Annual Report 2017 - Highlights

Human Performance Lab

Human Performance Laboratory

The Year 2017

The Human Performance Laboratory (HPL) in the faculty of Kinesiology at the University of Calgary was founded in 1981 by Dr. Benno Nigg. In the now 37 years of its existence, the HPL has been involved in, and has organized, some exciting international events. We hosted an international contingent of leading sport scientists for the 1988 winter Olympic games. We provided support for these researchers, actively participated with our own projects, and built the infrastructure for some unique measurements, such as an in-house-developed force platform system to measure the take off forces in ski jumping.

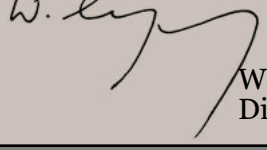
Other highlights include the hosting of the 1999 conference of the International Society of Biomechanics (ISB) and the 2002 World Congress of Biomechanics (WCB), held in conjunction with the meetings of the Canadian and American Societies for Biomechanics. These events attracted thousands of researchers, provided a forum for international exchanges, and allowed us to showcase Calgary, the university, and of course the Human Performance Lab. Who could ever forget the Wartenweiler Memorial Lecture at the 1999 ISB conference, featuring the undisputed leader in muscle physiology/mechanics, Nobel Prize winner, Andrew Huxley. At the age of 82 he challenged us all in our thinking, and was likely the most active participant throughout the entire conference. Or Steven Chu, Nobel Prize winner in physics, who gave a memorable keynote address at the WCB 2002 conference, introducing us to LASER trapping of isolated molecules for the purposes of unraveling the mysteries of protein mechanics, which turned out to be crucial in my own research on “titin” properties.

However, and most importantly in my mind, international events, such as the Olympic games in Calgary, and hosting the premier international conferences in our field with thousands of participants from all parts of the globe, provide a common goal. It reminds us of what is important, everybody pulls in the same direction, and it brings out a collegiality, a generosity, a bond, that otherwise would not exist. Big events let us set aside the little quibbles and worries of everyday work and life. A bigger picture emerges, and everybody wants to help and be part of it.

In 2019, we will again be hosting the biggest and most important international scientific gathering of biomechanics researchers: the 27th Congress of the International Society of Biomechanics, in conjunction with the Conference of the American Society of Biomechanics (www.isb2019.com). The Conference will be held at the Calgary Convention centre from July 31st to Aug 4th, 2019. It is another opportunity for us to be host to the world, and we are embracing it. It is another opportunity for the HPL to pull on one string and produce that magic that happens when a big event has first priority, and all our mundane, every day worries disappear.

I cannot wait to welcome you all to ISB/ASB 2019, to Calgary, and to the HPL.

My big thanks and great appreciation go to all of you who have supported us in all our endeavors, the sensible endeavors and the crazy ones; you are our friends, colleagues, sponsors, the University of Calgary, and the Faculty of Kinesiology.



Walter Herzog
Director

UNIVERSITY OF CALGARY

The full version of the annual report can be found at www.ucalgary.ca/hpl

Awards and Honors

Members of the Human Performance Laboratory and the Sport Medicine Centre that were honored for their scientific contributions:

Internal Awards

Vinzenz von Tscharner	RJC Faculty Award
Eng Kuan Moo	RJC Post Doctoral Fellow Award
Jordyn Vienneau	RJC Staff Award
Jodi Nettleton & Colin Firminger	RJC Student Award
Reed Ferber	Teaching Award for Educational Leadership
Carolyn Emery	Distinguished Acheivment Award, Cumming School of Medicine

External Honors

Walter Herzog	Muybridge Career Award, International Society of Biomechanics
Walter Herzog	Geoffrey Dyson Career Award, International Society of Biomechanics in Sports

Special Appointments

Brent Edwards	Secretary General, International Society of Biomechanics
David Hart	Co-Chair, Human Space Flight Consultation Committee, Canadian Space Agency
Arthur Kuo	Tier I Canada Research Chair, Biomaterials Neuromusculoskeletal Biomechanics

External Awards

Ziad Abusara	Meniscus Section Member Poster Award, Orthopaedic Research Society
Michael Asmussen	Sport Performance Research Award Presented by Under Armour
Kyla Coates	M.Sc. Poster Award, Canadian Society for Exercise Physiology Annual Conference
Colin Firminger	Peter Cavanagh Award for Basic Research presented by Nike
Teja Klancic	Best Poster Award. Canadian Obesity Summit
Maurice Mohr	E.C. “Ned” Frederick Young Investigator Award, sponsored by Li-Ning
Heather Paul	American Society for Nutrition’s Emerging Leader
Robert Souron	Young Investigator Award, Congrès International de l’Association des Chercheurs en Activité Physique et Sportive

Support

Our work was financially supported by many different sources, the University of Calgary, Government Grants, Industry and Non-Government Sources and External Student Support. The corresponding amounts in Canadian dollars were:

University	$4.4M	39%
Gov. Grants	$3.2M	29%
Industry	$2.5M	22%
Ext. Students	$1.1M	10%
Total	**$11.1M**	

For 2017, the average research dollers available per faculty member, was about $651,077. We would like to thank all supporters of our work, the Faculty of Kinesiology, the University of Calgary, all Granting Agencies, Industry and our major sponsor, Engineered Air.

Biomechanics Conference

International Society of Biomechanics

We are pleased to announce that Dr. Walter Herzog has been named chair of the 27th meeting of the International Society of Biomechanics. The conference will take place at the Telus Convention Centre in Calgary, Alberta, July 31 - August 4, 2019.

Functional Threshold Power

Exercise training is critical for performance. However, even though we all agree that optimizing the training load is important, assigning adequate intensities of exercise to a training session is not always a straightforward task. To achieve this goal, different approaches are commonly used.

In cycling, the concept of critical power (CP) has become of paramount importance. It theoretically demarcates the upper boundary of exercise that can be sustained for a prolonged period of time while maintaining a physiological steady-state (i.e., elevated but stable oxygen consumption (VO_2) and blood lactate concentration ([La])). This CP value should coincide with the physiological "gold-standard" for measuring this upper limit of metabolic stability, known as the maximal lactate steady-state. Research conducted in Dr. Juan Murias laboratory, in collaboration with Dr. Passfield (University of Kent), and executed by Felipe Mattioni Maturana and Danilo Iannetta, has shown that the concept of CP, although theoretically appealing, has limitations. Depending on the model selected to predict CP, this upper limit of sustainable exercise can vary by a power output (PO) of ~30 W. Such a large variation in PO is unacceptable for predicting sustainable performance and assigning adequate training intensities for the cyclists.

Another measure commonly used by cyclists is the 20-minute functional threshold power (FTP) test, which has recently become a popular tool among cyclists. 95% of the mean PO derived from the FTP test (FTP95) is said to represent the highest power output with elevated but stable VO_2 and [La] (i.e., CP and/or MLSS). Despite its popularity amongst cyclists, little is known about the physiological basis and validity of this test. Research conducted by Calaine Inglis has shown that the PO at MLSS actually corresponded to 88±5% of the mean PO from the 20-minute FTP test. The study revealed that the FTP95 highly overestimates the PO at MLSS, which indicates that prescribing exercise intensities based on this test would have severe limitations.

Interestingly, another study from our laboratory has shown that individuals are capable of self-selecting POs that are in line with the upper limit of metabolic stability (i.e., MLSS) with more accuracy than laboratory derived measures of CP. This is an interesting concept because it highlights the relevance of perception of effort, in addition to other physiological and mechanical markers of intensity and performance.

In today's world, athletes have access to technological devices that allow for easy and economical measures of PO, heart rate, tissue oxygenation, and other physiological markers of intensity. How we use that information to improve exercise testing and prescription is a challenge for the near future.

Where are they now?

Geng Luo has always been fascinated by athletic footwear designs. From an early age, he called himself a sneakerhead. But it wasn't just how they looked that held his attention. He has always been obsessed with the science and technology behind them. By the time he moved from his native China to North America, Geng had already contacted a designer at Nike and created a plan for his own career. A plan which included a job at Nike.

After completing a Bachelor degree at the University of Waterloo, Geng came to Calgary to pursue a PhD in the HPL with Dr. Darren Stefanyshyn. It was all part of his plan. Being in the HPL, and in Dr. Stefanyshyn's group, brought him into contact with researchers from various shoe companies. One of the people he met was Matt Nurse, an HPL alumnus and now Vice President, Nike Explore Team Sport Research Lab. Once Geng completed his PhD, he was able to secure his dream job – a researcher for Nike, on Matt Nurse's research team. Today, Geng leads a team at the Nike lab, focusing on running footwear research.

Recently, Geng was instrumental in helping to design a shoe for a runner with cerebral palsy. This young athlete had set a goal of completing a half marathon in under two hours. Geng studied his gait and created a shoe that provided extra support and cushioning in specific areas. The shoe was also reinforced in key areas and provided extra stability.

Over the last few years, Geng had been part of the team that worked on Breaking2; Nike's push to break the two hour barrier for running the marathon distance. Geng was key in the creation of the Vaporfly series. He and his team brought years of scientific insights in the field, including a lot generated at the HPL, to this design. The shoe looks and feels counter-intuitive as a marathon 'racing flat', but delivered a 4% improvement in running economy. The Vaporfly series took the industry by storm, and went on to be used by many athletes to win major marathons. It inspired many Nike running shoe designs, and according to Geng, this is just the beginning. In fact, Eluid Kipchoge just shattered the old record for a marathon run, by 78 seconds, while wearing the Vaporfly shoe.

Geng is always grateful for all the help he got along the journey, especially during the time he spent in the HPL. He has a simple philosophy - be helpful to others doing what he enjoys doing, and at moments of uncertainty, "just do it". How appropriate that he works for Nike.

Introducing

Dr. Tyler Cluff's laboratory studies the human sensory and motor systems. We are interested in how the central and peripheral nervous systems work together with the body to produce skilled actions. Our work is based on a multidisciplinary approach that integrates behavioural experiments, neurophysiological methods, and computational models. The lab is interested in how humans use sensory information from their eyes, skin and muscles to select, plan and control voluntary movements. An emerging interest is how neurologic injuries, diseases, or disorders degrade sensory feedback, its transmission, and/or processing in the cerebral cortex, and how this can cause movement impairments. Our efforts have been focused on understanding: 1) basic mechanisms and processes that support human movement, and 2) how they shape motor learning outcomes in healthy adults, and individuals with neurologic diseases (e.g., stroke) or injuries (e.g., concussion). Potential applications include sensitive assessments to monitor sensory and motor function, and rehabilitation efforts that target motor control and learning impairments in clinical populations.

Dr. Art Kuo's laboratory studies the mechanics, energetics, and control of human locomotion and movements. Research in locomotion includes studies of why and how walking requires metabolic energy, and how energy expenditure may be influenced by assistive or rehabilitative devices. Applications include development of prosthetic and orthotic devices for the impaired, and assessment of the energetic demand to carry extra loads or walk on uneven terrain. The laboratory also examines how humans control their movement using sensory information from vision, inner ear balance organs, and other physiological sensors within the body. These sensors are degraded by injury, disease, or age, and can affect ability to balance, walk, and perform daily activities. Applications include assessment of mobility with aging, and methods for training for improved balance in the impaired. The laboratory has also developed methods to extract biomechanical data from body-worn devices, and gain detailed mobility data during daily activities.

Dr. Ryan Peters's laboratory studies the neural control of movement by recording directly from sensory receptors and motorneurons in awake behaving humans. Currently, they are investigating fundamental aspects of muscle spindle receptors, which detect stretching of the muscles, and cutaneous receptors, which detect skin pressures, vibrations, and stretches as we move around the world. Their focus is on understanding how exactly this sensory information shapes muscle activation patterns, particularly for the case of active, goal-directed movements like reaching to targets or maintaining a particular posture of the arm in the face of mechanical perturbations. Dr. Peters is also applying the knowledge derived from these experiments to develop new biomarkers that assess the extent of damage and track plastic changes over rehabilitation by measuring functional neural connectivity along important sensorimotor pathways – spinal reflex pathways, corticospinal pathways, and somatosensory pathways – in cerebral palsy patients and individuals that have suffered a stroke.