

Institute Insider

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

At the forefront of Human Factors since 1950 Volume 7, No. 3, Autumn, 2004



Women at Least Twice as Likely to Get Some Musculoskeletal Disorders

Women are at least twice as likely as men to develop some musculoskeletal disorders of the upper body—according to a finding from an Institute for Ergonomics student and researcher.

This new work, though it did not yield specific incidence rates for different disorders, gives researchers a critical baseline for comparing gender differences in the prevalence of disorders of the neck, shoulders, arms, and hands.

Until now, some researchers suspected that women only appear to have a higher incidence of these disorders because they are more likely than men to admit that they are in pain and get treatment. Others thought the gender difference was due to a greater exposure to certain risk factors for women.

Delia Treaster, a former doctoral student under advisor Dr. William Marras, conducted this research with **Dr. Deborah Burr-Doss**, assistant professor of epidemiology and biometrics. They performed a statistical analysis of previous studies to remove factors that could have skewed the results either way. They described their findings in a recent issue of the journal *Ergonomics* (47(5), 495-526, 2004).



When they accounted for factors such as a person's age, occupation, and whether the person reported their disorder themselves or whether it was clinically diagnosed, they were surprised to find that the gender difference still remained.

"Any way you slice the data, women have a significantly higher prevalence—anywhere from two to ten, even eleven times higher than men—for many of these disorders," Treaster said. "The question now is, why? Is it biomechanical, physiological, psychological, or what? Most likely, it is due to a combination of factors."

Burr-Doss cautioned women to be aware that they could develop these disorders, especially as they grow older. "Women should talk to their doctors about it, and doctors should look out for it," she said.

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Team Wins NSF Competition

Institute members **Dr. David Woods** and **Dr. James Davis** are part of a multi-disciplinary scientific team that won an intense competition under the National Science Foundation's Information Technology Research for National Priorities (ITR) program.

The other team members are Dr. Richard Parent and Dr. Raghu Machiraju (OSU Computer Science and Engineering) and Alan Murray (OSU Department of Geography).

This \$1.3 million project involves Multi-level, Active Attention Surveillance and will run through 2007.

In summary, this project seeks to advance security surveillance monitoring by introducing event-based reasoning. Members will use a formal event-discovery protocol to uncover event categories and the temporal structure of events. This will result in an event template hierarchy. The event template hierarchy is supported by the enabling technologies of smart sensors, a reconfigurable network, and the use of persistent models for tracking. The result is an autonomous sensor network that can be effectively coupled to human operators in order to allow top-down control of the resources as well as the ability to modify the models for event and background activities. While the methodology



Woods



Davis

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Patient Safety Research Makes Headlines

Groundbreaking research conducted by Institute members has been featured across the country.

The work of **Dr. Emily Patterson** and **Dr. David Woods**, focused on reducing medical errors especially during shift changes, aims to prevent worker fatigue and ensure patient safety. This work was profiled in an earlier issue of the *Institute Insider* (Vol. 7, No. 2) and has been profiled on several on-line publications, including:

“**Strategies Could Make for Safer Shift Changes at Hospitals**” in *Medical News Today* (April 16th), *Infection Control Today* (April 19th), *Medi-Lexicon* (April 30th), *RT Image* (May 3rd), and *St. Francis Hospitals* (May 7th).

“**Could Nuclear Power and Space Exploration Improve Hospitals?**” in *Ergonomics Today* (May 5th)

“**OSU Study Designed to Help Hospitals with Shift Change Policies, Procedures**” in *The Daily Reporter* (May 5th)

“**How to Handle Handoffs Without Dropping the Ball**” in *Nursing Spectrum* (August 1st)

“**PDA’s Can Help Create Safer Shift Changes**” in *PDA Cortex* (September)



The Central Ohio Chapter of the Human Factors and Ergonomics Society was re-activated this past spring and is making plans for events for this Autumn and Winter.

Meetings of this local professional organization provide a great opportunity to meet others with interests and expertise in various areas related to HF/E.

Please consider becoming involved in the group and contributing to its successful revitalization by attending meetings, hosting a tour of your work facility, or making a presentation about your work to the group.

Information about the chapter can be found at its web site: <http://www-iwse.eng.ohio-state.edu/ISEFaculty/sommerich/centralohhfes/>.



The Institute’s *2003 Year in Review: Research* publication is available on-line! This document, which summarizes Institute members’ research (by topic area) can be downloaded from the Institute web site, <http://osuergo.eng.ohio-state.edu/institute/yearinreview.htm>.

On the Move



Dr. David Woods received an IBM Faculty Award for his work on Human Centered Automation. IBM is using this effort as part of their initiatives on *Autonomic Computing* to allow increases in adaptive computing infrastructure to coordinate with human system administrators.



Dr. George Smith, former Chair of IWSE, delivered a keynote address at a World Logistics Symposium in Beijing, PRC on September 22nd, 2004. In his address, "The Promise of Productivity," he argued that productivity improvements create wealth and prosperity which, when distributed fairly and equitably, can be major contributing conditions to world peace.

Dr. Smith is the President of the World Academy of Productivity Sciences and Senior Vice President for Technical Networking of the Institute of Industrial Engineers. He can be reached at smith.14@osu.edu.



Dr. William Marras spoke on "The Biomechanics of Low Back Pain" at the Stooped Postures in the Workplace Conference, which was held at the University of California, Berkeley (July 29th-30th, 2004).



Through a Department of Education grant, **David Woods** has established an undergraduate student exchange program with Brazilian universities on Cognitive Engineering and Safety in the Petroleum Industry. Five ISE undergrads are currently spending six months in Rio de Janeiro, taking classes and working with an international oil company as part of their capstone project.



Congratulations to **Emily Patterson**, who won the Alexander C. Williams Jr. Design Award, which is given annually by the Human Factors and Ergonomics Society.

This design award was given to Dr. Patterson for Bar Code Medication Administration. BCMA is an innovative software product that reduces the opportunities for medication errors by using barcodes to verify the identity of the patient and the medication name, dose, route, and time. BCMA has been in continuous use in all 163 medical centers at the Veteran's Administration since 2000.

The Alexander C. Williams Jr. Design Award recognizes those who have made outstanding contributions to the conception or design of any product, service, or system that has had a significant impact on users and exemplifies the excellent use of empirical human factors design principles.

David Woods was an Invited Speaker at a law conference on medical malpractice. He spoke on "Escaping Conflicts between Learning and Accountability in Patient Safety" at the 10th Annual Clifford Symposium on Tort Law and Social Policy. Starting Over?: Redesigning the Medical Malpractice System. This was held at the DePaul Law School (Chicago IL), April 15th-16th, 2004.



William Marras and **Steve Lavender** spoke on "The Monitoring of Load Moment Exposure in the Workplace" at PREMUS 2004, the Fifth International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders in Zurich, Switzerland (July 11th-15th, 2004).



"Escape from Data Overload" was the topic of the Keynote Address given by **David Woods** at the VHA eHealth University annual meeting of the Veterans' Health Administration (Dallas TX, May 24th-25th, 2004). Dr. Woods addressed over 1,000 attendees, as this is largest health care organization in the U.S.



David Woods was appointed to the Human Factors Discipline of the Super Problem Resolution Team (SPRT) for the new NASA Engineering and Safety Center. These teams are part of NASA's response to the recommendations from the Columbia Accident Investigation Board (CAIB) on how developing an independent technical voice in safety related decisions. Dr. Woods also was an advisor to the Columbia board.



Graduate Student News

Jennifer Bower graduated with her Masters in Cognitive Systems Engineering, under advisor Philip J. Smith. She is now an Instructor at the U.S. Military Academy at West Point and was recently selected for promotion to Major in the Army. Jen can be reached at jennifer.bower@usma.edu.



In July, **Mark Nikolic** successfully defended his doctoral dissertation, in which he studied, "How Human-Machine Teams Create, Explain, and Recover from Coordination Break-downs: A Simulator Study of Disturbance Management on Modern Flight Decks." Under advisor Nadine Sarter, Mark's research focused on cognitive engineering issues of human-automation interaction. He completed his dissertation research (which was supported by a Presidential Fellowship) on a flight simulator at Boeing in Seattle, Washington. Dr. Nikolic can be reached at nikolic.5@osu.edu.



In September, **Naira Campbell-Kyureghyan** successfully defended her doctoral dissertation. Under advisor William Marras, she studied, "Computational Analysis of the Time-Dependent Biomechanical Behavior of the Lumbar Spine." For more information on this research, Naira can be reached at campbell-kyuregh.1@osu.edu.



Magnus Feil successfully completed his MFA degree in Industrial Design, which involved developing new concepts for human-robot coordination. His thesis, "The Dynamic Perceptor Sphere: Concepts of Functional Presence in Human-Robot Coordination" included a demonstration of how remote human observers can see through a robot's sensor, as if the person were present. This work is an advance in search and rescue robotics. Magnus' co-advisor on this work was David Woods. Magnus can be reached at feil.11@osu.edu.



Honda Co-Op Positions Available

Honda of America Mfg., has co-op positions open to students interested in industrial ergonomics. These positions usually last for 12 weeks.



Typical co-op tasks include line-side job analysis (possibly including developing ergonomics countermeasures) and drafting ergonomics guidelines (such as reviewing research, building consensus, and drafting documents).

Honda's ideal candidate is someone who is interested in becoming an industrial ergonomist and who has taken some ergonomics courses at either the undergraduate or graduate level.

Pay for these positions is in the \$13-\$16 per hour range. Honda also provides low cost housing for students, if needed.

These positions are available until March, 2005. If interested, send your resume to:

David D. Wood, CPE, Corporate Ergonomics, Honda Support Office, 19900 State Route 739, Marysville, OH 43040 (phone: 937-644-0427, ext 60891).

Student-Faculty Research Fellowships Available

Applications for engineering fellowships currently are being accepted for student/faculty teams to conduct research in areas specified by the Air Force Research Laboratory (AFRL) at Wright-Patterson Air Force Base, near Dayton, Ohio.

These one-year funds, provided through the Dayton Area Graduate Studies Institute (DAGSI), will cover graduate student tuition up to \$22,500 and faculty stipends of \$10,000, plus program- and travel-related expenses.



Student work is intended to take place at AFRL, typically during the summer term.

More information about this opportunity, including research priority areas, eligibility requirements, and applications, are available on DAGSI's web site, www.dagsi.org. The application deadline is January 31st, 2005, with awards announced by mid-March, 2005.

Selected Research Abstracts

How Human-Machine Teams Create, Explain, and Recover from Coordination Breakdowns: A Simulator Study of Disturbance Management on Modern Flight Decks

Mark I. Nikolic, PhD

In many domains, introducing automation technology is considered a "mixed blessing." It has extended operator capabilities and increased safety and efficiency of operations, but has also led to new cognitive demands, such as errors and performance breakdowns.

Training, design, and procedures have been directed at preventing erroneous actions and assessments, but error prevention is not a sufficient strategy to improve safety in complex high-risk systems. A more effective solution requires a deeper understanding of how operators cope with their errors, or more appropriately, with the resulting disturbances to the monitored process.

The final step in a research program included jump-seat observations, a flight instructor survey, and an incident database analysis. The first full-mission simulator study in this area was conducted with 12 pilots, to examine the effectiveness of current pilot strategies for diagnosing and recovering from disturbances, and the impact of current automation design on these processes. Pilots flew a one-hour scenario containing challenging events that probed their knowledge of, and proficiency in using, the autoflight system. A process tracing methodology was used that integrated behavioral and verbal data to identify patterns in strategies across pilots.

Overall, pilots completed the scenario successfully but varied considerably in how they coped with disturbances to their flight path. Our results show that aspects of feedback design delayed the detection and thus escalated the severity of a disturbance. Diagnostic episodes were very rare, due to pilots' knowledge gaps and time-criticality. Consequently, in most cases, generic, rather inefficient, recovery strategies were observed, and pilots tended to rely on high levels of automation when trying to manage the consequences of erroneous actions or assessments. Furthermore, our scenario illustrated the role of external agents in coordinating recovery actions by various participants in the system. Our findings are discussed in the context of disturbance management and the development of cognitive tools to support this process.

Computational Analysis of the Time-Dependent Biomechanical Behavior of the Lumbar Spine

Naira Campbell-Kyureghyan, PhD

Significant effort has gone into developing finite element models (FEMs) in spinal biomechanics. However, nearly all previous studies have applied artificially set static or short duration dynamic loads (< 1 sec) to a single motion segment, while most low back disorders found in industry result from tasks that are repetitive in nature. Thus, the purpose of this study was to develop a model of the complete lumbar spine capable of determining the response to realistic repetitive motion.

A new FEM of the lumbar spine was developed that considers nonlinear material and geometric behavior, including large displacements and rotations. It was interfaced with an EMG-assisted free-dynamic model that provides subject-specific motion data for use as partial input to the FEM. The initial geometry of the lumbar spine is a crucial part of the input, and a new method for determining the neutral posture geometry using an external goniometer was developed and validated.

Validation and sensitivity analyses were performed on both the individual model components and the complete model. Also, the model response, including stresses, deformations, and energy dissipation, for up to twenty minutes of continuous, measured repetitive sagittally-symmetric flexion was calculated. The dynamic creep and energy dissipation at all intervertebral discs levels was determined for 8 hours of cyclic loading.

The model developed in this study is able to simulate large displacement, dynamic, cyclic behavior using realistic motions through linking to human subject experiments. Larger forces, creep, and energy dissipation were predicted at the lower lumbar spine levels, and the maximum stresses and energy dissipation were found to be highly dependent upon the bending motion, not only the axial compression. Also, higher lifting frequencies and velocities lead to increased creep and energy dissipation, with velocity having a larger effect. Subject specificity, including the initial lumbar spine geometry and motion during flexion was found to have an important effect on the resulting spinal loads. The results suggest that the new model is a valid approach to assessing the effect of repetitive motion on the lumbar spine.

The Impact of Asynchronous Multimedia Communications on Understanding and Recall

Jennifer Bower, MS

This research focused on the design of software environments to support rich asynchronous communication and to understand the impact of such communications on understanding and recall in a military context.

The goal was to explore how the design of a multimedia asynchronous communication tool influenced the understanding and recall of information.

Forty-six ROTC cadets each received a company Operations Order, and based on that were required to write a platoon OPORD followed by two recall questions. Half of the cadets received the company OPORD in a conventional text format that included a static map overlay. The others received the OPORD with four sub-sections presented with a multimedia presentation tool that included synchronized animation and voice narration.

Overall, our findings show that the group that viewed the multimedia presentation recalled mission critical information 26-47% more often.

PUBLISH

or perish



These recently published articles were written or co-authored by Institute members. Their names appear in boldface type.

Cervicobrachial Muscle Response to Cognitive Load in a Dual-Task Scenario

E. Leyman, G.A. Mirka, D. Kaber, and **Carolyn M. Sommerich**. *Ergonomics*, 47, 625-45, 2004.

Fifteen Best Practice Recommendations for Bar-Code Medication Administration in the Veterans Health Administration

Emily S. Patterson, M.L. Rogers, and M.L. Render. *Joint Commission Journal on Quality and Safety*, 30(7), 355-365, 2004.

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 L. Burr**. *Ergonomics*, 47(11), 1226-1237, 2004.

Productivity and Ergonomic Investigation of Bent-Handle Pliers

K. Duke, G.A. Mirka, and **Carolyn M. Sommerich**. *Human Factors*, 46, 234-243, 2004.

A Simulation-Based Embedded Probe Technique for Human-Computer Interaction Evaluation

Emily S. Patterson, M.L. Rogers, and M.L. Render. *Cognition, Technology, and Work*, 6(3), 197-205, 2004.

Institute Member Activity at the Human Factors & Ergonomics Society's 48th Annual Meeting - New Orleans, LA



Institute members were active on several levels at this year's HFES meeting. Their contributions (with names in boldface) are listed below.

Panel Sessions

The Role of Human Factors in Health Care-2020

C. Alvarado, G. Klein, M. Weinger, **Emily Patterson**, R. Cook, P. Carayon

Colloquia

Afterwords: The Quality of Medical Accident Investigations and Analyses

C. Nemeth, R. Cook, **Emily Patterson**, Y. Donchin, M. Rogers, P. Ebright

Posters

College Students' Use of Computers: Assessment of Musculoskeletal Discomfort and Potential Risk Factors

K. Cooper, G. Mirka, **Carolyn Sommerich**

Computer Input Devices: Quantification of Use and Variation in Use

Carolyn Sommerich, **Sahika Vatan**, **Amy Asmus**

Experimentation for Envisioned Worlds: Understanding the Limitations of the Military after Action Review as Experimental Data

Jodi Obradovich, J. Graham, M. Schneider, C. Gonzalez, R. Harder

Lectures

Application of Universal Design Principles in the Design of a Self-Checkout System

K. Bajaj, G. Mirka, **Carolyn Sommerich**, H. Khachatoorian

Clinical Reminders: Why Don't They Use Them?

L. Militello, **Emily Patterson**, T. Tripp-Reimer, S. Asch, C. Fung, P. Glassman, S. Anders, B. Doebbeling

Error Management on Modern Flight Decks: How Pilots Explain and Recover from Unintended Actions and Outcomes

Mark Nikolic, **Nadine Sarter**

The Impact of Asynchronous Multimedia Communications on Understanding and Recall

Jennifer Bower

Low Back Disorder Risk in Automotive Parts Distribution

Steven Lavender, D. Oleske, P. Zold-Kilbourn, E. Taylor, M. Morrissey, G. Andersson

New Approaches to Overcoming E-Mail Overload

S. Weil, **David Tinapple**, **David Woods**

Supporting Synchronous Distributed Communication and Coordination through Multimodal Information Exchange

Chih-Yuan Ho, **Nadine Sarter**

Women and MSDs

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Musculoskeletal disorders (MSDs) affect the muscles, tendons, ligaments, and joints. One 1998 study found that 15% of the American working population suffered one or more MSDs and that this rate could increase to 18% within the next 30 years.

Researchers believe that doing highly repetitive or physically stressful work can cause MSDs. There can be psychological and social factors as well. Dr. Marras, co-director of the Institute and director of the Biodynamics Laboratory, had previously linked high performance pressure and job dissatisfaction to low back pain, the most common MSD.

This latest study focused on upper-body disorders other than back pain, the highest-profile of which is carpal tunnel syndrome (CTS). For sufferers of CTS, a nerve in the wrist becomes irritated, causing pain and numbness in the hands.

As Treaster and Burr-Doss reviewed studies from 13 countries, they found much data concerning CTS in the U.S., while most European studies focused on shoulder and neck disorders.

“Now the pendulum is swinging the other way—neck and shoulder pain is becoming a hot issue here, and European scientists are becoming interested in carpal tunnel,” Treaster said.

MSDs can be difficult to diagnose, she added. Doctors can perform clinical tests for CTS, but for neck and shoulder disorders “all you have to go on is whether someone is in pain, and pain is so subjective.”

The conventional wisdom is that men do physically demanding work such as heavy lifting that makes them more susceptible to back problems, while women do the fine, repetitive work that can lead to neck, shoulder, and wrist problems. But this new study showed that women were more likely than men to develop MSDs even when they have the same job.

To Treaster, the study underscores the need to prevent MSDs from happening in the first place. One way to do that is through better workplace design, equipment selection, and work practices. “This is yet another gender difference that will have to be taken into account,” she said.

Treaster is now a professional ergonomist helping the U.S. Post Office implement the ergonomics in its distribution centers. Burr-Doss has no immediate plans to continue this research, though she says she might like to further analyze the data and compute more detailed incidence rates for individual disorders.

For more information, Dr. Treaster can be reached at treaster.3@osu.edu. Dr. Burr-Doss can be contacted at 614-293-3906 or doss.12@osu.edu.

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



Treaster



Burr-Doss

NSF

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is suitable for a wide variety of application domains, the team will ground their work in a campus security and surveillance paradigm.

By integrating research from Cognitive Science, Geography, and Computer Science (Graphics, Visualization, and Vision), the team will create a paradigmatic shift in the way that surveillance systems are viewed and developed. The data stream is no longer composed merely of video and perhaps some low-level alarms. Their focus will be extended to include events.

Data and information no longer only flow uphill toward a user sitting in front of a wall of monitors. Event contexts, set by higher level events as well as by operators in-the-loop, flow down to direct and focus attention in order to detect differences from a dynamic model of background activity.

The result is that the information will be more meaningful, the surveillance systems more focused, and the cognitive skills of the operators more efficiently utilized.

A prototype system will be made available for pertinent security personnel to train and test. It is likely that this project will have an impact in the literature on surveillance topics in the fields of visualization, computer graphics, computer vision, cognitive science and geography. Additionally, it will also contribute to training methodologies of security personnel.

The NSF panel reviewing this application complimented the team’s approach. They stated:

- “The review panel was very impressed with the well-integrated multidisciplinary team assembled to execute this research.”



- “Their multidisciplinary team has formed a coherent research proposal that effectively leverages the capabilities inherent in each discipline to pursue a common goal.”

- “Systems such as that proposed here, that augment the capabilities of humans--based on recognition and understanding of the limitations of the human sensory and cognitive systems--will be essential in a world where data stream growth far outstrips the capabilities of humans to process directly.”

