

from Research to Reality

Slips and Falls

Using Perception
to Gauge Risk

LIBERTY MUTUAL RESEARCH INSTITUTE FOR SAFETY

SCIENTIFIC UPDATE



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Letter from the Director



Dear Readers

Slips and falls are alarmingly common. U.S. emergency rooms treat about 25,000 patients with severe, fall-related injuries every day. What's worse is that the burden associated with fall injuries is on the rise. The working world saw a 42 percent increase in the burden associated with same-level falls from 1998 to 2010 (2012 Workplace Safety Index).

*This issue of *Scientific Update* profiles an area of slips-and-falls research aimed at identifying modifiable risks that can be lessened through simple, often low-cost interventions such as proper housekeeping. A principal thesis of this research is that surveying employees about risks is a quick and easy way to identify hazardous environments in the workplace. The featured study is the first to demonstrate that subjective assessments of slipperiness are reliable indicators of actual risk and can be used to prioritize fall intervention opportunities. While the research to date has focused on workplace risk factors, the findings will help everyone exposed to these common, everyday hazards.*

In the News section we highlight the recent contributions of Dr. Clark Dickerson, the Institute's 2013 Visiting Scholar, as well as those of Dr. Lora Cavuoto and Mr. Denny Yu, who joined us through the American Society of Safety Engineers Fellowship program. We also congratulate Dr. Marvin Dainoff, director of the Center for Behavioral Sciences, on the prestigious Distinguished Service Award he received from the Board of Certification for Professional Ergonomics.

We invite you to read more about these developments, and, as always, we welcome your feedback.

A handwritten signature in black ink, reading "Ian Noy".

Ian Noy, Ph.D.
Vice President and Director

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Slips and Falls

No Laughing Matter

If you go to YouTube and type in “slips and falls,” thousands of videos appear, and many are tagged with words like “funny,” “hilarious,” or “hysterical.” However, the serious injuries that occur every day due to slips and falls are no laughing matter. According to the U.S. Centers for Disease Control, nearly a third of non-fatal injuries treated at emergency departments in 2011—more than nine million—were related to falls. Falls were also the second-leading cause of fatal traumatic injuries.

Falls are the leading cause of injuries in the U.S. overall, the number-one cause of off-the-job injuries, and the second-leading cause of injuries at work. “From the Global Burden of Disease and Injury studies, we know that falls are also one of the fastest growing causes of disability in the U.S. and Canada,” says Theodore K. Courtney, M.S., CSP, director of the Center for Injury Epidemiology (CIE) at the Liberty Mutual Research Institute for Safety. “That’s why slips and falls continue to be a primary focus at the Research Institute.”

For nearly 60 years, the Liberty Mutual Research Institute for Safety has conducted research to examine how and why falls occur and to provide a scientific basis for strategies to help control slip and fall risk. Early Institute research examined the role of friction in slips and falls. It sought ways to make friction measurements feasible, reliable, and repeatable in the workplace. The research efforts resulted in the development of the Horizontal Pull Slipmeter™—an ASTM-standard device developed by Institute researchers. This slipmeter has been used for decades to assess floor friction in thousands of industry settings.

Over the years, the Institute broadened its research in order to look at various contributing factors as well as risk-control strategies for slips and falls. Investigations of the effects of contamination and friction changes, as well as studies of footwear

and various floor-cleaning protocols, have produced useful knowledge for slip-prevention best practices. A recent research collaboration with the U.S. Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health showed that double-digit risk reduction is possible when using a practical portfolio of interventions.

This body of research helps improve worksite safety in many different sectors including healthcare, retail, hospitality, and other environments where the risk of slipping is high. The findings have important safety implications for workers as well as customers, patients, vendors, and contractors. “By mitigating the risk of slips and falls for employees, you also reduce risk for everyone else who comes onto that site,” asserts Courtney.

Most recently, researchers from the CIE and other Institute Centers, along with collaborators at the Harvard School of Public Health, explored the association between workers’ perceptions of floor slipperiness and the actual rates of slipping in the workplace. Explains Courtney, “We originally set out to better understand how perception interacted with floor friction. Along the way, however, we discovered that perception holds much greater potential for reducing slips and falls than we initially imagined. The knowledge gained through this research provides the basis for a new approach to slip risk assessment that could help prevent serious fall-related injuries.”

Unlocking the Power of Perception



Slip Risk Assessment

Same-level falls are a leading cause of injury — both on and off the job — but are we doing all we can to help reduce these incidents? Recent research developments suggest that surveying employees about their slipping risks at work can provide valuable information for assessing and addressing these hazards.

As the primary initiating event for same-level falls, slipping contributes to up to 85 percent of fall-related workplace injuries. For that reason, safety researchers have long been interested in finding ways to accurately measure slipperiness. For the most part, researchers and practitioners rely on objective friction (i.e., slipmeter) measurements to evaluate floor surfaces. However, recent research has shown that subjective measures—namely, workers' perceptions of slipperiness—may provide an effective and more practical alternative to objective measurement strategies. "Employees accumulate a wealth of information about potential workplace hazards while simply doing their jobs. We are now beginning to understand how to tap into this information to better assess slip risk," explains Theodore K. Courtney, M.S., CSP, director of the Institute's Center for Injury Epidemiology.

Testing Perceptions: From Idea to Application

The idea that employees' perceptions could be potential indicators of actual slip and fall risks evolved gradually, originating at the Institute's Hopkinton Conference in 2000. The conference brought together university, industry, and government representatives from seven different countries to address the current state of research on slips and falls. Participants explored several major areas of research including epidemiology, biomechanics, tribology, and human-centered approaches. Courtney notes, "With respect to perception, we discussed existing research on objective and subjective methods. There was considerable evidence that people could discriminate [among] differing degrees of slipperiness in controlled laboratory studies, but this had not been tested beyond the laboratory in the uncontrolled, real-world environment."

In 2002, Institute researchers led by Senior Research Scientist Wen-Ruey Chang, Ph.D., examined objective and subjective

measures in a cross-sectional field study of 10 limited-service restaurants and 126 workers. As part of that project, the investigators collected workers' self-reported perceptions of slipperiness and compared them with objective friction measures taken in eight areas of each restaurant. The findings, published in the *Journal of Occupational and Environmental Hygiene* (Vol. 3, No. 11, 2006), confirmed a correlation between perceived slipperiness and measured friction.

The research team also asked workers if they had slipped and/or fallen at work within the four weeks prior to their interview. "Because the team asked these additional questions, we later discovered a strong association between friction and workers' self-reported slip experiences," notes Senior Research Scientist Santosh K. Verma, M.D., Sc.D., M.P.H., one of the study's co-investigators. Dr. Verma notes, "This finding, published in *Injury Prevention* [Vol. 16, No. 1, 2010], opened the door to future studies where we could evaluate the influence of various factors, including perception, on slipping risk over a longer period of time."

Study Explores Power of Perception

In 2008, Dr. Verma and a team of Institute researchers joined forces with researchers at the Harvard School of Public Health to examine the influences of individual, environmental, and organizational factors on workplace slips and falls. This project, which involved 36 limited-service restaurants and 475 workers, led to some exciting firsts including the first independent confirmation that slip-resistant footwear reduces slipping risk by 54 percent (*Occupational and Environmental Medicine*, Vol. 68, No. 4, 2011 and *Scientific Update*, Vol. 14, No. 1, 2011). As part of this investigation, researchers also examined the association between workers' perceptions of slipperiness and their slipping outcomes.

“The findings from our research could have broad application for organizations that are looking to reduce slip hazards and to help people stay safer.”

Researchers collected objective and subjective data in each of the participating restaurants. At the baseline, teams measured the coefficient of friction (COF) in eight functional areas in each restaurant. These objective measures were averaged at the restaurant level to calculate each restaurant's mean COF. To assess employee perceptions, researchers asked participants to rate floor slipperiness in these same eight areas based on a typical workday scenario. Participants used a four-point rating scale in which: 1 = not slippery, 2 = a little slippery, 3 = more slippery, and 4 = very slippery. Researchers aggregated and averaged these ratings at both the restaurant level (finding an overall rating for each restaurant) and at the area level (finding eight ratings per restaurant for each of the eight areas surveyed).

After completing the baseline measurements and surveys, the team asked participants to report their slip experiences each week for the following 12 weeks by phone (via interactive voice-response system), an Internet-based survey, or paper survey forms. Each week, participants reported their number of slips and the number of hours they had worked during the previous week. They also reported the functional area(s) within the restaurant where they had slipped.

The study's findings, published in *Occupational and Environmental Medicine* (Vol. 70, No. 11, 2013), revealed that each increase of 1 point (on the 4-point scale) in the mean restaurant-level perception of slipperiness was associated with a 2.71-times higher rate of subsequent slipping. Results were similar for area-level perceptions within the restaurant.

“Slipping rates nearly tripled with each one-point increase in aggregated perception. That is very significant,” says Courtney, the study's first author, who notes that this finding has implications for those industries most affected by slips and falls—such as healthcare, retail, hospitality, and construction. “The strong association between perception and actual slipping means that workers' perceptions can be used to help identify and control slipping hazards. This is a highly scalable risk assessment approach,” explains Courtney, meaning that smaller enterprises as well as larger organizations could readily leverage the method.

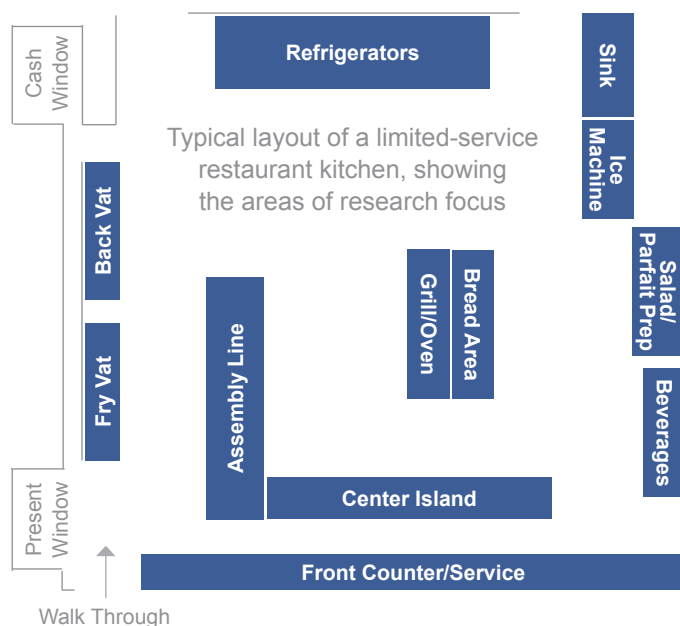
With that in mind, the Research Institute is currently examining slipperiness perception in a new study of full-service restaurants. In addition to back-of-the-house kitchen areas, this study examines front-of-the-house areas, including reception, take-out, bar, dining rooms, and other areas that are open to both employees and to the general public. In this way, employees' perceptions of floor slipperiness may provide useful information for helping restaurant patrons, as well as workers, avoid falls.

“We now have evidence that workers can identify future slip risk across a given location fairly accurately by using this method. This suggests that workers' perception ratings should be considered in risk assessment and reduction strategies,” says Courtney. “The findings from our research could have broad application for organizations that are looking to reduce slip hazards and to help people stay safer.”

Perception of Floor Slipperiness Study

Workers rated slipperiness of eight restaurant areas on a “typical day” using a 4-point Likert scale:

“On a scale of 1 to 4, with 1 being not slippery and 4 being very slippery, circle the number that you think best describes the floor condition for each area on a typical workday.”



Survey Offers Proactive Approach to Slips and Falls Prevention

Research to Reality

One of the particular challenges associated with managing same-level slips and falls is that most work environments are dynamic, which makes it difficult to identify a hazard prior to injury. Rather, an individual falls, suffers an injury, and the unfortunate event brings attention to a hazard that may have otherwise gone unnoticed.

In some situations, a slip or fall that occurs without an injury goes unreported, leaving a potentially hazardous condition for the next person. “That’s why, in many cases, slips and falls interventions are implemented *reactively*,” says Wayne Maynard, CSP, CPE., Liberty Mutual Risk Control Services product director. “We have to find more ways to be *proactive* in this area and to identify potential risks before the slips and falls happen.”

A more proactive approach is precisely what Maynard and a team of risk-control specialists are working on, using the evidence provided by the Research Institute’s slipperiness perceptions research. “Our research showed a strong association between employee perception of slipperiness and subsequent slipping at work. That means that employees’ perceptions are an accurate indicator of slip risk, and it is not necessary to wait for an injury to occur to take action,” explains Maynard. “Areas of risk can be identified using a perception survey, and then practitioners can look for ways to reduce that risk.”

While not discounting the value of objective measures, such as friction, Maynard notes that these measures can be expensive and difficult to implement in the field. “Slipmeters are great tools for assessing floor surface friction and related risk; however, they are not always practical,” explains Maynard. Industries that have a particularly high risk for same-level slips and falls—retail, restaurant, hospitality—are fast-paced and conditions are ever-changing. “Employers can’t just stop everything to take slipmeter measures during the course of normal business. A perception survey, on the other hand, is entirely scalable and non-disruptive to everyday business operations.”

Maynard and the team are currently working to develop an online slipperiness perception survey that can be accessed via smartphone or other computer device. Beginning in 2014, restaurants will be able to administer the customized online survey at very low cost, without disrupting daily operations. The survey data will provide slip-risk information for the various areas of their business.

Based on the survey findings, practitioners will be able to identify high-risk areas and then select appropriate interventions for mitigating slips and falls in those areas. “One of the real advantages to this process is that, after an intervention is implemented, the survey can be re-administered to determine whether or not it was successful,” notes Maynard.

The straightforward and time-efficient risk assessment survey approach requires little to no technical background to use. “Organizations can easily implement the survey. Even a small organization that doesn’t have access to mechanical slip-assessment devices (and the expertise to use them) can employ the survey as a stand-alone approach to slipperiness assessment,” notes Maynard. “However,” he adds, “if an employer can combine the survey data with objective measures, it will provide a more comprehensive approach to slip-and-fall risk assessment.” While the initial survey is envisioned for restaurants, Maynard says surveys will be developed for other industries over time.

An additional benefit of the employee perception survey is that it encourages employee engagement in the safety process. In early 2013, the National Safety Council listed employee

“Our research showed a strong association between employee perception of slipperiness and subsequent slipping at work. That means...it is not necessary to wait for an injury to occur to take action.”

engagement as among one of the four fundamentals of successful safety management. Maynard elaborates, “It is important to engage employees in the risk identification process. The slipperiness perception survey gets workers thinking about, believing in, and actively contributing to safety efforts. When that happens, morale improves and employees become advocates of the company’s safety program. That’s always a win.”

“This is going to be a very helpful tool,” says Maynard. “It adds an important arrow to the quiver of slips-and-falls safety management protocols. “It is very difficult to take slipmeter measurements during the normal course of business, and you need the device and a trained operator to take the readings. A perceptions survey, on the other hand, is entirely scalable and non-disruptive to everyday operations.”

Wayne S. Maynard CSP, CPE is a product director for Liberty Mutual Insurance Risk Control Services. As product director specializing in ergonomics and tribology, Maynard works closely with the Research Institute and business units within Liberty Mutual to develop high-end research-based products and tools that support the company’s book of business and target-industry strategies. Prior to his current position, Maynard served as manager of technical services and product development at the Research Institute.

Maynard has authored/co-authored numerous articles and presented many times at industry and safety conferences. He belongs to several technical committees on ergonomics, pedestrian walkway safety, and footwear. Maynard holds a B.A. from the University of Maine and is a Certified Safety Professional and Certified Professional Ergonomist. He also holds the Associate in Loss Control Management designation.



“We can identify areas of risk using a perception survey, and then look for ways to reduce that risk.”

Winning Paper Examines the Interaction of Force and Repetition on Musculoskeletal Disorder Risk

Researchers Sean Gallagher, Ph.D., CPE and John R. Heberger, M.A., M.S., were recently awarded the 2013 International Ergonomics Association (IEA)/Liberty Mutual Medal in Occupational Safety and Ergonomics. The researchers received the honor for their scientific paper “Examining the Interaction of Force and Repetition on Musculoskeletal Disorder Risk: A Systematic Literature Review” (*Human Factors*, Vol. 55, No. 1, 2013). Dr. Gallagher is an associate professor in the Department of Industrial and Systems Engineering at Auburn University, Auburn, AL, and Mr. Heberger is an epidemiologist at the National Institute for Occupational Safety and Health in Pittsburgh, PA.

The winning paper describes a consistent pattern of interaction between the musculoskeletal disorder (MSD) risk factors of force and repetition and provides a likely theoretical basis for this relationship. For the investigation, the researchers conducted a systematic review of epidemiology studies that tested for a force-repetition interaction. These studies indicated that repetition had a vastly different impact on MSD risk, depending on the amount of force involved. Typically, increased repetition rates led to a modest increase in risk for low-force tasks, while high-force tasks greatly magnified the effect of repetition rate.

The authors note that the pattern of risk observed in the epidemiology studies strongly suggests an underlying fatigue-failure process in the affected tissues. Fatigue failure begins when a sufficient force imposes upon exposed tissue, creating a small area of damage. If forceful loading continues, the weakened area of the tissue expands. This

paper details the rate of expansion as a function of the specific combination of applied force and number of repetitions experienced.

“This winning paper demonstrates how scientific research contributes to understanding and preventing injuries,” says Andrew S. Imada, Ph.D., IEA past president and awards-committee chair. “Rather than looking at known risk factors for MSDs independently, the authors identified more complex relationships between force and repetition that are more representative of work in the real world. This illustrates how science can be translated into ergonomics practice.”

The Medal was presented on October 1, at the 57th International Human Factors and Ergonomics Society Annual Meeting held in San Diego, CA. Gallagher said, “We are deeply honored to be the recipients of this prestigious award. We would like to express our appreciation to both Liberty Mutual and the IEA for their leadership and long-standing commitment to the field of ergonomics.”



Research Institute director Dr. Ian Noy congratulates Dr. Sean Gallagher, Ph.D., CPE on receiving the 2013 IEA/Liberty Mutual Medal while IEA past president Andrew S. Imada looks on.

Visiting Scholar Collaborates on Shoulder Research



Dr. Dickerson

The Liberty Mutual Research Institute for Safety selected Clark Dickerson, Ph.D., of the University of Waterloo in Ontario, Canada, as the 2013 Visiting Scholar. During his three-month tenure, Dr. Dickerson collaborated with research scientists on an investigation studying the prevention of muscular fatigue in the shoulder. The study's purpose was to identify different postural zones, which could ultimately help practitioners prevent shoulder injuries, including impingement and rotator-cuff disease, when designing work practices across a wide range of occupational sectors. The findings of this study should provide insight into muscle use and fatigue, helping to improve theoretical predictive models to help researchers and practitioners reduce injury risk.

Prior to arriving at the Institute, Dr. Dickerson had conducted laboratory work examining body postures during manual tasks, focusing on how the tasks affect key muscles of the rotator cuff that control arm rotation. His initial pilot research in this area revealed repeatable relationships between the tasks and these muscles. This knowledge, coupled with prior shoulder-posture studies undertaken at the Institute, formed the basis for an expanded study that addressed hand requirements, shoulder postures, and muscle use.

For the investigation, researchers observed 20 subjects (10 males and 10 females) as they performed tasks with different force requirements and postures, involving both internal and external shoulder rotation. The study's participants exerted specified forces against a frame while the researchers collected data using motion capture, force profilometry, and electromyography. With the data-collection phase complete, Dr. Dickerson has returned to his university to analyze the results and will collaborate with Institute researchers to develop a related manuscript for publication.

Dr. Dickerson is an expert researcher in the area of shoulder mechanics. He has produced one of the most advanced ergonomic shoulder-exposure prediction models available worldwide. His research aims to generate new knowledge regarding fundamental shoulder function and dysfunction; the creation and validation of mathematical models to predict shoulder demands; applications of shoulder biomechanics toward workplace-injury prevention; and rehabilitative and preventative strategies for ensuring lifelong shoulder health.

At the University of Waterloo, Dr. Dickerson is an associate professor in the Department of Kinesiology. In 2005, he earned his Ph.D. in Biomedical Engineering from the University of Michigan. Prior to that, he earned a Master of Science degree in bioengineering from Clemson University and a Bachelor of Science in mechanical engineering from Alfred University. He is a member of the American Society of Biomechanics, the

Association of Canadian Ergonomists, the Canadian Society for Biomechanics, the International Society of Biomechanics, and the International Shoulder Group (a technical group of the International Society of Biomechanics). Dr. Dickerson has published more than 50 scientific journal articles and has presented his work widely.

"My work at the Research Institute has been a valuable experience," says Dickerson. "Having different perspectives, particularly the business case side, was useful and certainly different than my usual scientific motivations. It put the real world application in the forefront of the investigation. It moved the work beyond a theoretical exercise."

ASSEF Fellows Conduct Biomechanics Studies Related to Obesity and One-Handed Pulling

Lora A. Cavuoto, Ph.D., an assistant professor at the University of Buffalo, SUNY, and Denny Yu, M.S.E., a doctoral candidate at the University of Michigan, recently completed fellowships through the Research Institute's joint program with the American Society of Safety Engineers Foundation (ASSEF). The Safety Research Fellowship Program encourages safety research activity; familiarizes graduate students, faculty members, and researchers with current scientific projects, research models, and applications; and expands and stimulates safety-research understanding. The program also provides a forum for linking safety professionals, industry needs, and quality research programs. The fellows spend four to six weeks working with research scientists at the Institute.



Dr. Cavuoto

Lora A. Cavuoto, Ph.D.

Dr. Cavuoto collaborated with Institute research scientists on a study that used near-infrared spectroscopy to quantify obesity-related differences in the brain and to examine how the body responds during a strenuous lifting task. The aim of the project is to enhance the understanding of how obesity impacts a worker's physiological ability and to encourage design improvements for ergonomic interventions and workplace wellness programs.

During her tenure, Dr. Cavuoto assisted researchers in conducting pilot testing, establishing a final research protocol and beginning data collection. Dr. Cavuoto will continue to work with the Institute beyond her tenure to complete the investigation and develop a manuscript for publication.

At the University of Buffalo, Dr. Cavuoto works in the department of Industrial and Systems Engineering and directs the Ergonomics and Biomechanics Laboratory. Her research interests include industrial ergonomics, biomechanics, occupational safety and health, and designing workplace accommodations for the obese and older populations. She received a Ph.D. in industrial and systems engineering from Virginia Tech. She earned an M.S. in occupational ergonomics and safety and a B.S. in biomedical engineering from the University of Miami.

Continued on next page

Dr. Cavuoto is an active member of the Human Factors and Ergonomics Society, the Institute of Industrial Engineers, and the Obesity Society.

"This fellowship provided a valuable experience in a strong collaborative environment," says Dr. Cavuoto. "I was able to advance my knowledge while working with some of the leaders in work physiology and ergonomics research. Going forward, I plan to continue working relationships with the Liberty Mutual research scientists, and I hope to extend this summer's work into other projects."



Mr. Yu

Denny Yu, M.S.E.

Mr. Yu worked with Institute researchers on a biomechanics investigation of one-handed pulling with the goals of identifying the biomechanical limitations of one-handed maximum pull strength at different handle heights and understanding the effects of anthropometry (body size, weight, and proportions), posture, and balance. The models created from this research are meant to assist ergonomics profession-

als with task design and job assessment in an effort to prevent worker fatigue and injuries. During his tenure, Yu assisted researchers in creating and testing biomechanical models for 31 subjects and 186 pull postures collected from prior Liberty Mutual research. He plans to continue his collaboration beyond his tenure to write a manuscript for scientific publication.

Yu's research focuses on developing tools to improve surgical procedures. Specifically, his work involves analyzing complex and technical surgical procedures to help determine best practices by linking techniques with patient outcomes and surgeon performance. His current research involves hierarchical task analysis for describing surgical procedures, standardization of surgical-technique patient outcomes, and evaluation of visual aids for surgeon performance and comfort in microsurgery. Yu is pursuing his Ph.D. at the University of Michigan, where he has received an M.S.E. in industrial and operations engineering. He also earned a B.S. in bioengineering at the University

of California, Berkeley. Currently, he is a National Science Foundation Graduate Student Fellow and a member of the Human Factors and Ergonomics Society and the International Society of Biomechanics.

"This has been an invaluable and unforgettable experience," says Yu. "The fellowship provided an opportunity to interact with some of the top researchers in the field. I believe the experience provided a solid foundation to develop future research collaborations."

Dainoff Receives Distinguished Service Award



Dr. Dainoff

Marvin J. Dainoff, Ph.D., CPE, director of the Research Institute's Center for Behavioral Sciences, received the Distinguished Service Award from the Board of Certification for Professional Ergonomics (BCPE) at the Human Factors and Ergonomics Society Annual Meeting held in October in San Diego. The BCPE is the accredited certifying body for professionals whose education and experience indicate broad expertise in the practice of human factors, ergo-

nomics, and user-experience research. From 2003 to 2012, Dr. Dainoff chaired the BCPE examination committee. During this time, he coordinated the revision of the description of core competencies for the professions of ergonomics, human factors, and user experience. Using this revision as a framework, he supervised the process of updating the certification examination. The first pilot version of the new examination was administered in September 2013.

Dr. Dainoff is professor emeritus of psychology at Miami University, Oxford, Ohio. He is a past president and fellow of the Human Factors and Ergonomics Society, and a past board member of the Council of Scientific Society Presidents. He has been with the Research Institute for Safety since 2008.

News and Notes

- More than 75 participants recently toured the Research Institute as part of the **Network of Employers for Traffic Safety (NETS) Annual Conference**. Attendees learned about the Institute's research program, visited laboratories, and met with researchers. The NETS is an employer-led public/private partnership dedicated to improving the safety and health of employees, their families, and members of the communities in which they live and work by preventing traffic crashes that occur both on and off the job.
- Principal Scientist **Lawrence Hettinger**, Ph.D., and Research Scientist **Michelle M. Robertson**, Ph.D., CPE, co-organized a panel session at the 57th Annual Meeting of the International Human Factors and Ergonomics Society, held recently in San Diego, CA. The topic of the round-table panel discussion focused on outcomes from the 2012 Liberty Mutual Hopkinton Conference regarding future directions for sociotechnical systems and safety.
- Center for Injury Epidemiology (CIE) Director **Theodore K. Courtney**, M.S., C.S.P., was recently elected Governing Councilor of the Injury Control and Emergency Health Services Section of the American Public Health Association.
- CIE Principal Research Scientist **David A. Lombardi**, Ph.D., recently accepted an invitation to serve on the editorial board of the *Scandinavian Journal of Work Environment and Health*.

Publications

Arlinghaus, A., Lombardi, D.A., Courtney, T.K., Christiani, D.C., Folkard, S. and Perry, M.J. (2013) The effect of rest breaks on time to injury: A study on work-related ladder-fall injuries in the United States. *Scandinavian Journal of Work and Environmental Health*, 38(6), 560-567.

Boyer, J., Lin, J.H. and Chang, C.C. (2013) Description and analysis of hand forces in medicine cart pushing tasks. *Applied Ergonomics*, 44(1), 48-57.

DiDomenico, A., McGorry, R.W. and Banks, J.J. (2013) Methodological considerations of existing techniques for determining stabilization times following a multi-planar transition. *Gait and Posture*, 38(3), 541-543.

Iles, R.A., Wyatt, M. and Pransky, G.S. (2013) Multi-faceted case management: Reducing compensation costs of musculoskeletal work injuries in Australia. *Journal of Occupational Rehabilitation*, 22(4), 478-488.

Johnston, V. and Shaw, W.S. (2013) Helping workers help themselves: Empowering physiotherapy clients to manage musculoskeletal problems at work. *Physical Therapy Reviews*, 18(8), 373-378.

Kraaijeveld, R.A., Schaafsma, F.G., Boot, C.R., Shaw, W.S., Bultmann, U. and Anema, J.R. (2013) Implementation of the participatory approach to increase supervisors' self-efficacy in supporting employees at risk for sick leave: Design of a randomised controlled trial. *BMC Public Health*, 13(1), 750.

Lesch, M.F., Powell, W.R., Horrey, W.J. and Wogalter, M.S. (2013) The use of contextual cues to improve warning symbol comprehension: Making the connection for older adults. *Ergonomics*, 56(8), 1264-1279.

Liang, Y., Lee, J.D. and Yekshatyan, L. (2013) How dangerous is looking away from the road? Algorithms predict crash risk from glance patterns in naturalistic driving. *Human Factors*, 54(6), 1104-1116.

Lin, J.H., McGorry, R.W. and Maynard, W.S. (2013) One-handed standing pull strength in different postures: Normative data. *Applied Ergonomics*, 44(4), 603-608.

Lin, T.C., Verma, S.K. and Courtney, T.K. (2013) Does obesity contribute to non-fatal occupational injury? Evidence from the National Longitudinal Survey of Youth. *Scandinavian Journal of Work and Environmental Health*, 39(3), 268-275.

Marucci-Wellman, H., Willetts, J.L., Diep, N.B. and Binh, T.T. (2013) The utility of injury narratives for prioritising future prevention activities in small and medium enterprises in rural Vietnam. *Injury Prevention*, 19(2), 92-99.

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Xu, X., Faber, G.S., Kingma, I., Chang, C.C. and Hsiang, S.M. (2013) The error of L5/S1 joint moment calculation in a body-centered non-inertial reference frame when the fictitious force is ignored. *Journal of Biomechanics*, 46(11), 1943-1947.

Xu, X., Lin, J.H. and Boyer, J. (2013) Shoulder joint loading and posture during medicine cart pushing task. *Journal of Occupational and Environmental Hygiene*, 10(8), 446-454.

Conferences

3rd International Conference on Driver Distraction and Inattention: Sept. 4-6, Gothenburg, Sweden

- Examining Fatigue and Inattention in Night Shift Workers During a Two-Hour Post-Shift Commute – Y. Liang, Ph.D.

American College of Epidemiology Annual Meeting: Sept. 21-24, Boston, MA

- Narrative Analysis in Injury Research: Methodological Issues – D.A. Lombardi, Ph.D.

57th International Human Factors and Ergonomics Society: Sept. 29-Oct. 4, San Diego, CA

- Future Directions for Sociotechnical Systems and Safety: Outcomes from the 2012 Liberty Mutual Hopkinton Conference: Communication and Decision Making – M. Dainoff, Ph.D., CPE
- A Work System Conceptual Model for Teleworkers: A Multi-Level Systems Perspective – M.M. Robertson, Ph.D., CPE

International Conference on Fall Prevention and Protection 2013: Oct. 23-25, Tokyo, Japan

- The State of Science on Occupational Slips, Trips and Falls on the Same Level and Available Coefficient of Friction Associated with Different Slip Probabilities for Level Walking – W.R. Chang, Ph.D.
- Current Priorities in Fall Prevention Research at the Liberty Mutual Research Institute for Safety – Y.I. Noy, Ph.D., CPE

141st American Public Health Association Annual Meeting: Nov. 2-6, Boston, MA

- Perception of Slipperiness and Prospective Risk of Slipping – T. K. Courtney, M.S., CSP
- Are Multiple Job Holders at Increased Risk of Injury? Findings from the National Health Interview Survey – H. Marucci-Wellman, Sc.D.
- Internet and Telephonic IVR Mixed-Mode Survey for Longitudinal Studies: Choice, Retention, Data Equivalency – S.K. Verma, Sc.D., M.D., M.P.H.

21st International Symposium on Shiftwork and Working Time: Nov. 4-8, Salvador Bahia, Brazil

- The Impact of Work Shift Starting Time on Sleep Patterns and Alertness Prior to Injury in the People's Republic of China – D.A. Lombardi, Ph.D.



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