

# 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. 2, Spring, 2005



## Center for Resilience is Formed

The OSU College of Engineering has announced the formation of the Center for Resilience, a research center that will help companies to assure the resilience of their global operations. *Resilience* is the capacity for complex industrial systems to survive, adapt, and grow in the face of turbulent change, including catastrophic events. The Center will explore how the characteristics that typify resilient living systems can be designed into industrial systems, ranging from manufacturing processes to entire business enterprises.

Co-Directors for the Center for Resilience are Bhavik Bakshi, Associate Professor in the Department of Chemical and Biomolecular Engineering, and Joseph Fiksel, Senior Research Scientist in the Department of Industrial, Welding and Systems Engineering. Fiksel is an internationally recognized expert in sustainable development. One of their first steps was to form an Industrial Advisory Board of executives from leading multi-national companies, including Dow Chemical, General Motors, and International Paper.

The Center for Resilience will build on the systems engineering research of IWSE faculty members **David Woods** and Allen Miller, as well as Bakshi's research in process engineering and industrial ecology. In particular, Woods' work on resilience in system safety can potentially be extended to address organizational decision-making in a variety of complex industrial systems.

The Center is intended to act as a hub for multidisciplinary research in industrial resilience, drawing upon faculty members from the College of Engineering, Fisher College of Business, College of Food, Agricultural and Environmental Sciences, and other areas at Ohio State.



**Bakshi**



**Fiksel**

## Knapik Hired by Biodynamics Lab

In April, 2005, **Gregory Knapik** began work as a Senior Research Associate-Engineer, in the Ohio State Biodynamics Laboratory. In this position, Greg will be continuing his work to develop advanced biomechanical models. He can be reached in the Lab at 614-292-2016 or via email ([knapik.1@osu.edu](mailto:knapik.1@osu.edu)).



In March, 2005, Greg earned his Masters degree from OSU in Mechanical Engineering. The abstract of his thesis, "A Three-Dimensional, EMG-Assisted, Push-Pull Model for Assessing Dynamic Loads on Each Level of the Lumbar Spine," can be read on page 7.

## Patterson Named to CPod

In March, **Emily Patterson** was hired as the Associate Director of the CPOD (Converging Perspectives on Data), which is an interdisciplinary consortium of world-class researchers in Information Analysis and Comprehension.



The consortium pools expertise in cognitive systems engineering, political science, design, cognitive science, field research, perception, and computer science to solve problems at the intersections of people, technology and work.

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**Summer Institute:  
Data Overload in Information  
Analysis & Comprehension**

The new initiative at Ohio State, Converging Perspectives on Data (CPoD), is pursuing innovative solutions to data overload problems in information analysis and comprehension tasks. This summer, CPoD is conducting an interdisciplinary Summer Institute to:

- Innovate solutions to data overload that go beyond "tweaks" to existing tools;
- Advance methods for collaborative envisioning of what would be useful support for information analysis and comprehension tasks; and
- Develop interdisciplinary talent well versed in Design and Cognitive Systems Engineering methods and concepts to meet the demands of the intelligence community and others.



Participation in the Institute is by invitation only and relatively equally represent expertise in Cognitive Systems Engineering, Design, and International Relations (Political Science).

The Summer Institute will begin with an intense two-day kickoff on June 27<sup>th</sup>-28<sup>th</sup>, 2005, where faculty members will present their perspective on data overload in information analysis and comprehension. The Institute will end on August 25<sup>th</sup>, three days after multi-media presentations by the student teams on their innovative approach to addressing data overload.

For more information, contact Emily Patterson, the Associate Director of CPoD ([patterson.150@osu.edu](mailto:patterson.150@osu.edu)), or David Woods, CPoD's Director ([woods.2@osu.edu](mailto:woods.2@osu.edu)).

**Resilience**

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The Center for Resilience plans to work with industrial sponsors to develop a new generation of tools that are modeled after successful patterns in ecological and social systems. By measuring and managing the resilience of their products, processes, and assets, companies should be able to improve the safety, reliability and robustness of their supply chain processes, as well as the effectiveness of their technological innovation.

More information about the Center for Resilience can be found at [resilience.osu.edu](http://resilience.osu.edu).

## On the Move



**Stu Zweben** presented the paper, "Computing Accreditation: A New Criteria Structure and New Flexibility," at the ACM Technical Symposium on Computer Science Education (SIGCSE 2005) in St. Louis, Missouri (February, 2005).



**Wayne Carlson**, Chair of the OSU Department of Industrial, Interior, and Visual Communication Design, has been named to the Apple Distinguished Educator program for the Class of 2005.



The program provides a unique forum for Apple and exemplary educators worldwide to exchange ideas and information about the effective uses of new technologies in the creation of engaging learning environments. The Apple Distinguished Educator Summer Institute takes place July 11<sup>th</sup>-16<sup>th</sup> in San Jose, California.

The program began in 1994; it focuses on educational excellence and leadership. Educators are members of a select group of K-12 and higher education professionals possessing an identified expertise in educational technology leadership. This group of over 450 educators has members in the USA, Canada, Europe, Australia, New Zealand, and Japan.



**Emily Patterson** spoke on "Cognitive and Human Factors in Health Care" for the Committee on Identifying and Preventing Medication Errors at the Institute of Medicine of the National Academies (April 13<sup>th</sup>, 2005) in Arlington, Virginia.



**Jim Davis** (Assistant Professor in Computer Science & Engineering) was given a 2005 Lumley Award by the OSU College of Engineering. The award, established to promote and enhance research within the CoE, is given to a select researchers who have shown exceptional activity and success pursuing knowledge within their fields.



On April 16<sup>th</sup>, 2005, **Emily Patterson** presented a lecture on, "Lessons Learned for Improving Patient Safety with Bar Code Medication Administration at the American Organization of Nurse Executives Meeting and Exposition in Chicago, IL.



## IN THE NEWS

**Dr. Muhammet Dursun Kaya** is a Visiting Scholar from the Vocational College at Ataturk University in Erzurum, Turkey. He will be spending six months working with Dr. William Marras in the OSU Biodynamics Laboratory.



During his stay, Dr. Kaya can be reached at 614-292-2016 or [kaya.12@osu.edu](mailto:kaya.12@osu.edu).



The Human Factors and Ergonomics Society invites you to attend the 49<sup>th</sup> Annual Meeting, to be held September 26<sup>th</sup>-30<sup>th</sup>, 2005, in the Royal Pacific at Universal Orlando in Orlando, Florida.

Check out the HFES web site (<http://hfes.org>) for an overview of the technical sessions and for upcoming registration information, technical group meetings dates, and a downloadable Program Booklet.



A new study indicates that older workers may be the easiest segment of employees to convince that change is good.

Dr. Tracey Rizzuto (Louisiana State University) surveyed over 360 workers, nearly 60% of whom were aged 46 or older, and 11% were over 55. Her survey focused on willingness to learn new systems, motivation, commitment and satisfaction in accepting changes. She found that the older workers were more willing and excited about changes.

Rizzuto credited the openness to change to the older workers' loyalty to their co-workers and their employer. If the changes were perceived as beneficial to everyone, the older workers were more apt to sign on. Rizzuto noted that while other studies have indicated that older workers may not learn new technology as quickly as some younger workers, this could merely be an indication that specialized training programs that focus on older workers would be beneficial.

Dr. Rizzuto presented these findings at the 20<sup>th</sup> annual conference of the Society for Industrial and Organizational Psychology in April, 2005.

## PUBLISH or perish

Recent publications written by Institute members (indicated in boldface font) include:

### Airport Resource Management and Decision Aids for Airlines

**Amy Spencer, Philip J. Smith, and Charles Billings**, *Proceedings of the 13<sup>th</sup> Int'l Symposium on Aviation Psychology*, Oklahoma City, OK, April, 2005.

### Classification of Jobs with Risk of Low Back Disorders by Applying Data Mining Techniques

J. Zurada, W. Karwowski, and **William S. Marras**, *Occupational Ergonomics*, 5:1-15, 2005.

### Computing Accreditation: A New Criteria Structure and New Flexibility

**Stu Zweben**, H. Reichgelt, and G. Yaverbaum, *Proceedings of the 2005 ACM Technical Symposium on Computer Science Education (SIGCSE 2005)*, St. Louis, MO, 560-561, February, 2005.

### Coordinated Contingency Planning in the Face of Uncertainty in the National Aviation System

**Philip J. Smith, Amy Spencer, and Charles Billings**, *Proceedings of the 13<sup>th</sup> Int'l Symposium on Aviation Psychology*, Oklahoma City, OK, April, 2005.

### Exploring Barriers and Facilitators to the Use of Computerized Clinical Reminders

J.J. Saleem, **Emily S. Patterson**, L. Militello, M.L. Render, G. Orshansky, and S.M. Asch, *Journal of the American Medical Informatics Association*, E-Published March 31<sup>st</sup>, 2005.

### Functional Impairment as a Predictor of Spine Loading

**William S. Marras, Sue A. Ferguson, Deborah Burr**, K.G. Davis, and P. Gupta, *Spine*,30(7):729-737, 2005.

### Migration of FACET Simulation Environment to Dispatcher Decision Support System

B. Sridhar, K. Sheth, **Philip J. Smith**, and W. Leber, *Proceedings of the 6<sup>th</sup> USA/Europe Seminar on Air Traffic Management Research and Development*, Baltimore, MD, June, 2005.

### Representing and Providing Access to "Tribal Knowledge" about Airspace Constraints in the Aviation System

**Amy Spencer, Philip J. Smith**, G. Wilmouth, and M. Klopfenstein, *Proceedings of the 2005 Industrial Engineering Research Conference*, Atlanta, GA, May, 2005.

### Sagittal Plane Moment Arms of the Female Lumbar Region Rectus Abdominis in an Upright Neutral Torso Posture

M.J. Jorgensen, **William S. Marras**, F.W. Smith, and M.H. Pope, *Clinical Biomechanics*, 20:242-246, 2005.

### The Use of Integrated Historical and Predictive Data to Support Flight Planning by Airline Dispatchers

**Chrissy Liu, Philip J. Smith, Charles Billings**, K. Sheth, S. Grabbe, and B. Sridhar, *Proceedings of the 13<sup>th</sup> Int'l Symposium on Aviation Psychology*, Oklahoma City, OK, April, 2005.

## Best Practices Guide for Food Distribution Centers Now Available

The Institute is proud to make available the book, *A Best Practices Guide for the Reduction of Musculoskeletal Disorders in Food Distribution Centers*.

Co-authored by William Marras, Gary Allread, Mike Jorgensen, and Carol Stuart-Buttle, this *Guide* provides useful information for individuals and companies who work in or with the food distribution industry on issues and solutions to reduce health and safety concerns. More information is available at the Institute's web site, [www.ergonomics.osu.edu](http://www.ergonomics.osu.edu).

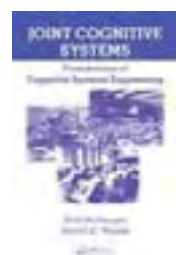


## Joint Cognitive Systems: Foundations of Cognitive Systems Engineering

Erik Hollnagel and **David D. Woods**  
Taylor & Francis, 2005. (200 pages, \$99.95)

How do people work around complexity and exploit new capabilities in work? How do systems of people and artifacts adapt to the demands of work? What are the surprising reverberations of technology change? Cognitive Systems Engineering arose about 25 years ago to meet these challenges.

This book provides the authoritative guide to the origins and basic concepts, from two of the pioneers in the field.



# 13<sup>th</sup> International Symposium on Aviation Psychology Oklahoma City • April 18<sup>th</sup>-21<sup>st</sup>, 2005

Several Institute for Ergonomics members presented at the 2005 International Symposium on Aviation Psychology. Abstracts of their research are shown below.

## *Representing and Providing Access to "Tribal Knowledge" about Airspace Constraints in the Aviation System*

Amy Spencer, Philip J. Smith, G. Wilmouth, M. Klopfenstein

**Abstract.** In aviation, task-specific knowledge has been distributed among operational staff based on their historically defined responsibilities. As new procedures have changed responsibilities, a barrier to performance has been the difficulty of disseminating relevant "tribal knowledge" to those who now require it. This paper discusses the design of a new tool to support the dissemination of such "tribal knowledge" regarding routine airspace constraints and traffic flows to help ensure more timely and effective route and traffic flow planning decisions using a form of constraint propagation within this distributed cognitive system.

## *Coordinated Contingency Planning in the Face of Uncertainty in the National Aviation System*

Philip J. Smith, Amy Spencer, Charles Billings

**Abstract.** A major challenge for strategic planning in aviation is uncertainty about weather and traffic constraints, as traffic managers often have to disseminate reroute advisories 2 hours before an expected constraint impacts an airport, and dispatchers file flight plans 60-75 minutes before a flight's departure. When the predictions used for these plans are wrong, significant inefficiencies (unused airspace & runway capacity and delayed flights) often result. To make operations more adaptive, new procedures have been developed. These involve using predefined Coded Departure Routes and are now being extended to include the dissemination of strategic plans that explicitly deal with uncertainty. Through this process, the decision about what departure route to actually use for a flight can be delayed until it is ready to depart, avoiding the need to make an early (and potentially poor) commitment to a departure route that may be unavailable at the time the flight taxis out for departure, while still keeping the dispatcher in the loop.

## *The Use of Integrated Historical and Predictive Data to Support Flight Planning by Airline Dispatchers*

Chrissy Liu, Philip J. Smith, Charles Billings, et al

**Abstract.** Airline dispatchers play a critical role in the National Airspace System. Their flight planning decisions have a direct impact on the efficiency and safety of the resultant traffic flows and on contingency plans to deal with possible events that could arise while enroute. Their decisions also have an important impact on the operating costs for an airline. This paper discusses the results of two focus groups with airline & mili-

tary dispatchers that served to identify potential uses by dispatchers of the functionality contained in NASA's Future ATM Concept Evaluation Tool (FACET). It uses trajectory modeling to generate predictions of ATC sector loadings and to generate and evaluate alternative routes for an aircraft in terms of potential traffic congestion concerns. The paper then discusses follow-up work based on one of these findings: The potential value of combining data from FACET with historical data about a flight's past performance in order to improve pre-flight planning and flight-following while an aircraft is enroute.

## *Airport Resource Management & Decision Aids for Airlines* Amy Spencer, Philip J. Smith, Charles Billings

**Abstract.** Airport surface management is fundamentally a task requiring decision making under uncertainty. For example, there is uncertainty about when an aircraft will be ready to push back, how long it will take a departing flight to taxi to the departure runway queue and how long it will take an arriving flight to taxi to its gate from the arrival runway. As a result, managing traffic on the airport surface, and coordinating this surface movement with airspace constraints, is a risk management task. Decision support tools which provide better access to airport surface data and predictions, as well as access to NAS-Status data such as airspace constraints, will reduce but not eliminate uncertainty. Therefore, to be effective, tools designed to support surface management decisions regarding events such as those listed above must reason about the inherent uncertainty in these events and assist airport users in their decisions regarding aircraft surface operations.

## *Migration of FACET Simulation Environment to Dispatcher Decision Support System*

B. Sridhar, K. Sheth, Philip J. Smith, W. Leber

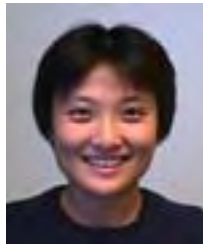
**Abstract.** Traffic Flow Management in the U.S. is a collaborative effort for dynamic & integrated handling of air traffic and airspace between the FAA, Airline Operations Centers, & other flight operator organizations. Tools & decision support systems used manage this complex task are rapidly changing and need improvement. NASA has developed concepts to evaluate what-if situations affecting traffic flow in the National Airspace System, assessed using Future ATM (Air Traffic Management) Concepts Evaluation Tool (FACET), an environment for modeling and evaluating system-wide airspace operations over the U.S. Part of FACET has been developed to test functionalities from an airline dispatcher's perspective. This paper describes the approach taken to develop AOC requirements, assess feasibility of enabling such functionality, implement corresponding capabilities & ongoing efforts to transfer FACET derived technology to users of the NAS. State-of-the-art advances for handling flights using integrated air traffic & weather data, along with the coupled applications of risk analysis, demand forecasting & management, and efficient route planning for various phases of flight are addressed. Though the implementation issues are presented here with respect to FACET, the comments apply generally to the development of most dispatcher tools.

## Graduate Student News

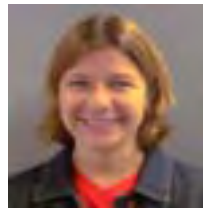
In March 2005, **Jake Banks** graduated with a Masters degree in Biomedical Engineering. He studied under advisor Dr. Steve Lavender. Jake's thesis involved, "Measuring Palmar Pinch Strength for Macaca Fascicularis: Establishing a Representative Carpal Tunnel Syndrome Animal Model." Jake can be reached at [banks.221@osu.edu](mailto:banks.221@osu.edu).



During the Winter Quarter, 2005, **Chrissy Liu** successfully completed her General Exam. Her advisor is Dr. Philip J. Smith.



**Amy Asmus** completed her Masters degree in March, 2005, under advisor Dr. Carolyn Sommerich. Her thesis topic was, "The Effects of Manual Pruning Tool Design Parameters on Muscle Activity, Wrist Posture, and Perceived Effort."



Amy is now an engineer at NASA Glenn Research Center in Cleveland. She is working with electron and optical devices for space communications and is on a team to develop the communications system to be used in the astronauts' EVA space suits in the next phase of lunar missions. She can be reached at [asmus.4@osu.edu](mailto:asmus.4@osu.edu).



**Gregory Knapik** graduated with his Masters degree in Mechanical Engineering in March 2005. Under advisor Dr. William Marras, Greg completed his thesis, "A Three-Dimensional, EMG-Assisted, Push-Pull Model for Assessing Dynamic Loads on Each Level of the Lumbar Spine."



Greg is now working as a Senior Research Associate-Engineer in the OSU Biodynamics Laboratory and will be continuing his work in advanced biomechanical model development. He can be reached at [knapik.1@osu.edu](mailto:knapik.1@osu.edu).



## Benefits of Human Factors & Ergonomics Society Membership

Membership in the Human Factors and Ergonomics Society (HFES) offers valuable and rewarding opportunities to students, both in education and in career development.

Student Affiliate members benefit from the following HFES programs:

- All Basic Membership benefits, which includes subscriptions to the *Human Factors* journal, *Ergonomics in Design*, the annual *Directory and Yearbook*, and the *HFES Bulletin*, in total a \$412 dollar value (<http://hfes.org/MemberDesk/memberbenefits.html>)
- Graduate Program Directory (<http://hfes.org/Publications/2002Gradschools/TofC.html>)
- Preparing for a career in human factors/ergonomics (<http://hfes.org/careerguide/index.html>)
- Tips for finding a human factors/ergonomics job (<http://hfes.org/publications/quicktips1.html>)
- Job placement service (<http://hfes.org/placement/placementnotice.html>)
- Membership in student chapters
- Student listserv
- Best Student Paper Award
- Student Member with Honors Award
- Outstanding Student Chapter Award
- Networking opportunities with other professionals

Get involved! The on-line Student Application can be found at <http://hfes.org/memberdesk/Student.html>.



HUMAN FACTORS and  
ERGONOMICS SOCIETY

## Measuring Palmar Pinch Strength for *Macaca Fascicularis*: Establishing a Representative Carpal Tunnel Syndrome Animal Model

Jacob J. Banks, Masters Thesis

**Abstract.** The primary purpose of this study was to develop the methodology to determine *Macaca fascicularis* static pinch strength. The larger purpose of this work is to properly scale a pinching task for the monkey that can be used to study dose-response relationships for the development of carpal tunnel syndrome that are applicable to humans.

Three female and one male macaque of varying size and age were trained to perform a left-handed palmar pinch. The task required 60° of wrist flexion at a static pinching distance of 3 cm between the thumb and fingers. Subjects were trained for 20 weeks. Then, an analysis by way of performance gradients found that they had each reached a plateau in their force output. Pinch strength for the four animals ranged from 3.0-6.1 kg (with the lone male animal responsible for greatest strength value).

Comparison with literature showed the data were consistent with human findings. Regression analysis of several anthropometric factors indicated that body weight and wrist circumference showed the most promising correlation to pinch strength, exhibiting adjusted R<sup>2</sup> values of 0.93 (significance of 0.024) and 0.96 (significance of 0.015). This study laid the groundwork for future monkey pinch strength research; more importantly, it provided initial values that could be used to design a subject-specific pinching task for investigations focused on carpal tunnel syndrome development.

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## The Effects of Manual Pruning Tool Design Parameters on Muscle Activity, Wrist Posture, and Perceived Effort

Amy Asmus, Masters Thesis

**Abstract.** This study examined effects of pruning tool design and age on muscle activity, wrist posture, and perceived effort. Twelve right-handed females each used four different pruners (labeled A, B, C, and D) of different designs and various handle sizes, shapes, and features. The women, selected in age groups of under 30 years and over 50 years, performed a series of cuts on dowel rods of uniform size. One pruner had an angled handle and a rotating power gear to assist the hand (A), another did not have an angled handle and was considered the control (B). Two others, also with angled handles (C and D), were identical to each other except for their size. The smaller pruner (D) has been marketed to users with smaller hands. The study observed fourteen dependent measures.

Electromyographic data for four muscles involved in gripping were recorded: flexor digitorum superficialis (FDS), flexor carpi ulnaris (FCU), flexor digitorum radialis (FCR), and muscles of the thenar eminence. The 50<sup>th</sup> and 90<sup>th</sup> percentile normalized activity levels were examined. Wrist goniometers were used to record wrist position data for radial/ulnar deviation and flexion/extension. A discomfort and effort survey obtained sub-

jective data about each pruner. Subject anthropometry also was recorded.

Combined EMG, subjective, and wrist data results indicate a benefit to pruner A. All subjects were sensitive to the design features of the pruners, but additional significant differences between pruners were seen among the older group. These differences were seen in the normalized peak activity of the two wrist flexor muscles. Of the small and the large pruners, the large pruner (C) required less muscular effort than the small pruner (D). This was true even for users with smaller hands. This is most likely because the larger pruners provide a mechanical advantage with more leverage than the smaller pruners.

Studies such as this one may assist pruning tool users, whether professional gardeners or beginners, to make informed product decisions based on a quantitative evaluation of design features, as well as consideration of subjective assessments.

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## A Three-Dimensional, EMG-Assisted, Push-Pull Model for Assessing Dynamic Loads on Each Level of the Lumbar Spine

Gregory Knapik, Masters Thesis

**Abstract.** Industrial work has changed recently, favoring pushing and pulling with carts and other material handling devices instead of lifting. In pushing and pulling, most of the force requirement is in the horizontal, rather than vertical, direction. While the magnitude of the force typically is smaller than in lifting, the horizontal direction of the force results in the application of greater shear forces on the spine in pushing and pulling. The few studies examining shear forces have reported that the spine has a smaller tolerance to shear forces than compressive forces. As a result, even though smaller magnitude forces are imposed on the spine than in lifting, there is still a possibility of injury in pushing and pulling due to the lower tolerance level.

There are very few biomechanical models of sufficient complexity to accurately assess pushing-pulling loads on the spine. To address this current void, a 3-dimensional, dynamic, EMG-assisted model was developed that features a more detailed representation of the lumbar spine that takes into account the dynamic curvature of the spine and measures compressive and shear loads at multiple lumbar levels.

This model was used to examine spinal loads in 20 volunteers performing pushing and pulling exertions at three different handle heights (50%, 65%, and 80% of subject stature), at three hand force levels (20%, 30%, and 40% of subject weight), and at two different handle conditions (with and without horizontal freedom).

Compressive loads were found to be below literature tolerance values at each level of the lumbar spine. Anterior-Posterior shear loads, however, were found to reach or exceed tolerance limits at the higher lumbar levels, identifying a possible mechanism for low back injury in pushing and pulling. Overall spinal loads were found to vary as a function of hand force level, handle height, and gender at each lumbar level for both pushing and pulling.