HERL Newsletter
News from the Human Engineering Research Laboratories Vol 16, No 2 · July 2017

BREAKTHROUGH:
PneuMobility Goes Viral

You might have heard of the Human Engineering Research Laboratories' PneuMobility project: it aims to make assistive mobility devices that run solely on compressed air. Using air instead of a typical battery has several advantages: a shorter recharge time; easier maintenance; lighter weight; and a waterproof design. Currently, two versions have been constructed: the PneuChair and the PneuScooter. Both are powered by onboard air tanks.

If you've heard of the PneuChair, it's probably because on April 7, the first model was unveiled at the Morgan's Wonderland theme park in San Antonio, Texas. The park was built specifically for individuals with disabilities, and 10 of these chairs are now available to patrons at the venue's new splash park, Morgan's Inspiration Island.

In the internet age, news can spread by "going viral" – the news is reported by one source, which is then quickly picked up by other news distributors. Sometimes, the news distributor is very large and reaches millions of people, in which case the news item may be shared around the internet thousands of times. And that's exactly what happened to PneuChair.

First, PneuChair is a brilliant idea that fills a need that most people never even think about – specifically the ability of people who use wheelchairs to enjoy water parks. Second, the idea was expertly designed and built by HERL's crack engineering team. Third, officials at Morgan's Wonderland knew a good idea when they saw one – Morgan's Inspiration Island is a terrific concept all by itself. And finally, the Public Affairs departments at the University of Pittsburgh and Morgan's Wonderland teamed up to write and distribute a well-crafted press release, and the VA Pittsburgh Healthcare System Public Affairs office created a concise video about PneuMobility that illustrated the project perfectly.

All these things together allowed PneuChair to go viral. As of this writing, PneuChair has been reported on by more a mix of more than 40 traditional and "new media" news sources across the Internet, most notably CNN, Time, ABC, Gizmodo, Mashable, Mental Floss, Bored Panda, Scary Mommy, Women's Day, Good Housekeeping, The Independent, MSN, Epoch Times, New Mobility, and Mobility Management. Likewise, VAPHS's PneuMobility video has been viewed more than 12,500 times on YouTube – a figure that doesn't even take Facebook views or news site republished or remixed versions into account.

Above: PneuChair at Morgan's Wonderland.
Below: VA Secretary David Shulkin (center) rides PneuScooter.

While no one can truly predict which news articles will go viral and which won't, it was obvious that the conditions were exactly right for PneuChair and Morgan's Wonderland. A great product put to the best use, smartly publicized by hard-working teams was the winning formula in this case. As a result, millions more people are now aware of Morgan's Inspiration Island and the Human Engineering Research Laboratories, and as a proven creator of useful inventions, interest in HERL continues among news networks even months later.

For more information:
• http://herl.pitt.edu/research/pneumobility
• http://herl.pitt.edu/news-events/pneuchair-unveiled-water-park

HERL researchers contribute to *TSCIR* special issue

The Human Engineering Research Laboratories is pleased to announce the publication of several articles by HERL staff in the "Emerging Technologies" Special Issue of *Topics in Spinal Cord Rehabilitation*, a quarterly research journal published by Thomas Land Publishers, Inc. (ISSN 1082-0744).

Each article summarized in this newsletter's Current Research Abstracts section below and on the next page can be found in Volume 23, Issue 2 of *Topics in Spinal Cord Rehabilitation.*

To view the articles, go to **http://archive.scijournal.com/toc/tscr/23/2**. A subscription is required. For subscription information, go to **http://tscirservice.com/subscribe.php**.

Current Research Abstracts

Kelleher AR, Dicianno BE, Eckstein S, Schein R, Pearlman J, Cooper RA, Consumer Feedback to Steer the Future of Assistive Technology Research and Development: A Pilot Study, Topics in Spinal Cord Injury Rehabilitation, pp. 89-97, Vol. 23, No. 2, Spring 2017.

SUMMARY: Discusses the development of a questionnaire to identify consumer needs.

Objective: The overall objective of this project was to identify consumers' opinions of their needs and wants related to assistive technology (AT) in a systematic and quantitative manner via a questionnaire that can be used to validate existing and establish new research priorities.
Methods: This pilot study describes questionnaire development, online implementation, and revisions considered to the questionnaire in preparation for conducting a nationwide survey. Data from a sample (N = 112) are presented. The pilot study was critical to refine the questions and ensure that meaningful information was being collected.
Results: It was identified that revisions were warranted to provide more structure and allow for consumers to prioritize AT research efforts.
Conclusion: The questionnaire results, although positively in favor of many of the technologies presented, are inconclusive to identify generalizable research priorities, thus expansion to a nationwide population is warranted.

Sundaram SA, Wang H, Ding D, Cooper RA, Step Climbing Power Wheelchairs: A Literature Review, Topics in Spinal Cord Injury Rehabilitation, pp. 98-109, Vol. 23, No. 2, Spring 2017.

SUMMARY: A literature review of efforts to create a step-clibing power wheelchair.

Background: Power wheelchairs capable of overcoming environmental barriers, such as uneven terrain, curbs, or stairs, have been under development for more than a decade.
Method: We conducted a systematic review of the scientific and engineering literature to identify these devices, and we provide brief descriptions of the mechanism and method of operation for each. We also present data comparing their capabilities in terms of step climbing and standard wheelchair functions.
Results: We found that all the devices presented allow for traversal of obstacles that cannot be accomplished with traditional power wheelchairs, but the slow speeds and small wheel diameters of some designs make them only moderately effective in the basic area of efficient transport over level ground and the size and configuration of some others limit maneuverability in tight spaces.
Conclusion: We propose that safety and performance test methods more comprehensive than the International Organization for Standards (ISO) testing protocols be developed for measuring the capabilities of advanced wheelchairs with step-climbing and other environment-negotiating features to allow comparison of their clinical effectiveness.

Candiotti J, Sundaram SA, Daveler B, Gebrosky B, Grindle GG, Wang H, Cooper RA, Kinematics and Stability Analysis of a Novel Power Wheelchair When Traversing Architectural Barriers, Topics in Spinal Cord Injury Rehabilitation, pp. 110-119, Vol. 23, No. 2, Spring 2017.

SUMMARY: The development of MEBot, a robotic wheelchair, is discussed in this article.

Background: Electric-powered wheelchairs (EPWs) are essential devices for people with disabilities for mobility and quality of life. However, the design of common EPWs makes it challenging for users to overcome architectural barriers, such as curbs and steep ramps. Current EPWs lack stability, which may lead to tipping the EPW causing injury to the user. An alternative Mobility Enhancement Robotic Wheelchair (MEBot), designed at the Human Engineering Research Laboratories (HERL), was designed to improve the mobility of, and accessibility for, EPW users in a wide variety of indoor and outdoor environments. Seat height and seat inclination can be adjusted using pneumatic actuators connected to MEBot's 6 wheels.
Method: This article discusses the design and development of MEBot, including its kinematics, stability margin, and calculation of the center of mass location when performing its mobility applications of curb climbing/descending and attitude control. Motion capture cameras recorded the seat angle and joint motion of the 6 wheel arms during the curb climbing/descending process. The center of mass location was recorded over a force plate for different footprint configurations.
Results: Results showed that the area of the footprint changed with the location of the wheels during the curb climbing/descending and attitude control applications. The location of the center of mass moved ±30 mm when the user leaned sideways, and the seat roll and pitch angle were 0° and ±4.0°, respectively, during curb climbing and descending. Conclusion: Despite the user movement and seat angle change, MEBot maintained its stability as the center of mass remained over the wheelchair footprint when performing its mobility applications.

Current Research Abstracts

Daveler B, Wang H, Gebrosky B, Grindle GG, Schneider U, Cooper RA, Integration of Pneumatic Technology in Powered Mobility Devices, Topics in Spinal Cord Injury Rehabilitation, pp. 120-130, Vol. 23, No. 2, Spring 2017.

SUMMARY: Development of a novel air-powered wheelchair prototype.

Advances in electric motors, electronics, and control systems have enhanced the capability and drivability of electric power mobility devices over the last 60 years. Yet, battery technologies used in powered mobility devices (PMDs) have not kept pace. Recent advances in pneumatic technology, primarily the high torque, low speed design of rotary piston air motors, directly align with the needs of PMD. Pneumatic technology has advantages over battery-powered technology, including lighter weight, lower operating costs, decreased environmental impact, better reliability, and increased safety. Two prototypes were created that incorporated rotary piston air motors, high-pressure air tanks, and air-pressure regulators. Prototype 1 was created by modifying an existing electric PMD. Range tests were performed to determine the feasibility of pneumatic technology and the optimal combination of components to allow the longest range possible at acceptable speeds over ideal conditions. Using a 1.44 L air tank for feasibility testing, prototype 1 was capable of traveling 800 m, which confirmed the feasibility of pneumatic technology usage in PMDs. Prototype 2 was designed based on the testing results from prototype 1. After further optimization of prototype 2, the average maximum range was 3,150 m. Prototype 2 is up to 28.3% lighter than an equivalent size electric PMD and can be fully recharged in approximately 2 minutes. It decreases the cost of PMDs by approximately $1,500, because batteries do not need to be replaced over the lifetime of the device. The results provide justification for the use of pneumatic technology in PMDs.

Chung C, Ka H, Wang H, Ding D, Kelleher AR, Cooper RA, Performance Evaluation Of A Mobile Touchscreen Interface For Assistive Robotic Manipulators: A Pilot Study, Topics in Spinal Cord Injury Rehabilitation, pp. 131-139, Vol. 23, No. 2, Spring 2017.

SUMMARY: Pilot study of a touchscreen interface for a robotic arm.

Background: Assistive robotic manipulators (ARMs) have been developed to provide enhanced assistance and independence in performance of daily activities among people with spinal cord injury when a caregiver is not on site. However, the current commercial ARM user interfaces (UIs) may be difficult to learn and control. A touchscreen mobile UI was developed to overcome these challenges. Objective: The object of this study was to evaluate the performance between 2 ARM UIs, touchscreen and the original joystick, using an ARM evaluation tool (ARMET).

Methods: This is a pilot study of people with upper extremity impairments (N = 8). Participants were trained on 2 UIs, and then they chose one to use when performing 3 tasks on the ARMET: flipping a toggle switch, pushing down a door handle, and turning a knob. Task completion time, mean velocity, and open interviews were the main outcome measurements.

Results: Among 8 novice participants, 7 chose the touchscreen UI and 1 chose the joystick UI. All participants could complete the ARMET tasks independently. Use of the touchscreen UI resulted in enhanced ARMET performance (higher mean moving speed and faster task completion).

Conclusions: Mobile ARM UIs demonstrated easier learning experience, less physical effort, and better ARMET performance. The improved performance, the accessibility, and lower physical effort suggested that the touchscreen UI might be an efficient tool for the ARM users.

Burkman J, Grindle GG, Wang H, Kelleher AR, Cooper RA, Further Development of a Robotic Assisted Transfer Device, Topics in Spinal Cord Injury Rehabilitation, pp. 140-146, Vol. 23, No. 2, Spring 2017.

SUMMARY: Continuing development of the Strongarm transfer device is described.

Background: The task of performing transfers, such as from a wheelchair to a bed, has a high risk of injury to both the caregiver and the person being transferred. Although mechanical transfer devices can reduce these risks, these devices are not meant for use in the community and they still place strain on the caregiver when used.

Purpose: The aim of this study is to describe feedback gathered from focus groups of potential users of the Robotic-Assisted Transfer Device (RATD) and describe design changes aimed at preparing the device for the next step in the development process.

Method: The RATD was transferred to a newer electric-powered wheelchair (EPW), key components were redesigned, and the control program was updated to increase the safety of the device. Two focus groups, one consisting of people with disabilities and the other consisting of clinicians and caregivers, were conducted to gather feedback from potential users.

Results: Error checking, safety zones, a motor brake, and a new track helped increase the safety of the device. Sixty-three percent of the people with disabilities and 83% of caregivers surveyed said they would use the device.

Conclusions: The results from the focus groups were positive and the design changes were successful, but more development is needed before the RATD can be marketed.

Diplomats "Experience America" at HERL

The U.S. State Department and the Human Engineering Research Laboratories hosted 30 international diplomats, their families, and their aides on May 22 as part of the State Department's "Experience America" program. The program takes diplomats to cities across the United States, visiting the most historical and most interesting places in each location.

National Academies release report on assistive technology

With support from the Social Security Administration, the National Academies of Sciences, Engineering, and Medicine convened an ad hoc, expert committee to provide an analysis of the use in adults of selected assistive products and technologies, within four categories including, wheeled and seated mobility devices, upper-extremity prostheses, hearing devices, and communication and speech technologies. In The Promise of Assistive Technology to Enhance Activity and Work Participation, the committee describes the range of available products and technologies in each of these categories and examines how they may mitigate the effects of impairments and the extent to which they may help enable people with disabilities to enter or return to the workforce.

HERL Director Dr. Rory Cooper was a member of this committee - the Committee on the Use of Selected Assistive Products and Technologies in Eliminating or Reducing the Effects of Impairments.

The U.S. Census Bureau has reported that 56.7 million Americans had some type of disability in 2010, which represents 18.7 percent of the civilian noninstitutionalized population included in the 2010 Survey of Income and Program Participation. The U.S. Social Security Administration (SSA) provides disability benefits through the Social Security Disability Insurance (SSDI) program and the Supplemental Security Income (SSI) program. As of December 2015, approximately 11 million individuals were SSDI beneficiaries, and about 8 million were SSI beneficiaries.

SSA currently considers assistive devices in the nonmedical and medical areas of its program guidelines. During determinations of substantial gainful activity and income eligibility for SSI benefits, the reasonable cost of items, devices, or services applicants need to enable them to work with their impairment is subtracted from eligible earnings, even if those items or services are used for activities of daily living in addition to work. In addition, SSA considers assistive devices in its medical disability determination process and assessment of work capacity.

This new report, from the National Academies, provides an analysis of selected assistive products and technologies, including wheeled and seated mobility devices, upper-extremity prostheses, and products and technologies selected by the committee that pertain to hearing and to communication and speech in adults.

This briefing was for members of Congress and congressional staff only. The report was publicly released on May 9, 2017 and can be found, in its entirety, on the Web site of the National Academies Press.

For more information:

http://nationalacademies.org/hmd/reports/2017/promise-of-assistive-technology-to-enhance-activity-and-work-participation.aspx

https://www.nap.edu/catalog/24740/the-promise-of-assistive-technology-to-enhance-activity-and-work-participation

Paralyzed Veterans of America

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Don't miss our Open House!

HERL presents our annual Open House on July 28, 2017.
ALL ARE INVITED! NO RSVP NECESSARY!
Snacks and drinks will be provided.

Distinguished Guests will include:
Karin McGraw, Director, VA Pittsburgh Healthcare System
Dr. Carolyn Clancy, Deputy Under Secretary for Health for Organizational Excellence, Veterans Health Administration
Patrick Gallagher, Chancellor, University of Pittsburgh
Mark Baldwin, HERL/Pitt Alum, Lockheed Martin

Also includes REU/ELeVATE Poster Session and Award Ceremony.

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HERL alum Mark Baldwin, Lockheed Martin, Orion spacecraft
VA Pittsburgh Healthcare System leadership
Human Engineering Research Laboratories leadership

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No RSVP necessary. All are invited!
Come for free tours and demos of current HERL projects.
Snacks and drinks will be provided.

Connect with HERL at these upcoming events

Paralyzed Veterans of America 7th Annual Summit + Expo
Gaylord National Resort & Convention Center, National Harbor, Maryland, August 29-31

Association of the U.S. Army Annual Meeting & Exposition
Walter E. Washington Convention Center, Washington, D.C., October 8-11

ACC Smithsonian Creativity & Innovation Festival
National Museum of American History, Washington, D.C., October 13-15

126th Annual AMSUS Meeting
Gaylord National Resort & Convention Center, National Harbor, Maryland, Nov. 28 - Dec. 1

State of the Science Symposium, 14 April 2017
Virtual Reality Applications for Advancing Rehabilitation

The State of the Science Symposium on Virtual Reality Applications for Advancing Rehabilitation was held in Sanford Auditorium at the Uniformed University of the health Sciences in Bethesda, Maryland on Friday, April 14, 2017, presented by the Center for Rehabilitation Science Research; the Department of Physical Medicine and Rehabilitation at the Uniformed Services University of the Health Sciences; the Department of Rehabilitation, Walter Reed National Military Medical Center; the University of Pittsburgh, School of Health and Rehabilitation Sciences,

Department of Rehabilitation Science and Technology; the Human Engineering Research Laboratories, VA Pittsburgh Healthcare System; the University of Pittsburgh School of Medicine Center for Continuing Education in the Health Sciences; with generous support from the Paralyzed Veterans of America.

Presentations at the Symposium:

Opening Remarks - MG(ret) Richard W. Thomas MD DDS, President of the Uniformed Services University of the Health Sciences

Introduction to Virtual Reality and Its Application in Rehabilitation - Alison Pruziner PT DPT, Research Physical Therapist, Walter Reed National Military Medical Center

Enhancing the Identification and Treatment of Combat-Related PTSD with Virtual Environments - Michael Roy MD, Director, Division of Military Internal Medicine, Uniformed Services University of the Health Sciences

Virtual Reality and Serious Games for Rehabilitation of Balance, Mobility and Fitness of Persons Post-Stroke - Judith E. Deutsch PhD, Director, RiVERS Lab, Rutgers University

Measurement of Cognitive Function Using Gamified Assessments and Interventions - Sheryl Flynn PhD, Co-Founder and CEO, Blue Marble Health

Virtual Reality in Rehabilitation: Applications for Wheelchair Users - Brad Dicianno MD, Medical Director and COO, Human Engineering Research Laboratories

The Healing Power of Video Gaming - Steve Spohn, COO and Community Outreach Director, AbleGamers

Driving Simulators as a Tool in Hemianopia Research and Rehabilitation - Alex Bowers PhD, Associate Professor of Ophthamology, Harvard University

Control Within a Virtual Environment is Correlated Functional Outcomes When Using a Physical Prosthesis - Levi Hargrove PhD, Associate Director, Center for Bionic Medicine, Shirley Ryan AbilityLab

Recovering Stereo Vision Through Virtual Reality - Dennis M. Levi PhD, Professor of Optometry and Vision Science, University of California, Berkeley

Balance Rehabilitation Through Virtual Environments - Emily Keshner PhD, Professor and Chair, Department of Physical Therapy, Temple University

Expanding the Rehabilitation of Injured Service Members Using Immersive, Large-Scale Virtual Environments - Pinata Sessoms PhD, Research Biomedical Engineer and Biomechanist, Naval Health Research Center

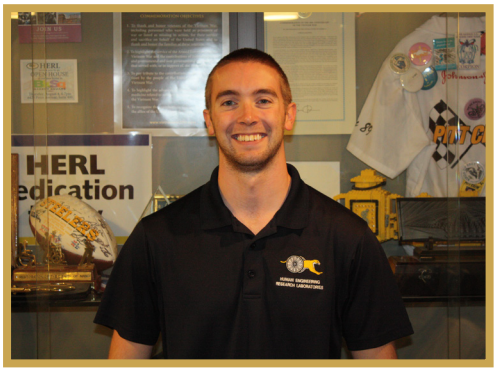
Future Directions for Virtual Rehabilitation: Science and Clinical Care - Christopher A. Rábago PT PhD, Research Physical Therapist, Center for the Intrepid

Videos, presentations, and photos from these symposia, along with biographies of all speakers, are available on the HERL website at **http://herl.pitt.edu/education-outreach/symposia**.

Find the summary of Virtual Reality Applications for Advancing Rehabilitation at **http://herl.pitt.edu/vr-rehab**.

Get to know HERL staff and students with our Newsletter profiles! This issue features HERL researcher and doctoral student Joseph Ott.

HERL Profiles: Joseph Ott



Joseph Ott is currently a second year doctoral student at the University of Pittsburgh studying Rehabilitation Science and Technology. He conducts research on wheelchair durability testing equipment for the International Society of Wheelchair Professionals as well as the Human Engineering Research Laboratories. He is a founding member of two student groups on campus and volunteers for other organizations in the surrounding community. Furthermore, he is a Senior Mechanic and holds the rank of Sergeant in the U.S. Army Reserves with over six years of service. He leads a team of six mechanics in preventative maintenance, annual service, and repairs for his unit's vehicles. He graduated from Robert Morris University in the Spring of 2016 with a Masters of Science in Engineering Management and Bachelors of Science in Mechanical Engineering.

On May 15, HERL was honored to host Rachel B. Ramoni, DMD, ScD, the Chief Research and Development officer for the U.S. Department of Veterans Affairs. Dr. Ramoni was in Pittsburgh to attend Research Week at VA Pittsburgh Healthcare System.

Many Accolades for HERL Director Dr. Rory Cooper

HERL Director Dr. Rory Cooper has been in the spotlight throughout 2017.

His PneuChair invention continues to spread virally on the Internet (see story, p. 1). He completed the 2017 Dick's Pittsburgh Marathon in the handcycle division, and was on Pittsburgh's KDKA-TV discussing handcycling (**https://www.msn.com/en-us/news/us/marathon-week-spotlight-on-handcycles/vp-BBADzaO**). He co-authored a report on assistive technology for the National Academies (see story, p. 4).

He was featured as the cover story in the May 2017 issue of New Mobility magazine (**http://www.newmobility.com/2017/05/rory-cooper/**).

And finally, he was announced as a finalist for a 2017 Samual J. Heyman Service to America Medal - known as the Sammies, these awards honor the very best federal employees (**https://servicetoamericamedals.org/honorees/view_profile.php?profile=470**).

Congratulations, Dr. Cooper!

Human Engineering Research Laboratories

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School of Health & Rehabilitation Sciences
School of Medicine

University of Pittsburgh
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National Science Foundation
Advanced Technology Education Center

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To access the questionnaire, go to

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If you would like to participate but don't have access to the internet, please contact one of our clinical coordinators.

Following completion of the questionnaire you may choose to be entered into a drawing to win $100.

Human Engineering Research Laboratories

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If you have questions or are interested in learning more about the study, contact our Clinical Coordinators at (412) 822-3700.

Contact us!

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