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Cutting Edge Ergonomics for Laboratories

Presented by Melanie Alexandre

Ergonomics Subject Matter Expert

Lawrence Livermore National Laboratory

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Science in the National Interest

National Ignition Facility

Supercomputing Facility

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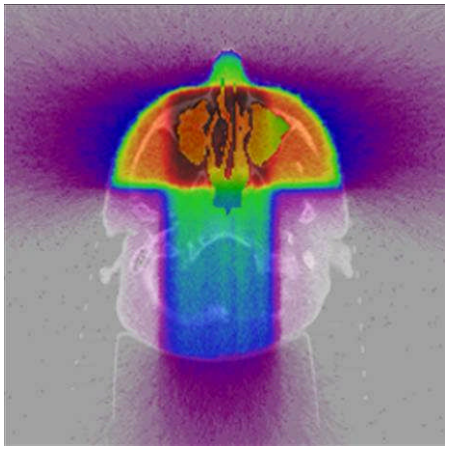


Peregrine

My job is to help ensure all work areas are user friendly and safe!

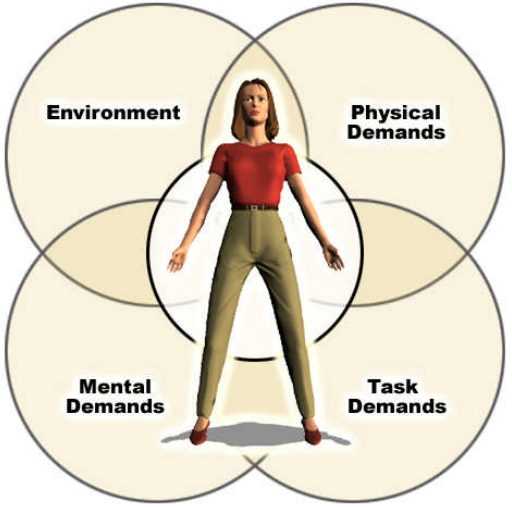
What will we be doing?

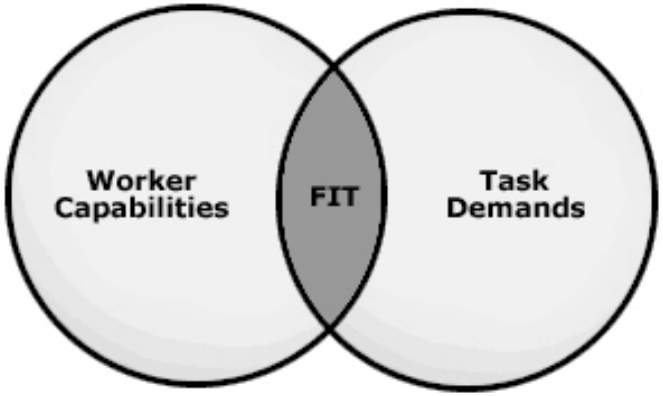
- What is ergonomics
- Risk factors
- Latest research
- Common risks and controls
- Problem solving
- Ways to control risks
- Case study
- Lessons learned

Goal for each participant:
Learn one thing that they can apply immediately!

Ergonomics is…

- Fitting workstations to workers
  - Optimize comfort, safety, and productivity





Ergonomics looks at engineering, work habits, and administrative controls
Ergonomics is most effective when considered during the early stages of design/planning

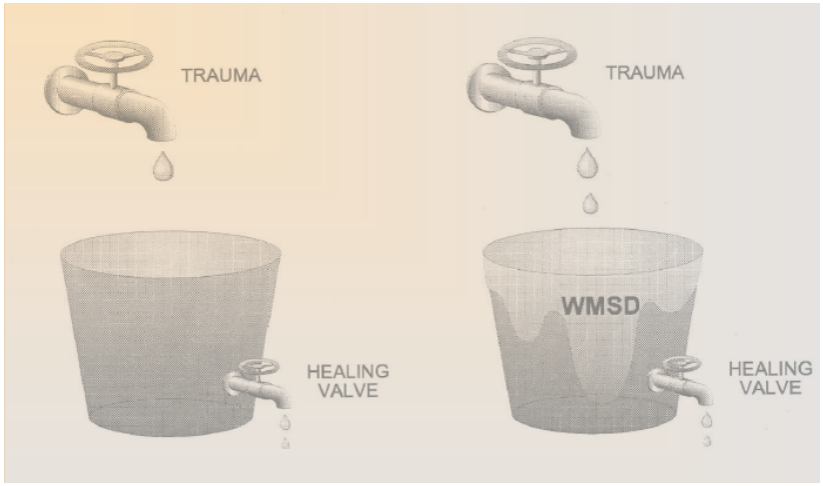
What are ergonomic risk factors?

- Awkward postures
- Force
- Repetition
- Extreme temperatures
- Vibration
- Contact pressures
- Stress
- Static postures

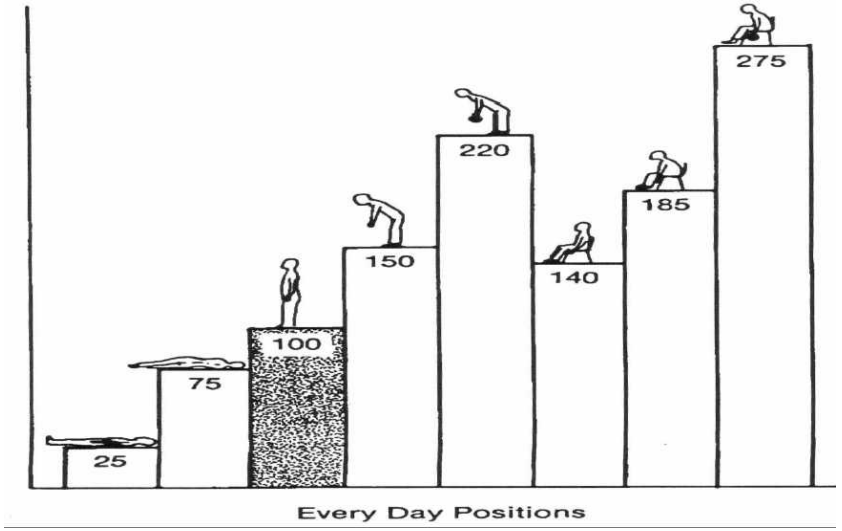
# of risk factors + duration of exposure = greater likelihood of injury

These injuries do not happen overnight, but when they happen they are debilitating!

Why do these injuries occur anyway?



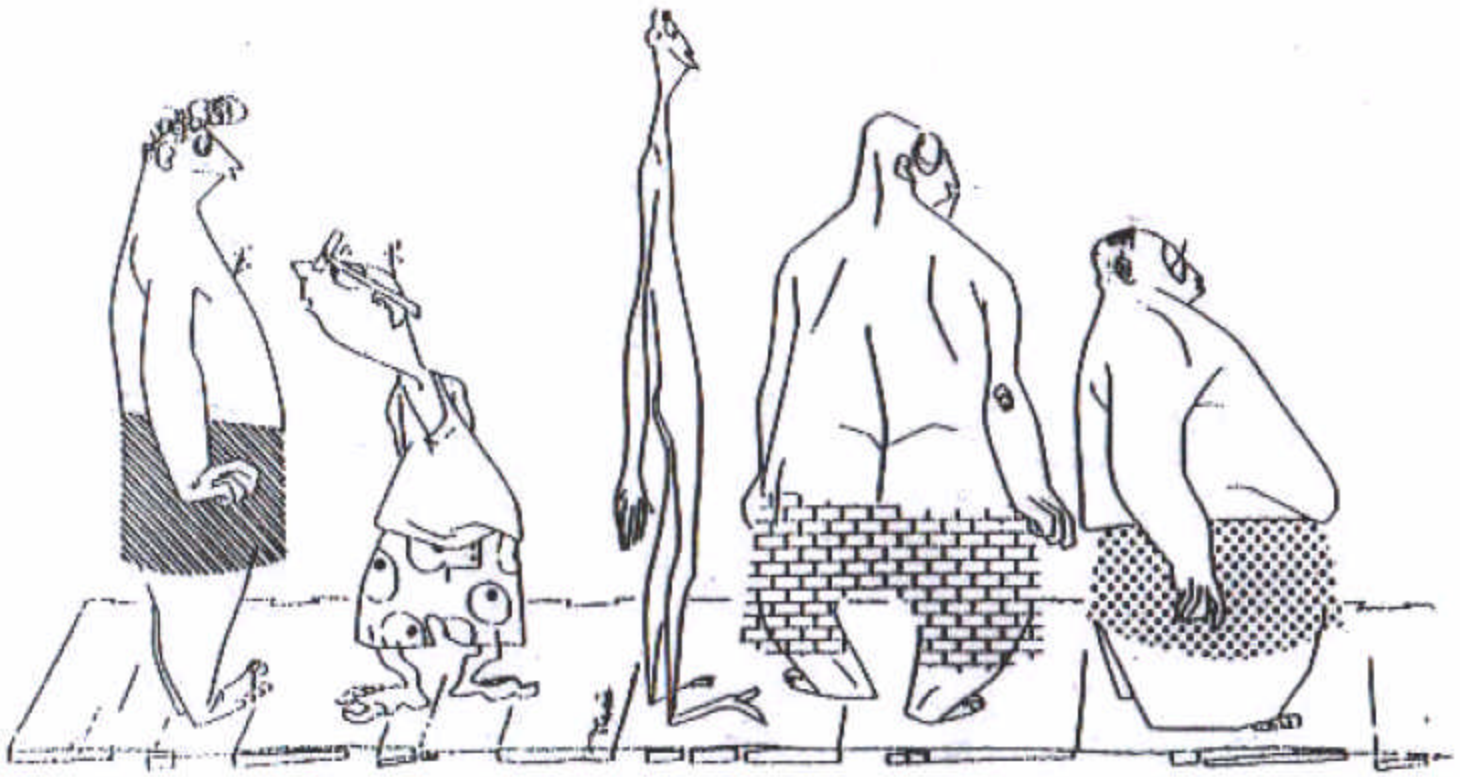
Cumulative/ Repetition



Postures

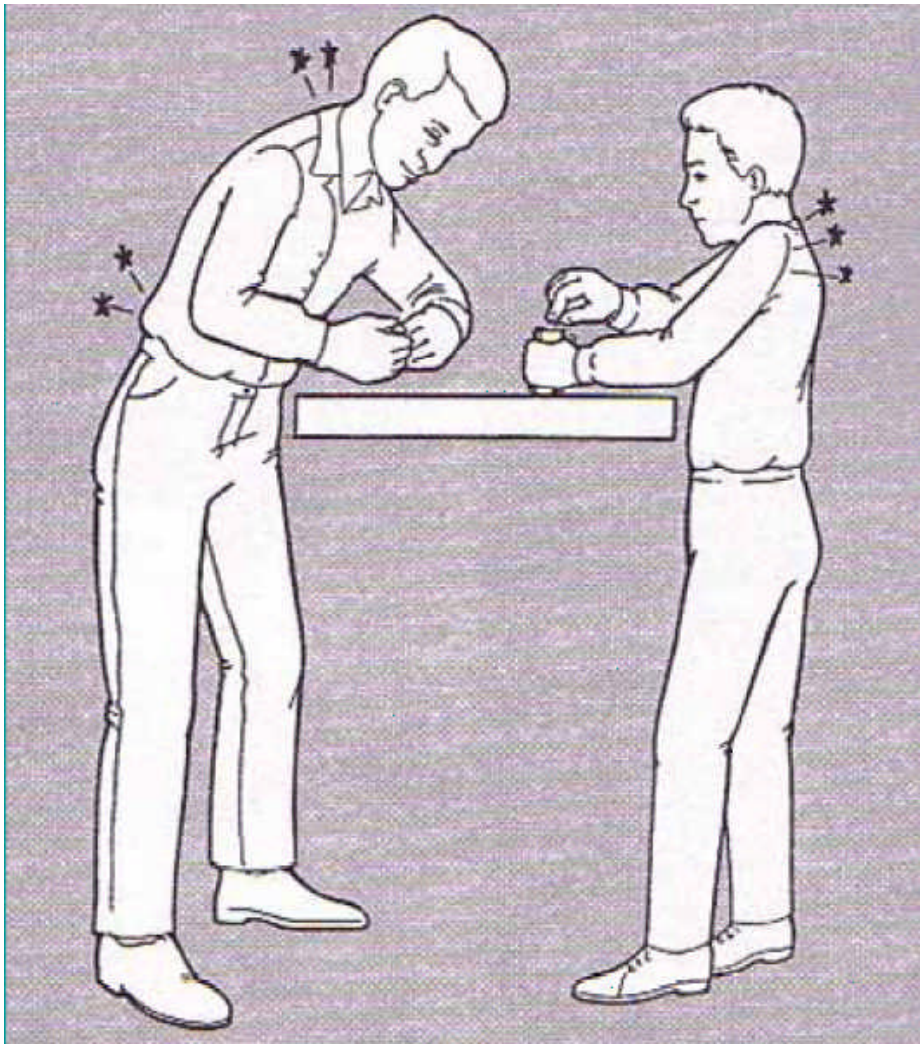
Static Sitting/Standing

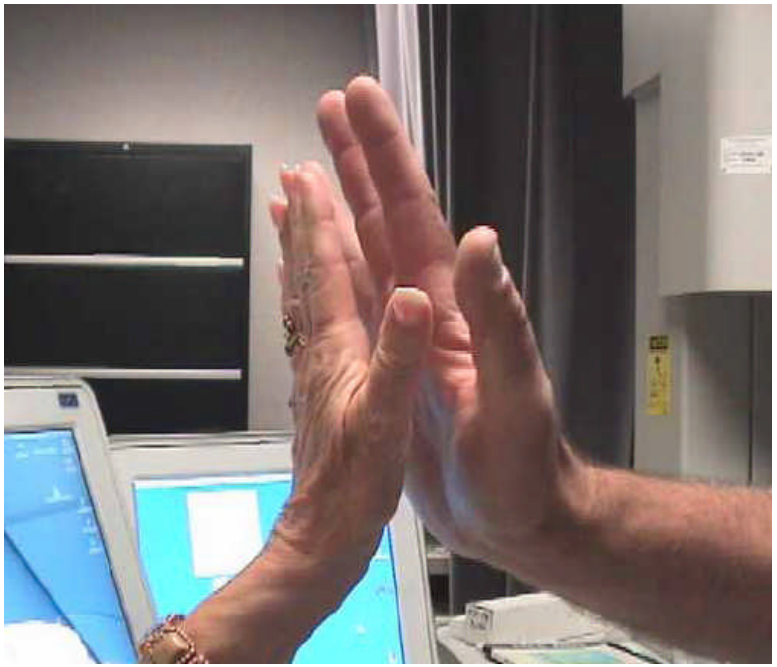
How many of you know someone who has had an ergonomic-related injury?



Demo of individual differences

Effects of improper fit





What happens if something is too short/tall or large/small for an employee?

Recommended Work Zones*

* References: Pheasant, Stephen. Bodyspace, Anthropometry, Ergonomics and Design. Philadelphia: Taylor and Francis, 1996.
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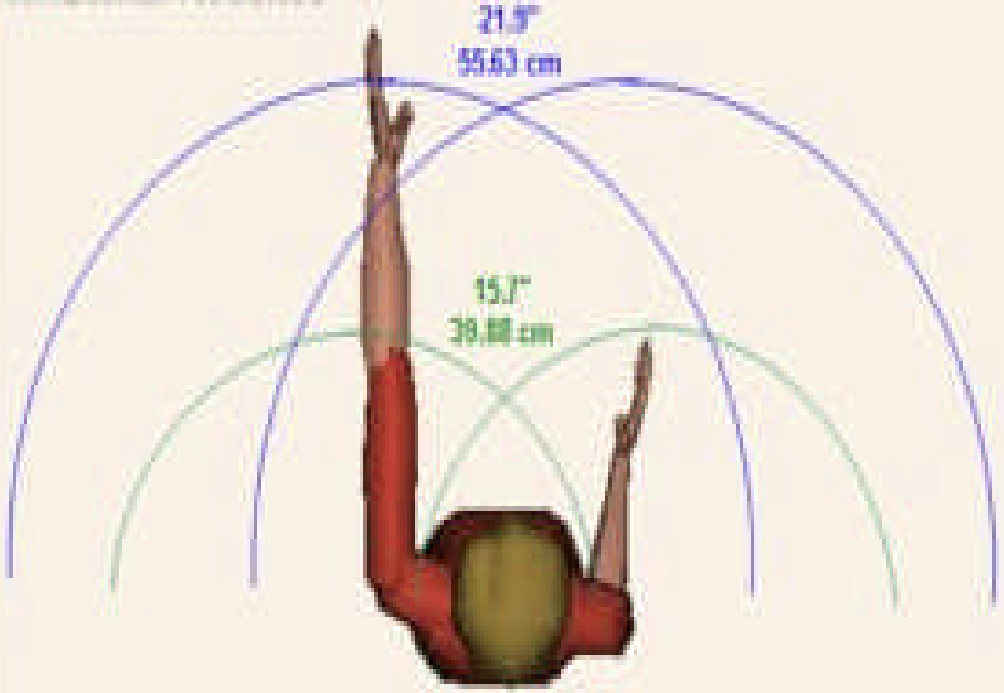
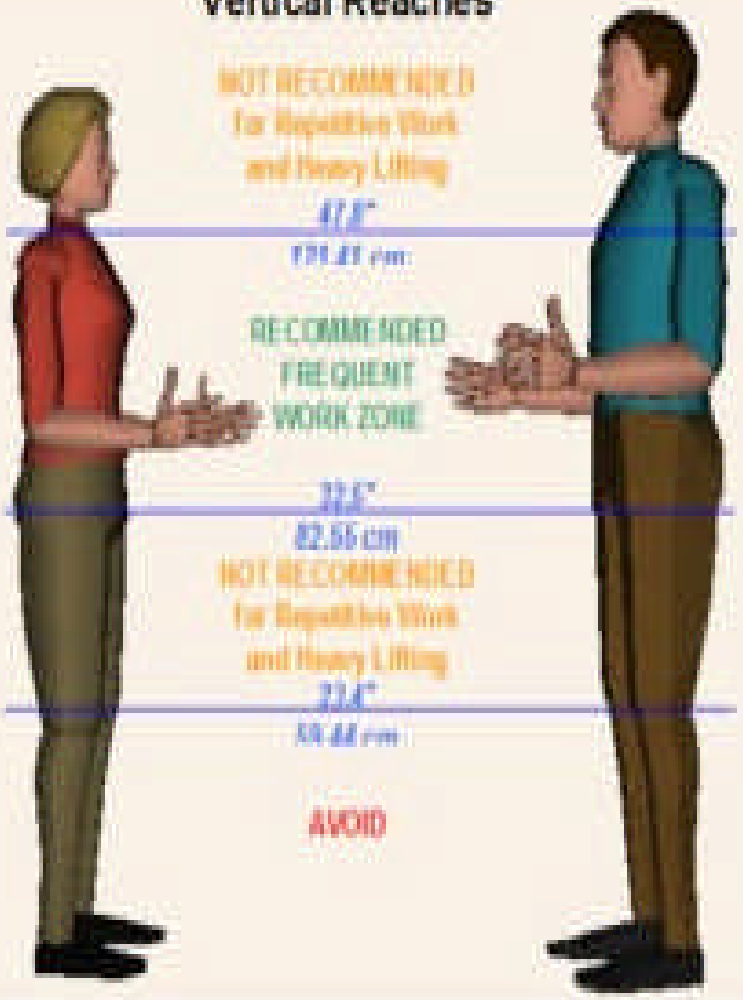
Horizontal Reaches



Vertical Reaches

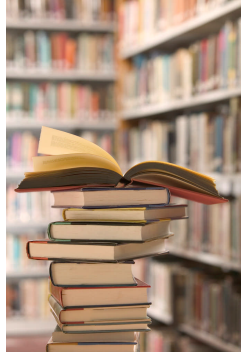


Dimensions used for Horizontal Reaches: 5%tile female Elbow-Fingertip Length and Shoulder-Grip Length
Dimensions used for Vertical Reaches: 95%tile male Knee Height, Knuckle Height and 5%tile female Shoulder Height

What research shows…

- Pipetting
  - Fredriksson, K. (May 2005)
    - The symptoms increase with:
      - Amount of time spent pipetting
      - Age
      - Weak thumb muscular structures
    - Suggestions include:
      - Consider automation as amount of time increases
      - Design with minimal button resistance
      - Handles that fit different hand sizes
- Biosafety cabinets
  - Jones, R.L. & Eagleson, D (May 2001)
    - Reach= shortest anthropometrics 8-14 inches
    - Use footrests and armrests
    - 10 degree angled view screen slope
    - Place at edge of work surface
- Lab design
  - Garikes, R.W. (July 2004)
    - Six Sigma can improve quality, eliminate waste, reduce lead time and costs while also improving ergonomics and work flow
      - Flexibility is the most important design element
        - » Create abilities to expand, modify, and completely change
  - Baron, E.J. (2002) Speculations on the microbiology laboratory of the future (2002)
    - Information technology will allow immediate global access to laboratory results with greater automation

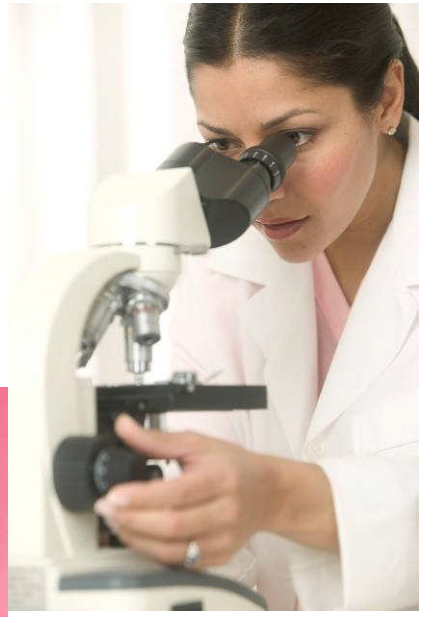
What research shows…

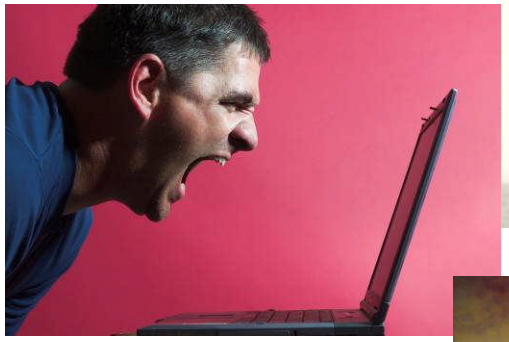


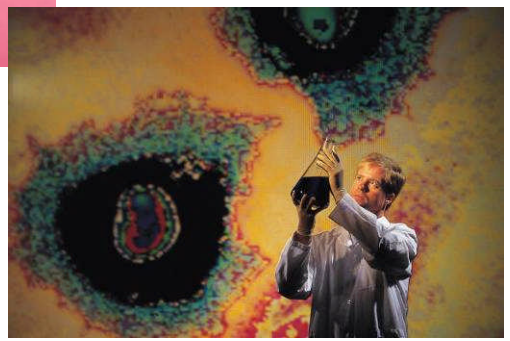
- Microscopy
  - Thompson, S.K. & Mason, E. (December 2004)
    - Established work load limits should consider accuracy, productivity, and ergonomics
    - Found 85% of survey respondents perform only 56% of maximum work limit, but have Musculoskeletal Disorder Symptoms (MSDs)
  - James, T., Lamar, S., Marker,T. & Frederick, L. (2000)
    - Key features of ergonomically designed microscope include tilting and telescopic head, optional riser tubes, one-hand focus control, and in-line focusing
    - Results included increased comfort, especially in the neck and shoulders area when using an ergonomic microscope versus traditional microscope
  - Kofler, M., Kreczy, A., & Gschwendtner, A. (February 19, 2002)
    - EMG activity was reduced for all muscles that were studied when using the ergonomic workstation versus a standard workstation
    - Ergonomic workstation included adjustable table, microscope, and horizontal forearm supports
  - Sillanpaa, J, Nyberg, M. & Laippala, P. (July10, 2003)
    - Key features of ergonomically designed microscope include adjustable ocular angle and height, adjustment knobs positioned low, forehead support
    - Key features of ergonomically designed microscope table include adjustable height, adequate space and leg room, cut-away section at front of table, tilt able ocular angle, forearm and forehead support,
- Standing work
  - Whistance, R.S., Adams, L.P., VanGeems, B.A., & Birdger, R.S. (December 1995)
    - Postural adaptations for work that is too far away include trunk and hip flexion
    - Postural adaptations for work that is too close include neck flexion and thoracic kyphosis

Common laboratory tasks

- Pipetting
- Microscopy
- Micromanipulation
- Biosafety cabinets, fume hoods, and glove boxes
- Material handling
- Standing
- Sitting
- Computer use

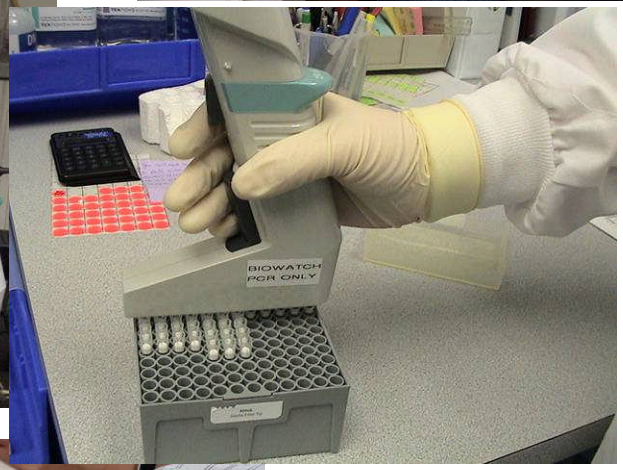






Pipetting

- Risks
  - Repetitive
  - Forceful exertions
  - Awkward positions
  - Extended reach
  - Monotonous
- Controls
  - Determine best tool for job
    - Consider volume, weight, balance, length, plunger force, blowout force, tip eject force, grip comfort, display, and volume adjustment
  - Optimal work station set up
  - ‘Switch hit’
  - Create time limits/ restrictions
  - Self care techniques



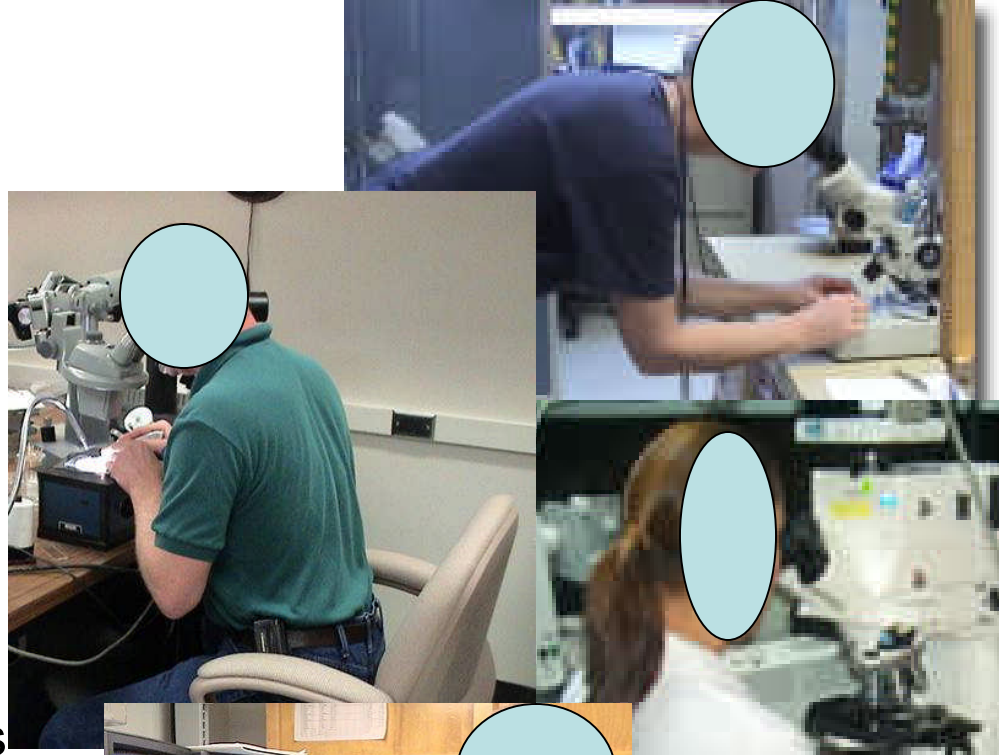
Pipetting

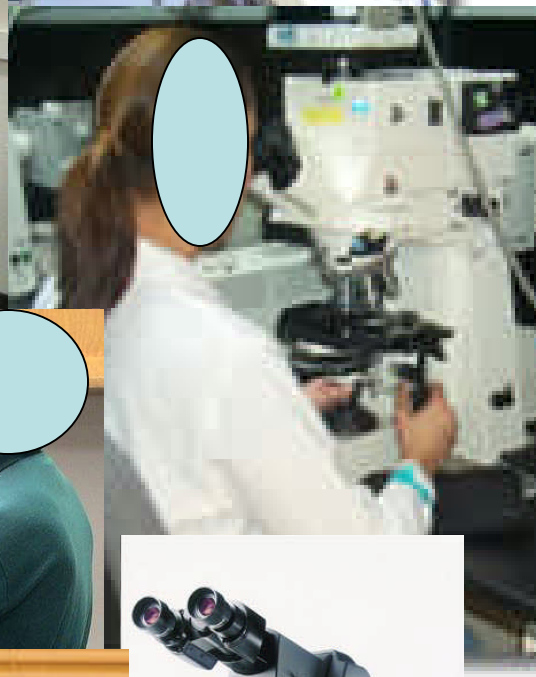
Target	Recommendation	Reference
Physical Environment	•Minimal per person space requirement > 10 m^2 / 107 ft^2 •Passageways (1 person: 2 feet 2 persons: 3 feet)	NF X35-102
Furniture	•Use adjustable tables and seats •Hoods with easy access and comfortable seating •Place frequently used items in logical locations	NF X35-104 NF X35-105 ISO 9241-5 Ref.9
Pipettes	•Choose pipette that fits the task •Use manufacturers recommended tips •Use multi-channel for 96+ well plate applications •Use motorized pipettes for repetitive and mixing tasks	ISO 8655
Work Organization	•Do not exceed more than 30 gestures/minute •Take frequent, short breaks •Take a mandatory pause after each sequence of repetitive tasks •Vary tasks (work with different muscles)	NF EN 1005-5
Work Conditions	•Noise <55dBA •Comfortable ambient temperature •Lighting 300-600 lux •Eliminate glare and reflections	ISO 9241-6 ISO 7730 NF X35-103

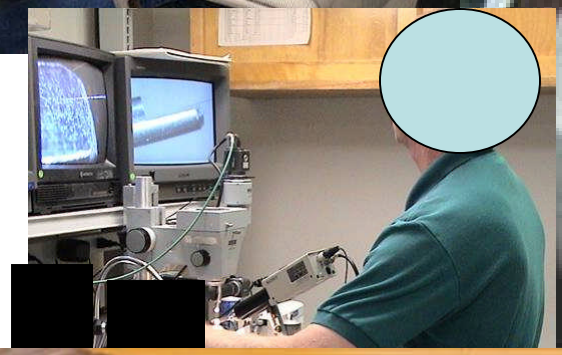
Adapted from Gilson Laboratory Ergonomics: Things you should know… things you should do http://www.gilson.com/Downloads/mlhAppNote1.pdf

Microscopy

- Risks
  - High visual demands
  - Monotonous
  - Extended reach
  - Repetitive motion
  - Static/ awkward postures
  - Contact pressure
- Controls
  - Optimize equipment and set-up
    - Consider adjustable
  - Use external monitors
  - Self care techniques

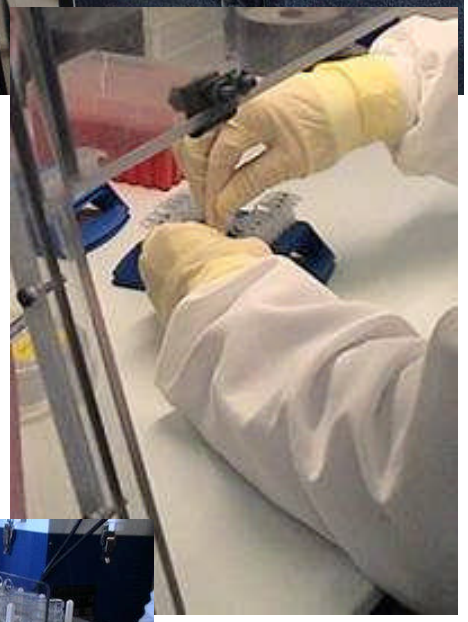


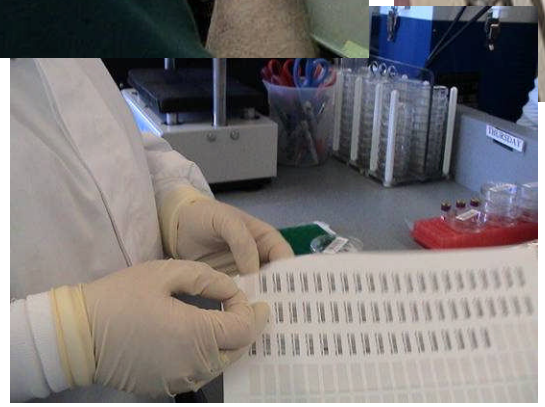




Micromanipulation

- Risks
  - Repetitive
  - Forceful use of small muscles
  - High visual demands
  - Awkward/ static postures
  - Monotonous
  - Contact pressure
- Controls
  - Optimize workstation set-up
  - Turn ‘pinch’ into ‘grip’
  - Self care techniques

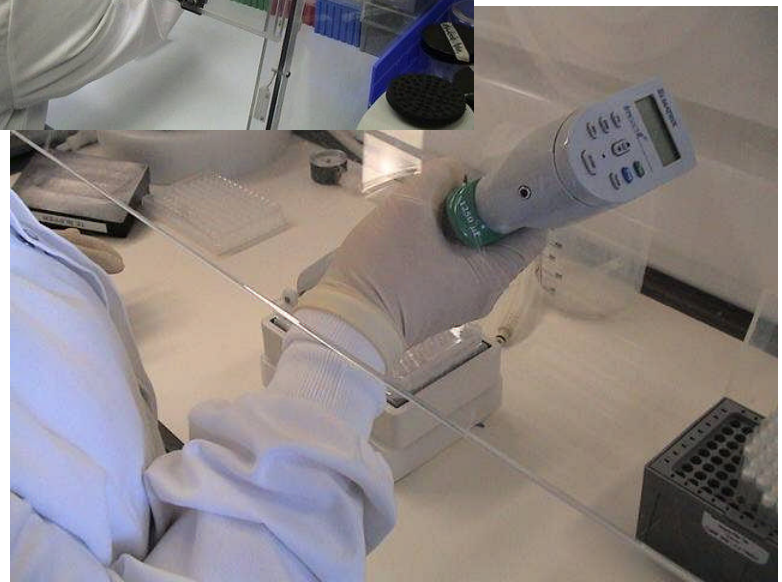




Biosafety cabinets & fume hoods

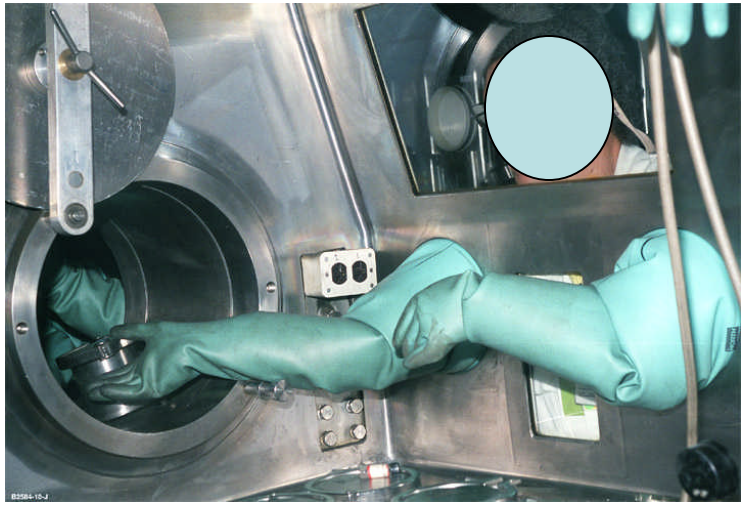
- Risks
  - Glare
  - Extended reach
  - Awkward/static postures
- Controls
  - Optimal workstation set-up
  - Shorter handled tools
  - Self care techniques

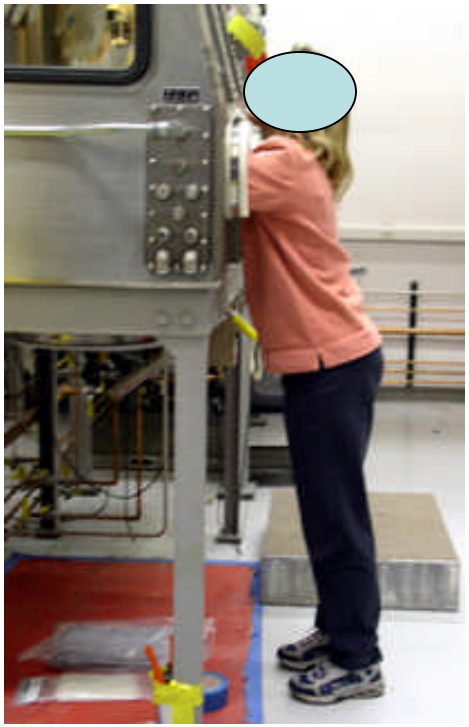
What are some design guidelines for height and reach?

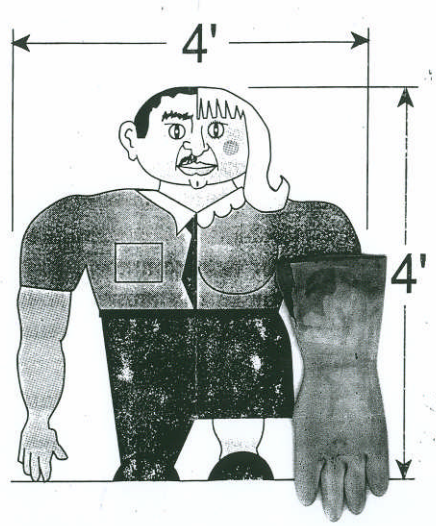


Gloveboxes

- Risks
  - Excessive reaching forward and sideways
  - Prolonged standing
  - Forceful grasping, reaching and lifting
  - Reduced strength due to poor fitting gloves and working out of comfort zone
    - Thicker gloves and ambidextrous gloves make the hands work harder
  - Forearm pressure from rim of glove ports
  - Glare
- Controls
  - Optimize height
  - Use properly fitted gloves
  - Avoid manual handling of objects greater than 15 pounds
  - Increasing length of levers, dials, and tools
  - Establish ways to avoid elbow and forearm pressure
  - Eliminate sources of glare
  - Place items within a comfortable reach
  - Self care techniques



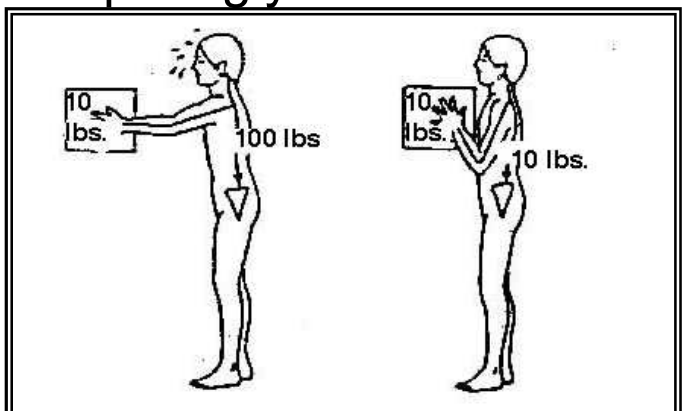




"Ideal" glovebox worker

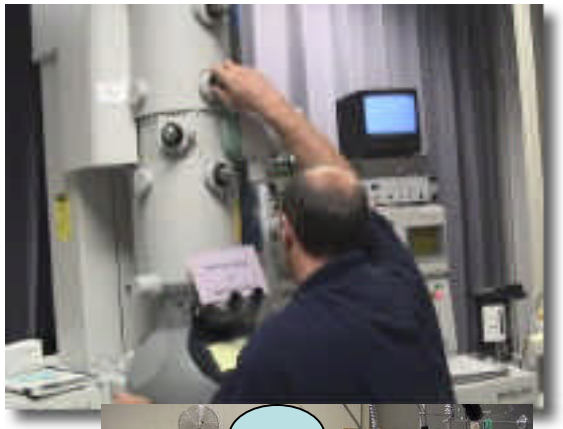
Material handling

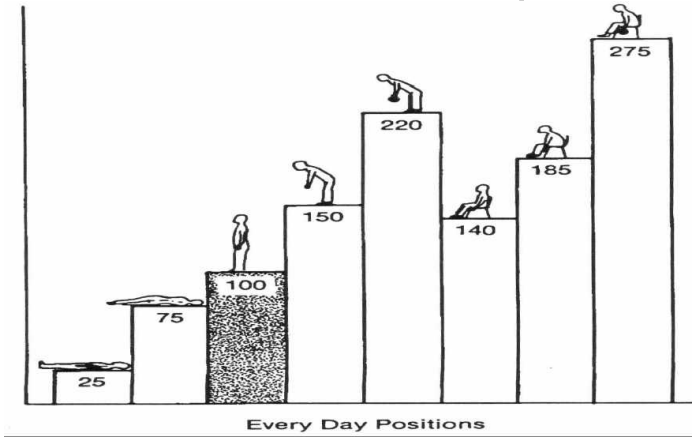
- Risks
  - Forceful exertions
  - Awkward postures
- Controls
  - Eliminate manual handling
  - Optimize placement (between chest and thigh level)
  - Self care techniques
  - Note: use team lifts sparingly



Standing

- Risks
  - Static posture
  - Can be coupled with awkward postures
- Controls
  - Optimize work station set-up
  - Provide alternatives
    - Sitting
    - Elevating a foot
    - Vary stance
  - Anti-fatigue products
  - Self care techniques



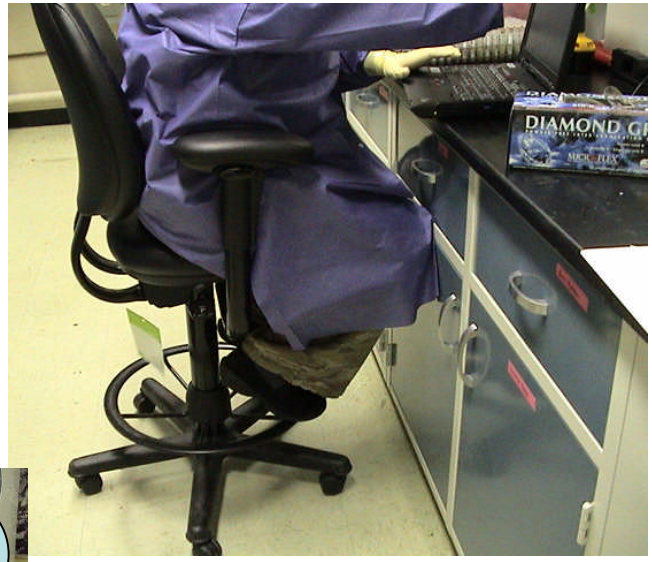


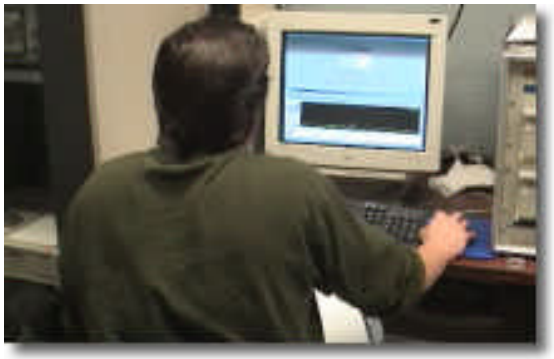
Sitting

- Risks
  - Static posture
  - Can be coupled with awkward postures
  - Inadequate leg clearance
- Controls
  - Optimize work station set-up
  - Provide alternatives
  - Self care techniques

Computer use

- Risks
  - May not follow the same guidelines that are applied in the office set-up
- Controls
  - Apply the same guidelines for office set-up





What common risk factors are found in laboratories?

What can you do about them?

Picture 1

Picture 2

Picture 3

What risk factors do you see?
What can be done?

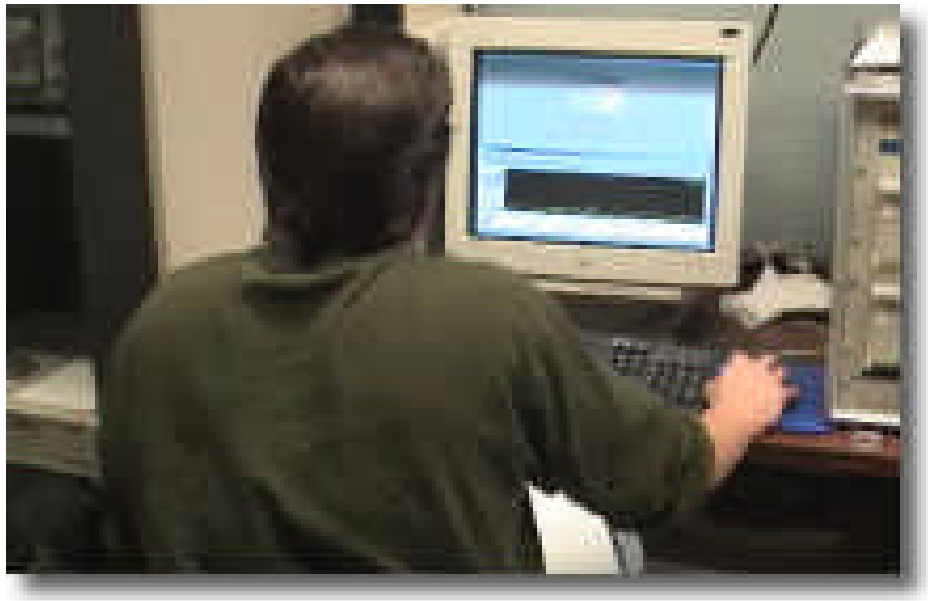
Picture 1

Picture 2

What risk factors do you see?
What can be done?

Picture 3

Picture 1



Picture 1

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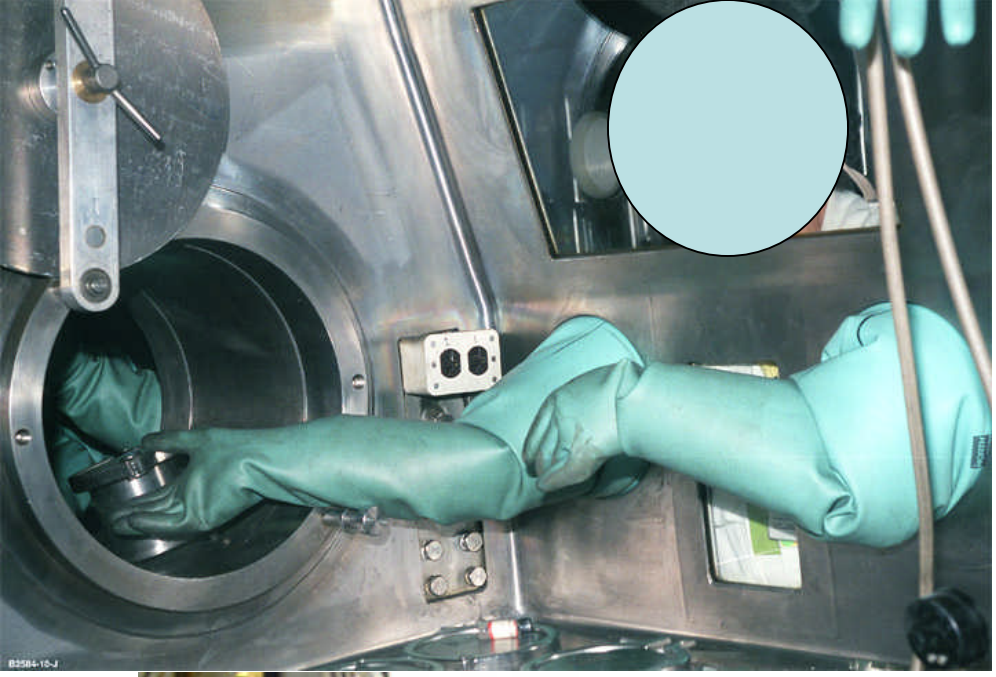

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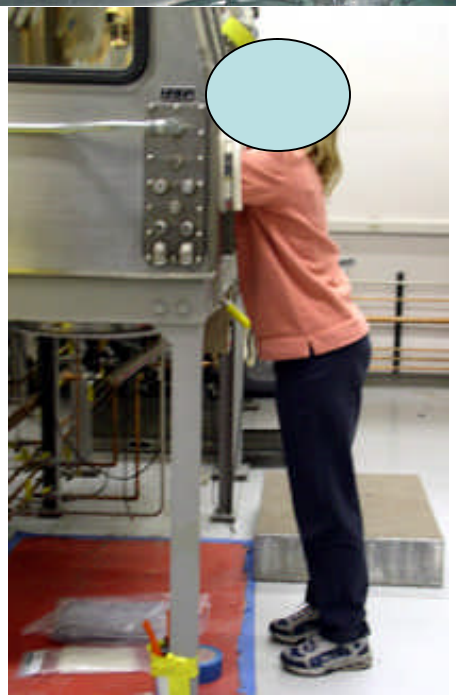

Picture 3

Picture 2

What risk factors do you see?
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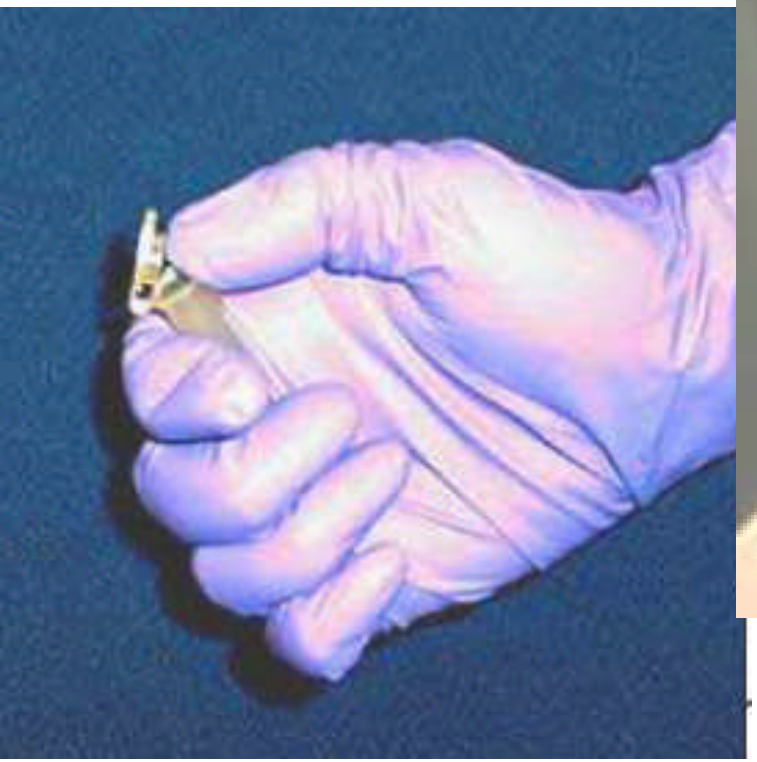

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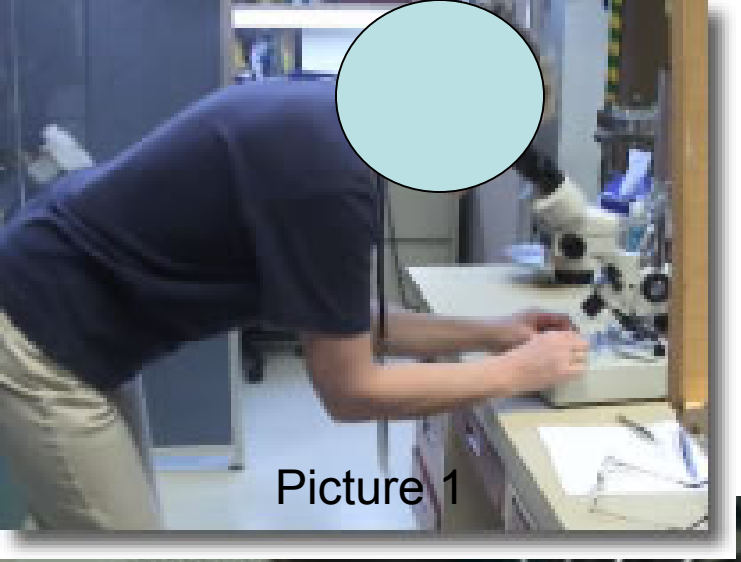

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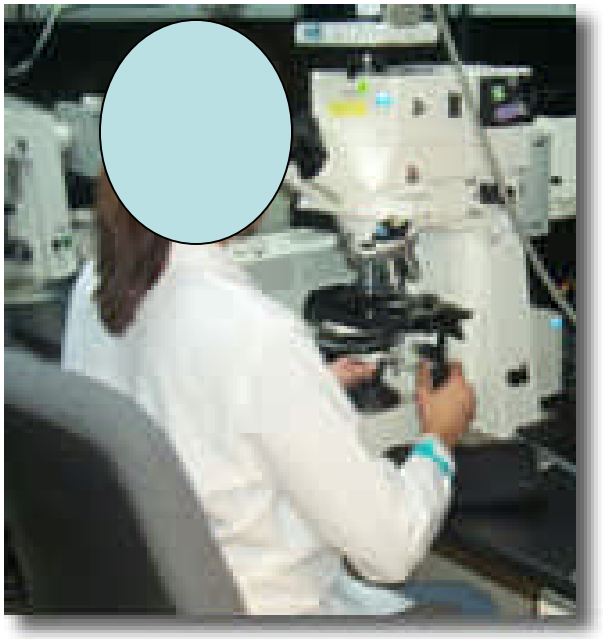
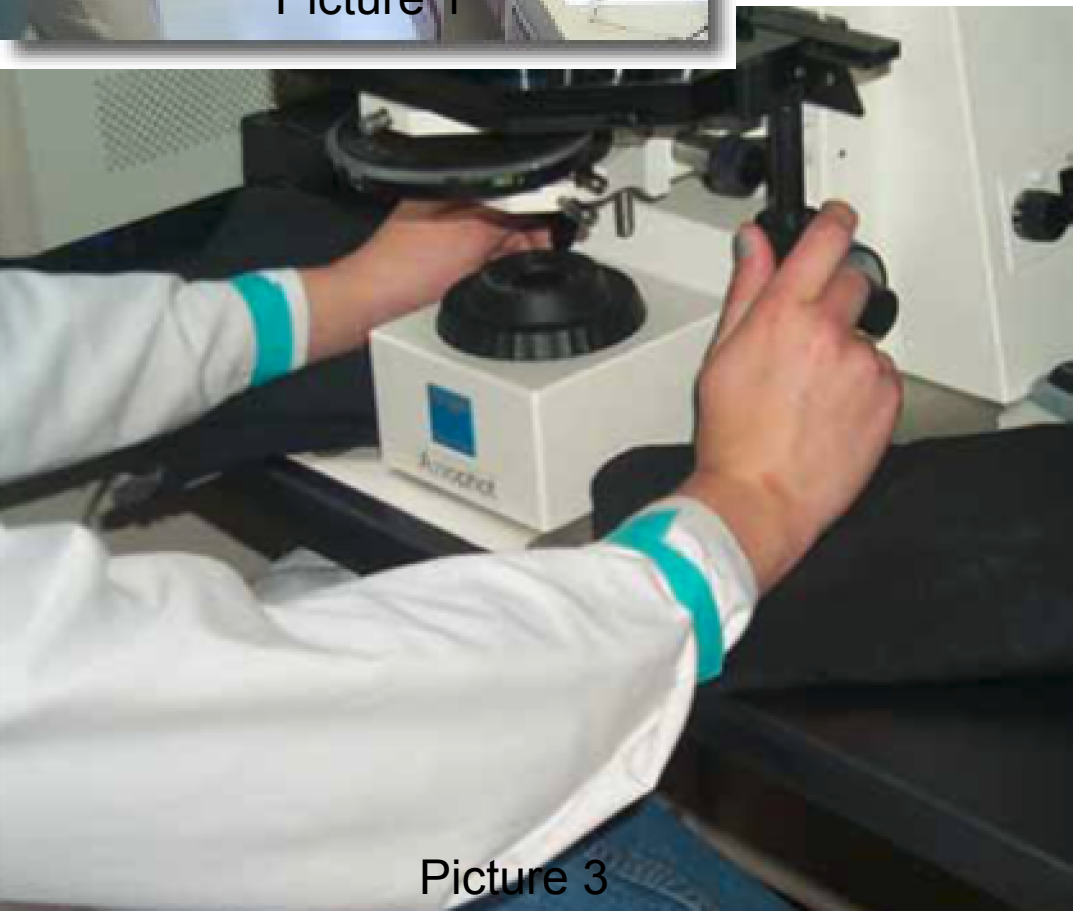


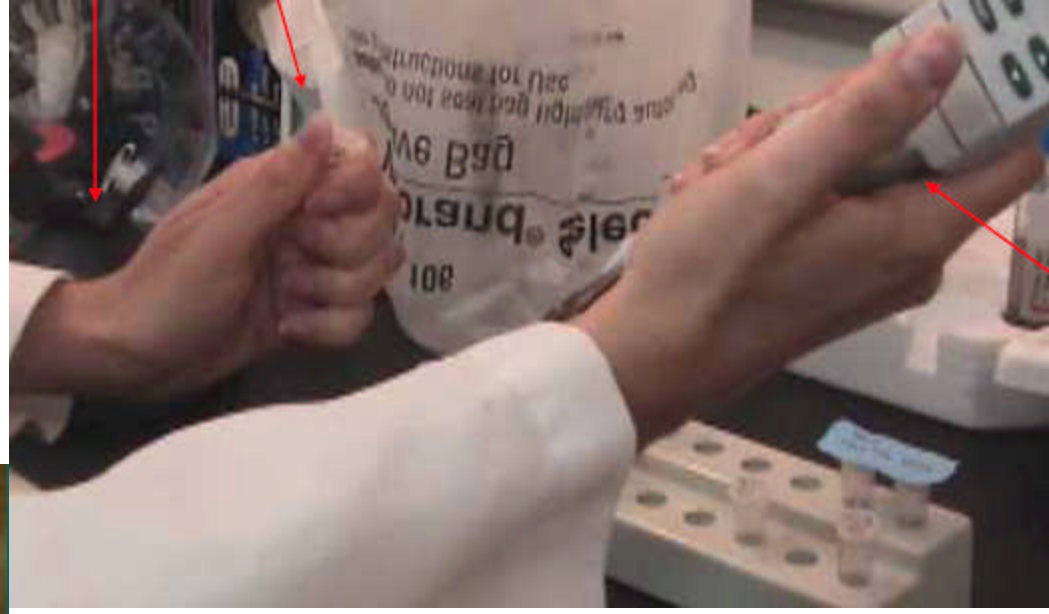
Picture 2



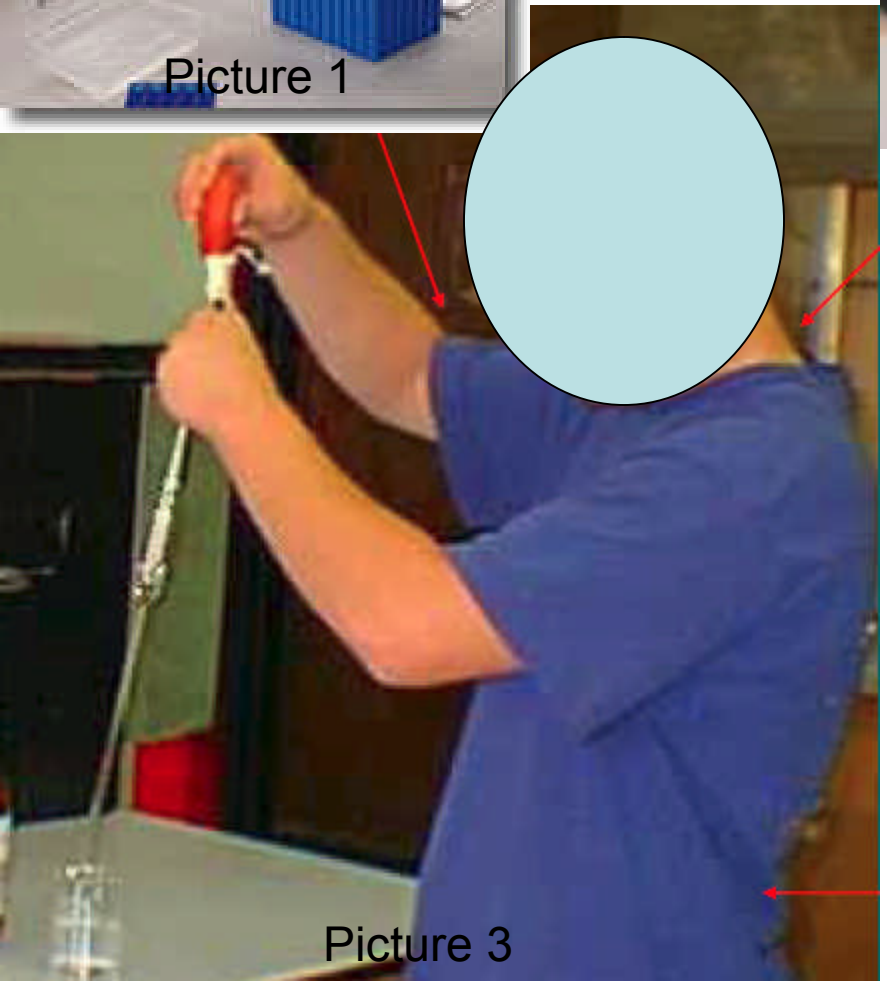
Picture 3

What risk factors do you see?
What can be done?

Picture 1



Picture 2

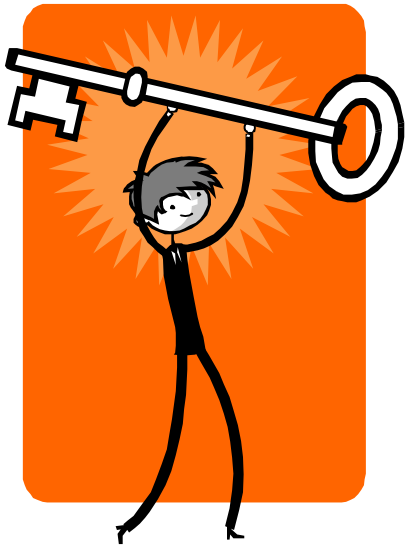


Picture 3

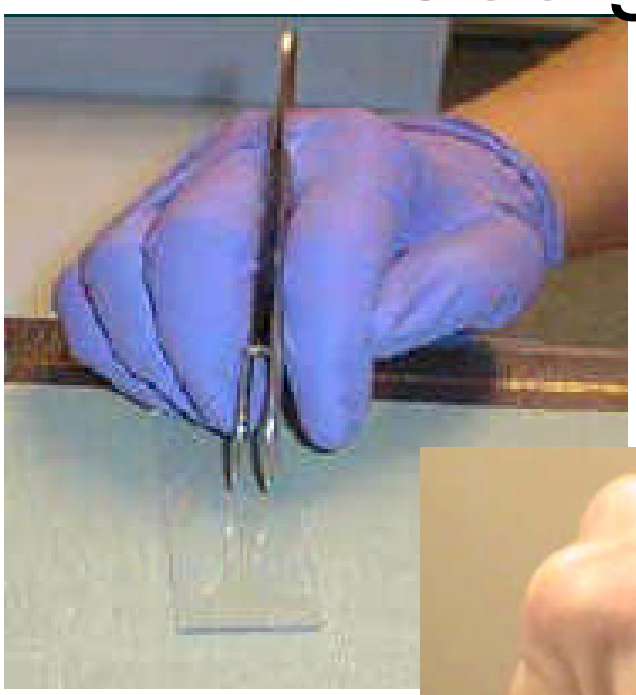
What risk factors do you see?
What can be done?

Ways to control risk factors

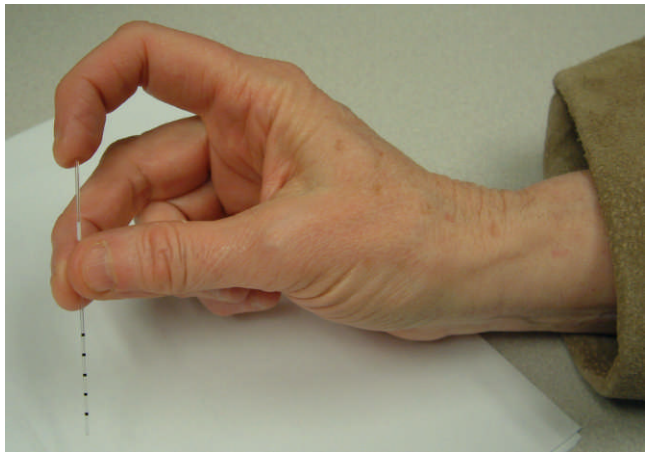
1. Work with elbows close to body
   - Avoid excessive forward and sideways reaching
2. Avoid overhead and below knee tasks
3. Alternate tasks
   - To avoid repetition
   - Sitting ⟷ Standing
4. Optimize work environment/ equipment
5. Use grip versus pinch
6. Utilize arm/forearm support
7. Take breaks
8. Perform stretches
9. Alternate hands
10. Use both hands



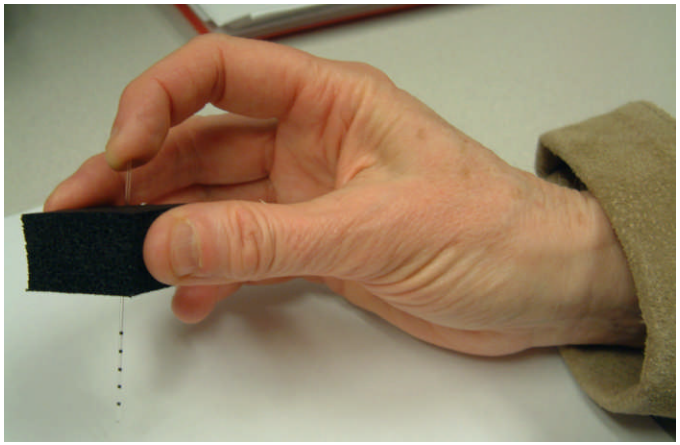
Ways to control risk factors : Use grip versus pinch



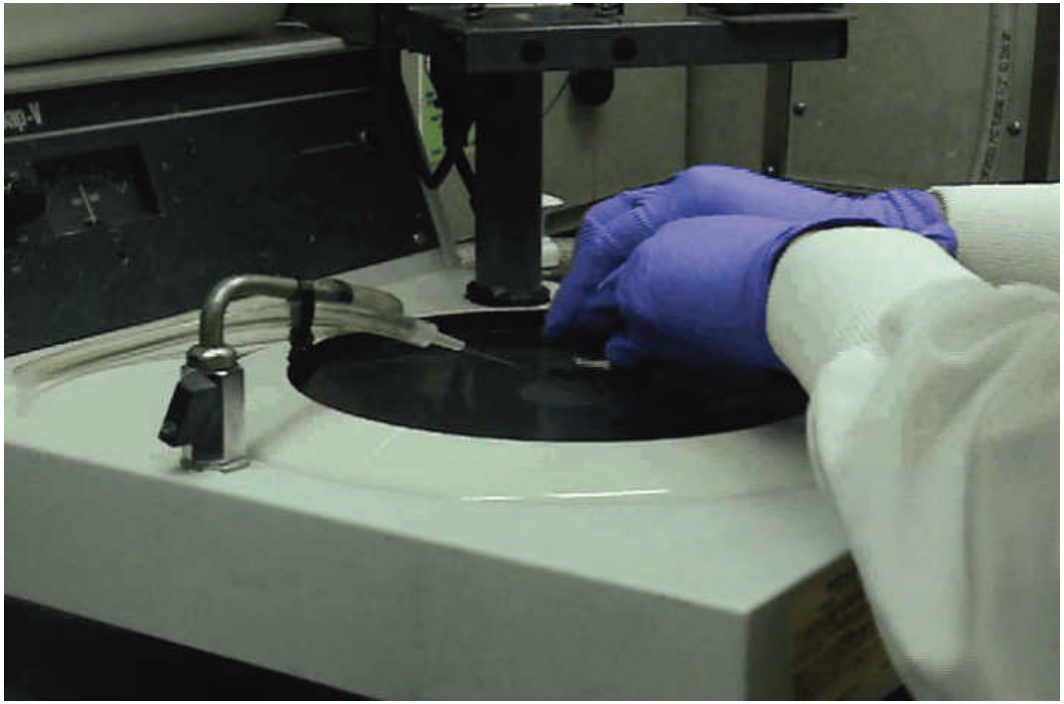
Ways to control risk factors : Use grip versus pinch & use both hands



Change a finger pinch grip…



into a hand grip



Two hands are better than one!

Ways to control risk factors: Alternate tasks & take breaks

Elevate a foot

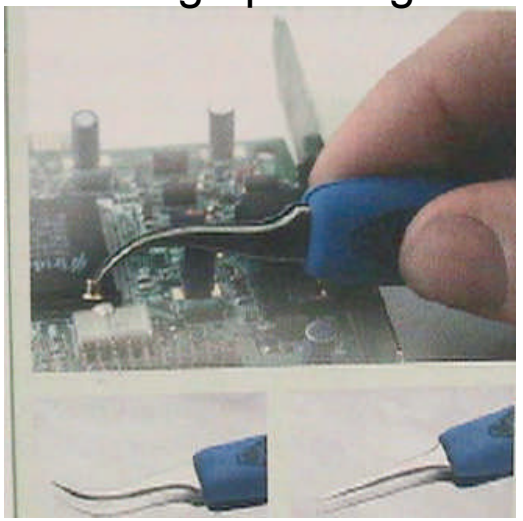
Take a seat

Use anti-fatigue mats or personal shoe covers/inserts

Ways to control risk factors
Optimize equipment & utilize support

Microscope arm pads

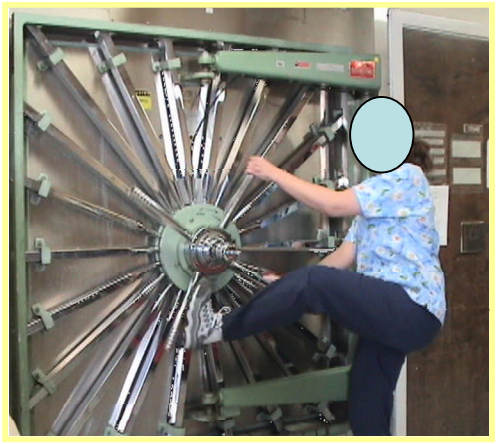
Edge padding



Reverse action padded tweezers

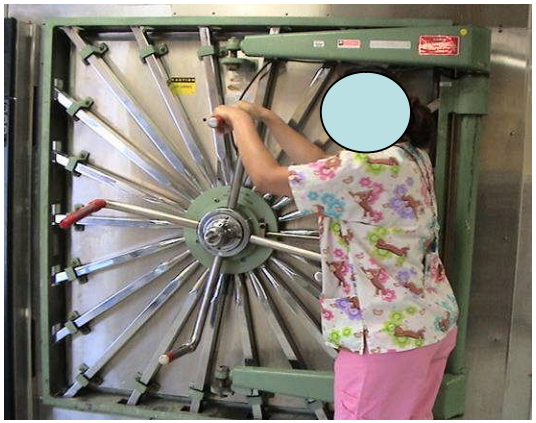
Case Study

- Animal care facility
  - Significant risk factors
    - Prolonged standing
    - Repetitive hand and arm activities
    - Overhead and below knee reaching, bending, and stooping
    - Forceful lifting, carrying, bending, reaching, pushing, and pulling



Before

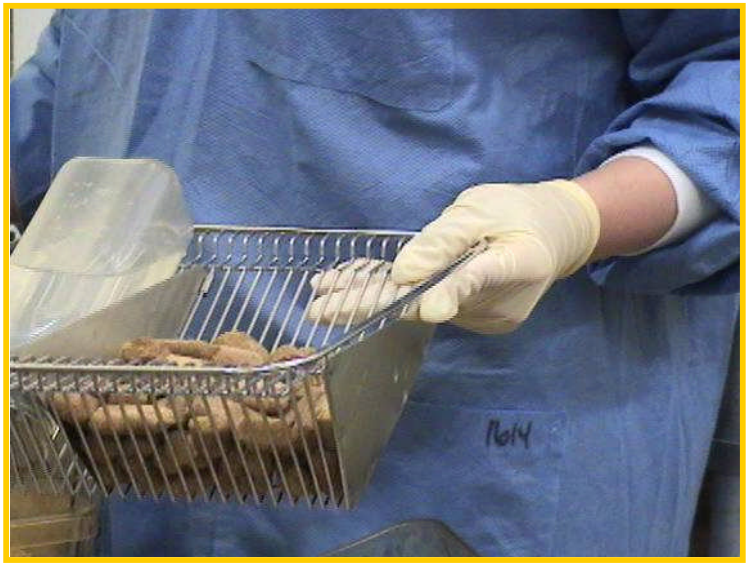
Before



After

After

Case Study



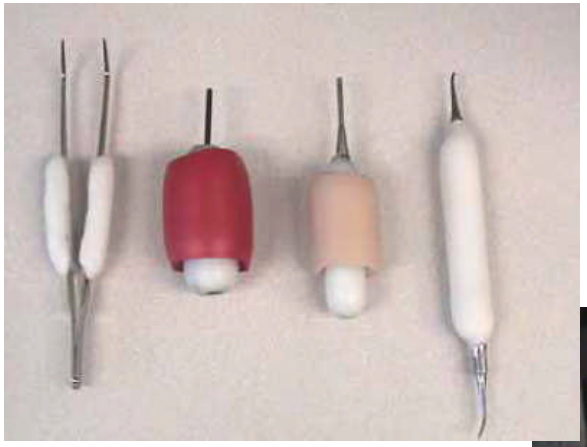
What would you do?

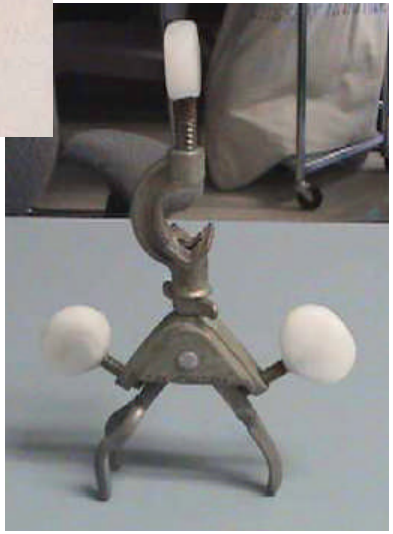
Lessons Learned

- Be the ‘wind beneath the wings’
  - Do not have to be a know-it-all
  - Have an “employee knows best” attitude
- Speak several languages
  - Management= $, productivity, ROI, savings
  - Employees= apply info specifically to them

Lessons Learned

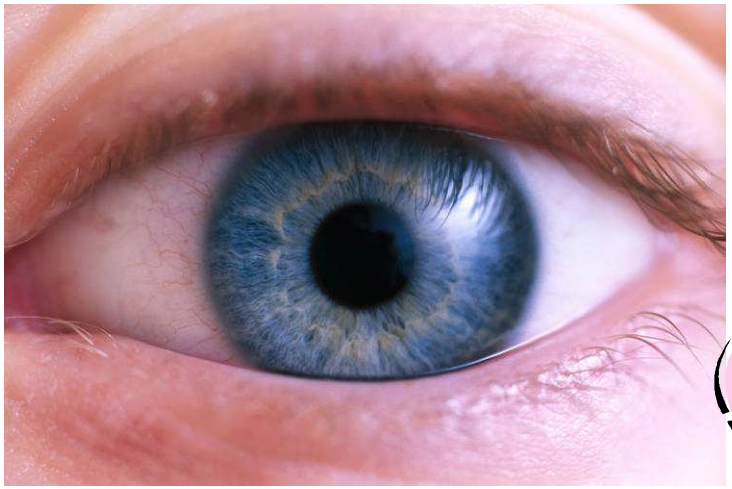
- Think out of the box
- K-I-S-S





Lessons Learned

- Small successes can pave the way for bigger ones
- Create ergonomics ‘eyes and ears’ everywhere



Lessons Learned

- Utilize research from others to create useful tools

General Principles of Laboratory Bench Design

Area	Recommendations	Yes	No	N/A	Comments
Work bench	Is it suited to tasks performed?				
	Does it allow comfortable sitting and standing?				
	Is there adequate leg and thigh clearance				
	Is a footrest or foot rail available?				
	Is an adjustable seat provided?				
	Are sharp edges padded?				
	Is anti-fatigue matting provided for prolonged standing areas?				
Equipment installation	Have modifications been made to the height of workbench for large equipment?				
	If work height is too high is a platform provided?				
	Are the visual demands of tasks considered when determining work height?				
	Are lifts provided for heavy components of processing machines?				
Equipment layout	Are pieces of equipment located in a logical sequence for a comfortable flow and movement of the body?				
	Is equipment arranged to be within easy reach?				
	Are organizer accessories used i.e. lazy susans, carousels?				
	Are waste bins placed in convenient locations?				
	Are procedures/ reference materials propped up i.e. clear cookbook holder?				
	Is work tipped or raised to comfortable working positions?				
	Are devices used to reduce sustained activities i.e. reverse tweezers?				
	Is there adequate knee space below cabinets (move pipes and pumps if indicated)?				
	Is an adjustable chair provided with seat and back tilt forward (allows person to get closer to cabinet)?				
Containment cabinets / safety cabinets / safety hoods	Are arm supports provided?				
	Is a footrest or foot rail available?				
	Is the placement of materials set up so reaches for sitting tasks within 16 inches from front of work surface?				
	Is the placement of materials set up so reaches for standing tasks within 20 inches from front of work surface?				
	Are shorter instruments available i.e. short pipettes?				
	Are manual handling of heavy items minimized?				
	Are there time limits established for performing sustained postures or repetitive tasks?				
	Are tasks able to be rotated?				

"No" answers indicate potential areas of improvement

Adapted from Chengalur, S.N. Rodgers, S.H. & Bernard, T.E. (2004). Kodak's Ergonomic Design for People at Work. 2nd Ed. John Wiley & Sons, Inc. pp. 270-271

Can be found at:
http://www.llnl.gov/ergo/lab_ergo.html

LLNL Laboratory Ergonomics Self-Assessment Checklist

Date: Location:

Activity:

COMPUTER WORKSTATIONS	Yes	No
Is a seat provided?		
Is the seat adjustable to fit all users?		
Is lumbar back support provided?		
Is there adequate leg room?		
Is there ample room to accommodate a keyboard/mouse so the employee can rest their arms at their side and forearms parallel to the floor?		
Is the top of the monitor positioned at about eye level?		
Is the monitor centered at least arm's length distance from the employee?		
If documents are frequently used, is there a document holder?		

LABORATORY BENCHES	Yes	No
If the worker stands, is anti-fatigue matting supplied?		
Is the height of the bench appropriate for the work that is performed?		
If the worker sits, is there adequate leg room?		
Are there contact stresses between sharp edges and forearms?		

LABORATORY CHAIRS	Yes	No
Can all lab chairs be adjusted to accommodate all workers in the area?		

MICROSCOPES	Yes	No
Are the worker's shoulders rounded and/or the worker is hunched over?		
s the worker's neck bent >25 degrees?		
Are there contact stresses between sharp edges and forearms?		
s the microscope pulled out to the edge of the work bench?		
s there adequate leg room?		
Does the worker have proper foot support? (Floor, chair ring, footstool)		
Has the individual been trained how to properly sit at a microscope?		
Are microscope work breaks provided?		
For extensive use, are camera/ projection systems used?		
Are arms close to body and wrists straight?		

PIPETTING	Yes	No
Are manual pipettors used?		
Are electronic pipettors used?		
Are computer controlled pipetting systems used?		
s th pipettor designed to reduce amount of hand use force?		
Has the individual been trained how to properly operate the pipettor?		
Does the worker pipette more than 2 hours per day?		
Are frequent breaks provided?		
Are arms close to body and wrists straight?		

FINE MOTOR SKILLS	Yes	No
Does the worker alternate use of both hands?		
Does the worker perform work involving pinching more than 5 hours per week?		
Are there contact stresses between sharp edges and forearms?		
Are frequent breaks provided?		
Are handles/tools large enough to allow gripping versus pinching?		
Are arms close to body and wrists straight?		

ALL TASKS	Yes	No
Are tasks and positions varied?		
Are frequently used supplies/ materials located within arms length?		
Is arm reach optimized (between chest and thigh height)?		
Are frequent breaks provided?		
Are arms close to body and wrists straight?		

X =Checked shaded boxes indicate potential areas of improvement

Adapted from NIEHS Laboratory Checklist




Identify techniques or ideas you can immediately apply





Thank you!

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