Institute *Insider*

The Newsletter of the Institute for Ergonomics at The Ohio State University

At the forefront of Human Factors since 1950 Volume 8, No. 1, Winter, 2005

Marras Earns Honorary Doctorate for Back Injury Research

Professor **William Marras**, the Honda Chair in Ergonomics and Co-Director of the Institute for Ergonomics, was presented with a Doctor of Science (D.Sc.) at the University of Waterloo's fall 2004 convocation, in the Canadian city of Waterloo, Ontario. The University of Waterloo is one Canada's premier academic institutions and is known for research in spine biomechanics.

Dr. Marras's research, whose work most recently has linked design with the causes and prevention of work-related low back injuries, has found that certain types of people are more apt to incur injuries than others, even though they are performing identical tasks. His research has led to safer workplaces and improved the health of workers.

Dr. Marras gave the convocation address to graduates during the convocation. In his address, he advised Waterloo graduates on how to pursue greatness in their new careers. He stated that most new advances are coming at the intersections of traditional fields, so forming interdisciplinary partnerships is essential.

Pictured (L to R): **Mike Lazaridis** (co-CEO of Research in Motion and "father of the Blackberry"); **William Marras** (Ohio State); **Stuart McGill** (University of Waterloo Professor and Kinesiology Department Chair); and **David Johnston** (President of the University of Waterloo).

Woods Receives NSA Grant

Dr. David Woods has been awarded a grant from the National Security Agency to study *Cognitive Systems Engineering for Innovation in Information Analysis and Comprehension: OSU Interdisciplinary Consortium*.

Woods

The goal of this research is to develop a long-term strategic partnership with NSA to address problems of data overload through cognitive engineering models and techniques.

As Principal Investigator, Dr. Woods began work on this grant, funded at over $813,000 for the first two years, in October, 2004.

Study Reveals Why Eyes in Some Paintings Seem to Follow Viewers

Todd

You've seen it in horror movies or at the local museum–a painting in which the eyes of the person portrayed seem to follow you around the room. People have described the effect as creepy, eerie, or supernatural. But now researchers have demonstrated the very natural cause for this visual effect.

All it takes for the effect to work is to have the person in the painting, or photograph, look straight ahead, said Institute for Ergonomics member **James Todd**, co-author of the study and an Ohio State professor of Psychology. Our visual perception takes care of the rest.

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In *This* Issue . . .

Institute *for* Ergonomics

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Spotlight On . . . Resilience Engineering

Dr. David Woods recently co-organized the *International Symposium on Resilience Engineering*, which was held in October 2004 in Soderoping, Sweden. Individuals from ten countries participated in this symposium, whose objective was to provide an opportunity for experts to meet and debate the presence and future of resilience engineering.

Safety is a system property that emerges from a mix of components, subsystems, software, organizations, and human behavior. The number of recent major mishaps has made it clear that organizations must revise their handling of processes and capabilities to address not only technical but also human and organizational risk factors. Numerous strategic case studies and accident analyses have pointed to the need to monitor and manage risk continuously throughout the life cycle of a system and to find ways of maintain a balance between safety and the often considerable pressures to meet production and efficiency goals (just think of NASA).

The traditional fields of practice, such as risk analysis and probabilistic safety assessment, have been unable to provide the much needed solutions. There are several reasons for this, the most important probably being that they are firmly rooted in oversimplified accident models.

Safety is something a system does, rather than something a system has. This means that we must understand how a system can actively ensure that things do not get out of hand and that control is not lost. Systems should be made resilient, rather than reliable. It is not enough that they are reliable so that the failure probability is acceptably low; they must also be resilient and have the ability to recover from irregular variations, disruptions and a degradation of expected working conditions.

Resilience engineering stands for the view that failure is the flip side of the adaptations necessary to cope with the complexity of the real world, rather than a breakdown or malfunctioning as such. The performance of individuals and organizations must always adjust to the current conditions, and because resources and time are finite, such adjustments are always approximate.

Success has been ascribed to the ability of organizations, groups and individuals to anticipate the changing shape of risk before failures and harm occur. Failure is simply the absence, temporary or permanent, of that ability.

Interested in learning more about resilience engineering? Contact Dr. David Woods (woods.2@osu.edu) or visit his web site (http://csel.eng.ohio-state.edu/woods/).

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On the Move

David Woods gave the Plenary Address, *Making Health Care Safer 2004*, at the Royal College of Physicians and British Medical Journal, in London (Oct. 16th-17th, 2004).

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Emily Patterson has become an Editorial Board member of the journal *Human Factors*.

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Cognitive Systems Engineering was the topic of a seminar taught by **David Woods** to approximately 30 participants at the Linkoping Technical University in Linkoping, Sweden (Oct. 13th-15th, 2004).

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Gary Allread gave the Keynote Address at the Capital Area Safety Council Ergonomic Conference in Columbus, Ohio (Nov. 17th, 2004). His topic was, "A Look at the Ergonomics "Big Picture": Understanding the Types of Factors Related to Injury Risk."

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A special issue of IEEE Systems, Man and Cybernetics, on Using Field Studies to Understand Technical Work in Healthcare, was co-edited by **David Woods** (Nov. 2004).

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David Woods became an invited member of the Visual Analytics Research & Development Agenda of the National Visualization and Analytics Center. Established in 2004, NVAC™ is funded by the Department of Homeland Security's Science & Technology Directorate.

NVAC's goal is to help counter future terrorist attacks in the U.S. and around the globe. The Center, led by Pacific Northwest National Laboratory (PNNL), is a national resource that provides strategic direction and coordination of activities to discover, develop and implement innovative visual information analysis methods.

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IN THE NEWS

Scholars Visit Biodynamics Laboratory

In January, two employees from Kia Motors in Korea arrived at the OSU Biodynamics Laboratory, to begin a six-month assignment, working with Dr. William Marras and his graduate students on ergonomics research projects.

Kyung Ho Kim hails from Hwa-Sung. His work at Kia involves assembly of the Kia Sorento. While in the U.S., he can be reached at kim.2043@osu.edu.

Kim

Park

Cheol Woong Park also is involved in assembly, of the Kia Sedona in Kwang-Myeong. His email address while at OSU is park.789@osu.edu.

Are you involved in eye tracking research? If so, contact the OSU **Center for Cognitive Science**. Their initiative continues to provide faculty and students access to eye tracking equipment and support staff. The goal of the initiative is to foster a campus-wide interest in eye tracking tools for research and to provide researchers with initial no-cost access to the eye tracking facility to gather pilot data for seeking external funding.

Visit their web page (http://etlab.cog.ohio-state.edu/) for more information.

Attending this year's Ohio Safety Congress & Expo? This is the event's 75th anniversary; one of the finest occupational safety & health events in the Midwest.

The Congress & Expo will be held at the Columbus Convention Center during March 29th-31st.

Stop by the Institute booth (#322) and say hello!

2005 Ergonomics Short Course Dates Announced

The 2005 training schedule has been set for *Putting Ergonomics Into Practice*, the Ergonomics Short Course held annually on The Ohio State University Campus. This comprehensive course, which teaches a systematic approach to integrating ergonomics principles into the workings of an organization, will be held:

April 26th-29th, 2005

October 25th-28th, 2005

More details are available on the Institute web site, http://osuergo.eng.ohio-state.edu/institute/.

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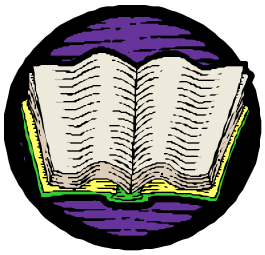

Recent publications written by Institute members (denoted in bold) include:

Differences in Motor Recruitment and Resulting Kinematics between Low Back Pain Patients and Asymptomatic Participants During Lifting Exertions

Sue A. Ferguson, **William S. Marras**, **Deborah Burr**, K. Davis, and P. Gupta. *Clinical Bio-mechanics*, 19(10):992-999, 2004.

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Examining the Complexity Behind a Medication Error: Generic Patterns in Communication

Emily S. Patterson, R.I. Cook, **David D. Woods**, and M.L. Render. *IEEE Transactions on Systems, Man and Cybernetics Part A: Systems and Humans*, 34(6):749-756, 2004.

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The Influence of Individual Low Back Health Status on Workplace Trunk Kinematics and Risk of Low Back Disorder

Sue A. Ferguson, **William S. Marras**, and **Deborah Burr**. *Ergonomics*, 47(11):1226-1237, 2004.

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Messy Details: Insights from the Study of Technical Work in Healthcare

C. Nemeth, R.I. Cook, and **David D. Woods**. *IEEE Transactions on Systems, Man and Cybernetics Part A*, 34(6):689-692, 2004.

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Physical Demands and Low-Back Injury Risk Among Children and Adolescents Working on Farms

W. Gary Allread, **John R. Wilkins III**, T.R. Waters, and **William S. Marras**. *Journal of Agricultural Safety and Health*, 10(4):257-274, 2004.

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Ten Challenges for Making Automation a "Team Player"

G. Klein, **David D. Woods**, J. Bradshaw, R.R. Hoffman, and P.J. Feltovich. In *Joint Human-Agent Activity. IEEE Intelligent Systems*, November/December, 19(6):91-95, 2004.

❖

Themes Surrounding Novice Nurse Near-Miss and Adverse Event Situations

P. Ebright, L. Urden, **Emily S. Patterson**, and B.A. Chalko. *Journal of Nursing Administration*, 34(11):531-538, 2004.

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What is Design in the Context of Human-Centered Computing?

R.R. Hoffman, **Axel Roesler**, and B.M. Moon. *IEEE Intelligent Systems*, July/August, 19(4):89-95, 2004.

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Workplace Design Guidelines for Asymptomatic vs. Low Back Injured Workers

Sue A. Ferguson, **William S. Marras**, and **Deborah Burr**. *Applied Ergonomics*, 36:85-95, 2005.

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Ergonomics Process Guidelines Available

Institute members **William Marras** and **Gary Allread** have published the document, *How to Develop and Manage an Ergonomics Process*, which is based on their years of experience assisting companies with their ergonomics issues. This guide instructs the reader on how to establish and maintain an effective ergonomics process in an organization and includes details on the important components necessary for success.

These guidelines are **free** and are available for download from the Institute for Ergonomics' web site: http://osuergo.eng.ohio-state.edu/institute/guidelines.htm.

Research Corner

Abstracts of recently published research by Institute members

Differences in Motor Recruitment and Resulting Kinematics between Low Back Pain Patients and Asymptomatic Participants During Lifting Exertions

Sue A. Ferguson, **William S. Marras**, **Deborah Burr**, K. Davis, and P. Gupta. *Clinical Biomechanics*, 19(10):992-999, 2004.

Background. Low back disorders are prevalent in today's society and may lead to chronic debilitating low back pain. Developing our understanding of temporal muscle and kinematic patterns during manual material handling tasks may provide insight for preventing the cascading series of events leading to chronic low back pain.

Methods. Sixty-two low back pain patients and 61 asymptomatic participants performed a variety of lifting exertions that varied in lift origin horizontal and vertical distance, lift asymmetry, and weight. Electromyographic activity of 10 trunk muscles as well as trunk and pelvic kinematics was recorded during each exertion. Differences in muscle activation and kinematic parameters were compared between low back pain patients and asymptomatic participants as a function of experimental conditions.

Findings. Both the left and right erector spinae activated significantly earlier and were on significantly longer in low back pain patients compared to asymptomatic participants. The horizontal and vertical location of the lift influenced the EMG and kinematic differences between the low back pain patients and asymptomatic participants.

Interpretation. These finding indicate that low back pain patients would be exposed to increased muscle activity, resulting in higher spine loads for a greater length of time compared to asymptomatic participants. The longer exposure time to increased spine load may lead to greater risk of future low back injury and cascading events leading to debilitating low back pain. The longer muscle activation time suggests that low back pain patients have changed their motor program from an open to a closed loop system.

Examining the Complexity Behind a Medication Error: Generic Patterns in Communication

Emily S. Patterson, R.I. Cook, **David D. Woods**, and M.L. Render. *IEEE Transactions on Systems, Man and Cybernetics Part A: Systems and Humans*, 34(6):749-756, 2004.

Abstract. Communication was the most frequently cited cause of medication errors reported between 1995 and 2003. More detailed models of how communication breakdowns contribute to adverse events are needed to intervene to improve communication processes. We describe in detail an incident where an oncology fellow physician erroneously substituted the medication navelbine for the intended etoposide during ordering, resulting in a prolonged hospitalization with severe leukopenia for the patient. A team of human factors and medical experts analyzed the case and identified communication patterns described in the human factors literature. We discuss how the findings suggest targeted ideas for improving communication processes, media, and systems that may have higher "traction" for improving patient safety than are possible solely from aggregated analyses of coded descriptions of large sets of cases.

Effect of Experience on Motor Control during Repetitive Lifting Exertions

Julia Parakkat, MS

Thesis Abstract. The objective of this study was to examine the motor control learning hierarchy when acquiring a manual material handling (MMH) skill, as exhibited by novice and experienced MMH workers. Twelve novice and 12 med- and high-experienced MMH workers performed repetitive, asymmetric lifts at various load and lift frequency levels throughout an eight-hour period. Muscle coactivity, joint kinematics, and spinal loading were compared between novice and experienced subjects.

Novices had higher coactivities and spinal loading than experienced subjects. Med- and high-experience subjects behaved similarly in terms of muscle coactivity. The timing of peak kinematics demonstrated that novices moved slower during the complex phases of the lift and, as with med-experience subjects, had a lack of joint coordination as compared with high-experience subjects. Only at high experience levels was integrative learning exhibited in terms of efficiently manipulating the length-strength properties of the erector spinae. Level of MMH experience affects the level at which motor skill learning is focused. Due to the impact that early stages have on later ones, the hierarchy of motor skill learning is such that successful accomplishment of executive control at the neuromuscular level must occur prior to fine-tuning at the behavioral level to allow the worker to minimize cumulative loading throughout the day.

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Research Corner
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Predicting Dynamic Three-Dimensional Spine Loads during Lifting Activities using Linear Regression Models

Aniruddha Kohok, MS

Thesis Abstract. Accurate estimation of spine loads is necessary to determine risk of back pain and disc injury associated with specific lifting activities. Epidemiologic and biomechanical studies have shown that the endplate is vulnerable to large compressive and shear loads. Those wishing to estimate these loads are confronted with many types of models, ranging from static single muscle equivalent models, static optimization models, neural network models, to electromyographic assisted dynamic models. All of these models are limited in their applicability to the analysis of industrial tasks, by the fact that they are static models or by their data collection complexity (requiring EMG). The purpose of this project was to develop linear regression models, based upon the results from a dynamic EMG assisted model, which would enable practitioners to estimate the peak dynamic compressive and shear forces at L_5/S_1 with easily obtained parameters.

The Effect of Cellular Phone Design on Upper Extremity Discomfort and Muscle Fatigue

Anne-Marie L. Chany, MS

Thesis Abstract. The objective of this study was to compare use of a small cellular phone with a landline phone in the development of discomfort and muscle fatigue. Phone use may be influenced by design, and anthropometry may change shoulder and hand postures during use, which may modify the length-strength relationship and moment arms of the involved muscles. Discomfort data were recorded on ten males and females using a cellular phone and landline phone, as was electromyographic muscle activity on the trapezius, deltoid, flexor digitorum superficialis, and thenar muscles. Discomfort and muscle fatigue data were analyzed to assess differences between phone models and anthropometry.

Two major factors that determined discomfort and fatigue development during phone use were phone design and anthropometry. Grip style was dictated by phone design and changed the length-strength relationship of the hand, resulting in differing discomfort and fatigue levels. Anthropometry played a modifying role in both the shoulder and hand and determined the severity of the discomfort and fatigue present.

Graduate Student News

Aniruddha Kohok graduated with his Masters degree in August 2004, under advisor Dr. Steve Lavender. The title of Aniruddha's thesis was, "Predicting Dynamic Three-Dimensional Spine Loads during Lifting Activities using Linear Regression Models."

Aniruddha is now working as a Logistics Engineer with Ford Motor Comapany in Detroit. He can be reached at kohok.1@osu.edu.

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In 2004, **Justin Grossman** completed a three-month internship as a cognitive engineer in the Cognitive Systems Engineering Center (CSEC) of Mantech International's Security and Mission Assurance division in Pittsburgh, PA. Mantech is mainly active in the national security domain. Justin worked on several projects, primarily helping to develop advanced decision support systems for aerospace command and control. His work related to modeling critical relationships, decisions, and functions in the context of the specific aerospace domain, and developing new insights and system design concepts based on analysis of their findings.

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In December 2004, **Anne-Marie Chany** received her Masters degree. Her advisor was Dr. William Marras. Under his tutelage, Anne-Marie completed her thesis, "The Effect of Cellular Phone Design on Upper Extremity Discomfort and Muscle Fatigue."

Anne-Marie has accepted a position at Columbus Children's Hospital, in the Center for Injury Research and Policy. She is the project manager for the Ohio Crash Outcome Data Evaluation System (CODES) and will be doing research on motor vehicle crash injuries. Anne-Marie can now be reached at chanya@ccri.net.

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Julia Parakkat graduated with her Masters degree in December 2004. Under the advisement of Dr. William Marras, Julia studied, "Effect of Experience on Motor Control during Repetitive Lifting Exertions."

In February 2005, Julia will begin a position at Wright-Patterson Air Force Base, in the Air Force Research Laboratory Human Effectiveness directorate. She can be reached at parakkat.1@osu.edu.

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Painting

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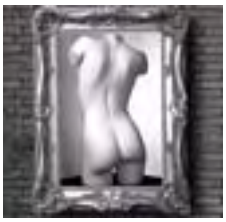
"The core idea is simple: no matter what angle you look at a painting from, the painting itself doesn't change. You're looking at a flat surface. The pattern of light and dark remains the same," Todd said. "We found that our visual perception of a picture also remains largely unchanged as we look at it from different vantage points. If a person in a painting is looking straight out, it will always appear that way, regardless of the angle at which it is viewed."

The study was conducted at the University of Utrecht in the Netherlands, along with Jan Koenderink, Andrea van Doorn, and Astrid Kappers. Their results were published in a recent issue of the journal *Perception*.

Scientists have considered the reasons behind this visual effect for decades, but advances in the field of perception now allow for better ways to study why it occurs, Todd said. "Researchers have developed powerful techniques that allow us to measure the perception of complex shapes in a very precise way."



In this study, the authors viewed on a computer screen a picture of a human torso in a richly sculpted gilded frame that appeared to be hanging on a brick wall. The wall and frame were shown in color, the torso in neutral gray.

To answer their questions, the researchers needed to determine how an object's apparent 3D structure was influenced by changes in the viewing direction. They were particularly interested whether points that appeared to be closest or farthest in depth relative to other neighboring points would remain the same when the picture was observed at different viewing angles. They also wanted to determine how the relative magnitude of the perceived depth in different regions of the picture would be affected when viewed at different angles.

To address these issues, the researchers did two tasks. First, they moved a dot around on the computer screen to show which points on the torso appeared to be nearest and which appeared to be the furthest away. Second, they used a gauge figure that had to be placed on the torso so it looked to be flat against the surface. This determined how viewers perceived the 3D shape of the depicted object.

The researchers repeated this process for six different conditions, including sessions in which they looked straight at the monitor, and others in which they looked at it from an angle. "These experiments took hours," Todd said. "We made judgments at numerous probe points on each image, so that when all of the different conditions were completed we ended up making thousands of settings over the course of the experiment. From all that data we were able to mathematically construct a surface that is most consistent with the overall pattern of judgments in each condition."

However, the different viewing conditions didn't yield many different results. "It turned out that that changes in viewing direction had remarkably little effect on the observers' perceptions," Todd said.

The only difference they found is that, when viewed from an angle, the torso looked thinner to viewers. But the far points and near points, and the overall relief of the depicted object, remained proportionally the same. The key is that the near points and far points of the picture remained the same no matter the angle the picture was viewed from, Todd said. "When observing real surfaces in the natural environment the visual information that specifies near and far points varies when we change viewing direction," he said.

"When we observe a picture on the wall, on the other hand, the visual information that defines near and far points is unaffected by viewing direction. Still, we interpret this perceptually as if it were a real object. That is why the eyes appear to follow you as you change your viewing direction."

Todd said people may be surprised by this phenomenon because of the unique perceptual aspects of viewing a picture. We perceive an object in a painting as a surface in 3-dimensional space, but we also perceive that the painting itself is a 2-dimensional surface that is hanging on the wall.

"When we look at a picture, you have these two perceptions simultaneously, but it is difficult to make sense of that conceptually. That's why this issue has fascinated people for hundreds of years."

In fact, many researchers have continued to follow the theories of LaGournerie, a French researcher who proposed a mathematical analysis in 1859 of why eyes in a painting seem to follow viewers. "One of the contributions of our study is that we showed that while LaGournerie had the basic idea right, his mathematical description was wrong," Todd said. "We were able to use new methodologies to give a more correct mathematical analysis of what is going on."

For additional information, contact: James Todd, (614-292-8661 or todd.44@osu.edu).

Written by Jeff Grabmeier (grabmeier.1@osu.edu).