Ergonomics & Musculoskeletal Disorders

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What is ergonomics?

Ergonomics:

- Derived from two Greek words:
  - "***Ergon***" meaning work
  - "***Nomoi***" meaning natural laws
- ***human factors engineering***
- the study of the physical and cognitive demands of work to ensure a safe and productive workplace.

Ergonomics:

- The study of the physical & cognitive demands of work to ensure a safe and productive workplace

Ergonomics:

- Ergonomics is the science and practice of designing jobs and workplaces to match the capabilities and limitations of the human body.

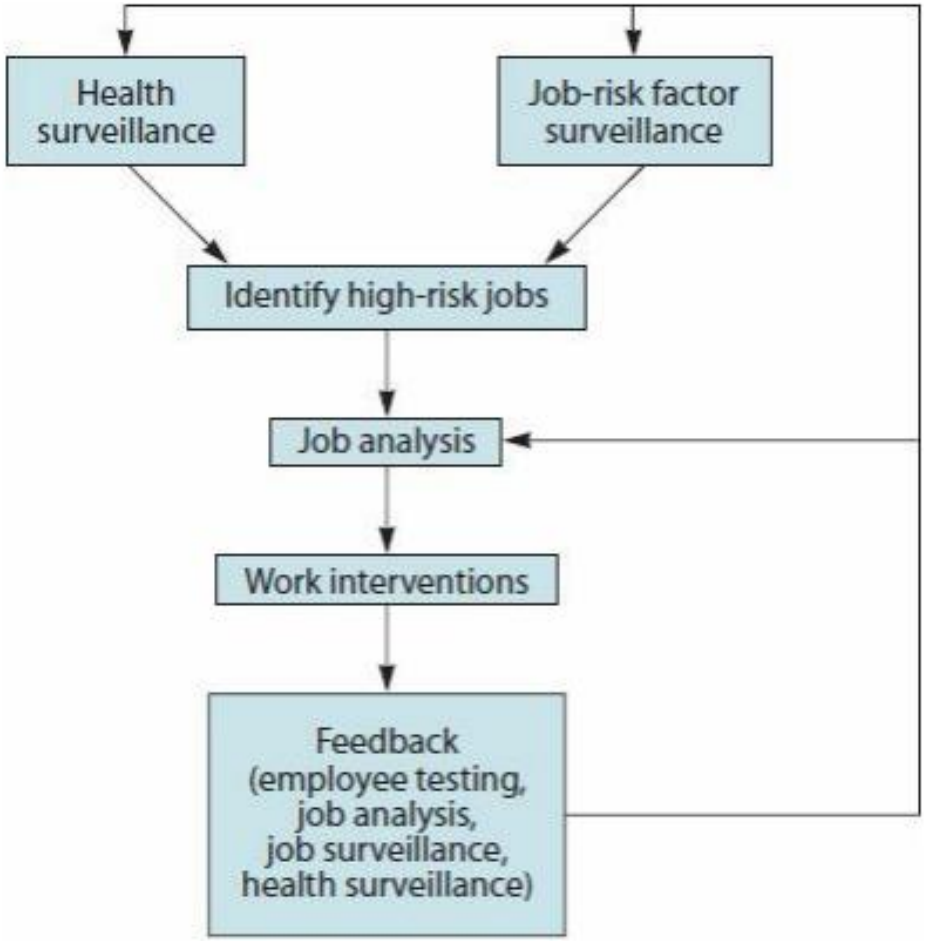
- Ergonomics means “fitting the job to the worker”

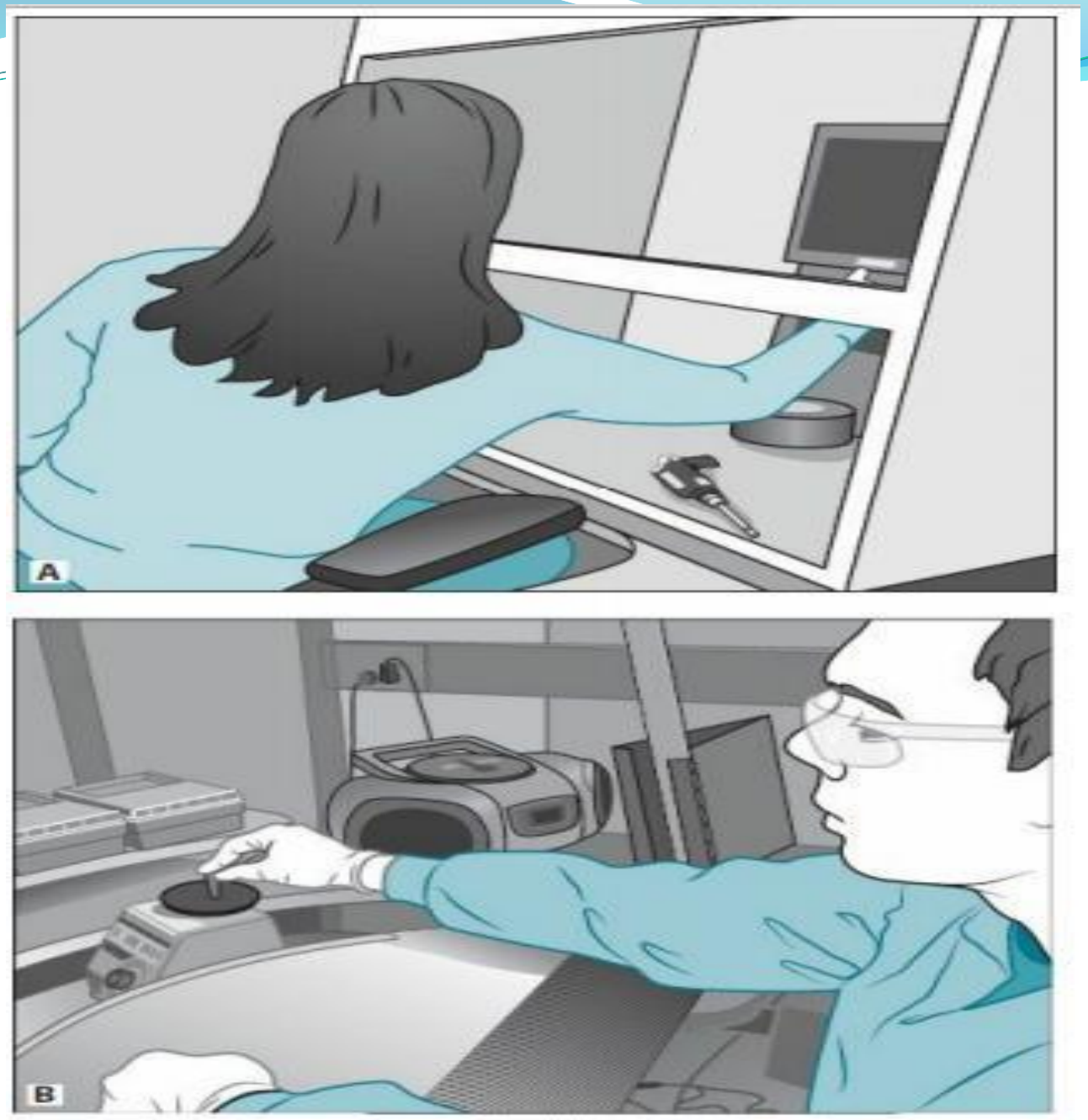
Approach to Prevention of Occupational Injuries

- Health professionals should:

- tour work
- familiarize themselves with job procedures, equipment, and working conditions.
- job redesign: job simplification or job enlargement

Components of an ergonomics program




A
B

Cost-Effectiveness of Preventive Activities

- Management support is critical for success
- initial trainings may lead to increased injury reports
- but long-term impact of ergonomics programs reduce the overall costs and severity of work-related injuries
- payback period of less than 1 year

Occupational Musculoskeletal Disorders (MSDs)

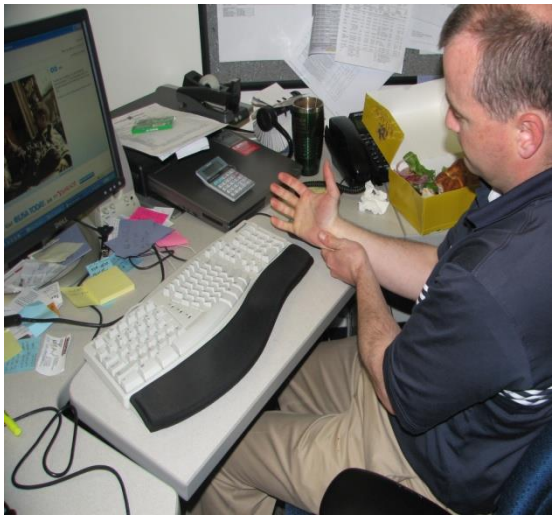
Material Safety Data Sheet (MSDS)

Musculoskeletal Disorders (MSDs)

- Muscles
- Tendons
- Ligaments
- Bones
- Nerves
- Blood Vessels
- Disks

PHYSICAL RISK FACTORS ASSOCIATED WITH MSDs

- The NIOSH and the National Academy of Sciences have reviewed the physical stressors or risk factors that are associated with upper extremity and neck disorders and low-back pain.



ACGIH_HAL
NIOSH Lifting Equation
The Strain Index

WORKSTATION DESIGN PRINCIPLES

Reduce Sustained Awkward Postures

- Work should be designed to prevent sustained :
  - • Neck or trunk flexion, extension, or rotation
  - • Squatting
  - • Shoulder elevation, abduction, flexion or external rotation
  - • Elbow flexion
  - • Wrist extension, flexion or ulnar or radial deviation
  - • Finger extension or abduction

These risk factors for upper extremity are:

- The application of sustained or high forces
  - Sustained awkward postures
  - Rapid, repeated motions
  - Contact stress
  - Vibration
  - Cold environment

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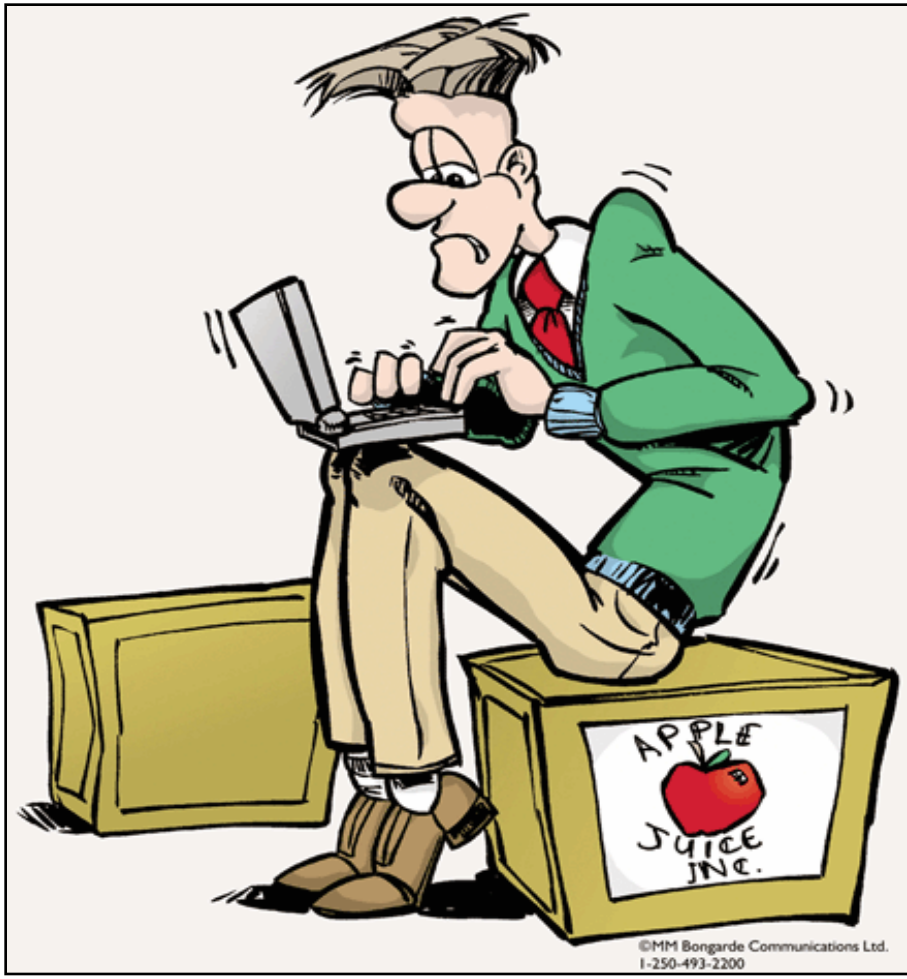
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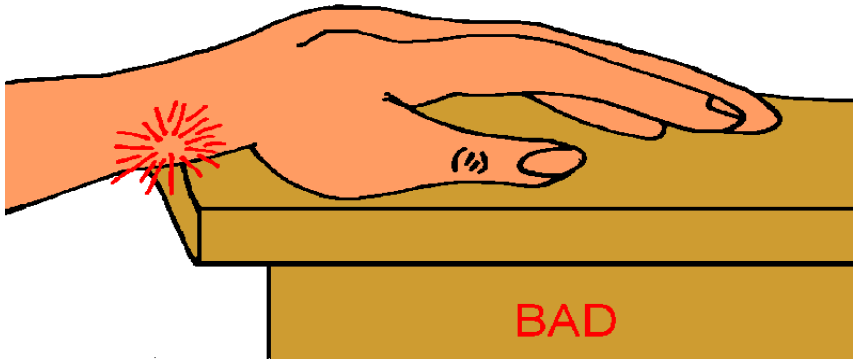
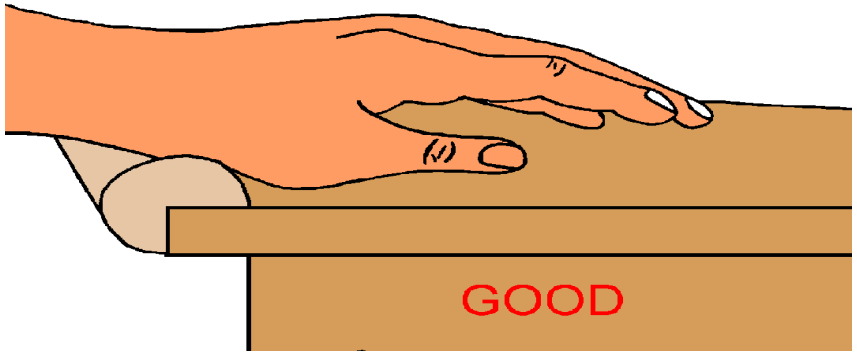
Reduce Contact Stress

Forearm support for sustained work at the computer

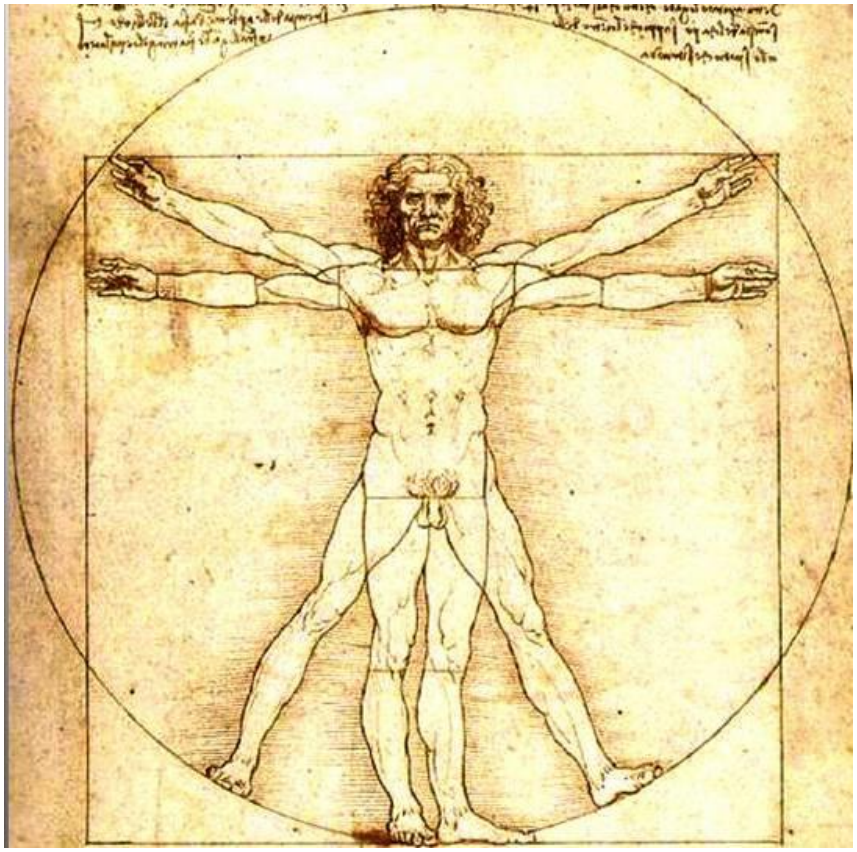
- support surfaces should be rounded and padded to minimize the risk of contact stress and located on sensitive body regions (rist or elbow).

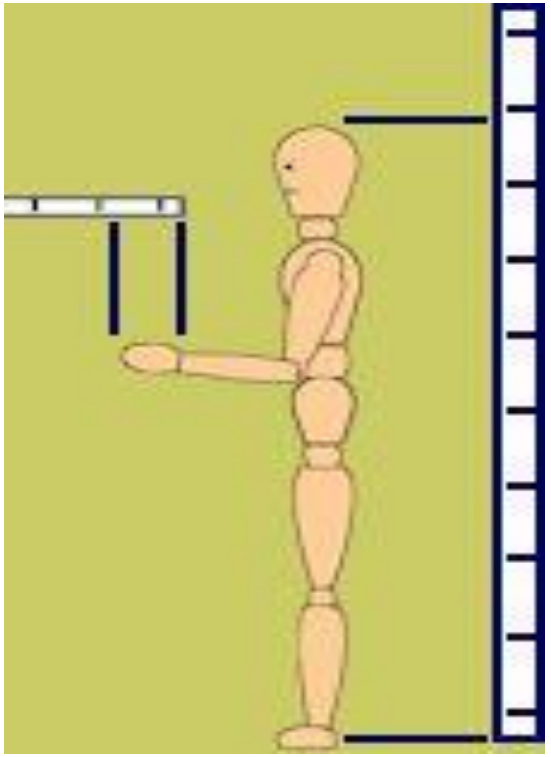
Reduce contact stress





Anthropometry





Design Work Based on Anthropometric Data

- mismatch in size between the worker and the workplace, equipment, or tools = work related MSD

- prolonged forward bending to reach for tools or materials

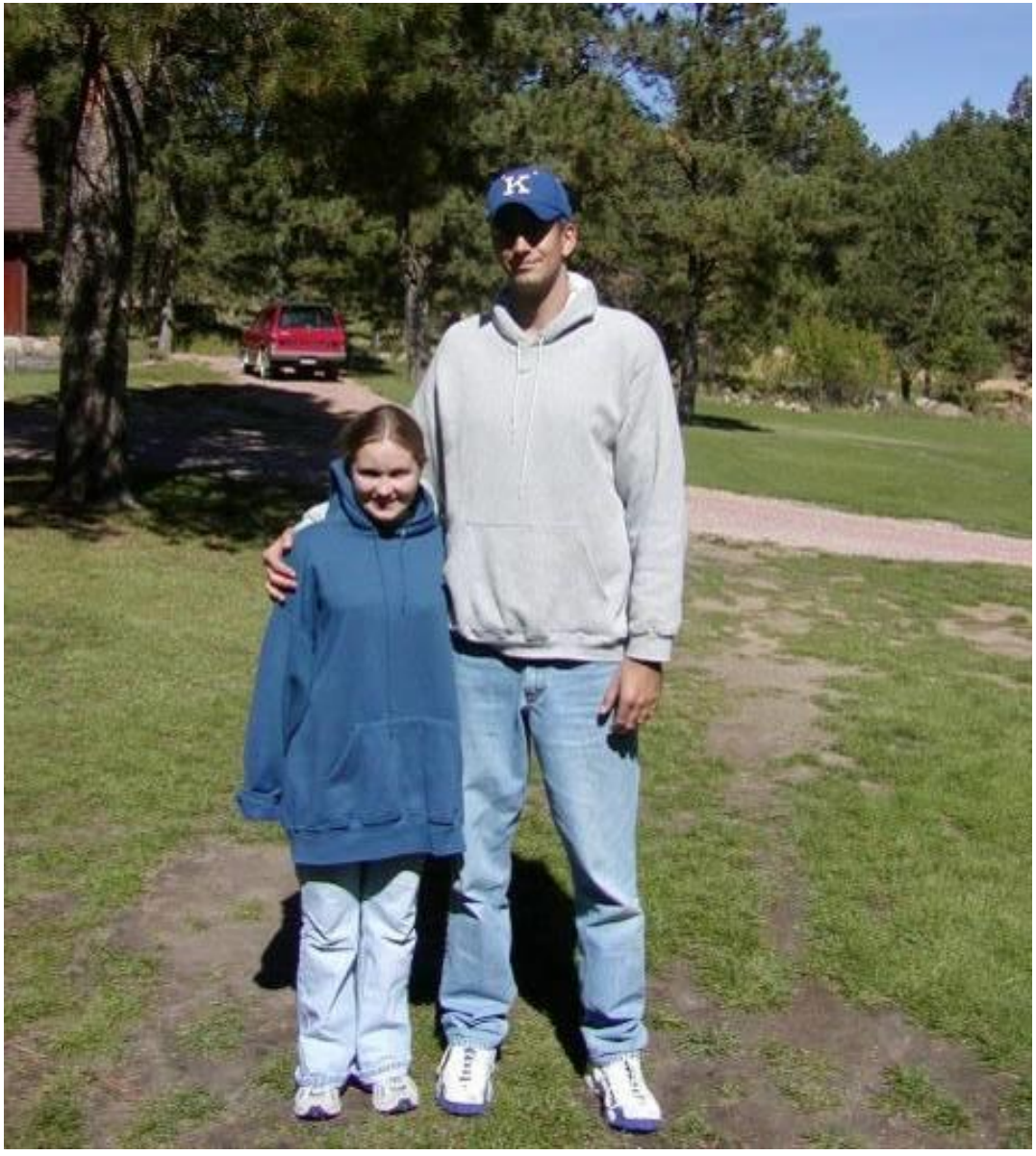
- having to hold a heavy tool at some distance from the body

- having to sit in a position that is too low or too high for the hands.

People Are Different

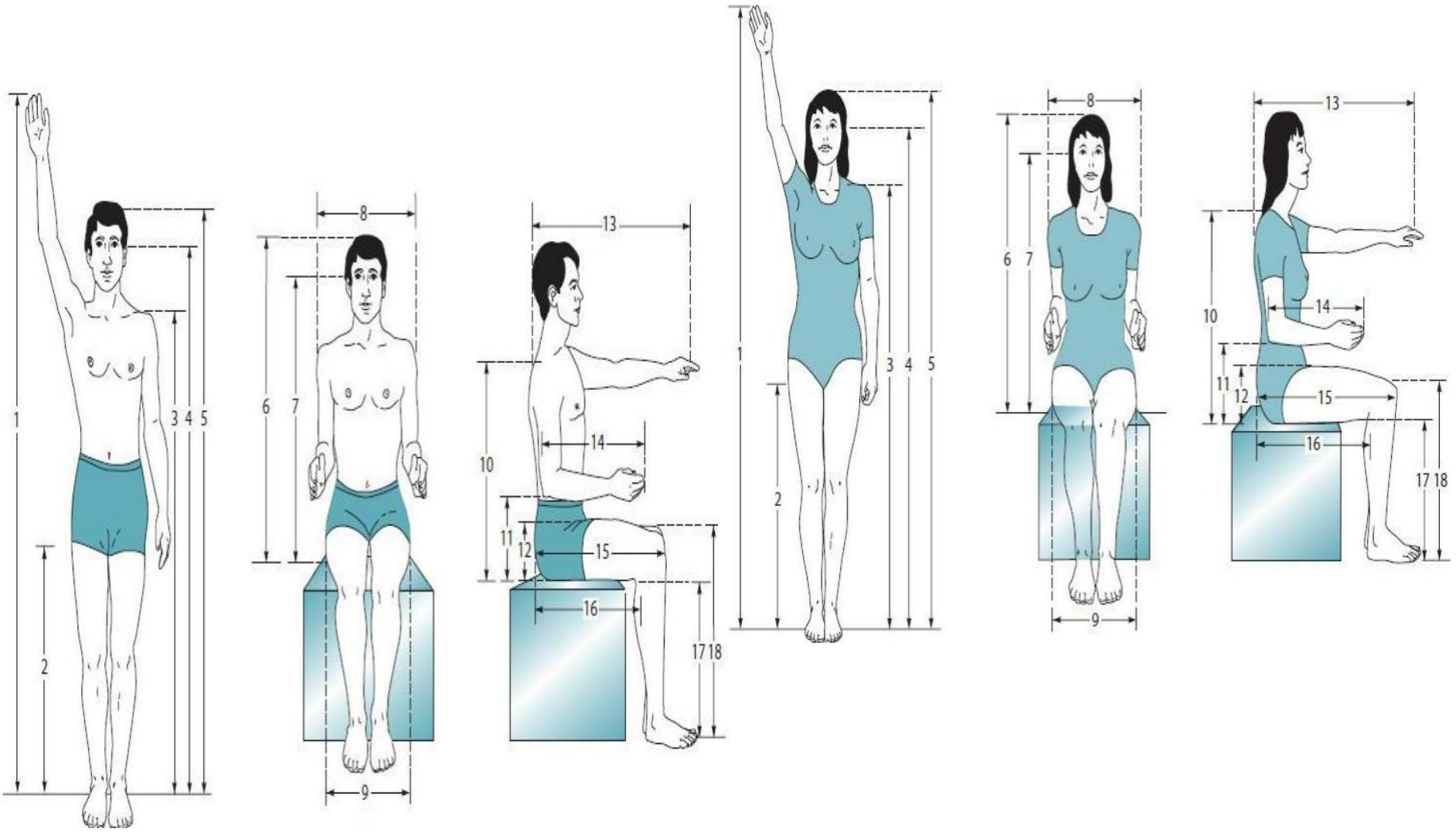
Age Differences

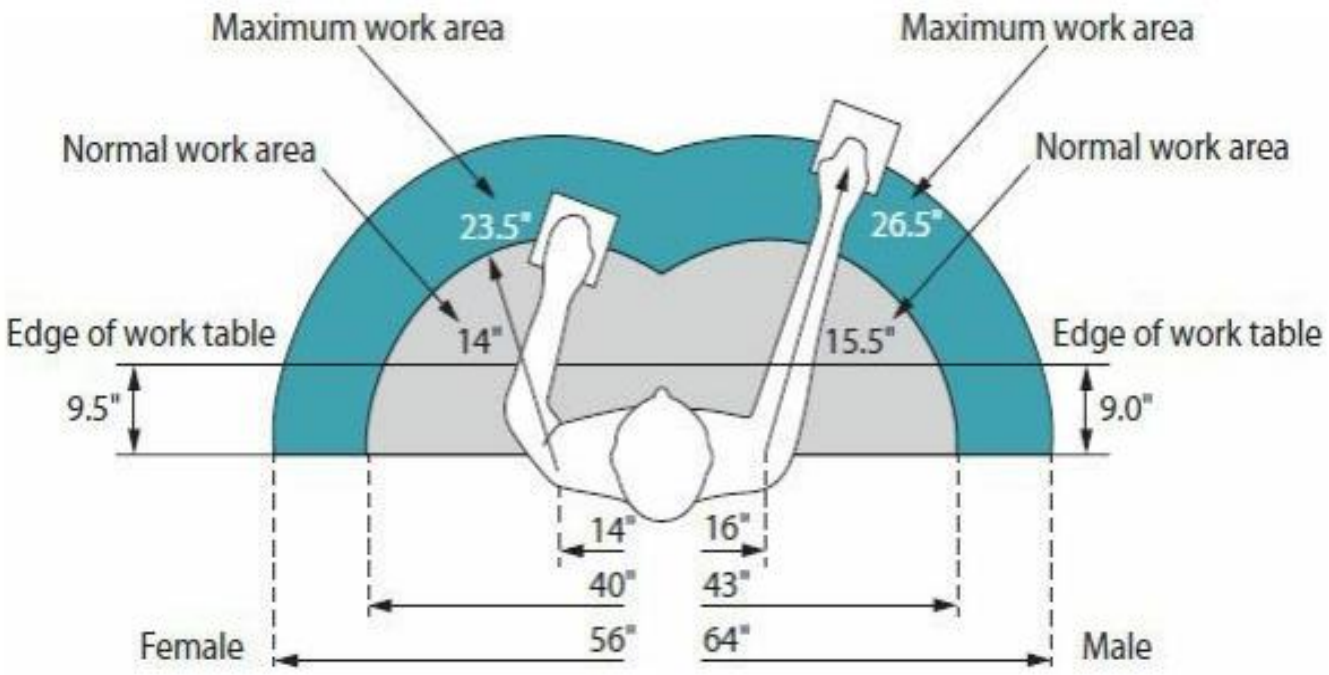
Height Differences



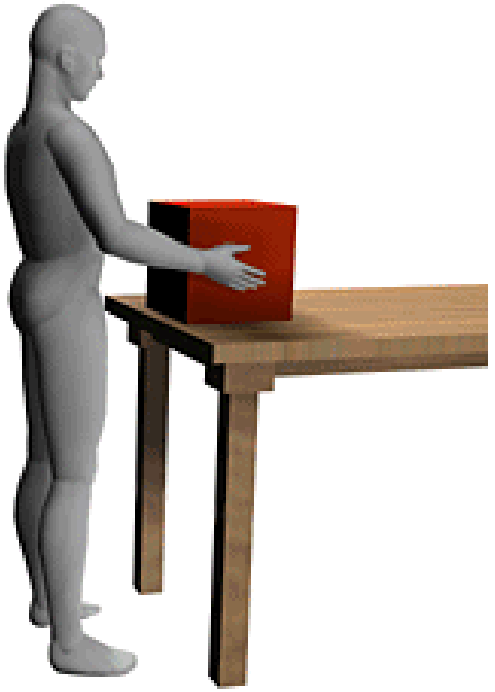
Male Body Dimensions (cm)					
Dimension Number	Dimension Name	5th Percentile	50th Percentile	95th Percentile	Standard Deviation
1	Vertical reach	195.6	209.6	223.5	8.46
2	Crotch height	75.4	83.1	90.7	4.67
3	Shoulder height	133.6	143.6	154.1	6.22
4	Eye height	152.4	163.3	175.0	15.29
5	Stature	163.8	174.4	185.6	6.61
6	Height, sitting	84.5	90.8	96.7	3.66
7	Eye height, sitting	72.8	78.8	84.6	3.57
8	Shoulder breadth	41.5	45.2	49.8	2.54
9	Hip breadth, sitting	30.7	33.9	38.4	2.38
10	Shoulder height, sitting	57.1	62.4	67.6	3.18
11	Elbow height, sitting	18.8	23.7	28.0	2.78
12	Thigh clearance	13.0	14.9	17.5	1.36
13	Thumb tip reach	74.9	82.4	90.9	4.85
14	Elbow-fingertip length	44.3	47.9	51.9	2.31
15	Buttock-knee length	54.9	59.4	64.3	2.85
16	Buttock-popliteal length	45.8	49.8	54.0	2.50
17	Popliteal height	40.6	44.5	48.8	2.50
18	Knee height, sitting	49.7	54.0	58.7	2.73

Body dimensions for men & women





Forearm-only (preferable) and full-arm (satisfactory) reach limits for men and women in working areas shown in the horizontal and vertical planes.



Too low

Too far away

Too high

Too high

Avoid high and low object placement, especially as the weight and/or size of the object increases.

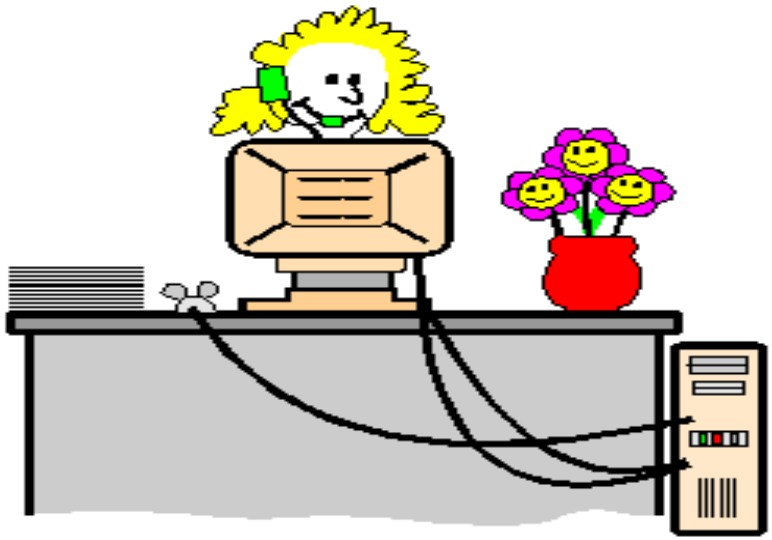
Too high

Too low

OFFICE ERGONOMICS

FROM THIS

TO THIS!

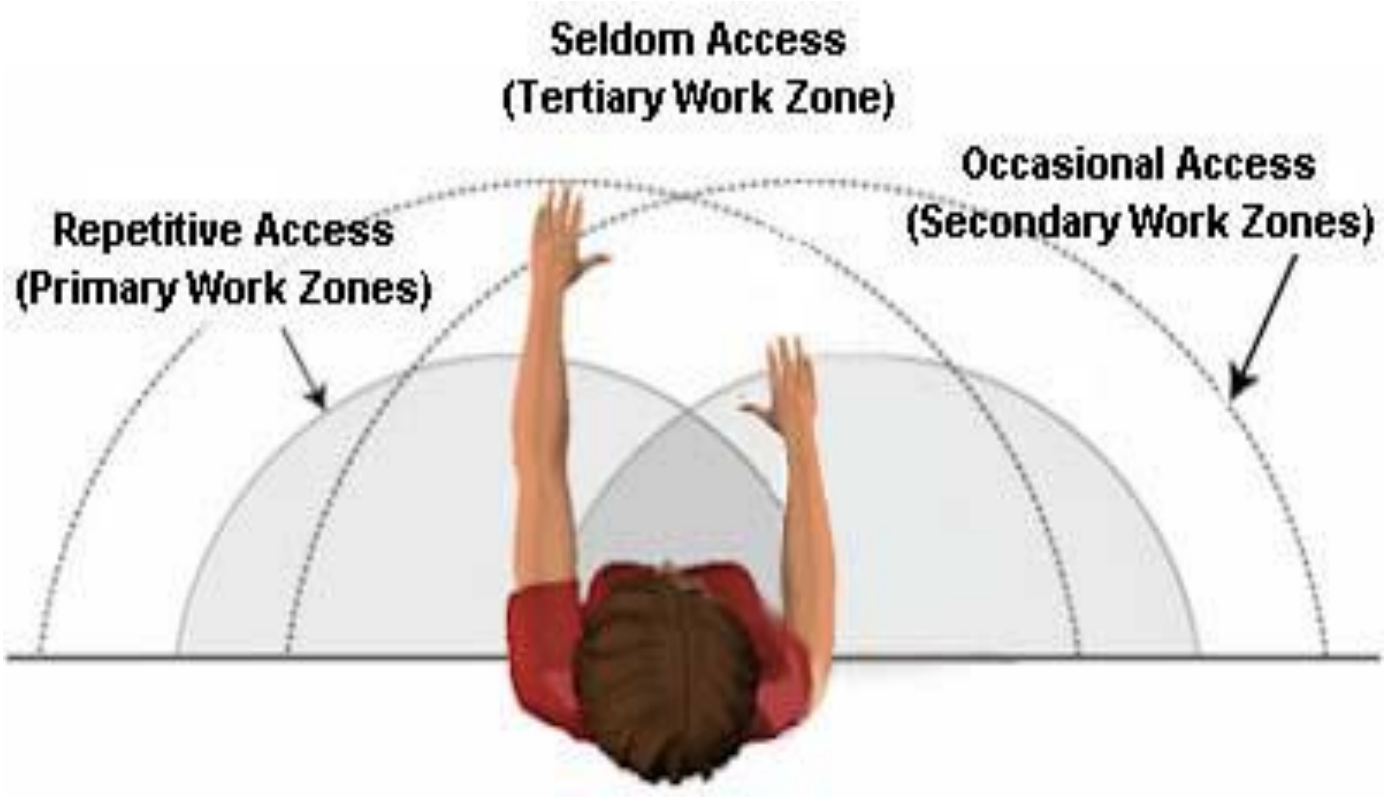


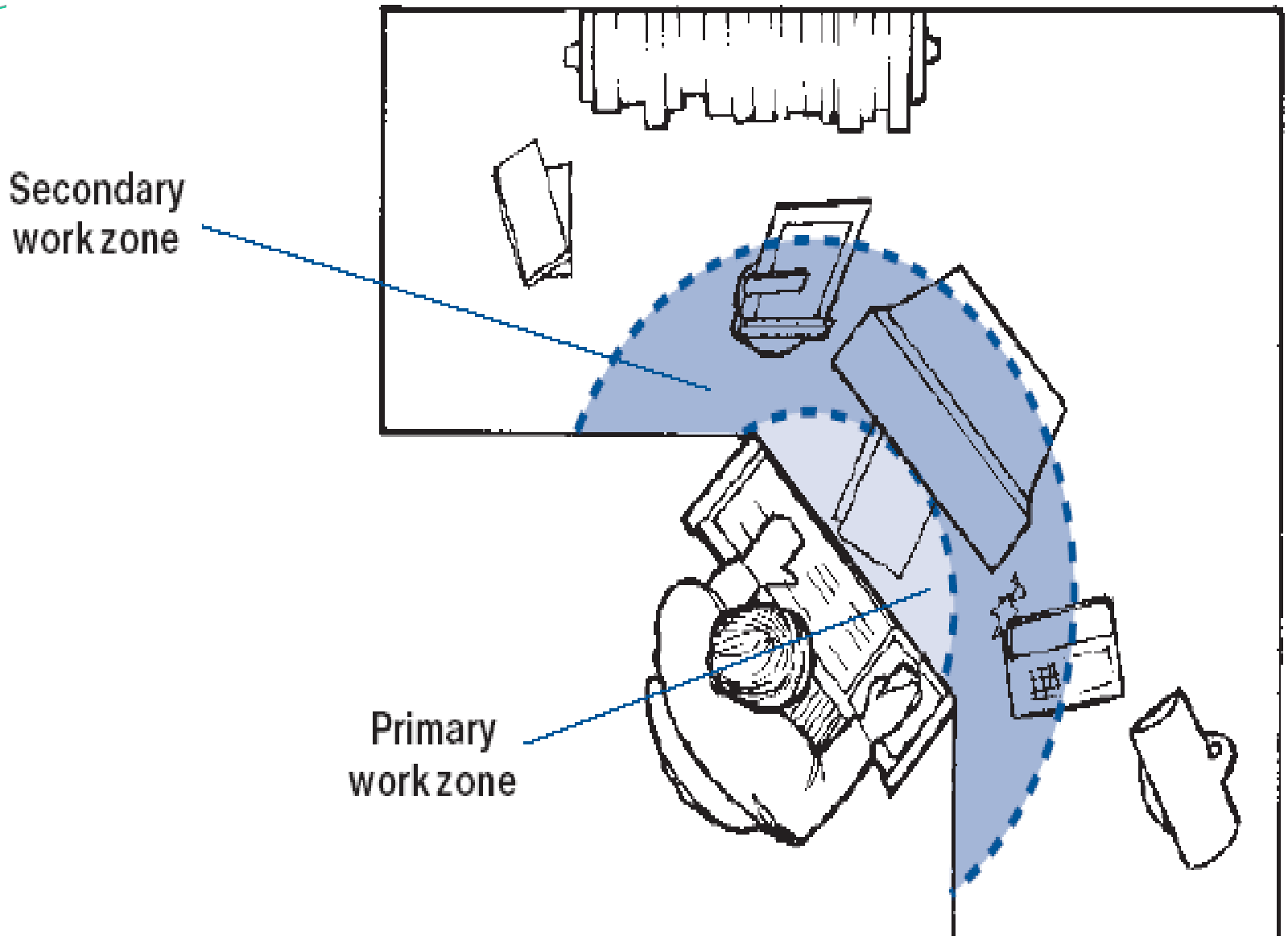
RATHER THIS!

THAN THIS

Logically Locate Controls & Displays

- Primary controls _forearm-only reach limits and between the shoulders
- infrequently used controls _full-arm reach limits




Secondary
work zone
Primary
work zone

Proper Design of Chairs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E
I
G
A
C
D
H
F
B

Declined Sitting

Reclined Sitting

Upright Sitting

Standing

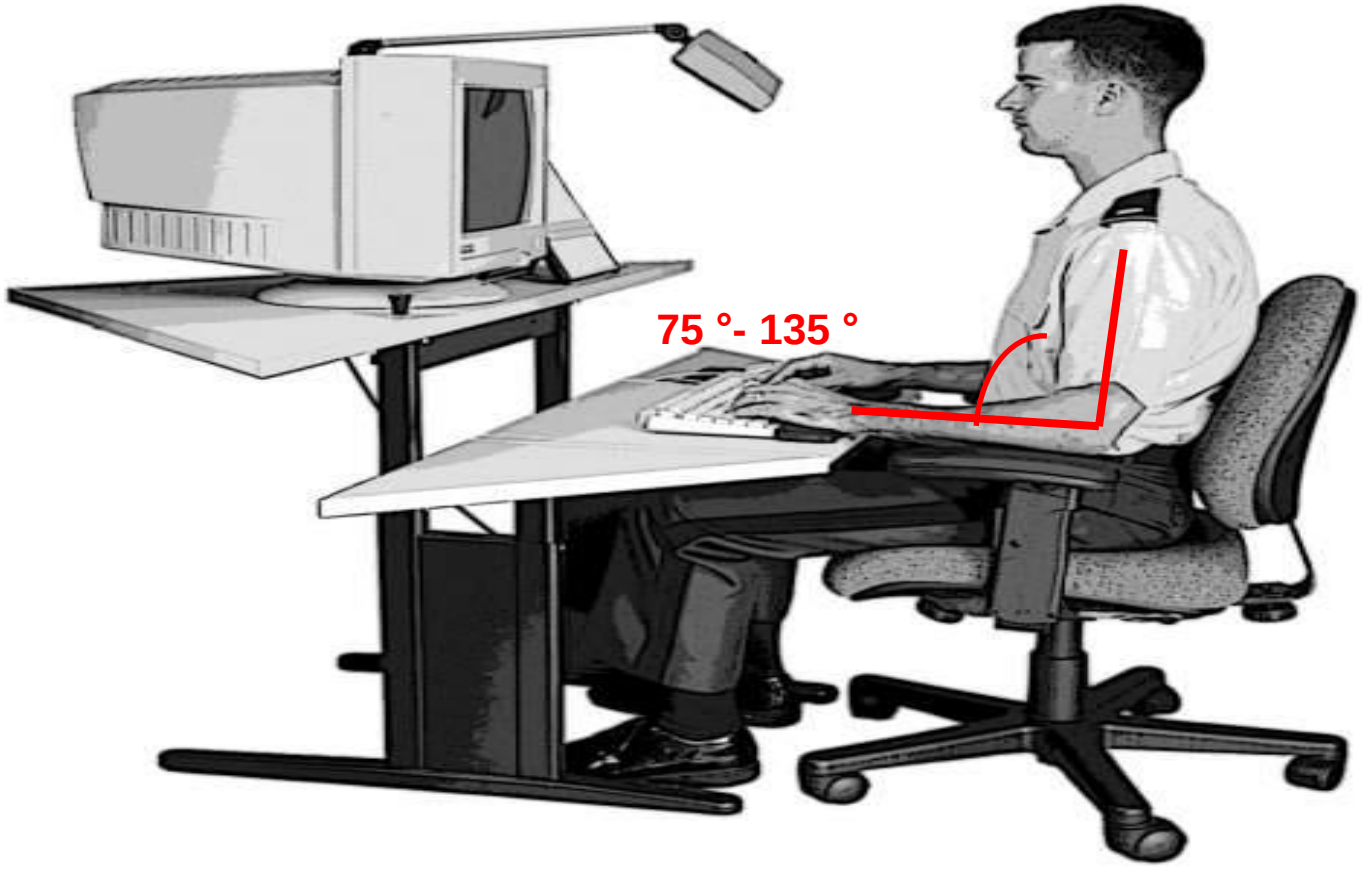
Seat pan length adjustment

Seat Pan


Relaxed
Armrest too High
Armrest too High & Wide

Proper Selection of Chairs

The Desk



Avoid Static Body Positions: Task Variation

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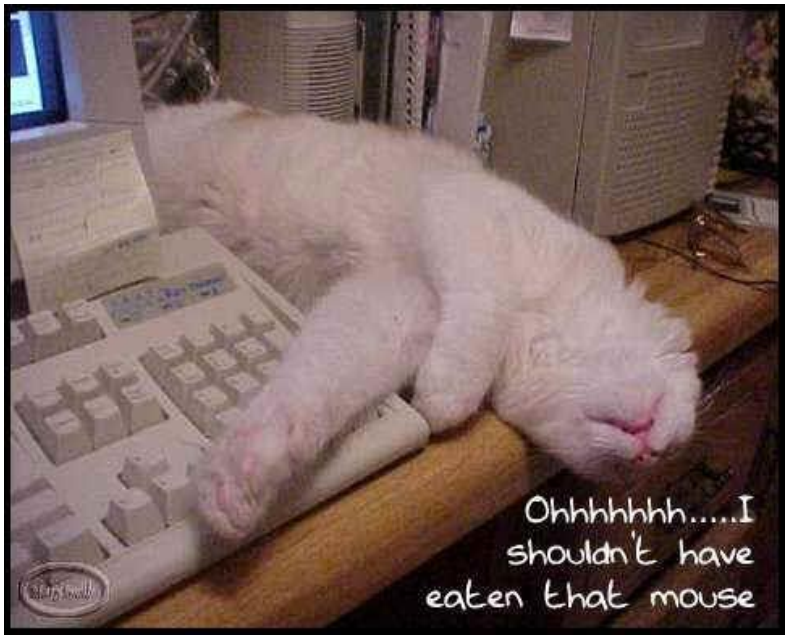
Break Time

COMPUTER WORKSTATIONS

Computer operators often complain of:

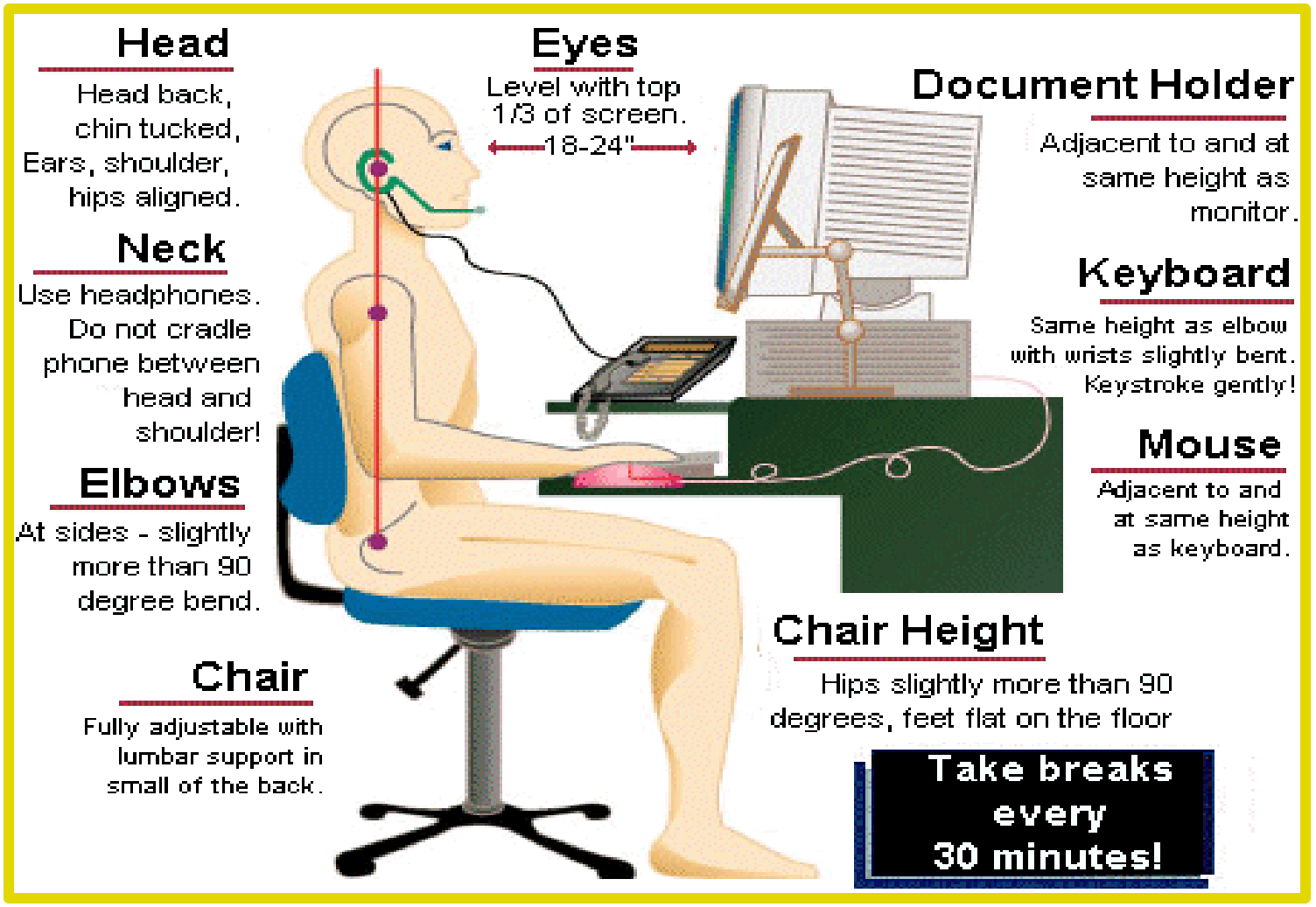
- pain and fatigue in the neck, upper back, shoulders, forearms, or wrists
- visual fatigue or eyestrain



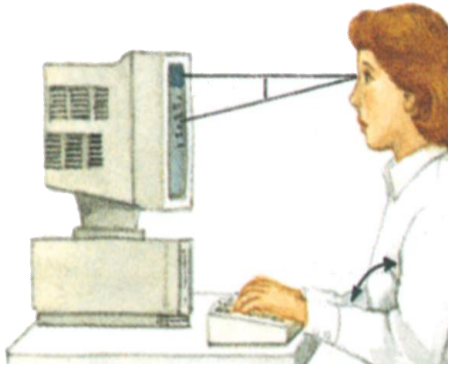
Adjust Chair First

The sitting posture during work can vary from forward sitting (visually demanding task) to upright sitting, reclined sitting (writing computer code), or standing.

Proper Placement of Monitor & Documents



- Primary visual targets should be between 0 to 30 degrees below eye level
- Bifocal lens users need the primary display 30 to 45 degrees below eye level and may benefit from prescription monofocal or occupational bifocal lenses




40-75 cm
min 20°
90-100°
72-75 cm
38-55 cm
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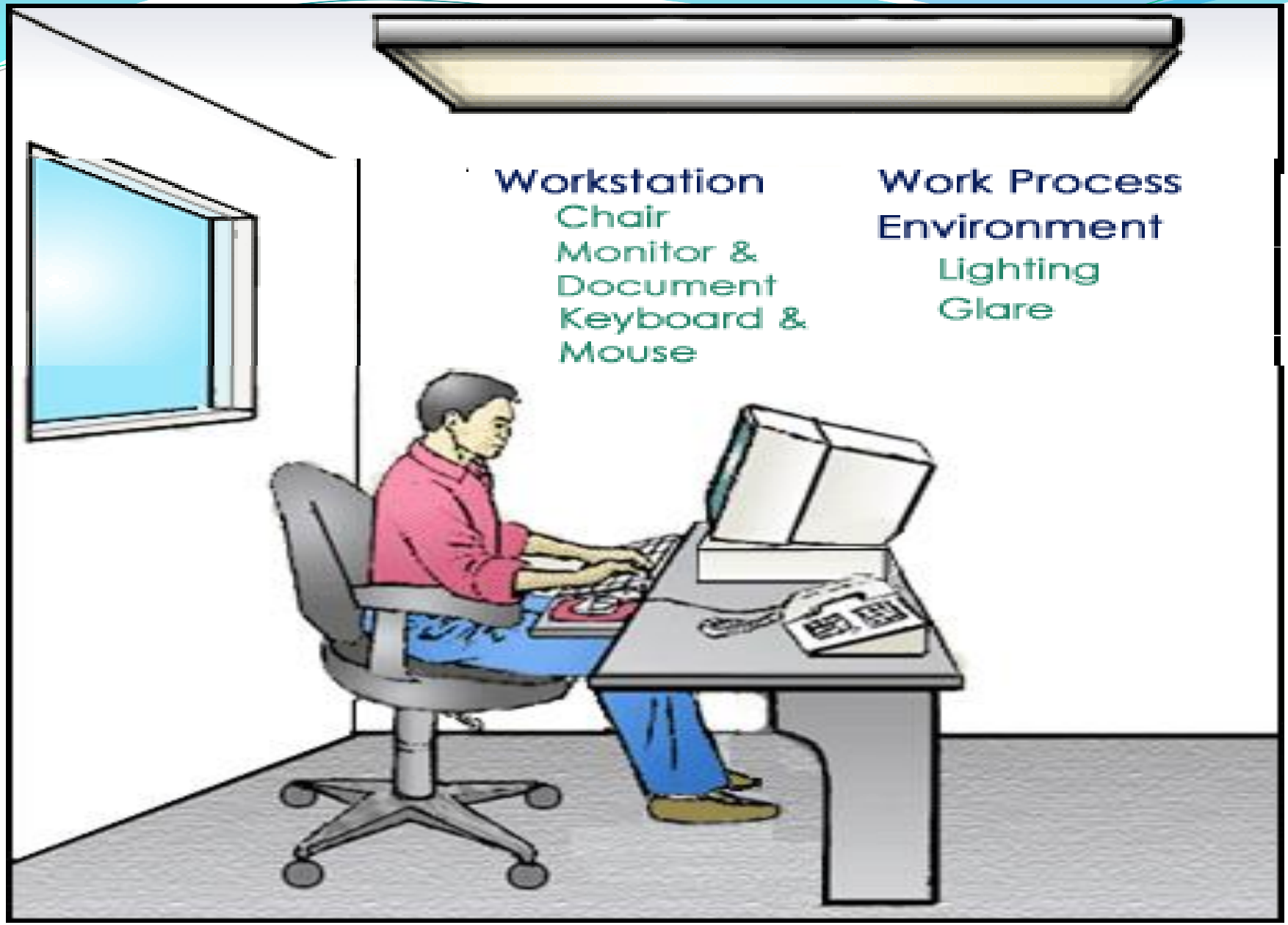
Eliminate Glare

The computer monitor should be positioned so that glare is minimized:

1. the bright light source the side of or above the computer user
2. Reduce the general illumination in the room to about 500 lux.
3. Provide more illumination where needed with desk lamps
4. use glare-reducing filters on computer screens


Workstation
Chair
Monitor &
Document
Keyboard &
Mouse
Work Process
Environment
Lighting
Glare

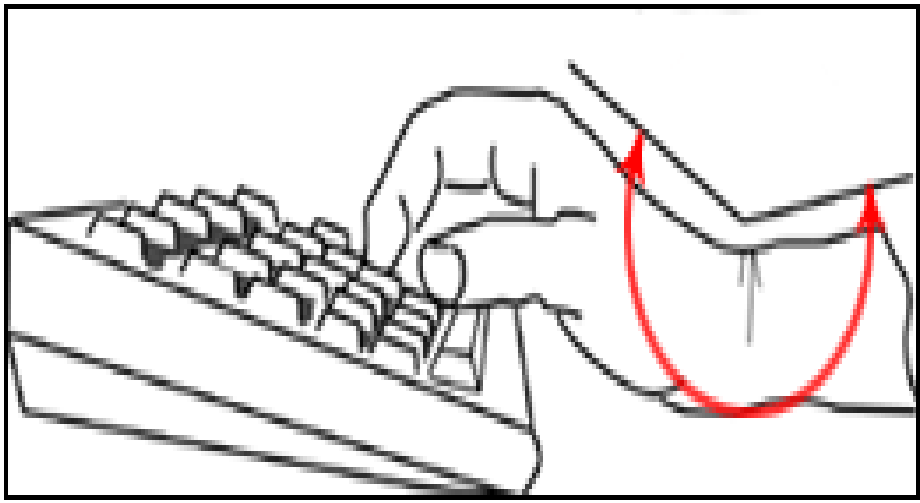
Position of Input Devices

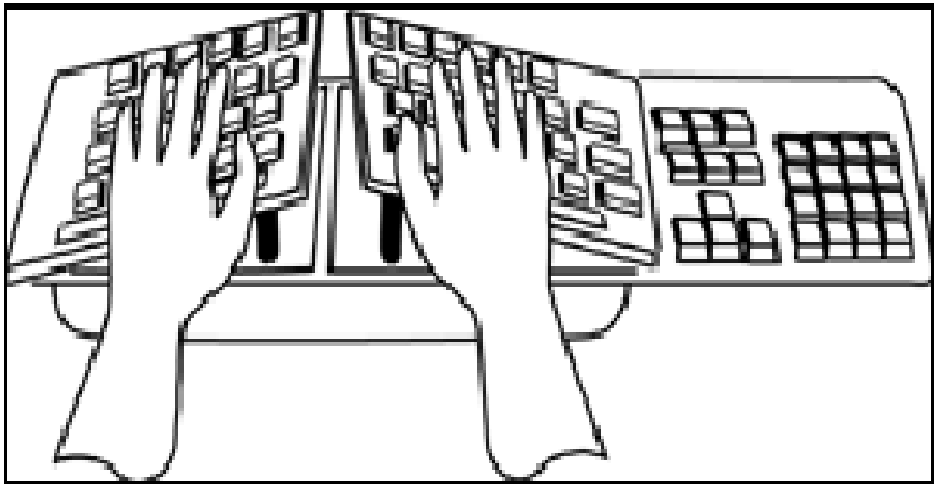
- The height of keyboard and pointing device should be adjusted so that the shoulders are not elevated and the wrists are relatively straight during use
- Alternative keyboards or pointing devices can reduce awkward wrist and forearm postures

Pointing Devices

Type of Keyboards

Mini Keyboards





Bad

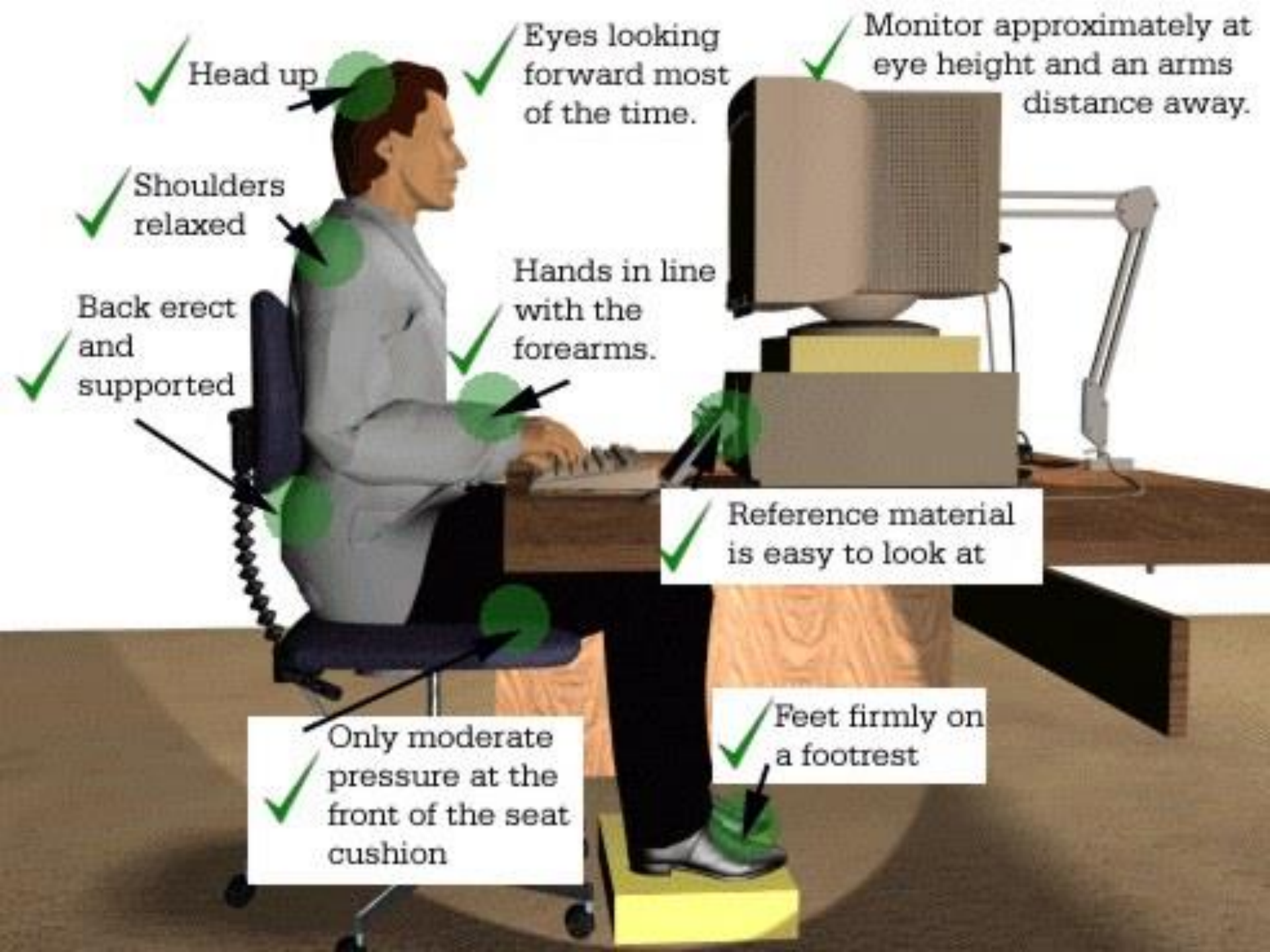
Good

Good

Bad

Mouse wrist rest

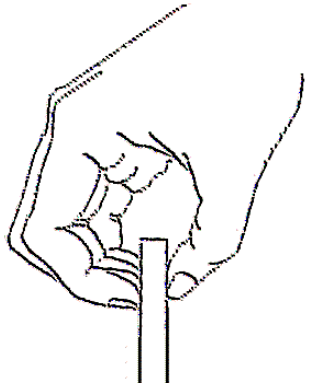

Cacti grow well in hot,dry environments
Monitor not positioned head on
Neck twisted to look at monitor
Incorrect positiong of desk lamp
Keyboard at an angle, increasing angle at wrist
Using mouse too far away causing strain on shoulder
Back not supported by the backrest
Feet not firmly on the floor
Cushion pressing into underside of thigh


Head up
Eyes looking forward most of the time.
Monitor approximately at eye height and an arms distance away.
Shoulders relaxed
Hands in line with the forearms.
Back erect and supported
Reference material is easy to look at
Only moderate pressure at the front of the seat cushion
Feet firmly on a footrest

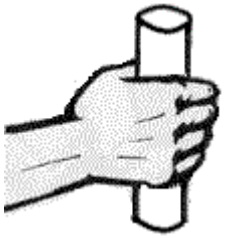
HAND TOOL DESIGN & SELECTION

Reduce Hand Force:

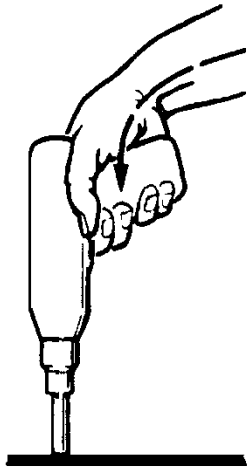
- The repeated high-pinch force or grip power tools is associated with tendon disorders of the forearm, muscle fatigue, and carpal tunnel syndrome

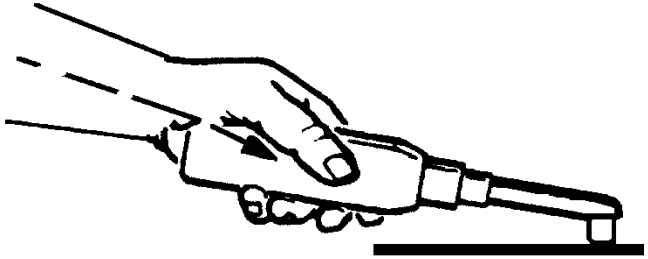


Pinching with the fingertips



Gripping with the whole hand





Sustained or repeated pinch grip puts tendons at even greater risk than a power grip. Tools can be redesigned to convert use from a pinch grip to a power grip

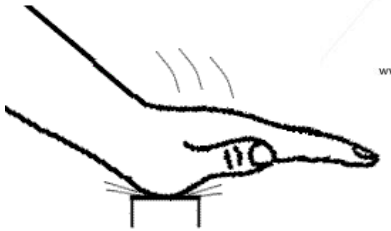
Avoid Static Holding Positions

- Heavy parts can be held with a jig or clamp so that the nondominant hand is not applying a constant grip force

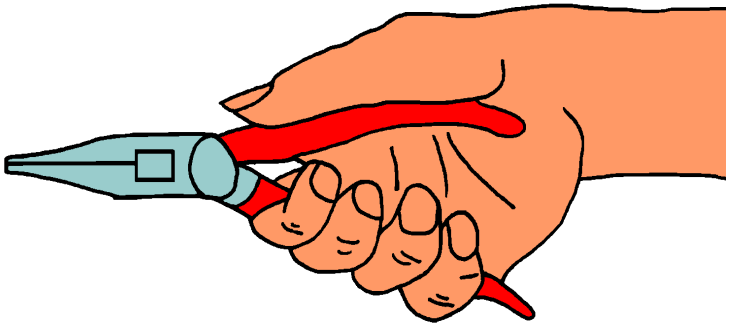
When sustained holding is still necessary, the tool can be suspended from cables with a balancing system or articulated with antitorque bars to decrease grip force

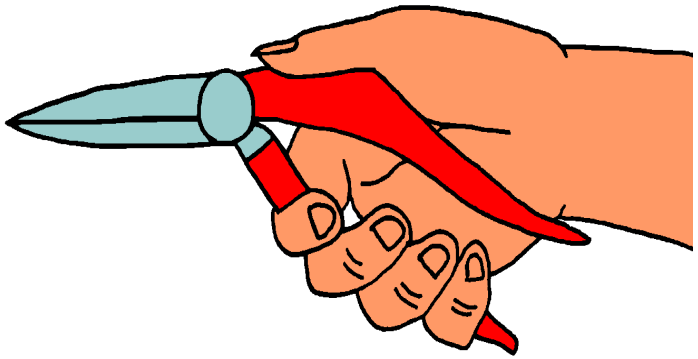
Tool Balancer

- Avoid Use of the Hand as a Tool

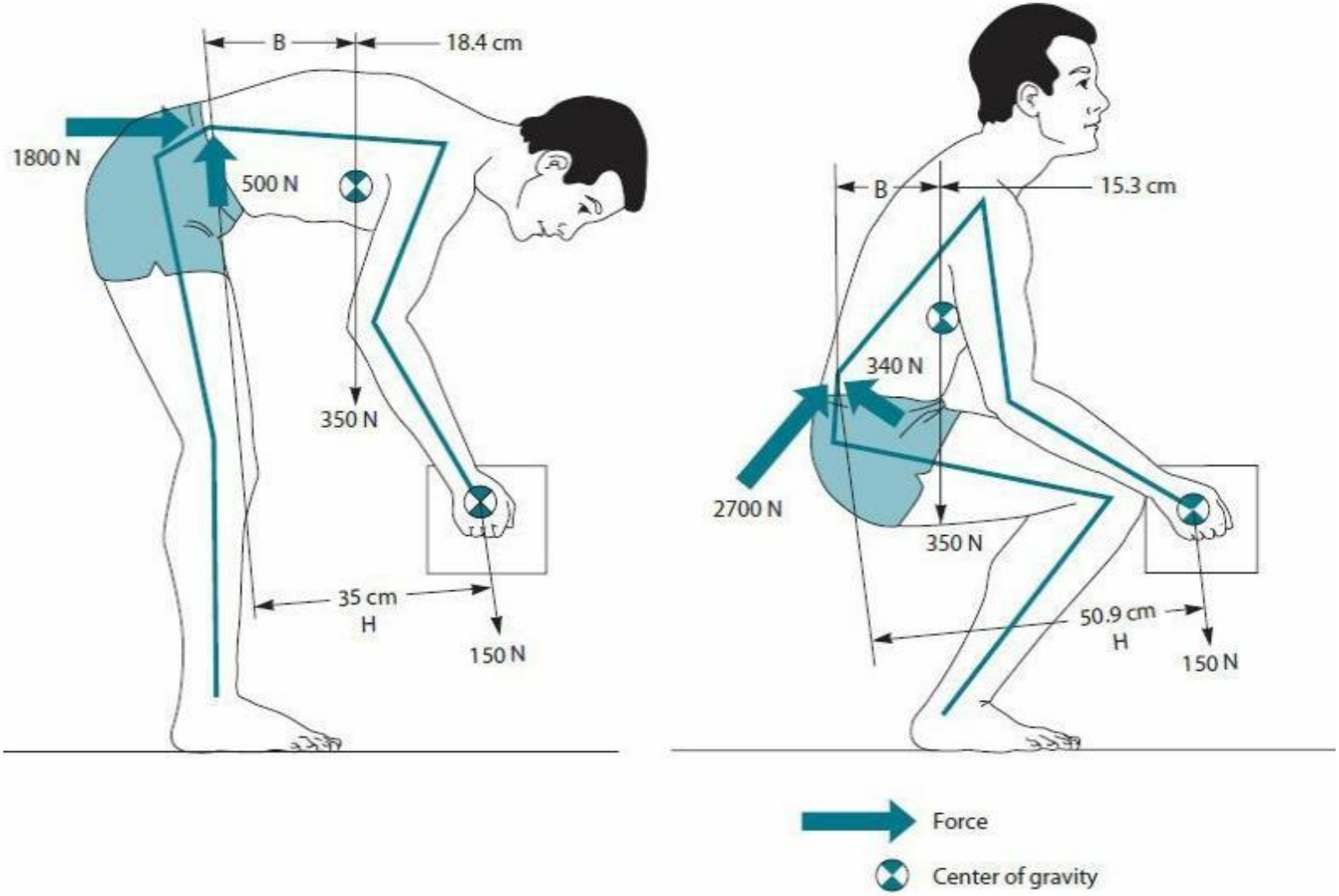


- Proper Design of Tool Handles

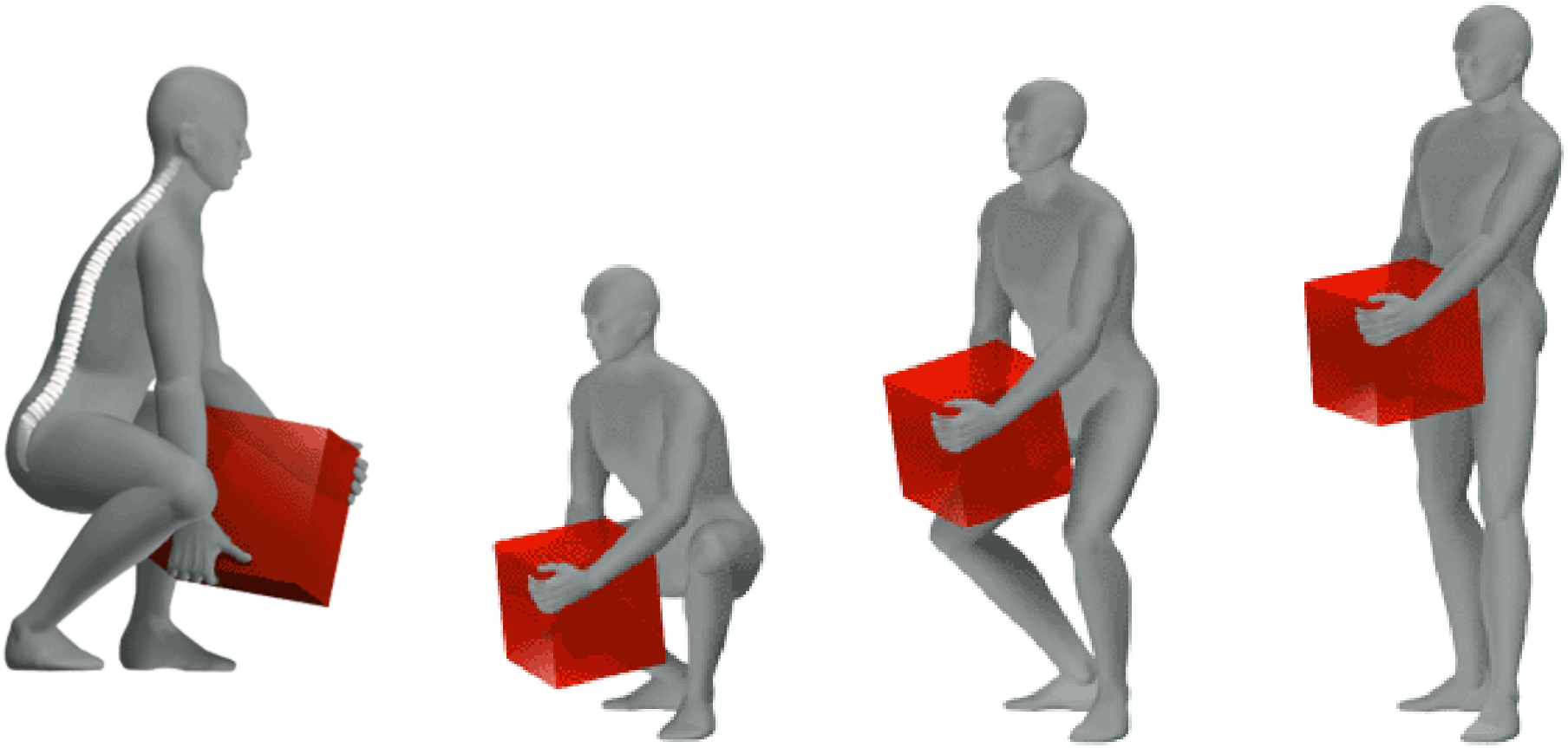




BIOMECHANICS OF LIFTING, PUSHING, & PULLING


B
18.4 cm
1800 N
500 N
350 N
35 cm
H
150 N
B
15.3 cm
340 N
2700 N
350 N
50.9 cm
H
150 N
Force
Center of gravity

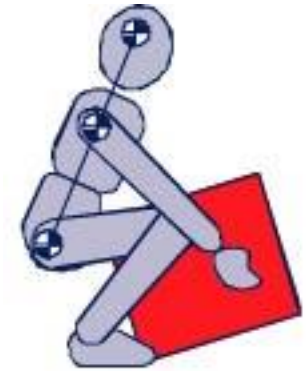
A commonly repeated safety rule is to "lift with the legs" and keep the load close to the body



❑Optimal lifting styles are those that :

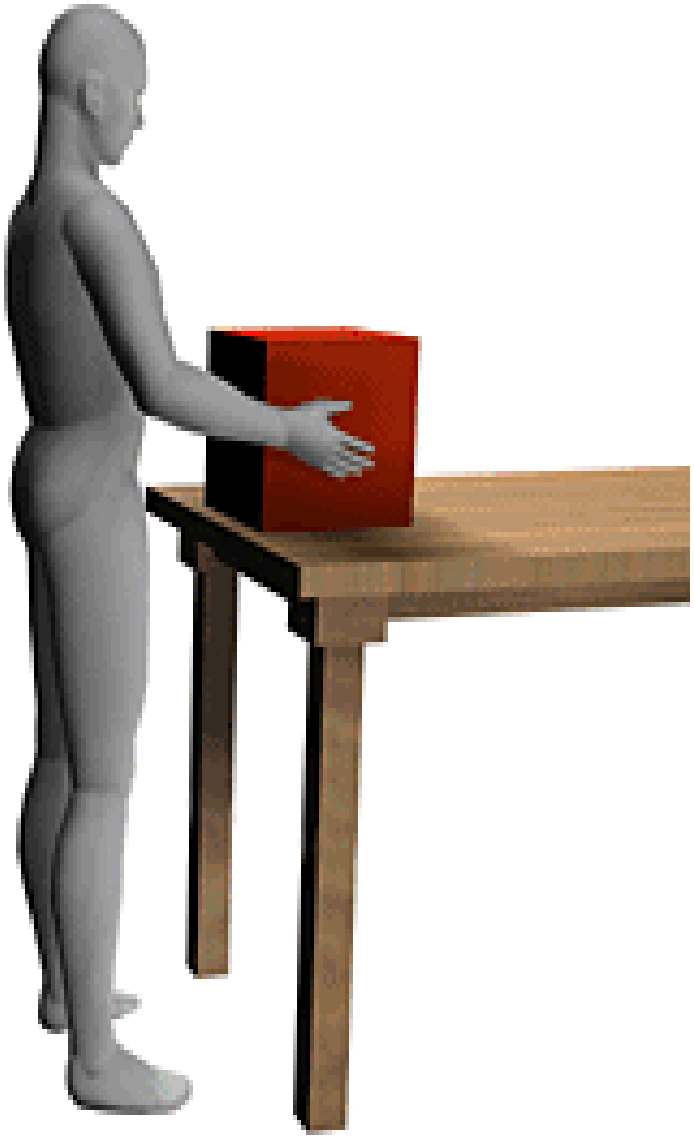
- Allow the load to be kept as **close** as possible to the spine.
- Offer a broad base of support for **good balance**.
- Allow the worker to **see ahead** and avoid obstacles.
- Allow the worker to retain a comfortable position (“**neutral posture**”) of the spine, avoiding extremes of bending or twisting.

Correct & Incorrect Techniques



Correct lifting technique

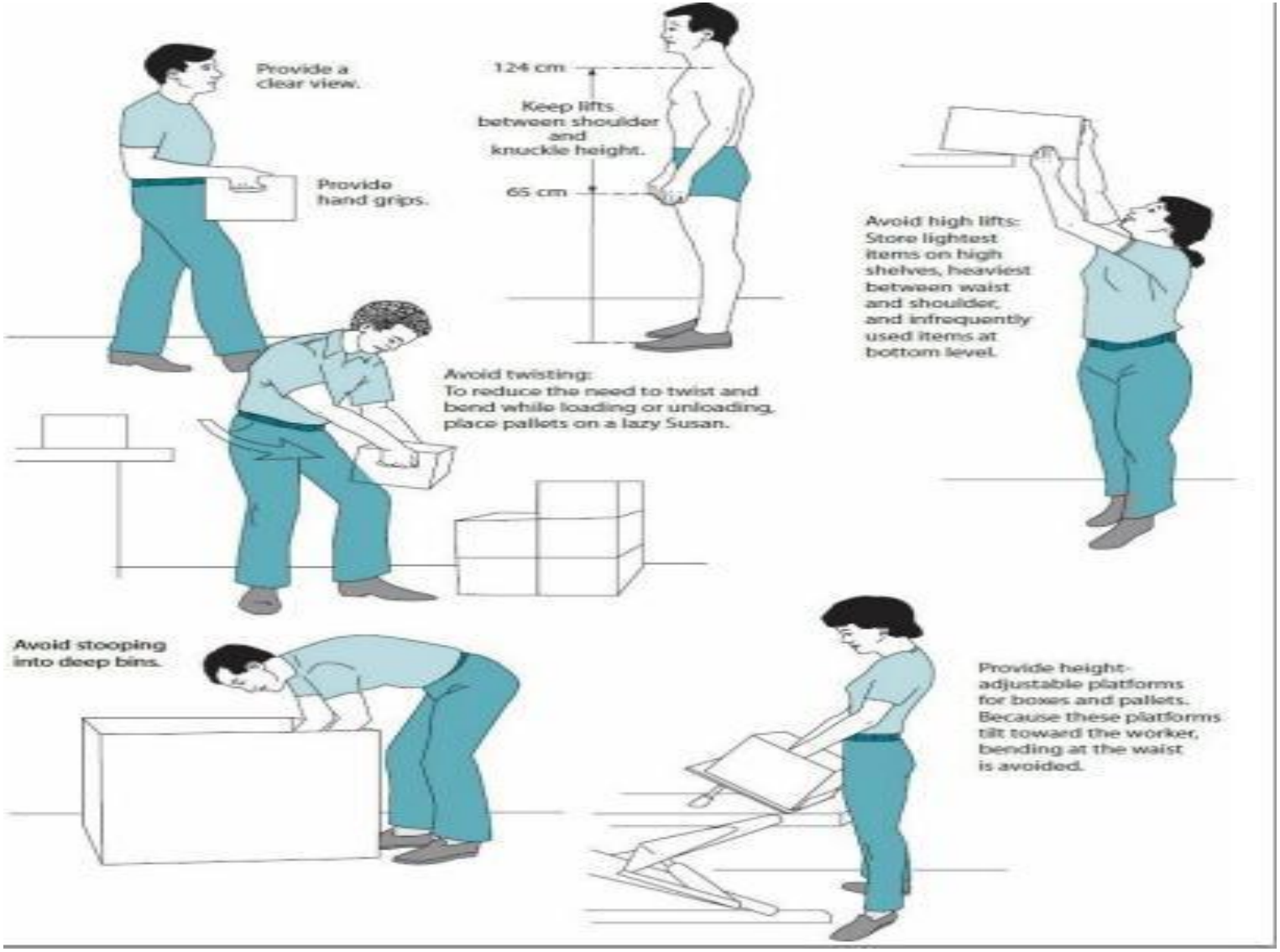
Incorrect lifting technique



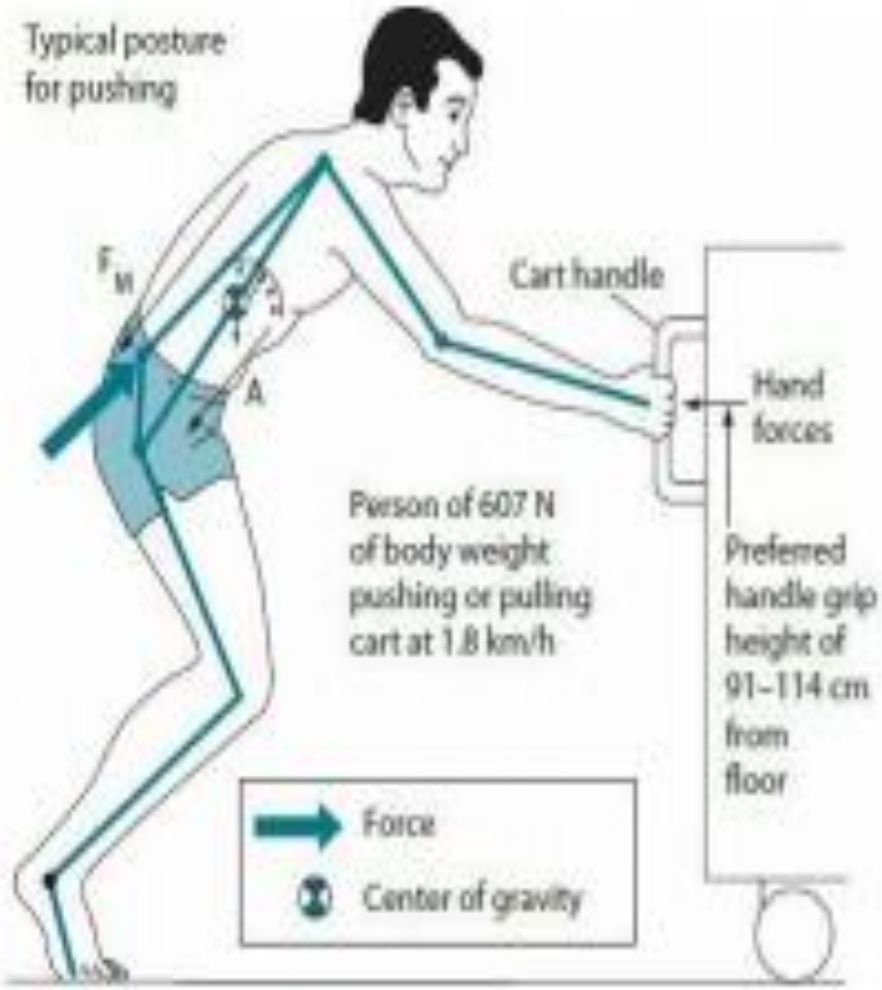
- Test the load; get help if needed.
- Plan the lift and the path you will take.
- Keep the load as close to the body as possible.
- Pivot and move your feet with a broad base of support to avoid twisting.
- Try to keep your movements smooth and coordinated.
- Keep the back in a straight line from "head to tail."

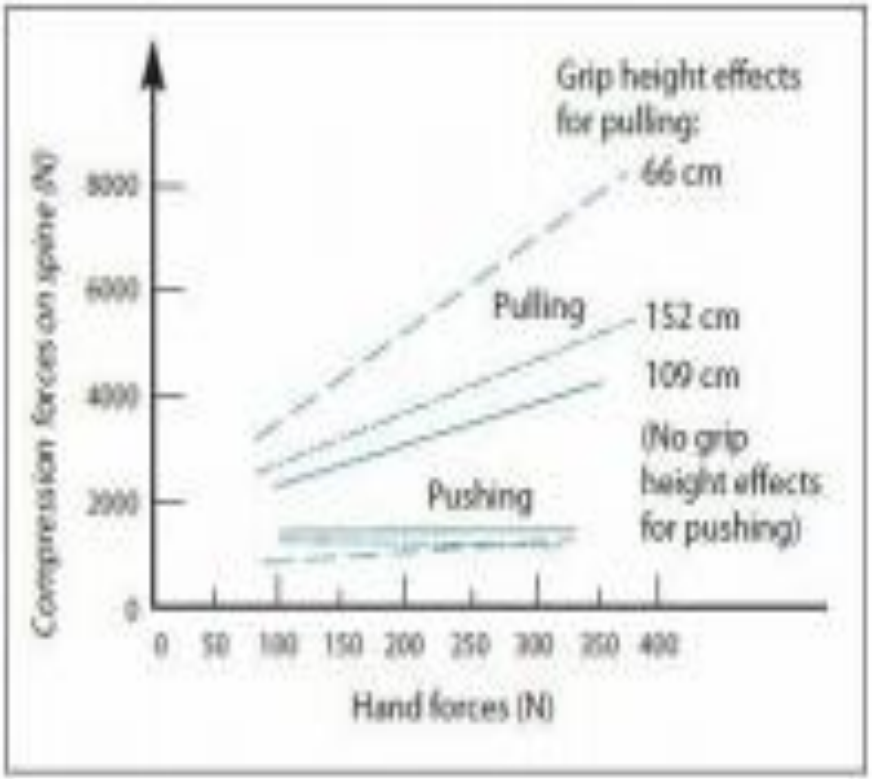
With good lifting technique, the spine is kept stable even when it must be tilted forward.

Suggestions for safe lifting



Principles of Pushing & Pulling





general guidelines to prevent injuries when pushing or pulling heavy loads:

- (1) Make certain that the area ahead of the load is **level,** offers **adequate traction**, and is **clear of obstacles**.
- (2) **Push** the load, **rather than pull** it.
- (3) Wear **shoes** that provide **good** foot **traction**.
- (4) When starting to push a load, **brace the rear foot** and **shift** the body weight **forward**.
- (5) Pushing or pulling is **easier** when the **handles** of the loaded cart are at **about hip height** than when they are at shoulder height or above.

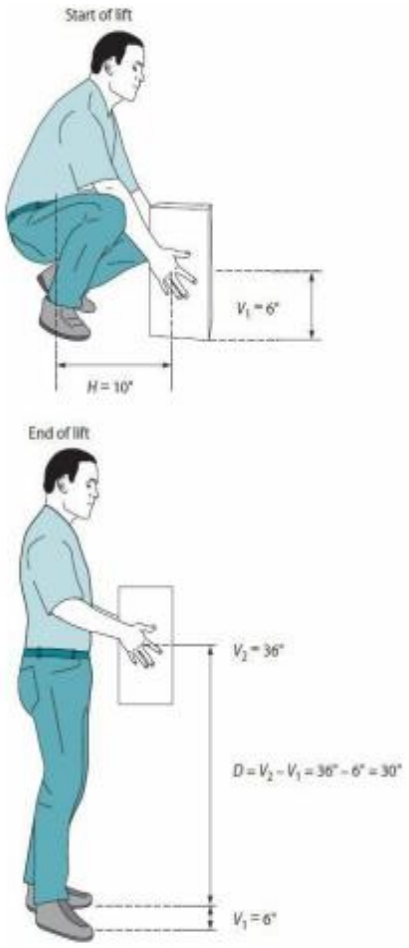

smartview

NIOSH LIFTING EQUATION

- The NIOSH lifting equation aims to provide **recommended weight limits (RWLs)** that are protective of at least **75%** of working **women** and **99%** of working **men**
- **The lifting index** less than 1.0 is considered relatively safe for most workers.
- The load constant (**23 kg** [51 lb]) is **the highest RWL** that would be possible, under ideal circumstances of **good location**, **good coupling**, and **low repetition rate**.

"modifiers", reduce a worker's ability to lift and therefore would reduce the RWL:

- The horizontal modifier **(HM)**
- The vertical modifier **(VM)**
- The distance modifier **(DM)**
- An asymmetry modifier **(AM)**
- The frequency modifier **(FM)**
- A coupling modifier **(CM)**
- **RWL=23*HM*VM*DM*AM*FM*CM**

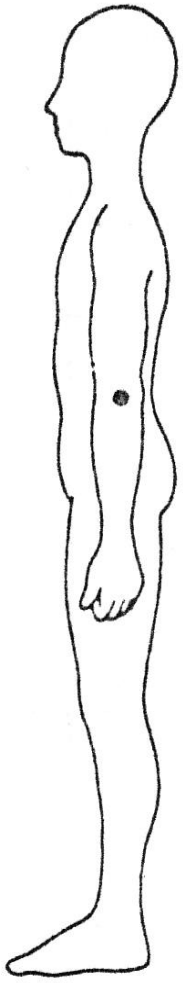


Low Back Pain (LBP)

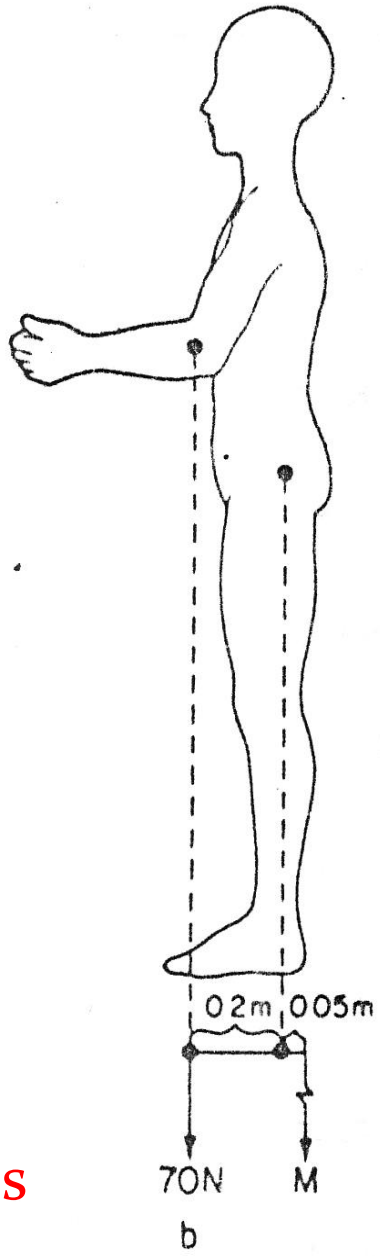
- Definition: A pain that occurs in the lumbar region , buttocks, or proximal posterior thighs
- Low back pain (LBP):
  - Specific LBP: specific cause can be found (disease, injury)
  - Non Specific LBP: specific cause cannot be found(80%of all)

Low Back Pain (LBP)

- Epidemiology:
  - Point Prevalence 18%
  - Life Long Prevalence 80% - 90%
- Cost:
  - Direct cost 12 billion $
  - Indirect cost 50 billion $



a



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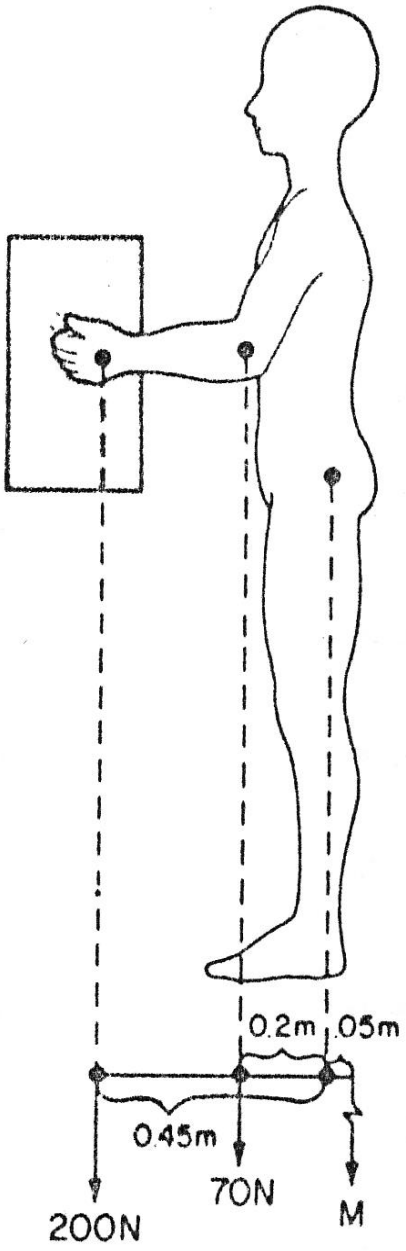


c

Biomechanics

Management of NSLBP

- A careful medical evaluation : for R/O serious spinal or non-spinal pathology
- In the absence of red flags:
  - Over-the-counter drugs (NSAIDs, Muscle relaxant, TCA, Steroid?)
  - Incomplete bed rest for 48 h, (as active as possible)
  - Leisure and work activities should be resumed as soon as possible
  - Spinal manipulation is helpful in acute NSLBP
  - Temporary symptomatic relief from heat and cold

Laboratory & Imaging

- ***X-rays:*** **no routine evaluation within the first 4 weeks. Unless a red flag and high index of suspicion.**
- ***CBC & ESR:*** **If symptoms >4 weeks**
- ***MRI:*** **persistent or progressive neurological deficits and an exam consistent with a nerve root impingement**

  (asymptomatic adults, prevalence of disk herniation 22-40%)

Prognosis

- Up to 90%: recover within 4 weeks and 96% recover between 4-12 weeks
- 4% of all patients remain disabled after 12 weeks
- Recurrence: 8.9% to 44% (social system, culture, type of work)
- Patients do not recover after 4 weeks: At risk for delayed recovery and prolonged disability

Occupational Low Back Pain

RED FLAGS

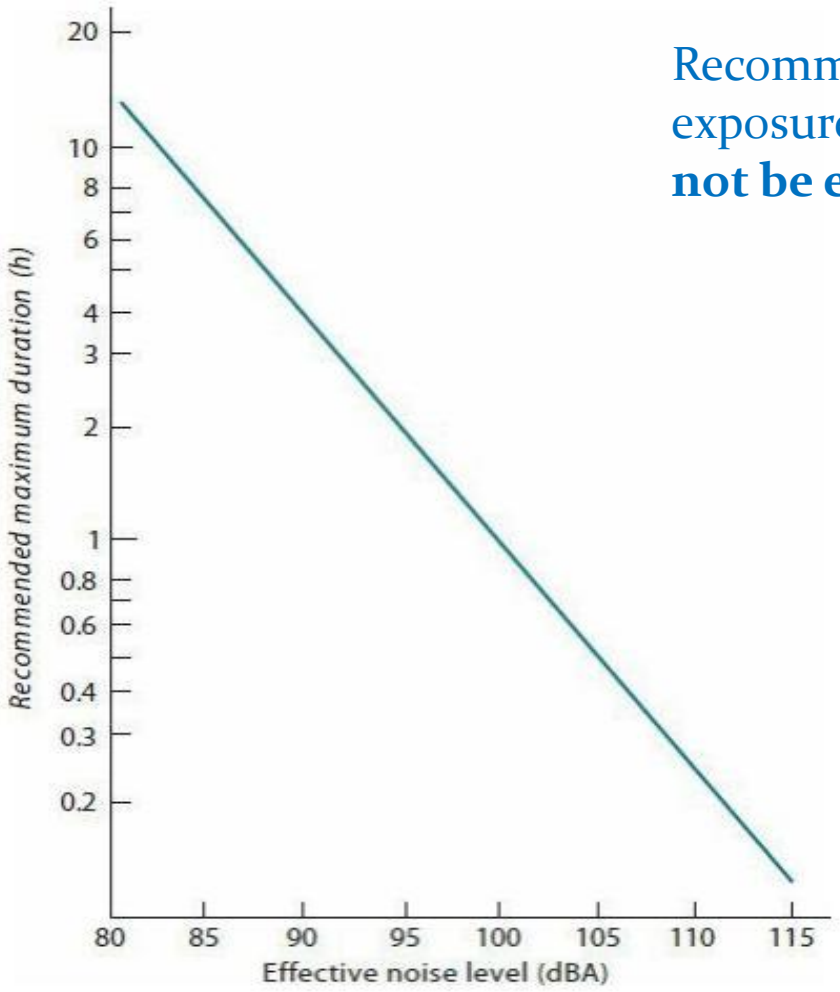
- **Presentation Age <20 or >55**
- **Non mechanical pain**
- **Constitutional symptoms (fever, weight loss)**
- **Widespread neurology**
- **Structural deformity**
- **Systemic disease**
- **History of cancer**
- **Systemic steroid use**
- **Recent bowel or bladder dysfunction**
- **Saddle anesthesia**
- **Violent trauma**

ENVIRONMENTAL FACTORS

Physical Hazards:

- Noise
- Lighting
- Temperature & Humidity
- Vibration

Noise



Recommended maximum duration of human exposure to various noise levels. Workers **should not be exposed** to sounds **above 115 dBA**

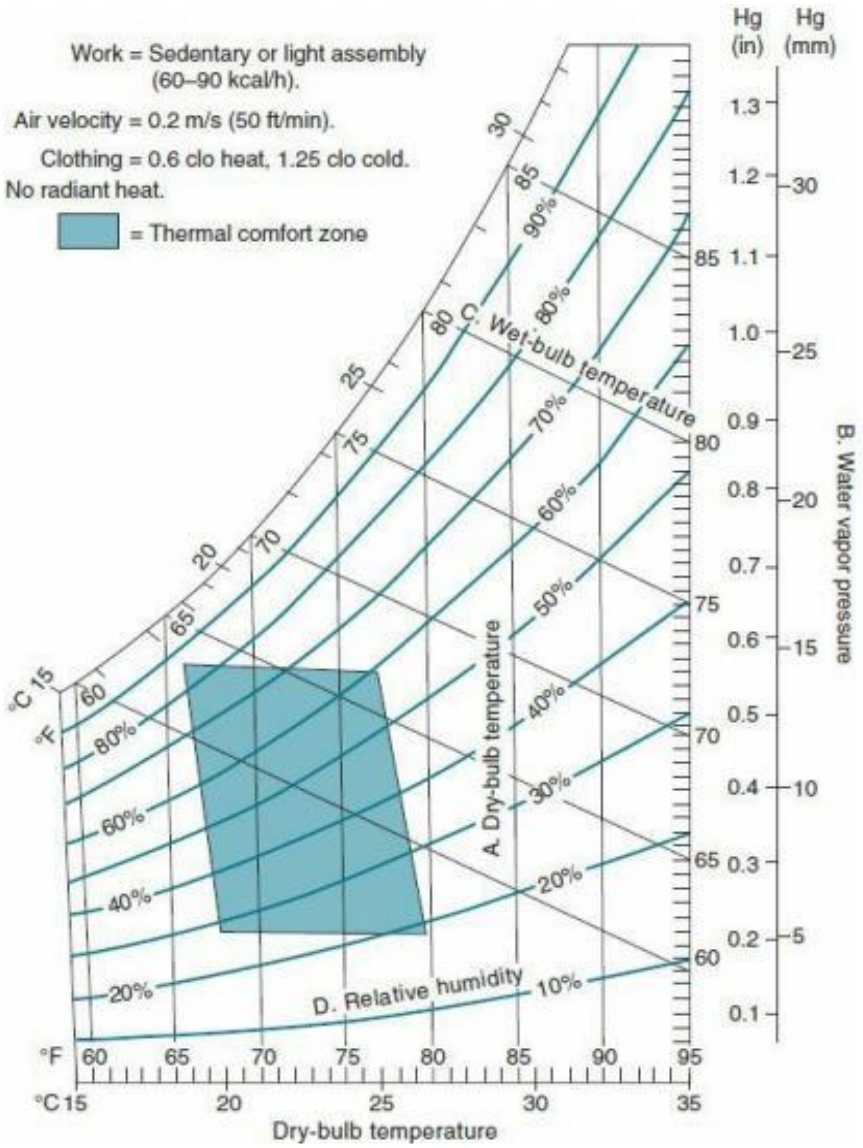
Lighting

Type of Activity or Area	Range of Illumination[a]	
	Lux	Footcandles
Public areas with dark surroundings	20–50	2–5
Simple orientation for short temporary visits	>50–100	>5–9
Working spaces where visual tasks are only occasionally performed	>100–200	>9–19
Performance of visual tasks of high contrast or large size: reading printed material, typed originals, handwriting in ink, good xerography; rough bench and machine work; ordinary inspection; rough assembly	>200–500	>19–46
Performance of visual tasks of medium contrast or small size: reading pencil handwriting, poorly printed or reproduced material; medium bench and machine work; difficult inspection, medium assembly	>500–1000	>46–93
Performance of visual tasks of low contrast or very small size: reading handwriting in hard pencil on poor-quality paper, very poorly reproduced material; very difficult inspection	>1000–2000	>93–186
Performance of visual tasks of low contrast and very small size over a prolonged period: fine assembly, highly difficult inspection, fine bench and machine work	>2000–5000	>186–464
Performance of very prolonged and exacting visual tasks: the most difficult inspection, extra fine bench and machine work, extra fine assembly	>5000–10,000	>464–929
Performance of very special visual tasks of extremely low contrast and small size: some surgical procedures	>10,000–20,000	>929–1858

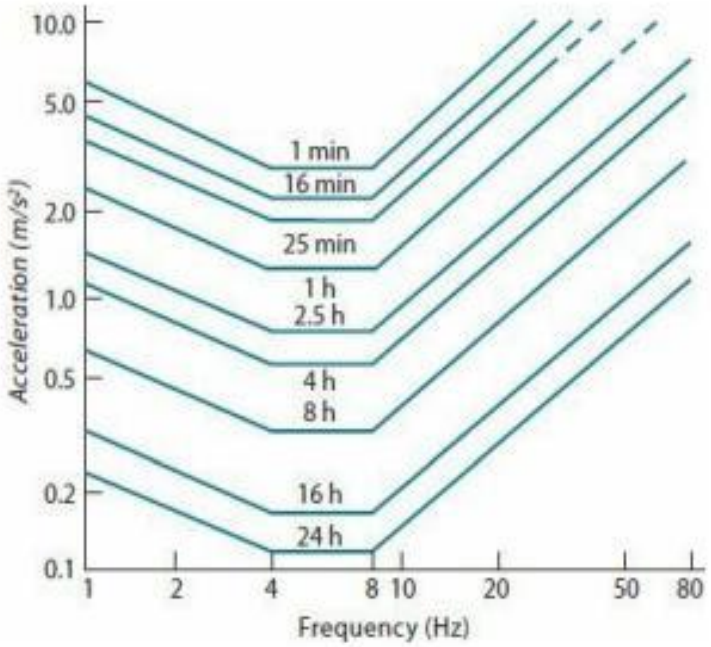
Recommended ranges of illumination for various types of tasks.

Temperature & Humidity

The thermal comfort zone :
is characterized by the ideal temperature and humidity conditions for work



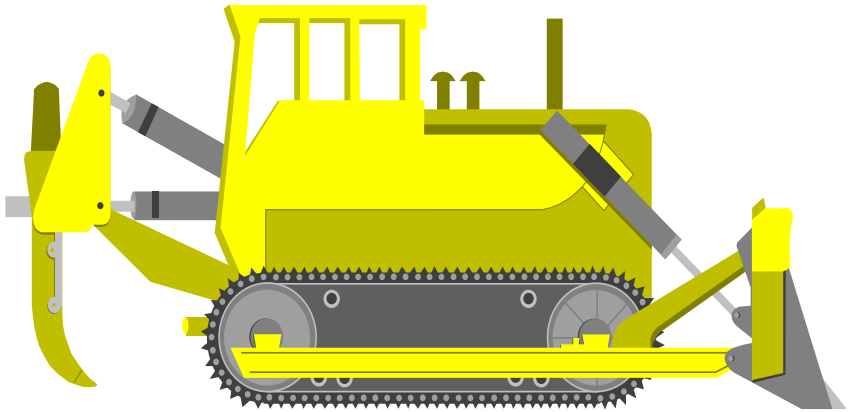
Vibration

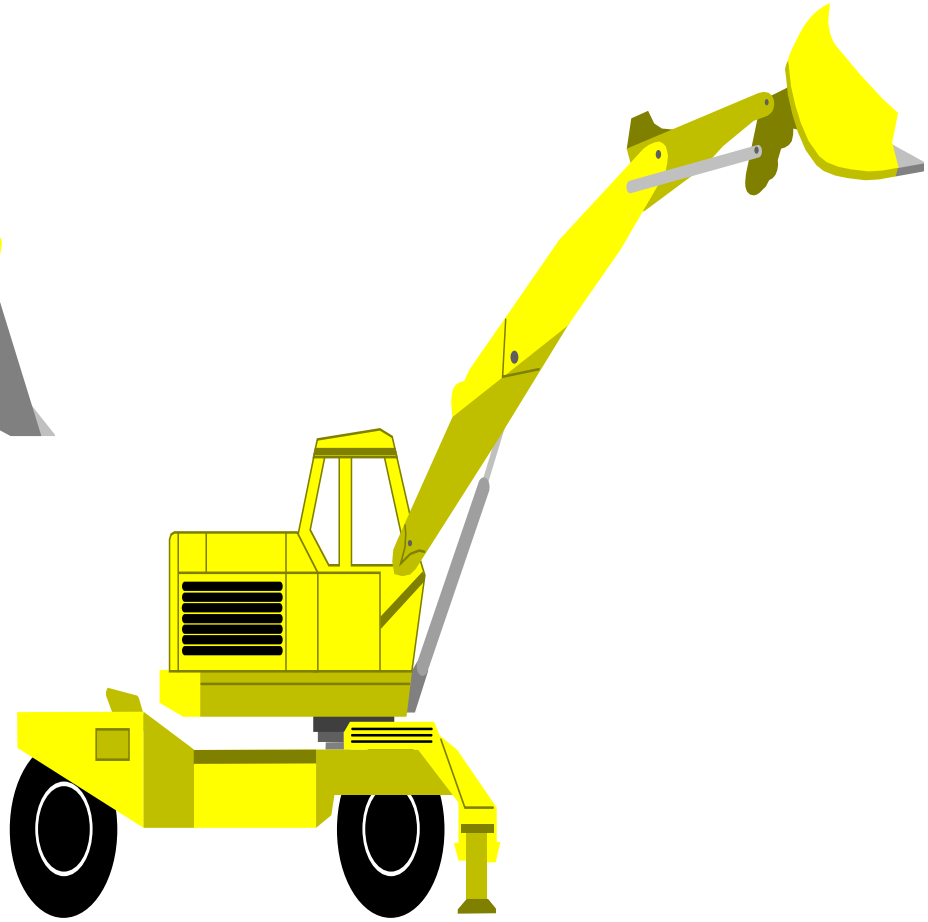


Maximum acceptable whole-body vertical vibration exposure times to various frequencies and accelerations.

The least-acceptable range of frequencies at all accelerations and durations of exposure is from 4 to 8 Hz

Whole Body VIBRATION





Hand Arm Vibration Syndrome
HAVS


Any Questions,
Thanks