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Discussion Panel
Research to Practice to Research (RtPtR) – Bridging the Gap between the Practitioners and Academics

Panel co-chairs:
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Panelists:
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Jeong Ho (Jay) Kim, *Oregon State University, OR*
Gwendolyn Malone, *General Motors Global Manufacturing Engineering, MI*
Robert Fox, *General Motors Company, MI*
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Abstract: This panel seeks to improve understanding of different perspectives and generate ideas for improving the process of research to practice to research (RtPtR). Academic researchers are challenged by various factors when conducting research leading to valuable ergonomic or safety recommendations for industries. Practitioners in various industries may view research as unnecessary to the decision-making process, too costly, or lacking in practical, productive applications. More efforts to bridge the gap between research and workplace practices are needed in order to examine the effectiveness of practical solutions while improving productivity and cost savings, etc. Each panelist presents the relevant applications of RtPtR in several areas of research and practice. The continuing relevance and directions of RtPtR are explored in discussion with the panelists and audience.

Keywords: commercial airplanes, computer mouse, construction, global ergonomics, manual materials handling, operator tool, practice, research

RtPtR – Ergonomics in Construction Industry

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Sang D. Choi, Ph.D., CPE, CSP, University of Wisconsin – Whitewater

Research to Practice to Research - RtPtR Model Diagram

The above diagram depicts the concept of Research to Practice to Research (RtPtR) model: the continuous improvement process of academics translating the safety, health & ergonomic (SH&E) knowledge/research findings into best/good practices (RtP) and then practitioners complete the loop by providing feedback to researchers (PtR)

(Choi & Borchardt, 2016). As a practitioner who has been using Snook's Tables and NIOSH's Lifting Equation (LE) since the 1980's and 90s, Borchardt realized the importance of being able to determine the weight of construction materials so these assessment tools could be used more easily at worksites. The co-authors explored and developed the B Factor concept that the density of most construction materials were uniform and their weight could be determined by units easy to measure by safety and ergonomics practitioners at worksites (Choi & Borchardt, 2009; Borchardt & Choi, 2012). Liberty Mutual's "redo" of the Snook Tables (2002 -2008) found evidence the psychophysical capacity of today's workers is about 69% of workers studied in the 1970 – 80s. If validated by future research, the set points or load constant (LC) of the NIOSH LE and its derivatives may need to be lowered. These preliminary results also suggest workers may be at greater risk to overexertion from the manual materials handling tasks of lifting, pushing/pulling, and carrying. Consequently, Professor Choi and Mr. Borchardt have begun promoting the concept of Ergonomic Action Level (EAL) where analysis and redesign of manual construction tasks begins at about 70% of the current LC (Borchardt & Choi, 2015). Such a shift suggests utilizing prevention through design (PtD) approach and increased need for mechanization, automation, modularization and prefabrication (Choi et al., 2014). Moreover, executing *"construction ergonomics"* campaign in construction trades is warranted to develop contractor success stories, and increase education and awareness.

GM Global Ergonomic Manufacturing Engineering
Process - Applying consistent strategies and methodologies for success

Gwendolyn Malone, MPH, GM Technical Fellow and Senior Manager, General Motors Global Manufacturing Engineering, Ergonomics

General Motors (GM) ergonomics activity began over 30 years ago as a decentralized, activity. In the mid-80's GM and The United Automobile Workers (UAW) Union participated in an ergonomics pilot project with the University of Michigan (resulting in several published articles). In 1990 UAW-GM- Occupational Safety & Health Administration (OSHA) entered into an agreement on Ergonomics, which was the catalyst for Ergonomics Program in General Motors. By the mid-2000's GM recognized how critical it was to shift more attention to "designing in" ergonomic principles and guidelines early in the vehicle and powertrain development process. Today, our Global Manufacturing Engineering Ergonomics team (Program Ergonomists) consist of individuals around the globe that execute our ergonomics process across several functional groups, as a single voice to ensure:

1. Vehicle and Powertrain Product Engineering (PE) teams implement ergonomic principles in the products we make, and
2. Manufacturing Engineering (ME) teams implement ergonomic principles when launching new programs in the manufacturing plants.

Our primary focus is to design out systemic product and manufacturing issues and prevent future ergonomics issues before the product goes into production.
GM's ergonomics process is based on proactive assessments using internal and external ergonomic tools, research, and guidelines.

The three ergonomic analysis phases are:

1. Virtual Analysis, where we have collaborated with universities and OEMs to create digital models with both improved realism of the models and postures when analyzing reach, access, clearance, and operator's line of sight or field of vision analysis. We also evaluate operator strength capabilities (relative to the force required for installing parts) 2-3 years before production; due to the advancements in model's algorithms to better predict how a body reacts to an applied force in a specific direction.

2. Pre-Production Analysis focuses on the measurement/evaluation of installation forces that cannot be evaluated virtually. The acceptable force for any component is evaluated against internal GM specifications, guidelines, and requirements.

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3. Program Launch activities validate the agreed upon resolutions demonstrated during pre-production were implemented (e.g. clip change to reduce force). Multiple vehicle or powertrain components are measured and signed off before an issue is considered closed.

At GM, Ergonomics is a key enabler to all successful program launches by all levels of leadership. Ergonomics is an accepted core requirement to design and build vehicles and powertrains around the world.

Manual Material Handling in the Automotive Industry: Research, Guidelines and Standards
Robert Fox Ph.D., CPE, General Motors Company, MI

Automotive manufacturing is, and always has been, intensive in regards to manual material handling (MMH). While the nature of tasks in the various phases of automotive manufacturing may be highly varied, most involve some degree of lifting and lowering as well as pushing, pulling and carrying. This presentation will explore the development of lifting guidelines focusing on the NIOSH Lift Equation and how it has been interpreted and applied in automotive manufacturing. The introduction of Kanban and Lean material strategies in the 1980s and 1990s produced many changes to how material was handled and delivered to production lines. These changes in business strategies and the resulting changes in the nature of many material handling jobs will be discussed and how the NIOSH Lift Equation was adapted and applied to it. The interplay and exchange between ergonomics practitioners, NIOSH and MMH researchers and eventually with international standards developers over the 25 year years.

Operator-Power Tool Interaction and the Need to Update the Standards
Jia-Hua Lin, PhD, CPE, SHARP, Washington State Department for Labor and Industries

Due to the lack of means to measure the force or torque encountered at the hand-handle interface, past ergonomic studies about operator response towards power hand tool operations mainly rely on indirect measures such as electromyography and subjective ratings of discomfort or exertion. A hand-handle interface force and torque measurement system is introduced as an alternative to fill the void acknowledged in the international standard ISO 6544, which governs pneumatic assembly tool reaction torque and force measurement. This system consists of an instrumented handle with a sensor capable of measuring grip force and reaction hand moment when threaded fastener driving tools are used by operators. The handle is rigidly affixed to the tool in parallel to the original tool handle with minimal interference on actual fastener-driving tasks. Demonstration of this proposed system was made with tools of three different shapes: pistol grip, right angle, and in-line. During tool torque buildup, operators exerted greater grip force on the soft joint than on the hard joint. The soft joint demanded greater hand moment impulse than the hard joint. This system, supplemental to ISO 6544, can provide additional force and torque related information experienced by the tool operator, and hence allow ergonomics and occupational safety practitioners to better assess the impact of power hand tool operations. A resultant peer-review paper was published in the *Journal of Occupational and Environmental Hygiene*. However, no update has been amended to the standard. The procedure to update an ISO standard for an individual scientist is not readily available. The sub-committee of various ISO standards may not have the incentive to initiate updates. Certain form of facilitation should exist to take advantage of research findings.

Translational Research in Ergonomics: from Mobile Devices to Semi-trucks
Jay Kim, PhD, Environmental and Occupational Health, Oregon State University
Peter W. Johnson, PhD, University of Washington

As Ergonomics is applied science to optimize the interface between human and environment, most ergonomics research is inevitably related to the concept, "Research to practice" (r2P). Many of our research studies at the University of Washington and Oregon State University have resulted in interventions and/or provide scientific evidences for recommendations and interventions. In this panel discussion, we will introduce two relevant ergonomic research studies. One study evaluated and compared biomechanical exposures including typing force, muscle activity, usability, and subjective discomfort among different key sizes on touch screen devices. The results showed that the keyboard with the 13x13 mm keys (15 mm center-to-center key spacing) had a slower typing speed, higher static (10th %tile) shoulder muscle activity, and greater wrist extension in both hands. The study findings were used to develop recommendations and guidelines for choosing an adequate mobile device (i.e. mobile phone). The other study is a evaluated the efficacy of a newly-developed active vibration cancelling suspension seat in reducing whole body vibration (WBV) exposure and its related adverse health outcomes such as low back pain and other musculoskeletal disorders. The results suggested that reducing exposure to WBV can reduce associated low back pain and other adverse health outcomes. The study results will provide a basis for developing new engineering controls to reduce WBV exposures and help in better targeting such future interventions to improve occupational health outcomes among professional truck drivers. These two studies are great examples to show how research findings can be translated into practice and evidence-based intervention programs.

Commercial Airplanes: Research and Design
Dianne McMullin, PhD, Associate Technical Fellow, Human Factors Engineering, Boeing Company, WA

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