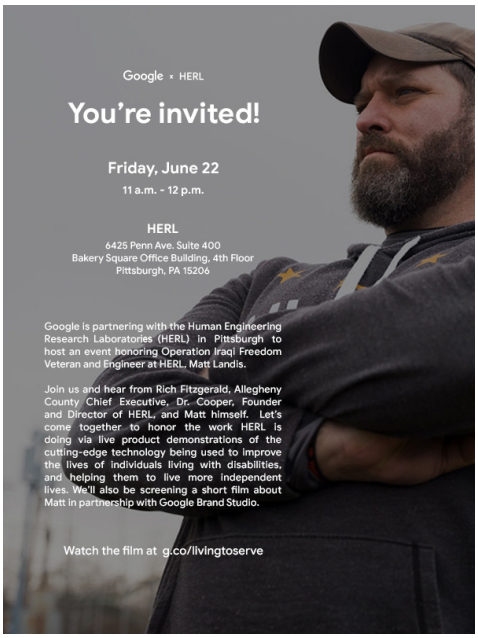
HERL Newsletter

News from the Human Engineering Research Laboratories Vol 17, No 2 · July 2018



HERL Engineer Matt Landis featured in Google video

A passion for service and open source technologies is helping HERL engineer and Veteran Matt Landis build a more inclusive world. For him, being a Veteran is more than being "someone who used to be a soldier." Now working to give his autistic son and others a chance to live more independently, Matt is proving that a Veteran is someone who never stops serving others.

Google has released a video about HERL engineer and Veteran Matt Landis, his work at HERL, his family, and his important work with all of the Veterans of Western Pennsylvania and nationwide. You can find the video, entitled "Living to Serve," on YouTube or on Google (with notes and bonus materials) at https://www.google.com/about/stories/livingtoserve/.

HERL Director Dr. Rory Cooper writes this about Matt Landis:

"Matt is an Army Veteran who served two tours in Iraq as an Apache Helicopter pilot. He was recruited by me to participate in our ELeVATE program supported by the National Science Foundation (NSF) and Disabled Veterans National Foundation (DVNF). Matt enrolled in and graduated from the University of Pittsburgh Swanson School of Engineering with a BS degree in Electrical Engineering. While a student, he participated in our NSF supported Research Experience for Undergraduates through Veteran Supplement. Upon earning his degree, he became a full-time employee in the Human Engineering Research Laboratories working for the University of Pittsburgh and US Department of Veterans Affairs. As part of his contributions, Matt taught participants in the ELeVATE program and our NSF Advanced Technology Education program. Matt is very active in the Veteran community, especially through The Mission Continues and No One Left Behind groups. He shares this excellent example of the tremendous potential and the accomplishments of Service Members and Veterans with disabilities succeeding in life and making a difference in their communities."

Make a difference: Help us raise $250,000 for our 25th anniversary

The Human Engineering Research Laboratories will turn 25 years old in 2019, and we're commemorating our anniversary by working to raise $250,000 through the end of our anniversary year. Our fundraising plans got off to a terrific start - thanks to the generosity of 176 donors, HERL came out on top of the Pitt Programs & Experiences Leaderboard at the conclusion of the University of Pittsburgh's Day of Giving on Febraury 28, 2018. That earned HERL an extra gift of $30,000 from the University! HERL finished ahead of runners-up The Pitt Fund (167 donors), Pitt Athletics' Willis Academic Center Enhancement Fund (100 donors), and the University Center for International Studies (63 donors).

Your generous gift to HERL will help us continue working on research that improves the lives of Veterans and all those with disabilities - projects like PneuChair, the wheelchair powered by compressed air, and MEBot, the wheelchair that climbs curbs. Your donation will also help us continue our educational programs for Veterans with disabilities: Experiential Learning for Veterans in Assistive Technology and Engineering (ELeVATE) and Advancing Inclusive Manufacturing (AIM).

You can donate online to HERL at any time by going to the HERL website at http://herl.pitt.edu/ and clicking the "Show Your Support" link.

Current Research Abstracts

Gebrosky B, Pearlman J, Cooper RA, Comparison of High Strength Aluminum Ultralight Wheelchairs using ANSI/RESNA Testing Standards, Topics in Spinal Cord Injury Rehabilitation, pp. 63-77, Vol. 24, No. 1, Winter 2018.

Background: The use of ultralight manual wheelchairs has been shown to benefit wheelchair users when compared to other types. New aluminum alloy frame materials coming to the market have not been independently evaluated for durability and cost benefit.

Methods: Three 70XX aluminum ultralight wheelchair models were tested and compared based on dimensions, stability, and durability using the ANSI/RESNA standards. The results were also compared to previous manual wheelchair studies.

Results: This study found that there were no significant cost benefit or durability differences between the wheelchairs tested and previous aluminum or titanium ultralight rigid models. Additionally, 5 of the 9 wheelchairs tested failed to meet the minimum ANSI/RESNA requirements for durability.

Conclusion: These results are similar to results from previous rigid ultralight wheelchair studies and indicate that the quality of wheelchairs of this type has not improved and better requirements are necessary for wheelchairs marketed in the United States.

SUMMARY: The quality of ultralight wheelchairs has not improved. 5 of 9 tested examples failed.

Cooper RA, Tuakli-Wosornu YA, Henderson GV, Quinby E, Dicianno BE, Tsang K, Ding D, Cooper R, Crytzer TM, Koontz AM, Rice I, Bleakney AW, Engineering and Technology in Wheelchair Sport, PM&R Clinics of North America, pp. 347-369, Vol. 29, No. 2, May 2018.

Key points:

As technology and engineering continue to evolve, athletes and their coaches will be confronted with selecting sports equipment that maximizes performance and safety.

Wheelchair athletes must be cognizant of their upper limb health because injury can profoundly affect daily function and, ultimately, quality of life.

Ideally, wheelchair systems designed to promote efficient transfer of energy to the handrims should be evaluated for their simultaneous effects on the upper limbs.

There is enormous opportunity for the development of technologies capable of projecting injury and performance metrics to athletes and coaches.

SUMMARY: An overview of current technology and future directions in wheelchair sports.

Alibeji NA, Molazadeh V, Dicianno BE, Sharma N, A Control Scheme That Uses Dynamic Postural Synergies to Coordinate a Hybrid Walking Neuroprosthesis: Theory and Experiments, Frontiers in Neuroscience, Article 159, Vol. 12, April 2018.

A hybrid walking neuroprosthesis that combines functional electrical stimulation (FES) with a powered lower limb exoskeleton can be used to restore walking in persons with paraplegia. It provides therapeutic benefits of FES and torque reliability of the powered exoskeleton. Moreover, by harnessing metabolic power of muscles via FES, the hybrid combination has a potential to lower power consumption and reduce actuator size in the powered exoskeleton. Its control design, however, must overcome the challenges of actuator redundancy due to the combined use of FES and electric motor. Further, dynamic disturbances such as electromechanical delay (EMD) and muscle fatigue must be considered during the control design process. This ensures stability and control performance despite disparate dynamics of FES and electric motor. In this paper, a general framework to coordinate FES of multiple gait-governing muscles with electric motors is presented. A muscle synergy-inspired control framework is used to derive the controller and is motivated mainly to address the actuator redundancy issue. Dynamic postural synergies between FES of the muscles and the electric motors were artificially generated through optimizations and result in key dynamic postures when activated. These synergies were used in the feedforward path of the control system. A dynamic surface control technique, modified with a delay compensation term, is used as the feedback controller to address model uncertainty, the cascaded muscle activation dynamics, and EMD. To address muscle fatigue, thestimulation levels in the feedforward path were gradually increased based on a model-based fatigue estimate. A Lyapunov-based stability approach was used to derive the controller and guarantee its stability. The synergy-based controller was demonstrated experimentally on an able-bodied subject and person with an incomplete spinal cord injury.

SUMMARY: A new prosthesis combining a lower-limb exoskeleton and functional electrical stimulation was tested.

Current Research Abstracts

Tsai C, Boninger ML, Bass SR, Koontz AM, Upper-limb biomechanical analysis of wheelchair transfer techniques in two toilet configurations, Clinical Biomechanics, pp. 79-85, Vol. 55, June 2018.

Background: Using proper technique is important for minimizing upper limb kinetics during wheelchair transfers. The objective of the study was to 1) evaluate the transfer techniques used during toilet transfers and 2) determine the impact of technique on upper limb joint loading for two different toilet configurations.

Methods: Twenty-six manual wheelchair users (23 men and 3 women) performed transfers in a side and front wheelchair-toilet orientation while their habitual transfer techniques were evaluated using the Transfer Assessment Instrument. A motion analysis system and force sensors were used to record biomechanical data during the transfers.

Findings: More than 20% of the participants failed to complete five transfer skills in the side setup compared to three skills in the front setup. Higher quality skills overall were associated with lower peak forces and moments in both toilet configurations ($-0.68 < r < -0.40$, $p < 0.05$). In the side setup, participants who properly placed their hands in a stable position and used proper leading handgrips had lower shoulder resultant joint forces and moments than participants who did not perform these skills correctly ($p \leq 0.04$). In the front setup, positioning the wheelchair within three inches of the transfer target was associated with reduced peak trailing forces and moments across all three upper limb joints ($p = 0.02$).

Interpretation: Transfer skills training, making toilet seats level with the wheelchair seat, positioning the wheelchair closer to the toilet and mounting grab bars in a more ideal location for persons who do sitting pivot transfers may facilitate better quality toilet transfers.

SUMMARY: Studied two separate toilet transfer setups and investigated ways to improve them.

Burrola-Mendez Y, Goldberg M, Gartz R, Pearlman J, Development of a Hybrid Course on Wheelchair Service Provision for clinicians in an international context, PLoS ONE, Article No. 10.1371, June 2018.

Introduction: Wheelchair users worldwide are at high risk of developing secondary health conditions and premature death due to inappropriate wheelchair provision by untrained providers. The International Society of Wheelchair Professionals (ISWP) has developed a Hybrid Course based on the World Health Organization's Wheelchair Service Training Package—Basic Level. The Hybrid Course leverages online modules designed for low-bandwidth internet access that reduces the in-person training exposure from five to three and a half days, making it less expensive and more convenient for both trainees and trainers.

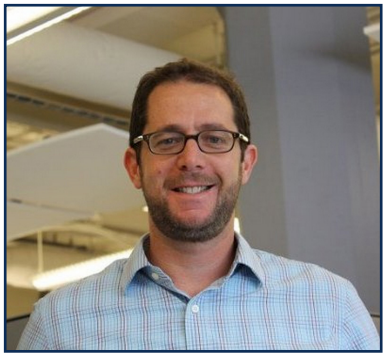
Methods: The Hybrid Course was designed using a systematic approach guided by an international group of stakeholders. The development followed the Quality Matters Higher Educational Rubric, web design guidelines for low bandwidth, experts' opinions, and the best practices for blended course design. A quasi-experimental approach was used to evaluate the effectiveness of the Hybrid Course taken by six graduate students in Rehabilitation Sciences at the University of Pittsburgh by measuring pre- and post knowledge using the validated ISWP Wheelchair Service Provision—Basic Test. The outcome measure was assessed using a paired sample t-test between pre-test and post-test scores. The quality of the Hybrid Course was evaluated by three external reviewers using the Quality Matters Higher Educational Rubric who were blind to each others' evaluation and the results of the training intervention.

Results: Hybrid Course participants reported significant increases in scores on the ISWP Wheelchair Service Provision—Basic Test after participating in the training, with an average increase of 10.84 ± 5.42, $p = 0.004$, Cohen's $d = 1.99$. In addition, the Hybrid Course met the Quality Matters Standards in two out of three evaluations and reported a percentage of agreement between evaluators of 84%.

Conclusions: The Hybrid Course met quality standards and proved to be effective in increasing basic level wheelchair knowledge in a group of Rehabilitation Science graduate students.

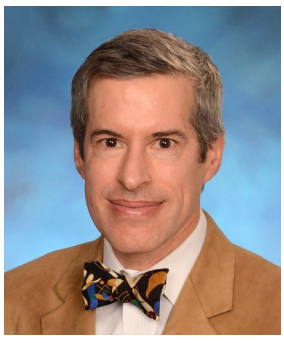
SUMMARY: The Hybrid Course was found to be effective in increasing basic wheelchair servicing knowledge.

HERL Honors



Congratulations to HERL Associate Director for Product Innovation and Translation **Dr. Jon Pearlman**, who has been appointed Chair of the Department of Rehabilitation Science and Technology in the School of Health and Rehabilitation Sciences (SHRS) at the University of Pittsburgh. He replaces HERL Director Dr. Rory Cooper as Chair, who stepped down to concentrate on his roles as HERL Director and SHRS Associate Dean for Inclusion.

HERL would like to extend a warm welcome to new faculty members **Dr. Nitin Sharma** (pictured left) and **Dr. George F. Wittenberg** (pictured right). Dr. Sharma has been Assistant Professor in the Department of Mechanical Engineering and Materials Science at the University of Pittsburgh since 2012. Dr. Wittenberg was recently Director of the VA Maryland Exercise and Robotics Center of Excellence and previously was Director of the Rehabilitation Program within the Department of Neurology at Wake Forest University.



PhDs were recently awarded to HERL staff members **Dr. Jorge Candiotti**, **Dr. Jonanthan Duvall**, **Dr. Garrett Grindle**, and **Dr. Anand Mhatre**. Congratulations!

Dr. Joshua Chung demonstrated HERL's Jacontrol robotic arm controller app at VA Pittsburgh's Take Yor Child to Work Day on April 26.

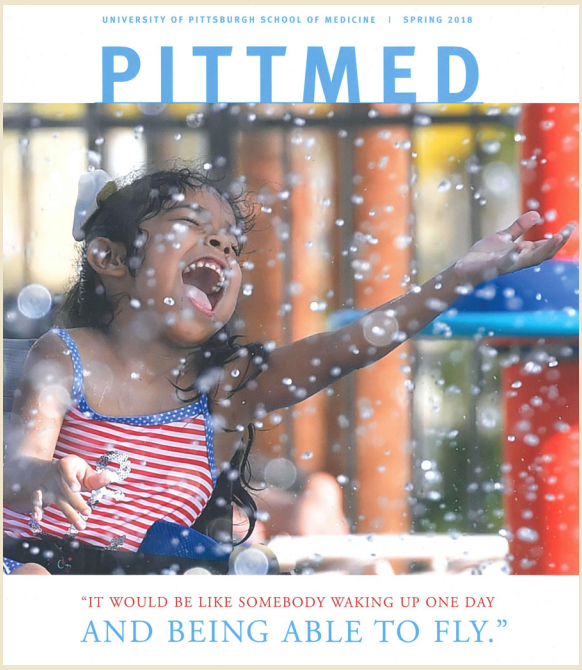
PneuChair in *Pitt Med* Magazine

"It would be like somebody waking up one day and being able to fly."

That's what Brandon Daveler, HERL lead researcher on the PneuChair project team, had to say about the potential effect of PneuChair - the wheelchair powered entirely by compressed air - for children who had, up to now, never visited a water park. (Typical battery-powered electric wheelchairs can never get wet.) And that's the quote printed on the cover of the Spring 2018 issue *Pitt Med*, the magazine published by the University of Pittsburgh's School of Medicine.

The illustrated five-page cover story by Gavin Jenkins (with an accompanying illustrated one-page piece about Morgan's Inspiration Island, the waterpark where PneuChair was used first) discusses not just PneuChair, but many of HERL's projects such as the Personal Mobibility and Manipulation Appliance (PerMMA) and the Mobility Enhancement Robotic Wheelchair (MEBot), and includes thoughtful, detailed biographies of Daveler, HERL researcher Dr. Jonathan Duvall, and HERL Director Dr. Rory Cooper.

You can find the Spring 2018 issue of *Pitt Med* online at https://www.pittmed.health.pitt.edu/spring-2018.



HERL receives Technology Transfer Assistance Project Grant

HERL has received a grant from the U.S. Department of Veterans Affairs to create the Technology Transfer Assistance Project (TTAP). The mission of the VA TTAP is to support the VA Technology Transfer Program (TTP) in the commercialization of VA inventions to benefit Veterans and the American public through evaluating and enhancing the design of products and devices, working with inventors to create working prototypes, and to consult on pathways for commercialization.

The VA TTP translates the results of worthy discoveries made by VA inventors into practice and helps to ensure that Veterans receive access to the latest technologies developed within the VA. This process will benefit from the TTAP program in educating inventors concerning their rights and obligations, rigorously evaluating all inventions, obtaining patents, and assisting in the commercialization of new products. TTAP will also be used to assist the VA (and therefore the American public) in receiving their fair share of royalties from patents and joint ventures with non-governmental agencies and private companies. Since most VA researchers are clinicians, TTAP will also lead to a focus on research areas most likely to benefit Veterans.

The VA TTP receives approximately 325 invention disclosures per year; of those, about 60 patents are filed each year, and about 30 patents are issued per year. However, VA is the lead or sole organization on only 15 active license agreements. Most often a patent is licensed to a company which will develop the invention into a product that benefits the public. Many of the VA patents filed and license agreements established are managed by the 100 partnerships with academic institutions. The TTP currently has no fabrication or testing capabilities. This often leaves VA inventors at a disadvantage as they may have an important concept or idea, but little opportunity to realize the potential of the device. The TTAP will fill this void and help to accelerate VA inventions from conceptualization to commercialization and adoption. The TTAP will help the TTP in "Bringing Research Advancements for Veterans to Everyone" (BRAVE). The TTAP will also support the "Aspirational Goals" of the TTP to increase the current average of 215 invention disclosures per year to over 700. Furthermore, the TTP has set a goal of over 400 patents per year and over 150 licenses. To achieve these goals, the TTP needs field-based assistance to help VA inventors (who do not have the local infrastructure and commercialization know-how) as well as additional resources. The TTAP will fill this gap.

HERL Profile:
Alicia M. Koontz, PhD RET
Associate Director for Research

Dr. Alicia Koontz is an Associate Professor at the University of Pittsburgh and a VA Research Biomedical Engineer. She received her PhD degree in Rehabilitation Science from the University of Pittsburgh in 2001 and B.S. and M.S. degrees in Biomedical Engineering from Wright State University in 1993 and 1994, respectively. Dr. Koontz's research is aimed towards improving the health, function, and quality of life of individuals with disabilities. She has a multidisciplinary background and track record of scientific discovery around upper limb biomechanics and new clinical assessment tools and training approaches for upper limb injury prevention. She also has extensive experience in assistive technology product development, evaluation, and research.

Her research career was launched in the VA with the receipt of a VA Pre-Doctoral Award, followed by two VA Career Development Awards (CDA1 and CDA2). Over the past 12 years, she has maintained continuous research funding as a PI or co-PI on six VA Merit Review grants, three Contract Awards with the United States Access Board, a National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) Disability and Rehabilitation Research Project (DRRP), two National Institutes of Health (NIH-NICHD) Small Business Innovative Sub-Award Grants (Phase 1 and 2), and a PVA clinical trial research grant. She also has over 200 peer reviewed journal and conference proceedings publications.

Her work has been published in top-tier rehabilitation and biomechanics journals, including *Archives of Physical Medicine and Rehabilitation*, *Journal of Rehabilitation Research and Development*, *Biomed Research International*, and *Clinical Biomechanics*. She has supervised over 25 Award Winning Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) Student Scientific Papers and received a Liberty Mutual Best Paper award from Elsevier Ltd. for a first author scientific journal paper published in the International Journal of Industrial Ergonomics (2005). Dr. Koontz has also served on 16 doctoral and 9 masters student committees—of these she was primary advisor to 7 doctoral and 5 masters students. In addition, she has mentored 4 post-doctoral students, 3 medical residents, and over 30 undergraduate student researchers.

State of the Science Symposium, May 2, 2018
Recent Advances for the Care of the Combat Amputee

The State of the Science Symposium on Recent Advances for the Care of the Combat Amputee was held in Sanford Auditorium at the Uniformed University of the Health Sciences in Bethesda, Maryland on Wednesday, May 2, 2018. The symposium was 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.

This symposium was based on material from the textbook *Care of the Combat Amputee* (Care of the Combat Amputee, Paul F. Pasquina, MD and Rory A. Cooper, Ph.D., editors. 739 pages. Washington, DC: Department of the Army, Office of The Surgeon General, Borden Institute, 2009).

Presentations at the Symposium:

Updates to Developing a System of Care for the Combat Amputee - Dr. Paul Pasquina, Department Chief and Chair, Physical Medicine & Rehabititaion, Uniformed University of the Health Sciences

Current Concepts in Amputation Trauma Surgery - Dr. Joseph Webster, Associate Professor, Department of Physical Medicine & Rehabilitation, Virginia Commonwealth University

Adipose Stems Cells for Amputee Care - Dr. Peter Rubin, Chair of the Department of Plastic Surgery, University of Pittsburgh

Pain Management for Individuals with Limb Loss - Dr. David E. Reece, Interventional Spine & Pain Physiatrist

Updates on Rehabilitation for the Poly-Trauma Causalty with Limb Loss - Dr. Jacqueline Moore, Physical Therapist, Comprehensive Combat and Complex Casualty Care

Rehabilitation Post Transhumeral Amputation with Osseointegration - Michelle Nordstrom, OT & Laura Friedman, PT, Occupational & Physical Therapy, Walter Reed National Military Medical Center

Medical Issues in the Care of the Combat Amputee - Dr. Megan J. McHenry, Chief, Physical Medicine & Rehabilitation, Brook Army Medical Center

Overuse Injuries and Secondary Musculoskeletal Complications Associated with Limb Loss - Dr. Brad Hendershot, Reserach Biomedical Engineer, Walter Reed National Military Medical Center

Clinical Practice Guidelines: Lower Limb Amputees - LTC Keith P. Myers, Associate Professor, Department of Physical Medicine & Rehabilitation, Uniformed University of the Health Sciences

Interdisciplinary Outpatient Amputee Clinics: Commonalities and Variance in Practice - MAJ(P) Kevan Spencer, Acting Chief, Physical Medicine & Rehabilitation, Walter Reed National Military Medical Center

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**. You can find videos and presentations from Recent Advances for the Care of the Combat Amputee, and well as presenter biographies and other information, at **http://herl.pitt.edu/combat-amputee**.

HERL Director Dr. Rory Cooper with Dr. Cheri Blauwet of Harvard Medical School and the U.S. Olympic Committee Board of Directors. Dr. Blauwet gave the Dr. Clifford E. Brubaker Lecture at HERL on May 25 on the topic of "Evidence based Injury and Illness Prevention in Paralympic Sport."

OPEN HOUSE

HUMAN ENGINEERING RESEARCH LABORATORIES

1-5pm
THURSDAY
JULY 26
2018

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Free tours & demonstrations!
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Awareness of Wheelchair Related Technologies and Clinical Guidelines

We are looking for volunteers who...

- are 18 years of age or older and
- use one or more assistive devices for mobility, such as a cane, walker, manual wheelchair, power wheelchair, scooter, or lower extremity prosthesis

Researchers at the Human Engineering Research Laboratories want to know what you know about assistive technology.

Complete a brief research questionnaire that will ask for information about yourself, the types of assistive technology that you use, what you know about specific devices, and what sources you use to get your information.

To access the questionnaire, go to: https://is.gd/wheelchairtech

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.

Principal Investigator: Rory Cooper, PhD

Human Engineering Research Laboratories
Bakery Square, 6425 Penn Avenue, Suite 400
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If you have questions or are interested in learning more about the study, please contact our Clinical Coordinators at (412) 822-3700.

Human Engineering Research Laboratories

VA Center for Wheelchairs and Associated Rehabilitation Engineering

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School of Health & Rehabilitation Sciences
School of Medicine

University of Pittsburgh
NIDILRR Model Center on Spinal Cord Injury

National Science Foundation
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Director

Brad Dicianno, MD
Medical Director

Michael L. Boninger, MD
Senior Associate Medical Director

Alicia Koontz, PhD, RET
Associate Director for Research

Garrett Grindle, PhD
Assistant Director for Engineering

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

6425 Penn Avenue, Suite 400
Pittsburgh, PA 15206-4022
Phone: 412-822-3700
Fax: 412-822-3699
herl@shrs.pitt.edu
http://herl.pitt.edu/

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VOLUNTEER!

HERL is always on the lookout for people to participate in our research studies!

Check out our current studies at

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including:

- Effectiveness of Online Transfer Training Materials
- Participatory Evaluation of Assistive Technologies
- Field Validation of Wearables for Detecting Activity Patterns in Wheelchair Users
- Effects of Vibration Exercise on Upper Limb Strength, Function and Pain
- Power Mobility Screening Tool / Power Mobility Clinical Driving Assessment
- Feasibility and acceptibility of a six week high intensity interval training program for persons with SCI

INTERESTED? For more details, visit the website.
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Editor: Michael Lain