



HERL Quarterly Newsletter



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LETTER FROM THE EDITOR

As our 10th anniversary approaches, we at HERL thoughtfully reflect on our past, present, and future accomplishments. At the time this issue of the newsletter is going to press, HERL staff will be eagerly preparing for the March 29th 10th anniversary celebration, which will coincide with

HERL's advisory board meeting. We have invited many of our friends, supporters and collaborators from the University of Pittsburgh, UPMC, and the Department of Veterans Affairs, as well as from many disability

organizations and other research facilities and companies we have worked with over the years. R. Lee Kirby, M.D., from the Nova Scotia Rehab Centre in Canada, will be the keynote speaker at the celebration. We will provide extensive coverage of the HERL 10th anniversary celebration and advisory board meeting in the next (summer) issue of the newsletter.



VA Chief of Staff Rajiv Jain, M.D. (R) presented Michael Boninger, M.D. (L) with the 2003 VA Stars and Stripes Healthcare Network annual award on February 5th

HERL director Dr. Rory Cooper, Study Coordinator Rosemarie Cooper, Machinist Mark McCartney, and HERL students Emily Zipfel and Jon Pearlman have just returned from Kanpur, India. The team traveled to the Artificial Limb Manufacturing Company (ALIMCO), the largest wheelchair manufacturer in South Asia, as part of a NIDRR collaborative design project. Brig. General (Ret.) Uppal, ALIMCO Chairman and Managing Director, presented the design team with the "Restoration of the Dignity of Man Award" for their work in improving the design of wheelchair and assisting with increasing their manufacturing capacity and quality assurance programs. We will include a feature article about the India trip in the summer newsletter.

We are proud to report many HERL faculty and students achievements and awards since our last update. HERL Director Dr. Rory Cooper was a finalist for the 2004 Pittsburgh Healthcare Hero Award for Innovation and Research. HERL Medical Director Dr. Michael Boninger was promoted to professor with tenure in the De-

partment of Physical Medicine and Rehabilitation with adjunct appointments in the Departments of Rehabilitation Science and Technology and Bioengineering in January. Dr. Boninger was also presented with the 2003 VA Stars and Stripes Healthcare Network Annual Award for outstanding achievement in clinical research in February. The PAVE Africa 7th International Conference on Concrete Block Paving in South Africa bestowed their "Best Paper Award" to HERL for our paper "Interaction of Wheelchairs and Segmental Pavement Surfaces" (Cooper RA, Wolf EJ, Fitzgerald SG, Dobson A, Ammer WA, Smith DR). Student Ana Alegratti was granted travel funding to present her paper, "Pelvic Positioning Evaluation for Wheelchair Selection: A Comparison Between in-person Seating and Video Conferencing," at the 2004 International Seating Symposium in Vancouver, British Columbia. Ana was one of 3 authors chosen to receive travel funding to present at the conference. Finally, HERL student and distinguished athlete Ian Rice, a member of the Pittsburgh Steelwheelers Rugby Team, made the all-tournament team for his classification level and was voted the overall MVP of the Iron Horse Rumble Tournament in Milwaukee in February. The Steelwheelers Rugby team placed second in the tournament.



The Pittsburgh Steelwheelers rugby team placed second in the Iron Horse Rumble Tournament, February 7-8, 2004. HERL student Ian Rice (3rd from left) was voted overall MVP and made the all-tournament team for his classification level.

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Everyone at HERL continues to thank you for your readership and interest and participation in our research. Look for our next newsletter this summer!

-Christine Heiner, newsletter editor

CURRENT RESEARCH ABSTRACTS

Summary: Pittsburgh Wheelchair and Seating Biomechanics Research Program

Rory Cooper, Ph.D., Michael Boninger, M.D., Dave Brienza, Ph.D., Linda van Roosmalen, Ph.D., Alicia Koontz, Ph.D., Ed LoPresti, Ph.D., Donald Spaeth, Ph.D., Gina Bertocci, Ph.D., Songfeng Guo, Ph.D., Mary Ellen Buning, Ph.D., Mark Schmeler, M.S., OTR/L, Mary Jo Geyer, Ph.D., Shirley Fitzgerald, Ph.D., Dan Ding, Ph.D.

Full article published in the **Journal of the Society of Biomechanisms**, Vol. 27, No. 3, pp. 144-157, 2003.

Wheelchairs and seating provide critical functions to millions of people with disabilities. While there have been several important studies and new product designs, progress has been limited by the lack of a consortium of talented and dedicated investigators. The Department of Rehabilitation Science & Technology (RST) in the University of Pittsburgh has made a concerted effort to advance wheelchair and seating biomechanics research. This overview of our research program will help to convey the depth and breadth of the research that has been conducted, as well as to provide some insight into future directions. Two of the increasingly important aspects of our biomechanics research is the translation of research findings into clinical practice while allowing consumer and clinical needs to drive the research agenda, the other is to continue to expand the impact of the studies whether through more comprehensive studies with large sample sizes or through introducing new technologies.

We provided an extensive overview of 12 aspects of our research program:



1. Wheelchair propulsion study
Purpose: to fully understand the mechanics of propulsion and to apply this information in a clinically relevant fashion.

2. Transfer biomechanics study

Purpose: was to identify less strenuous transfer techniques and help individuals with lower extremity dysfunction learn safer and less injurious transferring skills.

3. Modeling and simulation study

Purpose: to understand wheelchair propulsion technique and analyze joint mechanics.

4. Wheelchair driving accident study

Purpose: to investigate proper use or installation of safety systems and adjustment of wheelchairs.

5. Rider comfort and whole-body vibration exposure study

Purpose: to evaluate the vibration exposure for electric powered wheelchair as well as manual wheelchair propulsion over different road surfaces.

6. Wheelchair transportation study

Purpose: to evaluate wheelchair occupant safety during impact and to develop design guidelines occupant restraint systems.



7. Head/neck operated interface study

Purpose: to investigate the feasibility and efficacy of head/neck mounted interfaces.



8. Hand operated interface study

Purpose: to develop an isometric joystick and evaluate it through comparing with position joysticks.



9. Soft tissue analysis and wound prevention study

Purpose: the prevention, evaluation, and treatment of soft tissue pathology.

10. Exercise systems for wheelchair users study

Purpose: to develop interfaces between a computer and a roller system or an arm ergometer, and evaluate the usefulness of these systems to wheelchair users.

11. Wheelchair sports study

Purpose: to investigate wheelchair racing.

12. Clinical application study

Purpose: to deliver the service and clinical components that assess and provide assistive technology interventions to people with disabilities.

Overall, it is our ultimate goal to provide solutions for people with disabilities, their families, and the people who provide products and clinical services.

-Dan Ding, Ph.D.

CURRENT RESEARCH ABSTRACTS

Whole Body Vibration During Manual Wheelchair Propulsion with Selected Seat Cushions and Back Supports

Carmen P. DiGiovine, PhD, Rory A. Cooper, PhD, Shirley G. Fitzgerald, PhD,
Michael L. Boninger, MD, Erik J. Wolf, BS, Songfeng Guo, PhD

Full article published in **IEEE Transactions on Neural Systems and Rehabilitation Engineering**, Vol. 11, No. 3, pp. 311-322, September 2003.

Purpose of Work. The purpose of this study was to determine if the selected wheelchair seat cushions and back supports minimize the transmission of vibrations. **Subjects/Procedure.** Thirty-two wheelchair users propelled over an activities of daily living course three times using sixteen randomly selected seating systems (cushion and a back support) as well as their own seating system. Vibrations were collected using accelerometers at the seat and participant's head.

Results. The weighted fore-to-aft (T_x), vertical (T_z) and resultant (T_r) transmissibility based on the vibrational-dose-value (VDV) were used to determine if differences exist among the seat cushions and back supports while traversing different obstacles. When examining all of the obstacles com-

bined, significant differences among the seat cushions were not observed. Significant differences among the back supports were found when traversing the curb descent, the dimple strip and the rumble strip as well as all of the obstacles combined.

Relevance to Wheelchair Users. Neither a single seat cushion or back support stands out as producing the best or worst results. This may be explained by the diversity in the physical characteristics of the individuals with a disability. The individual may be biased towards the seating system that was most similar to her/his own. In general, the individuals' own seating system is not optimized for reducing the transmission of vibrations, which may increase the individuals' likelihood of incurring a secondary injury (e.g. low-back pain).
-Erik Wolf

Scapular Range of Motion in a Quasi-Wheelchair Push

Alicia Koontz, Ph.D., Rory Cooper, Ph.D., Michael Boninger, M.D., Aaron Souza, M.D., Brian Fay, Ph.D.

Full Article Published in **International Journal of Industrial Ergonomics**, Vol. 33, No. 3, pp. 237-248, March 2004.

Purpose of work: Persons with lower limb paralysis or dysfunction rely extensively on their upper limbs to accomplish daily tasks such as transfers, wheelchair propulsion and pressure relief. Unfortunately, overuse of the upper limbs can lead to shoulder pain and injury. To identify the causes of shoulder pain and injury from overuse, improved methods are needed for studying shoulder function during daily tasks. The purpose of this study was to develop a method to analyze movement of the scapular bone (a.k.a. shoulder blade) during wheelchair propulsion. Because of the inaccuracies in recording scapular motion during fast arm movements, the positions of the scapula were recorded with the hand placed at specified locations along the pushrim, simulating the path traveled by the hand during actual propulsion.

Subjects/Procedures: Eight men and two women with paraplegia participated in the study. Their average age was 40 years and they had incurred a spinal cord injury an average of 16 years prior to this study. Each person was tested in his or her

own manual wheelchair which was secured to a platform. A custom designed device called a digitizing stylus was used to record the positions of the participant's scapula, upper arm and chest as the person placed their hand along marked points on the pushrim of their wheelchair. At each position, the person was instructed to hold still while the data were recorded.

Results: Scapular movements were related to the movements of the upper arm and chest in a simulated push. Using complex regression statistics, a mathematical relationship was developed that enables for determining scapular positions given the known positions of the upper arm and chest during propulsion. The findings provide a deeper understanding of shoulder function during propulsion.

Relevance to the Veteran Population. Understanding shoulder function during wheelchair propulsion is important for developing effective techniques and strategies for preventing injuries.

-Alicia Koontz

RECENT HERL PUBLICATIONS

Schmeler MR, Boninger ML, Cooper RA, Cooper R, Freestyle Seating, **Rehab Management**, Vol. 17, No. 1, pp. 38-42, January/February 2004.

Koontz AM, Cooper RA, Boninger ML, Souza AL, Fay BT, Scapular Range of Motion in a Quasi-Wheelchair Push, **International Journal of Industrial Ergonomics**, Vol. 33, No. 3, pp. 237-248, March 2004.

HERL IN THE MEDIA

Engineering Advantage, Fall 2003:
Page 25: EE Alum Received Prestigious Magnuson Award

Pittsburgh Tribune-Review, December 7, 2003:
Teamwork Key to Robotics Competition



Pictures of HERL featured in:
Traditions of Caring: History of the VA Pittsburgh Healthcare System 1925-2003, p. 10

2003 VA Pittsburgh Healthcare System Annual Report, p. 5 & 8

Disability World, Nov./Dec. 2003:
Wheelchairs for a Small World

Paraplegia News, February 2004:
Pp. 40: Award Winner



CURRENT EVENTS



It's almost time for the **2004 National Veterans Wheelchair Games**, the largest annual wheelchair sports event in the world! Researchers from the Human Engineering Research Labs will be there in St. Louis, MO to participate as well. Visit the NVWG website, <http://www1.va.gov/vetevent/nvwg/2004/> to register, volunteer, or get more information on the games. We're looking forward to seeing you there!

The 2004 Rehabilitation Engineering Society of North America (RESNA) Conference, the premiere conference for people interested in technology and disability, is in Orlando, FL, June 18-24. RESNA encourages rehab engineers, therapists, vocational rehab professional/counselors, suppliers/manufacturers, researchers, educators, assistive technology specialists and program directors, and policy experts and advocates to attend. HERL submitted 35 research papers to this year's RESNA conference.

The UPMC Rehabilitation Hospital and the UMPC-SCI Model Center on Spinal Cord Injury is sponsoring a **Wheelchair Slalom** on Sat. May 1. For more information, please call (412) 420-2504 or e-mail: hullmj@upmc.edu



The 2004 NMSS MS Walk in Pittsburgh is on Sunday, April 18 at the Amphitheater at Station Square. To register to participate in the walk, go to www.nmss-pgh.org or contact Amyjo McDade at (412) 261-6347. Go to www.nationalmssociety.org for information on MS walks in cities all across the U.S.!

If you know of a current event or have an ad that you would like to post in the HERL Quarterly Newsletter, please contact Christine Heiner at (412) 365-4854 or by e-mail at heinercm@pitt.edu

FACULTY PROFILE: Songfeng Guo, Ph.D.

Songfeng Guo joined the Human Engineering Research Labs as a Research Scientist in August 1999 after earning his Ph.D. degree in Biomedical Engineering and Instrumentation from Xi'an Jiaotong University, Xi'an P.R. China. Dr. Guo is also an assistant professor in the Department of Rehabilitation Science and Technology at the University of Pittsburgh. Prior to coming to Pittsburgh, he had researched in the area of biomedical engineering since 1993. Dr. Guo's research interests include biomedical instrumentation design and biomedical signal processing. Dr. Guo has extensive research experience in the rehabilitation science area. He teaches the class Functional Neuromuscular Stimulation to graduate students in the Department of Rehabilitation Science and Technology and supervises HERL students on research projects.

Dr. Guo's expertise in high speed digital electronics and digital signal processing has been instrumental in the design and development of



Songfeng Guo, Ph.D.

assistive devices for many of HERL's research projects. These projects include design of a clinical SMART^{Wheel}, The Characterizations of Reverse Instability in Electric Powered Wheelchairs and the Role of Caster Orientation, Power Wheelchair Crash Study, and the Improvements in Controls for Electric Powered Wheelchairs. He has also collaborated on NIH and VA funded projects Arm Pain in People with Paraplegia during Wheelchair Propulsion and Development of the GAME^{cycle} Exercise System. Dr. Guo also contributed significantly to the electrical design of a remote controlled retractable cane for the visually impaired, a collaborative research project between HERL and the Atlanta VA.

Dr. Guo is a member of RESNA and received an award for his 1998 project: A long-term dynamic multi-parameters monitoring and analyzing system for upper digestive tract.

-Christine Heiner

FEATURED HERL STUDENT: Stephanie Martin



Stephanie Martin

Stephanie Martin worked at the Human Engineering Research Labs in the summers of 2002 and 2003 as an undergraduate intern. She assisted with data entry and file organization for HERL research studies conducted at the National Veterans Wheelchair Games. Stephanie was selected to attend the 2002 games in Cleveland to assist the HERL

team of researchers with data collection and subject recruitment. She graduated with a B.S. in Rehabilitation Science and Technology (RST) from the University of Pittsburgh in April 2003 and joined the lab as a graduate researcher in the fall. Stephanie is working towards a Masters in RST.

Stephanie will begin work soon on her masters

degree project, Dr. Shirley Fitzgerald's research study "Hearing and Service Dogs: An Alternative Assistive Technology." In this study, Stephanie will work either with people with disabilities who use assistive service dogs to aid them with various tasks or with people with hearing impairments who use assistive dogs to act as their "ears." These assistive dogs are trained to alert their owners to respond to important environmental cues, such as doorbells, telephones, fire alarms, or the owners' name. The aim of the study is to determine the functionality and reliability of assistive dogs over other types of assistive devices.

Stephanie submitted a paper entitled "Do Organized Sporting Events Make a Difference for Individuals who use Wheelchairs" to the 2004 Rehab Engineering Society of North America (RESNA) Conference. In her paper, she examines mood and community participation levels among National Veterans Wheelchair Games participants.

-Christine Heiner

HERL Students Participate in 2nd Tech-Link Robotics Camp

The FIRST LEGO LEAGUE (FLL) is a robotics competition, held all across the world, which engages students in robotic design. The ultimate goal is to inspire children to work together as a team and use their creativity and ingenuity to address real world situations and opportunities. Individual tournaments are held all across the world on a local (city), state, national, and international level. One of state-level sites is The National Robotics Engineering Consortium in Pittsburgh, Pennsylvania. Every year this tournament attracts teams, all eager to showcase their designs and take home a coveted Lego trophy, from across the Eastern region.

This year two of the participating teams were sponsored by Tech-Link, a local Pittsburgh company dedicated to helping children with disabilities advance towards careers in math, science and technology. Sondra Balouris Brubaker, executive director of Tech-Link, coordinated the efforts of five graduate students and two staff members from the



Andy Kwarciak (L), HERL student and team mentor, working with Tech-Link team members to build their Lego robot.

from the Human Engineering Research Laboratories (HERL), as well as four undergraduate students from the University of Pittsburgh School of Engineering. Led by Erik Wolf, Andrew Kwarciak, Jon Pearlman, Karl Brown, Stephanie Martin, Don Spaeth and Diane Collins from HERL, the group mentored two teams of eight students from several area middle schools. Adopting the names the Raptors and the Transformers, the teams competed on December 6, 2003 against 65 other teams of similarly aged students with and without disabilities.

The main goal of the competition is to design and program a robot to complete a variety of tasks on the game board. All robots must be built with LEGO pieces and can be programmed with using a variety of software packages. Prior to competition the teams designed their



The 2003 Tech-Link Robotics Teams

robots and practiced completing the tasks within the challenge. This year's challenge was titled 'Mission Mars'. In this challenge, teams were required to perform tasks that astronauts may face on the Red Planet, such as clearing dust a solar panel, launching a sample canister, and freeing a rover from a sand dune. Each successfully completed task earned the team points, based upon the difficulty of the task. Teams tried to complete as many of the nine

tasks as they could within two minutes; some teams actually completed all nine! Overall, the excitement of completing the tasks and the unexpected successes and failures that occurred along the way lead to great amount of energy in competitors and spectators alike.

Based on three rounds of robot competition, the Raptors finished in 31st place closely followed by the Transformers in 32nd place. Also, the Raptors were ranked 7th in

overall robot design. Both teams had their share of challenges, but ultimately, the students enjoyed their experiences both at, and leading up to the tournament. The thrill of competing with a robot they designed and built was undeniable. Many of the students were already talking about next year, and how much better they will do. In addition to having fun and learning about design and programming, the students learned other important life lessons, such as the importance of planning, preparation, and teamwork. It is certain that next year will bring more enthusiasm and excitement from students who are ready to learn and make their ideas come to life, with the help of LEGOs. -Andrew Kwarciak



HERL students Karl Brown (L) and Erik Wolf (R), assisting their team in making their robot perform programmed tasks



HERL student Jon Pearlman and Tech-Link students watch a robot steer itself across the playing field

FEATURED STAFF MEMBER: Mark McCartney

Mark McCartney is a master machinist at the Human Engineering Research Laboratories and senior machinist for the Center for Assistive Technology (CAT) at the University of Pittsburgh Medical Center. The CAT is an assistive technology clinic where clinicians ensure individuals with disabilities receive appropriate assistive devices. Mark is responsible for the CAT Machine Shop, where he fabricates those assistive devices for people who are evaluated at the clinic. He also machines and builds project materials for the University of Pittsburgh's School of Health and Rehabilitation Sciences. Mark has worked for the Center for Assistive Technology since 1994.

Mark also works at the Human Engineering Research Labs 2 days a week, helping students design and build parts and devices for research projects in our Design and Prototyping Laboratory. He serves as an instructor for the HERL machine shop class, HRS 1709: Design/Fabrication with Engineering Materials. Mark has also volunteered his machining expertise to past FIRST competitions, in which HERL engineers worked with high



Mark McCartney, Machinist

school students to build a competitive robot.

Recently, Mark was a key player on the India Chair project team. This project is a collaborative effort between the Indian government and ALIMCO (the largest wheelchair manufacturer in South Asia), NIDRR and HERL to improve their wheelchair designs. Mark was heavily involved in the design and construction of the final India Chair prototype. In February, the final chair prototype was delivered to ALIMCO and the team traveled there to demonstrate the prototype to Indian Spinal Cord

Injury Center therapists and wheelchair users and work with ALIMCO engineers and machinists to begin production on the new design.

Mark completed a four-year machinist apprenticeship program at Contraves Goerz Corporation in 1978 and is vested by the state of Pennsylvania as a Journeyman Machinist. Mark worked as a Machinist and a Precision Mechanical Assembler at Contraves for 20 years, the last 9 years in domestic and international field service. *-Christine Heiner*

HERL WANTS YOU TO SHARE YOUR STORY!



Perhaps you are a person or the family member of a person who uses a wheelchair, a disability advocate, or a clinician or researcher who has an experience to share that would be interesting and beneficial to our newsletter readers. Well, we want to hear from you! HERL is very interested in publishing your "real life" personal stories about living with a disability or supporting and participating in disability research. We're looking for essays anywhere from 250-1,000 words.

This is your chance to speak out! If you are

interested in submitting your personal story, please e-mail me at heinerercm@pitt.edu, or please mail it to me at the following address:

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7180 Highland Drive
Building 4, 2nd Floor East, 151R-1
Pittsburgh, Pa, 15206

If we select your story for publication, we will send you a HERL T-shirt! We're looking forward to hearing about your experiences!

-Christine Heiner

Human Engineering Research Laboratories

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E-mail any comments, corrections, or questions concerning
the newsletter to the editor, Christine Heiner at:
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Wheelchairs and Associated
Rehabilitation Engineering

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ARE YOU INTERESTED IN WHEELCHAIR RESEARCH?

The Human Engineering Research Laboratories is recruiting individuals interested in participating in research studies for the **WHEELCHAIR USERS REGISTRY**. If you would like to be notified of Wheelchair related Research Studies for which you may be eligible to participate, contact The Human Engineering Research Laboratories and join the Wheelchair Users Registry. This is an informational resource and notification of a study does not obligate you to participate. You do not need to be located in nor are you required to travel to Pittsburgh in order to participate in research studies. If you are at least 18 years of age, and use a wheelchair or scooter, please contact **Rosi, Annmarie, or Amy**, for more information.

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