023, he was awarded the National Medal of Technology and Innovation and was inducted into National Inventors Hall of Fame.

AI for Good is the United Nations' leading platform on artificial intelligence to solve global challenges. The summit is organized by the International Telecommunication Union in partnership with over 40 UN Sister Agencies and co-convened with the Government of Switzerland.



*Dr. Cooper speaking at the UN's AI for Good Summit in Geneva, Switzerland.*

# Accolades & Events

Celebrating our best moments and achievements from the past three months.

Director, **DR. RORY COOPER**, spoke at the July AI for Good Summit in Geneva and the AI Horizons panel on Military Medicine, right here in Bakery Square in September! He was a keynote speaker at the 2025 American Society of Biomechanics conference in August, and presented a lecture on Inclusion and Transformative Technologies at the 2025 disABILITY Conference in September. Associate Director for Stakeholder Engagement, **ROSEMARIE COOPER**, also gave a lecture at the event, where they were both recognized for their contributions by the state of Pennsylvania. Dr. Cooper has moved on to the National Veterans Creative Arts Festival finals with his entry in the B&W Photo category. Medical Director, **DR. BRAD DICIANNO**, was lauded with the CLASS Community Hero Award, which will be presented in October. He gave lectures at the VA Advanced Platform Technology (APT) Center in July, and the Lund University Spina Bifida conference as well as the Disability Pride PGH 2025 festival in September. Senior Associate Director for Research, **DR. ALICIA KOONTZ**, gave a presentation at the PVA Summit in August along with staff researcher, **DR. SHANTANU SATPUTE**, and at the VAPHS 18th Annual Best Practice Conference in September. Student researchers **OWEN FLAUGH**, **JEFFREY PETTIGROW**, also presented their work at the VAPHS event. Core Investigator, **DR. GEORGE WITTENBERG**, presented at NERD Hour in July, and the CMU Neuro-design Seminar in September.

As a team, the Human Engineering Research Labs participated in and attended a vast array of events this quarter. This included the National Veterans Wheelchair Games in July, the PVA Summit in August, and the AI Horizons Summit, UPMC Wheelchair Rehab institute Wheelchair Wash, Disability Pride PGH, and Steelwheelers 5k—where Drs. Cooper and Sivakanthan came in 3rd in their respective categories—in September. The labs also hosted a variety of events, like our annual Research Experience (REx) Symposium and Open House in July (**FEATURED IN OUR PREVIOUS NEWSLETTER**), and a showcase event co-hosted with Google in August followed by a group of visitors from the American Society of Biomechanics conference. HERL alum, **ERIC SINAGRA**, earned a Pitt School of Health And Rehabilitation Sciences Distinguished Alumni award.

Student researcher, **RUTUJA KULKARNI**, had her first primary author manuscript published in August, followed by her second one in September! **DRS. SANGMI PARK** and Brad Dicianno published manuscripts in July, followed by **DR. BREELYN STYLER** in August.

## OUR PROGRESS THIS YEAR

- 9** prestigious science, engineering, and athletics awards received.
- 12** manuscripts published in respected, peer-reviewed journals.
- 2** patents awarded by the USPTO, and Germany, France, UK.
- 26** lectures and visits from distinguished peers and organizations to our lab.
- 8** scholarships for Veterans funded.
- 28** media features of our research.

## IN 2025, WE'VE PRESENTED LECTURES AND RESEARCH ACROSS

- 2** continents
- 4** countries
- 6** American states + the District of Columbia

# Publications Manuscripts

Check for updates

Research Article  
Gamifying education on addressing real-world barriers, obstacles, and challenges commonly encountered by mobility device users: A convergent mixed-methods feasibility study

Sangmi Park , Jorge L. Candiotti<sup>1,2</sup>, Verity Rampulla<sup>3</sup>, Evan J. Rafferty<sup>4</sup>, Rosemarie Cooper<sup>4,5</sup>, Nikhil Deepak<sup>1</sup>, Sivashankar Sivakanthan<sup>6</sup>, Jason Raad<sup>6</sup>, Rory A. Cooper 

<sup>1</sup>Human Engineering Research Laboratories, Department of Veterans Affairs and University of Pittsburgh, Pittsburgh, PA, USA; <sup>2</sup>Department of Physical Medicine and Rehabilitation, University of Pittsburgh, Pittsburgh, PA, USA; <sup>3</sup>Department of Biomechanics, University of Pittsburgh, Pittsburgh, PA, USA; <sup>4</sup>Department of English, Kenneth P. Dietrich School of Arts and Sciences, University of Pittsburgh, Pittsburgh, PA, USA; <sup>5</sup>Department of Rehabilitation Science and Technology, University of Pittsburgh, Pittsburgh, PA, USA; <sup>6</sup>Department of Pediatrics, University of Pittsburgh, Pittsburgh, PA, USA

**Context:** Despite significant improvements in the built environment over the past 30 years, barriers and obstacles still make navigating accessible environments challenging. Mobility Device Users (MDUs) typically receive training in controlled settings; however, this training may not adequately prepare them for real-world challenges. To address this gap in training, essential skills were identified and gamified into an educational board game called HERL-Town.

**Objective:** To assess the feasibility of the game as a training tool.

**Design:** A convergent mixed-methods qualitative study collected using the Model for the Evaluation of Educational Games (MEEGA+) instrument and qualitative data gathered in 10 focus groups.

**Setting:** National Disabled Veterans Winter Sports Clinic (Snowmass Village, Colorado).

**Results:** The analysis included 35 adult MDUs who use ground transportation at least once a week and 15 travel companions who travel regularly with MDUs. Transformed mean scores for all nine MEEGA+ dimensions were 55.85, suggesting favorable educational potential and user experience. Content analysis of focus group discussions revealed four themes for improving navigation skills in dynamic environments through some suggested enhancements to educational content and usability of physical elements of the game.

**Conclusion:** HERL-Town offers a new and novel approach to training essential skills needed to utilize ground transportation effectively. MDUs may know how to operate mobility devices; however, anticipating challenges and identifying strategies for addressing these challenges in real-world environments requires trial and error garnered over an extended period. Gamification of these strategies may help MDUs anticipate these challenges and identify adaptive responses in dynamic environments.

**Keywords:** Assistive technology, Community integration, Gamification, Power scooter, Wheelchair training

Correspondence to: Rory A. Cooper, 6425 Penn Avenue, Suite 400, Pittsburgh, PA 15206-4022, USA. Ph: (412) 823-3706. Email: RCOOPER@pitt.edu

Color version of one or more of the figures in this article can be found online at <https://doi.org/10.1089/ASCI.2025.25090>.

Supplemental data for this article can be accessed online at <https://doi.org/10.1089/ASCI.2025.25090>.

© The Academy of Spinal Cord Injury Professionals, Inc. 2025  
DOI: 10.1089/ASCI.2025.25090

Introduction  
Limited mobility or changes in ability can significantly affect quality of life, economic stability, and civic and social participation (1–3). Ground transportation systems are essential for Mobility Device Users (MDUs) to maintain employment, run errands, access healthcare,

The Journal of Spinal Cord Medicine 2025

Check for updates



## Gamifying Education on Addressing Real-world Barriers, Obstacles, and Challenges Commonly Encountered by Mobility Device Users

Despite significant improvements in the built environment over the past 30 years, barriers and obstacles still make navigating accessible environments challenging. Mobility Device Users (MDUs) typically receive training in controlled settings; however, this training may not adequately prepare them for real-world challenges. To address this gap in training, essential skills were identified and gamified into an educational board game called HERL-Town.

*Park, S.; Candiotti, J. L.; Rampulla, V.; Rafferty, E. J.; Cooper, R.; Deepak, N.; Cooper, R. A. Gamifying education on addressing real-world barriers, obstacles, and challenges commonly encountered by mobility device users: A convergent mixed-methods feasibility study. The Journal of Spinal Cord Medicine. 2025.*

## Distance Traveled by People Using Permobil Power Wheelchairs Based on Large Data Analytics

Data logging technologies have been implemented in manual and power wheelchairs (PWCs) to measure device performance and user behaviors. Previous studies have investigated mean daily distance traveled in both types of wheelchairs, however, with small sample sizes and limited time frames. Permobil instrumented its PWCs with connectivity to continuously collect usage data. The purpose of this study was to use large data analytics to compare mean daily distance traveled and number of use days among five wheelchair models, and to compare the mean daily distance traveled between Group 3 and Group 4 PWCs. The study sample consisted of 3,058 Permobil PWCs across 5 models. Further reduced dataset for Group 3 and Group 4 devices comprised 2,615 wheelchairs. The results showed PWC users drove on average 1,256 km per month in PWCs compared to 1,040 km per month in manual wheelchairs. Group 3 PWCs were used on average 301 days in a year. Study results could inform scheduled maintenance, repair, and replacements based on usage versus current indicator of device age.

Zhu, H., Schein, R. M., Pramana, G., Nooijen, C., Leire, K., Dicianno, B. E., & Schmeler, M. R. Distance traveled by people using Permobil power wheelchairs based on large data analytics. *Assistive Technology*. 2025.



Taylor & Francis  
<https://doi.org/10.1089/ASCI.2025.25091>

### Distance traveled by people using Permobil power wheelchairs based on large data analytics

Hanju Zhu, MPH , Richard M. Schein, PhD, MPH , Gede Pramana, PhD , Carla Nooijen, PhD , Karin Leire, MSc<sup>b</sup>, Brad E. Dicianno, MD , and Mark R. Schmeler, PhD, OTR/L, ATP 

<sup>a</sup>Department of Rehabilitation Science and Technology, School of Health and Rehabilitation Sciences, University of Pittsburgh, Pittsburgh, Pennsylvania, USA; <sup>b</sup>Scientific and Medical Affairs, Permobil AB, Täby, Sweden; <sup>c</sup>Department of Physical Medicine & Rehabilitation, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, USA; <sup>d</sup>Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, Pittsburgh, Pennsylvania, USA

**ARTICLE HISTORY**  
Data logging technologies have been implemented in manual and power wheelchairs (PWCs) to measure device performance and user behaviors. Previous studies have investigated mean daily distance traveled in both types of wheelchairs, however, with small sample sizes and limited time frames. Permobil instrumented its PWCs with connectivity to continuously collect usage data. The purpose of this study was to use large data analytics to compare mean daily distance traveled and number of use days among five wheelchair models, and to compare the mean daily distance traveled between Group 3 and Group 4 PWCs. The study sample consisted of 3,058 Permobil PWCs across 5 models. Further reduced dataset for Group 3 and Group 4 devices comprised 2,615 wheelchairs. The results showed PWC users drove on average 1,256 km per month in PWCs compared to 1,040 km per month in manual wheelchairs. Group 3 PWCs were used on average 301 days in a year. Study results could inform scheduled maintenance, repair, and replacements based on usage versus current indicator of device age.

### Introduction

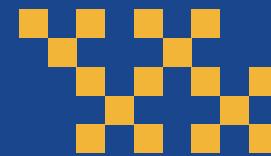
Wheelchairs are frequently prescribed to facilitate independent mobility (Ardine et al., 2011) and promote social participation of individuals with mobility limitations (Ferreri et al., 2022). According to the U.S. Census Bureau, approximately 5.5 million adults have had experience with using a wheelchair in the United States (Taylor, 2018). The utilization of power wheelchairs (PWCs) enable people with disabilities to maintain their independence in mobility (Peterson et al., 2014; Stenberg et al., 2016) and further reduce barriers to mobility around them (Frank et al., 2010).

Historically, data logging technologies have been implemented in manual wheelchairs (MWCs). Earlier studies had already validated the feasibility of accelerometers on MWCs to measure arm propulsion, activity level, and wheelchair propulsion (Postma et al., 2005; Tafuri et al., 1994; Washburn & Copay, 1999). These studies also provided future opportunities for data logging to include across different users and broader range of activities, and to compare interventions and users. A study of 52 MWC users using a data logger (Tolerico et al., 2007) indicated an event that promoted active participation resulted in greater travel distance and greater levels of active participation. A comparison of data loggers from the study also observed a more physical exertion in MWC users who were employed compared to those who were not. The study further reported data logging technologies assisted in recording MWC performance and user activity. A scoping review (Postma et al., 2018) on the use of data logging on MWCs have demonstrated its capability to examine discrete factors on wheelchairs such as maneuverability, operation time, travel distance, and speed, as well as user variables including heart rate. The review described additional clinical implications and outcomes as logging devices become more advanced, accurate, and user friendly over time.

Similarly, data logging technologies have also been implemented in PWCs. A study of 17 PWC users (Cooper et al., 2002) showed people had higher use of their PWCs when taking part in activity-promoting events or staying at home. The study highlighted the higher usage of PWCs during non-work activities, which were needed in PWC performance such as battery consumption, turning time, and direction detection as well as in user behaviors such as differences in use across season/climate conditions. Another study of 25 PWC users (Sonnenblom et al., 2009) reported data logging to examine the use of PWCs in different users, environments, and times. Another scoping review (Routhier et al., 2019) discussed research showing their applications for global positioning systems (GPS) and to measure the use of seat functions (such as tilt, recline, and lateral motion), pressure relieving activities, and time spent in the PWC.

Currently, some PWC manufacturers can provide information regarding wheelchair performance and user behaviors.

CONTACT Mark R. Schmeler, [Mschmeler@pitt.edu](mailto:Mschmeler@pitt.edu); Department of Rehabilitation Science and Technology, University of Pittsburgh, 6425 Penn Avenue, Suite 400, Office 10, Pittsburgh, PA 15206, USA.  
© 2025 IFSRM



Article

## Evaluation of a Vision-Guided Shared-Control Robotic Arm System with Power Wheelchair Users

Breelyn Kane Styler <sup>1,\*</sup>, Wei Deng <sup>1,2</sup>, Cheng-Shiu Chung <sup>3</sup> and Dan Ding <sup>1,2</sup>

<sup>1</sup> Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, Pittsburgh, PA 15260, USA; wed5@pitt.edu (<sup>W.D.</sup>); joshua.chung.cs@pitt.edu (<sup>C.-S.C.</sup>); dding@pitt.edu (<sup>D.D.</sup>)  
<sup>2</sup> Department of Rehabilitation Science and Technology, University of Pittsburgh, Pittsburgh, PA 15260, USA  
Correspondence: ten23@pitt.edu

### Abstract

Wheelchair-mounted assistive robotic manipulators can provide reach and grasp functions for power wheelchair users. This in-lab study evaluated a vision-guided shared control (VGS) system with twelve users completing two multi-step kitchen tasks: a drinking task and a popcorn making task. Using a mixed methods approach participants compared VGS and manual joystick control, providing performance metrics, qualitative insights, and lessons learned. Data collection included demographic questionnaires, the System Usability Scale (SUS), NASA Task Load Index (NASA-TLX), and exit interviews. No significant SUS differences were found between control modes, but NASA-TLX scores revealed VGS control significantly reduced workload during the drinking task. VGS control reduced operation time and improved task success but was not universally preferred. Six participants preferred VGS, five preferred manual, and one had no preference. In addition, participants expressed interest in robotic arms for daily tasks and described two main operation challenges: distinguishing wrist orientation from rotation modes and managing depth perception. They also shared perspectives on how a personal robotic arm could complement caregiver support in their home.

**Keywords:** assistive technology; robotic arm; mixed methods; usability

### 1. Introduction

Power wheelchair users with limited hand and arm function face challenges with reach [1] and independent manipulation tasks [2]. One option for enhancing this support are wheelchair-mounted assistive robotic manipulators which have been shown to increase independence and improve quality of life [3–7].

A large amount of research has made algorithmic advances in intuitive assistive robotic manipulator control [8], specifically for reaching and grasping objects in a task operation. Traditionally, robotic control requires switching between multiple control modes [3,8]. For example, one mode moves the robotic arm in an x-y plane, another for z-axis movement and rotating the wrist, and additional modes for wrist orientation and gripper control. Previous work has shown that a large amount of task execution time is spent sequentially selecting modes to complete even simple robotic arm tasks. Additionally, even basic automatic time-optimal mode switching [9] or probabilistic language-grounded selection approaches [8] can improve operational efficiency.

Further improvements on manual operation focus on challenges in mapping the low-dimensional user input (joystick axes) to high-dimensional actions of the robotic arm. One

# Evaluation of a Vision-Guided Shared-Control Robotic Arm System with Power Wheelchair Users

Wheelchair-mounted assistive robotic manipulators can provide reach and grasp functions for power wheelchair users. This in-lab study evaluated a vision-guided shared control (VGS) system with twelve users completing two multi-step kitchen tasks: a drinking task and a popcorn making task. Using a mixed methods approach participants compared VGS and manual joystick control, providing performance metrics, qualitative insights, and lessons learned. Data collection included demographic questionnaires, the System Usability Scale (SUS), NASA Task Load Index (NASA-TLX), and exit interviews. No significant SUS differences were found between control modes, but NASA-TLX scores revealed VGS control significantly reduced workload during the drinking task. VGS control reduced operation time and improved task success but was not universally preferred. Six participants preferred VGS, five preferred manual, and one had no preference. In addition, participants expressed interest in robotic arms for daily tasks and described two main operation challenges: distinguishing wrist orientation from rotation modes and managing depth perception. They also shared perspectives on how a personal robotic arm could complement caregiver support in their home.

*Styler, B.K.; Deng, W.; Chung, C.-S.; Ding, D. Evaluation of a Vision-Guided Shared-Control Robotic Arm System with Power Wheelchair Users. Sensors 2025.*



## Psychosocial Impact of Mobility Assistive Technology on Women Veterans

Despite the growing number of women Veterans with disabilities, data on how well mobility assistive technology (MAT) meets their needs are limited. Evaluating psychosocial impact is key to ensuring that MAT not only meets physical needs but also fosters social participation, mental well-being, and independence. In this study, we examined the perceived psychosocial impact of using MAT on women Veterans' mental health, independence, and self-esteem. Women veterans ( $N = 50$ ) who used MAT from the US Department of Veterans Affairs within the past five years completed a national online survey including the Psychosocial Impact of Assistive Devices Scale (PIADS). Women were asked to score the PIADS on the basis of their experiences using their primary device type: cane, leg-foot orthosis, walker, power wheelchair (PWC), scooters, manual wheelchair (MWC), or crutches. Results: Participants expressed an overall positive psychosocial impact of MAT on competence ( $mean = 1.03, SD = 1.23$ ), adaptability ( $mean = 0.76, SD = 1.43$ ), and self-esteem ( $mean = 1.22, SD = 1.22$ ), and 17% of the total sample reported a negative psychosocial impact of using MAT. PWC users ( $M = 1.03, SD = 1.23$ ) and MWC users ( $M = 0.76, SD = 1.43$ ) reported a higher positive psychosocial impact than those of other device-type users ( $0.001 < p < 0.023$ ). Discussion: Despite the overall positive psychosocial benefit of MAT, use was associated with feelings of low self-esteem, frustration, and embarrassment. The results highlight a possible mental health benefit for PWC users compared with other MAT users.

### RESEARCH

#### Assessing the psychosocial impact of mobility assistive technology on women Veterans

Rutuja A. Kulkarni<sup>1</sup>, Rajit Banerjee<sup>2</sup>, Kelsey Berryman<sup>3</sup>, Pooja Solanki<sup>4</sup>, Frances M. Weaver<sup>2</sup>, Brad E. Dicianno<sup>2</sup> and Alicia M. Koontz<sup>2\*</sup>

#### ABSTRACT

**Introduction:** Despite the growing number of women Veterans with disabilities, data on how well mobility assistive technology (MAT) meets their needs are limited. Evaluating psychosocial impact is key to ensuring that MAT not only meets physical needs but also fosters social participation, mental well-being, and independence. The aim of this study was to examine the perceived psychosocial impact of using MAT on women Veterans' mental health, independence, and self-esteem. **Method:** Women veterans ( $N = 50$ ) who used MAT from the US Department of Veterans Affairs within the past five years completed a national online survey including the Psychosocial Impact of Assistive Devices Scale (PIADS). Women were asked to score the PIADS on the basis of their experiences using their primary device type: cane, leg-foot orthosis, walker, power wheelchair (PWC), scooters, manual wheelchair (MWC), or crutches. **Results:** Participants expressed an overall positive psychosocial impact of MAT on competence ( $mean = 1.03, SD = 1.23$ ), adaptability ( $mean = 0.76, SD = 1.43$ ), and self-esteem ( $mean = 1.22, SD = 1.22$ ), and 17% of the total sample reported a negative psychosocial impact of using MAT. PWC users ( $M = 1.03, SD = 1.23$ ) and MWC users ( $M = 0.76, SD = 1.43$ ) reported a higher positive psychosocial impact than those of other device-type users ( $0.001 < p < 0.023$ ). **Discussion:** Despite the overall positive psychosocial benefit of MAT, use was associated with feelings of low self-esteem, frustration, and embarrassment. The results highlight a possible mental health benefit for PWC users compared with other MAT users.

**Keywords:** disability, efficiency, mental health, mobility aids, orthosis, PIADS, rehabilitation, wheelchair

#### RESUME

**Introduction:** Malgré le nombre croissant de vétérans ayant une invalidité, des données démontrent à quel point les technologies d'aide à la mobilité répondent à leurs besoins sont limitées. Il est essentiel d'évaluer l'effet psychosocial des TAM pour s'assurer qu'elles répondent non seulement aux besoins physiques, mais favorisent également la participation sociale, le bien-être mental et l'autonomie. L'objectif de cette étude était d'examiner la perception de l'effet psychosocial des TAM sur la participation sociale, le bien-être mental et l'autonomie des vétérans féminins. Méthode: Les vétérans féminins ( $N = 50$ ) qui ont utilisé une TAM dans les dernières cinq années ont complété un sondage national en ligne qui inclut l'échelle Psychosocial Impact of Assistive Device Scale (PIADS), qui échelle sur les effets psychosociaux des dispositifs d'aide. Les femmes ont été invitées à attribuer des scores sur l'échelle PIADS à leurs expériences d'utilisation de leur dispositif primaire : canne, orthèse jambe-pied, fauteuil roulant manuel, fauteuil roulant électrique (PWC), scooters, canne, orthèse jambe-pied, fauteuil roulant manuel, canne. Résultats: Les participants ont exprimé un impact psychosocial global négatif de la TAM sur la compétence ( $mean = 1.03, ET = 1.22$ ), l'adaptabilité ( $mean = 0.76, ET = 1.23$ ) et l'estime de soi ( $mean = 0.67, ET = 1.22$ ). Environ 17 % des réponses démontrent une perception négative de l'effet psychosocial de la TAM. Les utilisatrices de PWC attribuent des scores indiquant d'un effet psychosocial plus positif que celles d'autres dispositifs ( $0.001 < p < 0.023$ ). Discussion: Malgré les avantages psychosociaux auxquels les utilisatrices de TAM étaient associées à une mauvaise estime de soi, à la frustration et à la honte. Les résultats soulignent un bénéfice mental possible pour les utilisatrices de PWC par rapport à l'évaluation de la FRM.

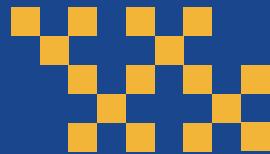
**Mots-clés :** aides à la mobilité, efficacité, santé mentale, aides mobiles, orthèses, PIADS, réadaptation, fauteuil roulant

Kulkarni, RA; Banerjee, R; Berryman, K; Solanki, P; Weaver, FM; Dicianno, BE; Koontz, AM. Assessing the psychosocial impact of mobility assistive technology on women Veterans. *Journal of Military, Veteran and Family Health*. 2025.



\* Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, Pittsburgh, Pennsylvania, United States  
Center for Innovation for Complex Chronic Healthcare, Edward Hines, Jr. VA Hospital, Hines, Illinois, United States  
Correspondence should be addressed to Alicia M. Koontz, Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, 6425 Penn Avenue, Suite 400, Pittsburgh, Pennsylvania, United States, 15260-4022, Telephone: 412-622-3700 ext. 5206 (ext. 5206); Email: akontz@pitt.edu

*Journal of Military, Veteran and Family Health*  
11(4) 2025 doi:10.3138/jmfr.2024-0091



### Validation of Inertial Measurement Units for Measuring Lower Extremity Kinematics during Squat-Pivot and Stoop-Twist Lifting Tasks

The purpose of this study is to evaluate the agreement between OMC and inertial measurement units (IMUs) for quantifying joint kinematics during squat-pivot and stoop-twist lifting tasks. Ten unimpaired adults wearing both IMUs and OMC markers performed 24 lifting trials.

*Kulkarni, R.A.; Banerjee, R.; Wang, V.Z.; Oliart, M.; Rampulla, V.; Das, P.; Koontz, A.M. Validation of Inertial Measurement Units for Measuring Lower-Extremity Kinematics During Squat-Pivot and Stoop-Twist Lifting Tasks. Sensors. 2025.*



#### Article

#### Validation of Inertial Measurement Units for Measuring Lower-Extremity Kinematics During Squat-Pivot and Stoop-Twist Lifting Tasks

Rutuja A. Kulkarni <sup>1,2</sup>, Rajit Banerjee <sup>1,3,4</sup>, Vicki Z. Wang <sup>1,5</sup>, Marcel Oliart <sup>1,2,6</sup>, Verity Rampulla <sup>1,2</sup>, Pritthvi Das <sup>1</sup> and Alicia M. Koontz <sup>1,2,4,\*</sup>

<sup>1</sup> Human Engineering Research Laboratories, VA Pittsburgh Healthcare System, Pittsburgh, PA 15260, USA; ruk20@pitt.edu ([R.A.K.](mailto:ruk20@pitt.edu)); rabi19@pitt.edu ([R.B.](mailto:rabi19@pitt.edu)); zw11@pitt.edu ([V.Z.W.](mailto:zw11@pitt.edu)); mao11@pitt.edu ([M.O.](mailto:mao11@pitt.edu))

<sup>2</sup> Department of Biostatistics, Swanson School of Engineering, University of Pittsburgh, Pittsburgh, PA 15261, USA

<sup>3</sup> Department of Physical Medicine and Rehabilitation, University of Pittsburgh Medical Center, Pittsburgh, PA 15261, USA

<sup>4</sup> Department of Biostatistics, Swanson School of Engineering, University of Pittsburgh, Pittsburgh, PA 15261, USA

\* Correspondence: [akontz@pitt.edu](mailto:akontz@pitt.edu)

<sup>5</sup> These authors contributed equally to this work.

#### Abstract

Optokinetic motion capture (OMC) is the gold standard for measuring the kinematics associated with lifting posture. Unfortunately, limitations exist, including cost, portability, and marker occlusion. The purpose of this study is to evaluate the agreement between OMC and inertial measurement units (IMUs) for quantifying joint kinematics during squat-pivot and stoop-twist lifting tasks in ten unimpaired adults wearing both IMUs and OMC markers. A total of 24 lifting trials were analyzed. Root Mean Square Error (RMSE) between IMU and OMC times-series signals were computed for trunk and lower-extremity joints. Peak values obtained from each system during each trial were analyzed via Bland-Altman plots. Results show high correlations for trunk, knee, and ankle flexion angles ( $>0.9$ ) and ankle rotation angles ( $>0.7$ ). Moderate correlation was found for trunk axial rotation and lateral flexion angles ( $0.5-0.7$ ). RMSE was under  $9^\circ$  for each angle. Biases between systems ranged from  $0.3^\circ$  to  $16^\circ$ . Both systems were able to detect statistically significant differences in peak angles between the two postures ( $p < 0.05$ ). IMUs show promise for recording field data on complex lifting tasks.

**Keywords:** motion capture; posture; inertial measurement units (IMUs); lifting technique; biomechanics

#### 1. Introduction

Lifting tasks are common during activities of daily living in home and workplace environments and during recreational activities like weightlifting. Such tasks can contribute to musculoskeletal injuries and lower-back pain due to risk factors such as workload, the speed of the lifting maneuver, the vertical and horizontal distance of the weight to the user, repetitions, and improper lifting posture [1–5]. Healthcare professionals, biomechanists, strength and conditioning trainers, and ergonomists have provided prevention strategies to minimize such injuries, especially through proper ergonomics and lifting technique education. For example, in weightlifting, increased knee internal rotation and tibial anterior translation angles during clean and jerk lifts have been shown to predispose weightlifters to



Peer Review of the Federal Aviation Administration's Study of the Effects of Passenger Seat Width and Pitch on Airplane Evacuation Performance



### Peer Review of Federal Aviation Administration Research on the Effect of Passenger Seat Pitch and Width on Aircraft Cabin Evacuation Efficiency

An ad hoc committee will conduct a peer review of the Federal Aviation Administration's (FAA's) report and accompanying data, including videos, documenting tests performed during 2019 and 2020 to determine the effect of passenger seat pitch and width on the egress time of cabin occupants during an emergency evacuation of a commercial airplane.

*National Academies of Sciences, Engineering, and Medicine Peer Review of the Federal Aviation Administration's Study of the Effects of Passenger Seat Width and Pitch on Airplane Evacuation Performance. Washington, DC: The National Academies Press. 2025.*



# HERL SPOTLIGHT



Robert Powell, Cesar Hernandez, and Gavin Davidson demonstrated outstanding presence of mind and courage during a medical emergency at the Human Engineering Research Laboratories. When their colleague collapsed and became unconscious from a severe seizure, they immediately assisted with rendering aid and emergency communications.

Through their quick and decisive actions, our machinists and engineers safeguarded the life of their colleague and exemplified the highest traditions of service, responsibility, and teamwork. These actions reflect great credit upon them, the Human Engineering Research Laboratories, the Department of Veterans Affairs, and the University of Pittsburgh.



*Top: Cesar accepting his award with Drs. Cooper, Grindle, and Dicianno.  
Bottom: Bob accepting his award with Drs. Cooper, Grindle, and Dicianno.  
Right: Gavin Davidson.*

# RECRUITING PARTICIPANTS.

## SIGN UP TO OUR **REGISTRY**



A research registry is a collection of individuals interested in learning about research studies that may be of interest to them. We are inviting you to join in the Human Engineering Research Laboratories (HERL) Assistive Technology Registry because you might be interested in participating in our current or future research studies.

## **1** ACCESSIBLE AIRLINE TRANSPORTATION FOR MOBILITY DEVICE USERS: SURVEY



**Purpose:** To estimate pent-up demand among mobility device (MD) users to travel on commercial airlines and identify MD users' needs and pain points.

**Study Requirements:** Complete a survey about your demographics and airline travel experiences. The survey is expected to take no more than 20 minutes to complete.

## **2** GUIDELINES FOR POWERED WHEELCHAIR AND COMMERCIAL AIRPLANE COMPATIBILITY



**Purpose:** This small group interview aims to identify the needs and challenges of power wheelchair users (PWUs) in air travel.

**Study Requirements:** Participate in an interview to share your experiences and perspectives accessing and utilizing air travel-related services.

## **3 CLINICAL LIMITS OF USE TOOLS (CLOUD) OFF-ROAD MOBILITY DEVICES**



**Purpose:** To develop clinical limits of use tools (CLOUD) for off-road wheelchairs and hand cycles to ensure their safe operation.

**Study Requirements:** Participate in one visit lasting up to 4 hours to conduct performance testing and mapping of the features of an off-road wheelchair or hand cycles.

## **4 VIRTUAL PEER COACHING IN MANUAL WHEELCHAIR SKILLS**



**Purpose:** To determine the effectiveness of virtual coaching from a peer to improve manual wheelchair skills.

**Study Requirements:** Six, weekly peer coaching sessions via Zoom to improve wheelchair skills, access to a library of wheelchair skills training videos, and completion of questionnaires before and after training.

## **5 ASSESSING THE CAREGIVER ASSISTED TRANSFER TECHNIQUE (CATT) INSTRUMENT**



**Purpose:** To validate the Caregiver Assisted Transfer Technique Instrument, a new tool to assess the assisted transfer performance of individuals with disabilities and their caregivers.

**Study Requirements:** The study takes place over two visits in your home or our lab (your choice), each visit is no longer than two hours.

## **6 POWERED PERSONAL TRANSFER SYSTEM (PPTS): FOCUS GROUP**



**Purpose:** To study the design of controls to better meet user needs of a robotic, independent-use, Group 3 Powered Personal Transfer System.

**Study Requirements:** You will be asked to watch a PPTS demonstration video and provide group feedback. The focus group will take no more than two hours.

## **7 AIRPORT MANUAL WHEELCHAIR: FOCUS GROUP**



**Purpose:** To design a manual wheelchair tailored for airport use, addressing the current practice of airlines requiring wheelchair users to travel in regular passenger seats which poses significant challenges.

**Study Requirements:** Participation will take no more than two hours.

## **QUESTIONS?**

CONTACT

**William Schoy**

RESEARCH PARTICIPANT ADVOCATE

wjs43@pitt.edu  
(412) 822-3675



# WILLIAM'S CORNER

INSIGHTS FROM OUR **PARTICIPANTS**

The Human Engineering Laboratories (HERL) has been a touch stone for me since its inception. I have personally and professionally worked with many of her old staff, students, and researchers, and have been delighted to be a part of this group. Unlike most university based research programs many of the staff, administration, and students are made up of qualified individuals from the population it serves, people with disabilities. That consumer control provides inherent quality assurance that I think other research programs lack. Why is that so important? I think it's important because they incorporate people with disabilities through stakeholder inclusion and engagement in addition to faculty, staff and students. When my son says "What did you do today Mom?" I respond by saying "I did a little research!" I get to help steer the ship that is research. If you want to feel a part of what's happening, know what's on the leading edge in technology, then be part of a stakeholder group at Human Engineering Research Laboratories. Because HERL has both types of experts, disabled and not disabled. There's a blend between reality and possibility. I see their programs beginning with thoughts, ideas, and what ifs being turned into prototypes, trials and projects. Support HERL by becoming part of their stakeholder engagement groups. Help steer the ship.

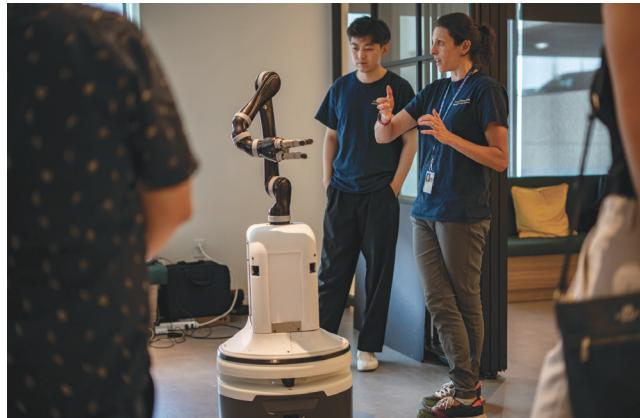
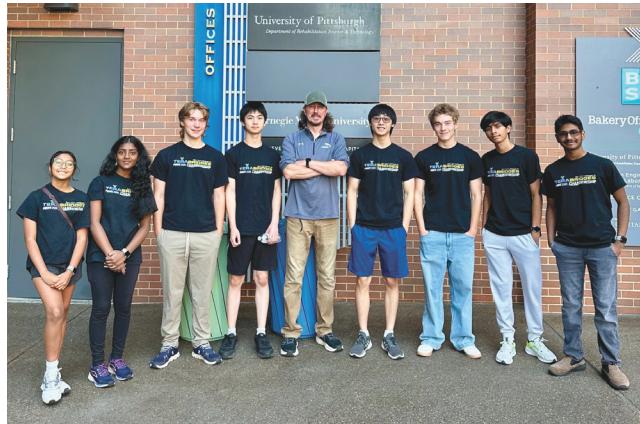
- DJ STEMMLER



# Photo Gallery

**Left to right, top to bottom:** The HERL team at the AI Horizons event in Bakery Square; Dr. Cooper with athletes at the National Veterans Wheelchair Games; Dr. Duvall and Eric Sinagra at the award ceremony; the HERL team at the Steelwheelers 5k in North Park; Drs. Sangmi park and Jorge Candiotti with their Summer students; Josh Marino with the TeraBridges High School robotics team after their visit to the labs; the panelists for the AI Horizons talk on Artificial Intelligence in Veteran and Military Medicine including Dr. Siva Sivakanthan as moderator; Rosi and Dr. Cooper pose with their awards for speaking at the 2025 disABILITY conference; the HERL team with the president of the PVA at the PVA Summit; Dr. Breelyn Styler demonstrating her research at a Google demo event; Rosi and Dr. Cooper with Congressman Chris Deluzio and Senior Vice Chancellor for Research, Rob Rutenbar.





# In the News

JULY-SEPTEMBER 2025

JULY 15

## Rory Cooper speaks at the UN

Rory Cooper spoke at the United Nations as part of the AI for Good Global Summit in Geneva.

PITTWIRE



JULY 23

## Club Lily and HERL Collaborate

HERL joined participants at Club Lily Summer Camp to research the use of newly developed pneumatic wheelchairs.

EASTERSEALS



JULY 28

## Rehabilitation Technology Research on Display for Congressional Visit

Pitt hosted U.S. Representative Chris Deluzio for a tour of the UPMC Vision Institute to see demonstrations of a wide range of ongoing physical rehabilitation research projects.

PITT RESEARCH



AUGUST 25

## IPC announces Paralympian VISTA 2025 keynote speaker

Announced as the second keynote speaker for December's VISTA 2025 Conference in Cairo.

IPC



AUGUST 27

### FEATURED MANUSCRIPT

## Women Veterans say mobility aids don't meet their needs

More than two million Veterans experience disabilities requiring a mobility device.

VA ORD



SEPTEMBER 5

## How to Get the Best Wheelchair Setup for Your Lifestyle

Three longtime experts in the wheelchair industry answer your questions.

NEW MOBILITY



SEPTEMBER 11

## Brad Dicianno Named a Community Hero

Vice chair for research in the School of Medicine's Department of PM&R, won a Community Heroes Award.

PITTWIRE



# SAVE THE DATE

---

**OCT 4**

Hail to Heroes Pitt  
Football Game

**OCT 10**

Army 10-Miler

**OCT 20**

Global Innovation  
Summit event at HERL

**OCT 27**

Marine Corps Marathon

**OCT 28**

CLASS Awards Dinner

**NOV 11**

Veterans Day

**NOV 27**

Thanksgiving

**DEC 7-12**

11th VISTA Conference

## OUR PARTNERS



## RUMINATION OF THE QUARTER

"HERL HAS BEEN THE PLACE WHERE I DISCOVERED MY PASSION FOR REHABILITATION ENGINEERING AND THE POWER RESEARCH HAS TO CHANGE LIVES. ALONG THE WAY, I'VE GAINED NOT ONLY TECHNICAL KNOWLEDGE, BUT ALSO FRIENDSHIPS, MENTORS, AND LIFE LESSONS THAT SHAPED ME AS A PERSON. I WOULDN'T BE ON THE PATH I AM TODAY WITHOUT THE SUPPORT AND OPPORTUNITIES THAT I'VE GOTTEN HERE."

- Rutuja Kulkarni  
Research Assistant

# ALL OUR LINKS



6425 Penn Ave  
Suite 400  
Pittsburgh, PA 15206

[herl@groups.pitt.edu](mailto:herl@groups.pitt.edu)  
[herl.pitt.edu](http://herl.pitt.edu)

