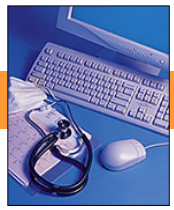

COMPUTER ERGONOMICS AND WORKSTATION DESIGN

Presented by:
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Solutions Northwest, Inc.
www.solutionsnw.com

History of Ergonomics

- The science was used before the term was coined
- 1857 Wojciech Jastrzebowski coined the term
- Industrial revolution
  - Taylor and Bethlehem Steel-Fredrick Taylor-Shovel size for product
  - Time motion studies, standardized tools and process-the beginning of "lean"
  - Henry Ford-Bring the work to the worker not vice versa
- WWII-more complex machines
- Work place – automotive, aero space

Learning Objectives

- Understand
  - Basic anatomy and physiology
  - Biomechanics
  - Ergonomic risk factors
  - Injuries and their causes
- Identify and reduce or eliminate ergonomic risk factors
- Discuss and introduce different tools
- Provide an overview of ANSI/HFES Standards

Objectives of Ergonomics

To enhance the effectiveness and efficiency with which work and other activities are carried out.

- Increased convenience of use
- Reduced errors
- Increased productivity

To enhance certain desirable human values.

- Improved safety and increased comfort
- Reduced fatigue, stress and injury
- Greater user acceptance
- Improved quality of life

ERGO <> NOMICS

Ergonomics is the study of the interaction between human beings, their work, the tools they use and the environment in which they function.

Ergos = work
Nomos = natural law, in this case law of science

Reality: Ergonomics = Human Factors

ANATOMY

&

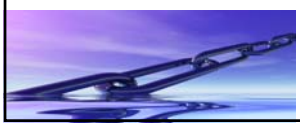
PHYSIOLOGY

Kinetic Chain

♦A kinetic chain is a connected system that is designed to absorb, distribute, and produce force.
- ♦Kinetic means force
- ♦Chain is a system linked together or connected

♦All components work together to produce motion

♦If one component isn't working properly, it will effect the others and effect the movement.



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Joints

Where two or more bones make contact

3 types by function:

immovable, (skull sutures)

slightly movable, (pelvis)

freely movable (ball and socket joint)

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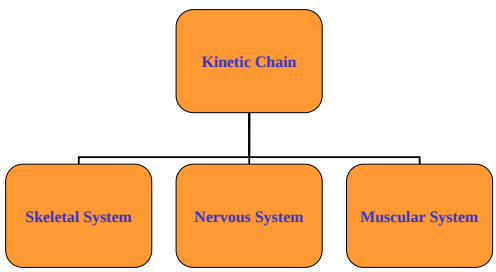
Kinetic Chain



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Ligaments

Connective tissue

Connects bone to bone

Strengthens joint

Provides joint flexibility and stability

Guides & limits motion

Supports internal organs

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Skeletal System

Body's framework
- Strong
- Flexible
- Supports body
- Protects organs

206 bones of which…

60 UE 60 LE Spine 26

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Tendons

- Attaches muscle to bone
- Transfer the force of the muscle to the bone
- Less blood supply
- Often first to injure

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Muscles

3 Types:

- Skeletal (striated/stripped)
- Cardiac
- Smooth (circular) (visceral)

Muscle fibers contract when stimulated by nerve impulses

Muscle tension causes movement at a joint

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Muscle Recovery and Dynamic Work

- <> **Promotes good work-rest cycles**
- <> **Allows more blood flow to muscles**
- <> **Oxygen needs are met**
- <> **Waste, such as lactic acid, is efficiently removed**
- <> **Muscles are resistant to fatigue**
- <> **Requires less rest period for muscle recovery**

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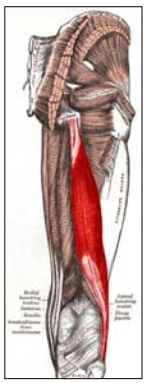
Muscle Action

Insertion is the more movable bony attachment and origin is the less movable attachment, function of action.



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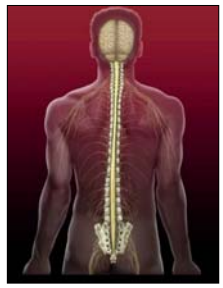
Nervous System

Includes the brain and connecting pathways.

Two Systems:

Central Nervous System- brain and spinal cord

Peripheral Nervous System-cranial and spinal nerves



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Types of Muscle Effort

•Dynamic (Motion) - Alternation of contraction and extension, tension and relaxation of the muscles.

•Static (Posture)- Prolonged state of contraction of the muscles.

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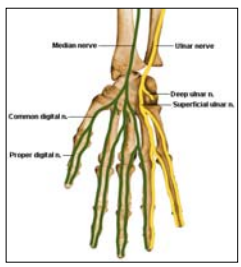

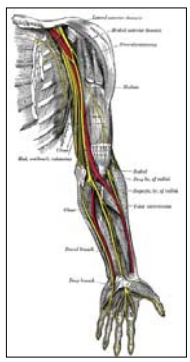

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THE SPINE

- 24 movable blocks of bones & 2 unmovable
- Shock absorbers
- Nerves
- Importance of maintaining s-curve
- Importance of movement
- Lifting and sitting most stressful

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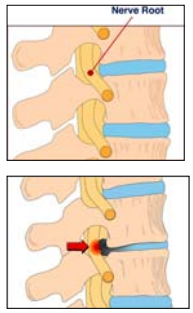
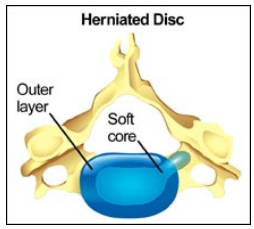
Spinal Nerves and Injury





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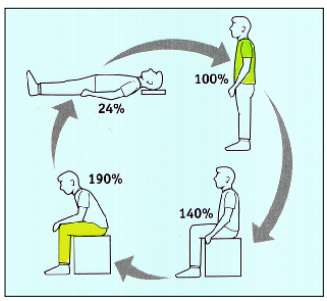
Spinal Compression Forces



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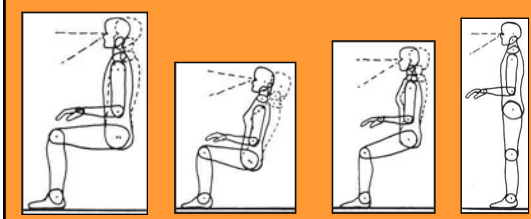

Changing back angle decreases disk pressure

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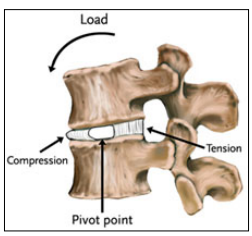

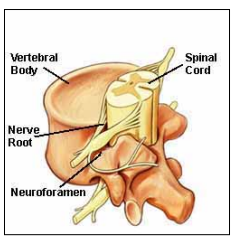

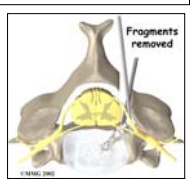

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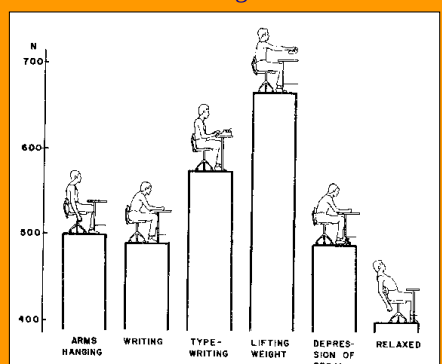
Activities While Sitting and Disc Pressure



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Causes of CTS

- Repetitive flexing and extending of the tendons in the hands and wrists
  - With force
  - For prolonged periods without rest
- Having a narrow wrist
- Having rheumatoid arthritis
- Having hormonal changes
- Pregnancy

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Musculoskeletal Disorders

Disorders that involve the muscles, tendons, ligaments, joints, blood vessels and/or nerves.

These disorders include, but are not limited to;

- **Tendonitis/Epicondylitis**
- **Carpal Tunnel Syndrome**
- **Low Back Strain**
- **DeQuervain's Disease**

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Ergonomic hazards contribute to these conditions.

Symptoms of Concern

- Pain & Discomfort
- Numbness
- Tingling
- Limited ROM
- Weakness
- Redness
- Swelling
- Burning

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Characteristics of MSDs

- Mechanical and physiological process
- Related to frequency, duration & intensity
- Cumulative in nature
- Occurs slowly over time
- Recovery period varies by injury and person
- Frequently under reported

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Management of Ergonomically Related Medical Disorders

When Prevention Doesn't Work

- Early Detection
- Appropriate Treatment
- Reduce/Eliminate Contributing Factors
- Follow-up
  - -Is further treatment needed?
  - -Have risks been reduced?
  - ***CLOSE THE CIRCLE***

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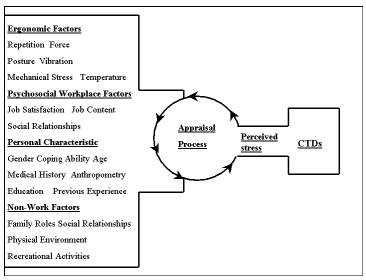
R. S. Lazarus' Psychological Stress Cumulative Trauma Model



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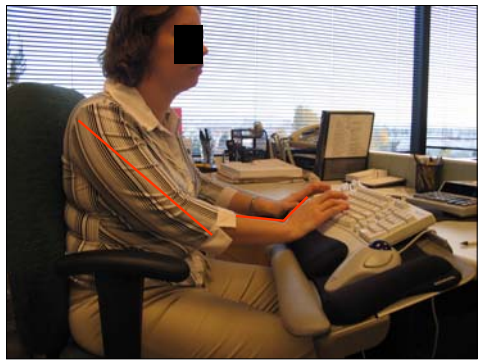

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Low Back Nerve Pain

Sciatic nerve impingement, also called sciatica, is common for people who sit for prolonged periods of time.

The sciatic nerve runs from your lower back down the back of your leg and into to your feet.

Swelling in certain muscles in the buttocks can put pressure on the sciatic nerve, causing pain down the leg.

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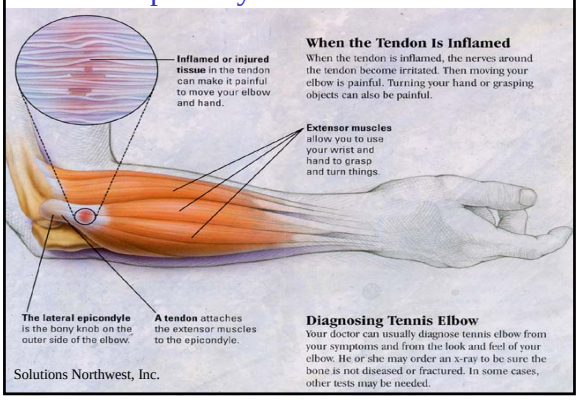
Lateral Epicondylitis = Tennis Elbow



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TENDONITIS

- ♦Tendons withstand bending, stretching and twisting
- ♦Become inflamed through overuse, disease or injury
- ♦The pain can be significant
- ♦Time to heal varies but can increase with continued use
- ♦More pressure on tendons when muscles are not strong

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Causes of Tennis Elbow

- Combination of:
  - Elbow extension
  - Wrist extension
  - Fingers flexion or extension
- Lifting stapler
- Pinching
- Pulling heavy items up

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Medial Epicondylitis – Golfer's Elbow

♦ Irritation of the tendon attachments of the finger flexor muscles on the inside of the elbow

♦Associated with tasks that require repeated or forceful rotation of the forearm and bending wrist at the same time

It is caused by damage to the tendons that cause the wrist to flex.

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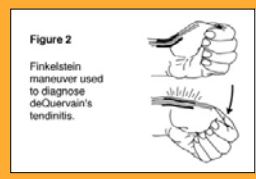
De Quervain's Tenosynovitis
Once called Washer Women's Sprain



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Causes in the Office for Epicondylitis

•Reaching forward for the mouse onto a desk that is higher than the keyboard.
•Reaching for the mouse placed to the far side of the keyboard.
•Gripping the mouse tightly while using wrist motion to activate.
•Planting the wrist down and swiveling the mouse using wrist motion.
•Reaching frequently for the phone or to take heavy manuals or binders down from high shelves.
•Pulling thick files out of densely packed cabinets or drawers.

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SYMPTOMS OF DE QUERVAIN'S

- Pain in wrist below thumb
- Tenderness
- Swelling over thumb side of wrist
- Pain with pinching & gripping

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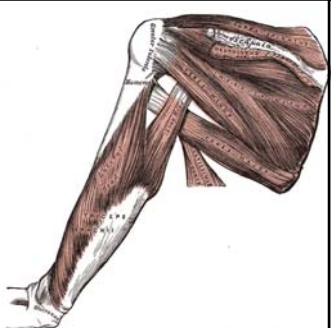
Rotator Cuff Tendinitis

♦ Four muscles: Supraspinatus, infraspinatus, teres minor, subscapularis.

♦Associated with work that requires the elbow to be elevated

♦Repeated overhead motion contributes to thickening of tendons and bursa, which can cause frozen shoulder syndrome



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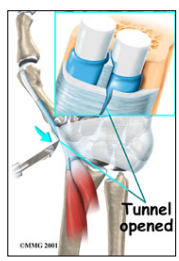
CAUSES OF DE QUERVAIN'S

- Repetitive use of the thumb
  - Pinching, filing
- Static or repetitive thumb abduction
  - Mothers with newborns
  - Trackball users
- Ulnar and radial wrist deviations
  - Mouse use



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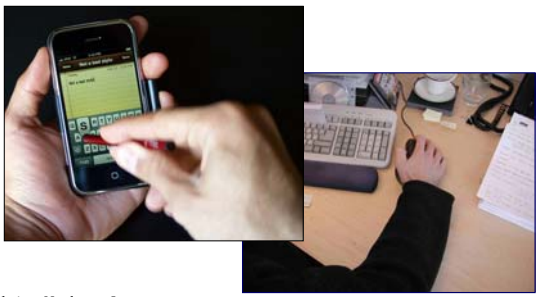
DE QUERVAIN'S



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Cubital Tunnel Syndrome

- Cubital tunnel or "funny bone"
- Ulnar nerve compression
- Tingling, numbness and weakness ulnar side of hand
- Ulnar nerve irritation elbow, forearm or hand

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Carpal Tunnel Syndrome (CTS)

♦Occurs when tendons or ligaments in the wrist become inflamed and enlarged

♦Due to the narrowed tunnel the median nerve gets pinched

♦The first symptoms usually appear at night and involve tingling or numbness

♦Results in difficulty gripping or making a fist, to dropping things

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Causes of Cubital Tunnel Syndrome

- Pressure on elbow, forearm
  - Examples: computer mouse, edge of desk, arm rest too high or too hard
  - Also can just cause ulnar nerve compression in the forearm
- Frequent or sustained elbow flexion
  - Holding phone to ear or leaning your elbow on the desk with your hand on your chin.

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Ergonomic Risk Factors

- **Awkward (Non-Neutral) Postures**
- **Static Muscle Loading**
- **Repetition**
- **Force**
- **Contact Pressure**
- **Lighting**
- **Work Space Issues**
- **Worker's Condition**

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RISK OF INJURY INCREASES AS RISK FACTORS COMBINE

Neutral (Natural) Posture

Resting position of each joint when the least tension on nerves, tendons, muscles and bones.

Muscles are neither contracted nor stretched.

- The Spine
- The Neck
- The Shoulders
- The Wrists: Horizontal plane created by the back of the hand is even with the horizontal plane created by the back of the forearm

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RECLINE POSITION

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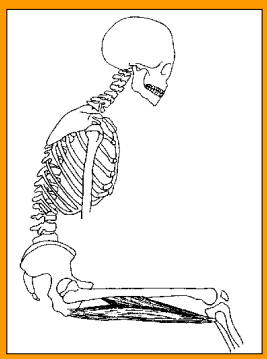

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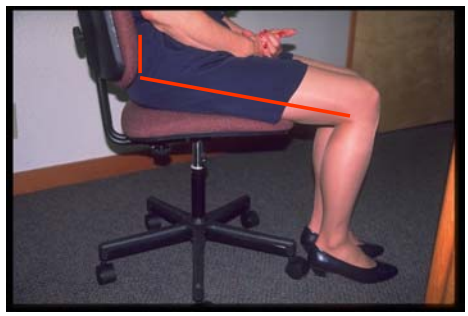
Flat Seat Pan but Slight Opened Hip Angle



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Change postures, upright, decline, recline and best of all, rock

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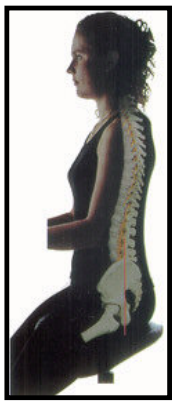

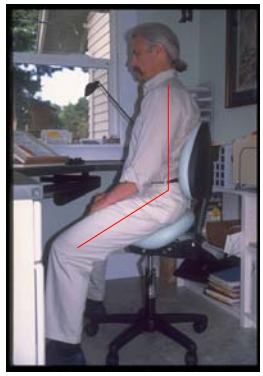

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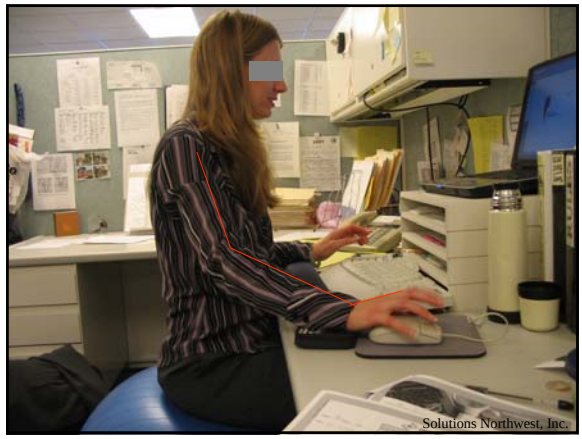

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Why is she using the back cushion?

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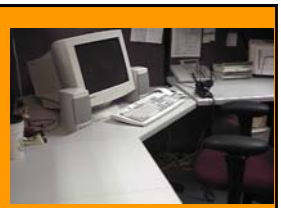
Adjustability Must Meet Users Needs



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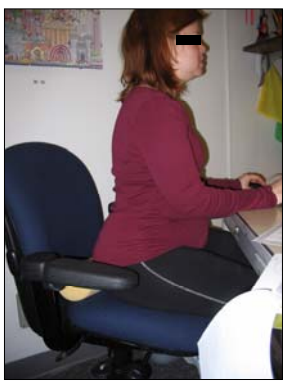

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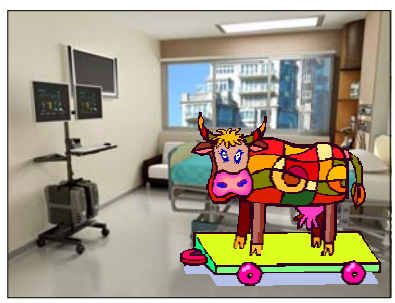
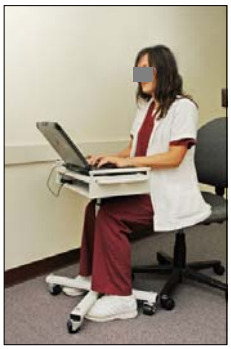
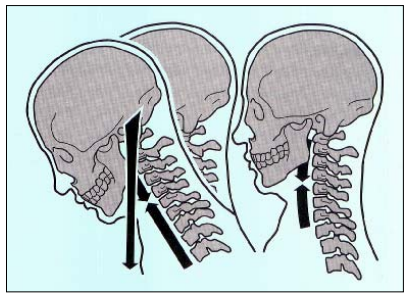
Did Anyone Notice the Cow in the Room?





THE NECK



HEAD WEIGHT?

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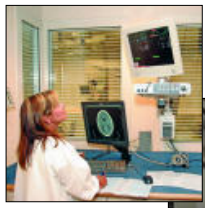

Neck Extension

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The Laptop Hunch

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THE

UPPER EXTREMITIES

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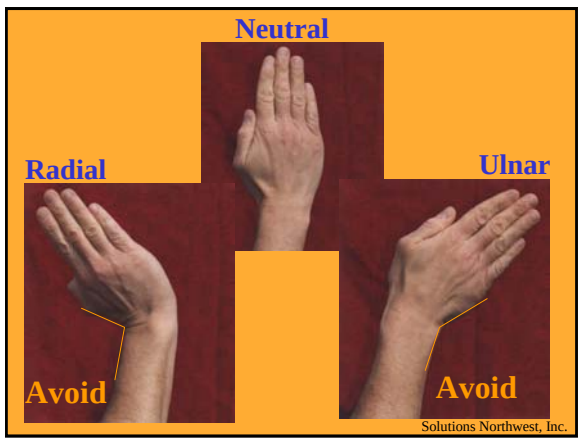

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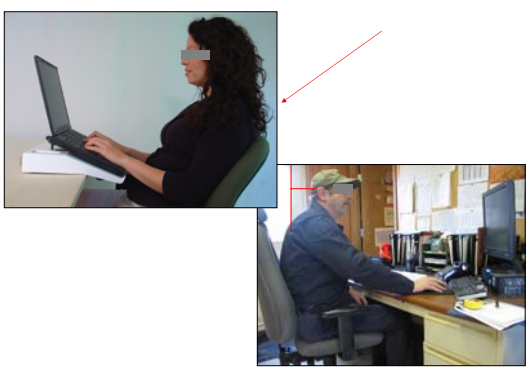

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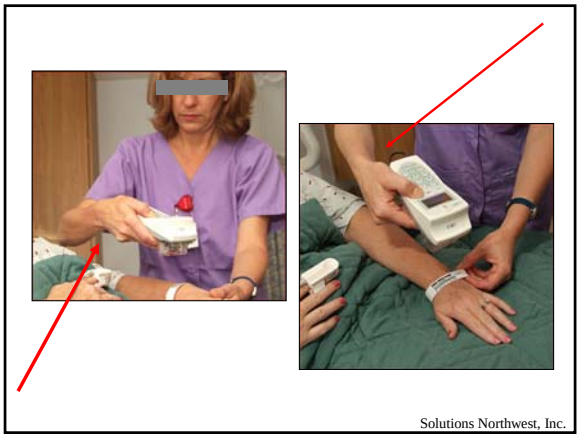
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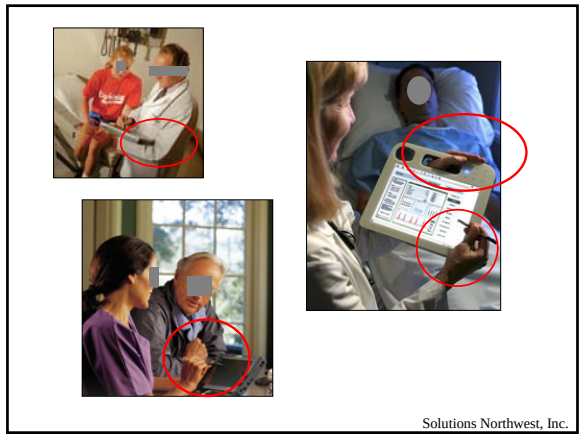
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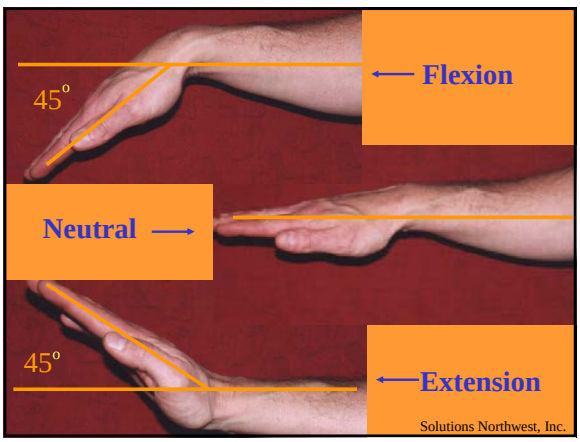
45°
Flexion
Neutral
45°
Extension
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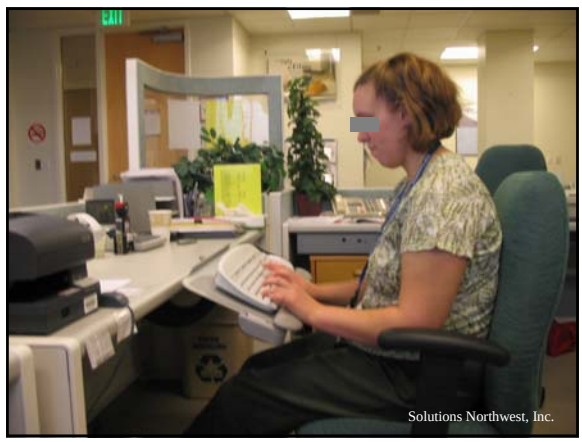
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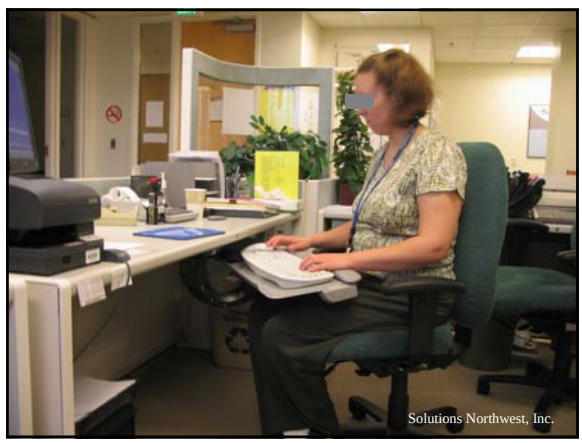
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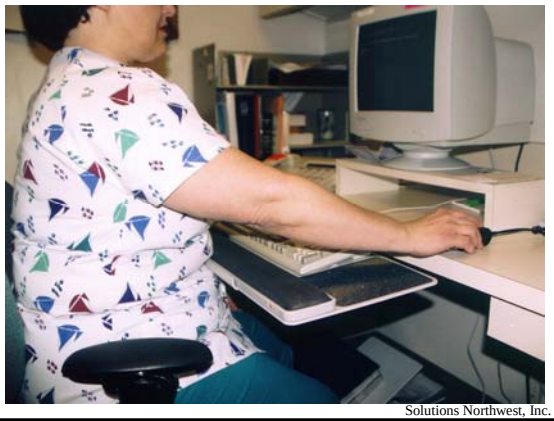

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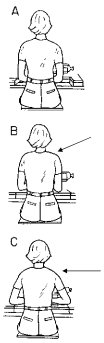
Shoulders



Height is just right

Too high

Too high

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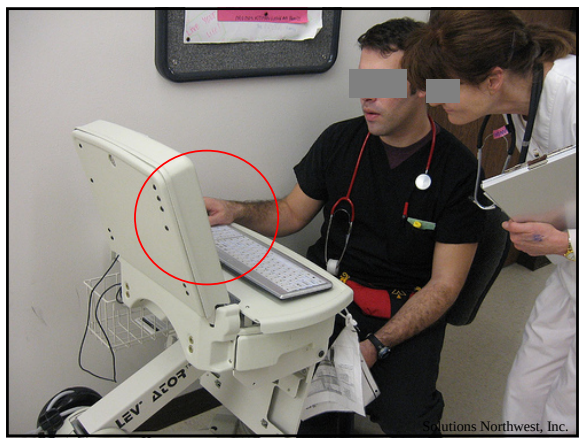

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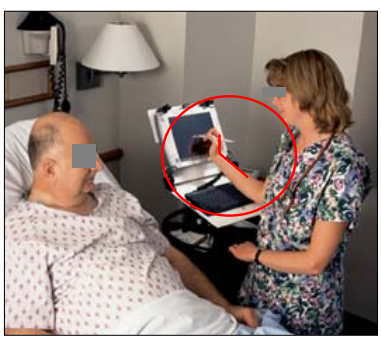

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Contact Pressure Can:

- Decrease Circulation
- Cause Tissue Damage
- Cause Nerve Damage

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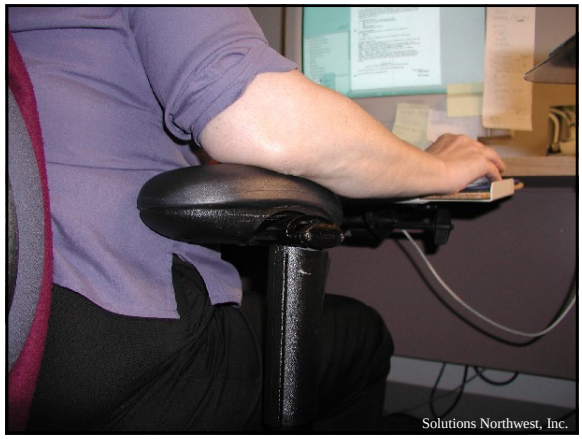
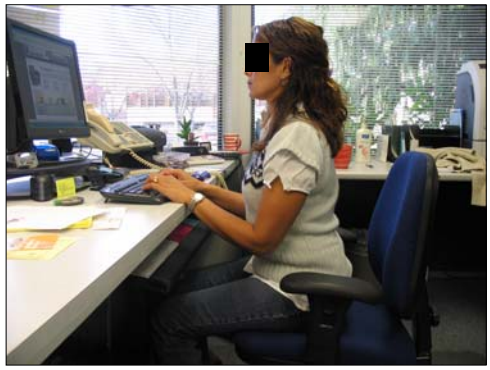
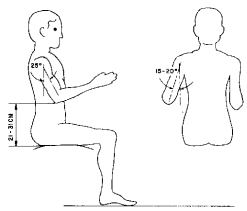




Do You Need Armrests?

SHOULDER FLEXION and ABDUCTION FOREARM POSITION



Goal: Abduction < 20° Flexion < 30°

Less Load, More Energy Efficient

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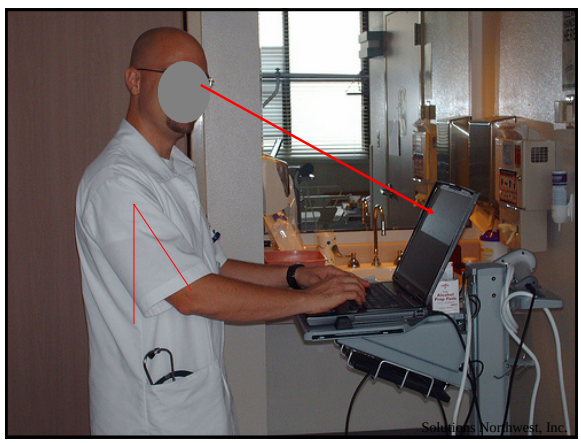
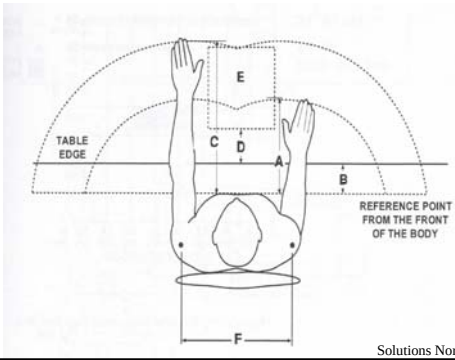


Reach Zone



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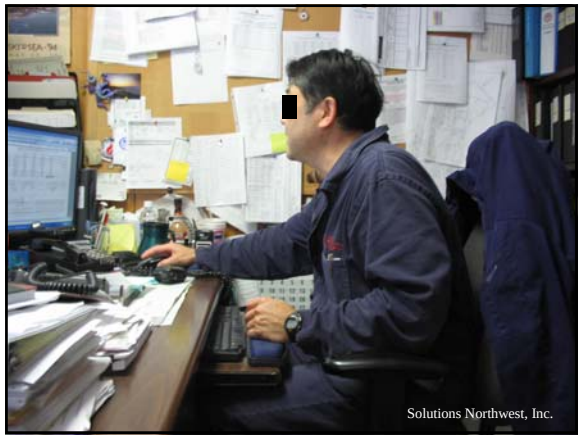

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Neutral Posture

- Head and neck in line with torso
- Shoulders relaxed
- Elbows close to body
- Lower back supported
- Wrist/Hands in line with forearms or ½”-1” below elbow height
- Wrists are straight
- Hips are ½”-1” above knees
- Feet flat on floor, shoulder width apart

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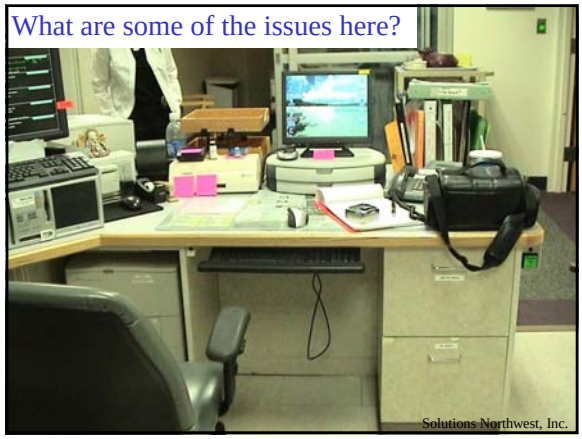
What are some of the issues here?



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FORCE IN THE OFFICE

Push/Pull

Lifting

Gripping

Pinching

Typing

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What can you see even without the person?

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Gripping and Pulling

Pushing with Wrist Extension

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How Much Does it Take to Push a C.O.W?

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Battery Lift Issues

Choose the best method

Gripping

And Pinching

Bending
Lifting
Gripping

What are the issues here?

The solution for limited chart space.

Have some one else hold it.

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New Concepts in the Standard

- New Devices: Beyond the keyboard
- New postures: What, something more than the 90-90-90 position?
- Integrated workstation set up: more than independent components

ANSI STANDARDS

ANSI/HFES STANDARDS 100 - 2007

Human Factors Engineering of Computer Workstations

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User Postures Criteria

- Elbow angles between 70-135 degrees
- Shoulder abduction angles less than 20 degrees
- Shoulder flexion angles less than 30 degrees
- Wrist flexion angles less than 30 degrees
- Wrist extension angles less than 30 degrees
- Torso-to-thigh angles equal to or greater than 90 degrees

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ANSI STANDARDS PURPOSE

- The purpose is to provide standards of acceptable applications of human engineering principles and practices to the design of computer workstations.
- The purpose is to provide specifications and guidance to individuals who have the responsibilities for acquiring, installing, and integrating computer workstations.

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Other Standards and Guidelines

- CSA Standard Z412: “Guideline On Office Ergonomics” released by The Canadian Standards Association in 2000
- “Ergonomics Guideline For VDT Furniture Used in Office Work Spaces” released by the Business and Institutional Furniture Manufactures Association in 2002
- ISO 9241 sections 1-9

ANSI CHAIRS

- The chair used to support the user and the workstation **shall**
  - Have a lumbar support
  - Have a backrest that reclines
  - Have a seat pan that adjusts for height and tilt
  - Support at least one other seated posture in addition to upright sitting
  - Provide support to user's back and thighs in the chosen reference postures

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Chair Seat Pan Adjustments

- The seat pan **shall**
  - Be height adjustable
  - Have a user adjustment for tilt
- The seat pan **should**
  - Be wide enough for hip width
  - Have sufficient depth to support user's back without contact to back of knees
  - Have a tilt lock or stop position the user can select while seated
  - Have a rounded front edge

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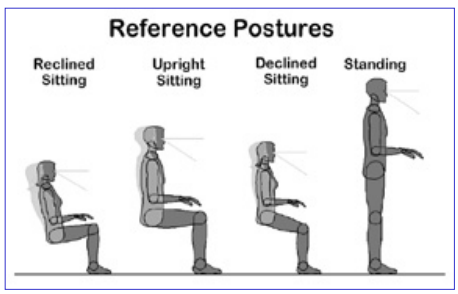

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Chair Backrest Adjustments

- The backrest **shall:**
  - Not constrain the user's torso to a position forward of vertical
  - Not force a torso-thigh angle less than 90 degrees
  - Allow adjusting the angle between the backrest and seat pan to an angle of 90 degrees or greater
  - Allow the user to recline at least 15 degrees from vertical
- The backrest **should:**
  - Allow the user to control the resistance necessary to recline the backrest
  - Provide support to the lumbar and thoracic regions of the back
  - Have a means of adjusting the backrest tension

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Steelcase Leap

Haworth Zody

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ANSI INPUT DEVICE SURFACE

- For seated work, the input-device support surface **shall** allow the user to work in at least two of the reference postures.
- For sit/stand work, the surface **shall** accommodate at least one of the three seated reference posture in addition to the standing reference posture.

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ANSI SURFACES

- Adjustable surfaces **shall** use a mechanism to prevent inadvertent movement and have a control locking mechanism to prevent inadvertent operation.
- Minimal work surface width should 27.6” based on 95th percentile male forearm to forearm breadth
- Minimal work surface depth should allow for a viewing distance of 19.7”

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Good Keyboard Trays



KEYBOARD TRAYS

- Keyboard trays push the user away from the desk
- May not be the best solution for multitaskers
- Should be set flat or negative tilt position
- Should not be set in negative tilt if not a touch typist

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Not So Good Keyboard Trays




ANSI DOCUMENT HOLDERS

- Document holders **should**
  - Allow placement of materials adjacent to the monitor at approximately the same height, distance, and angle to the user's eyes as the monitor screen
  - Be stable when loaded with the intended materials

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ANSI FOOTRESTS

- Footrests **shall** be provided when the range of the adjustment of the chair, work surface, or both does not permit the user's feet to be supported by the floor.
- Footrests **should**
  - Be at least 20.1 in. wide and 7.9 in. deep
  - Be height adjustable up to 8.7 in. and may be adjustable in angle

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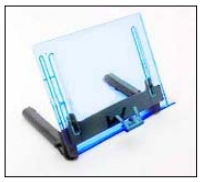

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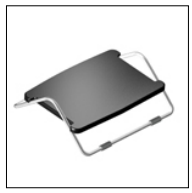
FOOTRESTS



Safeco

WorkRite

FOOTRESTS

- Provide postural variability
- Should rock
- Beware of over use
- May be needed in case the desk height can not be lowered
- Many have the problem with moving away from the user

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KEYBOARDS: SOME SHALLS

- Numeric keypads shall be grouped together
- Shall have at least one positive slope setting between 0-15 degrees
- Keys shall be from center to center .74" +or-.039" apart
- Key stroke force shall be between .9 ounces -5.4 ounces of force
- Key stroke shall have tactile of auditory feedback
- All keyboards must allow for the user to stay within the postures outlined in 5.2.1.1

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Sanitize in seconds

Disinfection without disconnection

Audio and visual alerts

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Quill

Vertical

No Hands Mouse

3M Joystick

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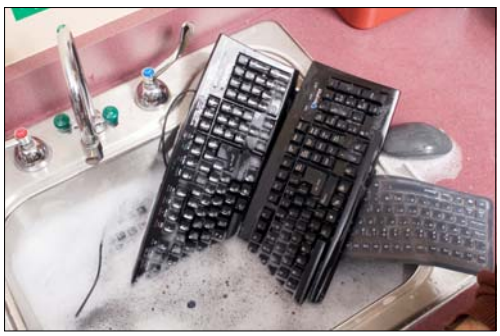
Seal Shield Washable Keyboard



Trackballs

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OTHER INPUT DEVICES

- Pucks
- Trackballs
- Joysticks
- Styli and Light Pens
- Tablets
- Touch-Sensitive Panels

Touchpad

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ONE SIZE or Type DOESN'T FIT ALL

Whale Mouse

Switch Mouse

Contour Design Mice

Waterproof

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Contour Design Rollermouse

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The Design Process

- Workstation design
  - Use standards and guidelines
  - Who should be involved
    - Users, Employee Health, IT, Admin, Management, Ergonomic Design Specialists
- Selection of tools
  - One size does fit everyone
  - Best one for the task
- Testing of tools
  - Try it before buying it

So this doesn't happen

Platforms

Kensington: Best Selection

Spans 90 degree corner

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THANK YOU

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Controlling Risk Factors

Engineering

- Design of Tools, Job, Workstation & Work Method

Administrative

- Work Load
- Job Rotation/Cross Training
- Ergonomic Awareness Training
- Matching Worker to Task

Work Practices

- How Workers Approach the Job
- Behavior
- Aerobic Exercise

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