

**Controls. Controls.  
You must learn controls.**

# Ergonomic Controls

**2024 Kansas Safety & Health Conference**

**October 1, 2024**

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## The Ergonomics Center

- Not-for-Profit organization founded in 1994
- Part of NCSU's Industrial & Systems Engineering department
- Nationwide occupational ergonomics
  - Consulting
  - Training
  - Applied research



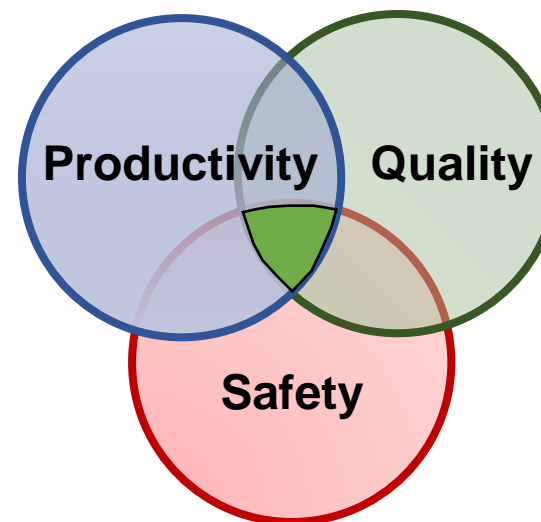
**EDWARD P. FITTS DEPARTMENT OF  
INDUSTRIAL AND SYSTEMS ENGINEERING**

# What is Ergonomics?

Ergonomics is the study of work in an effort to:

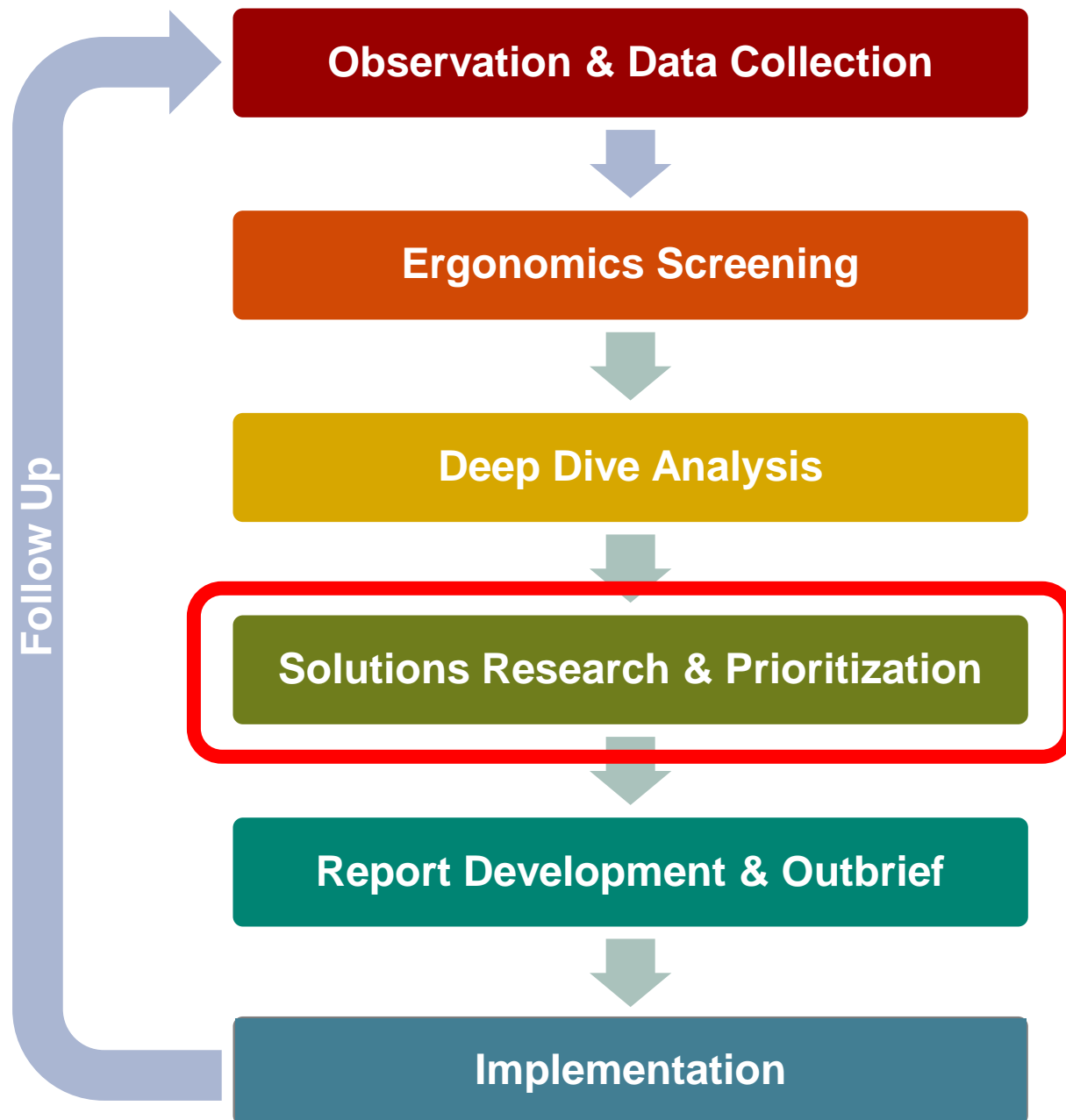
1. Improve employee well-being
2. Optimize system performance

*Fitting the task  
to the person*



**Creating  
a Balance**

# Ergonomics Evaluation Pathway



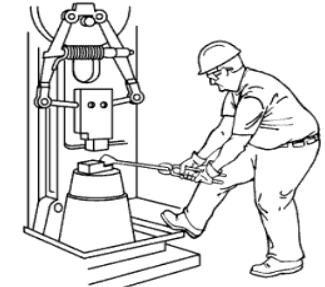
# Ergonomic Stressors



1. Excessive Force
2. Awkward Posture
3. Movement Extremes
  - Repetitive Actions
  - Static or Sustained Efforts

*The Big 3*

## 4. Work Environment



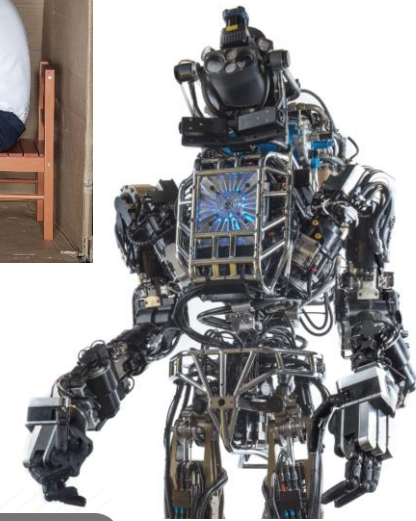
*Multiple stressors = Greater chance of injury*



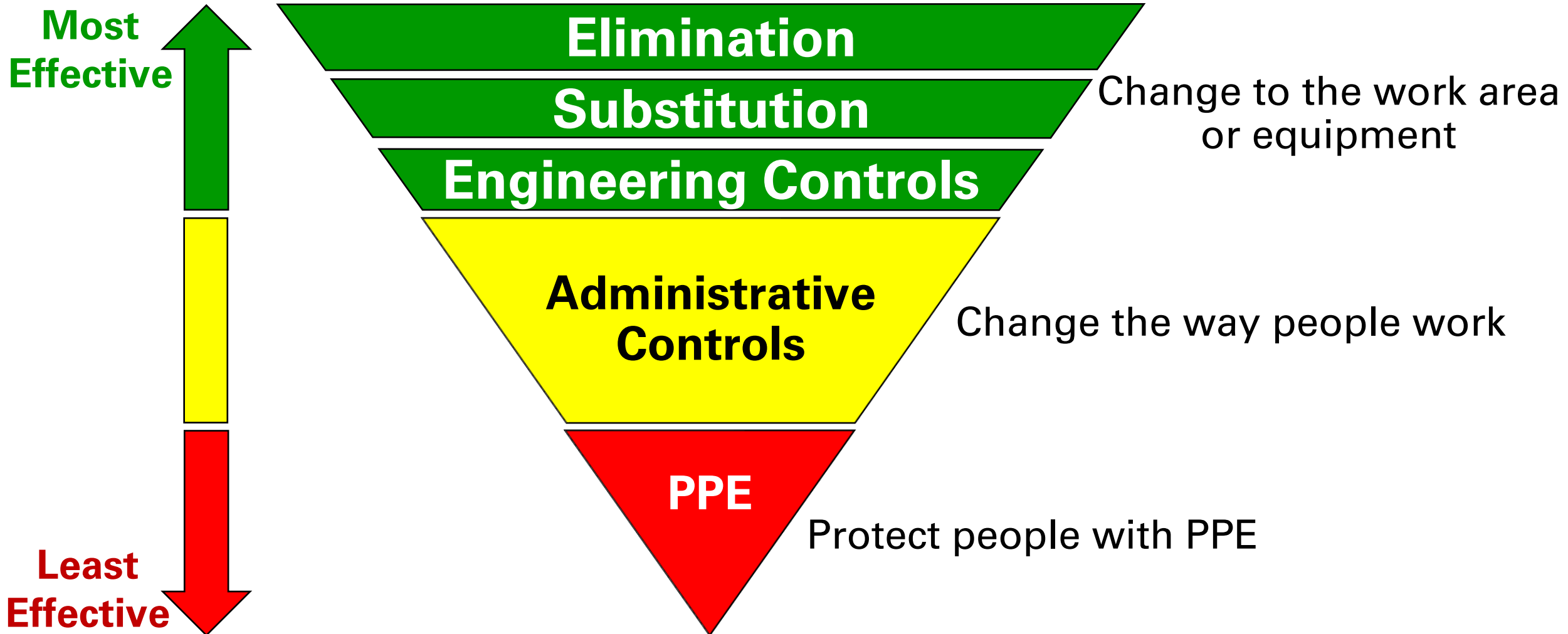
# Ergonomics Controls are NOT



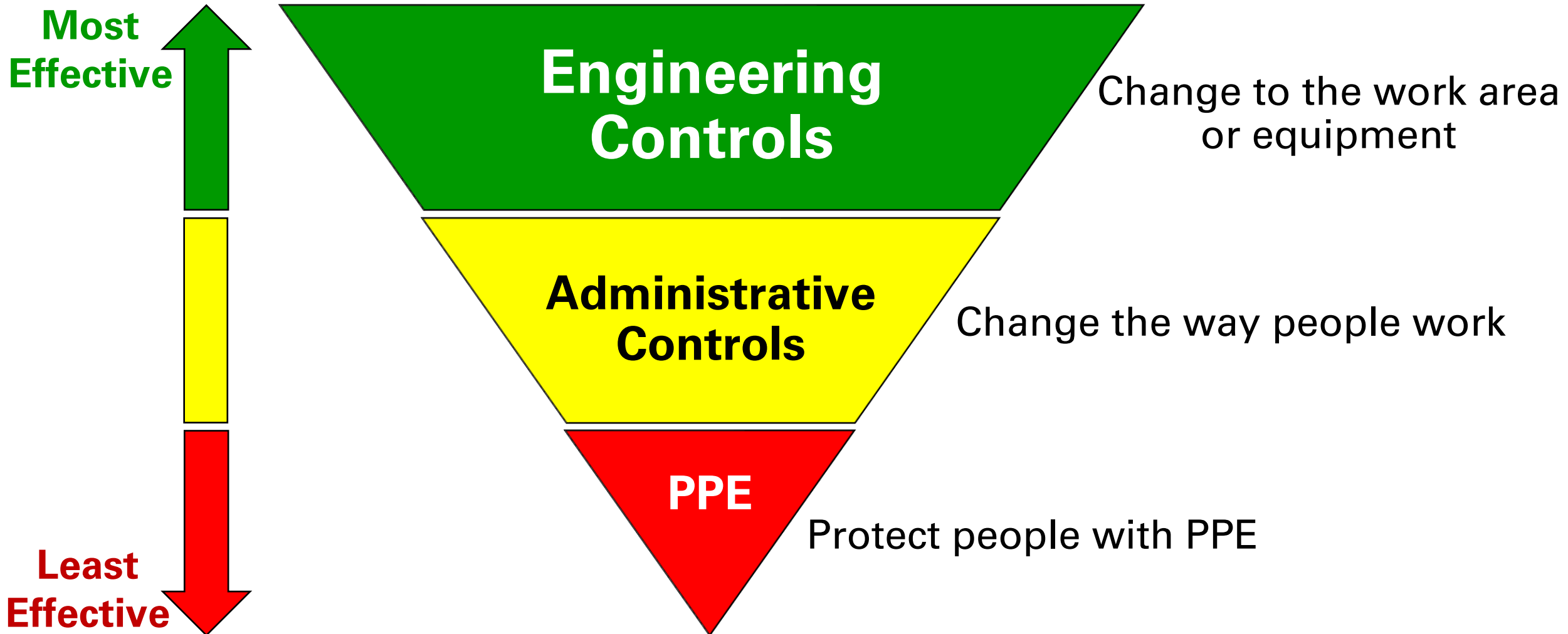
- Using oneself as the model for design
- Purchasing expensive equipment
- Always the right solution the first time



# Ergonomic Controls and Hierarchy



# Ergonomic Controls and Hierarchy



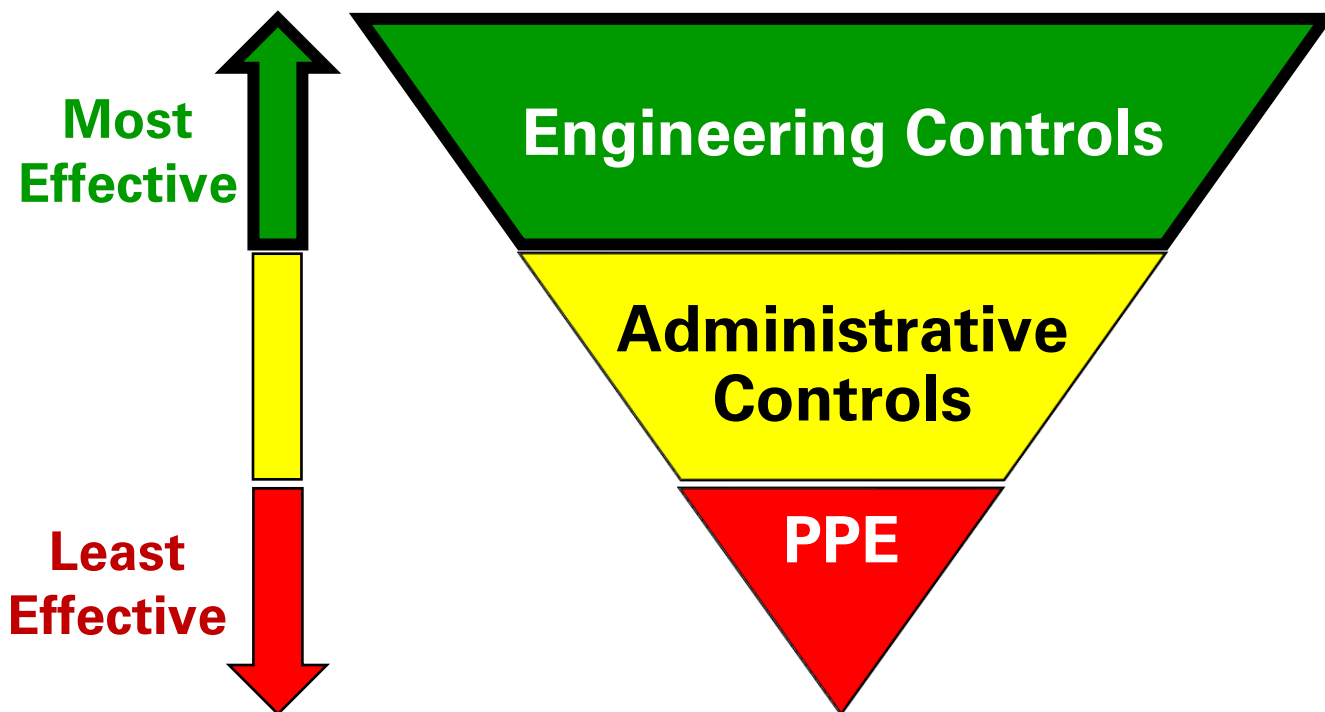


# Engineering Controls

Changes made to workstations, products, tools, machinery, or the work environment that alter the physical composition of a work area/process

Examples include:

- Pallet Lifts
- Shelving Adjustment
- Power Tools
- Hooks & Reachers



# Engineering Controls

The goal behind selection of good ergonomic engineering controls is to eliminate or greatly reduce the stressors that contribute to musculoskeletal disorders

**A good control provides the *opposite* of the stressor...**

| Stressor          | Engineering Control Example              |
|-------------------|--|
| Awkward Posture   | Raise the Load to Work in the Power Zone |
| Excessive Force   | Provide Push Assistance                  |
| Repetitive Motion | Provide a Power Tool                     |

# Work in the Power Zone



**The Power Zone**



**Shelved Location**



**Angled  
Gravity-Fed  
Shelving**

# Work in the Power Zone



**Tilt Stands**



**Adjustable-Height  
Work Benches**



**Tilters**



# Engineering Controls Example



**Static back & neck flexion  
cleaning engine compressor**



**Height & tilt adjustable work  
stand with Lazy Susan fixture  
to eliminate awkward postures**

# Raise the Load



**Pallet Lifts**



**Stacked Pallets**



# Raise the Load



**Load Lifters**



**Lift Carts**



**Stackers**

# Engineering Controls Example



**BEFORE**



**Lifting and/or carrying heavy or bulky items to/from truckbed**

**AFTER**



**Self-Loading Height Adjustable Pallet Jack**  
([www.innoliftusa.com](http://www.innoliftusa.com))

# Raise the Worker



**Step Stools**



**Portable Steps**



# Raise the Worker



**Platforms/Scaffolding**



**Personnel Lift Vehicles**



# Lower & Support the Worker



## Anterior Supports



## Stools



## Creepers



# Engineering Controls Example



**BEFORE**



**Awkward overhead reaching & squatting posture to polish canopy**

**AFTER**



**Height & tilt adjustable creeper to eliminate awkward arm and squatting posture**



# Improve Access



**Lowered Container Sides**



**Turntables (Lazy Susans)**

# Improve Access



**Worksurface Cutout**



**Vertical  
Carousels**



**Automated Storage  
& Retrieval Systems**

# Support the Container



**Drum & Pail Tipplers**



**Drum Lift Carts**



**Pumps/Siphons**



# Support the Container



**Manipulators**



**Vacuum Lifts**



**Cranes & Hoists**



**Screens/Grates**

# Support the Container



**Pallet Dispensers**



**Pallet Inverters**



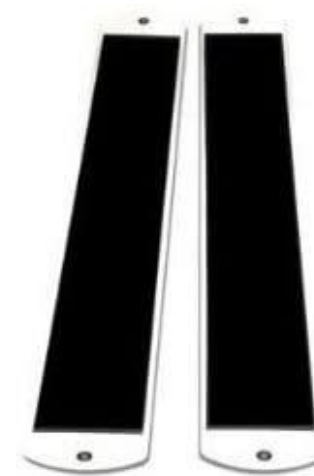
# Provide Push/Pull Assistance



**Carts**



**Dollies**



**Pallet Sliders**  
(Furniture Slides)



# Provide Push/Pull Assistance



**Automatic Guided Vehicles**



**Powered Pallet Jacks**

# Engineering Controls Example



**BEFORE**



**Pushing or pulling with high force**  
(i.e. leaning to push or pull)

**AFTER**



**Powered Pallet Jack Converter**

<http://powerhandling.com/powerpallet-2000/>



# Provide Push/Pull Assistance



**Tuggers**



**Pushers**



**Forklifts**



# Engineering Controls Example



**BEFORE**



**Manually push transfer cars**  
(380+ lb init. force, 150+ lb of sust. force)

**AFTER**



**Power Pusher**

# Provide Push/Pull Assistance



**Conveyors**



**Slides & Chutes**



**Skate Wheel  
Conveyors**



# Provide Push/Pull Assistance



**Conveyance Tops**



**Roller Balls**



**Air Ball Tables**



# Engineering Controls Example



**BEFORE**



**AFTER**



# Provide Packaging Assistance



**Packaging  
Manifesto  
Workstations**



**Automated  
Packaging  
Equipment**



**Semi-Automatic & Fully  
Automatic Wrappers**



# Provide Packaging Assistance



**Handheld  
Stretch Wrap  
Roll Holders**



**Stretch Wrap Carts**



**Stretch Wrap Poles**



# Provide the Appropriate Tool



**Balancers**



**Torque Arms**



**Tool Manipulators/Supports**

# Provide the Appropriate Tool



**Alternative Microscopes**



**Alternative Handles**



**Hooks & Reachers**

# Provide the Appropriate Tool



**Shovels & Brooms**



**Air Line Slide Valves**



**Portable Valve Actuator Tools**

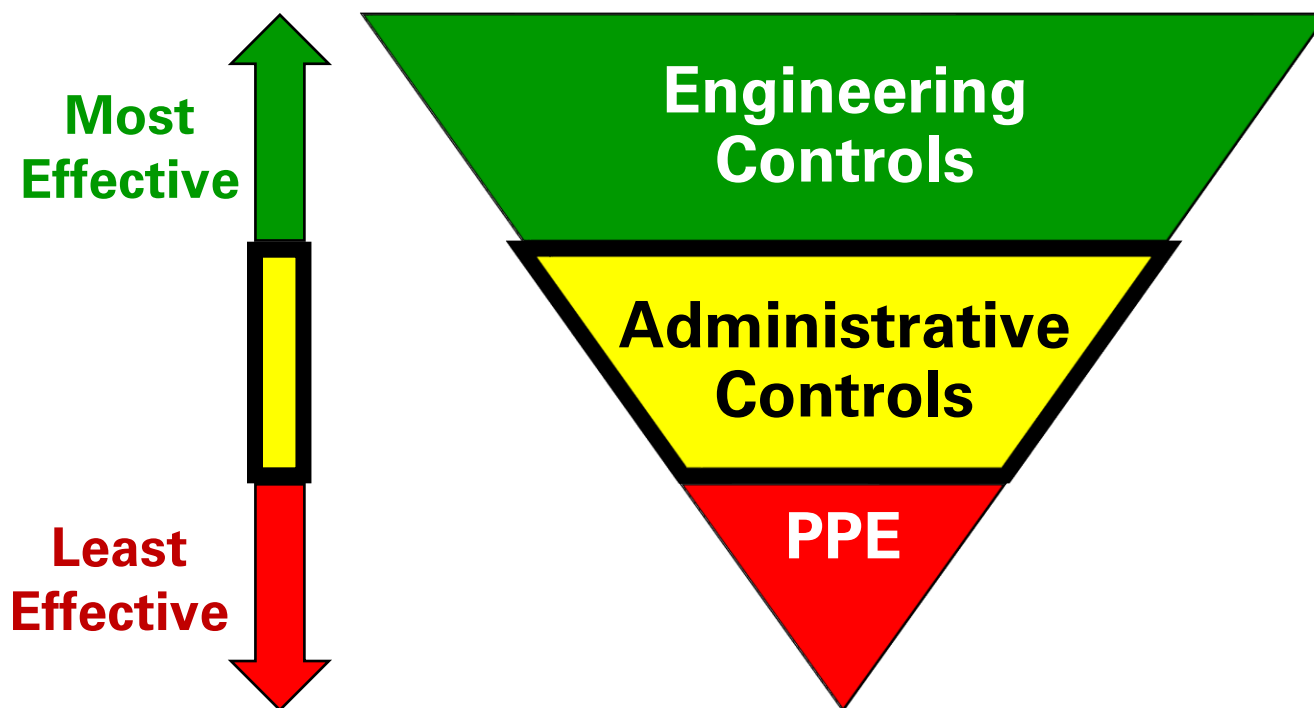


# Administrative Controls

Regulates exposure to ergonomic stressors *without making physical changes* to the work area or work process

Examples include:

- Stretching Exercises
- Job Rotation/Enlargement
- Work Practice Controls



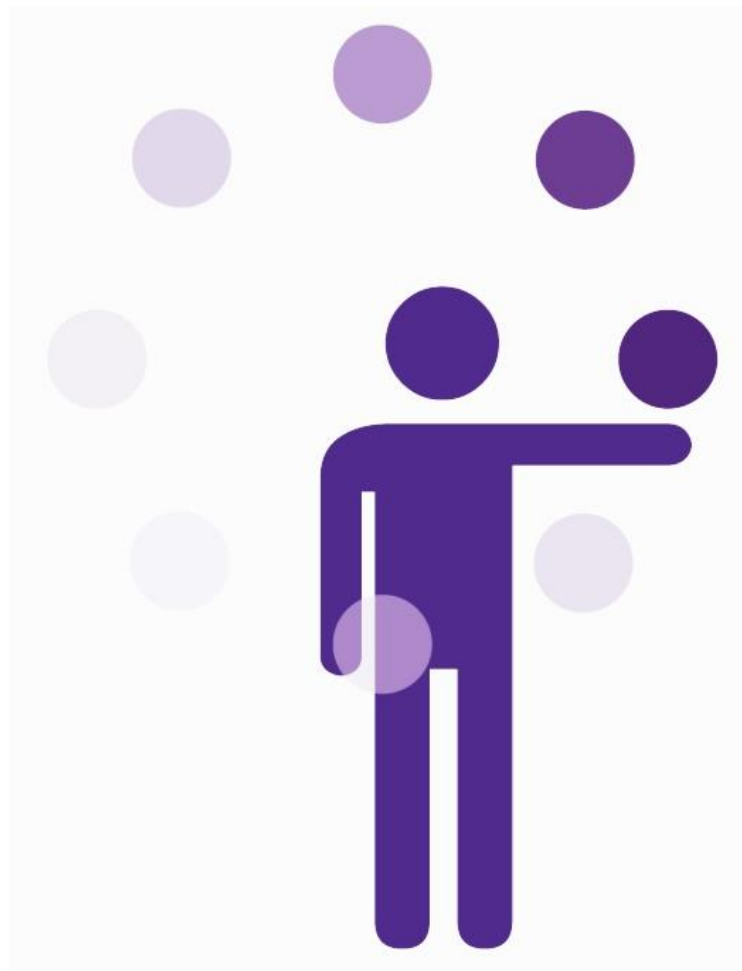
# Stretching



- Facilitates blood flow
- Warms up muscles
- Offers a break from activities
- Dynamic stretches favored
- Customize for task

*As with any exercise program, a certified physician or physical therapist should be consulted before beginning or increasing the parameters of an exercise program.*

# Job Enlargement

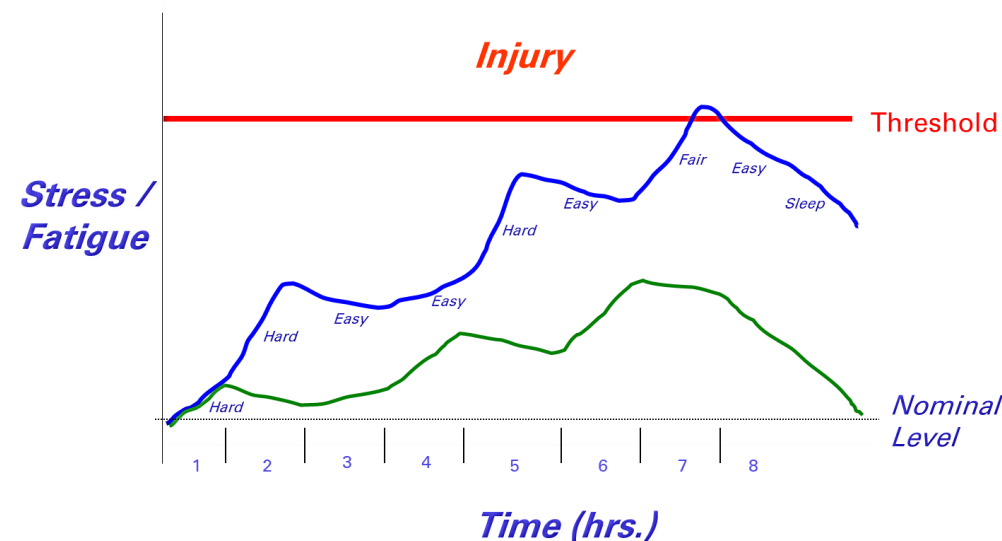


- Expand the number of tasks performed by a worker to reduce repetition affecting individual body parts
- Provide musculoskeletal variety offers recovery time for individual muscle groups



# Job Rotation

- **Distributes stressors** between a group of employees
- Can be **implemented quickly**
- **Reduces exposure time to stressors** causing musculoskeletal disorders
- Provides **recovery** from localized muscle fatigue by utilizing **musculoskeletal variety**

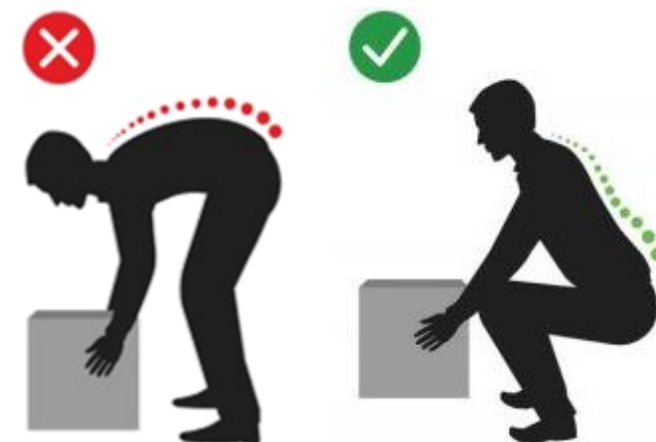


# Work Practice Controls

An **Administrative Control** that *changes the way employees perform job activities* to reduce exposure levels

Examples include:

- Methods Training
- Workstation Features Training
- Ramp In Conditioning or Work Hardening



# Lifting Tips

## If you do have to lift:

- Clear a path to your destination
- Avoid stairs, stools, and ladders
- Secure a good grip on the load
- Keep object close to body
- Neutral back, lift with legs
- Keep eyes up
- Use smooth lifting motion
- Move feet instead of twisting
- Get help if you need it!





# MMH Tips

- Avoid awkward back postures by storing products at waist level
- Slide products instead of lifting
- Push instead of pull
- Keep motions smooth and controlled
- Get assistance when moving heavy or bulky objects
- Avoid awkward grips and hand/wrist postures  
(Use power grip vs. pinch grip and keep wrists straight)



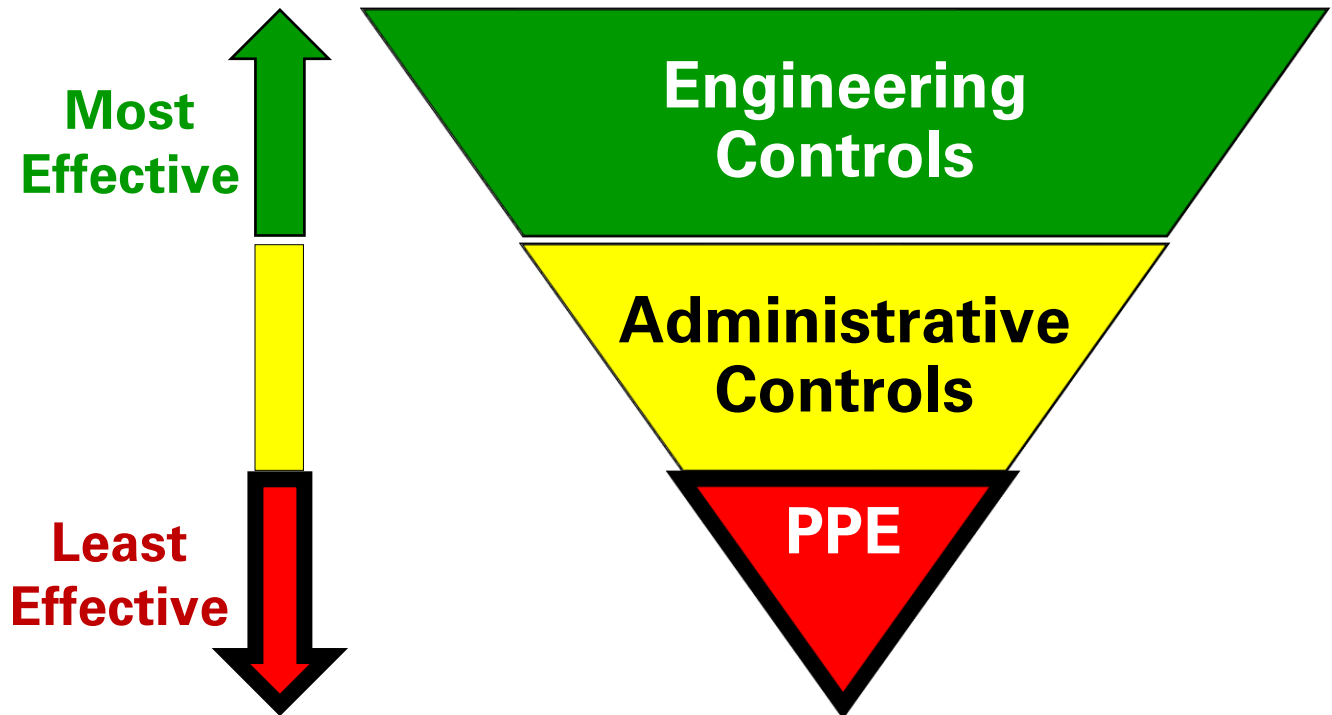
# Personal Protective Equipment



Equipment worn to minimize exposure or impact of certain risks; places a barrier between the worker's body and the risk

Examples include:

- Padding
- Anti-fatigue Insoles
- Vibration Damping
- Gloves
- Cooling / Warming Vests



# Padding & Anti-Fatigue Insoles

Consider **padding, anti-fatigue mats or insoles** to reduce contact stress & promote circulation





# Vibration Damping & Gloves

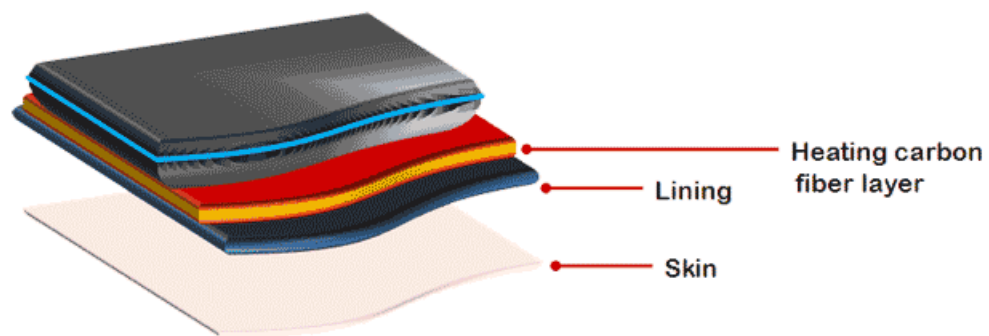
Consider **vibration damping wraps** and/or **anti-vibration gloves** when using tools with high vibration levels:

- Grinders
- Impact Guns
- Rivet Guns / Bucking Bars
- Jack Hammers



# Cooling & Warming

- Cooling Vests & Towels
- Heated Clothing



# Back Belts

NIOSH, OSHA & The Ergonomics Center **DO NOT** recommend the use of back belts to prevent injuries among workers

Findings on back belts:

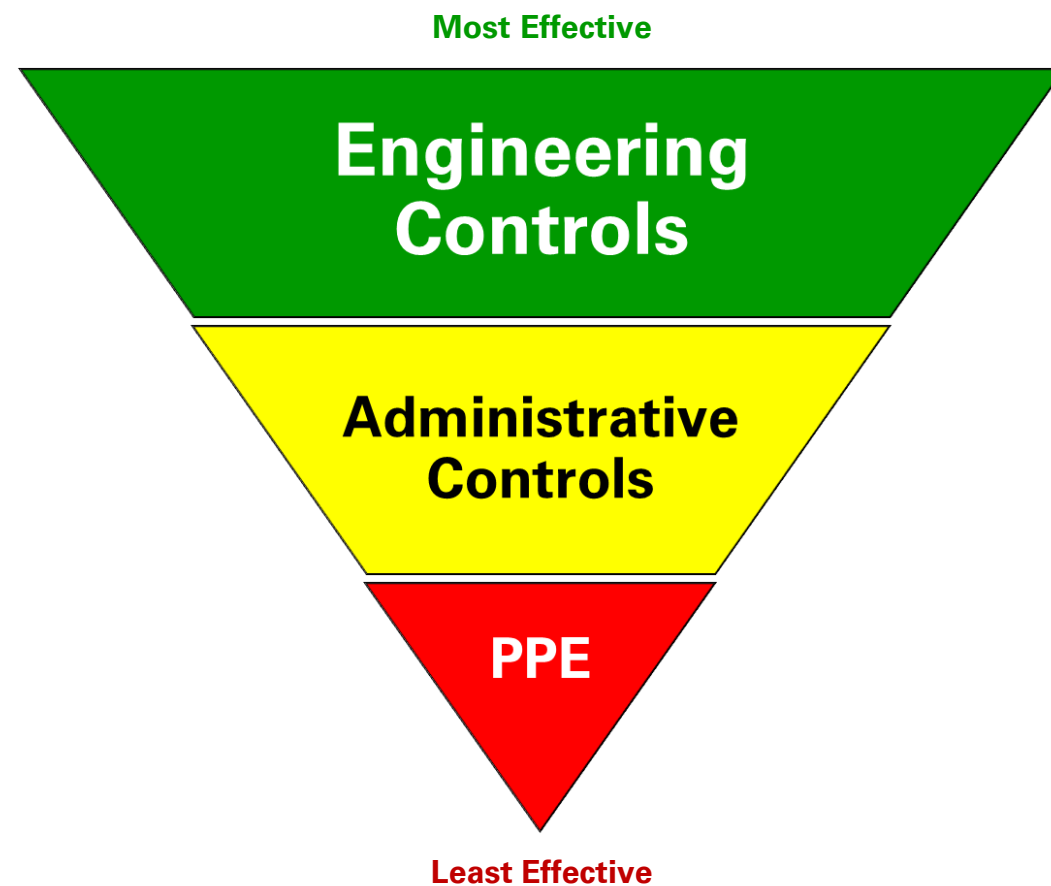
- No evidence of reduced injuries
- No evidence of reduced spine forces
- No evidence of reduced forward bending
- Back belts give false sense of security
- Heart rate & energy expenditure may increase with back belt use





# Controls Wrap Up

- Engineering controls are preferred over Administrative controls & PPE; they eliminate/reduce stressors
- Administrative controls & PPE do have their place, often as short-term easy-to-implement solutions
- Control implementation is a process
- Expect the need to tweak a newly implemented control based on feedback from employees



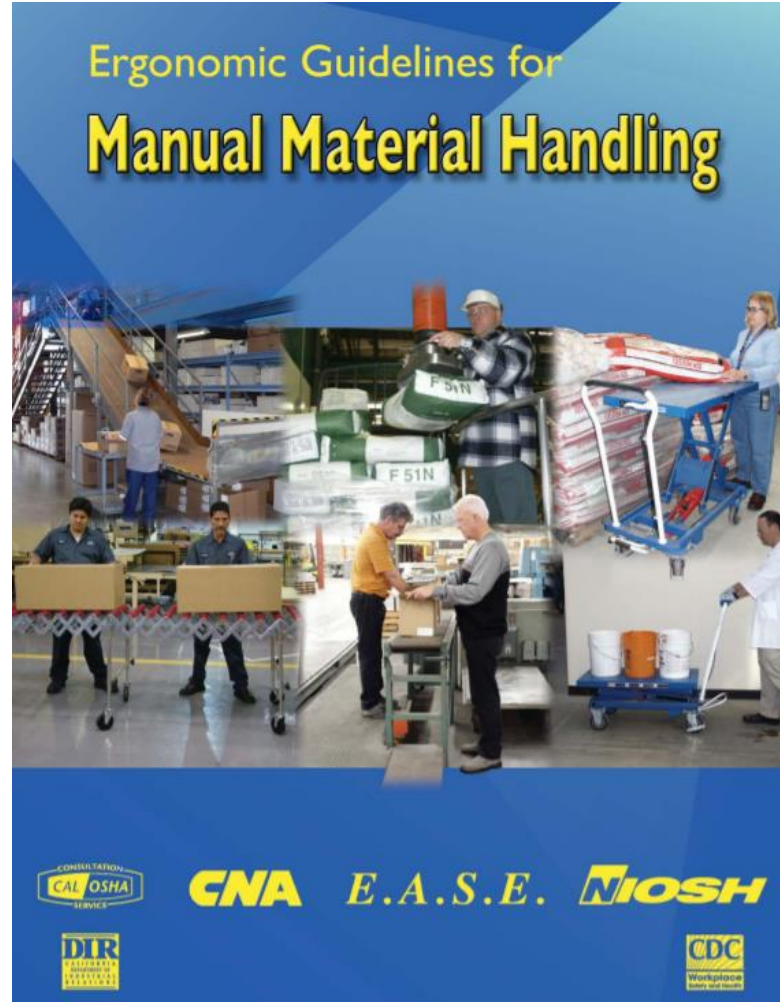
# Other Examples of Ergo Controls



## IISE Applied Ergo Conference Ergo Cup®

<https://www.iise.org/AEC/details.aspx?id=8956>

# FREE Resource



67 pages  
**Full Color**  
Resource Guide



[www.mhi.org/free/4607](http://www.mhi.org/free/4607)





# Resources for Controls

- Washington State Dept. of Labor & Industries:  
<https://lni.wa.gov/safety-health/preventing-injuries-illnesses/sprains-strains/>
- OSHA Ergonomics - Solutions to Control Hazards:  
<https://www.osha.gov/ergonomics/control-hazards>
- CDC / NIOSH Ergonomics Guidelines to MMH:  
<https://www.cdc.gov/niosh/docs/2007-131/>
- Canadian Centre for Occupational Health & Safety - Ergonomics: <https://www.ccohs.ca/oshanswers/ergonomics>
- NIOSH Ergonomics & MSDs:  
<https://www.cdc.gov/niosh/topics/ergonomics/default.html>
  - "Ergonomic Interventions by Industry"
  - "Ergonomic Recommendations"

Pass on what you  
have learned.



Thank You!

Questions, you have?

# Ergonomic Controls

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Please share  
your feedback

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NC STATE UNIVERSITY

# Feedback Survey



Your feedback is important to me!

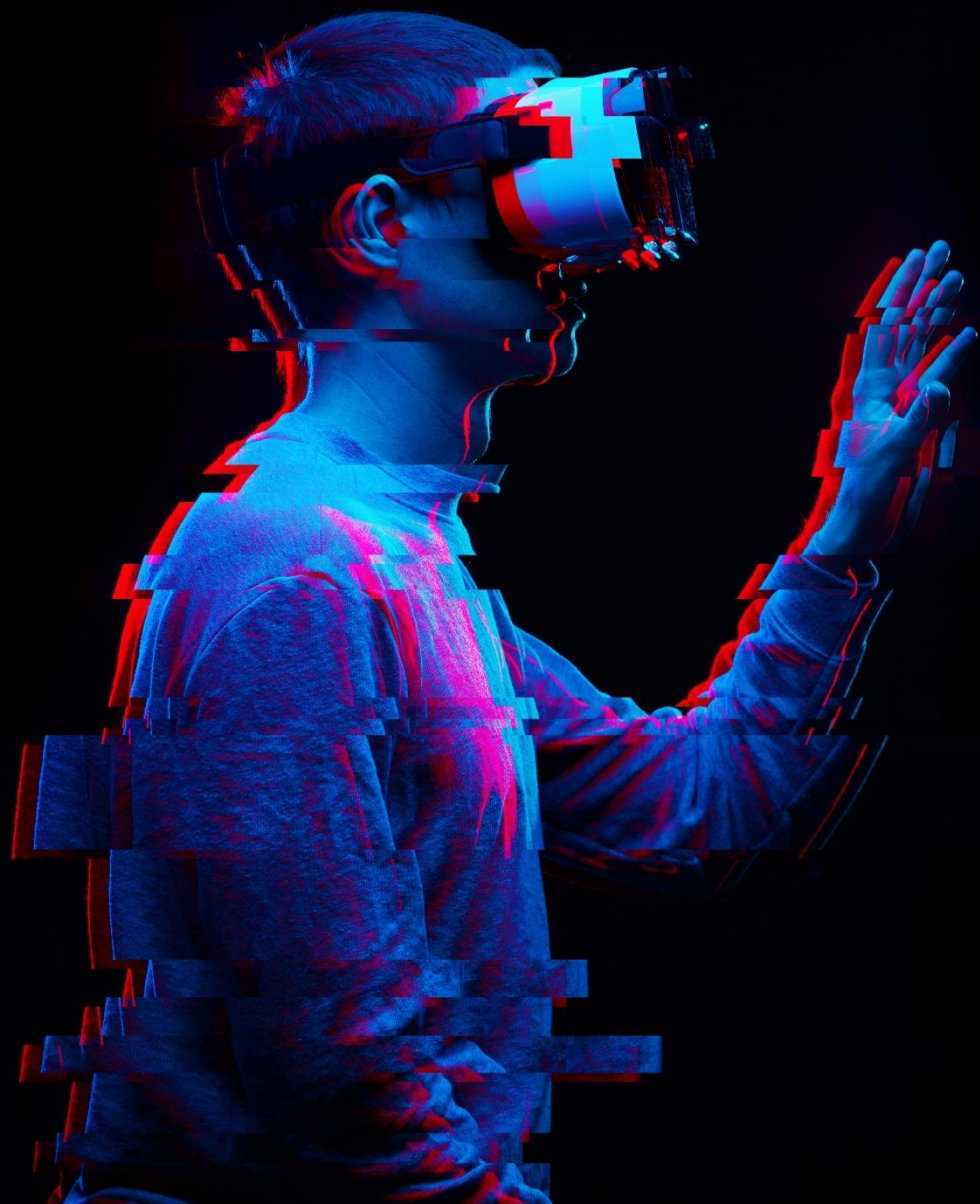




# Ergonomic Controls

## Bonus Content

(time permitting)



# Emerging Technology

# Smart PPE: Exoskeletons

- ASTM F48: “wearable device that augments, enables, assists, and/or enhances physical activity through mechanical interaction with the body”
- Exosuits: similar but have primarily soft and/or elastic structures
- Active vs Passive
- Viewed as PPE (by early adopters)
- Components
  - Shoulder/Arm assist
  - Back assist
  - Leg assist
  - Tool holding/support



**Sarcos Guardian XO**



**Strong Arm  
Technologies V22**



# Smart PPE: Exoskeletons



[Ekso Bionics](#)  
[EksoVest](#)



[Levitate](#)  
[Technologies](#)  
[Airframe](#)



[Lockheed Martin](#)  
[FORTIS](#)



[Laevo V2](#)



[Noonee](#)  
[Chairless Chair 2.0](#)



[SuitX MAX](#)



[Bioservo Ironhand](#)

[ASTM F48 Exoskeletons and Exosuits Committee Video](#)

# Smart PPE: Exoskeletons

- Research still on-going about use and MSD prevention
- Mostly small research sample sizes and in-field applications
- **Try before you buy!**
- Things to consider:
  - Task fixed better via engineering control?
  - Sizes (people & exos, adjustability)
  - Training & time (don, doff, adjustment, use, acceptance)
  - Sharing & cleaning
  - Maintenance & storage
- Not a magic bullet...yet!



# Future Direction

(from a Practitioner's Perspective)



## ↑ Exoskeletons

## ↑ Wearable Sensors

- Monitors posture/movement/location/proximity; provide tracking/feedback; brain sensors

## ↑ Computer Vision

- AI enabling computers to analyze postures/tasks, detect objects/damages, track/guide vehicles

## ↑ Virtual & Augmented Reality (VR/AR)

- VR = full immersion apart from real world, AR = overlays digital info on real world elements
- Design & prototyping; training; manufacturing/maintenance assistance

## ↑ Data Analytics, IoT, & Connected Machinery

- Design; manufacturing; diagnostics; service/repair

## ↑ Collaborative Robots (Cobots)

- Work in conjunction with & in close proximity to humans; pick & place tasks; machine tending; tool changes; raw material replacement

