



The global pandemic of the COVID-19 coronavirus has changed the way everyone in the world lives and works. At the Human Engineering Research Laboratories, we've had to change the way we work, too. However, we've used our unique position within the local, scientific, and disability communities to ensure that we can do the most good for the most people.

The first thing we at HERL were able to do was to harness the power of our machine shop and prototyping facility to produce nasal testing swabs, face shields, and desk shields for VA hospitals nationwide, which was made possible by the professionalism and expertise of our shop staff, led by Dr. Garrett Grindle, who also helped to develop an isolation bed in conjunction with staff from VA NY Harbor Healthcare System in Manhattan. HERL staffers and their families assisted efforts to create personal protective equipment (PPE) by sewing cloth masks (pictured; modeled by HERL Director Dr. Rory Cooper).



HERL's Response to COVID-19

HERL also received an emergency \$20,000 grant from the Nielsen Foundation specifically to assist people with disabilities in local communities with the provision of PPE, accessing home healthcare services, and to combat food instability. Our grant application focused on providing groceries based on what we knew local people with spinal cord injuries and other mobility impairments would need most. Many people with mobility issues are immunocompromised and/or have respiratory problems – two things that we know put people at much greater risk for severe COVID-19 symptoms.

Pandemic or not, HERL is still open for business. There has been a small team in the HERL offices daily since the beginning of the pandemic. We've restarted our most important research projects and continue writing and publishing. HERL also conducts meetings and continues outreach via distance meeting software.



*Above: Dr. Garrett Grindle and Ian Eckstein show freshly 3D printed nasal swabs.
Top right: Drying nasal swabs.
Bottom right: Sterilized nasal swabs.*

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Current Research Abstracts

Jeannis H, Goldberg M, Seelman K, Schmeler M, Cooper RA, Barriers and facilitators to students with physical disabilities' participation in academic laboratory spaces, Disability and Rehabilitation: Assistive Technology, pp. 225-237, Vol. 15, No. 2, 2020. <https://doi.org/10.1080/17483107.2018.1559889>

Purpose: To provide empirical evidence on learning barriers and facilitators in instructional science and engineering laboratory settings from a national survey on students with physical disabilities (SwD-P).

Methods: A nationwide self-report survey, the Full Participation Science and Engineering Accessibility (FPSEA), was disseminated online via Qualtrics. Approximately 1200 organizations and universities across the United States were contacted through purposive sampling. Descriptive statistics were primarily used for the analysis of the results.

Results: Survey findings reveal that students experience a wide range of limitations to full participation in the laboratory, from entering the laboratory (25%) to being given passive roles

(50%). Additionally, while 66% of respondents indicated that instructors were willing to help SwD-P participate in science and engineering (S&E) laboratories, 16.8% were not willing to do so, and 47% SwD-P felt that practices were not in place to provide accommodations. The survey revealed a range of facilitators such as elevators, ramps, accessible course materials and peer assistance. Most respondents (74%) also indicated that peers were helpful in completing laboratory tasks.

Conclusion: This survey provides empirical evidence that was previously voiced through non-empirical information in the literature. Participants cited barriers such as inappropriate accommodations and instructors' negative viewpoints, as well as gaining access to facilities even after the enactment of the Americans with Disabilities Act (ADA). These findings suggest that while ADA has lessened some barriers to SwD-P, barriers remain in using the laboratory space. The FPSEA survey fills the gap in finding barriers and facilitators to using S&E laboratories from the SwD-P's perspective.

SUMMARY: Study provides empirical evidence of barriers and facilitators to access to laboratory spaces for SwD-P.

Welcome to our newest VA employees!

February 2020

Beth Carmona, BS
Program Support Assistant

June 2020

Kasey Stepansky, CScD, MS, BS
Health Science Specialist

July 2020

Charles Lafe, PhD
Program Support Assistant

August 2020

Nicholas Gatto, BS
Clinical Coordinator

September 2020

Jonathan Duvall, PhD
Research Biomedical Engineer

*Sivakanthan S, Candiotti JL, Sundaram SA, Battles C, Dav-
eler B, Chung CS, Grindle GG, Cooper RM, Dicianno B,
Cooper RA, Usability evaluation of attitude control for a ro-
botic wheelchair for tip mitigation in outdoor environments,
Medical Engineering and Physics, pp. 86-96, Vol. 82, August
2020. <https://doi.org/10.1016/j.medengphy.2020.07.002>*

Tips and falls are the most prominent causes of wheelchair accidents that occur when driving on uneven terrains and less accessible environments. The Mobility Enhancement Robotic Wheelchair (MEBot) was designed to improve the stability of Electric Powered Wheelchairs (EPW) when driving over these environments. MEBot offers six independently height-adjustable wheels to control attitude of its seat over uneven and angled terrains. Its attitude control application uses an inertial measurement unit to detect seat angles changes to adjust each wheel-height accordingly. MEBot was compared to commercial EPWs in terms of EPW performance (seat angle changes and response time) and participant perception (satisfaction and task-load demand) towards each device. Ten participants drove their own EPW and MEBot for five trials each through driving tasks that replicated outdoor environments. Results showed less change in the pitch angle when driving up and down a 10° slope using MEBot ($5.6 \pm 1.6^\circ$, $6.6 \pm 0.5^\circ$) compared to the participants' own EPW ($14.6 \pm 2.6^\circ$, $12.1 \pm 2.6^\circ$). However, MEBot required 7.8 ± 3.0 s to self-adjust to the minimum angle when driving over the tasks. Participants reported no difference in satisfaction and task load demand between EPWs due to similarities in comfort and ease-of-use. Improving the speed and efficiency of MEBot's attitude control application will be addressed in future work based upon participants' feedback.

SUMMARY: MEBot demonstrated the potential to reduce tips and falls.

Current Research Abstracts

Gebrosky B, Grindle GG, Cooper R, Cooper RA, Comparison of Carbon Fiber and Aluminum Materials in the Construction of Ultralight Wheelchairs, *Disability and Rehabilitation: Assistive Technology*, pp. 432-441, Vol. 15, No. 4, 2020. <https://doi.org/10.1080/17483107.2019.1587018>

Carbon fiber-reinforced polymers have been used in the sporting goods industry for decades, and wheelchairs have incorporated the material since the late 1980s. There is no independently collected data available on carbon fiber-reinforced polymer wheelchairs' performance on the ANSI/RESNA testing standards, however. This study evaluated three full carbon fiber wheelchair specimens to determine their performance versus similar wheelchairs. Testing determined that while the frames survived more testing cycles than any other wheelchair, the casters and rear tires failed similarly to other devices. Overall, due to the purchase cost, the cost benefit of the tested wheelchair model was similar to aluminium wheelchairs.

Implications for rehabilitation:

Carbon fiber wheelchair construction is a viable alternative to aluminium, titanium, or steel construction, and decreasing costs will continue to improve the benefits of carbon fibre over these models

Carbon fiber wheelchair found to be more durable than aluminium models, but are also much more expensive. The additional cost may be justified for some users that need the increased durability, however

Increased durability will reduce the number of repairs and warranty claims, potentially reducing the burden on a wheelchair user, and also improving their ability to travel and participate in their community

The low weight of carbon fiber wheelchairs may increase the mobility of some users by allowing them to transfer more easily into and out of vehicles and manoeuvre throughout the environment

SUMMARY: Carbon fiber wheelchairs are a viable alternative to aluminum, titanium, or steel.

Sivashankar S, Blaauw E, Greenhalgh M, Koontz AM, Vegter R, Cooper RA, Person Transfer Assist Systems: A Literature Review, *Disability and Rehabilitation: Assistive Technology*, pp. 86-96, Vol. 82, August 2020. <https://doi.org/10.1080/17483107.2019.1673833>

Objective: Novel developments in the robotics field have produced systems that can support person wheelchair transfers, maximize safety and reduce caregiver burden. The purpose of this study was to identify and describe these systems, their usability (or satisfaction), the context for which they have been or can be used and how they have been evaluated to determine evidence for their effectiveness.

Method: Available research on Person Transfer Assist Systems (PTAS) was systematically gathered using similar standards to the PRISMA guidelines. The search terms were derived from common terms and via exploring similar review articles. Initial search terms displayed 1330 articles and by using the inclusion/exclusion criteria 96 articles were selected for abstract review. After full-text reviewing 48 articles were included.

Results: 29 articles concerned research in robotic transfer systems, 10 articles used both ceiling and floor-mounted lifts and 9 articles used only floor-mounted lifts as an intervention/control group. The results of this analysis identified a few usability evaluations for robotic transfer prototypes, especially ones comparing prototypes to existing marketed devices.

Conclusion: Robotic device research is a recent development within assistive technology. Whilst usability evaluations provided evidence that a robotic device will provide better service to the user, the sample number of subjects used are minimal in comparison to any of the intervention/control group articles. Experimental studies between PTASs are required to support technological advancements. Caregiver injury risk has been the focus for most of the comparison articles; however, few articles focus on the implications to the person.

SUMMARY: More studies including end-users are needed.

McKernan G, Izzo S, Crytzer TM, Houtrow AJ, Dicianno BE, The Relationship between Motor Level and Wheelchair Transfer Ability in Spina Bifida: a Study from the National Spina Bifida Patient Registry, *Archives of Physical Medicine and Rehabilitation*, pp. 1953-1960, Vol. 101, 2020. <https://doi.org/10.1016/j.apmr.2020.06.016>

Objective: To identify the specific features that contribute to the variability in baseline wheelchair transfer and the changes in transfer ability (gain or loss) over time for a large cohort of patients with spina bifida (SB) in the National Spina Bifida Patient Registry.

Design: Longitudinal cohort study

Setting: A total of 35 United States outpatient SB clinic sites.

Participants: Individuals (N=1687) with SB ages 5-73 (median, 13.33) years who were therapeutic ambulators or nonambulators.

Main Outcome Measure: Ability to transfer from a wheelchair to another level surface

Results: Bayesian Network Analysis was used to reduce the initial variable set to the following predictors: SB subphenotype, motor level, age, insurance, sex, race, ethnicity, surgical procedures, and number of visits. We used

a multinomial logistic model with Wald Chi-square analysis of effects to examine the relationships between transfer ability and predictors. A total of 295 of 1687 eligible patients (17.56%) with myelomeningocele (MMC) and 6 of 58 eligible patients (10.32%) with non-MMC experienced changes in transfer ability during the period of the study.

For those with MMC and non-MMC, the highest number of individuals exhibiting changes in motor level had changes from thoracic to high-lumbar, high-lumbar to thoracic, high-lumbar to midlumbar, and midlumbar to high-lumbar lesion levels. Results of the Bayesian Network Analysis revealed that motor level was the predominant factor associated with baseline transfer ability followed by age. The combination of SB sub phenotype, motor level, age, insurance status, number and type of surgical procedures, and time point accurately classified the loss, gain, or no change in transfer ability 82.7% of the time.

Conclusions: Motor level was the predominant factor associated with baseline transfer ability, and the change in transfer ability was directly related to a corresponding change in motor level that might be explained by changes in muscle strength of the iliopsoas and quadriceps.

SUMMARY: Motor level was the dominant factor associated with baseline transfer ability among patients with Spina Bifida.

Crash and Recovery

HERL Director Dr. Rory Cooper's Wikipedia page (https://en.wikipedia.org/wiki/Rory_A._Cooper#Athletics) describes him as "an accomplished handcyclist," so it was no surprise that Dr. Cooper participated in the Marine Corps Marathon in Washington, D.C. October 2019. Dr. Cooper regularly competes in marathons on his handcycle, often finishing near the top if not winning outright.

But the outcome of this race was horrible. The weather was cold, and the course was wet after heavy rain. On a downhill portion of the course, Dr. Cooper lost control and crashed, falling off his handcycle. With no help in sight, Dr. Cooper was able to climb back on his handcycle and finish the race before passing out at the finish line.

He was rushed to a hospital, where he was diagnosed with shock, hypothermia, severe lacerations, and broken legs and feet. He remained in a coma in the intensive care unit for the next four days, and remained in the ICU for almost an entire week after regaining consciousness.

However, it could have been much worse. Dr. Cooper had made it a habit to exercise at least 30 minutes a day, and because of his excellent physical condition he was able to begin his recovery almost immediately. Visits from his many friends and colleagues in Washington lifted his spirits. In November, he was well enough to fly back to Pittsburgh, where he began treatment at the VA Pittsburgh Healthcare System and UPMC.

Dr. Cooper brought the same determination and drive to his recuperation that has given him international acclaim as an inventor and engineer. According to Chad Evans at the VA, any other person's recovery would have taken up to three times longer.

Finally, Dr. Cooper capped his rehabilitation with the successful completion of the 2020 Pittsburgh Marathon.

See more about Dr. Cooper's recovery in Pittwire at <https://www.pittwire.pitt.edu/news/still-fight-pitts-rory-cooper-recovers-crash-complete-marathon>.

Meet Your Army is a monthly series of interviews by HERL Director Dr. Rory Cooper with notable people serving in the United States Army, Veterans of the U.S. Army, or otherwise attached to the Army.

The interviews can be attended synchronously online via Microsoft Teams after registration, or viewed asynchronously from the HERL website without registration at <https://herl.pitt.edu/meet-your-army>. Each interview is presented in downloadable video and audio formats.

If you'd like to be notified when registration opens each month for Meet Your Army, or have any other questions, contact Michael Lain at michael.lain@pitt.edu.

August 2020:

LTG Walter E. Piatt

Director of the Army Staff, Pentagon.

September 2020:

MG Mark J. Schindler

Deputy Adjutant General – Army, Pennsylvania National Guard, Joint Force Headquarters.

October 2020:

COL David M. Rozelle

The first amputee to return to U.S. military duty in a combat zone.

November 2020:

CSM(ret) Bart Womack

Served the Army as Drill Sergeant, Ranger Instructor, Relief Commander and Sergeant of the Guard at Tomb of the Unknown Soldier, served in Iraq and Korea, and in dual roles as Commandant and the 101st Airborne Division Command Sergeant Major.

VIPs from the U.S. Department of Veterans Affairs

On June 24, HERL hosted U.S. Department of Veterans Affairs Acting Deputy Secretary Pamela J. Powers, pictured right, along with honored guests from VA Pittsburgh Healthcare System.



On September 25, HERL hosted Mr. James Gfrerer, VA Assistant Secretary for Information and Technology and VA CIO, Mr. Brandon Hughes (VA CIO EA), Mr. Dewaine Beard (VA IT Executive Director) and Mr. John Kovac (Pittsburgh VA Area Manager) to discuss VA information infrastructure, pictured right with HERL Director Dr. Rory Cooper and IT specialist Ron Wesolowski.



New Patents



Pathway Measurement Devices, Systems and Methods. U.S. Patent #: 10,690,774, filed August 24, 2018, issued June 23, 2020. Inventors: Jonathan Pearlman, Eric Sinagra, Jonathan Duvall, Josh Brown, Dianna Stuckey, Tianyang Chen, Ian McIntyre, Rory A. Cooper. Application #: 16/111,921.



Computer Pointing Device. U.S. Patent D894,899, filed March 29, 2019, issued September 1, 2020. Inventors: Rory A. Cooper, Garrett Grindle, Zak Anzelone, Aaron Anderson. Application #: 29/685,637.

Virtual State of the Science Symposium August 31 and September 2, 2020 Mitigating Risks and Maximizing Benefits of Participating in Adaptive Reconditioning Programs

The State of the Science Symposium entitled “Mitigating Risks and Maximizing Benefits of Participating in Adaptive Reconditioning Programs” met online for the first time over two days via Microsoft Teams, due to the COVID-19 pandemic. The symposium was presented by the Center for Rehabilitation Science Research, the Department of Physical Medicine and Rehabilitation at The Uniformed Services University for the Health Sciences; the Department of Rehabilitation, Walter Reed National Military Medical Center; the Human Engineering Research Laboratories (a VA RR&D Center); and the University of Pittsburgh School of Health and Rehabilitation Sciences, Department of Rehabilitation Science and Technology. Course Directors were Rory A. Cooper, PhD and COL (Ret) Paul F. Pasquina, MD.

Presentations at the Symposium:

Virtual Adaptive Reconditioning Challenges and Competitions - Dr. Rory Cooper, University of Pittsburgh



Paralympic Medical Care and Health Promotion - Dr. Cheri Blauwet, Harvard Medical School

Handcycle Assistance Team H-CAT - Dan Fisher, University of Pittsburgh

Medical Aspects of Adaptive Reconditioning Participation - Dr. Ken Lee, Medical Director, National Veterans Wheelchair Games

International Society of Physical and Rehabilitation Medicine Perspectives - Dr. Yetsu Tuakli-Wosornu & Dr. Uma Pandiyan, International Society of Physical and Rehabilitation Medicine

Videos, presentations, and photos from archived symposia are available on the HERL website at <https://herl.pitt.edu/education-outreach/symposia>.

To be added to the mailing list, please contact michael.lain@pitt.edu.

Autonomous Vehicle Grant

The National Highway Traffic Safety Administration (NHTSA) released federal guidelines governing automated vehicles (AVs), but failed to address the specific needs of individuals with disabilities. To bridge this gap, we proposed to create the *Automated vehicle Service for People with disabilities - Involved Response Engineering* (ASPIRE) Center to research and define the needs of people with disabilities when using or interacting with AVs. Different levels of automation pose distinct challenges for people with disabilities; therefore, further research is needed to not only better understand these needs, but to also develop design strategies to meet them. Such research would be best accomplished by incorporat-

ing the principals of participatory design, where all stakeholders (e.g. engineers, designers, clinicians, scientists, and people with disabilities) work collaboratively in a transdisciplinary fashion.

The Department of Transportation recognized that HERL was the place where all these roles come together. Eventually, HERL will provide a roadmap for manufacturers and transportation system providers that is responsive to the needs of people with disabilities and demonstrates a path forward for the integration of accessible automated vehicles and mobility services. More information is available on the HERL website at <https://www.herl.pitt.edu/news-events/herl-awarded-1-million-usdot-grant>.

HERL News & Notes

The International Society of Wheelchair Professionals (ISWP) helps to professionalize wheelchair services around the world and make wheelchair provision more accessible. ISWP offers resources to develop and recognize providers' wheelchair service knowledge, most notably the Basic Wheelchair Service Provider Certification, which will allow people to market skills by demonstrating both the training and knowledge needed to provide wheelchairs at a basic level. Once registered, people can access additional training and certificates. Register today: <https://wheelchairnetwork.org/training-pathway/>

The National Mobility Equipment Dealers Association (NMEDA) and the University of Pittsburgh School of Health and Rehabilitation Sciences (SHRS) announced an agreement for the school's Department of Rehabilitation Science and Technology (RST) to oversee and administer the education and training programs offered by NMEDA. More information at <https://www.shrs.pitt.edu/news/pitt-rst-partners-non-profit-improve-transportation-access-people-disabilities>

On September 22, HERL Director Dr. Rory Cooper took part in an online panel discussion sponsored by the U.S. Department of Transportation and Partners for Automated Vehicle Education entitled "AVs for All: Inspiring Solutions for Accessible Design." View the full webinar at <https://www.youtube.com/watch?v=8E77maHcLJs> and find+ more resources at <https://pavecampaign.org/avs-for-all-inspiring-solutions-for-accessible-design-additional-resources/>.

On October 20, WARE Director Dr. Rory Cooper took part in a panel discussion sponsored by the U.S. Department of Labor in honor of the 75th annual National Disability Employment Awareness Month (NDEAM) and the 30th anniversary of the passage of the Americans with Disabilities

Act exploring the crucial role of accessible technology in relation to the theme of "Increasing Access and Opportunity" for people with disabilities. Besides Dr. Cooper, other panelists included Secretary of Labor Eugene Scalia, Google Chief Internet Evangelist Vint Cerf, Futurist Cathy Hackl, and others.

Dr. Cooper took part in another panel on October 8 entitled "Exclusion to Autonomy: The History & Future of Accessible Transportation," hosted by the Heinz History Center and the Western Pennsylvania Disability History and Action Consortium, tracing the roots of advocacy, innovation and change that led to accessible transportation in Western Pennsylvania.

A story about Dr. Cooper's accident and recovery, with a photo of him on his handcycle, appeared on the center pages of the October/November 2020 issue of AARP Magazine.

Dr. Cooper was elected to the National Board of Directors of Easter Seal and the U.S. Intellectual Property Association.

RESNA President-Elect Dr. Carmen DiGiovine is a HERL alum, and new RESNA Board member Dr. Mary Goldberg is a current HERL faculty member.

At the end of October, the University of Pittsburgh's Office of Diversity and Inclusion hosted two discussion panels to build awareness of opportunities for and the accomplishments of people with disabilities in the workplace, as well as how Pitt is addressing the challenges and successes that individuals with disabilities face every day. HERL's Rory Cooper and Libby Powers took part; learn more at <https://www.pittwire.pitt.edu/news/disability-advocates-still-fight-progress>.

Dr. Changfeng Tai receives \$10.5 million DARPA grant

Changfeng Tai, associate professor of urology and pharmacology in the University of Pittsburgh School of Medicine, was awarded \$10.5 million from the Defense Advanced Research Projects Agency (DARPA) to develop a medical device that would help people who have spinal cord injuries.

Dr. Tai's research interests include mechanisms underlying neuromodulation of an overactive bladder and restoring bladder function after spinal cord injury. Dr. Tai is a published author of many articles, abstracts, and book chapters, holds

several patents, and is a member of the Editorial Board of the Journal of Neurourology and Urodynamics and Frontiers in Autonomic Neuroscience. Dr. Tai is also a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE), and is Principal Investigator on several current research projects.

From August 1996 to August 1998, Dr. Tai was a HERL postdoctoral researcher supervised by Dr. Cooper, researching the effects of vibration on wheelchair rider comfort.



Human Engineering Research Laboratories



VA Center for
Wheelchairs and Associated
Rehabilitation Engineering



University of Pittsburgh
School of Health & Rehabilitation Sciences
School of Medicine



University of Pittsburgh
NIDILRR Model Center on
Spinal Cord Injury



National Science Foundation
Advanced Technology
Education Center

Rory A. Cooper, PhD
Director

Brad Dicianno, MD
Medical Director

Michael L. Boninger, MD
Senior Associate Medical Director

Alicia Koontz, PhD, RET
Associate Director for Research

Daniel Kysela, MA
Assistant Director for Finance & Research Administration

Garrett Grindle, PhD
Assistant Director for Engineering

Stacy Eckstein, BS, MT (ASCP)
Assistant Director for Clinical & Regulatory Affairs

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Assistant Director for Education & Outreach

Andrea Bagay, BS, CRA
*Assistant Director for VA Finance
& Research Administration*

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