MSD Prevention in Construction: RtPtR

National Occupational Research Agenda (NORA)
Construction Sector Council "virtual" Meeting
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Learning Objectives

- Explain how the Research to Practice to Research (RtPtR) model is evolved from the National Occupational Research Agenda (NORA)*.

- Explain RtPtR model and its importance to "bridging the gap" between SH&E academic research and practitioner application.

- Provide RtPtR examples and how it can assist academics and practitioners find solutions to real world SH&E exposures.

NORA – Musculoskeletal Health

October 2018

Objective 4: Develop & Evaluate Interventions to Prevent MSDs and Limit Disability due to MSDs.

4.1 Develop New Interventions

4.2 Evaluate Intervention Effectiveness

4.3 Medical Management of MSDs

4.4 Changing Workforce Demographics

Our target objectives: 4.1; 4.2 & 4.4

Outline

- About the Presenters
- Research to Practice to Research (RtPtR) Model
- Why Collaboration is Important?
- Collaboration/ RtPtR Examples (2008 – present)
  - LE for Construction
  - B Factor
  - Ergonomic Action Level (EAL)
  - Prevention through Design (PtD) examples
  - Publication and Dissemination
- Question and Answer

Research to Practice to Research (RtPtR) Model

EXAMPLE I -- NLE

*The Original Study in 2012**

Manual Lifting Task Observations

- Using the NIOSH's 1991 Lifting Equation – A total of 292 measurements was taken at the origin and destination of lifting/lowering tasks in the construction workplace.

* Sang D. Choi , James G. Borchardt and Travis L. Proksch (2012). *Translating Academic Research on Manual Lifting Tasks Observations into Construction Workplace "Good Practices".* ASSE Journal of Safety, Health & Ergonomic Research, 8(1), 3-10.

Hypothetically revised the **Load Constant (LC)** of NIOSH's Lifting Equation (LE) from 51 lbs to **35 lbs** based on reported workers' psychophysical changes which suggest the "set – point" of the LE may need to be lowered.**

**Ciriello et al (2008) *Secular changes in psychophysically determined maximum acceptable weights/forces over twenty years for male industrial workers.* Ergonomics, 51(5), 593-601.

2012 Results Using Load Constant (LC) 51 lbs

Observation		HM	VM	DM	AM	FM	CM	RWL (lbs)	Load Wt (lbs)	LI
(*n*=292)	Median	0.56	0.89	0.89	1.00	0.85	0.95	15.96	30.00	1.54
	Std Dev	0.29	0.07	0.05	0.20	0.14	0.03	7.13	26.57	2.44
	Min	0.19	0.63	0.82	0.42	0.35	0.90	2.84	1.00	0.04
	Max	1.00	1.00	1.00	1.00	0.94	1.00	33.36	192.00	12.76

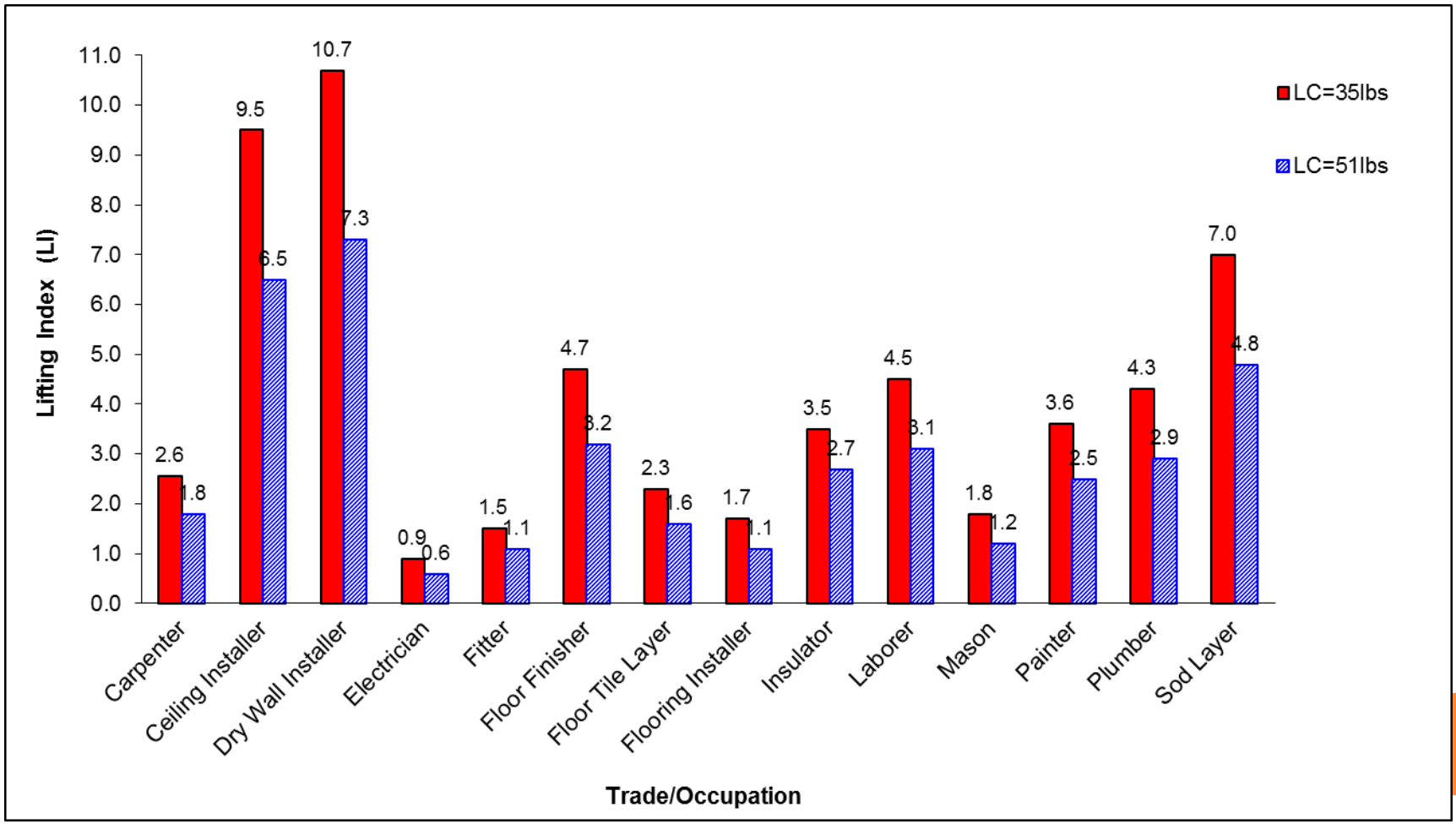
	LC	HM	VM	DM	AM	FM	CM	**RWL**	Load Wt	**LI**
Average	**51.00**	0.69	0.87	0.91	0.84	0.78	0.96	**16.33**	30.70	**2.35**

2015 Results Using Load Constant (LC) 35 lbs

Observation		HM	VM	DM	AM	FM	CM	RWL (lbs)	Load Wt (lbs)	LI
(*n*=292)	Median	0.56	0.89	0.89	1.00	0.85	0.95	10.95	30.00	2.25
	Std Dev	0.29	0.07	0.05	0.20	0.14	0.03	4.90	26.57	3.56
	Min	0.19	0.63	0.82	0.42	0.35	0.90	1.95	1.00	0.06
	Max	1.00	1.00	1.00	1.00	0.94	1.00	22.89	192.00	18.60

	LC	HM	VM	DM	AM	FM	CM	**RWL**	Load Wt	**LI**
Average	**35.00**	0.69	0.87	0.91	0.84	0.78	0.96	**11.21**	30.70	**3.42**

Lifting Index Results Comparison by Trade & Occupation



EXAMPLE II – Borchardt (B) Factor

B Factor Concept defined as:

- Weight of materials per “easy to measure” units of measurement such as weight (lbs or kg) per unit of volume, area, length or other “useful” measurement.

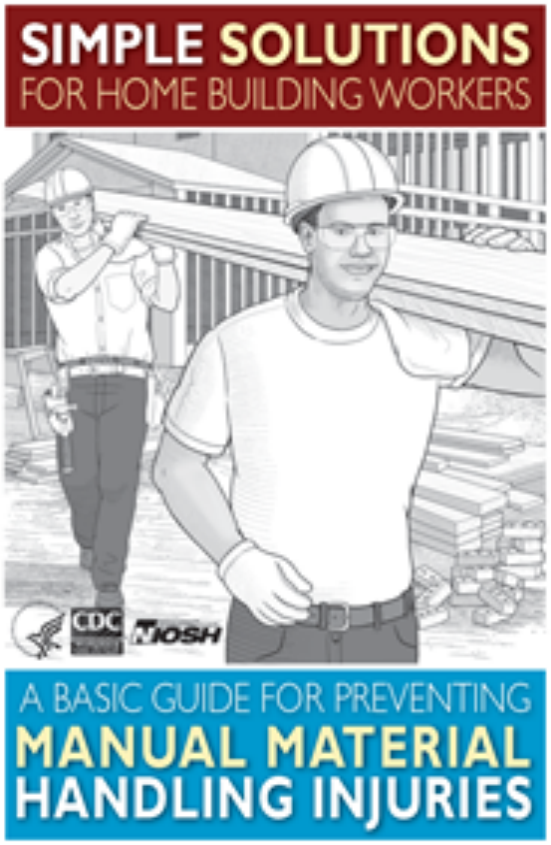
Examples: Density of rebar is 490 lbs per cubic foot

B(1/2 #4 rebar) = 0.668 lbs per linear foot

B(1/2” “light” drywall) = 1.35 lbs per square foot

B(“2x4” Studs – Pine or Douglas Fir w/15% moisture) = 1.066 lbs per linear foot

BORCHARDT (B) FACTOR
NIOSH PUB 2013-111 P 31



(NIOSH, 2013)

Lifting and carrying more than 50 lbs. increases your risk of low back injury. Use the list below to help keep the weight you handle to around 50 lbs.

LUMBER PIECES (KILN DRIED)			
4	10 ft.	2"x4"	51 lbs.
3	12 ft.	2"x4"	46 lbs.
2	10 ft.	2"x6"	40 lbs.
2	12 ft.	2"x6"	48 lbs.
2	10 ft.	2"x8"	53 lbs.
1	10 ft.	2"x10"	66 lbs.
1	10 ft.	2"x12"	41 lbs.
2	10 ft.	4"x4"	60 lbs.
LVL (LAMINATED VENEER LUMBER) PIECES			
1	10 ft.	1 3/4"x9 1/4"	47 lbs.
1	10 ft.	1 3/4"x11 7/8"	61 lbs.
1	10 ft.	1 3/4"x14"	71 lbs.
SHEETS— PLYWOOD / OSB			
2	3/8 in.	4'x8'	68 / 77 lbs.
1	1/2 in.	4'x8'	45 / 54 lbs.
1	5/8 in.	4'x8'	58 / 67 lbs.
1	3/4 in.	4'x8'	68 / 80 lbs.
SHEETS — CEMENTITIOUS BACKBOARD			
1	7/16 in.	4'x8'	96 lbs.
CONCRETE BLOCKS — LIGHT WT. / NORMAL WT.			
1		6"x8"x16"	22 / 34 lbs.
1		8"x8"x16"	27 / 44 lbs.

B Factor Example

- **2 1/4”x 10' #18 Rebar**

B(2 1/4” #18 Rebar) = 13.6 lbs/lf x 10' lf = **136 lbs**

Rebar Rod Number	Rod Size (in)	Rod Weight (lb per linear foot)
2	0.250 = 1/4	0.167
3	0.375 = 3/8	0.376
4	**0.500 = 1/2**	**0.668**
5	0.625 = 5/8	1.043
6	0.750 = 3/4	1.502
7	0.875 = 7/8	2.044
8	1.000	2.670
9	1.128	3.400
10	1.270	4.303
11	1.410	5.313
14	1.693	7.650
18	2.257	13.600

“2x4”Studs (pine or douglas fir)

B(2x4 Studs)= 1.0 lbs/linear ft.

Therefore “2x4”x8’ = 8 lbs

6 Studs weigh 48 lbs

4 Studs weigh 32 lbs

EXAMPLE III – Ergonomic Action Level (EAL)

A Conceptual "Ergonomic Action Level (EAL)"

- Analogous Concept to Action Level:
  - Toxic/Hazardous Substance
  - Noise Exposures
- Authors believe when a manual task has a Lifting Index of 0.7 or greater, the contractor should begin to Take Action.

The Action should follow:

- Hierarchy of controls
  - Elimination, Modification, Administrative
- Prevention through Design (PtD)
  - Architects, Designers, Engineers, Constructors
    - Mechanization, Automation, Modularization, Prefabrication

EXAMPLE IV -- Good Practices Handout

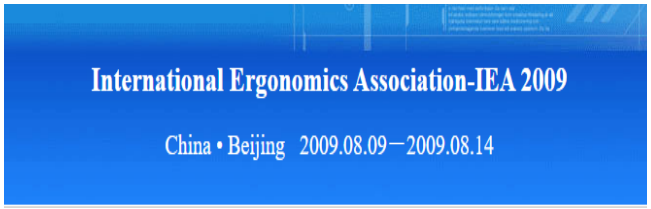
- Purchase "Lighter & Smaller"
  - MTE < 50 lbs
    - > 50 lbs – use handling aid, multiple workers
  - MTE < 10 inches center
    - 10" – 25+"center - multiple workers, use handling aid
- Design Work Sites
  - Lifts in Mid Range of Body
  - Close – within 15"
  - Directly in front – no twisting
  - Below shoulder height
- Establish Work Rules & Train
  - Know weight of MTE – Label
  - Multiple worker policy

- **MANUAL HANDLING MTE**
- Improving the Manual Handling of Materials, Tools and Equipment (MTE) on work sites can increase productivity by making manual tasks more efficient and may reduce worker injuries. Injuries from manual handling of MTE are the most frequent and costly type of worker injury in most industries. One or more of the following good practices will help achieve increased productivity and reduce the causes of worker injuries.

PUBLICATION AND DISSEMINATION

Collaborative Conferences & Publications
International Ergonomics Association (IEA)

❖Choi, S.D., Proksch, T., & Borchardt, J.G. (2009). Investigation of Common Construction Materials Weight and Related Manual Lifting Task Observations. In: Proceedings of the 17th World Congress on Ergonomics (IEA 2009). Beijing, China.



北京九华国际会展中心大酒店
Jiuhua International Convention Center

❖Borchardt, J., & Choi, S.D. (2015). Workers' Changing Psychophysical Characteristics Require Prevention through Design (PtD) and Safety, Health & Ergonomic (SH&E) Strategies at Construction Worksites. In: Proceedings of the 19the Triennial Congress of the International Ergonomics Association (IEA), 9-14 August 2015. Melbourne, Australia.

IEA VANCOUVER 2021

International Ergonomics Association
21st Triennial Congress

Collaborative Conferences & Publications

Joint Safety & Environmental Professional Development Symposium (PDS)

Naval Safety & Environmental Training Center Online Global

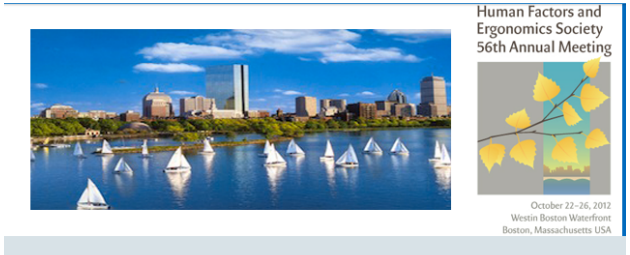
❖Choi, S.D., Borchardt, J.G., *Prevention through Design: Roadmap to Improving Safety, Health and Ergonomics on Worksites.* 25th Annual Joint Safety and Environmental Professional Development Symposium (PDS), Naval Safety & Environmental Training, April, 2017

❖Choi, S.D., Borchardt, J.G., *Prevention through Design: National Strategy for "Designing" Safety, Health and Ergonomics Improvements into Worksites.* 26th Annual Joint Safety and Environmental Professional Development Symposium (PDS), Naval Safety & Environmental Training Center. Online Global S&E PDS Program, April, 2018

❖Choi, S.D., Borchardt, J.G., *Emerging Technologies in Construction Increase Production, Improve Quality and Mitigate Safety, Health and Ergonomic (SH&E) Exposures.* 27th Annual Joint Safety and Environmental Professional Development Symposium (PDS), Naval Safety & Environmental Training Center. Online Global S&E PDS Program, April, 2019

Collaborative Conferences & Publication Human Factors & Ergonomics Society (HFES)

❖Borchardt, J., & Choi, S.D. (2012). B Factor and Its Importance to HFE Practitioners - Applying NIOSH's 1991 Revised Lifting Equation and Its Derivatives. In: Proceedings of the 2012 HFES 56th Annual Meeting. Human Factors and Ergonomics Society. Boston, Massachusetts, USA.



❖Choi, S.D., Yuan, L., Borchardt, J.G., *Critical Analyses of Work-Related Musculoskeletal Disorders and Practical Solutions in Construction.* 58th Annual Meeting of Human Factors and Ergonomics Society, Hyatt Regency Conference Center, Chicago, IL, USA, October, 2014.

❖Panel Member – *Research to Practice to Research – Practitioner and Academic Perspectives.* 60th Annual Meeting of Human Factors and Ergonomics Society, Washington Hilton, Washington, DC, USA, September, 2016

2016 HFES Annual Meeting

HFES
International
Annual Meeting

Washington, DC ▪ September 19–23, 2016

Collaborative Conferences & Publications American Society of Safety Professions (ASSP)

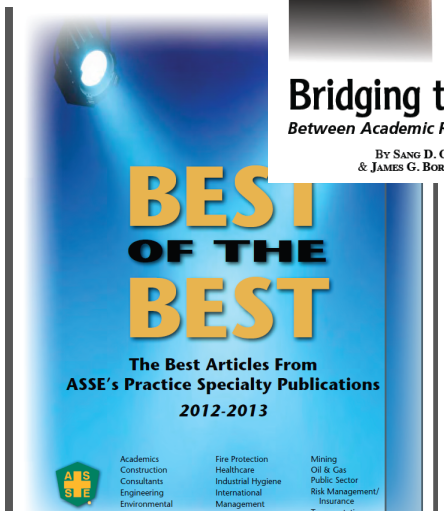
❖Borchardt, J.G., & Choi, S.D. (2012). Bridging the Gap between Academic Research and Construction Workplaces Using the NIOSH 1991 Lifting Equation. American Society of Safety Engineers, Des Plaines, Illinois, USA.

❖Choi, S.D., & Borchardt, J. (2012). Bridging the gap between academic research and construction. *Interface, 2*(3), 32-37.

❖Choi, S.D., Borchardt, J., & Proksch, T. (2012). Translating academic research on manual lifting tasks observations into construction workplace good practices. *Journal of Safety, Health and Environmental Research, 8*(1), 3-10.

❖Choi, S.D., Yuan, L., Borchardt, J.G., *Critical Analyses of Work-Related Musculoskeletal Disorders and Practical Solutions in Construction.* 58th Annual Meeting of Human Factors and Ergonomics Society, Hyatt Regency Conference Center, Chicago, IL, USA, October, 2014

❖Borchardt, J., & Choi, S.D. (2015). Psychophysical and Demographic Changes Require Rethinking Ergonomic Strategies. American Society of Safety Engineers, Dallas , Texas, USA.



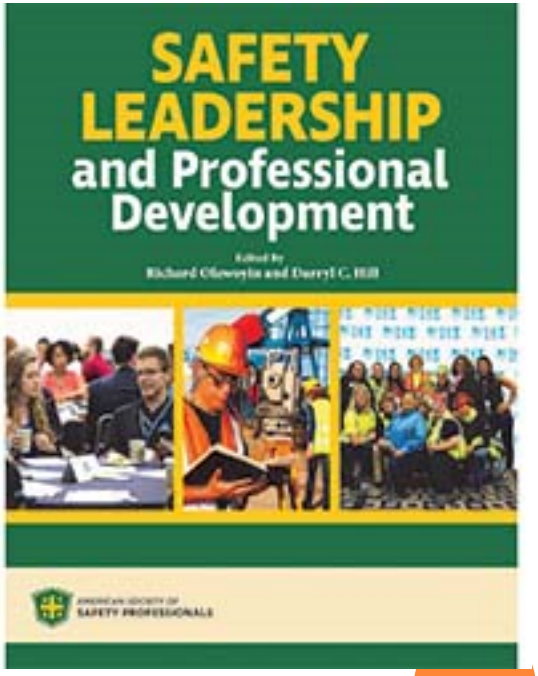
Collaborative Conferences & Publications American Society of Safety Professions (ASSP) (con't)

❖Borchardt, J.G., Choi, S.D., *Construction Ergonomics: Roadmap to Reducing Overexertion on Worksites; Prevention through Design (PtD): Needed to Implement Safety, Health &Ergonomic Strategies.* 2015 Alaska Safety Summit, Egan Conference Center Anchorage, AK

❖Choi, S.D., Yuan, L., & Borchardt, J.G. (2016). Musculoskeletal disorders in construction: Practical solutions from the literature. *Professional Safety, 61*(1), 26-32.

❖Borchardt, J.G., *B Factor and its Importance to Applying the NIOSH Lifting Equation and its European Derivates on Worksites.* Safety 2017 - American Society of Safety Engineers (ASSE) Professional Development Conference, Colorado Convention Center, Denver, CO, USA, June 2017

❖Co-authored Chapter 23,*"Prevention through Design (PtD) Research to Practice to Research (RtPtR): Sustainable Strategy for Promoting Safety, Health and Ergonomics"*, ASSP 1st Edition (2018) *Leadership in Safety and Professional Development* by R. Olawoyin & D. Hill (Editors)



Collaborative Conferences & Publications International Society of Occupational Ergonomics (ISOES)

❖Borchardt, J., & Choi, S.D. (2015). Changing Psychophysical Characteristics of Construction Workers Require New Ergonomic Strategies. In: Proceedings of the XXVIIth Annual Occupational Ergonomics and Safety Conference, Nashville, Tennessee, USA.

❖Choi, S.D., Borchardt, J.G., *Research to Practice to Research (RtPtR): A Roadmap for Occupational Ergonomics and Safety Practitioners and Researchers.* XXVIII International Occupational Ergonomics and Safety Conference (ISOES), Radisson Hotel Chicago O'Hare, Chicago, IL, USA, June, 2016

❖Borchardt, J. G., Choi, S.D., *RtPtR-Ergonomics in the Construction Industry* XXIX International Occupational Ergonomics and Safety Conference (ISOES), Four Points by Sheraton, Seattle, WA, USA, June, 2017.

❖Borchardt, J.G., Choi, S.D., *Computer-Assisted Technologies: Reduce Safety, Health and Ergonomic Exposures on Construction Work sites and Improve Project Quality and Efficiency – an Overview.* XXXIst Annual International Occupational Ergonomics and Safety Conference (ISOES), Earnest N. Morial Convention Center, New Orleans, LA, USA, June, 2019.

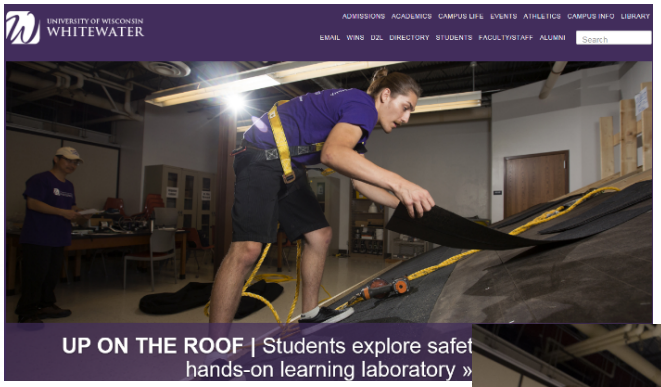
International Society for Occupational Ergonomics & Safety

Collaborative Recommendation

❖ Industry Practitioners should identify their “unresolved” Ergonomic, Safety and Health exposures (ES&H) , then Partner with ES&H Academics to find practical solutions.

❖ Academic Researchers should partner with Industry Practitioners so Both Presentation and Publication of Result Results have Practitioner input and participation.

(NIOSH, 2015)



Questions


Practice to Research (PtR)
SH&E Continuous Improvement
Research to Practice (RtP)