Institute *Insider*

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

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Institute Co-Sponsors MSD Research Symposium

In conjunction with the National Institute for Occupational Safety and Health (NIOSH), the Institute for Ergonomics was priviledged to have sponsored *The State-of-the-Art Research (STAR) Symposium: Perspectives on Musculoskeletal Disorder Causation and Control.*

Symposium Co-Directors Tom Waters, William Marras

This symposium took place on Ohio State's main campus in Columbus, Ohio, on May 21st and 22nd, 2003 and was attended by over 130 professionals.

For this symposium, NIOSH and Institute members brought together a comprehensive group of this country's leading researchers, in the fields of bioengineering, medicine, public health, psychology, and ergonomics. These experts critiqued the existing scientific literature, fit together the wealth of knowledge gained from various research approaches, and discussed future steps to advance the knowledge of how MSDs occur and how they can be reduced or eliminated.

Dr. Don Chaffin, Professor of Industrial & Operations Engineering, Biomedical Engineering, and Environmental & Industrial Health at the University of Michigan gave the symposium's Plenary Address.

Chaffin

The Institute also was honored to have Dr. John Howard, an occupational physician and the Director of NIOSH, as the Keynote speaker.

Panel of experts discuss directions of future research

Study Points to Methods for Safe Drug Dispensing via Computer

Researchers at the Institute have found that a new computer system using bar codes to safeguard patients' medications will work successfully but not without creating new, serious problems for nurses charged with patient care.

"In general, we viewed the system as successful. There are no magic bullet solutions to human error in any setting, and even the best systems will require constant maintenance and flexible redesign after implementation," said **Emily Patterson**, one of the Institute's research specialists.

The Veterans Health Administration (VA) recently designed a drug dispensing system called Bar Code Medication Administration (BCMA) and asked Dr. Patterson to evaluate it.

At issue is whether bar codes could enable healthcare professionals to verify that a patient is receiving the right drug, at the right dose, at the right time.

Dr. Patterson conducted the research with the VA Midwest Patient Safety Center of Inquiry in Cincinnati and published the results in a recent issue of the Journal of the American Medical Informatics Association. Her coauthors include Marta Render, director of the center and adjunct associate professor of internal medicine at

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In *This* Issue . . .

Institute *for* Ergonomics

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With airline delays increasing and transportation demand expected to triple within 50 years, NASA and the Federal Aviation Administration need to start planning next-generation transportation systems now. A new National Research Council committee will help address the problem.

David Woods, professor in the Institute for Ergonomics and co-director of the Cognitive Systems Engineering Lab, is one of 16 people who will conduct a study of the technology needed to achieve the national aviation vision for the next 25 to 50 years. Woods, an expert on human performance and human-computer interaction, was also recently selected to join a National Academy of Engineering and Institute of Medicine committee on engineering and health care.

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The **School of Public Health** has unveiled its new web site, www.sph.ohio-state.edu. It features increased content for prospective and current students, faculty and staff, and other audiences, such as public health agencies. The web site is part of an overall communications plan to raise the stature of the school nationally and internationally and recruit the best and brightest students and faculty. Other content areas such as *Alumni* and *Development* will soon be added. This site is the first in a series of Medical Center sites being re-designed in 2003.

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Information about the new **Orthopaedic Ergonomics Laboratory** can be found on its web site, www.ortho.ohio-state.edu/research/ergonomics. This lab is under the direction of **Steven A. Lavender**. Dr. Lavender holds joint appointments in the Departments of Industrial, Welding, & Systems Engineering and Orthopaedics, as an Associate Professor.

This lab aims to improve the physical interaction among workers, their jobs, and the environment, through study of the musculoskeletal system's response to work activities. The lab focuses on the body's biomechanical response to a variety of occupational tasks, potential workplace interventions, and the creation of models predictive of back injury development and recovery.

On the Move

The Columbus Technology Council has named **Stuart Zweben**, Chair of Computer and Information Science, as its Outstanding Educator Advancing Technology at the annual Top CAT Award banquet. The award is given to the educator demonstrating outstanding contributions in the advancement of technology through training, teaching and/or research.

The Top CAT awards are designed to recognize those who help to build a strong technology community in Central Ohio. CTC works to help local technology-based businesses become familiar with and access resources that they need to sustain a globally competitive organization, including creators of technology, users of technology, providers of technology, and those that support these organizations.

Dr. Zweben is also on the Board of Directors for the Institute.

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Sue Ferguson has been elected as Program Chair for the Industrial Ergonomics Technical Group of the Human Factors and Ergonomics Society. Dr. Ferguson's appointment runs through 2004.

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In February, **Anthony Maronitis**, a Research Associate Engineer, left the Biodynamics Laboratory, to become an Loss Prevention Consultant at the Liberty Mutual Group in Gahanna, Ohio. Good luck, Anthony.

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Gary Allread presented the talk *Ergonomics at the Desk* at the Ohio Library Council seminars held in Columbus and Toledo (April, 2003).

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Researchers Kermit G. Davis, **William S. Marras**, Catherine A. Heaney, Thomas R.Waters, and Purnendu Gupta were named the winners of the 2003 Alice Hamilton Science Award in the Human Studies Category for their paper, "The Impact of Mental Processing and Pacing on Spine Loading," which was published in 2002 in the journal *Spine* (Volume 27, pp. 2645-2653).

The Alice Hamilton Science Award for Occupational Safety and Health was established in 1988, for NIOSH scientists. The award is presented each year to the author(s) of a peer-reviewed publication.

Graduate Student News

New Students

Amy Asmus
(asmus.4@osu.edu)
Advisor: William S. Marras
Hometown: Worthington, Ohio

Greg Knapik
(knapik.1@osu.edu)
Advisor: William S. Marras
Hometown: Middleburg Hts, Ohio

Program Completions

In March, **Swetha Sivakumar** successfully defended her Masters' thesis. Studying under advisor Dr. William S. Marras, Swetha's research focused on the "Effect of Various Lifting Frequencies Throughout the Workday on the Spine Loads of Novice Workers."

Delia Treaster successfully defended her doctoral dissertation, in May. Her research, titled, "An Investigation of Postural and Visual Stressors and their Interactions during computer Work," was conducted under the direction of Dr. William S. Marras. Congratulations, Delia!

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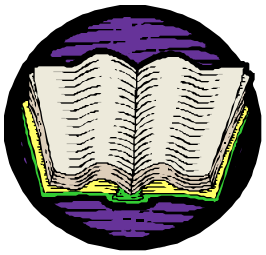
or perish



The recent publications written by Institute members include:

Cross-Sectional Area of the Lumbar Back Muscles as a Function of Torso Flexion. 2003. M.J. Jorgensen, W.S. Marras, P. Gupta, and T.R. Waters. *Clinical Biomechanics*, 18(4): 280-286.

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Gender Influences on Spine Loads during Complex Lifting. 2003. W.S. Marras, K.G. Davis, and M.J. Jorgensen. *The Spine Journal*, 3(2): 93-99.

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The Impact of Mental Processing and Pacing on Spine Loading. 2002. K.G. Davis, W.S. Marras, C.A. Heaney, T.R. Waters, and P. Gupta. *Spine* (Volvo Award for Low Back Pain Research), 27(23): 2645-2653.

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A Neuro-Fuzzy Modeling of Myoelectrical Activity of Trunk Muscles Due to Manual Lifting Tasks. 2003. W. Lee, W. Karwowski, W.S. Marras, and D. Rodrick. *Ergonomics*, 46(1-3): 285-309.

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Placement Control: A Nontraditional Risk Factor for Occupational Low Back Pain. 2002. K.G. Davis, P. Gupta, and W.S. Marras. *The Spine Journal Supplement*, 2(5), September/October.

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Spine Loading as a Function of Gender. 2002. W.S. Marras, K.G. Davis, and M.J. Jorgensen. *Spine*, 27(22): 2514-2520.

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Supporting Trust Calibration in Automated Decision Aids Through the Presentation of System-Generated, Dynamic Confidence Information. 2003. J. McGuirl and N. Sarter. *12th International Symposium on Aviation Psychology*, April 14-17, 2003, Dayton, Ohio.

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Towards A Model Of Error Management On Highly Automated Glass Cockpit Aircraft. 2003. M. Nikolic and N. Sarter. *12th International Symposium on Aviation Psychology*, April 14-17, 2003, Dayton, Ohio.

❖

Validity and Reliability of Sincerity Test for Dynamic Trunk Motions. 2003. S.A. Ferguson, S. Gallagher, and W. S. Marras. *Disability and Rehabilitation*. 25(4-5): 236-241.

New MRI Technique Can Compare Human and Monkey Brains

Researchers have developed a new way to use a decade-old imaging method to directly compare the brains of monkeys with those of humans. Their report appeared in the journal *Science*.

The method uses functional Magnetic Resonance Imaging (fMRI), a technique that measures blood volume and flow and blood-oxygen levels in the brain. It also provides an indirect measure of neuronal activity in different brain regions.

Neurons need oxygen and glucose to work. Blood carries both substances, and both can cross the blood-brain barrier. When a particular region of the brain is activated, the blood flow to that area temporarily increases to supply the neurons with fresh oxygen and glucose.

"What we're doing is an indirect measurement of the human brain's electrical activity," said Wim Vanduffel, the report's lead author and an instructor at the Athinoula A. Martinos Center for Biomedical Imaging in Charlestown, Mass. "It's the best way at present for investigating patterns of neural activity in humans."

The researchers used the same fMRI technique on humans and on monkeys to compare activity in an area of the brain called the visual cortex, the region that processes vision and motion. While each species shares similar traits in the visual cortex, the researchers did find distinct differences between the species in two key areas.

"Implicit in the neuroscience community was that the monkey cortex is a good model for the human cortex," said **James Todd**, a study co-author and professor of psychology at here Ohio State. "Scientists didn't have any choice but to make that assumption, as the monkey brain was the only model we had to work with."

Todd

What set the fMRI technique used in this study apart from past fMRI experiments on monkeys is that the monkeys remained conscious during the experiments.

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New MRI Technique

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"Until this point, anybody who has used fMRI on monkeys did so while the animals were sedated," Todd said. "That presents a real problem since sedation may alter the patterns of neural activity that occur when monkeys are awake."

Eleven human subjects each participated in 14 separate fMRI scan sessions, and three macaques participated in at least eight sessions. While each session produced data, some of the sessions produced weak signals. Therefore, the researchers averaged together the sessions to obtain reliable results.

The experiments were conducted in a laboratory run by Guy Orban, head of the division of neurophysiolgy at Katholieke Universiteit Leuven in Belgium. Todd was responsible for designing the images viewed by all of the subjects.

For each session, human subjects laid on their backs inside the fMRI and watched as nine randomly connected lines began to rotate on a monitor inside the machine. Monkeys do not like lying on their backs, so researchers used juvenile monkeys that could be seated within the fMRI apparatus.

The researchers looked for areas of the visual cortex that were activated while the subjects watched rotating 3-D images. Each portion of a subject's visual cortex was scanned during each session in the fMRI. To better see the areas of activity in the monkey brain, the macaques were injected with a solution that enhanced the contrast shown in the final scans.

"For unknown reasons, the fMRI signals from the monkeys were weaker than those from the humans," Orban said. "Since the monkey brain is smaller, we needed to use a contrasting agent to increase the fMRI's ability to pick up a signal."

While a regular MRI measures tissue density and structure, fMRI measures the flow, volume and oxygenation of blood in tissue. This technique was used here to investigate brain regions that were activated when subjects looked at the moving 3-D images. Orban said that the advantage of functional MRI is that scientists can see which regions of the brain are active.

The results showed pronounced differences between the two species: in an area of the human visual cortex called V3A, an area thought to be responsible for visual functions such as motion processing and stereoscopic depth, and in the intraparietal cortex. The researchers noted that, in humans, four distinct areas of the intraparietal cortex were involved in processing the rotating 3-D images. There is no clear counterpart to this region in monkeys. Orban said the results suggest that, as humans evolved, some portions of their brains adapted to produce specific abilities, such as controlling fine motor skills.

The results don't mean that monkeys don't have 3-D visual capabilities. The findings do show that researchers now have a technique enabling them to make reliable comparisons between a monkey brain and a human brain.

"This study provides the first evidence of a functional difference between the human and the monkey brain," Todd said. "The results show that, in at least one important aspect, the brains function quite differently."

"We were in a paradoxical situation before we had these results," Orban said. "On one hand, it's obvious that humans and monkeys are different. On the other hand, when we use the physiology of the monkey brain as a model to explain what we see in a human functional MRI scan, we had assumed that the activity was occurring in the same region in each brain. We had to make an assumption, which we knew would be wrong from time to time. We just didn't know when that assumption would be wrong. Now we have a way to verify when the monkey model does not apply and when it really can apply, and we can be much more precise in extrapolating findings from monkeys to humans."

Support for this research came from the Inter-University Attraction Poles and GOA (Belgian research supporters), the Fund for Scientific Research--Flanders, and the Queen Elisabeth Medical Foundation. Todd, Orban and Vanduffel conducted the study with Denis Fize, Hendrik Peuskens, Katrien Denys and Stefan Sunaert, all of Katholieke Universiteit Leuven.

Dr. Todd, who is also on the Board of Director for the Institute for Ergonomics, can be reached at todd.44@osu.edu.

Written by Holly Wagner, Research Communications

OSHA Ergonomics Update

In April, the Occupational Safety and Health Administration announced that nine of its regional offices across the U.S. have begun emphasis programs, which will focus on four industries having high rates of repetitive trauma or musculoskeletal disorders.

OSHA identified automotive parts manufacturing, hospitals, meatpacking, and warehousing as "high ergonomic hazard" industries.

The programs will concentrate on employers within these industries having at least 40 employees and who recorded a lost-workday illness and injury rate of eight or more per 100 workers in the year 2000.

The "regional emphasis programs," or REPs, are intended to run for about one year.

Regional Administrator Richard Terrill told the *Occupational Safety & Health Reporter* that the program is, "consistent with and supports the four-pronged approach" to ergonomics that was previously established nationally by OSHA.

Safe Drug Dispensing

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the University of Cincinnati, and Richard Cook, director of the Cognitive technologies Laboratory at the University of Chicago. The Department of Veterans Affairs funded the study.

With BCMA, hospital pharmacies label medications with bar codes, and patients wear bar-coded wristbands. Nurses scan a patient's wristband, and a laptop computer on the medication cart displays that patient's prescriptions. Before giving the medicine, the nurse scans the medicine bottle or other container, and BCMA records the drug as delivered. If the nurse accidentally scans the wrong medicine or dosage, or tries to give medicine at the wrong time, a warning pops up on the computer screen.

Patterson followed the activities of 26 nurses at three VA hospitals as they dispensed medication with BCMA. She also watched as doctors entered new prescriptions into the electronic medical record and pharmacists labeled prescriptions. Then she interviewed these people as well as hospital computer support personnel and nurse managers, to gauge everyone's opinion of the system.

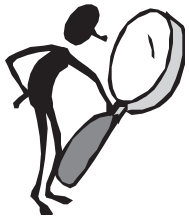
The study did not specifically examine errors caught or prevented by BCMA, but focused instead on the interaction of users with the system, in order to find ways to make the system work better.

Nearly all VA hospitals are now using BCMA software version 2.0, and Patterson and her colleagues are helping create version 3.0, which will address some of the problems found during the study. After that, Patterson and her colleagues will continue to help the system evolve over time.

Patterson cited a 1999 study at Brigham and Women's Hospital and Harvard Medical School that found medication errors fell 86 percent when doctors began entering their prescriptions orders via computer. When computer systems are optimized for taking human factors into account, errors can decrease even further, she said.

The new Ohio State study found five unanticipated negative side effects of introducing BCMA to hospitals:

1. *Sometimes the computer automatically removed medications from a patient's prescription list.* For example, one patient could not receive his dose of a drug on time, because he had been away in another part of the hospital when he was supposed to receive it. When the patient returned to the ward and the nurse administered his medications, BCMA no longer displayed the medication because it was dropped when a time window had elapsed. In most cases, the nurses knew to administer the medication and so asked a pharmacist to add it back to the prescription list, but some nurses reported that this sometimes did not happen in past cases.



Research Corner

2. *There was less coordination between doctors and nurses, compared to a paper-based system.* Doctors reviewed patient's medication orders less often, because doing so through the BCMA computer was more difficult or time-consuming than the old procedure, which involved simply reading the nurses' notes on a paper medical chart. That means doctors and nurses were less likely to know if a patient's medication needed to be changed.

3. *During the busiest parts of the day, nurses had to ignore some of the required BCMA procedures to save time.* For instance, bar codes didn't always scan properly on the first try. To avoid re-scanning a patient during crunch periods, nurses would often enter the seven-digit bar code number manually.

4. *Nurses became anxious about delivering medications on time.* The computer required the nurses to type an explanation when medications were given even a few minutes early or late, and nurses were concerned that the late administrations would reflect badly on their job performance. As a result, nurses tended to make just-in-time administration of medicines a high priority, compared to other duties.

5. *The computer didn't easily accept unusual dosage orders.* While the system streamlined the administration of consistent dosages of drugs, it wasn't set up to accept dosages that increased or decreased over time. For example, pharmacists had to enter 14 separate daily doses for a patient whose medicine was supposed to taper off over a two-week period.

In the future, Patterson and her colleagues will examine how BCMA is used differently in acute care wards, nursing homes, and intensive care units. **Roger Chapman**, another research specialist in Ohio State's Institute for Ergonomics, is going to investigate how nurses' use of PDAs, or personal digital assistants, instead of laptop computers will affect the use of BCMA.

The Food and Drug Administration is currently considering whether to require labeling of all prescription drugs with bar codes. In a recent public meeting, the FDA stated that Patterson's paper "highlights the importance of ensuring that bar-coding medical administration systems are flexible enough to be modified" when problems occur.

For more information about this research, contact Dr. Emily Patterson (614-688-3938; patterson.150@osu.edu.)

Written by Pam Frost Gorder (614-292-9475; Gorder.1@osu.edu).

Institute *Insider*

HUMAN CENTERED DESIGN

The Newsletter of the Institute for Ergonomics

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THE OHIO STATE UNIVERSITY

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