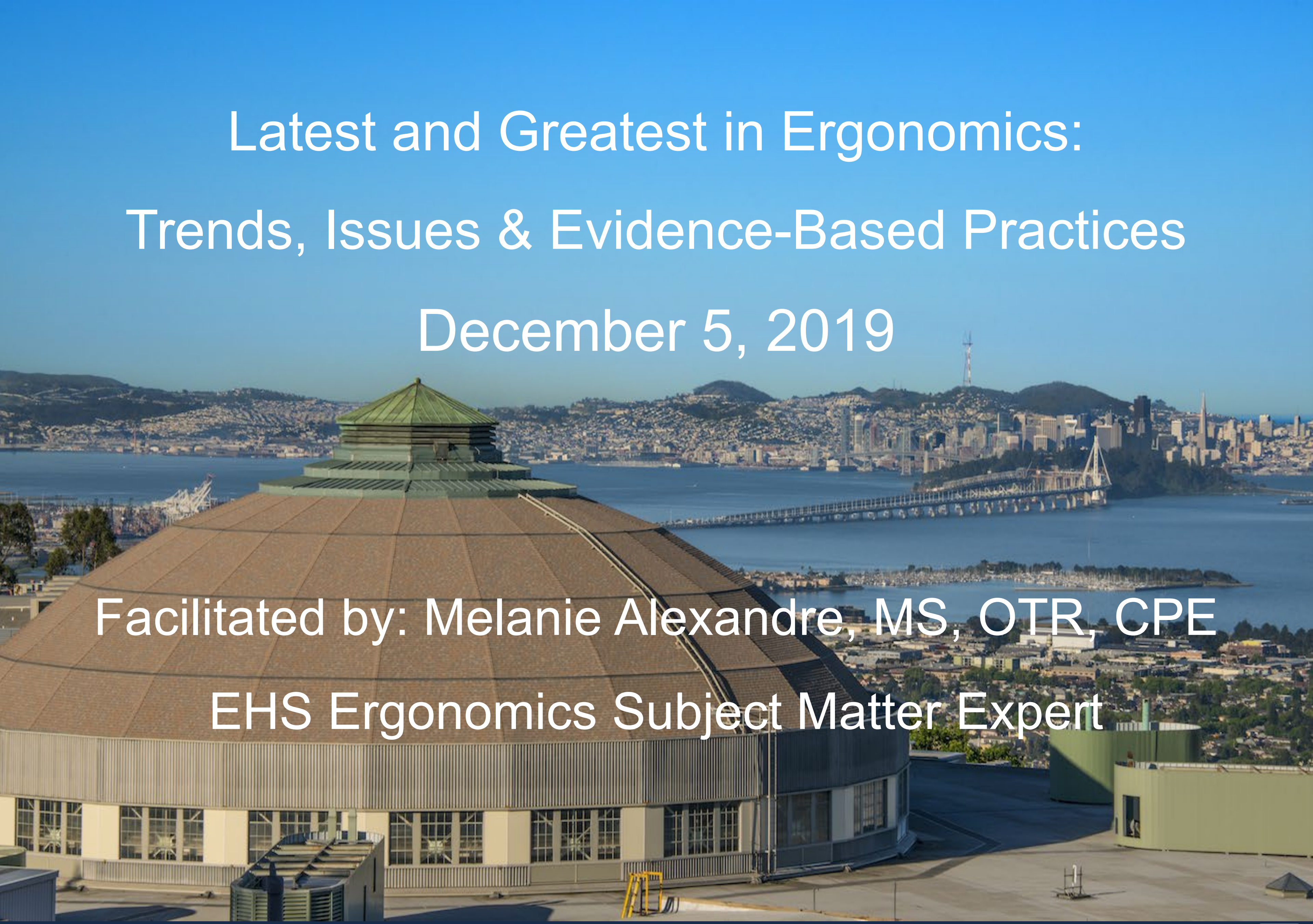


Latest and Greatest in Ergonomics:

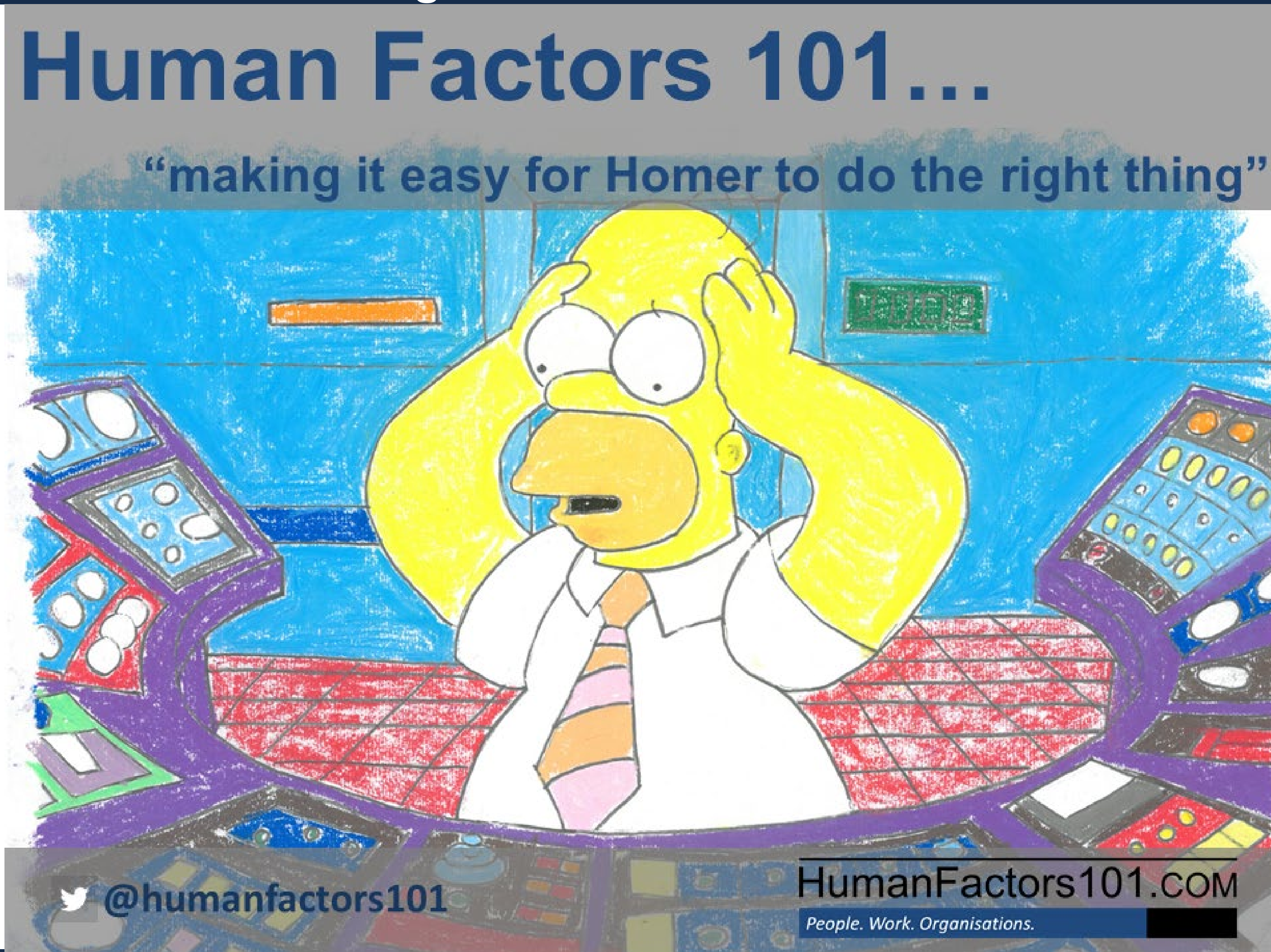
Trends, Issues & Evidence-Based Practices

December 5, 2019

Facilitated by: Melanie Alexandre, MS, OTR, CPE

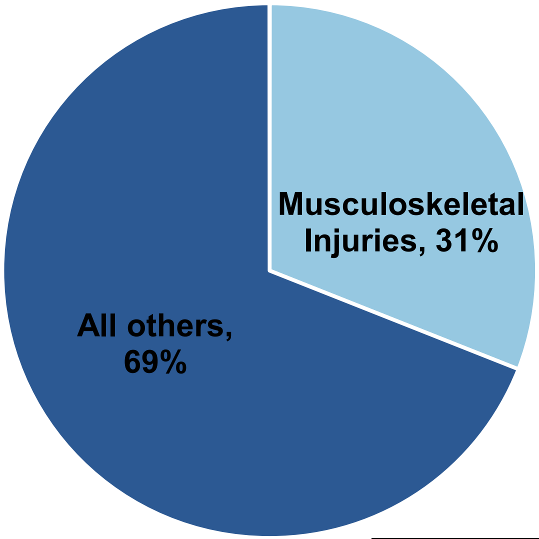
EHS Ergonomics Subject Matter Expert

Let’s start by ensuring we are all on the same page regarding what ergonomics/human factors is…

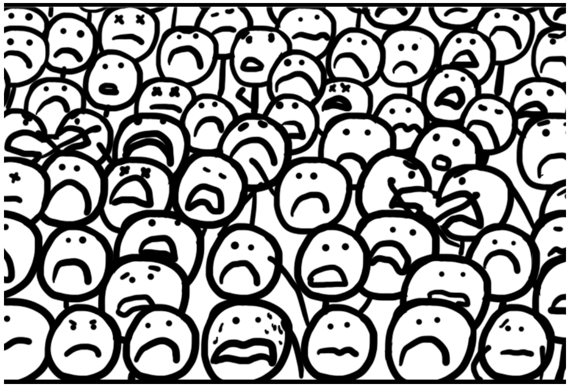


Ergo-related injuries are still prevalent in the workspace

Non-fatal work injuries/year



Estimated to cost between $45-54 billion/year



400,000 worker injuries/year

Ergo Headlines

Office

Lab

Material Handling

Wearable Technology

Workplace Design

Hazard Analysis

Evidence Based Practices

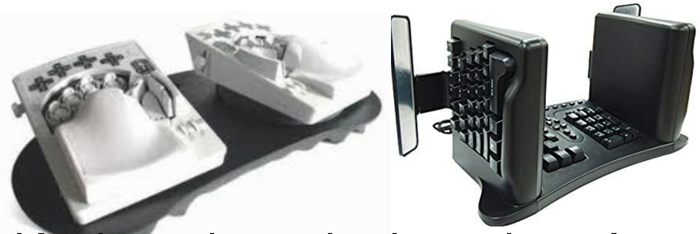
Ergo Gadget Overload!

Treadmill desks

Chairs, chairs and more chairs

Pedaling desks

Sit-stand converters

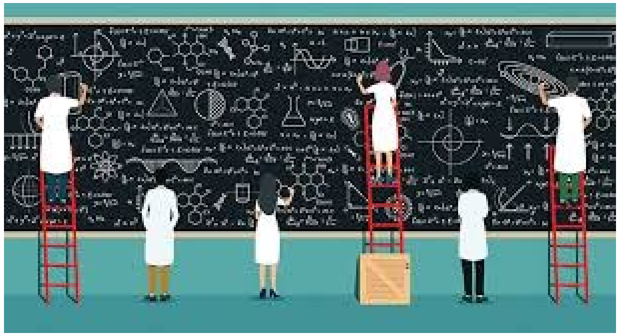


Keyboards and mice, oh my!

Standing desk + wobble board

Recommendations for managing gadget overload

Test & Validate



Research & Evidence

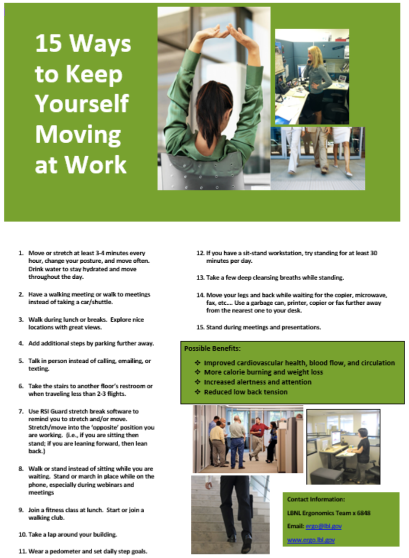
Keep it simple

Sitting is evil… well kind of

https://www.startstanding.org/sitting-new-smoking/#

Next position is your best position

Recommendations to improve movement



15 Ways to Keep Yourself Moving at Work

1. Move or stretch at least 3-4 minutes every hour, change your posture, and move often. Drink water to stay hydrated and move throughout the day.
2. Have a walking meeting or walk to meetings instead of taking a car/shuttle.
3. Walk during lunch or breaks. Explore nice locations with great views.
4. Add additional steps by parking further away.
5. Talk in person instead of calling, emailing, or texting.
6. Take the stairs to another floor's restroom or when traveling less than 2-3 flights.
7. Use RSI Guard stretch break software to remind you to stretch and/or move. Stretch/move into the 'opposite' position you are working. (i.e., if you are sitting then stand; if you are leaning forward, then lean back.)
8. Walk or stand instead of sitting while you are waiting. Stand or march in place while on the phone, especially during webinars and meetings
9. Join a fitness class at lunch. Start or join a walking club.
10. Take a lap around your building.
11. Wear a pedometer and set daily step goals.
12. If you have a sit-stand workstation, try standing for at least 30 minutes per day.
13. Take a few deep cleansing breaths while standing.
14. Move your legs and back while waiting for the copier, microwave, fax, etc.… Use a garbage can, printer, copier or fax further away from the nearest one to your desk.
15. Stand during meetings and presentations.

Possible Benefits:

- Improved cardiovascular health, blood flow, and circulation
- More calorie burning and weight loss
- Increased alertness and attention
- Reduced low back tension

Contact Information:

LBNL Ergonomics Team x 6848

Email: ergo@lbl.gov

www.ergo.lbl.gov

Make it easy and acceptable to move

' Sell' benefits of movement

Utilize cueing devices for when we get in the 'zone'

Mobile technology is great… well kind of

Risk Factors

-Since the laptop keyboard and the screen are integrated, either the keyboard is too high, causing risk to the shoulders and wrists or the monitor too low, causing risk to the neck (Asundi et al., 2010; Chandra et al., 2009; Ellison, 2012)

-Laptop use compared to desktop use increases head forward posture (Straker, Jones & Miller, 1997; Sommerich et al., 2002, Yu et al., 2018) a major contributor to neck pain (Szeto et al., 2005; Chiou et al., 2012)

-Compact laptop designs with small input devices increases ulnar deviation (Rempel et al., 2007; Yu et al., 2018) and internal rotation and variability of the shoulder (Sommerich et al. 2002)

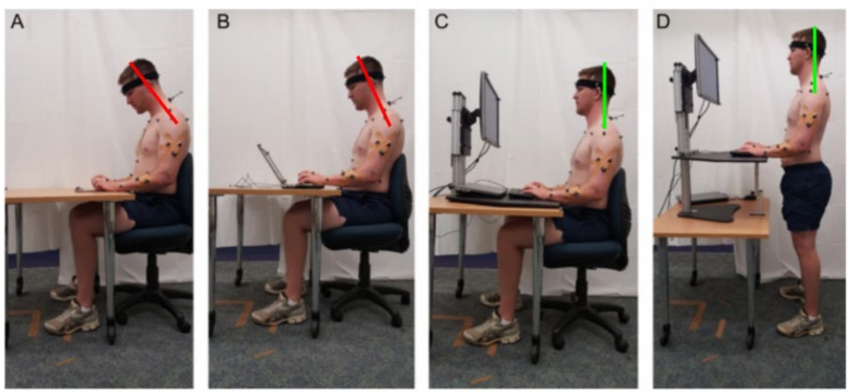
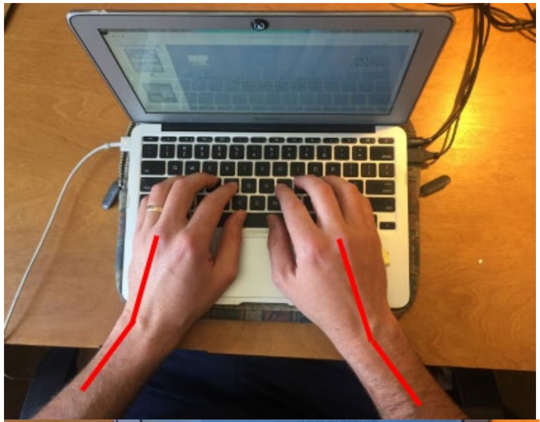


Fig. 1. Device placement for each experimental condition: (A) tablet, (B) laptop, (C) desktop, sitting, and (D) desktop, standing, with retro-reflective marker configuration.

Source: Yu et al., 2018



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Straker, L., Jones, K. J., & Miller, J. (1997). A comparison of the postures assumed when using laptop computers and desktop computers. *Applied ergonomics*, *28*(4), 263-268.

Szeto, G. P., Straker, L. M., & O'Sullivan, P. B. (2005). A comparison of symptomatic and asymptomatic office workers performing monotonous keyboard work—2: neck and shoulder kinematics. *Manual therapy*, *10*(4), 281-291.

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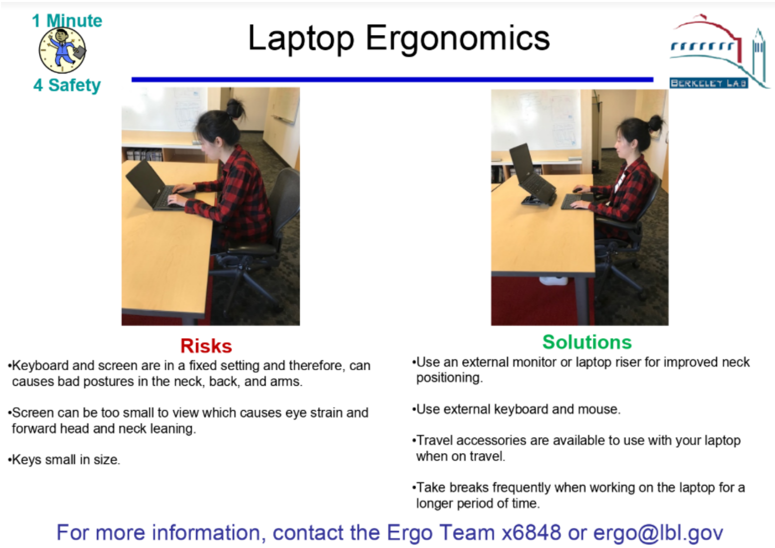
Werth, A. J., & Babski-Reeves, K. (2012, September). Assessing posture while typing on portable computing devices in traditional work environments and at home. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 56, No. 1, pp. 1258-1262). Sage CA: Los Angeles, CA: SAGE Publications.

Yu, Z., James, C., Edwards, S., & Snodgrass, S. J. (2018). Differences in posture kinematics between using a tablet, a laptop, and a desktop computer in sitting and in standing. *Work*, (Preprint), 1-10.

Mobile technology is great… well kind of

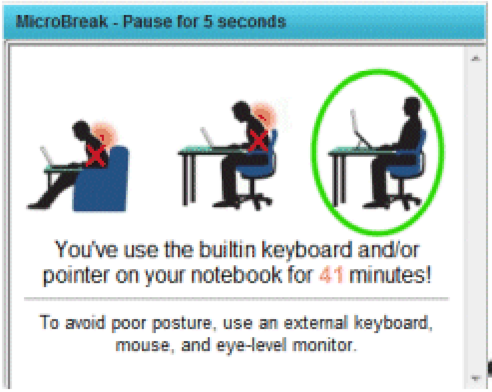
Best Practices

- Avoid conventional laptop use
  - Option 1: Use external monitor AND external mouse/keyboard
  - Option 2: Raise height of laptop (Ex. Use laptop station/riser) and use external mouse/keyboard
- If you MUST use laptop conventionally…
  - Avoid unconventional work postures such as working with laptop on your lap (Asundi, Odell, Luce, & Dennerlein, 2010; Werth, A. J., & Babski-Reeves, K., 2012)
  - Tilt screen 115-130deg to decrease head forward posture (Chandra et al., 2009; Chiou et al., 2012)
  - Alternate trackpad use R/L hands
  - Increase font size
  - http://ergo.human.cornell.edu/ergoguide.html… 1 hour max

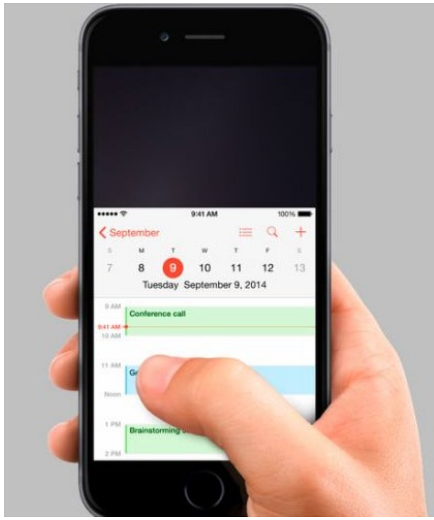


Three Key Takeaways

1. Laptop use causes increased neck, shoulder and wrist injuries compared to standard desktop computer use
2. There is no safe ergonomic way to use a laptop
3. Use external monitors and input devices with your laptop whenever possible



Mobile technology is great… well kind of



Key messages:
- ✓ Improve neck posture
- ✓ Mix it up
- ✓ Limit exposure
- ✓ Optimize hand use

Mobile technology is great… well kind of

Not sure what the future will bring…

… may pose new and challenging ergonomic risks

Office

Lab

Material Handling

Wearable Technology

Workplace Design

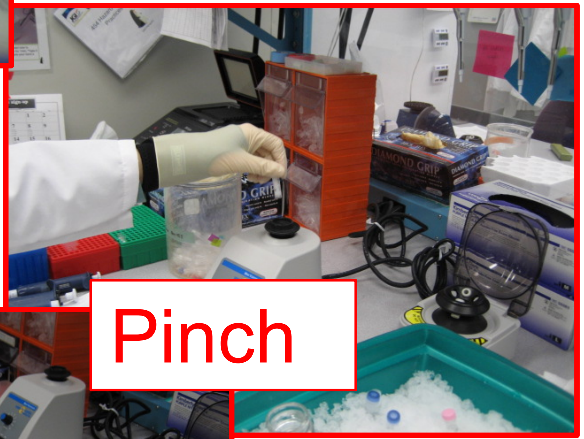
Hazard Analysis

Evidence Based Practices

In labs people… do it all!

Reach

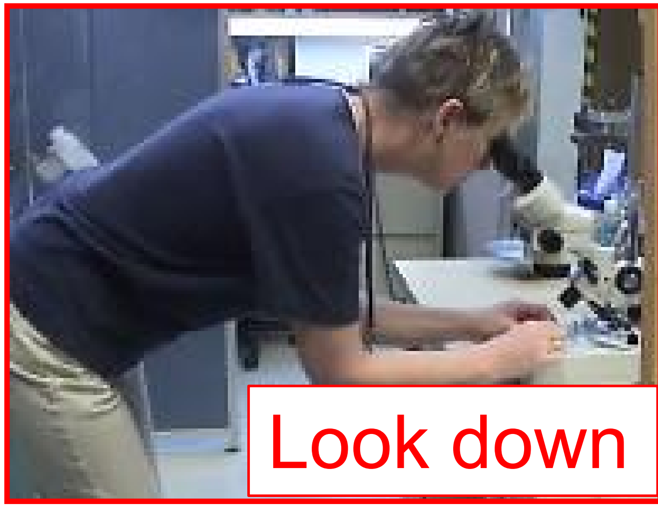
Stand

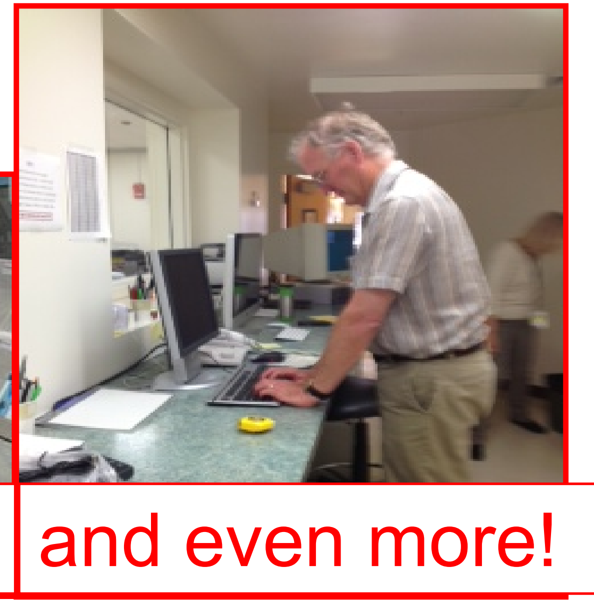


Pinch

Grip

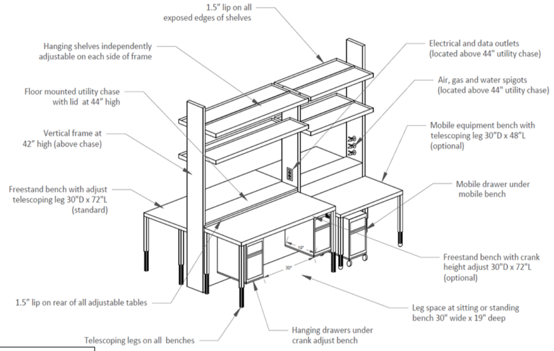
In labs people… do it all!





Ideas for lab ergonomics: Look for opportunities to align ergonomics early!

Diagram 1. Adjustable Height Work Bench

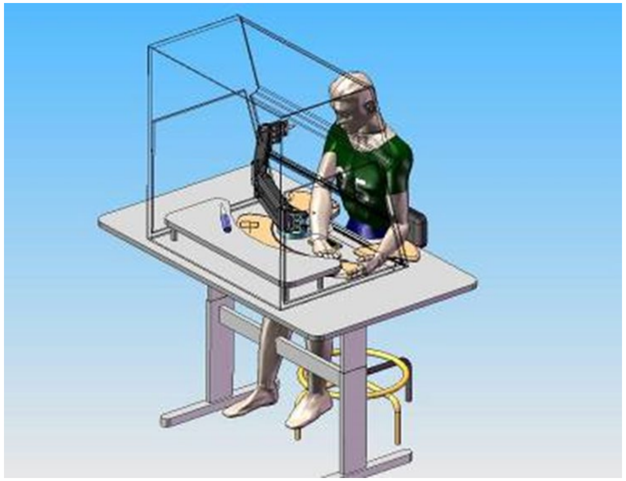


Special Note
Adjustable "Equipment Benches" would have similar features ...
- Freestanding (moveable)
- Adjustable legs
- Wheels (mobility)
- 1500 pound weight capacity
- Adjust/removable shelves above

Isometric View: Adjustable Height Work Bench
(freestanding tables and floor mounted utility chase)

Design Guidelines

Work Planning



Engage and align with employees

Equipment Procurement

Office

Lab

Material Handling

Wearable Technology

Workplace Design

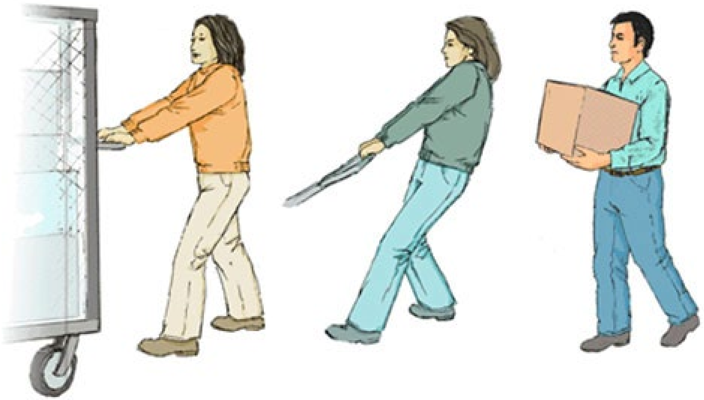
Hazard Analysis

Evidence Based Practices

Material Handling
More than just safe lifting

Avoid manual handling
whenever possible

Hands-on practical experiential learning
and reinforcement for ‘doing things right’



Pushing, pulling and carrying has risks

Safe work planning should also
consider pre and post tasks

Material Handling
More than just safe lifting

Ergonomic Assessment Tool Use	
Type of Task	**Ergonomic Assessment Tool**
Lifting / Lowering	WISHA Lifting Calculator or NIOSH Lifting Equation
Upper Body Posture	Rapid Upper Limb Assessment (RULA)
Entire Body Posture	Rapid Entire Body Assessment (REBA)
Pushing / Pulling / Carrying	Snook Tables
Vibration	Hand-Arm Vibration Calculator

https://health.usf.edu/publichealth/tbernard/tebstonewheels

AN OBJECTIVE SET OF GUIDELINES FOR PUSHING AND PULLING

Eric B. Weston, Alex Aurand, Jonathan S. Dufour, Gregory G. Knapik, W. Gary Allread, William S. Marras
Spine Research Institute, The Ohio State University, Columbus, OH USA

SUMMARY
Current guidelines related to pushing and pulling commonly used by practitioners were developed using *subjective* methods and may underestimate risk to the lower back and shoulders. This document describes the development of a new set of *objective* guidelines and how to implement them moving forward to help reduce the risk of workplace injury to the low back and shoulders.

BACKGROUND

Occupationally-related low back disorders (LBD) and shoulder musculoskeletal disorders are a leading cause of lost work days and are a costly occupational safety and health problem facing industry today. In the United States, treatment of low back pain costs over $50 billion annually in direct costs alone, while the direct cost of treating shoulder injury is over $7 billion (Meislin et al. 2005; Davis et al 2012).

As employers have recognized the risks associated with lifting, they have shifted the manual materials handling burden to interventions involving pushing and pulling (such as overhead hoists, carts, and articulating arms). However, pushing and pulling is also associated with its own risk of injury to the low back and shoulders as well.

Guidelines presented to practitioners have the potential to aid in workplace design and reduce the risk of low back and shoulder injuries. However, the only current pushing and pulling guidelines were developed *subjectively*, relying on the assumption that an individual's perception of maximum acceptable external forces corresponds to biomechanical risk to the low back and shoulders (Snook and Ciriello 1991). Prior literature shows this assumption is incorrect (Jorgensen et al. 1999; Davis et al. 2000; Le et al. 2012). ***Thus, objectively determined guidelines are necessary for pushing and pulling.***

This study used biomechanical information collected from 62 human subjects in a laboratory to develop pushing and pulling guidelines for practitioners. This was achieved via establishing a relationship between the biomechanical loads induced onto the spine and hand forces generated by the participants. Risk limits were determined by investigating which hand forces or turning torques led to spinal loads over risk thresholds (Gallagher and Marras 2012; NIOSH 1981). Loads on the spine were predicted using a unique biomechanical model that is validated for pushing and pulling, dynamic, and accurately accounts for the way each person recruits their muscles to complete a task (Granata and Marras 1993; Hwang et al. 2016; Knapik and Marras 2009).

Subjects performed activities including 1 Handed Pulling, 2 Handed Pulling, and 2 Handed Pushing. They performed exertions at three different handle heights (32 in, 40 in, 48 in) and performed both straight and turning push/pull exertions.

RECOMMENDATIONS FOR WORKPLACE DESIGN

The results of this study suggest that the following be considered related to pushing and pulling.

- Higher handle heights (up to 48 in.) are generally preferable for all pushing and pulling exertions.
- Turning push/pull exertions should be avoided where possible because these exertions generally subjected participants to higher biomechanical loads than straight exertions.
- Two handed turning exertions (such as moving a cart) are recommended over one handed turning exertions (such as moving a pallet jack).
- The widely-accepted *subjectively* determined limits for hand force during pushing and pulling (Snook and Ciriello 1991) are not protective enough of injury risk. The objective, biomechanically-determined risk limits derived from our study **are up to 30% lower than the limits reported previously.**

GUIDELINES FOR OCCUPATIONAL PUSHING AND PULLING

- The *objectively* determined guidelines are presented in tables below. These limits and are expected to be protective of both the low back and shoulders.
- Note that the pushing and pulling guidelines proposed within this investigation ***did not differ based on gender.***

https://www.bwc.ohio.gov/downloads/blankpdf/PushPullGuidelines.pdf

https://www.bwc.ohio.gov/employer/programs/safety/PushPullGuide/PushPullGuide.aspx

Office

Lab

Material Handling

Wearable Technology

Workplace Design

Hazard Analysis

Evidence Based Practices

Wearable Technology
Not sure if and how they will help worker safety

Exoskeletons do they…
Reduce fatigue, transfer loads away from spine, ensure proper techniques?

Key ergo considerations for wearable technology:

- ✓ Ease of use
- ✓ Simplicity
- ✓ Satisfaction
- ✓ User Friendly
- ✓ Intuitiveness
- ✓ Functional

BERKELEY LAB

Office

Lab

Material Handling

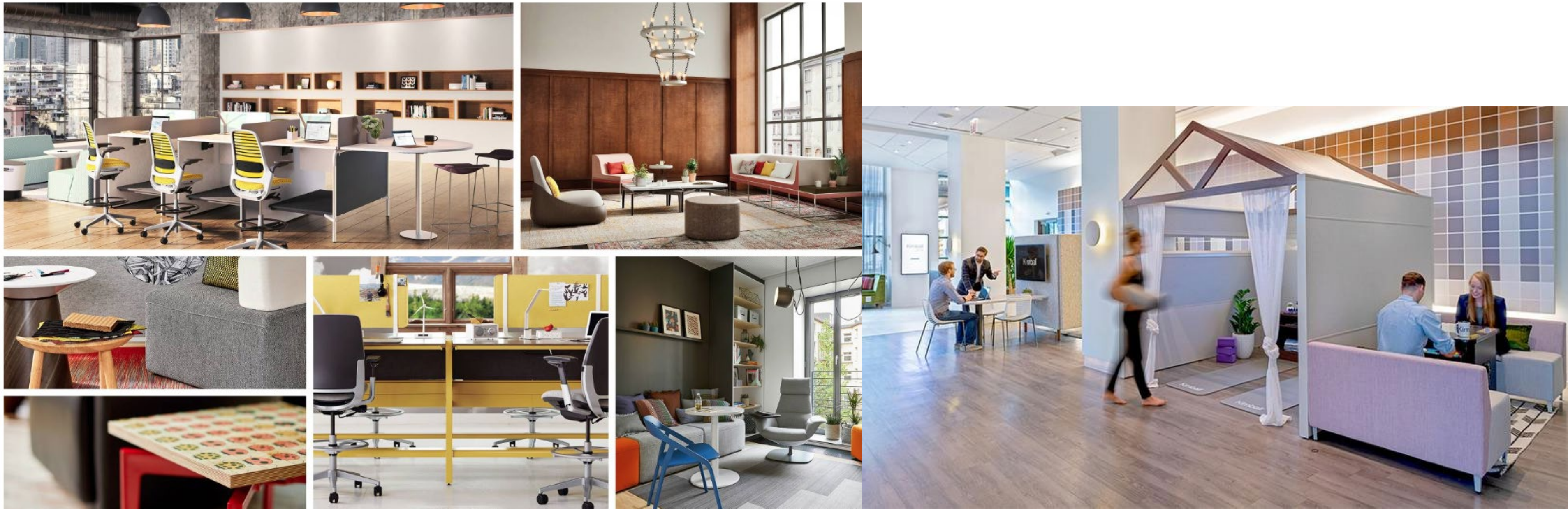
Wearable Technology

Workplace Design

Hazard Analysis

Evidence Based Practices

Workplace Design
The way we work is changing: Wellness and employee centered



THE WELL BUILDING STANDARD™

SEVEN CONCEPTS FOR HEALTHIER BUILDINGS

LEED BD+C: New Construction | v3 - LEED 2009

Ergonomics approach for computer users

EQpc44 | Possible 1 point

Design work areas and tasks hard to do the wrong thing and easy to do the right thing

Office

Lab

Material Handling

Wearable Technology

Workplace Design

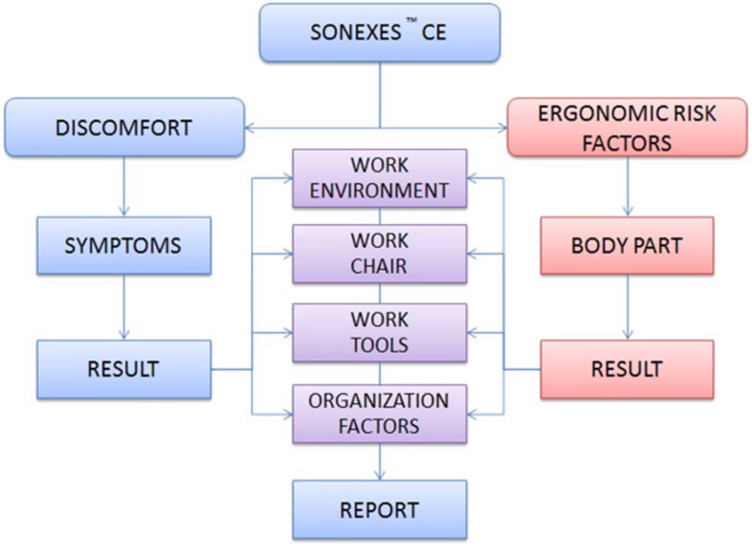
Hazard Analysis

Evidence Based Practices

Hazard Analysis:
CAD Human Modeling & Risk Detection

Predictive Analytics
Cloud based system with rapid early detection of ergonomic and injury risks for all types of work of large worker populations

CAD Human Modeling, Simulation, & Calculation
Helpful tool to ensure a good match between human capabilities, posture and work tasks



Hazard Analysis:
How to predict and measure fatigue

Applied Ergonomics
Volume 63, September 2017, Pages 142-150

Development and validation of an easy-to-use risk assessment tool for cumulative low back loading: The Lifting Fatigue Failure Tool (LiFFT)

Sean Gallagher, Richard F. Sesek, Mark C. Schall Jr., Rong Huangfu

Highlights

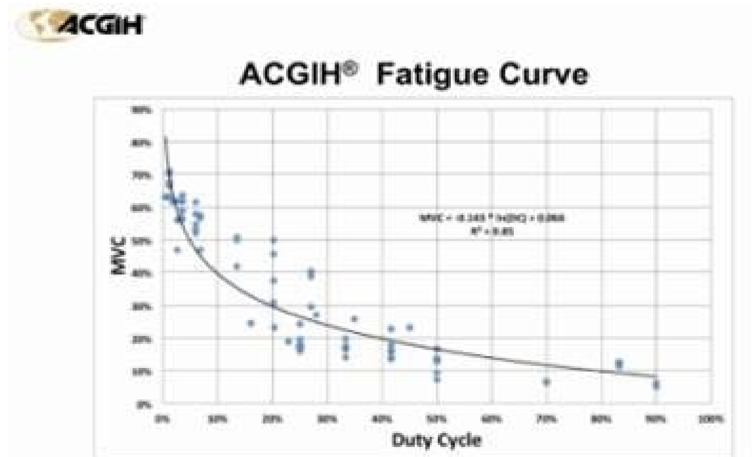
- A practitioner friendly risk assessment tool for manual lifting activities based on fatigue failure theory is presented.
- The tool requires only load weight, horizontal distance to the load, and the daily number of repetitions for each task.
- The cumulative load associated with multiple lifting tasks can be easily summed to get a "daily dose" of exposure.
- The cumulative damage metric demonstrated dose-response relationships with low back outcomes from two epidemiology studies.
- The strong relationship between our fatigue failure metric and back outcomes suggests a fatigue failure based etiology.

The Lifting Fatigue Failure Tool

Task #	Lever Arm (inch)	Load (lbs)	Moment (ft.lbs.)	Repetitions (per work day)	Damage (cumulative)	% Total (damage)
1	14	10	11.7	420	0.0012	5.1
2	18	44	66.0	75	0.0033	14.0
3	24	54	108.0	50	0.019	80.9
4			0.0		0.0	0.0
5			0.0		0.0	0.0
6			0.0		0.0	0.0
7			0.0		0.0	0.0
8			0.0		0.0	0.0
9			0.0		0.0	0.0
10			0.0		0.0	0.0
				Total Cumulative Damage:	0.0235	
				Probability of High Risk Job * (%):	51.4	

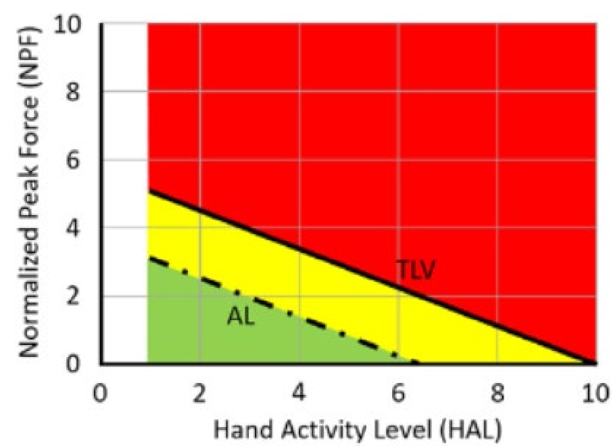
Reset Calculate

ACGIH- Upper Limb Localized Fatigue TLV New for 2016



- Duty Cycle Range: 0.5% to 90%
- For multiple tasks that are 2h or more each, none should exceed the TLV®

ACGIH- HAL TLV Changed in 2018



ACGIH HA TLV® Regression Equation
2018 TLV NPF = 5.6 – 0.56 * HAL
2018 AL NPF = 3.6 – 0.56 * HAL

Office

Lab

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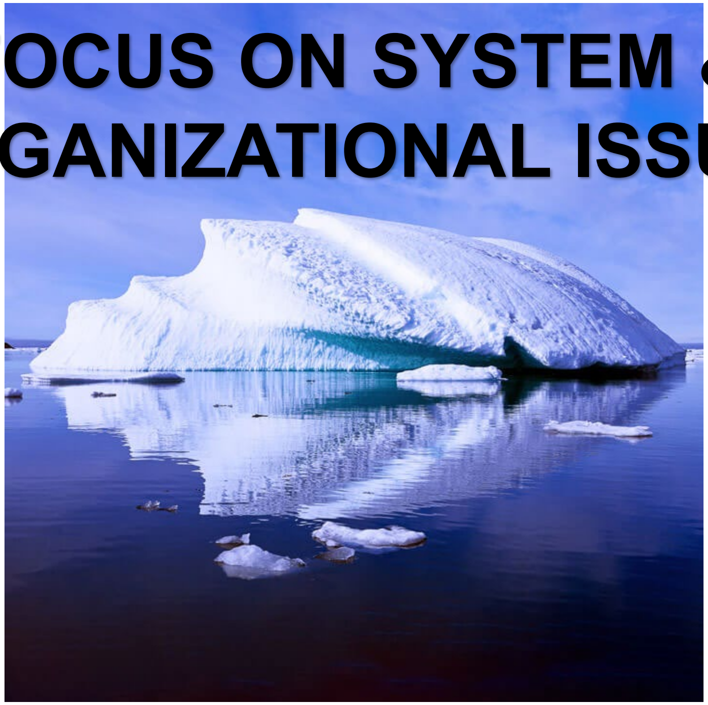
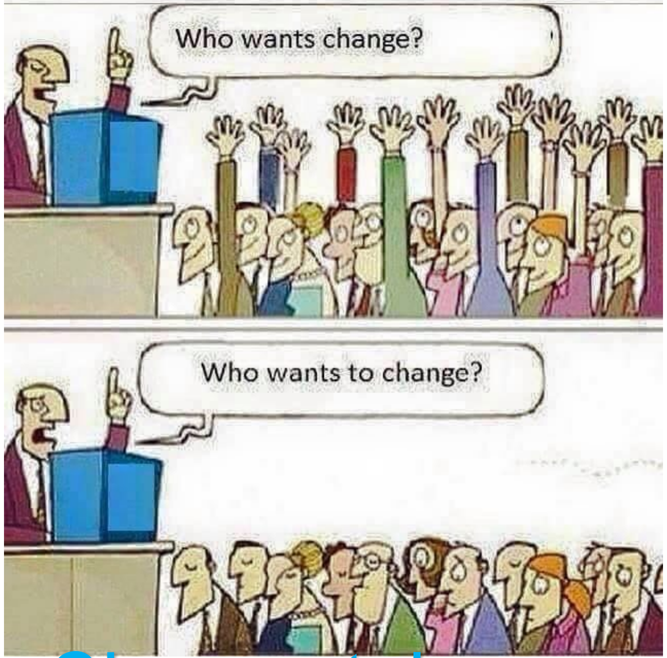
Evidence Based Ergo Practices

FOCUS ON SYSTEM & ORGANIZATIONAL ISSUES



CHAMPIONS & ALLIES

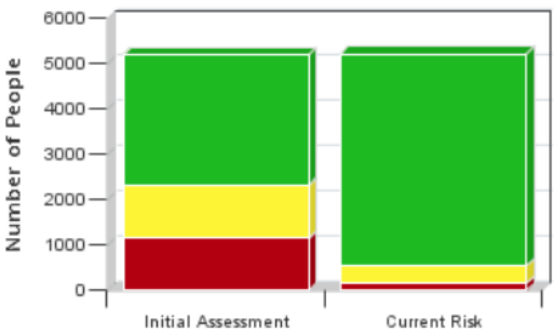
Evidence Based Ergo Practices *(Continued)*



Change tolerance

Evidence Based Ergo Practices *(Continued)*

Have comprehensive program with a variety of resources



Risk rating tool and training

Ergonomic Point-of-Contact

Convenient access to approved products/ one stop ‘shop’

Now it's time for a test…

Ergo Headlines

TRUE

Whatever you do...stay away from fatigue!

TRALSE

Mobile technology is out to get us!

TRUE

Pushing and pulling can be tough on the back!

TRUE

So many workers... so few ergonomists

TRUE

TRALSE

Sitting is Evil!

New workplace disease: Gadget Overload

TRALSE

TRALSE

Technology solves all the worlds problems!

Sit-stand desk converters are the best!

TRALSE

Key Takeaways

- ❑ Important to be in tune and adapt with latest trends, but base decisions on evidence
- ❑ Involve and integrate ergonomics early and often
- ❑ Thorough problem identification and appropriate intervention are key
- ❑ Promote movement… reduce fatigue
- ❑ Material handling is more than safe lifting

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