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HPER Biomechanics Laboratory 2006 Annual Report, Issue 5

Nebraska Biomechanics Core Facility
University of Nebraska at Omaha

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Director's Message



Another exciting year in our laboratory has passed. Several domestic and international visitors have toured our facilities and collaborated with our research team. Our annual report is designed to give you a brief look at who we are and what we do. We hope that after reading about us that you will want to come to the HPER Biomechanics Laboratory and visit us in person as well.

Our laboratory was established for the purpose of developing a new understanding of the dynamical aspects of human movement. Following Nebraska and National initiatives, the laboratory is interdisciplinary in nature. Our flourishing enterprise features engineers, mathematicians, scientists, surgeons, and clinicians exchanging ideas to gain additional insights on healthy and abnormal movement patterns. Our laboratory has earned a national and international reputation of excellence in basic and clinical research. Using techniques from biology, engineering and mathematics, we have revolutionized the way we perceive how the neuromuscular system controls human movement. Our success often leads us to new opportunities to advance the laboratory's research initiatives. Unfortunately these opportunities require funding beyond allocations provided by the state.

We continually pursue and frequently receive grants that support our research efforts. You will read about many of these awards on the following pages. While this funding is critical, charitable gifts from individuals, such as you, also are vital to advancing our work. Private support, for example, further enables us to:

- purchase upgraded equipment and new technology,
- attract and retain outstanding faculty and graduate students,
- fund a laboratory addition to alleviate the current shortage of research and office space.

To learn more about how you can support the important work of the HPER Biomechanics Laboratory, turn to page 18. Your gift will make a difference — enhancing our scientific pursuits and ultimately helping improve the lives of those we serve and beyond.

Thank you for your consideration.

Nick Stergiou, PhD

Dr. Nick Stergiou
Isaacson Professor and
Director of the HPER Biomechanics Laboratory

Co-Director's Message



Last year you read how I enthusiastically embraced this position. I continue to explore the many facets of our diversity. Our lab has grown with the addition of two-post doc research assistants. Their addition has helped to focus our efforts on five grants. With focus comes progress. Enjoy this report of our growth.

Shing-Jye Chen, PhD

Dr. Shing-Jye Chen
Co-Director of the HPER Biomechanics Laboratory

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Peripheral Arterial Disease and Geriatrics Research Update



Peripheral arterial disease (PAD) is a debilitating disease affecting 8 to 12 million people in the United States. The most common characteristic of this disease is the hardening and narrowing of the arteries in the legs. PAD patients develop increased pain in their legs when they walk for more than a block or even up a slight incline. As they walk, their leg muscles need more blood. Since their blood vessels are partially blocked, oxygen doesn't reach their working leg muscles which results in pain. Persons with PAD experience limitations of daily activities including impaired balance, increased risk of falls, poor health outcomes and physical dependence. These limitations are more pronounced in the elderly leading to falls, nursing home placement and subsequent loss of functional independence. The HPER Biomechanics laboratory realizes the debilitating nature of this disease and is working with physicians from the University of Nebraska



Medical Center (UNMC) and the Veterans Affairs Hospital of Omaha (VA-Omaha) to study the pathology of PAD. The HPER Biomechanics Lab requested and received a dedicated parking stall for our PAD patients to use during testing.



**Jason Johanning, MD
Jahnigen Award**

Dr. Jason Johanning received the 2006 Dennis W. Jahnigen Career Development Scholars Award from the American Geriatrics Society to evaluate gait and balance abnormalities in elderly PAD patients here at the HPER Biomechanics Laboratory. In this award, Dr. Johanning receives focused mentorship from Dr. Stergiou to explore the biomechanics of PAD in elderly patients. This grant is a two-year award for \$150,000 and is intended to assist young faculty in initiating and sustaining a career in research and education in the geriatrics aspects of their discipline.

Dr. Johanning, along with Dr. Iraklis Pipinos and Dr. Thomas Lynch are collaborators from the Department of Surgery at UNMC and the VA-Omaha. These physicians play an integral role in recruitment, screening, treatment and follow-up of patients for the study. Once the patients are recruited, our personnel are responsible for evaluating the patients' gait in our lab. The patients are grouped together by treatment, which includes surgery; medication and a conservative treatment (i.e. exercise). By using our specific biomechanical measures, we are able to identify differences between treatment

methods that previous research has been unable to find. So far, we have determined that PAD patients do have an altered gait pattern compared to healthy controls. More specifically, their gait pattern revealed a change, which affects the ability of patients to push off properly during walking. Interestingly, these changes are already happening prior to patients experiencing pain. This past year we were able to present preliminary research findings to PAD researchers Dr. Andrew Gardner and Dr. Gregory Landry, who came to our facilities. They both expressed great enthusiasm for our work.

Biomechanics Lab Co-Director, Dr. Shing-Jye Chen, and graduate students Jessie Huisinga, Sara Myers and Matija Radovic are the HPER Biomechanics Laboratory personnel working on this project. Jessie Huisinga received her BSE in Biomedical Engineering from the University of Iowa. Sara Myers received her BS in Exercise Science from UNO. Matija Radovic received his BS from the University of Belgrade, Serbia. All three are currently pursuing MS degrees in Exercise Science.

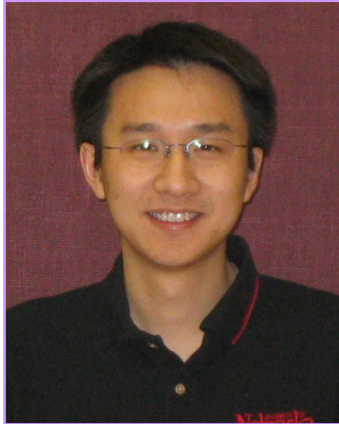


**Thomas Lynch, MD & Iraklis Pipinos, MD
Vascular Surgeons at UNMC**

Lab Expands with New Personnel

With the increase of our reputation, we had many requests from graduating doctoral students to work with Dr. Stergiou. During 2006, two exceptional scientists were admitted by Dr. Stergiou to work in our laboratory in the position of Post-Doctoral Research Assistant.

Dr. Joseph Ka-Chun Siu was born and raised in Hong Kong. Dr. Siu obtained his BS in Physical Therapy from the Kaohsiung Medical University, School of Rehabilitation Medicine in Taiwan ROC in 1999 and became a Registered Physical Therapist. In 2001, he began his doctoral studies in motor control and learning at the University of Oregon in the Department of Human Physiology. While at Oregon, he was a Graduate Teaching Fellow, Instructor, Graduate Research Fellow and Webmaster. His dissertation focused on how cognitive functions affect balance during obstacle crossing in healthy young, healthy elderly and elderly with balance impairments. He found that when elderly switch their attention between two tasks while walking, it significantly affects the stability of their gait. After receiving his doctorate in August of 2006, Dr. Siu immediately began working as a Post-Doctoral Research Associate for the HPER Biomechanics Laboratory. His duties include being the Project Leader for Robotic Surgical Tools, Instructor, Journal Club leader, grant writer and webmaster. His post-doctoral project is to discover and refine motor learning tasks for beginning surgeons to acquire proficiency in the use of the Da Vinci Robotic Surgical System. He is especially interested in developing appropriate training protocols to optimize surgical proficiency to perform robotic surgery. Dr. Siu has already presented this research work at the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), redesigned our website, and taught our Motor Control class, among other responsibilities.



Dr. Joseph Siu

Dr. Leslie Decker comes to us from France. She received her BS from the University of Very Val-d'Essonne in Evry France and her MS and PhD from the University of Pierre and Marie Curie in Paris France. During her collegiate studies, Dr. Decker was a national level athletic (400-m and 800-m races) competitor as well as a Graduate Teaching Assistant. Her love of running inspired her research topic. Her PhD dissertation compared the motor behaviors adopted by runners with different levels of expertise to determine possible performance differences these individuals have and to identify the motor performance characteristics involved in high level sprinting. Dr. Decker used novel, advanced mathematical methods to reveal significant functional differences and similarities among locomotor cycles. The French Athletics Federation and the Ministry of Youth and Sport financed this study. In August of 2006, Dr. Decker arrived in Omaha while still preparing for her dissertation defense. On October 26th 2006, she successfully defended her dissertation. Dr. Stergiou attended as a reviewer of her Dissertation Committee. At the HPER Biomechanics Laboratory, she is the Project Leader for the Gait-O-Gram™ Biomedical Device, part of the virtual reality group, Instructor and grant writer. Her background in statistical and mathematical algorithm applications on human movement becomes her stepping-stone as she launches into new research. Her post-doctoral project will investigate the effects of attention and visual information on the variability of gait. To achieve this she will conduct human experimentation using partial body weight support and virtual reality environments.



Dr. Leslie Decker

Labor on NIH grant is, “Gratifying labor” states Dr. Stergiou.

Since receiving a five-year, \$577,182 K-25 Mentored Quantitative Research Career Development Award from the National Institute of Child Health and Human Development of the National Institutes of Health, Dr. Stergiou has been busy. This is the second year of the grant, which also frees him from teaching regular classes. Free to study, meet with mentors, attend lectures, write, supervise the lab, analyze data, advise students, hunt for funding, and disseminate findings in lectures and at conventions. These activities are part of his nearly continuous work cycle. The purpose of this award is to help quantitative scientists, like Dr. Stergiou, re-focus their professional interests onto biomedical and behavioral research.



Two infants with motor development delays, during sitting.

Each semester he meets several times with three mentors in Omaha. First, he meets with his primary mentor Dr. Jeffrey French, University of Nebraska at Omaha - Psychology, who teaches him basic behavioral research. Next, he meets with his co-mentor, Dr. Bradley Schaefer, of the University of Nebraska Medical Center – Pediatrics, who serves as Dr. Stergiou’s guide in applied clinical pediatrics. Dr. Schaefer is also the Chief of Medical Genetics at the Munroe-Meyer Institute for Genetics and Rehabilitation. He meets with his consultant Dr. Jack Heidel, the chair of UNO’s Mathematics Department. Dr. Heidel assists him in his efforts in applying chaos and nonlinear mathematics to clinical pediatrics. Finally, a couple of times a year, he meets with his frequent collaborator, Dr. John Jeka at the University of Maryland. Dr. Jeka is the Director of the Cognitive

Motor Neuroscience Laboratory, which has been investigating human postural control for over 10 years. In 2006, Drs. Stergiou & Jeka met during the Neuroscience meeting.

During the fall of 2006, Dr. Stergiou began the first of his formal classes. He signed up for Developmental Psychology with Dr. Juan Casas. Together they quickly decided that with Dr. Stergiou’s schedule, mentoring sessions would be better. Dr. Casas was so pleased with his advanced student’s knowledge of the subject and progress, he asked Dr. Stergiou to give two lectures on Motor Development. He also attended lectures, such as the “Grass Foundation Lecture” at Boys Town National Research Hospital to make new contacts and possible collaborations in pediatric research.

All of these activities has helped him to focus his efforts on infant motor behavior and neurophysiology in a clinical setting. This change of focus has been noticed at national conventions. His poster presentation, *Nonlinear measures of neuromuscular control of sitting posture in infants*, at the Society for Neuroscience’s annual meeting in Atlanta received enormous positive feedback. He and his team were also successful at the NASPSPA and ASB annual meetings.

This NIH award compliments his award from the National Institute of Disability and Rehabilitation Research (NIDRR). Once again, the Monroe Meyer Institute, under the direction of Dr. Wayne Stuberg and with the support of their experienced physical therapists Regina Harbourne and Stacey DeJong, will facilitate his research experience. He is exploring how typically developing infants develop the ability to sit upright. In conjunction with the K25-award, this team is looking for infants possibly having benign congenital hypotonia for this study.



Dr. Stergiou, Regina Harbourne and infant on KETV News, *Healthwatch*.



For the project below, we are in need of infants developing typically (at age 4 months) and infants who are at risk/diagnosed for cerebral palsy, ages 5 months to 2 years. If you know of a baby that falls in this category and would like to participate, please contact Reggie Harbourne (559-6415 or rharbour@unmc.edu) or Lisa Holst (554-3075 or lholst@mail.unomaha.edu) for additional information.

Infantes que se han desarrollado típicamente (4 meses de edad) e infantes que están en riesgo o han sido diagnosticados con parálisis cerebral (5 meses a 2 años de edad) son necesitados para un estudio que investiga el desarrollo de la habilidad para sentarse de los infantes y el efecto obtenido por el tratamiento de terapia física. Se ofrecerá el cubrimiento de gastos de viaje hacia la clínica.

Llame a Ann Goehring, al teléfono 321-9141 para más información en español.

Federal Grant on Cerebral Palsy: Joint Venture Demonstrates Progress

Researchers at the University of Nebraska at Omaha and the University of Nebraska Medical Center have developed a new method for studying sitting skills in infants. Researchers want to better understand development of sitting in infants, and to identify whether physical therapy or an in-home program provides a better outcome for infants who are having difficulty learning to sit, such as infants with cerebral palsy or hypotonia. The U.S. Department of Education and the National Institute on Disability and Rehabilitation Research fund the study. Dr. Stergiou and his colleagues from the Munroe-Meyer Institute, Reggie Harbourne and Dr. Wayne Stuberg, are beginning the third year of a three-year \$450,000 grant titled "Investigation of the dynamics of development of sitting postural control in infants with cerebral palsy." Sitting is something an infant typically achieves at six or seven months. If that ability is not achieved, standing and walking can also be significantly delayed. Sitting also frees up an infant's arms so they can explore, play and learn. Research has linked the ability to sit to improved eye-hand coordination of infants.



**Wayne Stuberg and Regina Harbourne
Munroe-Meyer Institute colleagues**

To monitor their progress, infants come to the clinic and sit for a few minutes on a platform. The platform can measure subtle shifts in weight that occur as they maintain balance. The regularity of these weight shifts provides important information about the infants' ability to control movement. The process is fun for the infants - they are entertained the whole time with toys, which encourages them to stay seated and attentive. While they sit and play, they are helping researchers understand the incredible process of control of movement. Both healthy infants and developmentally delayed infants are participating in this innovative study. Developmentally delayed infants receive therapy either once or twice weekly with experienced therapists for a period of eight weeks.

In the past year, this study was featured several times on Omaha television newscasts and on *Community Health Line* with Tom O'Conner. Preliminary results from this project were presented to the scientific community at several meetings in 2006, including Neuroscience 2006, the annual meeting of the North American Society for Psychology of Sport and Physical Activity, and the American Society of Biomechanics Annual Meeting.



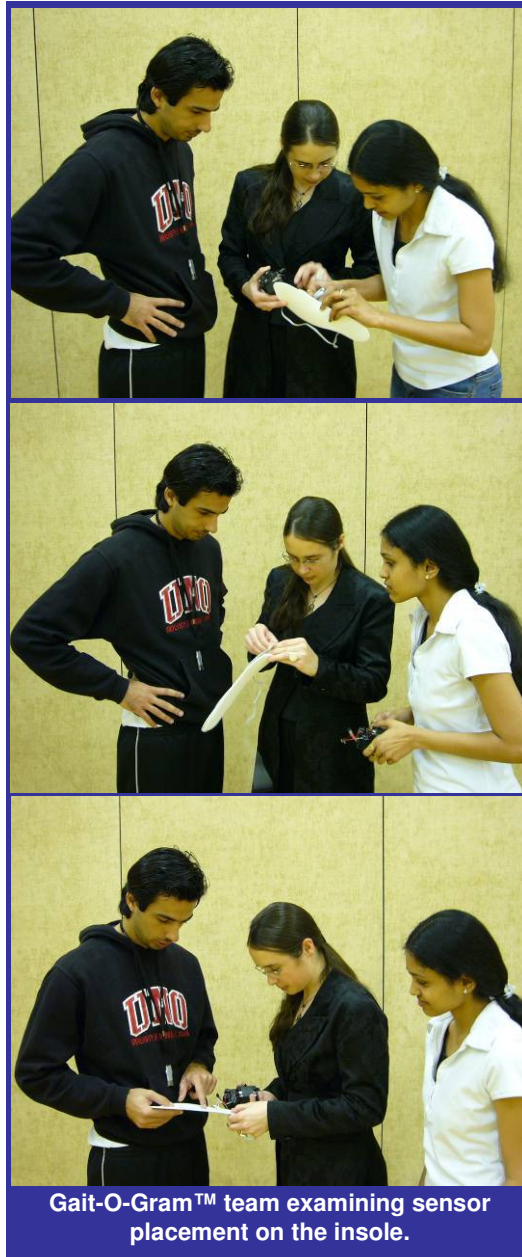
Typical sitting activity.

Working with Dr. Stergiou on this project are graduate research assistants Joan Deffeyes, MS and Anastasia Kyvelidou, MS. Joan received a MS in Mechanical Engineering from Stanford. Anastasia received her MS in Exercise Science from the University of Nebraska at Omaha. Both Joan and Anastasia are currently pursuing their doctorate under the direction of Dr. Stergiou.

Evolution of Wireless Gait Analysis

Since the Gait-O-Gram™ entered the patent process in 2005; it has evolved from the Gait-O-Gram™ 1.0 to the Gait-O-Gram™ 3.0. The original model had wires going from the person's insole up to their waist, connecting to a large data gathering device in a fanny pack. Now, the Gait-O-Gram™ 3.0 is not only smaller - it is *wireless*. The continued development of the Gait-O-Gram™, a portable, wearable biomedical device, has successfully progressed this year with support from the Nebraska Research Initiative. The device, modeled after the Holter monitor, which provides long-term assessment of the heart's performance, allows for rapid assessment of gait parameters over long periods of time. In order to create a device that is capable of producing similar measures for a person's walking performance, the Gait-O-Gram™ has gone through significant advances to evolve into a wireless device that is capable of transmitting information about a person's gait to remote locations. Clinicians such as physical therapists, neurologists, and orthopedists can then assess an individual's walking parameters to determine what effect a pathological condition may have. With the addition of the wireless technology of the Gait-O-Gram™, it will be possible for the clinician to receive and interpret the patient's gait information at any time using the custom, non-linear analysis software programs that have been created to analyze the gait data. These programs provide the ability to investigate a large number of steps and identify changes that may occur due to disease. These latest

improvements make our prototype much more attractive to venture capital.



Gait-O-Gram™ team examining sensor placement on the insole.

The advances noted above, resulted in an extension of funding for a third year from the Nebraska Research Initiative for \$83,079 under the title: "A Biomedical Device for Prognostic and Diagnostic Measures of Pathological Locomotive Bio-Rhythms". These funds will help to continue the development of the wireless technology for the Gait-O-Gram™. This grant also provides funding for Drs. Foster (UNL-engineering), Matache (UNO-math), and Heidel (UNO-math), who have all contributed expertise to the advancement of the project. In addition, we are forming new collaborations with Drs. Burnfield (Madonna Rehabilitation Hospital), Ci (UNL-engineering), and Nguyen (UNL-telecommunications) due to their specialized expertise and interest in this project. The HPER Biomechanics Lab graduate students involved in this project are Jessie Huisinga, MS, Hitika Tanwar, MS, Naomi Kochi, MS, Dimitrios Katsavelis, MS, and Navya Pandiri, BS. Hitika received her BE in Electronics and Communications from the

University of Rajasthan and is receiving her MS in Telecommunications from UNL. Naomi received her MS in Mathematics and is pursuing her PhD in Psychobiology from UNL. Dimitrios received his MS in Exercise Science from UNO and is pursuing his PhD in Biomedical Sciences from UNMC. Navya received her BT in Electronics and Communications Engineering from Jawaharlal Nehru Technological University in India and is pursuing her MS in Telecommunications from UNL.

Innovations of Robotic Assisted Surgery Research



The daVinci™ Surgical System in use.

Laparoscopy is a minimally invasive surgical technique that has been an invaluable tool for diagnosing abdominal diseases. It can be performed using manually operated graspers. It can also be performed using robotic surgical systems such as the daVinci™ Surgical System from Intuitive Surgical. The novel abilities of robotic systems, such as precision and efficiency, have recently received great attention.

However, methods for training surgeons in robotic laparoscopy have not been established. Doctoral Graduate Tim Judkins, under the direction of Dr. Nick Stergiou, addressed this problem while heading the laboratory's efforts on this project during the 2005-

2006 school year. He proposed various research projects performed by our laboratory in conjunction with medical doctors from the University of Nebraska Medical Center. Consequentially, we have been able to identify several parameters that can be used to judge proficiency in robotic surgery. From these findings, Dr. Judkins has published two articles and has presented several abstracts. After leaving his position here, he went to the University of Maryland as a Post-Doctoral Fellow.

Two years worth of research were presented at the following national conferences during 2006: the American Society of Biomechanics, the Society for American Gastrointestinal and Endoscopic Surgeons, the IEEE Conference on Rehabilitation Robotics, and at the Medicine Meets Virtual Reality Conference. Moreover, some of the research outcomes are published in Surgical Endoscopy and other clinical journals.

The HPER Biomechanics Lab is also participating in the Center for Advancement of Surgical Technology (CAST). CAST is a collaborative effort between UNO, UNMC, and UNL to facilitate interaction and collaborative research between surgeons, physicians, life scientists, engineers, and computer scientists specifically interested in contributing to work on the advancement of surgical technology. Currently, this collaboration has resulted in several patent-pending technologies. Work continues on other devices. Current CAST members are Dr. Dmitry Oleynikov (UNMC), Dr. Shane Farritor (UNL), Dr. Susan Hallbeck (UNL), Dr. Stephen Platt (UNL), Dr. Nick Stergiou (UNO), and administrator Marsha Morien (UNMC).

Our current objective is to develop feedback techniques, which will improve the surgeon's performance and a virtual reality training simulator. Our work is supported by funds from an ongoing Nebraska Research Initiative with Co-Investigators Drs. Dmitry Oleynikov and Nick Stergiou. Their ultimate goal is to develop an international certificate program for surgeons training in robotic laparoscopy administered here in Omaha. Our new research scientist, Dr. Joseph Siu, is heading the laboratory's efforts toward this project. He leads a multidisciplinary team of graduate students: Bernadette Brown-Clerk, BE, Dimitrios Katsavelis, MS, and Irene H. Lee, MS.

Bernadette Brown-Clerk received her BE from the Rose-Hulman Institute of Technology and is pursuing both her MS and PhD in Biomedical Engineering from UNL. Dimitrios Katsavelis has a BA from the Aristotle University of Thessaloniki, and his MS from UNO. He is pursuing his PhD through the Medical Science Interdepartmental Area (MSIA) Graduate Program through the University of Nebraska Medical Center (UNMC). Irene Lee received her BS in Computer Science and Mathematics from the University of Nebraska at Omaha and her MS in Mathematics from UNO. She has applied for admission to the MSIA program at UNMC. All three students are pursuing further studies under the guidance of Dr. Nick Stergiou.

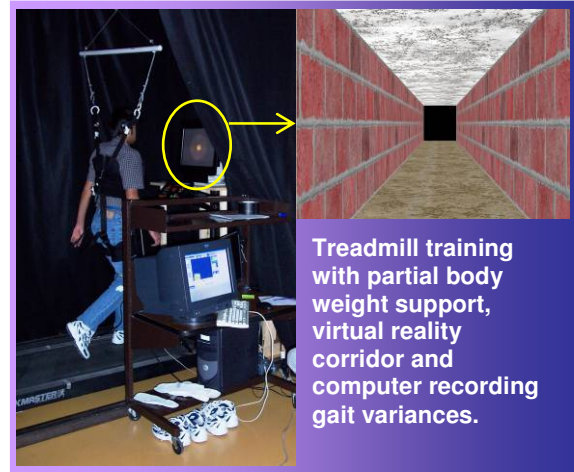


Needle threading training task.

Incorporating Virtual Reality

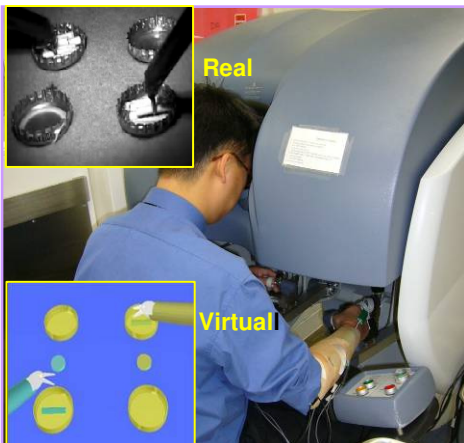
We are currently working on two projects that utilize a virtual environment to accomplish different goals: rehabilitation and training. The Gait-O-Gram™ incorporates a virtual environment to use with rehabilitation. The Robotic Surgical Tools grant incorporates a virtual environment for eventual use as a training and evaluation tool for beginning surgeons.

To address our first goal, we created a virtual environment that combines a body weight support system and a treadmill to simulate walking in real life. The long-term goal is to have a person with gait disturbances walking in a safe and pleasant environment as part of their rehabilitation regime. The present form of our virtual environment contains a walking pathway, which looks like a real life corridor. Our virtual environment gives the clinician the ability to manipulate various components of the environment by clicking specific buttons on the computer keyboard. Altering the texture mapping varies the user's panorama from a real life corridor to forests, athletic environments, walking on the street, and other scenes. Another interesting feature is the spatial manipulations of the environment. By perfectly matching the inclination and the speed of a motorized treadmill with the virtual environment, we can simulate uphill and downhill walking, as well as other movements used in daily living.



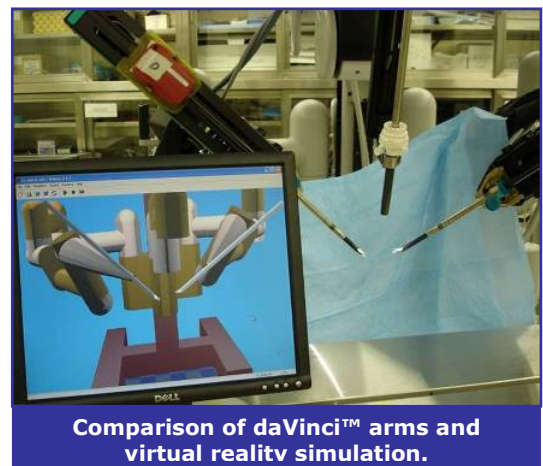
Treadmill training with partial body weight support, virtual reality corridor and computer recording gait variances.

In conjunction with the Robotic Surgical Tools grant, we built a virtual stereoscopic robotic simulator based on movement information gained from surgeons using the daVinci™ Surgical System from Intuitive Surgical. Our virtual simulator has the ability to manipulate virtual objects in training situations. Surgeons in training will be able to practice in our virtual simulation prior to performing an actual surgical procedure. The simulator can also serve as an objective tool for evaluation. In the robot simulation, the video image replaces the endoscopic camera image normally seen by the daVinci operator. Our ultimate goal is to establish the University of Nebraska as a national center for training in robotic laparoscopy. We envision developing an international training program to certify surgeons trained in robotic assisted surgery at our Omaha based program. At the moment, we are validating our virtual environments in terms of performance of the operator and identifying additional objective evaluation criteria.



Real and Virtual view of the training task: bimanual carrying.

Graduate students Dimitrios Katsavelis, Janmejy Tanwar, Bernadette Brown-Clerk and Matthew Fiedler are among the HPER Biomechanics Laboratory staff that work on the development of the virtual reality environments under the directions of Drs. Leslie Decker and Joseph Siu. Janmejy Tanwar received his BE in Computer Engineering from the North Maharashtra University in India and is pursuing his MS in Computer Science from UNO. Matthew Fiedler received his BS in Engineering from the University of Nebraska at Lincoln and is pursuing his MS in Exercise Science from UNO.



Comparison of daVinci™ arms and virtual reality simulation.

EVENTS IN THE LAB

➤ Symposium with Dr. Gardner.



Drs. Gardner and Chen.

The HPER Biomechanics Laboratory is currently engaged in clinical research on Peripheral Arterial Disease (PAD), in collaboration with the Vascular Surgical Department of UNMC. This clinical research aims to understand the walking deficits of PAD patients and their ability to regain lost ambulation after treatment. To further achieve the aims of the study, Dr. Andrew Gardner, a world renown authority in PAD, was invited to the UNO campus on Friday, May 12, 2006. Dr. Gardner holds current positions as the Director of the Applied Physiology and Human Performance Core in the General Clinical Research

Center at the University of Oklahoma, Health Sciences Center. During the morning, Drs. Johanning and Pipinos, from vascular surgery, along with Sara Myers, Jessie Huisinga and Dr. Shing-Jye Chen, from the Biomechanics Lab, presented their current PAD findings and exchanged ideas with Dr. Gardner. In the afternoon, the community was invited to share in Dr. Gardner presentation *Exercise rehabilitation for intermittent claudication*. His presentation was well attended. Also attending were the College of Education Dean and Associate Dean, Drs. Langan and Conway. After a brief social Dr. Gardner continued to give feedback to laboratory members. This symposium proved to be a springboard, which has improved the quality of our current PAD study research work.



➤ Dr. Wilson - Low Back Pain

The HPER Biomechanics Laboratory invited Dr. Sara Wilson, a professor of Mechanical Engineering at the University of Kansas, to give a presentation to the community October 13, 2006. Her presentation was titled: "Sense and Stability in the Lumbar Spine: An engineer's perspective on low back pain". She leads the Human Motion Control Laboratory within the Mechanical Engineering Department at the University of Kansas. One example of her research focuses on how jobs, which have a lot of vibration, i.e., truck driving, can alter the body's control system sensors. If the body's sense of where their back is in relation to objects around it is altered, that person becomes prone to low back pain. Solutions to this problem are the subject of some of her research.



Drs. Chen and Wilson.



➤ Dr. Joseph Threlkeld - Parkinson's Disease Walking Strategies

On March 24, 2006, A. Joseph Threlkeld, PhD, PT, visited the Journal Club. He is the Director of the Biodynamics Laboratory at Creighton University with a current research emphasis on the effectiveness of training strategies for persons with Parkinson's Disease. He presented some of those training strategies and specific problems related to each one. Dr. Threlkeld is an adjunct faculty with the HPER Biomechanics Laboratory and collaborates with us in a variety of projects.



Dr. Threlkeld

➤ HPER Biomechanics Hosts UNMC Colleague, G. Bradley Schaefer, MD



Dr. Schaefer

On November 17, 2006 G. Bradley Schaefer, MD gave a presentation titled "The Medical, Genetic and Legal Aspects of Cerebral Palsy". His talk focused on the difficulties of diagnosing an infant with Cerebral Palsy (CP). While our lab focuses on a biomechanical prognostic test, Dr. Schaefer gave us a broader understanding of why the medical community hesitates to give a diagnosis of CP. He also gave us details of some genetic and legal aspects which hinder this diagnosis. Dr. Schaefer is currently the Director of the Hattie B. Munroe Center for Human Genetics and the Associate Director of the Munroe-Meyer Institute for Genetics and Rehabilitation.

➤ Guests at the Lab:

On December 6, 2006, **Dr. Thomas Rosenquist**, Vice Chancellor for Research at the University of Nebraska Medical Center, visited the HPER Biomechanics Laboratory and reviewed our projects. Each student group set up posters on their project, a video and/or demonstration of the data collection process. They gave him a quick review of the purpose of their study and its current findings. He was delighted to step into our virtual environment and experience first hand this work in progress.

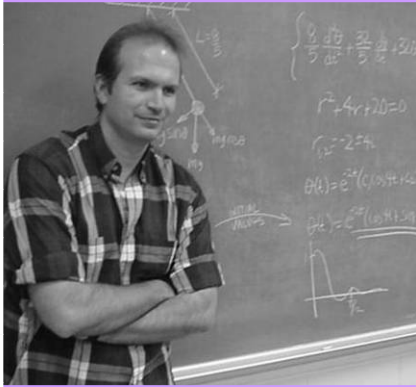


Dr. Rosenquist experiencing a basic virtual environment.

On October 20, 2006, seven High School teachers attending the **National Science Teachers Association** Midwestern Area Conference taking place in Omaha Nebraska, went on a Field Trip to the HPER Biomechanics Laboratory. Dr. Shing-Jye Chen, Co-Director of the Lab, gave them a hands on demonstration of our research techniques. One teacher donned markers to demonstrate our Motion Analysis system. Another teacher underwent muscle strength and endurance testing. The teachers were quite impressed with our ability to explore human anatomy. They will take this enriching experience back to their High School Science classes and inspire future biomechanists.



Dr. Nick Stergiou Awarded Outstanding Graduate Mentor 2006



Dr. Nick Stergiou



Mentors wear several hats. For their protégés they: teach, counsel, support, and thoroughly prepare them for their career. Mentors are so valuable that some businesses have incorporated the use of mentors to help retain the young people they hire and train. Each year UNO awards a tenure track faculty member the Outstanding Graduate Mentor of the Year. With over 400 eligible faculty members, the competition is stiff. The criteria includes, the ability to attract students to UNO, having a respected academic reputation, chairing masters, specialists, and doctoral committees,

as well as the ability to help the student toward further education and/or placement practices in their career field.

Dr. Nick Stergiou was awarded the UNO Outstanding Graduate Mentor of 2006. For this award, letters of nomination support were submitted on his behalf from his fellow faculty, new faculty he mentored, and a significant number of letters from past graduate students as well as his present graduate students. Congratulations to Dr. Stergiou for this significant achievement.



Lab rats: 2002



2003



2004



2005

Collaborations in Orthopedics

Dr. Stergiou conducted research at the Orthopedic Center in Sports Medicine (OCSM) for several weeks during 2006. The OCSM is located at the Ioannina Medical Center in Greece. He currently holds the title of the OCSM Scientific Consultant. In his ongoing collaboration with OCSM, Dr. Stergiou works closely with orthopedic surgeons in a well equipped biomechanical laboratory. Their collaborative work in 2006 resulted in several new manuscripts, four published articles, one article in press, four articles submitted for publication and multiple presentations at conferences. Their



Drs. Stergiou & Georgoulis with the entire OCSM staff.

work has lead to some very important findings regarding the reconstruction of one of the most important knee ligaments, the anterior cruciate ligament. They found that current surgical techniques fail to restore rotation of the lower leg during dynamic activities of every day life (i.e. walking, turning). They also found that proper placement of the graft is essential for subsequent knee stability. Currently, they are working on identifying the best surgical techniques that can keep the knee stable during daily activities. They have also started exploring how osteoarthritis of the knee is related to ligament damage. Their research has received € 306,121 from various sources.

The Media Features Efforts of the HPER Biomechanics Laboratory

- Community Health Line* with Tom O'Conner on National Public Radio Station KIOS at 91.5, on April 5, 2006 interviewed Nick Stergiou. This interview included all of Dr. Stergiou's projects. Internet link to *Community Health Line* and archives found on the Munroe Meyer Institute website: <http://app1.unmc.edu/publicaffairs/newsarchive/ch.cfm>
- WOWT Channel 6 News on April 27, 2006, featured: *Sitting Study: Therapy helps children overcome motor delay*. Staff Channel 6 News reporter went to the Munroe-Meyer Institute's Motion Laboratory. They interviewed two sets of parents with their infants and co-investigator Regina Harbourne. Both infants were participants in our development of infant sitting posture study funded by U.S. Department of Education, National Institute on Disability and Rehabilitation Research.
- Omaha World Herald*, on July 2, 2006. *Finding the Perfect Running Shoe*. The Gait Analysis service for the proper selection of running shoes was featured.
- Pinnacle Sports Network, October 21, 2006. Dr. Stergiou was interviewed by Jim Rose. They talked about all the current research in the laboratory. This was aired on radio stations carrying the Nebraska Husker football game.
- Omaha World Herald*, on December 17, 2006. *Biomechanics Research has Real-Life Impact*. This article resulted from an interview with Graduate Assistant Matija Radovic, which hi-lighted his work in the HPER Biomechanics Laboratory and the American Geriatrics Society grant on peripheral arterial disease.
- KETV Channel 7 News on December 29, 2006, featured a parent and a developmentally delayed infant participating in this study. It emphasized therapy for the motor control of developmentally disabled children. This study is funded by U.S. Department of Education, National Institute on Disability and Rehabilitation Research.
- UNO ALUM, Winter 2006 magazine: Development dynamics of sitting postural control in infants research and Dr. Stergiou's career development award was featured in the article titled "Professor Nick Stergiou: One-of-a-kind research". It gave a quick review of his work funded by both the U.S. Department of Education, National Institute on Disability and Rehabilitation Research and the National Institutes of Health, National Center of Medical Rehabilitation Research.

Other Continuing Collaborations

Duke Medical Center: Dr. Jim Cavanaugh, at the Duke University Medical Center and Durham Veterans Administrative Hospital, received a National Institutes of Health (NIH) R21 award in 2005. Dr. Nick Stergiou is a consultant on this grant and will contribute his expertise in nonlinear analysis of data. The project *Walking Activity and the Burden of Multiple Morbidities* uses an extended monitoring approach (Step Activity) to characterize the physiologically-based functional burden of older people with additional health problems. They hope to provide unique insight into the dynamics of elderly falling. This approach may contribute to the development of medical, surgical, or rehabilitative strategies for improving the ability of elderly patients to adapt to the physical demands of daily life.

CommGraphics: This Lincoln based company has an NIH grant to develop a Virtual Reality based program to improve physical activity in children entitled: *Child's Physical Activity/Cancer Prevention Video Game*. Bryan Rickertsen and his associates will use biomechanical measures to evaluate the efficacy of their Cancer Prevention Video Game. Dr. Stergiou is a consultant on this grant. <http://www.nanolegends.com/index.html>

Human Performance and Wellness: This is a company emphasizing Forensic Biomechanics. Dr. Stergiou is their Midwest representative and sits on the board of the Biodynamics Foundation. Dr. Stergiou visits them once a year in Las Vegas to be trained on issues related to Forensic Biomechanics. He also gives lectures at University of Nevada at Las Vegas and collaborates with several of their faculty (Drs. John Mercer and Janet Dufek). <http://www.hpw.net/index.html>

University of North Carolina at Chapel Hill: Dr. Stergiou has on-going collaborations with Dr. Kevin Guskiewicz and Dr. Darin Padua. He visited Chapel Hill during the dissertation of Chuck Thigpen in Spring 2006. Their recent collaborative work has examined shoulder related injuries. They use mathematical techniques from nonlinear dynamics to identify how abnormal posture affects shoulder injuries.

Landon Center of Aging/University of Kansas Medical Center: Collaboration with Drs. Nudo, Quaney, and Luchies. Dr. Stergiou was able to spend time in their laboratory during 2006. Together they work on issues related to aging, stroke and Parkinson patients. As a result KUMC was able to send Dr. Stergiou data for our lab to process. We provided them with comprehensive reports. Dr. Nudo also assists with grant preparations.

University of Houston: Collaboration with Dr. Max J. Kurz. This collaboration has resulted in multiple manuscripts and grant proposals every year.

University of Michigan: Collaboration with Dr. Beverly Ulrich. Dr. Stergiou has met with Dr. Ulrich and her doctoral student Beth Smith. Together they have initiated a project with the development of walking in children with Down Syndrome and Spina Bifida.

Pierre & Marie Curie University: Paris, France. This is a new collaboration with the "Adaptation and Evolution of Osteomuscular Systems" Laboratory. Dr. Stergiou met this laboratory team during his visit to France for Dr. Leslie Decker's dissertation defense. He was particularly interested in the equipment which takes both the biomechanical and physiological measures of long-term gait patterns in animals. Upon the request of their director, Dr. Vincent Bels, Dr. Stergiou is helping to establish experimental protocols to investigate gait variability in animal locomotion by applying nonlinear analysis techniques. <http://www.mnhn.fr/mnhn/usm302> and <http://www.animals-in-motion.com>

Boys Town Research Hospital. Dr. Stergiou gave a presentation to this group in 2006 regarding the use of nonlinear analysis for different forms of data. This meeting resulted in an exciting research topic for Dr. Stergiou's doctoral candidate, Anastasia Kyvelidou. Anastasia will collaborate with Boys Town scientists to examine sitting posture in infants with hearing problems.

OTHER EXCITING NEWS

➤ Ph.D.'s Awarded in our Laboratory



Dr. Judkins

- Max J. Kurz: Spring 2006. Now a faculty member at the University of Houston.
- Chuck Thigpen: University of North Carolina at Chapel Hill, Department of Allied Health Sciences, School of Medicine - Spring 2006. Now Assistant Professor in the Depts. of Physical Therapy and Athletic Training at the University of North Florida in Jacksonville, FL. Dr. Stergiou was a committee member.
- Timothy Judkins: Fall 2006. Now a Postdoctoral Fellow, Department of Physical Therapy & Rehabilitation Science, University of Maryland School of Medicine.



Dr. Kurz



Ms. Kyvelidou

- **Master's Degree Received:** Anastasia Kyvelidou: Summer 2006. She is continuing with doctoral studies at the University of Nebraska at Omaha, Medical Sciences Interdepartmental Area – Pediatrics.

➤ Convention Highlights

- In January 2006, Tim Judkins attended MMVR15 (Medicine Meets Virtual Reality Convention) in Long Beach California. The oral presentation covered aspects of the Robotic Assisted Surgery project.
- In June 2006, Dr. Nick Stergiou and Joan Deffeyes attended the North American Society for Psychology of Sport and Physical Activity Convention in Denver Colorado. The two oral presentations received positive feedback.
- In September 2006, six members of Laboratory attended the American Society of Biomechanics Convention in Blacksburg Virginia. They had five poster presentations and two oral presentations which covered all aspects of our current studies.
- In October 2006, Dr. Nick Stergiou went to the Society for NeuroScience Convention in Atlanta Georgia. Dissemination from the infant studies was particularly well received.

Professional Journal Publications for 2006

1. Georgoulis, A.D., Ristanis, S., Chouliaras V., Moraiti, C., & Stergiou, N. (2007) Excessive tibial rotation during high demanding activities is not restored by ACL reconstruction with a hamstring graft. *Clinical Orthopaedics and Related Research*. 454:89-94.
2. Volkman, K., Stergiou, N., Stuberg, W., Blanke, D. & Stoner, J.A. (2007) Methods to Improve the Reliability of the Functional Reach Test in Children and Adolescents With Typical Development. *Pediatric Physical Therapy*. 19(1):20-27.
3. Chouliaras, V., Ristanis, S., Moraiti, C., & Stergiou, N., Georgoulis, A.D. (2007) Effectiveness of reconstruction of the anterior cruciate ligament with quadrupled hamstrings and bone-patellar tendon-bone autografts: an in-vivo study comparing tibial internal-external rotation. *American Journal of Sports Medicine*. 35(2):189-86.
4. Stergiou, N., Harbourne, R.T., & Cavanaugh, J.T. (2006) Optimal Movement Variability: A New Theoretical Perspective for Neurologic Physical Therapy. *Journal of Neurologic Physical Therapy*. 30(3):120-129.
5. Wristen, B., Evans, S., & Stergiou, N. (2006) Sight-Reading Versus Repertoire Performance on the Piano: A Case Study Using High Speed Motion Analysis. *Medical Problems of Performing Artists*. 21(1):10-16.
6. Ristanis, S., Stergiou, N., Patras, K., Tsepis, E., Moraiti, C., & Georgoulis, A.D. (2006) Follow-up evaluation two years after ACL reconstruction with bone-patellar tendon-bone graft shows that excessive tibial rotation persist. *Clinical Journal of Sports Medicine*. 16(2):111-116.
7. Georgoulis, A.D., Moraiti, C., Ristanis, S., & Stergiou, N. (2006) A novel approach to measure variability in the anterior cruciate ligament deficient knee during walking: the use of the Approximate Entropy in orthopaedics. *Journal of Clinical Monitoring and Computing*. 20(1):11-8.
8. Judkins, T.N., Oleynikov, D., Narazaki, K., & Stergiou, N. (2006) Robotic surgery and training: Electromyographic correlates of robotic laparoscopic training. *Surgical Endoscopy* 20(5):824-9.
9. Cavanaugh, J.T., Guskiewicz, K.M., Giuliani, C., Marshall, S., Mercer, V.S., & Stergiou, N. (2006) Recovery of postural control after cerebral concussion: New insights using Approximate Entropy. *Journal of Athletic Training* 41(3):305-13.
10. Kurz, M.J. & Stergiou, N. (2006) Original investigation correlated joint fluctuations can influence the selection of steady state gait patterns in the elderly. *Gait and Posture*. 24(4):435-40.
11. Narazaki, K., Oleynikov, D., & Stergiou, N. (2006) Robotic Surgery training and performance: identifying objective variables for quantifying the extent of proficiency. *Surgical Endoscopy*. 20(1):96-103.

Selected Published Abstracts for 2006

1. Harbourne, R.T., Stergiou, N., Deffeyes, J.E., DeJong, S.L., & Stuberger, W.A. (2006) Motor learning interventions for the development of sitting postural control and use of nonlinear measures. *Journal of Sport and Exercise Psychology*, 28, (suppl.), S11-12.
2. Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Stuberger, W.A., Kyvelidou, A., & Stergiou, N. (2006) Variability in sitting posture in infants: Implications for learning postural control. *Journal of Sport and Exercise Psychology*, 28, (suppl.), S56-57.
3. Katsavelis, D., Kyvelidou, A., Stavropoulos, N., & Stergiou, N. (2006) Neuromuscular-induced fatigue increases running kinematic variability. *Journal of Sport and Exercise Psychology*, 28, (suppl.), S97-98.
4. Kurz, M.J. & Stergiou, N. (2006) Do horizontal forces influence the structure of chaotic gait patterns? *Journal of Sport and Exercise Psychology*, 28, (suppl.), S107.
5. Judkins, T.N., Oleynikov, D., & Stergiou, N. (2006) Robotic surgery and training: Does Augmented feedback help retain performance? Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
6. Katsavelis, D., Kyvelidou, A. & Stergiou, N. (2006) The effect of fatigue on movement variability during running. Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
7. Kochi, N., Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Stuberger, W.A., Kyvelidou, A., & Stergiou, N. (2006) A new method of determining the structure of biological time series by using approximate entropy and changing lag values. Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
8. Kurz, M.J. & Stergiou, N. (2006) Can hip joint actuations be used to control the structure of chaotic locomotion? Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
9. Kyvelidou, A., Ehlers, J.L., Kurz, M.J., & Stergiou, N. (2006) The effects of age and partial body weight support on kinematic variability during treadmill walking. Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
10. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., & Georgoulis, A.D. (2006) Current autografts used for ACL Reconstruction do not restore tibial rotation during pivoting. Proceedings of the 30th Annual Meeting of the American Society of Biomechanics. Blacksburg, Virginia, pp in cd-rom.
11. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., & Georgoulis, A.D. (2006) The effectiveness of reconstruction of the anterior cruciate ligament with quadrupled hamstrings and bone patellar tendon-bone autografts. An in-vivo study comparing tibial rotation. *Proceedings of the 12th ESSKA 2000 (European Society of Sports Traumatology Knee Surgery and Arthroscopy) Congress* in Innsbruck, Austria. O-81.
12. Chouliaras, V., Ristanis, S., Moraiti, C., Tzimas, V., Stergiou, N., & Georgoulis, A.D. (2006) ACL reconstruction with a quadrupled hamstrings tendon autograft does not restore tibial rotation to normative levels during landing from a jump and subsequent pivoting. *Proceedings of the 12th ESSKA 2000 (European Society of Sports Traumatology Knee Surgery and Arthroscopy) Congress* in Innsbruck, Austria, May, 2006. P -129.
13. Moraiti, C., Stergiou, N., Ristanis, S., & Georgoulis, A. (2006) Alterations in stride-to-stride variability after ACL rupture as measured using nonlinear methodology. *Proceedings of the 12th ESSKA 2000 (European Society of Sports Traumatology Knee Surgery and Arthroscopy) Congress* in Innsbruck, Austria. P-162.
14. Chen, S-J., Pipinos, I., Johanning, J., Huisinga, J. M., & Myers, S. A. (2006) The effect of claudication on joint moments during walking. Proceedings of the 31st Annual Meeting of the American Society Biomechanics, pp in cd-rom.

15. Myers, S. A., Huisinga, J.M., Pipinos, I., Johanning, J. & Chen, S-J. (2006) Ground reaction forces in patients with unilateral peripheral arterial disease. Proceedings of the 31st Annual Meeting of the American Society Biomechanics, pp in cd-rom.
16. Huisinga, J.M., Myers, S.A., Pipinos, I., Johanning, J., & Chen, S-J. (2006) The effect of pharmacologic therapy on kinetic gait parameters in patients with peripheral arterial disease. Proceedings of the 31st Annual Meeting of the American Society Biomechanics, pp in cd-rom.
17. Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., & Stuber, W.A., Kyvelidou, A., & Stergiou, N. Nonlinear measures of neuromuscular control of sitting posture in infants. Oral presentation at *Neuroscience 2006* held in Atlanta, Georgia, October 2006.
18. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., & Georgoulis, A.D. Current autografts used for ACL Reconstruction do not restore tibial rotation during pivoting. Oral presentation at *the 30th Annual Meeting of the American Society of Biomechanics*. Blacksburg, Virginia, September, 2006.
19. Thigpen, C.A., Padua, D.A., Stergiou, N., & Karas, S.G. Three dimensional coordination analyses of scapulohumeral motion between subjects with and without multidirectional shoulder instability. Oral presentation at the *Combined Sections Meeting of the American Physical Therapy Association*, San Diego, California, February, 2006.
20. Judkins, T.N., Oleynikov, D., & Stergiou, N. Real-time augmented feedback benefits robotic laparoscopic training. Oral presentation at *Medicine Meets Virtual Reality 14 Conference*, Long Beach, California, January, 2006.
21. Stergiou, N., Harbourne, R.T., Deffeyes, J.E., DeJong, S.L., & Stuber, W.A. The dynamics of development of sitting postural control. Poster presentation at the *National Center for Medical Rehabilitation Research Biennial Training Workshop*, Rockville, Maryland, December, 2005.

2006-2007 HPER Biomechanics Laboratory



Back Row: Lisa Holst, Sara Myers, Dr. Leslie Decker, Dr. Dan Blanke, Dr. Nick Stergiou, Dr. Shing-Jye Chen, Dr. Joseph Siu, Dimitrios Katsavelis, Matija Radovic.

Front Row: Bernadette Brown-Clerk, Jessie Huisinga, Hitika Tanwar, Natasha Kyvelidou, Naomi Kochi, Irene Lee, Joan Deffeyes, Elizabeth Luebbert.

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