# Industrial and Construction Ergonomic Principles for the prevention of UEMSD's

By

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# Ergonomics

From the Greek Words

- "ergos" = Work
- "nomos" = Laws

"*Laws of Work, The Study of Work*"

# The “Golden Rule” of Ergonomics

***“Fit the job to the person...***

***...not the person to the job.”***

# What is ERGONOMICS?

***The science of designing tools, equipment, workplace layout and work methods to fit people's abilities.***

# “A Win – Win Situation”

- Reduce injuries, errors, defects, and costs…
- Reduce employee turnover & absenteeism
- Increase employee comfort & morale
- Improve productivity
- Improve quality

# Ergonomic Design = User Centered Design

- Designs focus on prevention of illness and injury for people interacting with objects while performing a task
- Designs also focus on comfort, adaptability and adjustability (i.e. robustness)
- Designs are not exclusive for one age, sex, height, physical proportion, physical limitation or weight.

# What is Ergonomic Risk?

# Common Ergonomic Problems

- Manual materials handling Injuries
  - Musculoskeletal (Strains & Sprains)
  - Sometimes related to Slips & Trips
- Upper Extremity Musculoskeletal Disorders (UEMSD)
  - Cumulative trauma disorder (CTD)
  - Repetitive strain injury (RSI) - Same
  - Usually related to the use of tools and fixtures

# UEMSD's

## Causes at Work

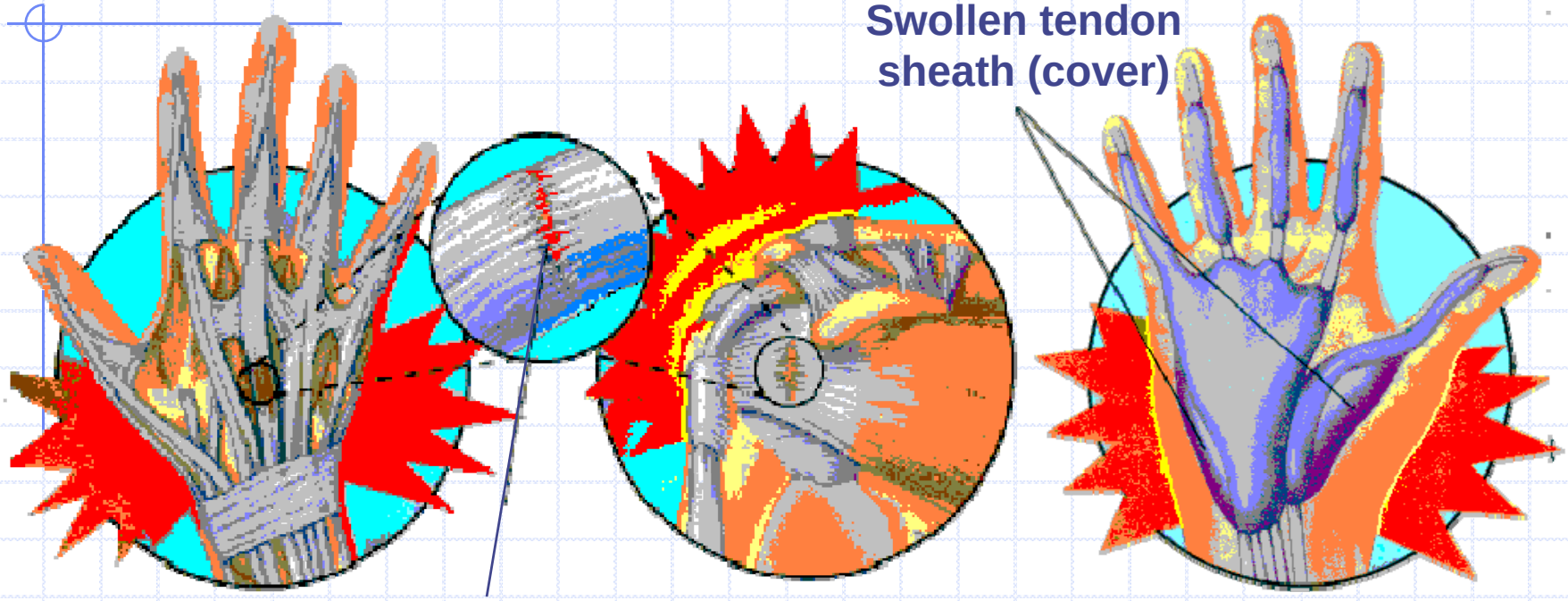
- Repetitive Motions
- Forceful Exertions
- Awkward Postures
- Concentrated Tissue Pressure
- Static/Sustained Exertion
- Unaccustomed Activities
- Environmental Issues (Cold, Vibration)

# UEMSD's

## Personal Causes

- Possible Genetic Predisposition
  - Existing disease processes (e.g., Diabetes, Arthritis)
- Gender - Females more prone to CTS
  - Pregnancy/Menopause
  - Average 50% less strength - higher relative force must be exerted by females
- Age - Body loses flexibility/strength
- Physical Conditioning

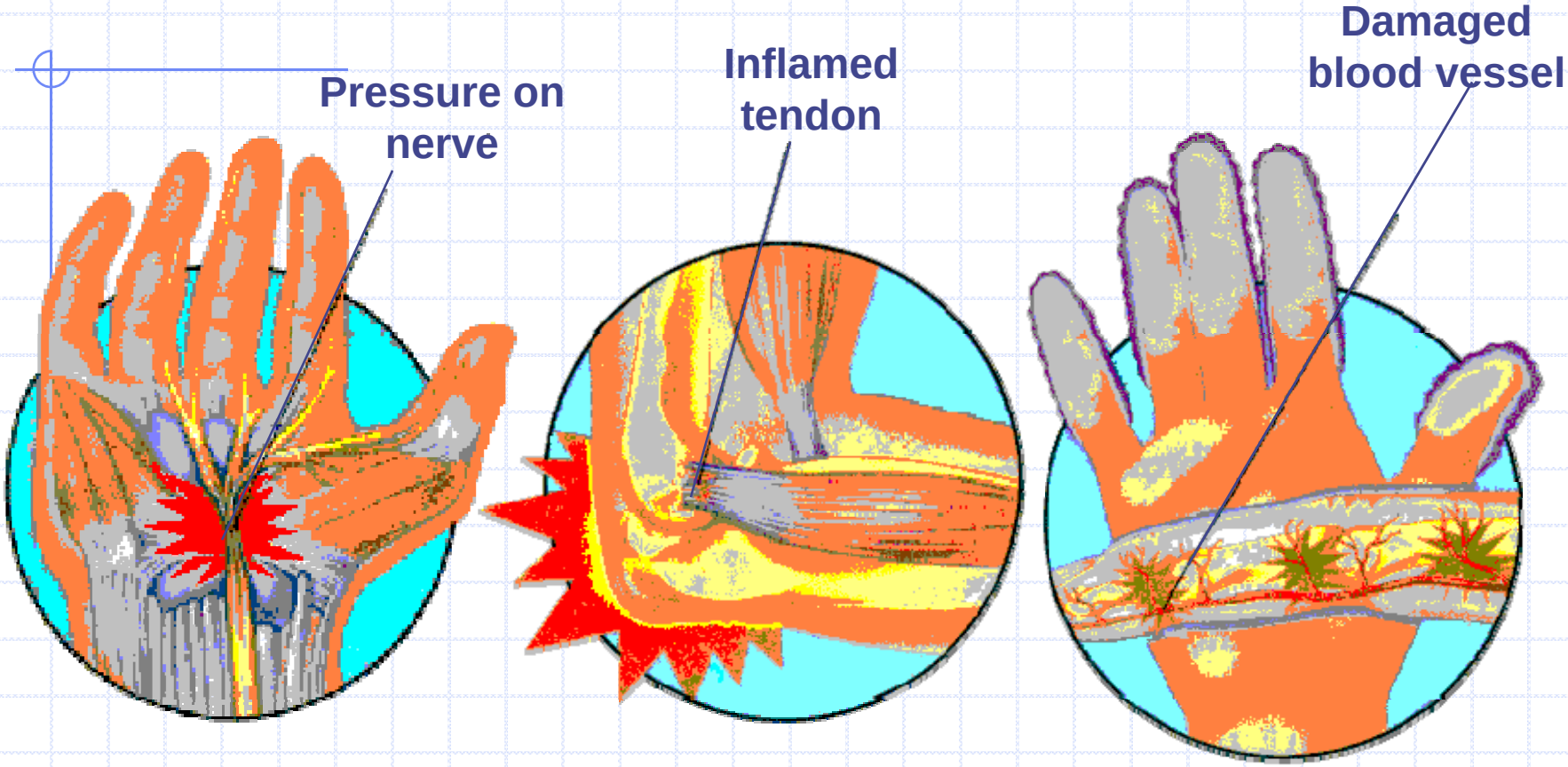
# What are the most common UEMSDs?




Tendinitis | Rotator Cuff injury | Tenosynovitis

* Pictures from “Preventing Repetitive Motion Injuries”; Krames Communications ©1994

# What are the most common UEMSDs?




Carpal Tunnel Syndrome

Epicondylitis

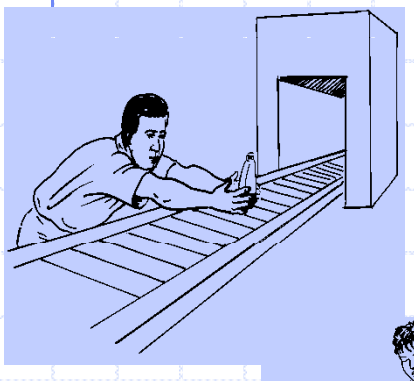
White Finger

* Pictures from “Preventing Repetitive Motion Injuries”; Krames Communications ©1994

# Ergonomic Risk Factors

*Actions or conditions that put excessive stress on the body*

***Occupational***



***Non-Occupational***

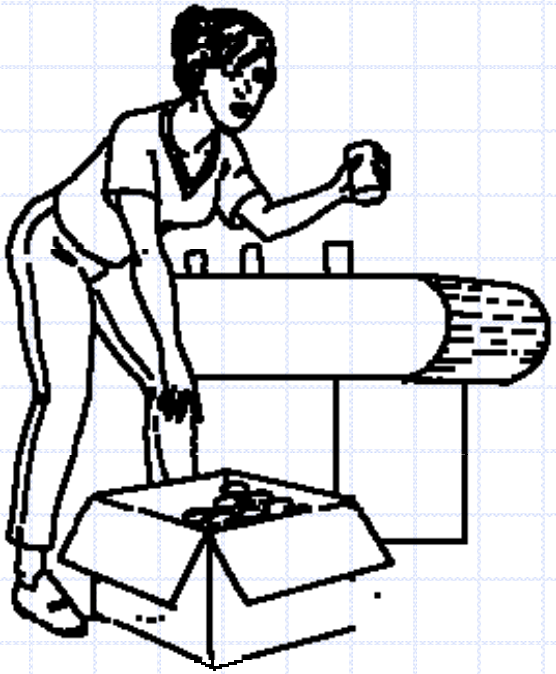
***Repetition***
***Force***
***Posture***
***Pressure***
***Environment***
***Stress***
***Genetics***
***Personal Factors***

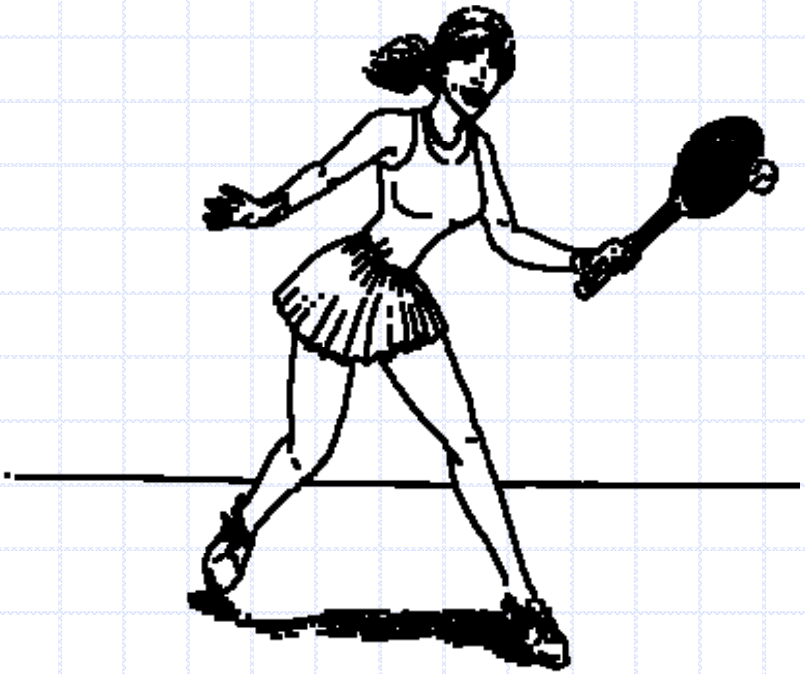
***Injury***

***Illness***

# Repetition

*Repeating the same motions or exertions over and over*





# Repetition

*Acceptable ranges of daily repetition are provided below:*

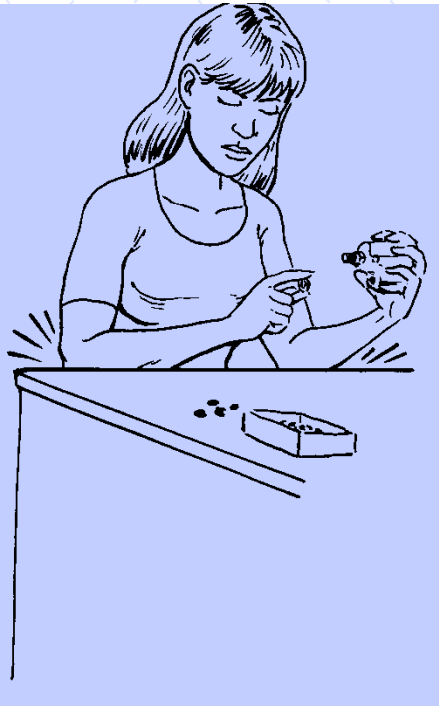
| Repetition Rating | | | |
|---|---|---|---|
| Body Part | Total Counts Per Workday | | |
| | High | Moderate | Low |
| Fingers | > 20000 | 16500 - 20000 | 10000-16500 |
| Hand/Wrist | > 6500 | 5001 - 6500 | 3000 – 5000 |
| Forearm/Elbow | > 3750 | 3001 - 3750 | 2000 – 3000 |
| Shoulder | > 900 | 701 - 900 | 400 – 700 |
| Neck | > 6500 | 5001 - 6500 | 3000 – 5000 |
| Back | > 700 | 501 - 700 | 300 – 500 |

# Force

*Amount of work which the muscles, tendons, joints and tissues must do in order to perform an operation*

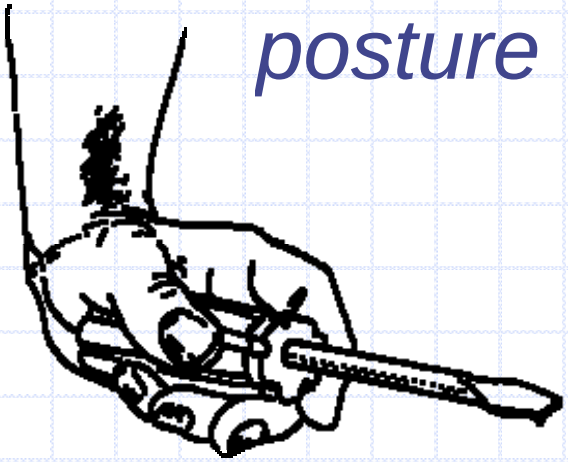
# Pressure

*Produced by the contact between body tissue and hard, sharp edges of tools, parts, work surfaces or work pieces.*

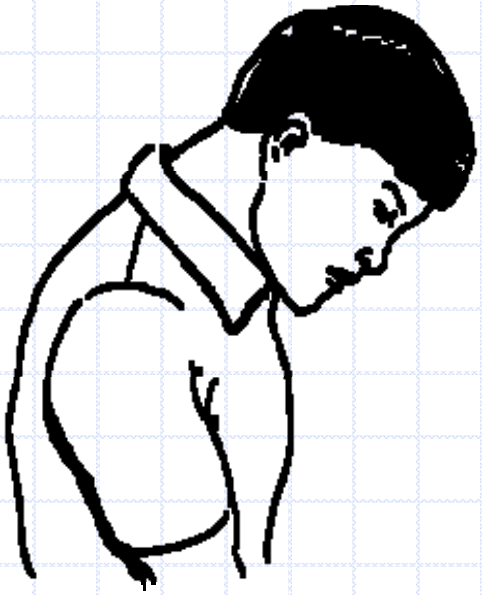


# Posture

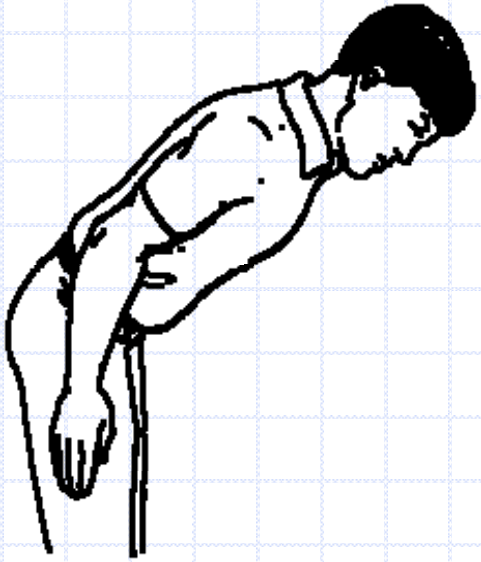
*Deviation from natural posture*



*Hand/Wrist Posture*



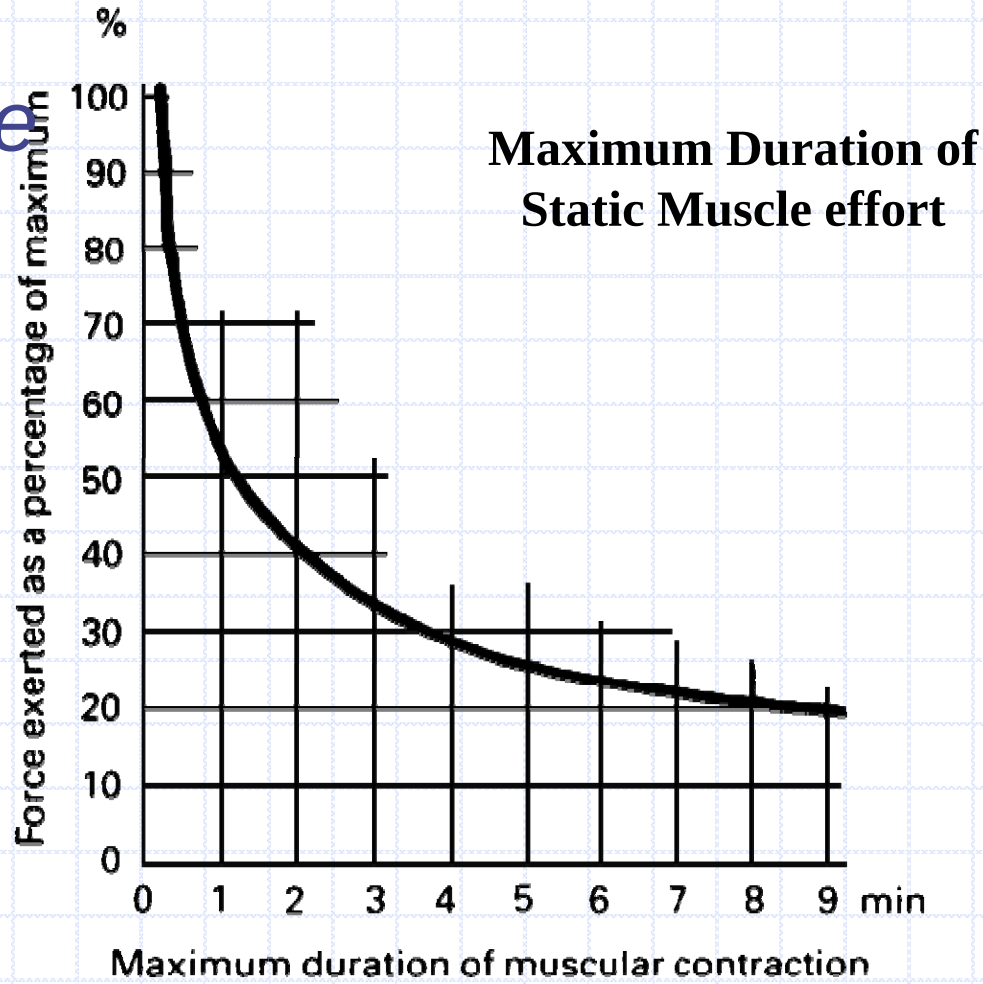
*Neck Posture*



*Back Posture*

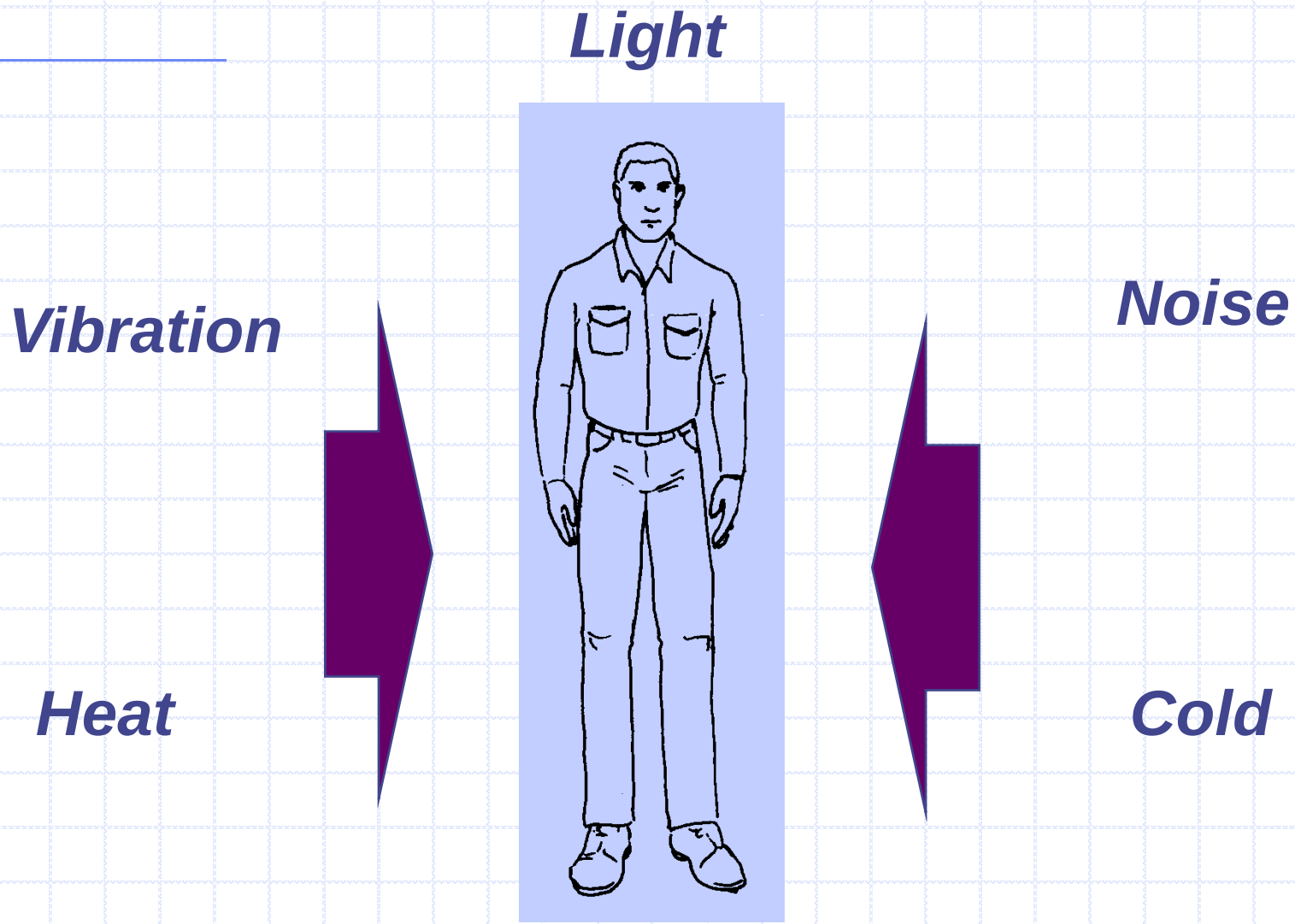
# Posture

*Static Posture*




**Maximum Duration of Static Muscle effort**

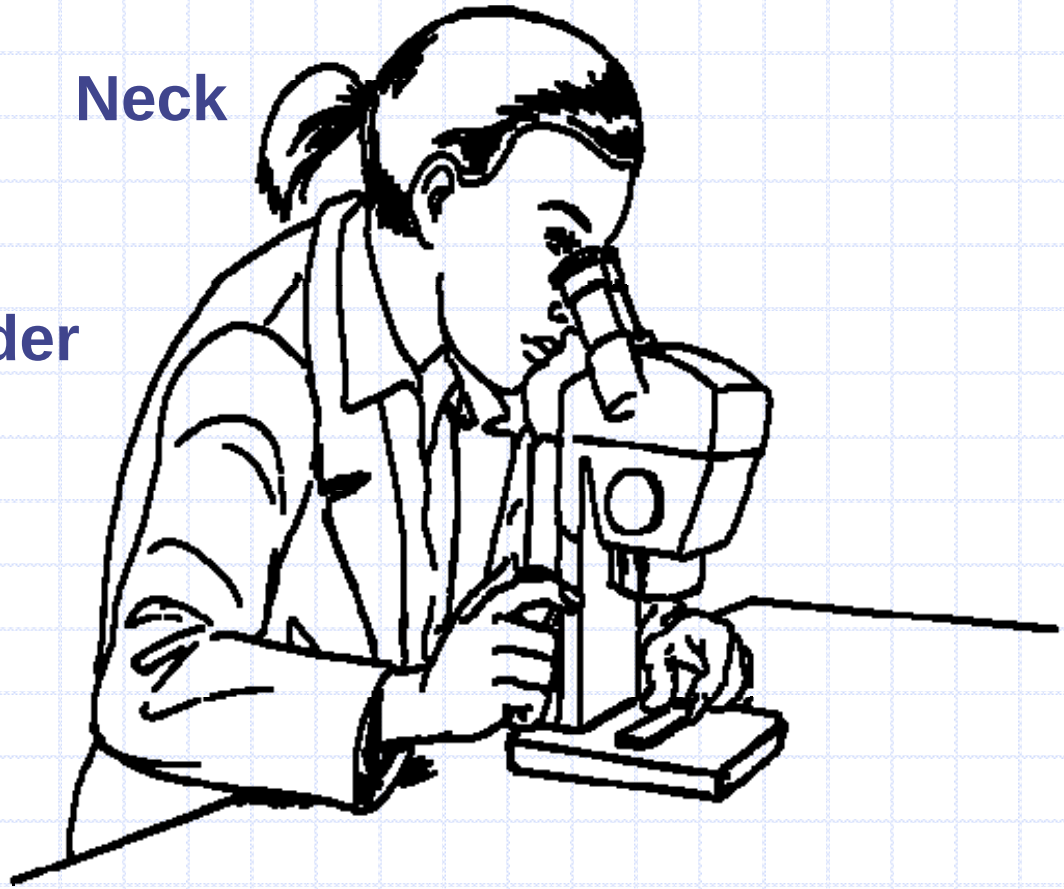
# Environment



# Risk Factors for ERGO Attack

- Personal Factors (e.g. Strength, Age)
- Lifestyle Factors (e.g. Exercise, Flexibility)
- Home Activity (e.g. Hobbies, Sports)
- Work Activity (e.g. Rep. Motions, Lifting)
- Combination determines total risk

# Upper Extremity Problems



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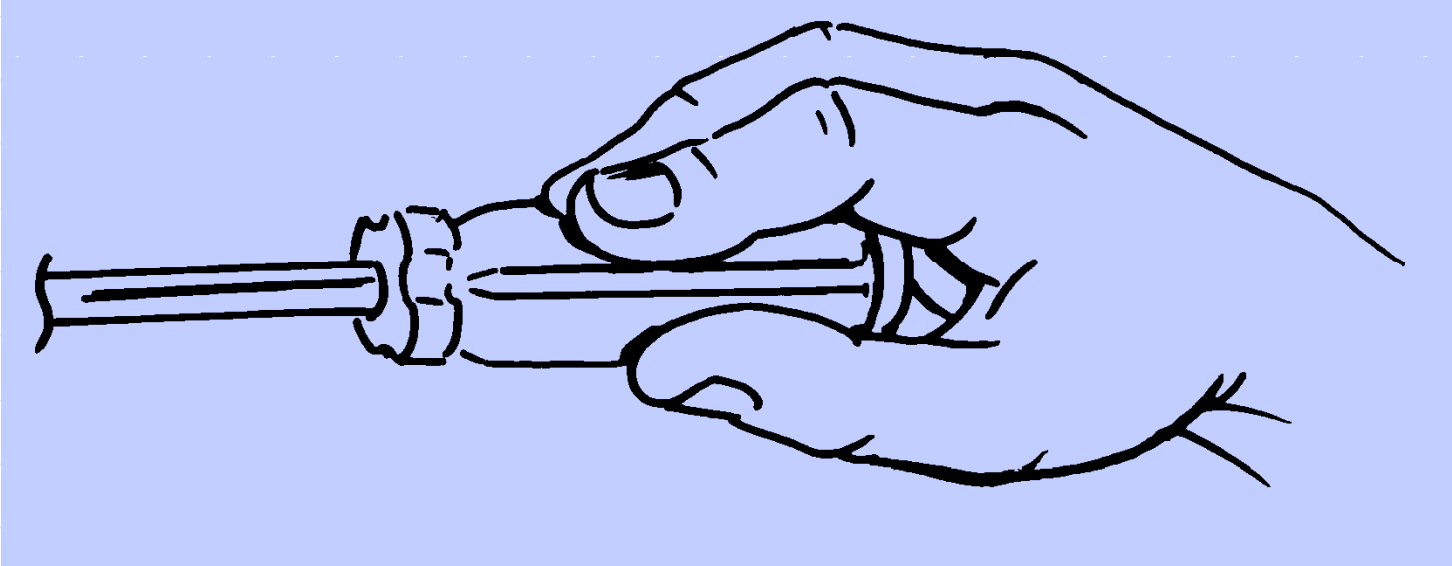
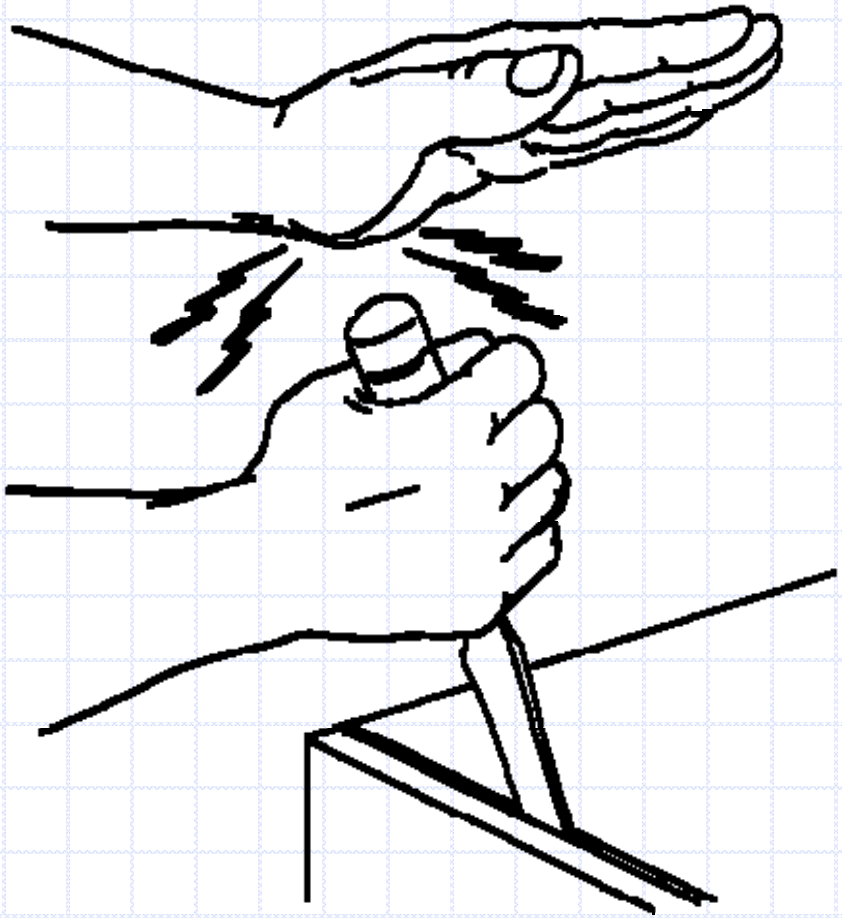


High Finger Pinch Forces

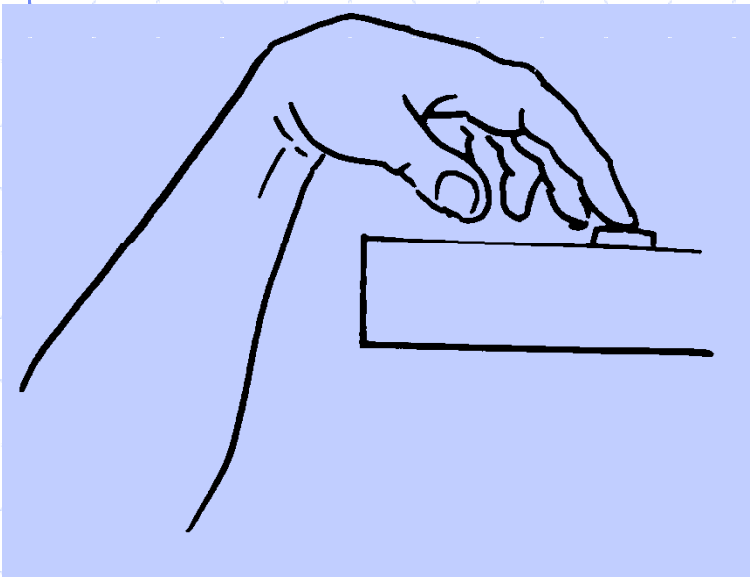
# Upper Extremity Problems



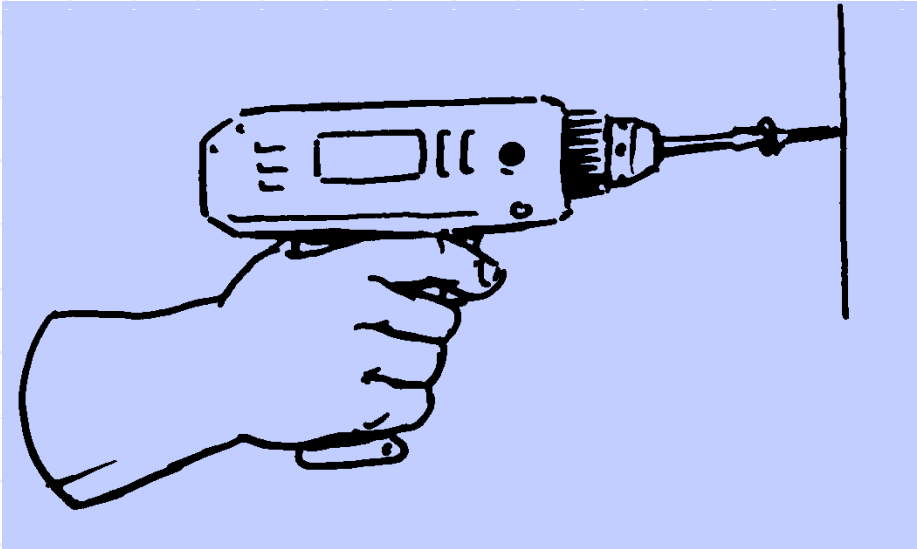
Hands used as a hammer

# Upper Extremity Problems

- Hands - Using fingers instead of the entire hand



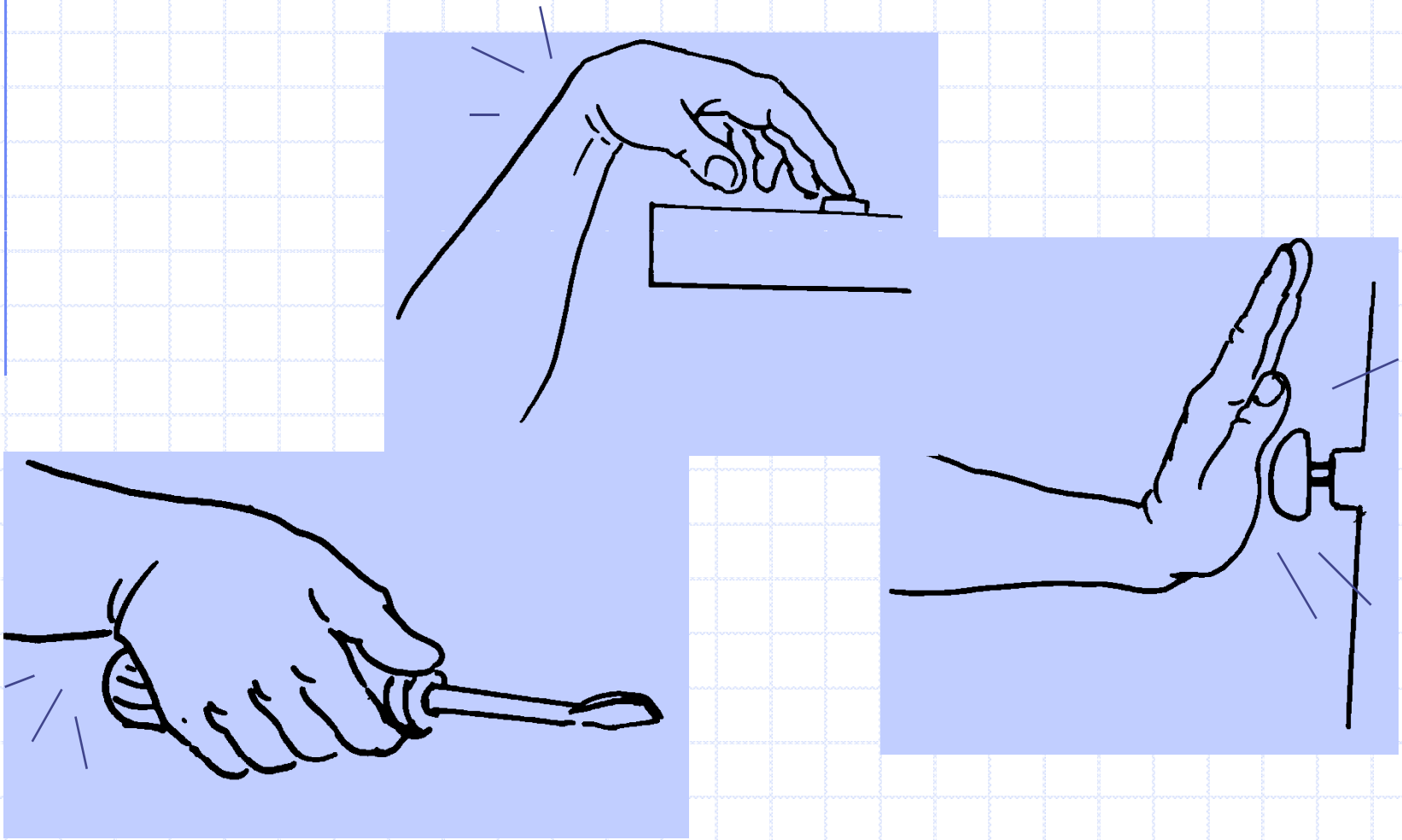
Using thumb or finger to activate a push button



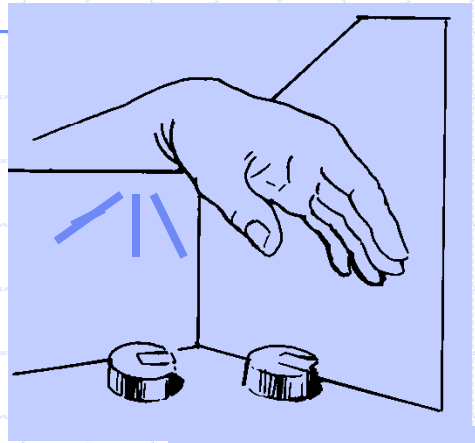
Finger triggering a power tool

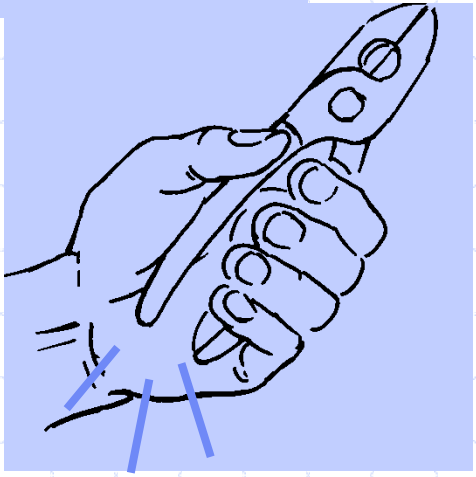
# Upper Extremity Problems

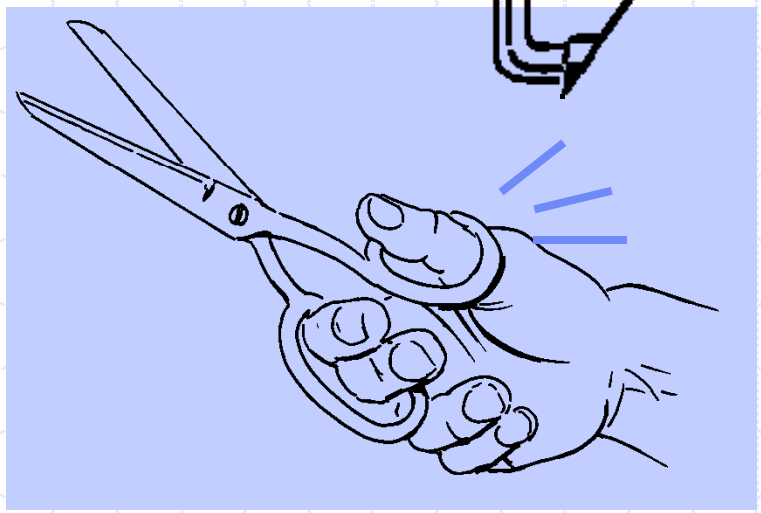
## Hands (Posture) - Extreme motion of the wrist

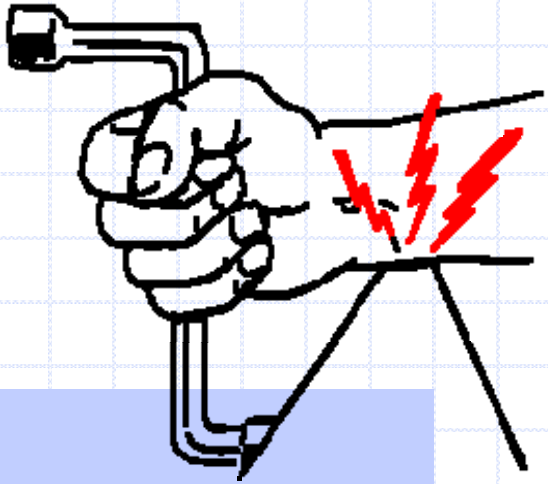


# Upper Extremity Problems





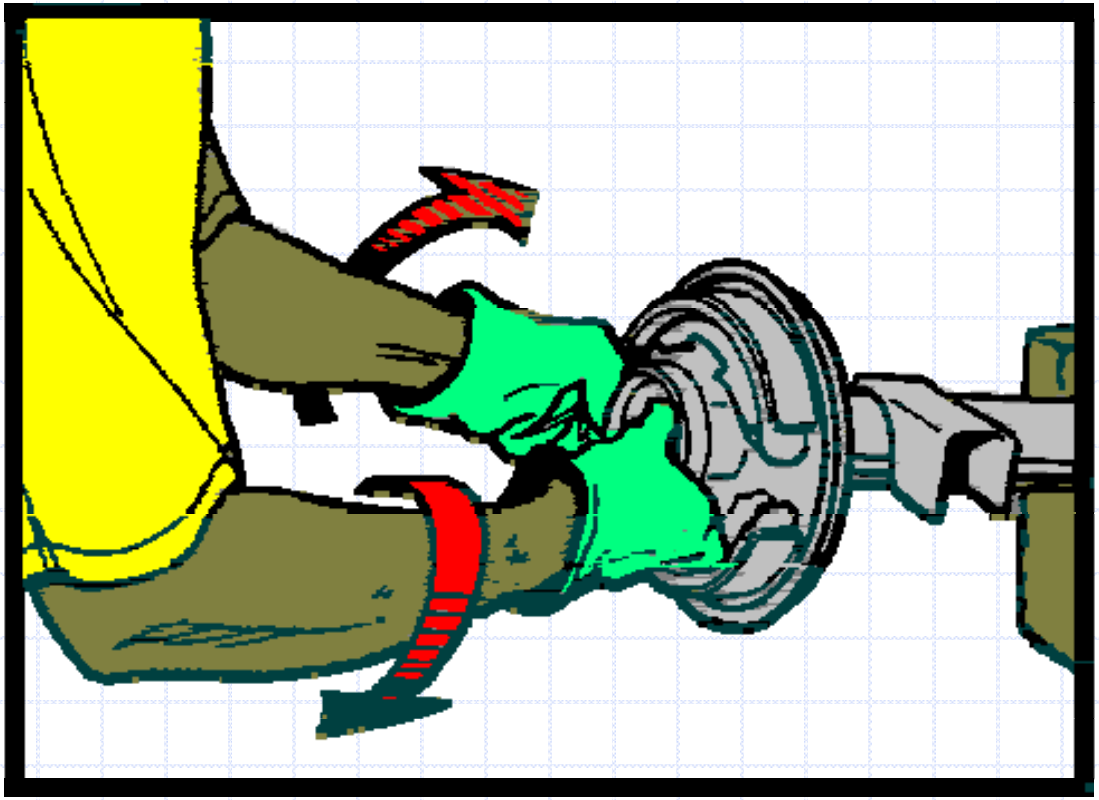




**Hands (Mechanical Pressure)**
**Contact with Hard Objects**

# Upper Extremity Problems

Elbow Problems - Repetitive and forceful rotation of the forearm, especially with the wrist bent or extended (e.g. turning knobs, manual screwdrivers, Tennis.)



“The UAW-Ford Ergonomics Process”; UAW-Ford National Joint Committee ©1990

# Upper Extremity Problems

Shoulder and Neck Problems

- Working with hands overhead
- Repeated lifting with arms extended
- Tilting the head for prolonged periods
- Stress - tightness in shoulders

# Upper Extremity Prevention Principles

Repetition

- Reduce the number of repetitions
- Use Machines and equipment to do the work

# Upper Extremity Prevention Principles

## Force

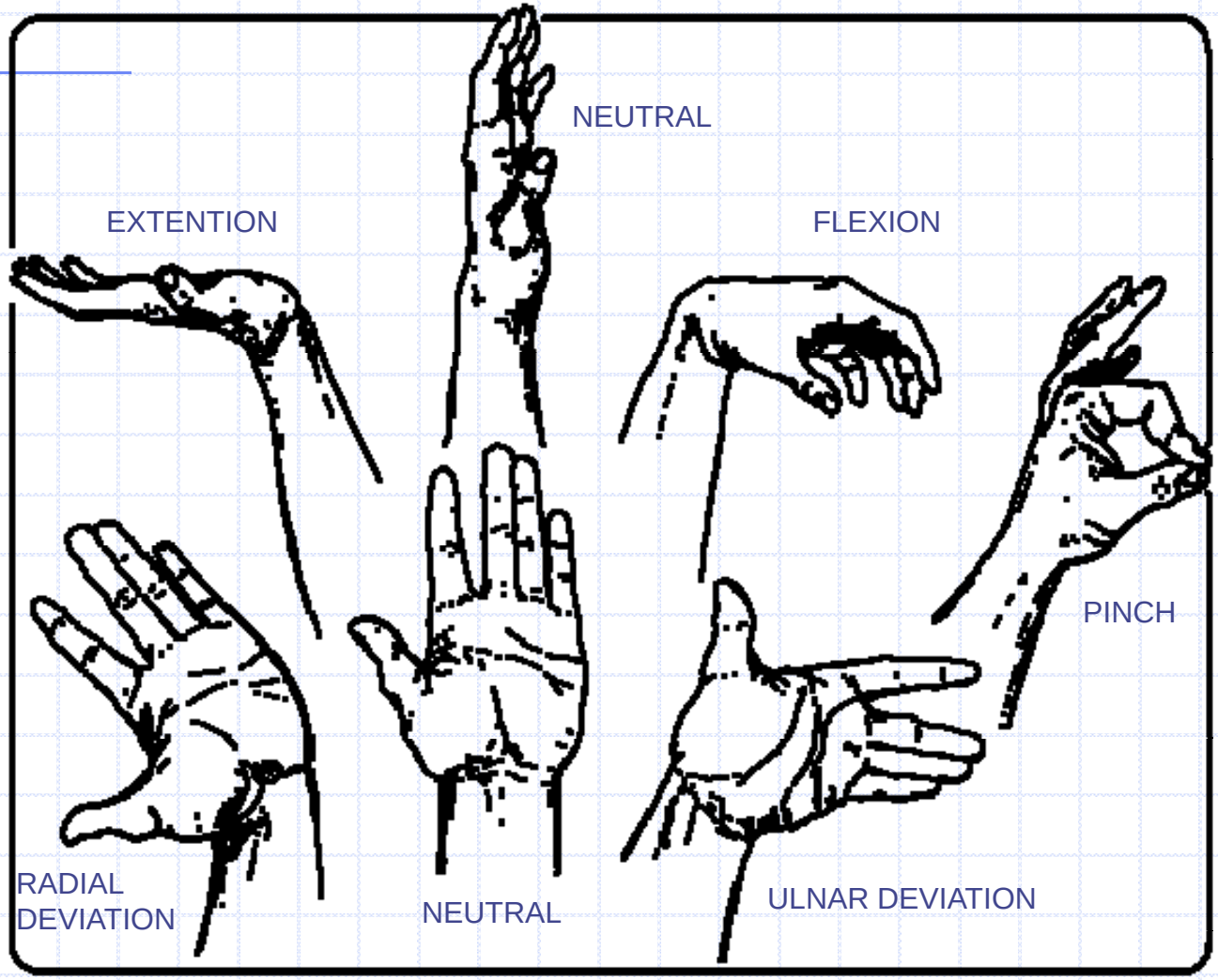
- Reduce the required force
- Design tools & equipment to allow use of a power grip, not a pinch grip
- Use fixtures or jigs (not hands) to hold products, part or tools
- Use mechanical assists

# Upper Extremity Prevention Principles

## Posture

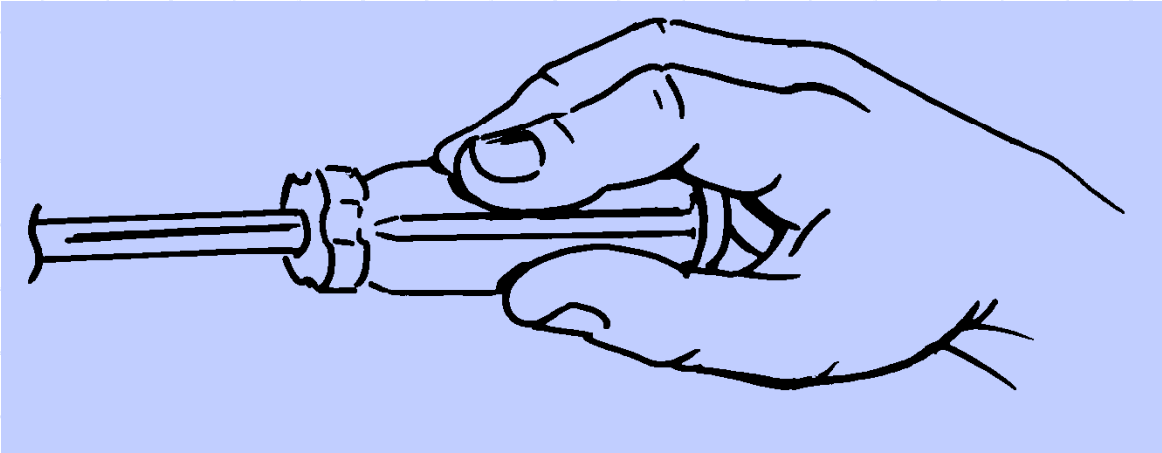
- Design tools & equipment to keep upper extremities in “neutral” position
- Keep arms low and elbows in
- Provide products, parts, and tools within easy reach

# Hand Postures

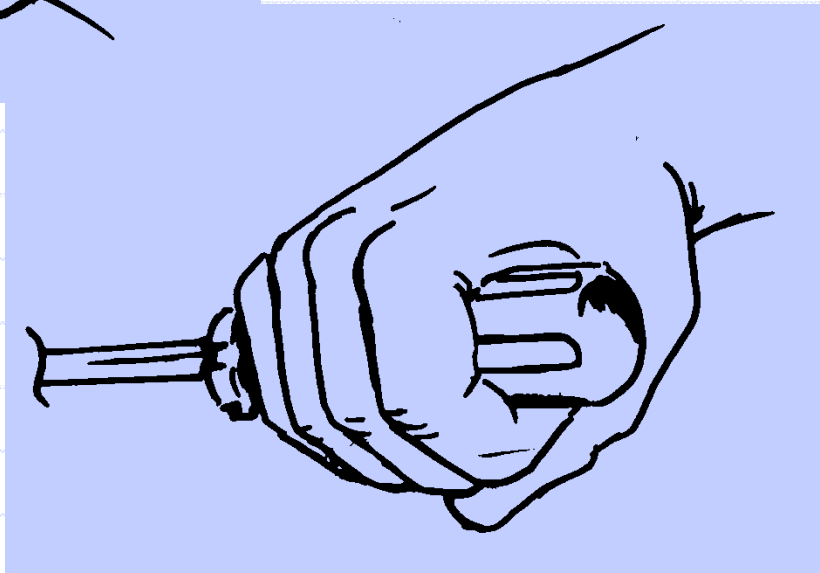



*From ”Cumulative Trauma Disorders”; Taylor & Friends ©1988

# Grips

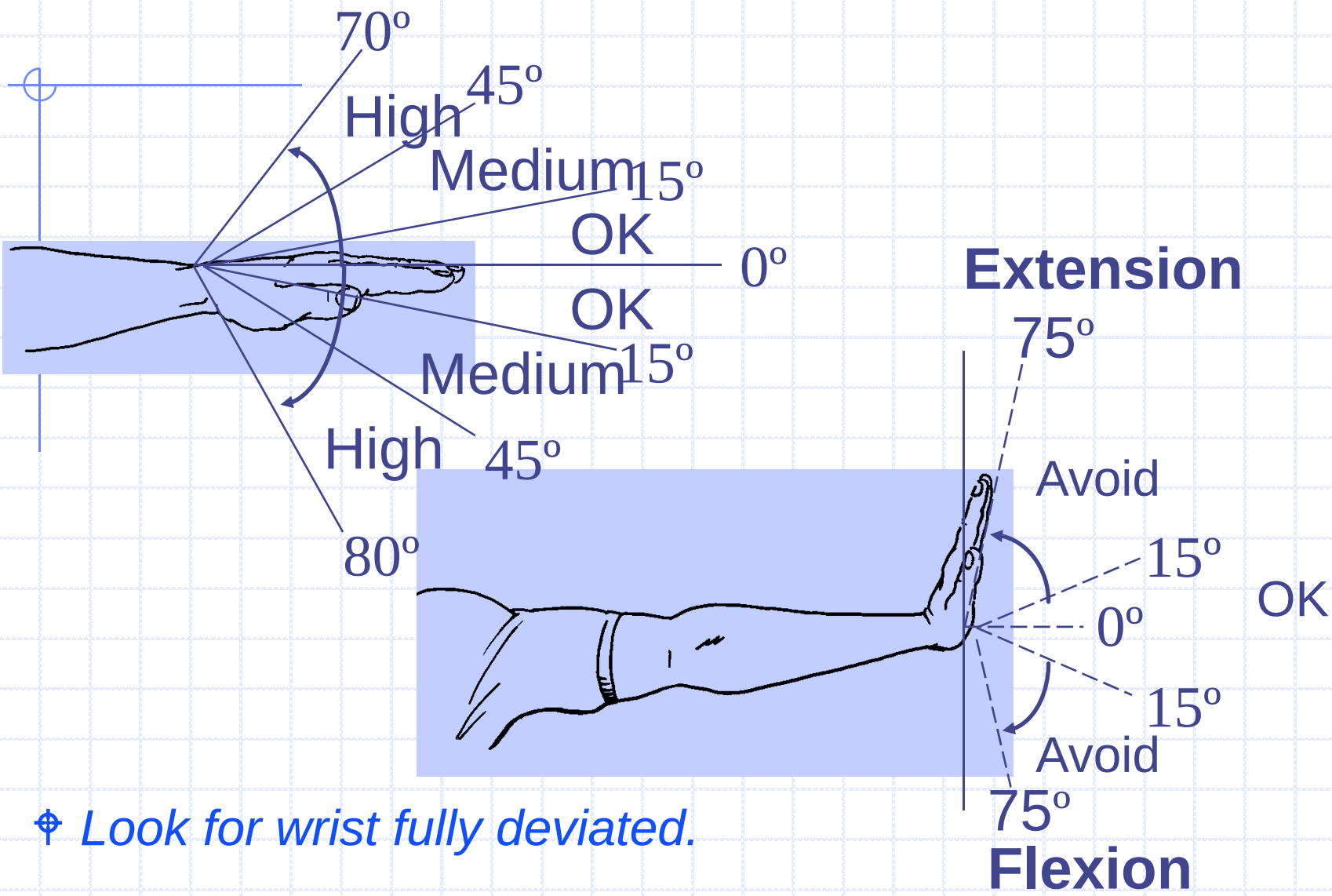


pinch grip



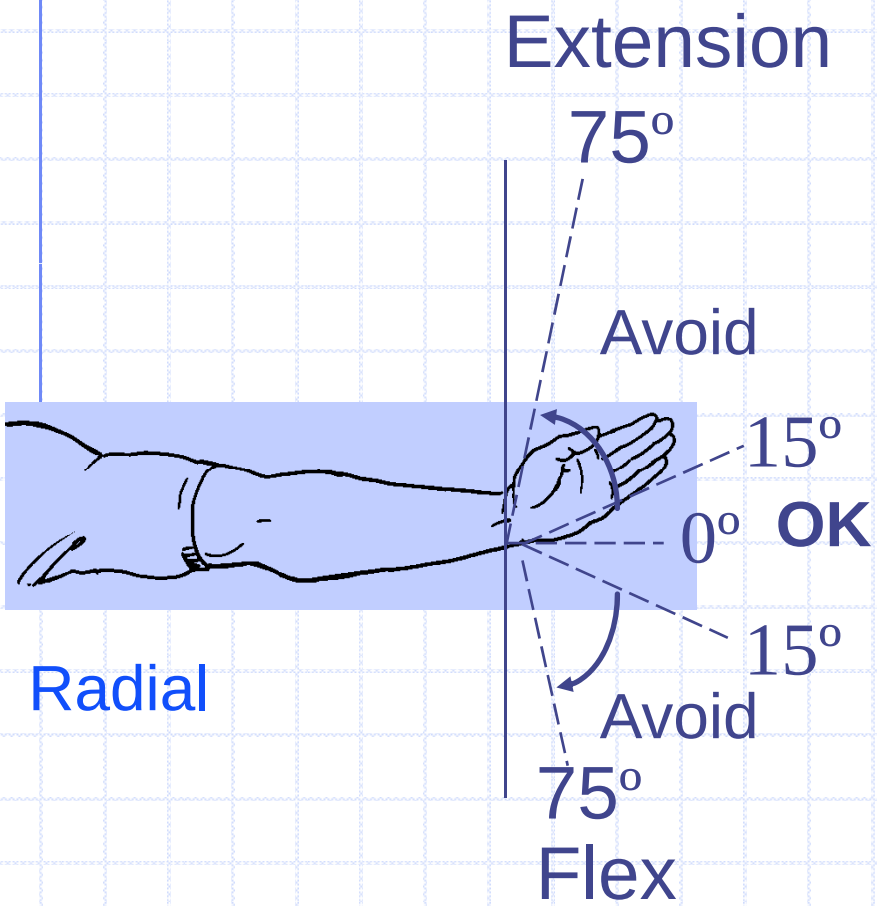
power grip

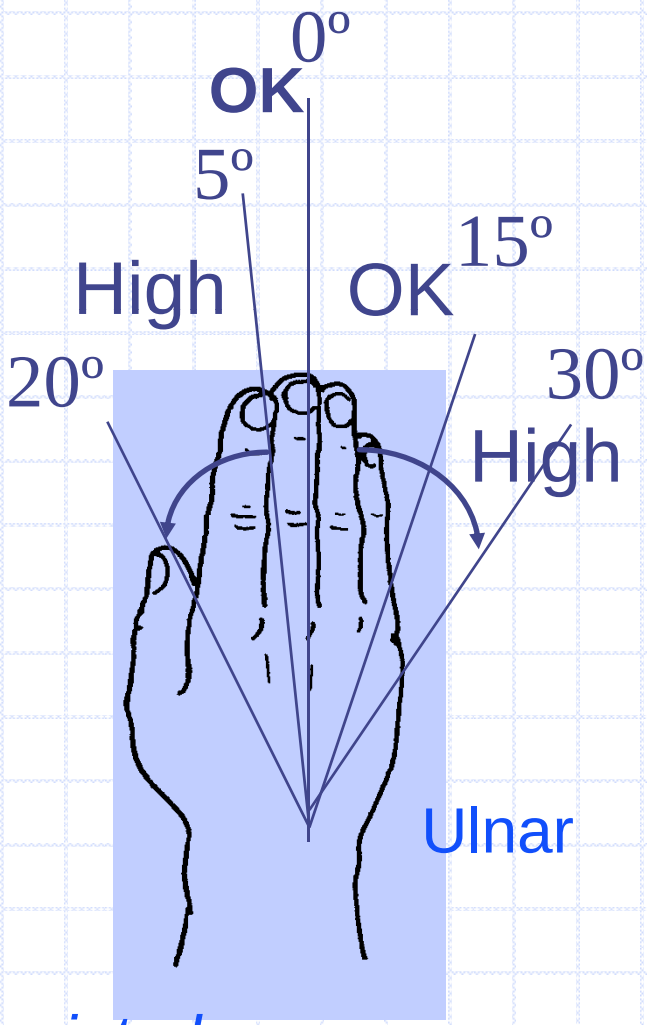
# Wrist Flexion & Extension




- *Look for wrist fully deviated.*

# Wrist Radial & Ulnar Deviation



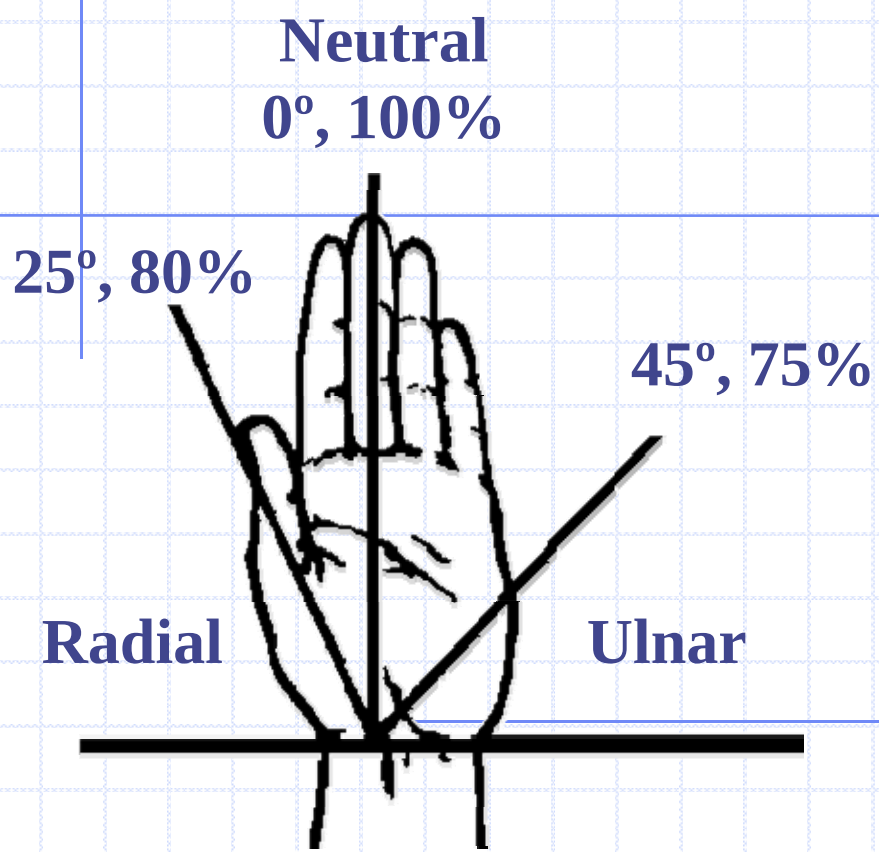



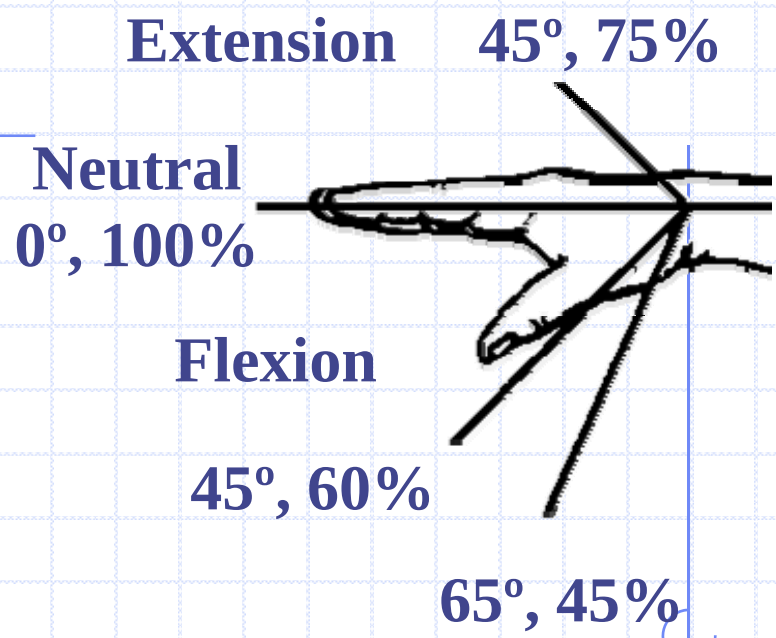

- *Look for wrist fully deviated.*

# Pinch Grip Force - Risk Level

| Total Counts Per Day | Force (lbs, kg) | | | | | |
|---|---|---|---|---|---|---|
| | High | | Mod | | Low | |
| 1–10 | >20 lbs | >9.0 kg | 17–20 lbs | 7–9 kg | 12–16 lbs | 5.5–7.2 kg |
| 11–100 | >10 lbs | >4.5 kg | 9–10 lbs | 4–4.5 kg | 6–8 lbs | 2.7–3.6 kg |
| 101–500 | >6 lbs | >3.0 kg | 5.1–6 lbs | 2.3–2.7 kg | 3.5–5 lbs | 1.6–2.3 kg |
| 501–2000 | >4 lbs | >2.0 kg | 3.3–4 lbs | 1.5–1.8 kg | 2.5–3.2 lbs | 1.1–1.5 kg |
| 2001–5000 | >3 lbs | >1.3 kg | 2.6–3 lbs | 1.2–1.4 kg | 1.7–2.5 lbs | 0.8–1.1 kg |

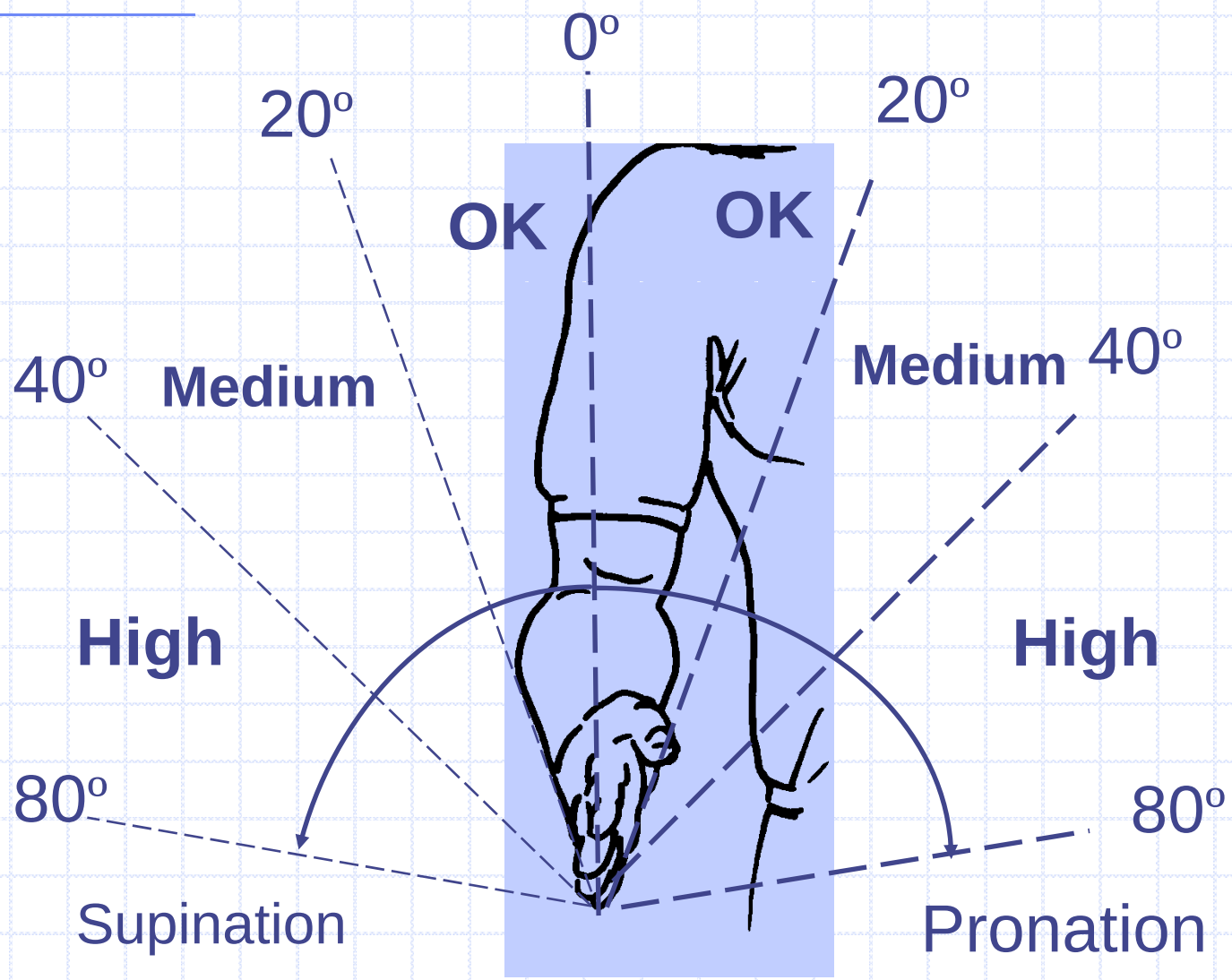
# Wrist Radial & Ulnar Deviation - Wrist Posture versus Grip Strength



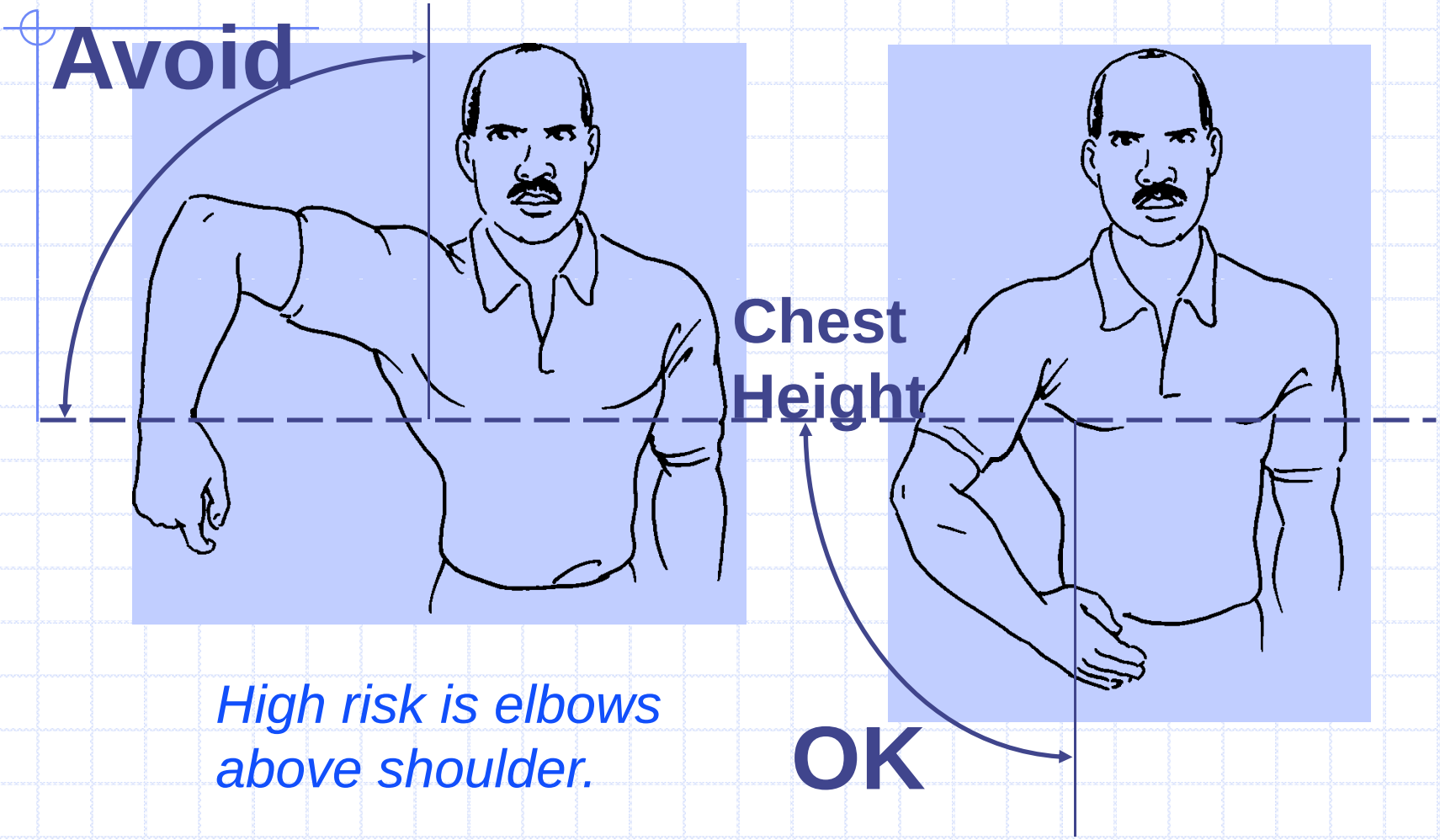



# Forearm Rotation

- *Look for palms "up".*

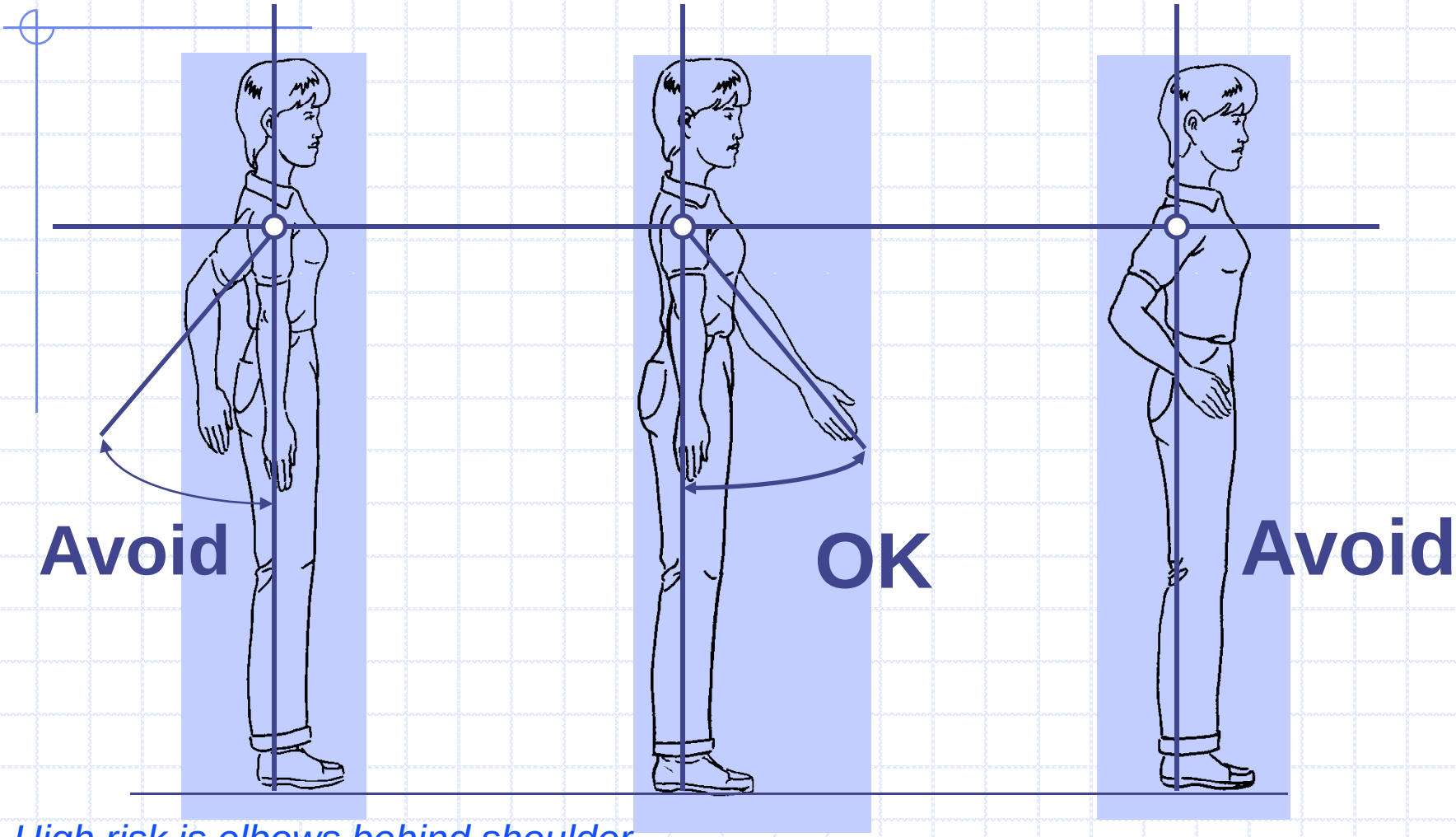


# Elbow Height



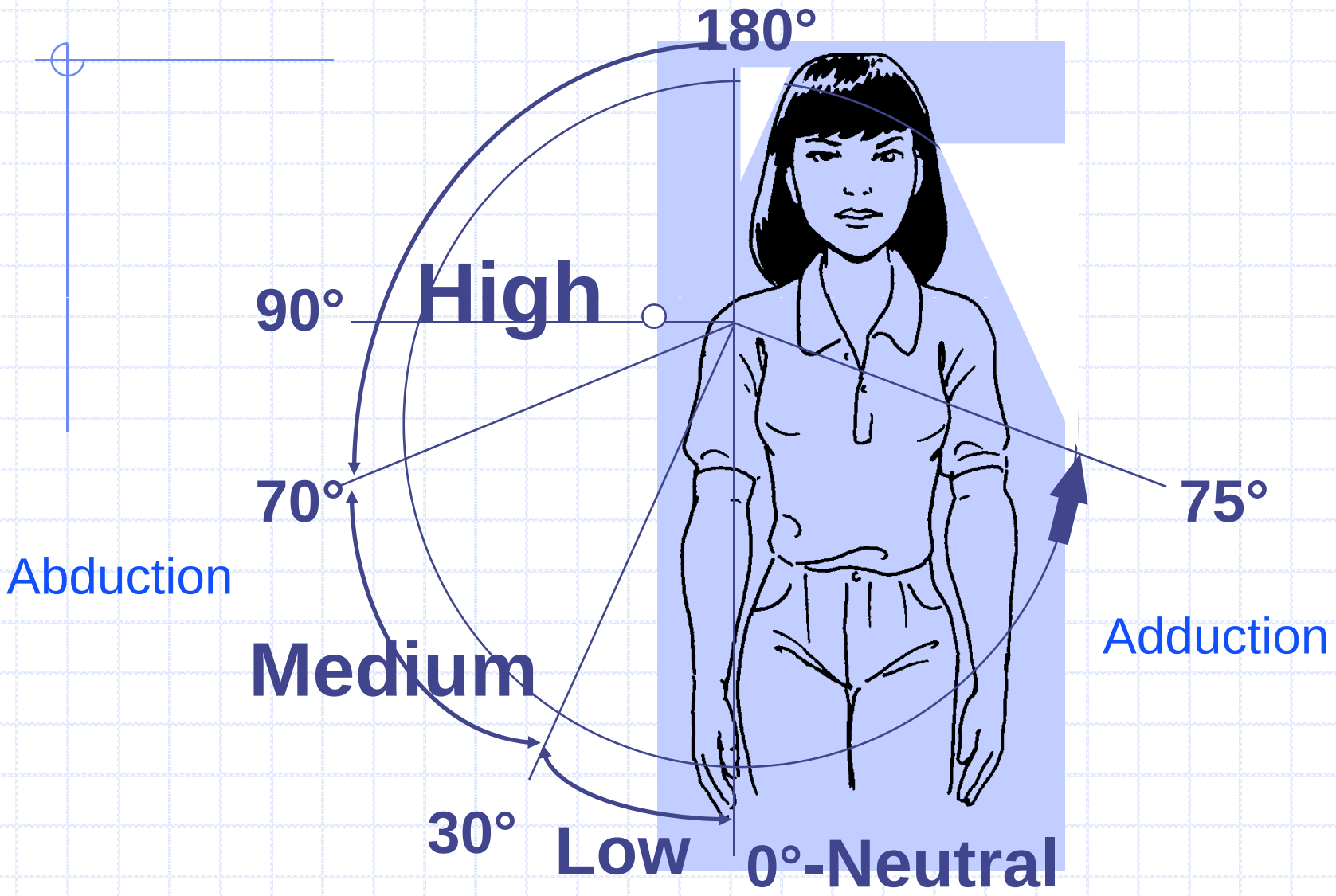

*High risk is elbows above shoulder.*

# Shoulder Posture - Flexion

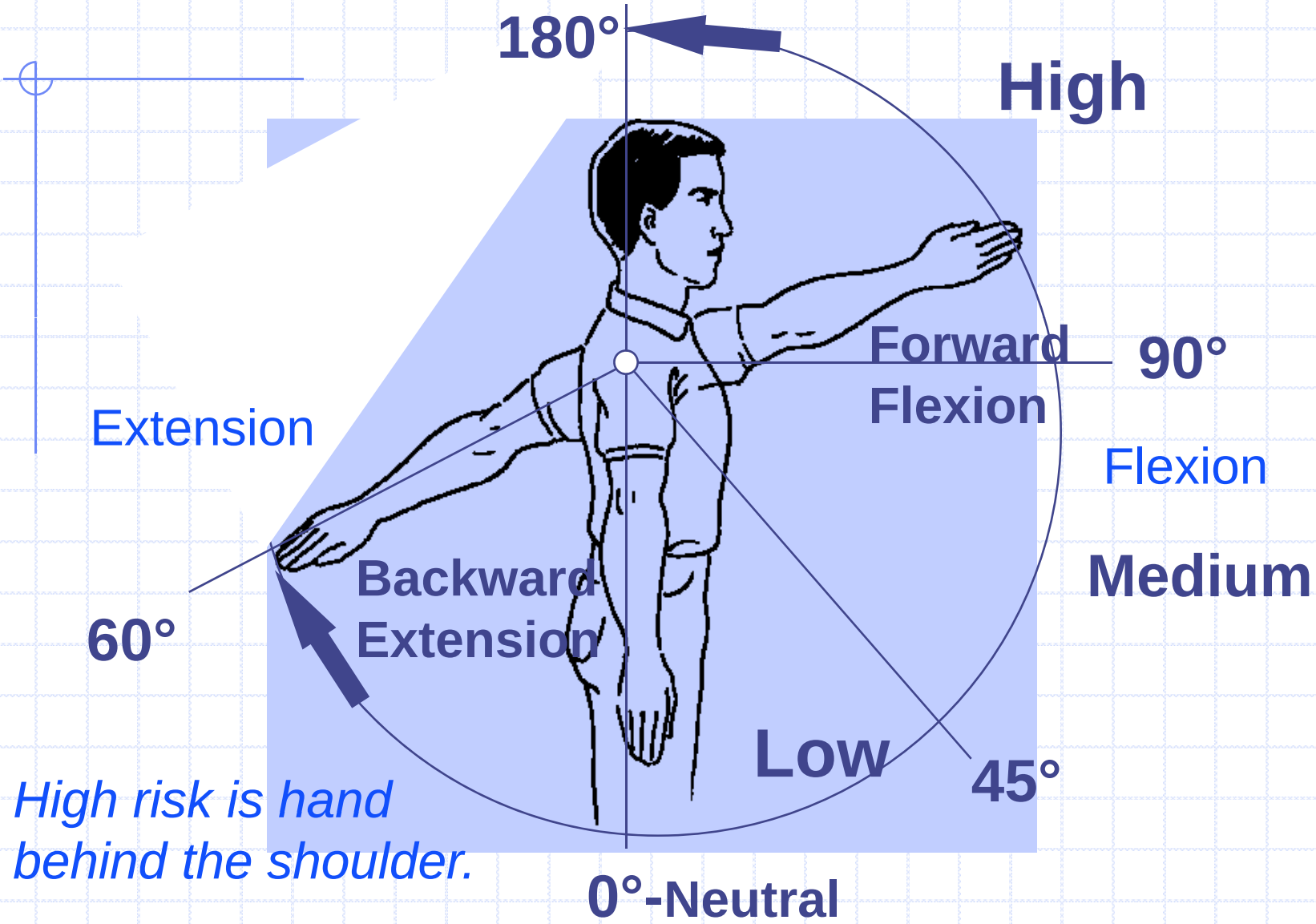



*High risk is elbows behind shoulder.*

# Shoulder Posture

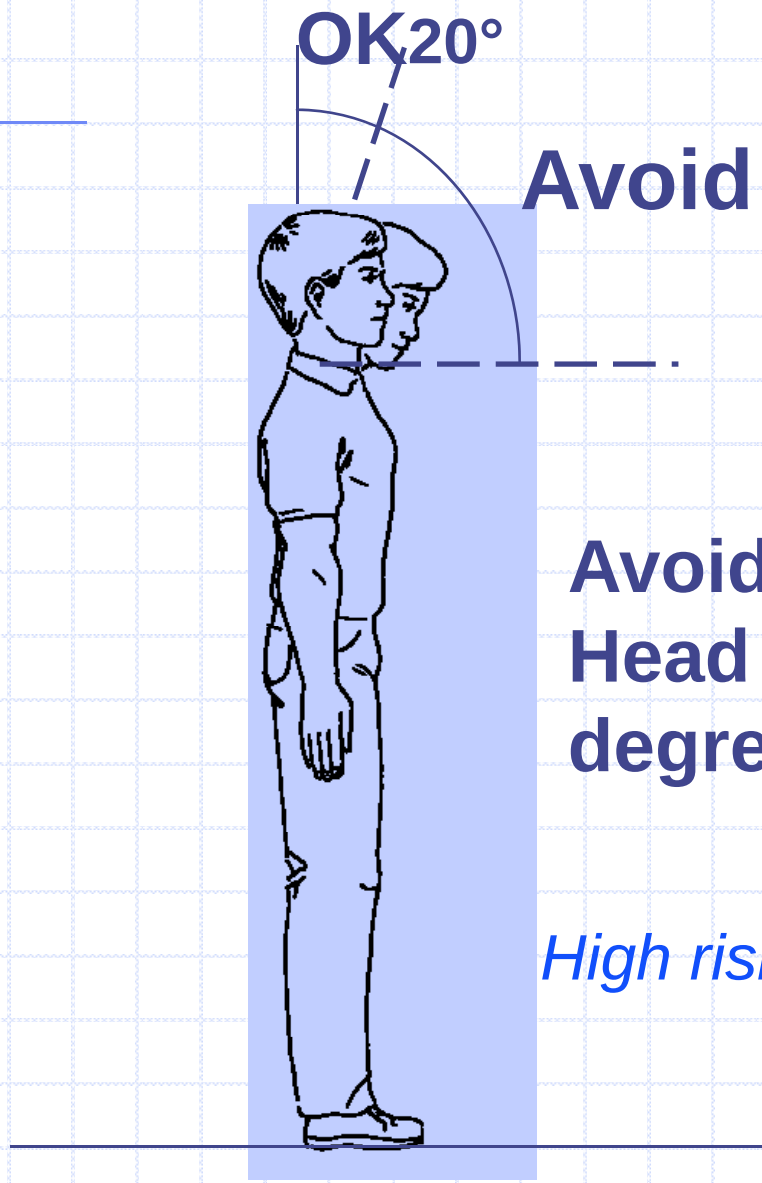


# Shoulder Postures




*High risk is hand behind the shoulder.*

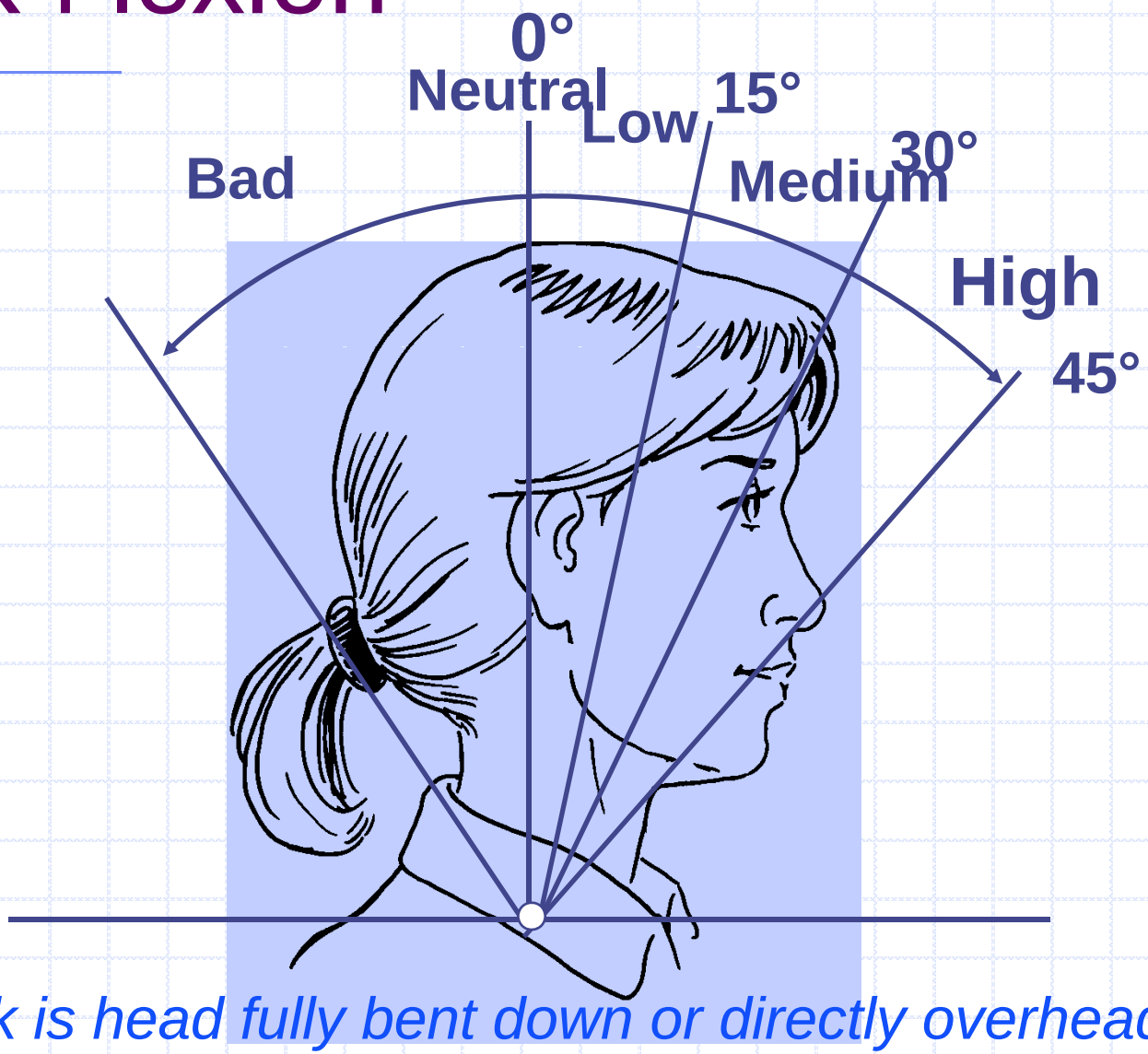
# Neck Flexion/Extension




**Avoid Tilting the Head More Than 20 degrees**

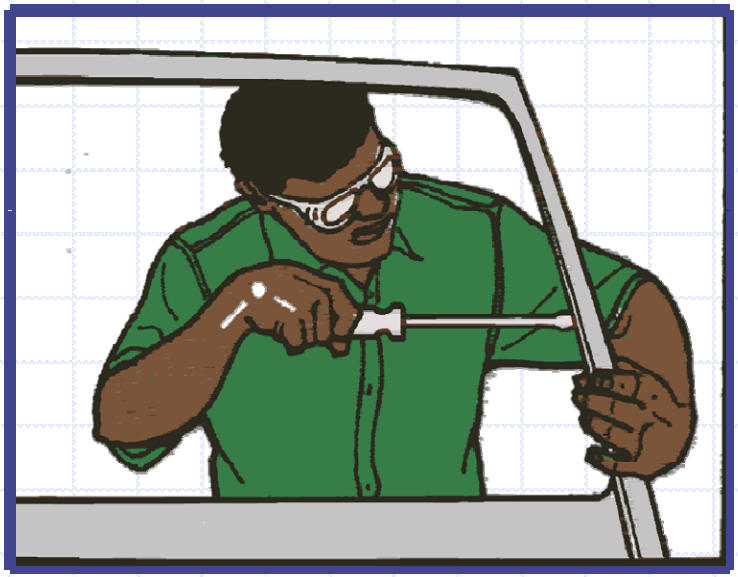
*High risk is head fully bent down.*

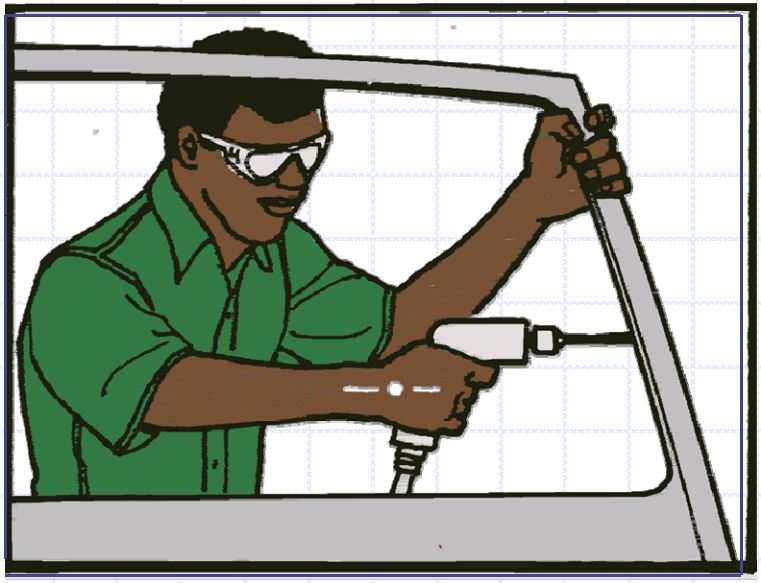
# Neck Flexion




*High risk is head fully bent down or directly overhead.*

# Posture - Before & After





pistol handle grip before & after

*"The UAW-Ford Ergonomics Process"; UAW-Ford Joint Committee ©1990

# Posture - Before & After

handle grip before & after pistol grip and tool balancer

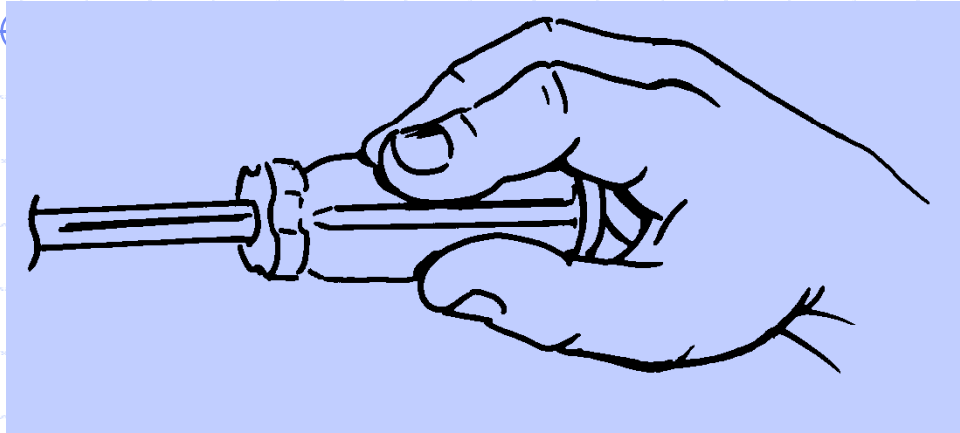
*"The UAW-Ford Ergonomics Process"; UAW-Ford Joint Committee ©1990

# Posture - Before & After

pistol handle grip before & after

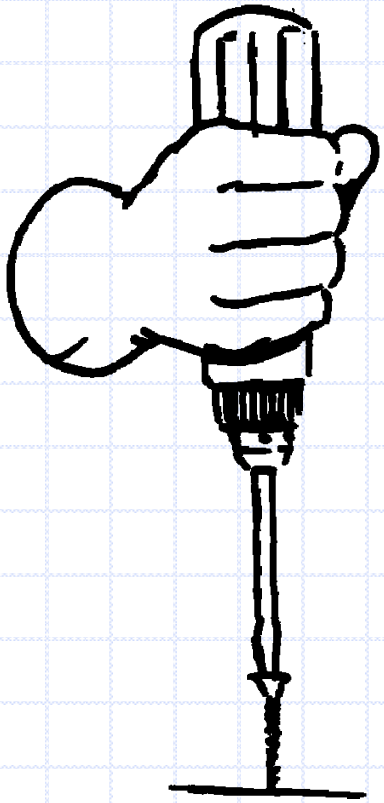
*"The UAW-Ford Ergonomics Process"; UAW-Ford Joint Committee ©1990

# Posture - Before & After



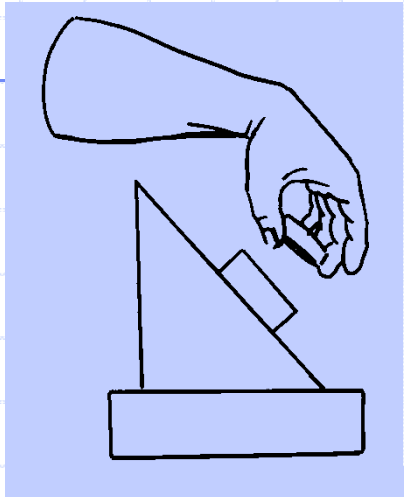
*Before - pinch grip*

screw driver grip

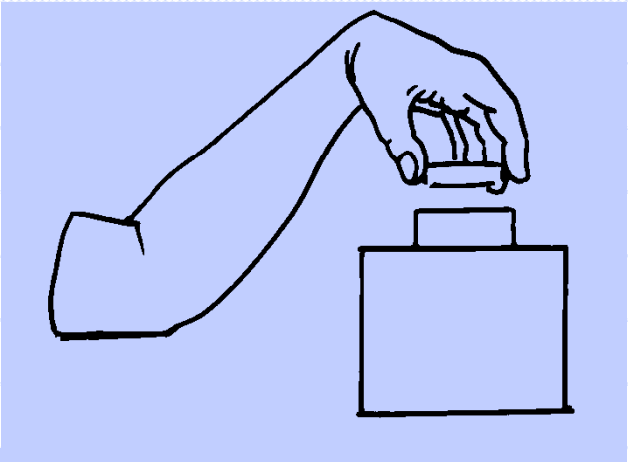


*After - power grip = better*
*Discuss best!*

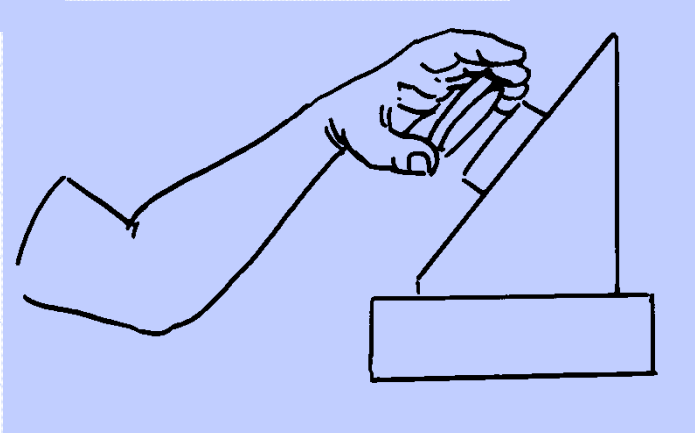
# Posture - Before & After



*Before*



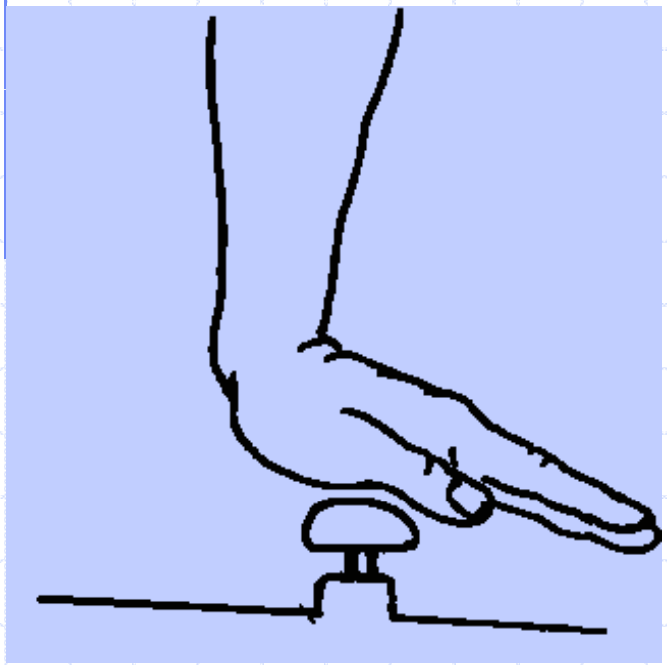
*Before*



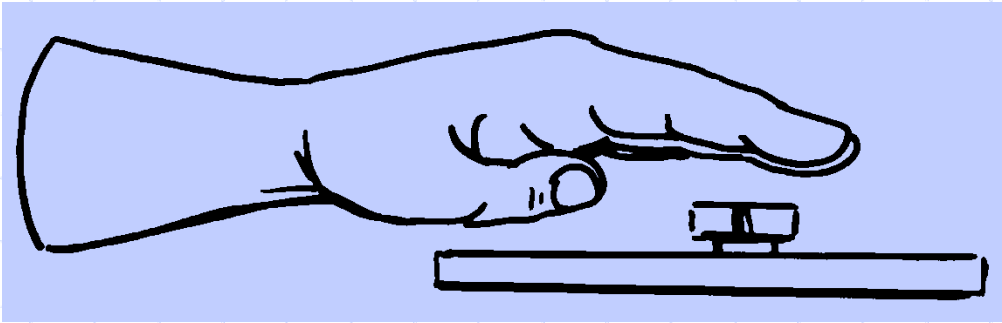
*After*

Jigs should be located and oriented so that parts can be assembled without flexing the wrist or limiting visual contact

# Posture - Before & After

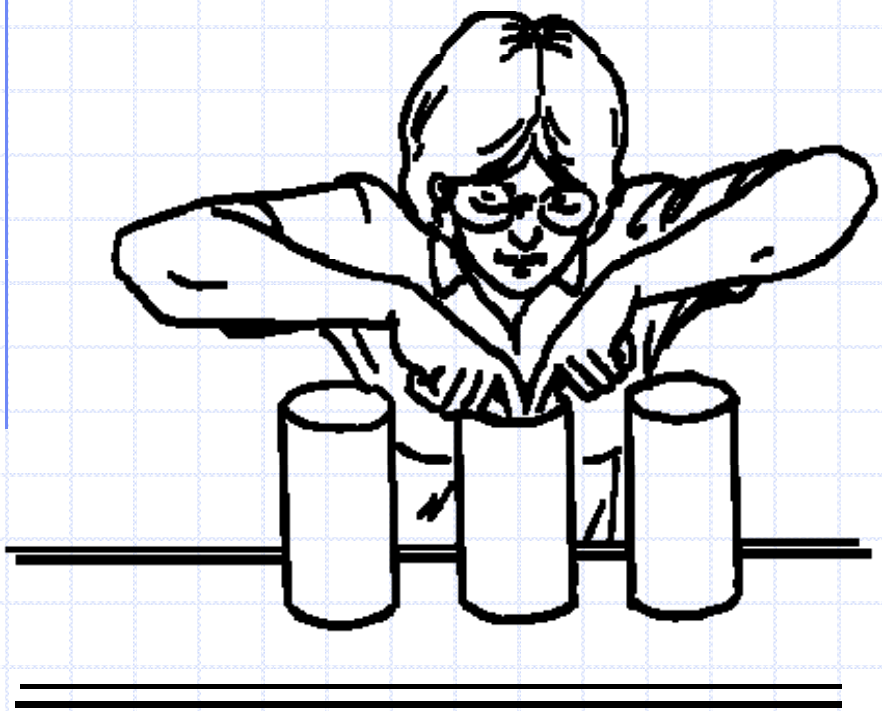


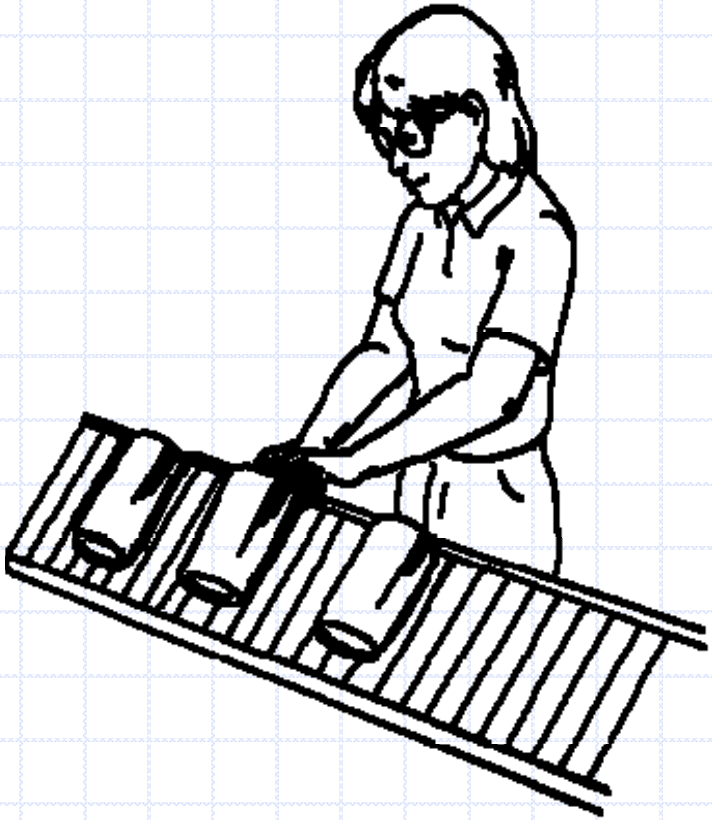
*Before*



*After*

# Posture - Before & After

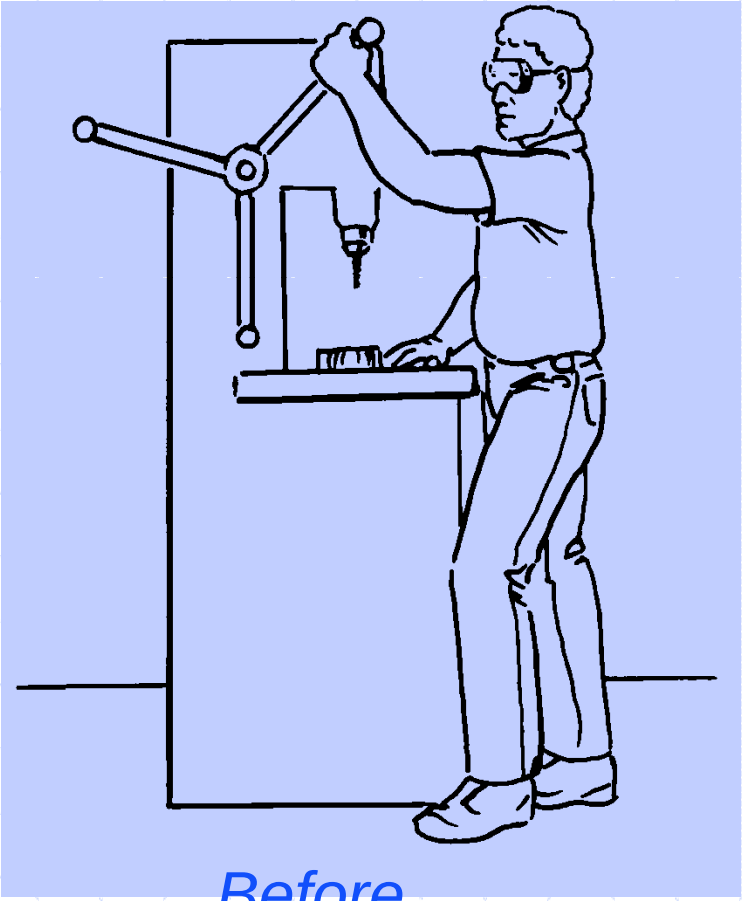




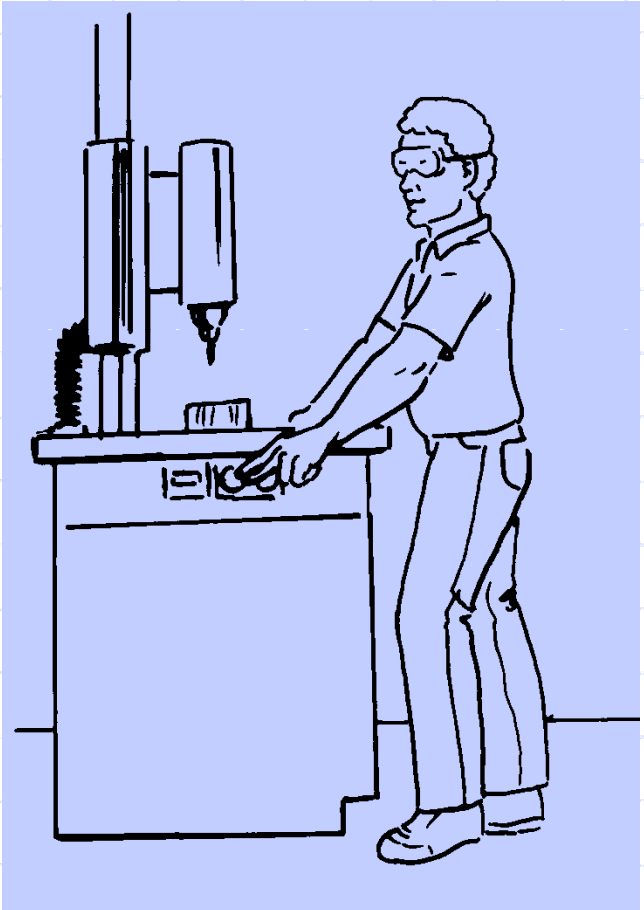
*Before* *After*

**Shoulder Abduction**

# Posture - Before & After



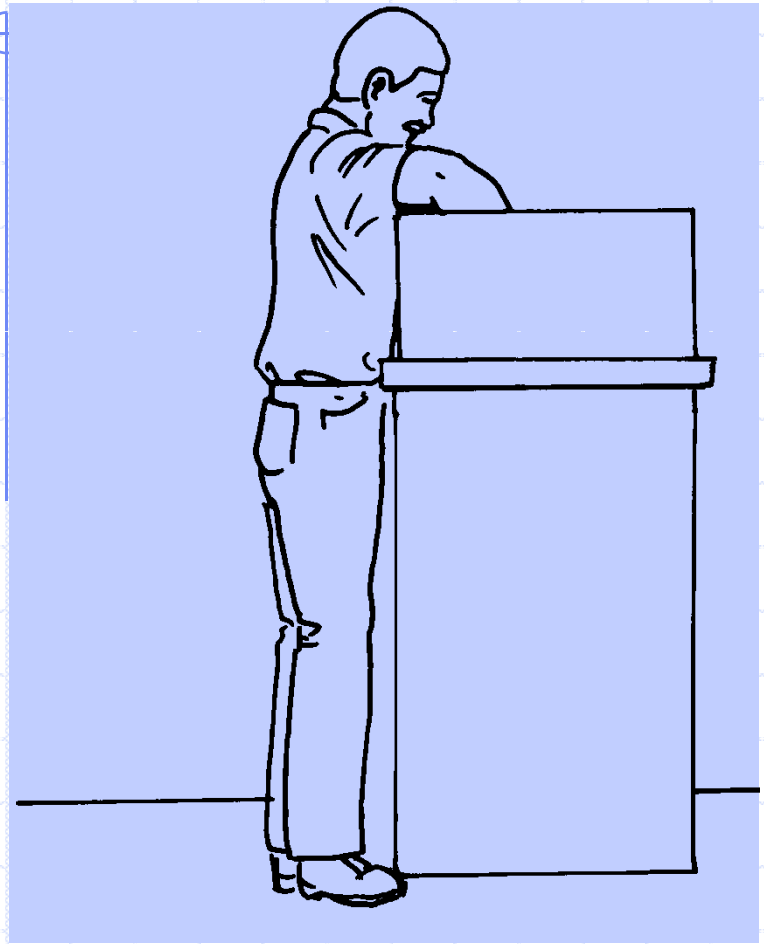
*Before*

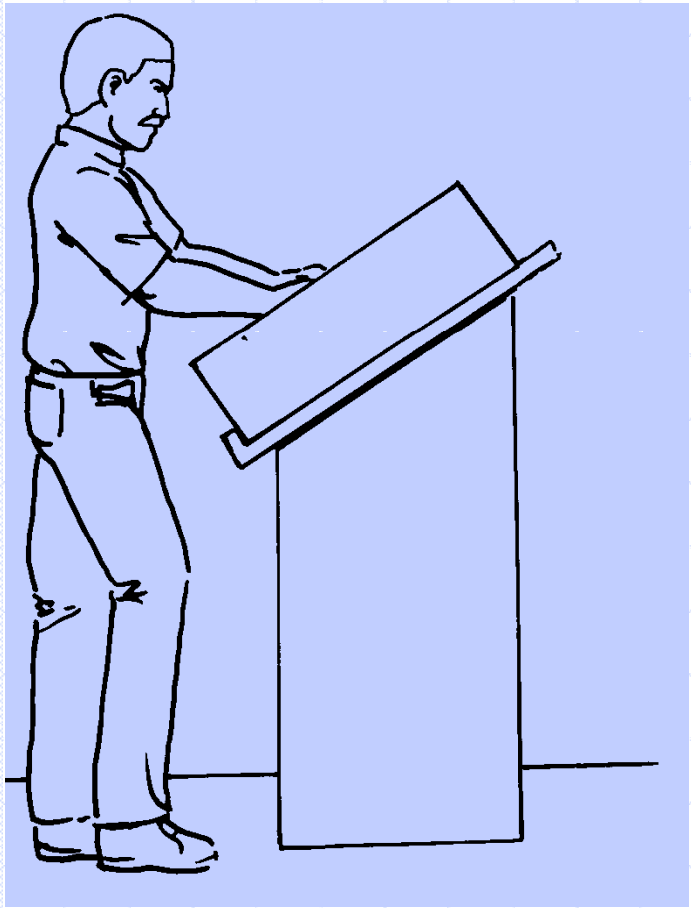


*After*

**Shoulder**

# Posture - Before & After





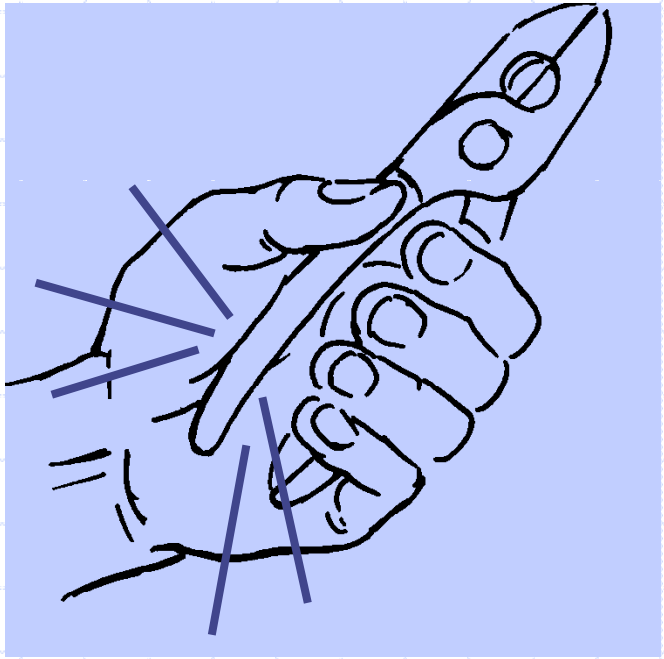
*Before* **Shoulder** *After*

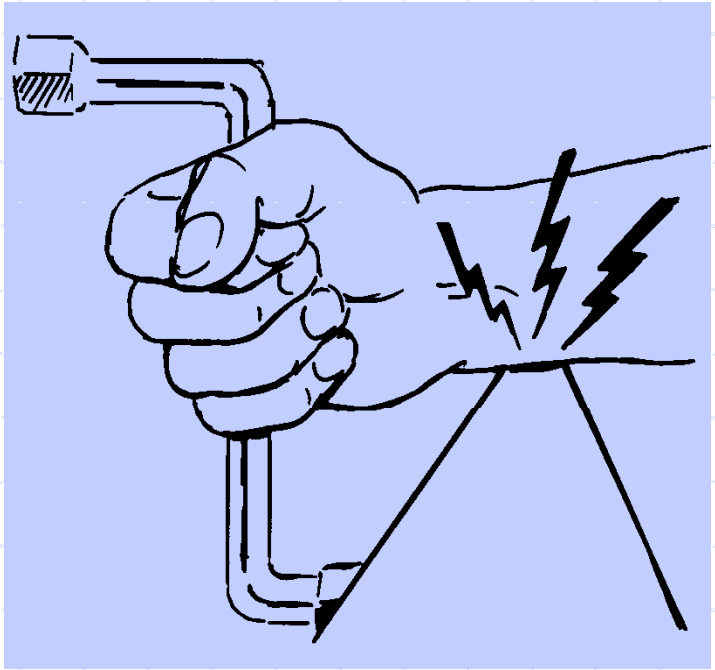
# Upper Extremities Prevention Principles

## Pressure

- Eliminate body contact with sharp edges and corners which concentrate pressure on body tissue
- Eliminate handles made of hard, cold materials
- Avoid form fitting handles

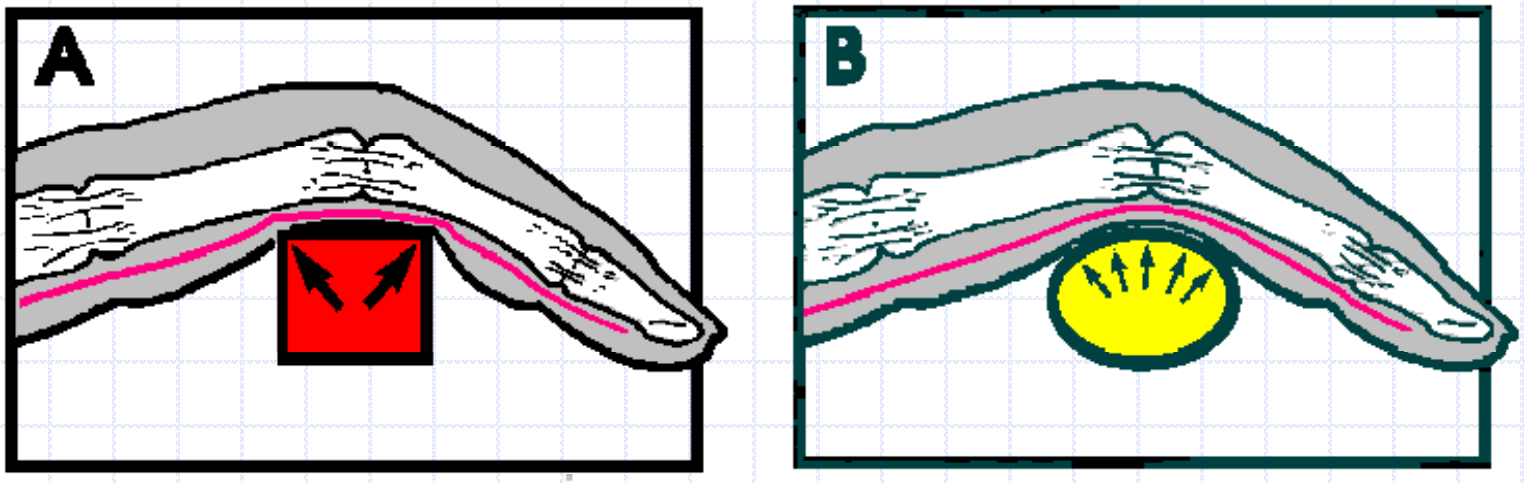
# Pressure





Eliminate direct pressure on the body

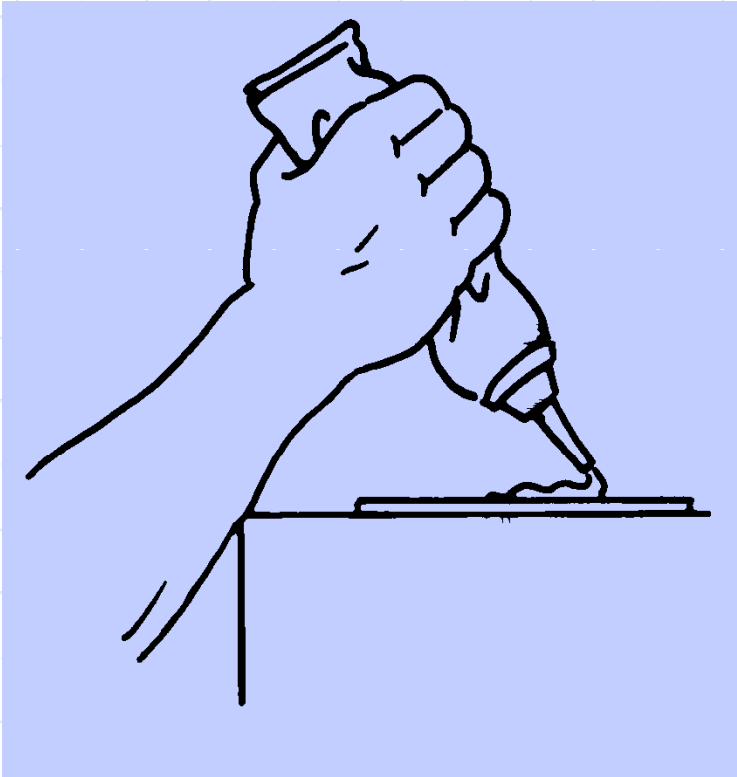
# Pressure



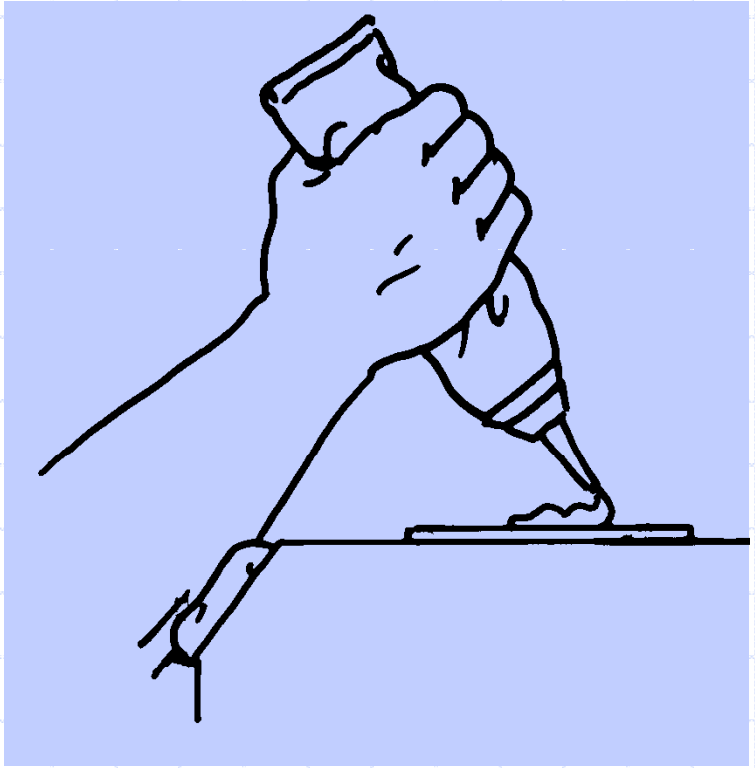

Eliminate handles with sharp edges and corners which press on small joints

*"The UAW Ford Ergonomics Process"; UAW Ford Joint Committee ©1990

# Pressure



**Bad**



**Better - Discuss Best!**

# Upper Extremity Prevention Principles

## Vibration

- **Isolate vibration by dampening tools or use gloves**
- **Power tools may reduce other risk factors but they may create vibration.**
- **Remember to:**
  - Isolate the vibration
  - Provide tools with internal torque control (reduce torque shock)
  - Fixture the tool
  - Triggering should be easy (trigger finger)

# Upper Extremity Prevention Principles

Temperature

- Insulate grip on cold tools
- Isolate associates from temperature extremes
- Wrist/arm covering

# Break for Questions before moving to Back Injury Prevention

# Back Injury Prevention

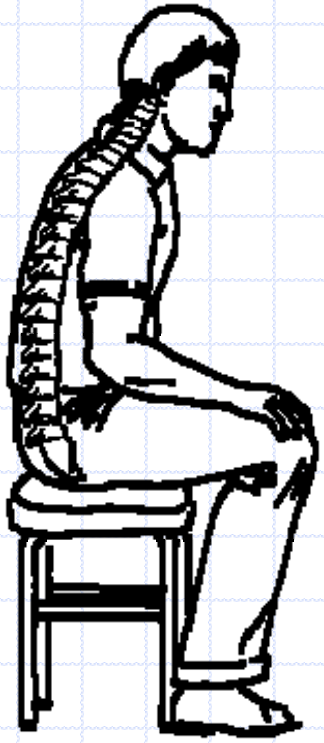
- “BACK”GROUND
- Back Injuries
- Warning Signs
- Back Injury Prevention Principles

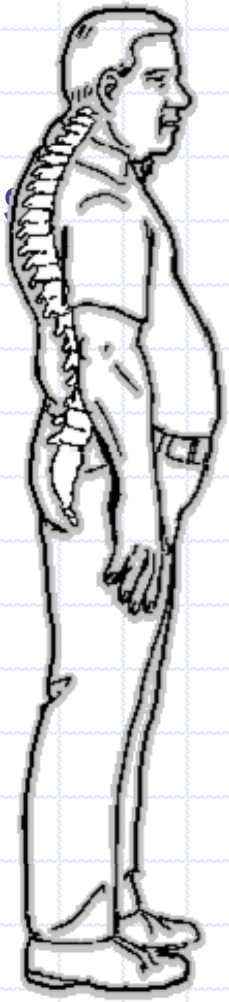
# Causes of Back Injury

- Poor Body Posture and Manual Material Handling Techniques
- Decline of Physical Fitness & Flexibility
- Degenerative Changes (Age)
- Stressful Living and Working Conditions
- Slips and Falls, Accidents
- Unaccustomed Activities

# Poor Back Postures

- **Over-Accentuated Curve (Hyperlordosis)**
  - Reaching overhead
  - Viewing object too high
- **Flatback (no curve)**
  - sitting (loose curve)
  - viewing object too low
  - extended reaching
- **Forward head**
- **Poor or static sitting**
  - Unsupported sitting
- **Poor or static standing**
  - hard floor

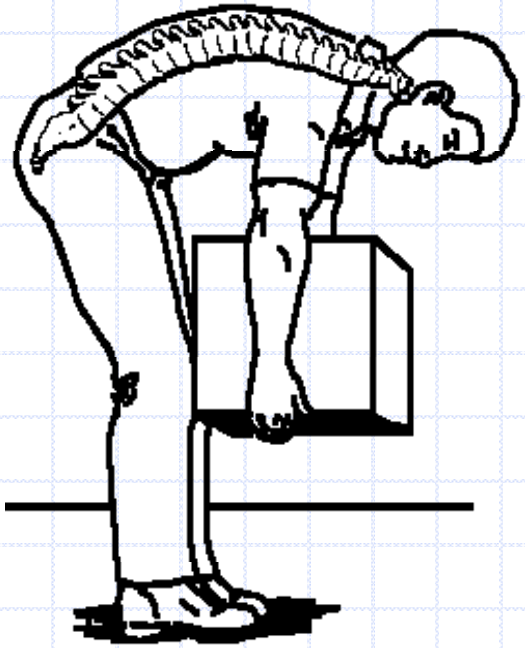


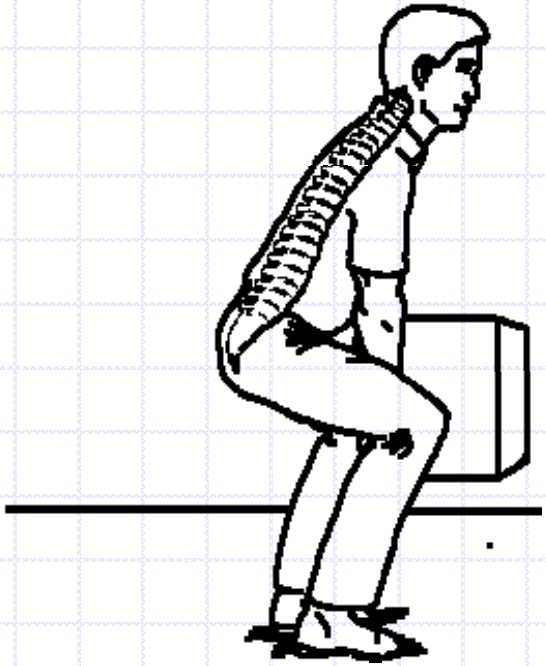


# Poor Body Mechanics

Reaching, lifting, carrying, pushing/pulling lowering loads plus:

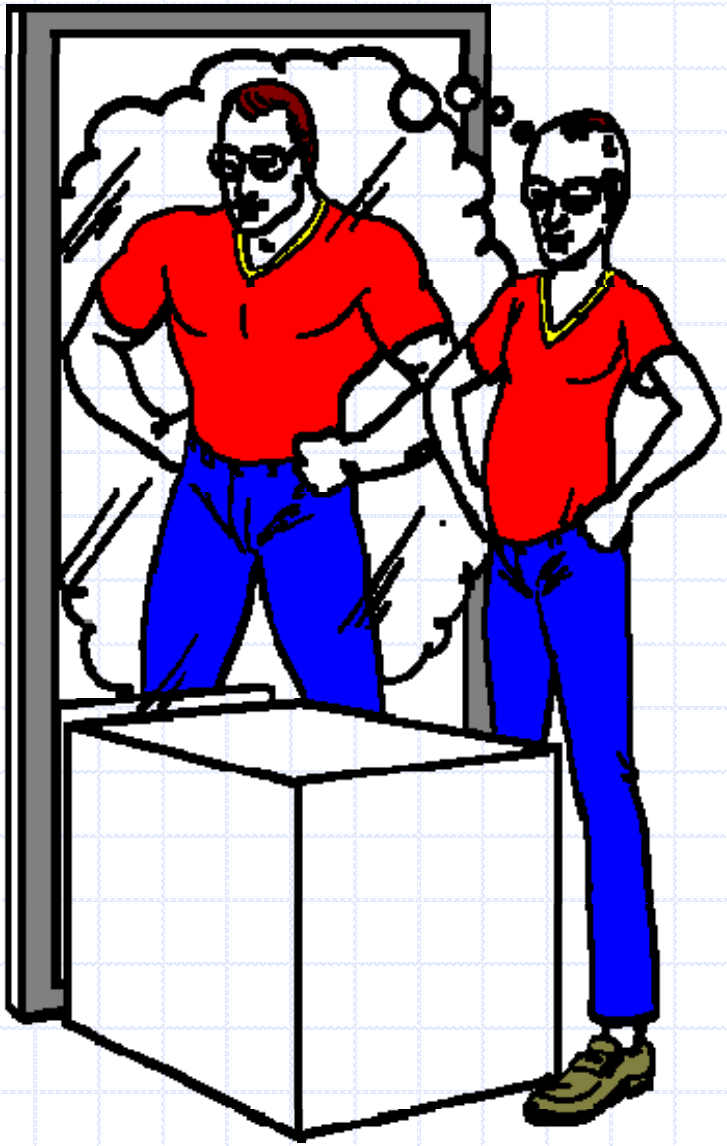
- Poor Posture
- Handling excessive weight
- Load not evenly distributed
- May be the result of poor workstation or habits





# Decline of Physical Fitness & Flexibility

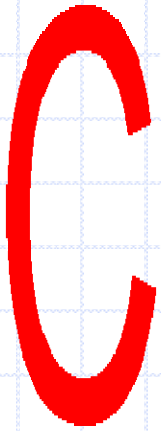
- People in poor condition are more vulnerable to back injuries
- Muscle fitness is needed for balance and coordinated movement
- Imbalance occurs when people compensate for pain
- Leg weakness may contribute to poor MMH (Manual Material Handling)
- Excessive weight
- People physically fit require less % of their total body strength to perform a task than an unfit person



# Degenerative Changes

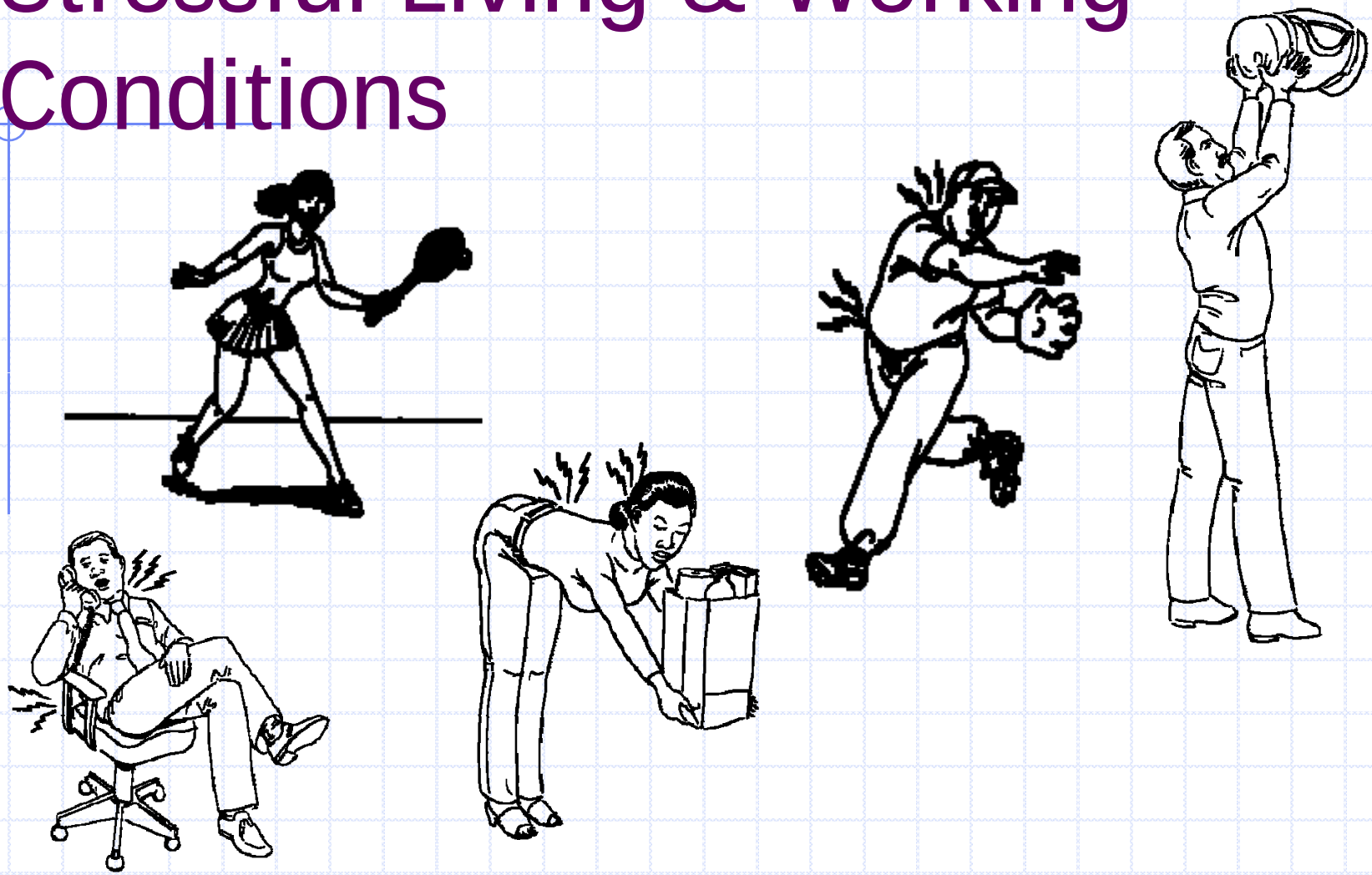
- Can be related to joint disease commonly of the L5/S1 disks
- Will begin to occur in 60% of people 50 years and older

Spine of young adult



Spine of an older adult

# Stressful Living & Working Conditions



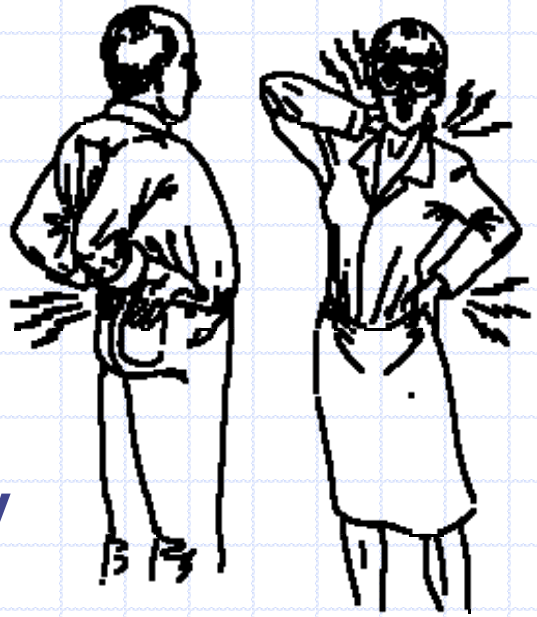
Your Back is Always Working

# Slips, Trips and Falls (Accidents)

# Physical Warning Signs

- Persistent Pain
- Soreness
- Stiffness
- Cramping
- Swelling
- Restricted Movement
- Inflammation

**If these are ignored, unreported or untreated, they may lead to:**



- lost function
- permanent damage
- surgery

# Behavioral Warning Signs

# Behavioral Warning Signs

- Rubbing
- Using altered work methods or substitute movements (e.g. moving object from the floor with the foot rather than bending forward to move it with the hands)
- Using a hand to support the body when reaching or bending to retrieve items below knee level
- Stiff, slow movements or hesitation to perform a movement

# Behavioral Warning Signs

- Frequent shifting of body weight
- Frequent changing of position (e.g. sitting to standing, or vice versa)
- Facial grimacing with movement
- Frequent breaks and/or absences

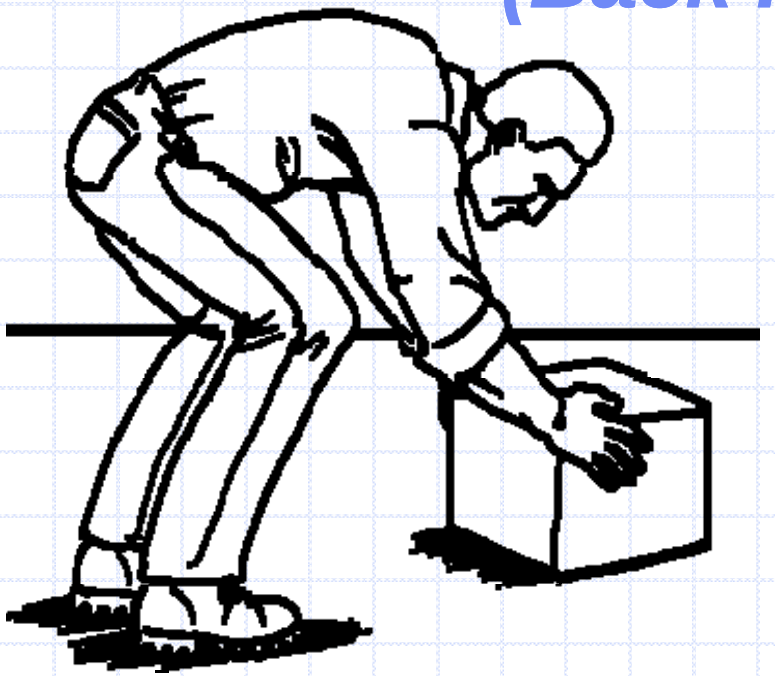
# Back Injury Prevention Principles

## *Risk Factors*

- Repetition
- Posture
- Load
- MMH (Manual Material Handling)
- Twisting
- Personal (strength, conditioning, flexibility
- Work & Living Habits

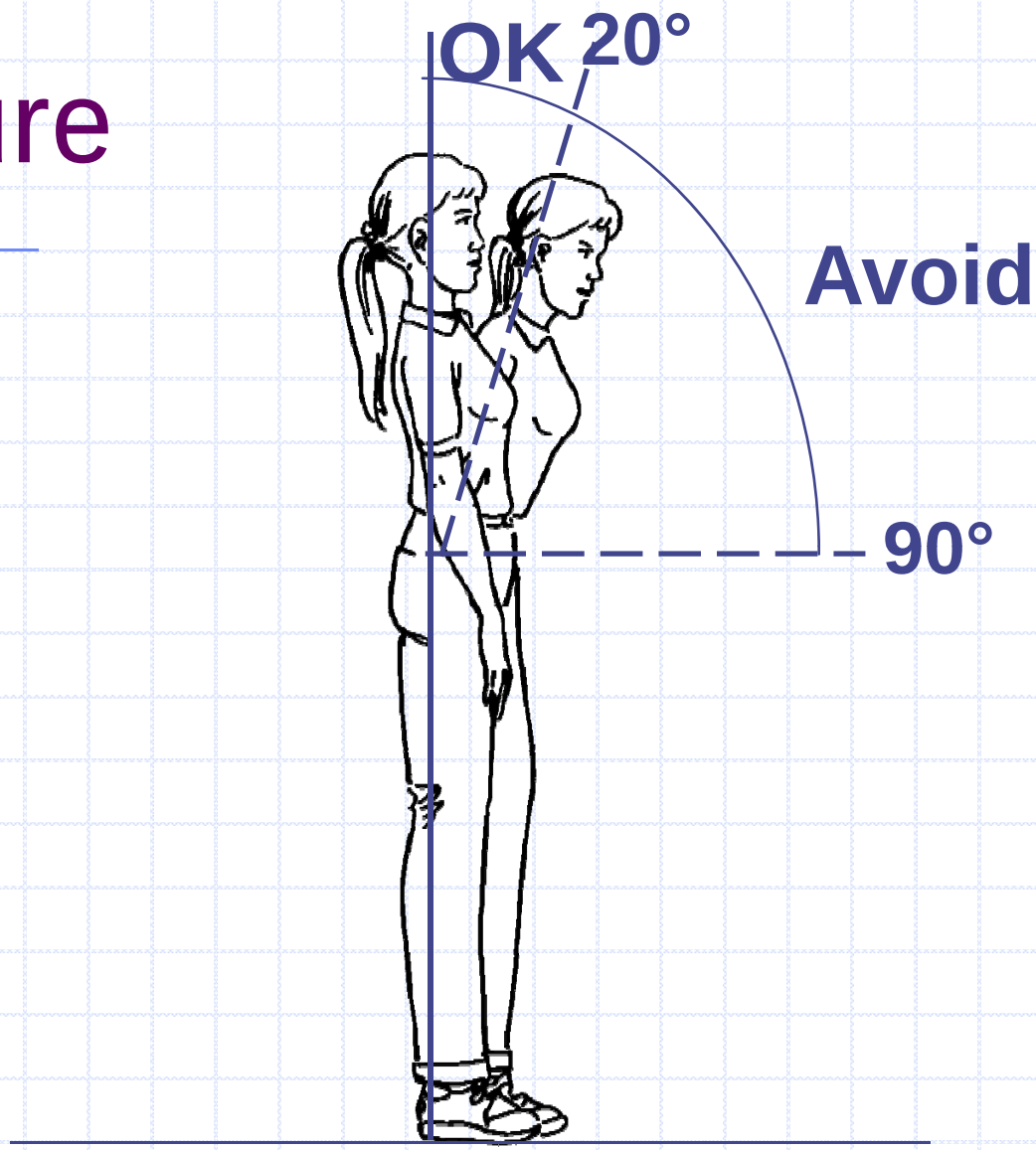
# Lower Extremity Prevention Principles

***(Back Risk Factors)***



Repetition = the # of times you bend your back

# Posture




Avoid tilting the upper body more than 20 degrees

# Manual Material Handling

Load (Object)

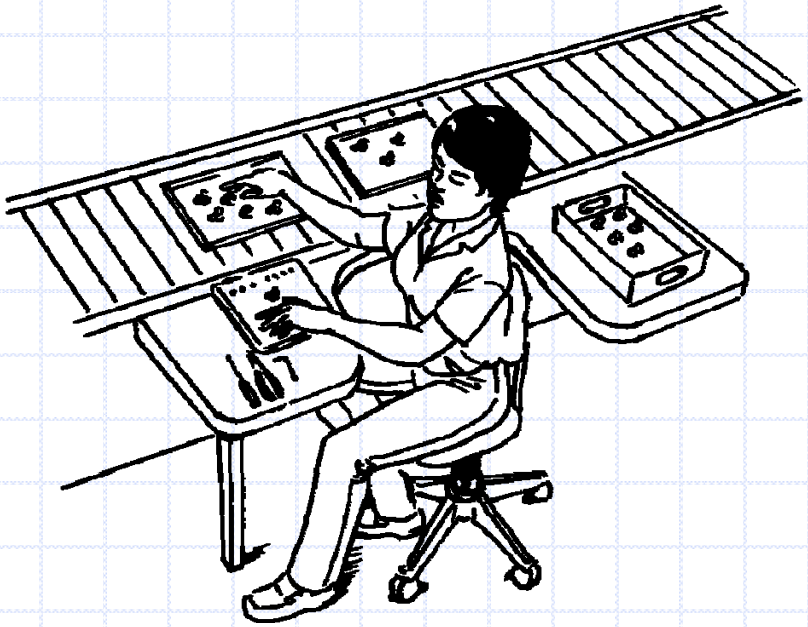
- Size, Shape
- Volume
- Weight
- Handles, sharp edges
- Stability of load

# Manual Material Handling

Handling Methods

- Reaching
- Bending
- Pushing vs Pulling
- Twisting
- Lifting

# Reaching



- Before
  - Minimize reach distances
- After

# Reaching

## Try not to reach above your shoulders

High reaching can strain your back & shoulders

- Reach only as high as your shoulders
- Use a stool or stepladder if you need to reach higher
- Test the weight of the load by pulling up on a corner before lifting. If it seems too heavy, GET HELP!

# Reaching - Before & After

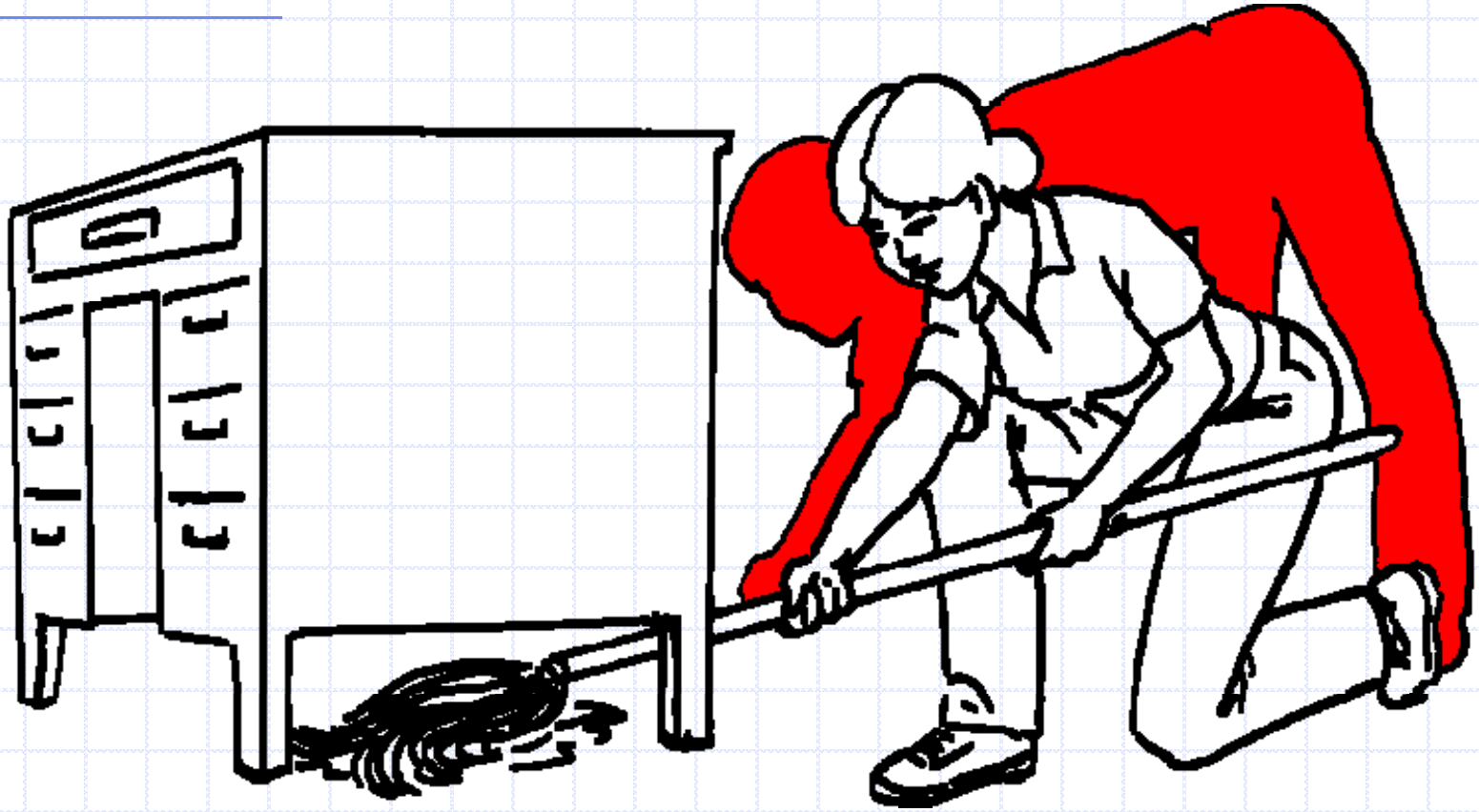
# Bending

## Don’t bend way over from your waist

When bending down to reach or lift, move your whole body to protect your back

- Bend your knees and hips, not your back
- Kneel down on one knee, if necessary
- Get as close to the object as you can, so you won’t have to reach with your arms
- If the object is too large to lift comfortably - GET HELP!

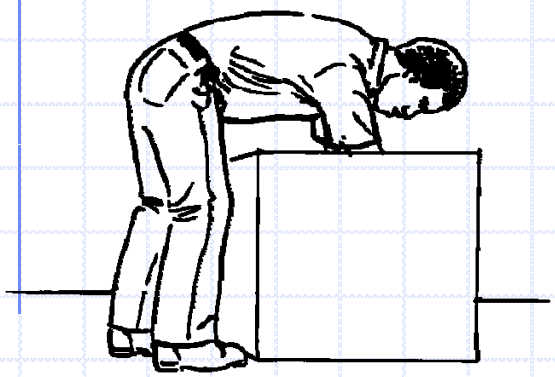
# Bending - Before & After



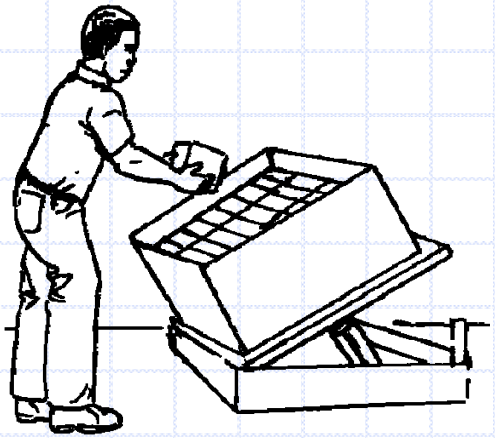
# Bending

## Design for Neutral Posture

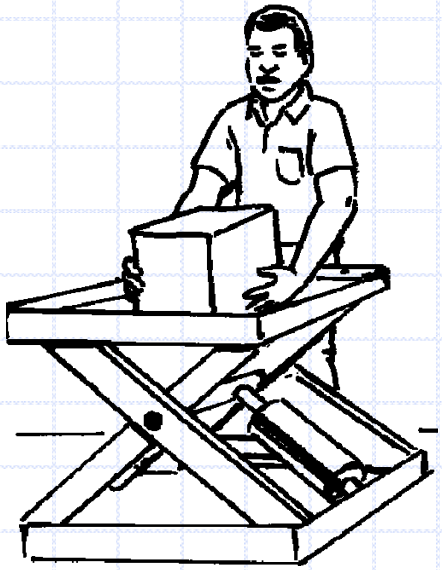
- Poor



- Improved



Power Tilter



Adjustable-height "Scissors Lift"

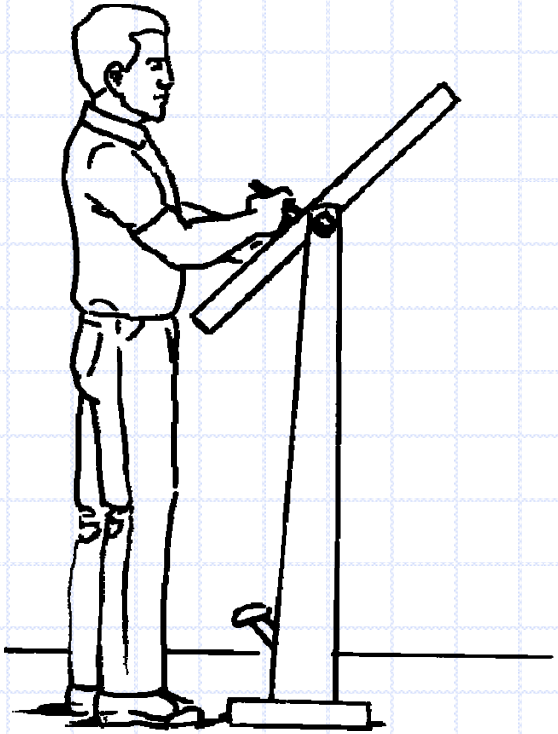
Avoid bending over continually

# Bending

## Design for Neutral Posture

Poor

Improved



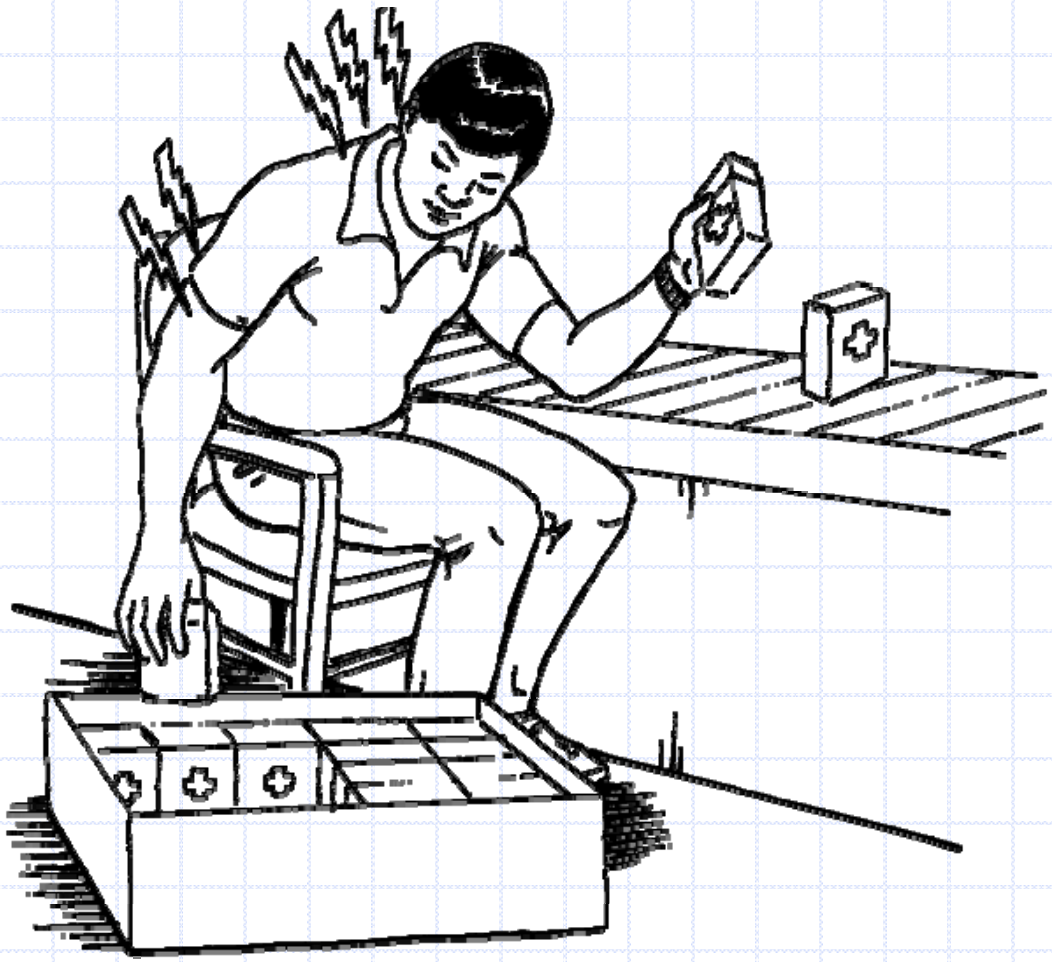
# Twisting

Twisting greatly increases your chances for injury.

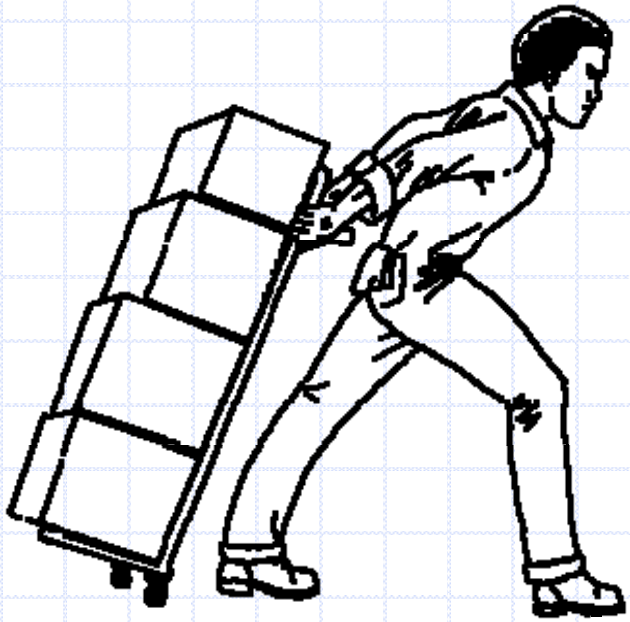
- Reposition the feet rather than twisting the body
- Get close to the object, you may need to kneel down on one knee
- Position yourself so you're stable
- Use your arms and legs to do the work - not just your back

# Twisting

Don’t twist your back



# Pushing



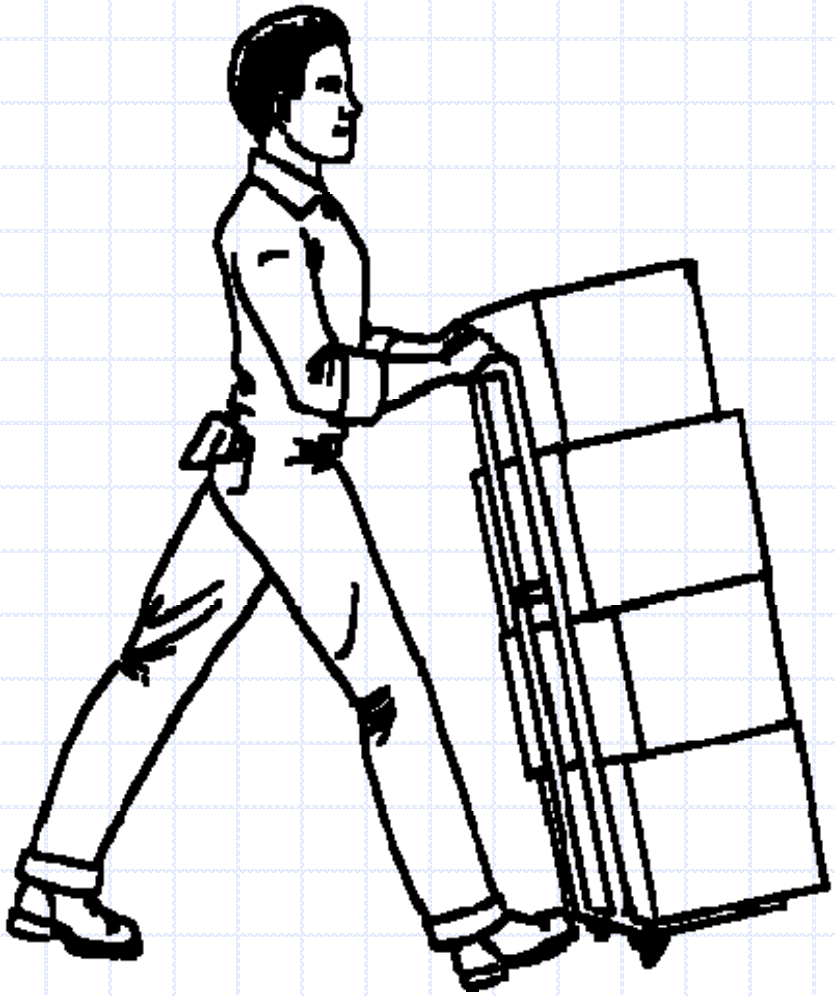
***Don't pull***

Pulling large objects can be as hard on your back as lifting. Instead, be sure to push.

- Stay close to the load, without leaning forward
- Tighten your stomach muscles as you push
- Push with both arms, keeping your elbows bent

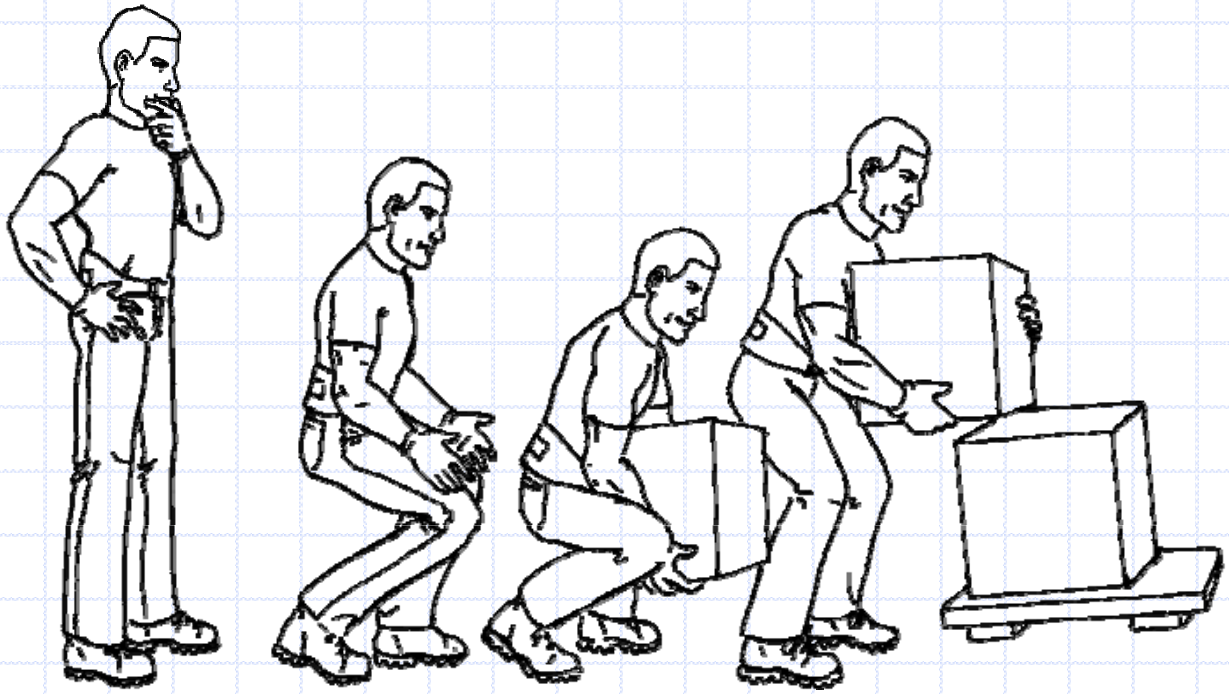
# Pushing

***Push it***



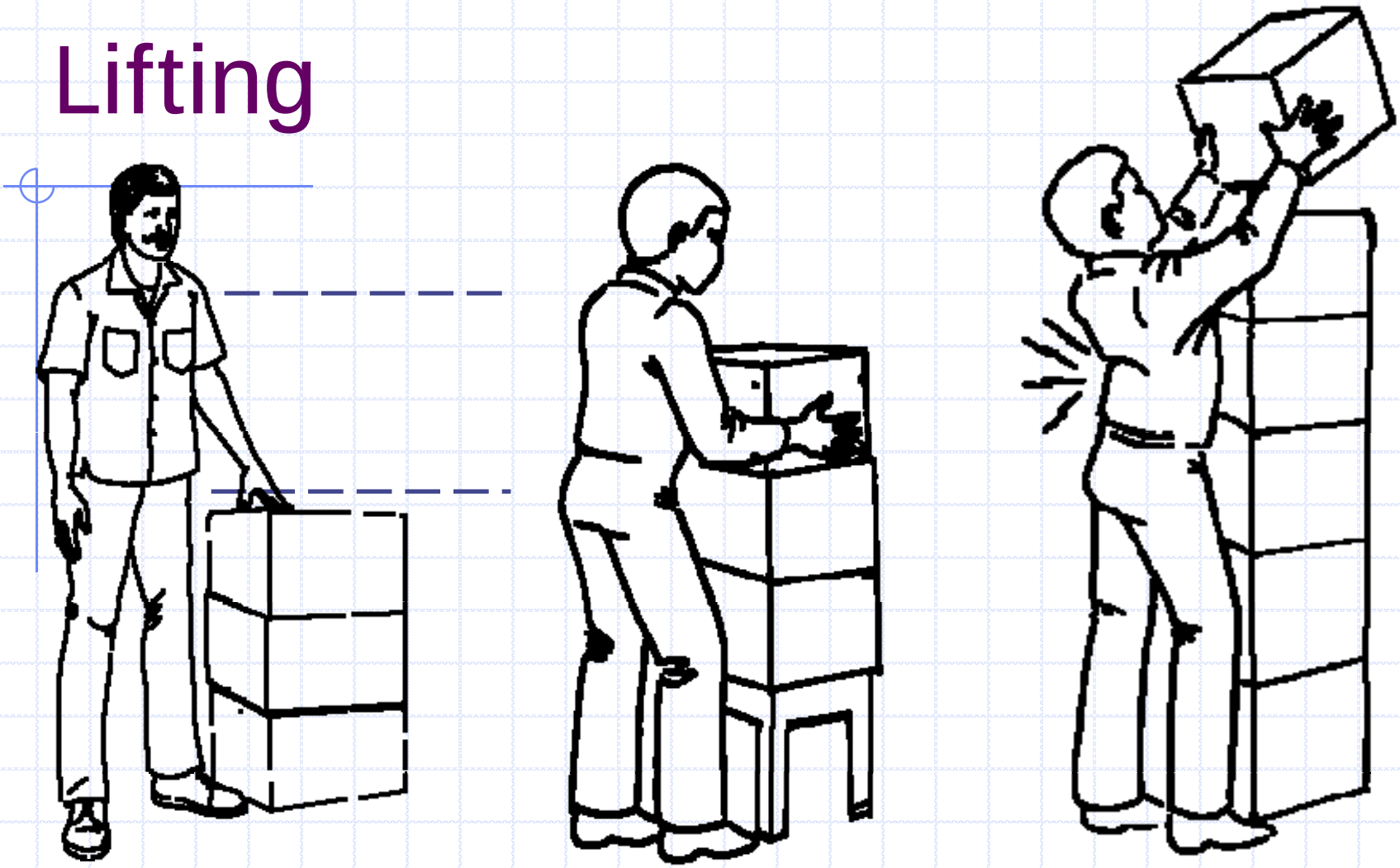
Be sure that you can see over the top

# Lifting Techniques



- Think
- Bend Knees
- Load Close to Body
- Lift with Legs

# Lifting



- Lift between shoulder & knuckle height

# Why Lift?

Eliminate Lifting

- Make Lifting Impossible by Increasing the Weight of the Load
- Why do we have to Lift? Let the Machine Do the Hard Work!

# Conclusions/Questions

mbenden@srph.tamhsc.edu

# Ergonomic Reference Books

- ***Applications Manual for the: Revised NIOSH Lifting Equation***

  U.S. Department of Commerce

  Technology Administration

  National Technical Information Service (NTIS)

  5285 Port Royal Road, Springfield, VA 22161

  1-800- 553-6847 (NTIS)

  Publication #:  PB94-176930

  Cost $12.00

# Ergonomic Reference Books

- ***The Measure of Man and Woman***
  Whitney Library of Design
  1515 Broadway
  New York, NY 10036
  1-800-278-8477

- ***Ergonomics Design for People at Work***
  By Eastman Kodak Company
  Volumen 1 & 2
  115 Fifth Avenue
  New York, NY 10003

- ***The Advanced Ergonomic Manual***
  Advanced Ergonomics Inc.
  5550 LBJ Freeway
  LB 40, Suite 350
  Dallas, Texas 75240
  1-214-239-3746

- ***Cumulative Trauma Disorders: A Manual for Musculoskeletal Diseases of the Upper Limbs***
  Taylor & Francis
  1900 Frost Road
  Suite 101
  Bristol, PA 19007