

Institute for Ergonomics



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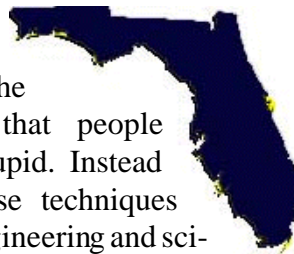
Florida Ballot Confusion has Human Factors Implications

The recent Presidential election has brought to the surface many stories of confusing ballot layouts, punch card problems, and machines that throw out votes. Many have mocked the stupidity of voters, saying that people only had to follow the arrows or that elderly voters were at fault for misreading the ballots.

Respect for users is a basic value in the science of ergonomics. When problems like ballot confusions occur, we

don't stop with the idea that people are stupid. Instead we use techniques of engineering and science to analyze and study the interface or interaction of people and device, and often find poor design and traps that could lead any of us to err. As Don Norman stated in one of his popular books on

Continued on page 8



Biodynamics Lab Gains National Coverage

Research from Ohio State's Biodynamics Laboratory was highlighted on television, both nationally and at a local level, on December 5th. During the CBS News with Dan Rather, a report on new findings regarding the lack of effectiveness of industrial back belts included an interview



with Dr. Bill Marras and footage of Institute for Ergonomics graduate students collecting

back motion data. A similar story also was presented locally on the NBC affiliate, WCMH - Channel 4.

See related articles, pages 3, 4.

Agency Releases Study on Work-Relatedness of Musculoskeletal Disorders, Intervention Program Effectiveness

There is scientific evidence that musculoskeletal disorders of the low back and upper extremities can be attributed to particular jobs and working conditions. That's the finding of a report released January 18 by the National Research Council and the Institute of Medicine of the National Academies.

When OSHA began making plans to implement an ergonomics standard, Congress asked the National Academies to review scientific evidence on work-related causes of MSDs as well as prevention strategies. The Academies' panel evaluated scientific literature on the topic, invited outside experts to share insights at its meetings, and visited two automobile plants as part of its research. The study was sponsored by the US Department of Health and Human Services.

Although the connection between the workplace and MSDs is complex, the report states that scientifically based prevention efforts can be effective in the workplace and can substantially reduce the risk of job-related MSDs.

Dr. Bill Marras, Co-Director of the Institute for Ergonomics, was on the panel of experts who studied this issue.

The entire press release can be read at: <http://national-academies.org>

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On the Move

Bill Marras received two grants from the National Institute for Occupational Safety and Health. The first, titled, "Muscle Overexertion During Repetitive Lifting," is funded through 2004. Funding for the second, "Identifying Safe Load Moment Exposures for the Back," runs through 2005. Together, these two grants total over \$2.5 million. Good work, Bill!

Stu Zweben gave a talk titled, "Computing's Role in Public Policy" at the University of Cincinnati (November).

"Human Factors Issues in the Support of Collaborative Decision Making in the National Airspace System," is the title of a grant funded by the Federal Aviation Administration and obtained by **Phil Smith**, Elaine McCoy and **Charles Billings**. It runs through 2003.

Gary Allread spoke on "New Ergonomics Standards in the Workplace" at the opening session of the Ohio AFL-CIO 22nd Annual Safety & Health Institute in Hudson, Ohio (December 4th).

Annual Short Course to be Held in May

The 2001 Ergonomics Short Course is scheduled for May 1st - May 4th. It will be held on the OSU Main Campus at the Fisher College of Business complex. In addition to presentations by Bill Marras and Phil Smith, Co-Directors of the Institute, guest speakers will include:

- **Dr. Dave Cochran** (University of Nebraska and recently with OSHA), to speak on OSHA's new ergonomics standard;
- **Dr. Cathy Heaney** (OSU School of Public Health), who will talk about links between psychosocial and work organizational factors and cumulative trauma;
- **Dr. Sue Ferguson** (OSU Department of Industrial Engineering), who will focus on the assessment of back injuries; and
- **Chris Hamrick** (Ohio BWC), who will train participants on ergonomic assessment tools for use in industry.

Contact the Institute, at 614.292.4565 or Candi McCain, at 614.688.8241, for more information.

"What is Ergonomics...and How Can I Use It to Make my Job Simpler" was the subject of a talk given by **Gary Allread** to the Ohio Extension Professionals Assn. in Columbus, Ohio (December 5th).

At the Fireside Chat Series for the Kuhn Honors & Scholars House, **Nadine Sarter** talked on "An Interdisciplinary Approach to Supporting Human Interaction With and Through Computers" (January 17th).

Sue Ferguson gave a series of presentations titled, "Understanding Cumulative Trauma Disorders" at the 2001 UAW-GM-Delphi Joint Health and Safety Training Conference in Palm Springs, California (January).

Call for Proposals

The 45th Annual Human Factors and Ergonomics Society will hold its annual meeting in Minneapolis/St. Paul from October 8-12, 2001. Proposals for all presentation types are due March 19th, 2001. For more information, visit the HFES web site, at <http://www.hfes.org>.



NIOSH Study Questions Back Belt Effectiveness

- Excerpted from a NIOSH Press Release, Dec. 5th, 2000

In the largest study of its kind, the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health found no evidence back belts reduce back injury or back pain for retail workers who lift or move merchandise, according to results published in the Journal of the American Medical Association's December 6th issue.

The study, conducted over two years, found no statistically significant difference between either the incidence rate of workers' compensation claims for job-related back injuries or back pain among employees who reported using back belts every day, and the incidence rate of such claims or back pain among employees who reported never using back belts or using them no more than once or twice a month.



Neither did the study find a statistically significant difference between the rate of back injury claims among employ-

ees in stores that required the use of back belts, and the rate of such claims in stores where back belt use was voluntary. These results are consistent with NIOSH's 1994 finding, that there is insufficient scientific evidence that wearing belts protects workers from risking job-related back injury.

An employee's back injury history was the strongest predictor of a back-injury claim or reported back pain, regardless of back belt use.

This was the largest prospective study ever conducted on back belt use. From April 1996 to April 1998, NIOSH interviewed 9,377 employees at 160 newly opened stores in a national retail chain. Store managers identified employees who lifted or moved merchandise. Data on workers' belt wearing habits, work history, lifestyle habits, job activities, demographic traits and job satisfaction were gathered. Also examined were workers' compensation claims for back injuries among employees.

In this study, NIOSH determined back belt use in advance of any injuries and collected data as workers filed back injury claims.

Major Findings

- There was no difference between back injury rates of workers who wore belts every day (3.38 cases per 100 full-time workers or FTEs) and rates of workers who never wore back belts or wore them no more than twice a month (2.76 cases per 100 FTEs).
- There was no difference in back pain incidence between workers who wore belts every day (17.1%) and those who never wore the belts or wore them no more than twice a month (17.5%).
- There was no difference between the rate of back injury claims in stores requiring the use of back belts and the rate in stores where back belt use was voluntary (2.98 vs. 3.08 cases per 100 FTEs).
- An employee's back injury history was the strongest predictor of a back-injury claim or back pain, regardless of belt use. The rate for those with a history of back pain was nearly twice as high as those without a previous history of back pain (5.14 vs. 2.68 cases per 100 FTEs).
- Even for employees in the most strenuous jobs, comparisons of back injury claims and back pain failed to show any differences in rates or incidence associated with belt use.

Job Stress May Lead to Back Injury for Some People, Study Finds

On-the-job stress doesn't just strain the nerves, it can strain the back, too. That's the implication of a study published by members of the Institute for Ergonomics that provides the first-ever link between stress and back pain. The findings should be significant to companies that depend on physical work from their employees.

The study appears in the December 1, 2000 issue of Spine. It found that people with certain personality types may increase their risk of back injury if they experience workplace stress. William Marras, Catherine Heaney, and their colleagues tested how 25 college students reacted to critical and unsupportive supervision when lifting boxes.

Students distressed by the criticism used their muscles in ways that might lead to injury over time. These results take a first step toward explaining why those with certain personality types, namely introverted

people and those who dislike performing repetitive tasks, are more likely to report back pain on the job.

"Sometimes, work isn't physically demanding, but psychologically demanding," Heaney said. "We found that

psychological stress seems to amplify the physical demands of lifting for certain personality types." Previous studies have shown a link between psychological work stress and back pain but have not provided an explanation why.

"I always thought there must be some kind of pathway between the two, something that damages the spine," Marras said. "One theory is that stressed people move differently when performing the same tasks."

To test that theory, researchers first gave students a common psychological test, the Myers-Briggs Type Indicator. The test rates certain personality aspects, such as introversion or extraversion.

In the lab with a supervisor,

"We found that psychological stress seems to amplify the physical demands of lifting for certain personality types."

- Catherine Heaney, Ph.D., OSU School of Public Health

the student lifted a 25-pound box several times. To complete the lift successfully, the student had to lift the box at a particular velocity.

The students wore the Lumbar Motion Monitor, a device to record back motion. Be-

cause it was attached to a computer monitor, students could gauge their performance and confirm whether they attained the correct-velocity when lifting the box. The LMM readings, and measured electrical activity of the trunk muscles, enabled the researchers to create a mathematical model of spinal forces.

For the first half of the experiment, the student's favorite music was played, and the researcher offered words of encouragement, such as "Good job!" or "Way to go!" For the second half of the test, the supervisor left the room, then returned, pretending to be in a foul mood. He turned off the music and told the student the lab director wasn't pleased with the experiment.

The researchers rigged the second half of the experi-

ment, so even when the student lifted the box correctly, the monitor indicated that he or she had failed. The supervisor then began criticizing the student's efforts, saying "You

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can do better than that," or "What happened that time?"

Blood pressure rose in all but two students during this phase, indicating they may have felt stressed. Of those 23, only two groups used their muscles differently; they were rated as either introverts or "intuitors" by the MBTI.

"The criticism just rolled right off the extraverts, but introverts changed the way they used their muscles, so that lifting became much more mechanically stressful," said Marras. When stressed, introverts lifted using muscles in their abdomen or sides that weren't necessary. As a result, certain spinal forces increased as introverts lifted. The same held true for intuitors.

For introverts, spinal compression increased by about 14%, while sideways spinal forces increased by about 27%. For intuitors, spinal compression increased nearly 11%, and sideways forces by about 25%. Over time, such force could lead to back injury.

Why would introverts and intuitors react so strongly?

According to psychologists, introverts commonly internalize feelings of frustration, while intuitors tend to dislike repetitive tasks. Thus, introverts may have been particularly upset by failing at the

task, while intuitors may have disliked having to repeat the task when they failed.

This surprised Heaney. "I didn't think we'd find much of a change in lifting from such a short experiment," Heaney said. "I thought, 'what could happen in 20 minutes?' But the students responded to the stress very quickly." She added that real workers would experience a more dramatic response than students, who volunteered for the study and weren't required to perform the task every day.

As to why stressed people may lift differently, Marras said the only analogous situation occurs for people who already have a back injury.

They contract many extra muscles to support the spine as they lift, so if they need to stop lifting suddenly because of pain, they can. This is known as "guarding." "I hesitate to call this behavior true guarding behavior, but it's the only thing I know of that's similar," Marras said.

While these results suggest that certain personalities may be better suited to handling job stress, Heaney feels making workplaces less nerve-racking is the best way to prevent stress-related back injuries. Marras agreed. "It makes a

whole lot more sense to design the workplace to be less stressful, because otherwise you're mixing and matching the needs of different employee personality types, and that would be really difficult to do. What may be a tolerable situation for one employee may be stressful for another."

While this research has revealed a potential pathway between psychological stress and back pain, such situations contribute to relatively few of the overall cases of injury.

"The vast majority of back injuries can be explained by the weight of the object, or the circumstances under which the person lifts. We're looking at a small subset of back injuries you can't readily explain," Marras said.

Marras and Heaney conducted this work with graduate students Kermit Davis and Anthony Maronitis and former graduate student Gary Allread. These researchers want to extend this work to actual workplaces. Marras and Heaney are also co-supervising a graduate student who will continue the project for his dissertation.

- Written by Pam Frost Gorder; Office of Research Communications

OSHA Ergonomics Standard Update

The Occupational Safety and Health Administration (OSHA) published its final ergonomics standard on November 14th, 2000; it became effective on January 16, 2001. This rule applies to all general industry employers in the U.S., which includes over 100 million employees at 6 million work sites. This ergonomics standard focuses on the prevention of work-related musculoskeletal disorders (MSDs), which are believed to afflict upwards of 1.8 million employees in the U.S. annually. Back injuries alone account for over one-third of these disorders.

The 7 Elements of a Full Ergonomics Program

1. **Management Leadership & Employee Participation.** Employer must set up the program, provide necessary resources, and establish how program is to be run; employees must have a way to report injury symptoms and be able to engage in the process.
2. **Job Hazard Analysis and Control.** If a job meets the Action Trigger, employer must determine if MSD hazards exist and, if so, implement control measures.
3. **Training.** Employer must provide training to employees in affected job(s), as well as their supervisors and those involved with managing the program.
4. **MSD Management.** Employer must provide employee access to a health care professional and provide temporary work, if necessary.
5. **Work Restriction Protection.** For injured employees off work or on temporary work assignments, pay must be maintained at set levels.
6. **Program Evaluation.** Program must be evaluated periodically to ensure its effectiveness.
7. **Record Keeping.** Program records must be kept of the process, and employees must have access to them.



What's New in the Final Rule

- It now covers all general industry.
- More employers can use the Quick Fix option.
- Work Restriction Protection now lasts until the injured employee can safely return to work, a Health Care Professional decides the employee can never return to work, or 90 days have passed, whichever comes first.
- A Basic Screening Tool is included, to be used when MSD signs/symptoms are reported.
- Employees are entitled to a second opinion by their own HCP.
- Specific job hazard assessment tools are listed.
- Changes were made to the Grandfather Clause and record keeping requirements.
- A variety of compliance dates were specified.

Read more information about the standard on page 7.

What People are Saying about OSHA's Ergonomics Standard

" OSHA's final ergonomics standard is the most important worker safety action developed in the agency's history." - John Sweeney, President, AFL-CIO

" OSHA's final ergonomic regulation, which is based on assumptions and speculation, will fail to assure the prevention of even one injury... We will work vigorously to overturn it in the courts, through Congress and through administrative processes."

- National Coalition on Ergonomics

" Although ergonomics is an evolving science, proper application of its principles can achieve the benefits, which are significant and immediate... AIHA supports the need for an ergonomics standard ."

- The American Industrial Hygiene Association

" The agency [OSHA] is not able to present the requisite amount of scientific and medical evidence that would justify promulgation of its standard. Without such a foundation, the standard is unsupportable and will not be honored in the agency's enforcement attempts."

- U.S. Chamber of Commerce

" This standard will play a major role in preventing the back injuries that affect up to 38% of all nurses."

- Mary E. Foley, President, American Nurses Association

How the Ergonomics Standard Could be Overturned

Any party aggrieved by the standard can obtain court review by filing a petition in a federal court of appeals within 59 days of the date the standard is published in the Federal Register (Nov. 14th, 2000).

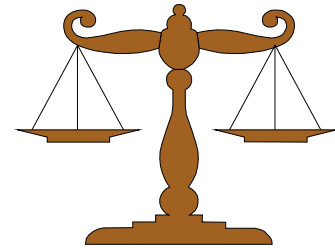
The court can vacate the rule if it finds the rule is not supported by substantial evidence in the rulemaking record or was issued without proper procedures. The party who files the suit also may ask OSHA to stay the rule until the case is decided. If OSHA denies such a request, the party may ask the court for a stay.

In ruling on a request for a stay, both the agency and court will consider these factors:

- The likelihood that the party seeking the stay will prevail on the merits of the appeal;
- Whether the party seeking the stay will be irreparably harmed absent a stay;
- The prospect that others will be harmed if the stay is granted; and
- Whether the public interest will be served or harmed by a stay.

The rule could also be overturned under the Congressional Review Act. Under this statute, if a resolution of disapproval is passed by both houses of Congress and is signed by the President, the rule is nullified.

The rule could also be with-



drawn or modified by further agency action. If the Bush administration is dissatisfied with the standard, it can propose to revoke or modify the standard. Any such action would require public notice and comment, and the amendment or revocation would be subject to judicial review.

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For more information on the requirements of this standard, visit OSHA's web site at <http://www.osha.gov>.

human-machine design, "Things can make us smart or dumb." Ergonomics begins with the insight that problems like ballot confusion are human-machine interaction problems. We are all vulnerable to err when the interface between users and machines is designed in certain ways.

Consider the layouts of the Florida butterfly ballot as one example of how science and engineering looks at interface design.

The Florida butterfly ballot layout violates many rules of thumb about how to avoid confusion in interface design that were developed from work on critical tasks like flying aircraft and operating nuclear power plants. With punch holes to the right of some candidates and to the left for others, the butterfly ballot violates a cardinal design rule avoid mirror images in the layout of options. Alignment is another important factor. Arrows were added to try to make up for the poor layout. But to determine how this will affect voters, one has to look at more than the layout of the paper but also the geometry of the voting booth, to determine the effects of other factors such as parallax, i.e., angular displacement of two objects at different distances

along (or near) the viewer's line of sight.

It is not simply the butterfly layout that creates difficulties. Many kinds of ballots can be designed that fail to give feedback that the machine registered a vote as intended. For punch card systems, voters can unknowingly fail to completely punch out the hole, invalidating their vote. As one colleague commented after the controversy, those who buy lottery tickets get immediate and effective feedback that the machine registered their number choices accurately.

How easy is it to correct a voting mistake? What do voters know about correcting a mis-entry? What outside factors effect people's ability to ask for help (e.g., staffing at polls; long lines)? Also, standard human-machine interface guidelines specify that the machine should check for illegal entries (e.g., entering two choices for one office). Simple techniques are available to make it impossible to vote inadvertently for two candidates.

Ergonomics is a science, meaning the factors that help or mislead voters in a particular ballot design are not debatable opinions but hypotheses that are easily testable. Arguments about how a layout did or did not confuse voters or how likely voters were to make errors can be settled by collecting data through

basic usability evaluations. More importantly, usability testing conducted before the election could have detected and prevented any problems with ballot layout. Usability testing was developed and adopted throughout the software industry because it is hard to anticipate the difficulties a design may create until people actually try to use it under realistic conditions.

Ergonomic results do not tell us how to resolve the dilemma of the close election, but they do expose the blame game as a destructive myth. The overconfident belief, I am more careful than those other people and could never have fallen into any of these traps, ignores basic science and engineering results. This myth is destructive because it has led officials to tolerate antiquated technology, poor design, and high failure rates in the voting and tabulation process for years. This myth is destructive because it leads us to ignore the predictable effects of poor design until disaster strikes; preventable disasters that often cost human lives in others areas such as transportation and health care.

- *David Woods and
Peter Hancock*

Note: This article reflects the authors' views and is not the position of any organization.

PUBLISH or perish

Some of the recent publications written by Institute members:

Anticipating the Effects of Technological Change: A New Era of Dynamics for Human Factors, DD Woods and SWA Dekker, in *Theoretical Issues in Ergonomic Science*, 1(3), 2000.

Bootstrapping Multiple Converging Cognitive Task Analysis Techniques for System Design, SS Potter, EM Roth, DD Woods, and W Elm, in Schraagen, Chipman and Shalin, eds., *Cognitive Task Analysis*, Lawrence Erlbaum, 2000.

Communication during Distributed Anomaly Response and Replanning, R Chow, K Christoffersen, DD Woods, J Watts-Perotti, and E Patterson, Institute for Ergonomics/Cognitive Systems Eng. Lab Report, ERGO-CSEL 00-TR-02, Sept, 2000.

Design Recommendations for an Integrated Approach to the Development, Dissemination and Use of Reroute Advisories, R Beatty and PJ Smith, Technical Report, Cognitive Systems Eng. Lab, 2000.

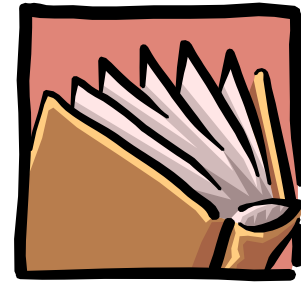
Distance Supervision-Local Action Given the Potential for Surprise, DD Woods and LG Shattuck, in *Cognition, Technology and Work*, 2:86-96, 2000.

Gaps in the Continuity of Care and Progress on Patient Safety, RI Cook, ML Render, and DD Woods, in *British Medical Journal*, 320: 791-794, 2000.

Human Error in Perspective: The Patient Safety Movement, CE Billings and DD Woods, in *Postgraduate Medicine*, January, 2001.

Issues in the Use of Coded Departure Routes, PJ Smith, E McCoy, and C Billings, Tech. Report, collaboration of the Cognitive Systems Engineering Lab (OSU) and the Dept. of Aviation (Ohio U), 2000.

Learning from Automation Surprises and Going Sour Accidents, DD Woods and NB Sarter, in NB Sarter and R Amalberti, eds., *Cognitive Engineering in the Aviation Domain*, Lawrence Erlbaum, Hillsdale, NJ, 2000.



A Model-Based Analysis of Flight Control Logs as Artifacts of Communication and Coordination, R Chow, Institute for Ergonomics/Cognitive Systems Eng. Lab Report, ERGO-CSEL 00-TR-03. Nov, 2000.

The Potential for Misinterpretation Considered More Globally: A Response to Vicente and Ethier, KB Bennett, DA Malek, and DD Woods, in *Human Factors*, 42(3): 455-457, 2000.

Prospective Validation of A Low-Back Disorder Risk Model and Assessment of Ergonomic Interventions Associated with Manual Materials Handling Tasks, WS Marras, WG Allread, DL Burr, and FA Fathallah, in *Ergonomics*, 43(11):1866-1886, 2000.

Team Play with a Powerful and Independent Agent: A Full-Mission Simulation Study, NB Sarter and DD Woods, in *Human Factors*, 42(3):390-402, 2000.

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