

Ergonomics & Musculoskeletal Disorders

Ramin Mehrdad MD. MPH.

Center for Research on Occupational
Diseases (CROD)

Tehran University of Medical Sciences
(TUMS)

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:

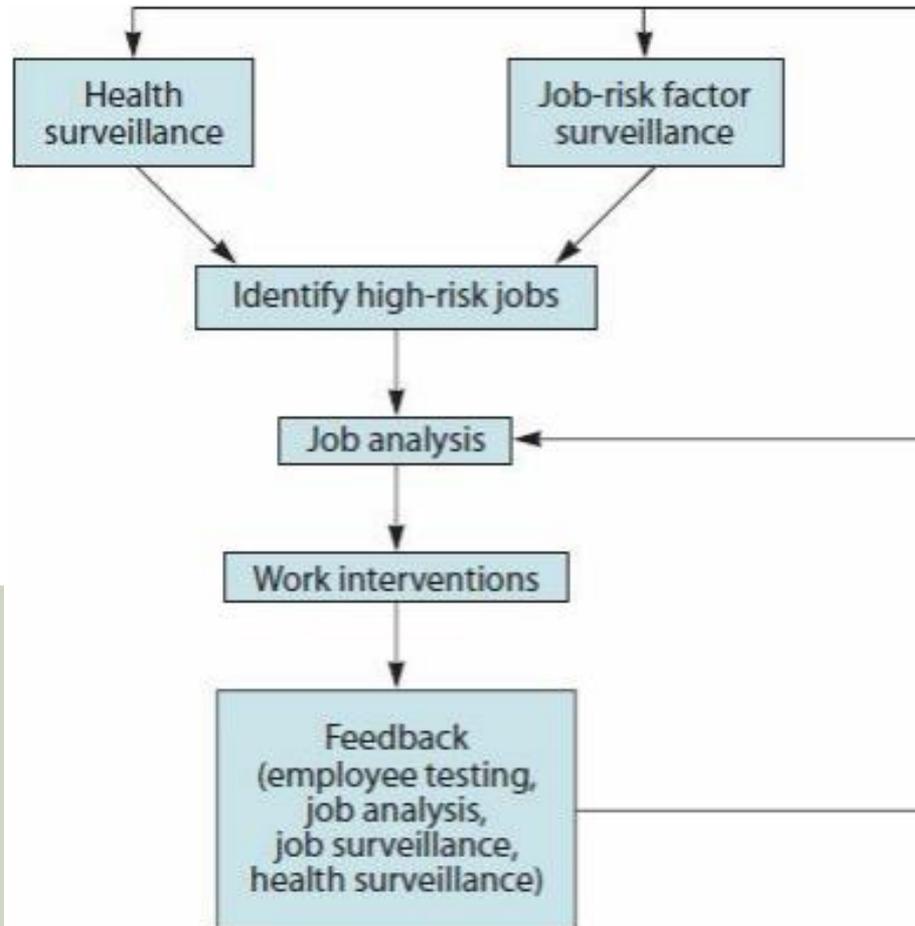
- Ergonomics is the **science and practice** of designing **jobs and workplaces** to match the **capabilities and limitations** of the human body.
- Ergonomics means **“fitting the job to the worker”**

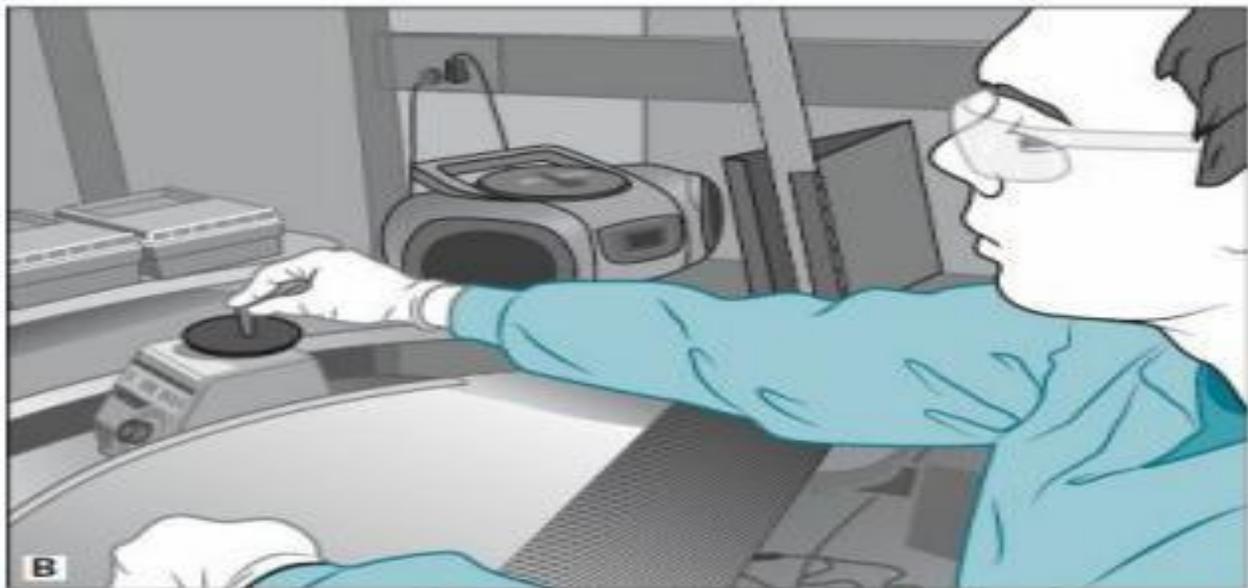
Approach to Prevention of Occupational Injuries

- 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





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)

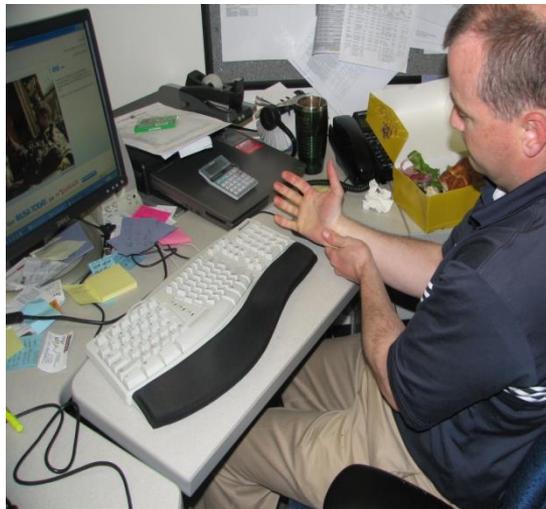
- Muscles
- Tendons
- Ligaments
- Bones
- Nerves
- Blood Vessels
- Disks

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.



www.shutterstock.com · 193462088



ACGIH_HAL

NIOSH Lifting Equation

The Strain Index



www.shutterstock.com · 161299151



www.shutterstock.com · 274561283



www.shutterstock.com · 86347318

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



www.shutterstock.com · 154592342



www.shutterstock.com · 73018588



www.shutterstock.com · 115301728



© Can Stock Photo - csp10503560

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



www.shutterstock.com · 302610677



www.shutterstock.com · 85711925



www.shutterstock.com · 226745545



Reduce Contact Stress

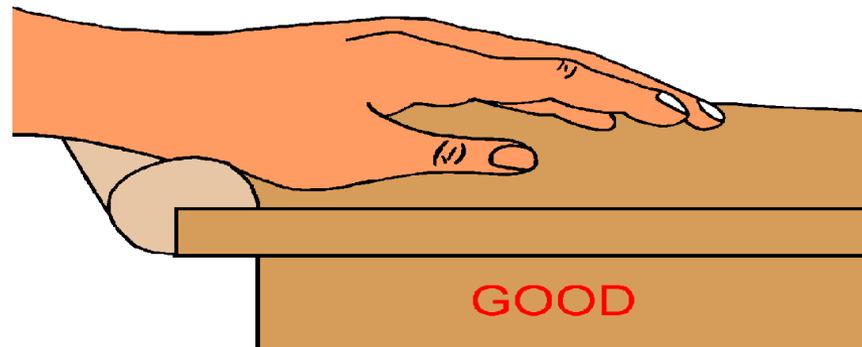
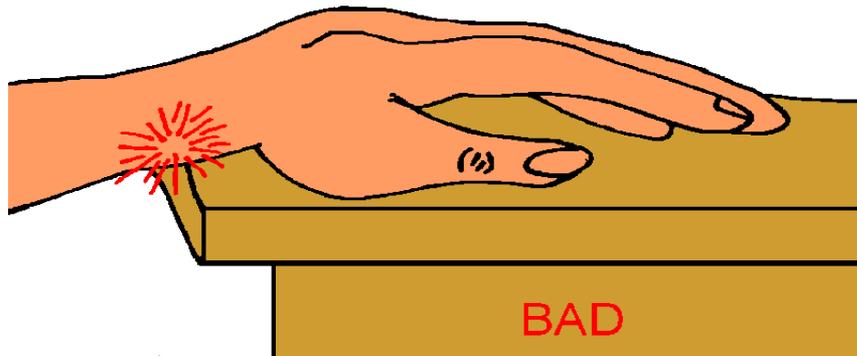


- support surfaces should be **rounded** and **padded** to minimize the risk of contact stress and located on sensitive body regions (rist or elbow).

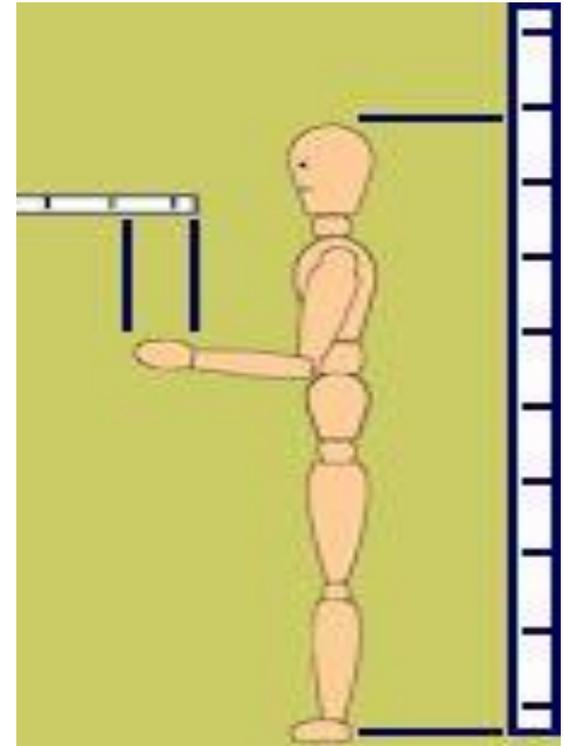
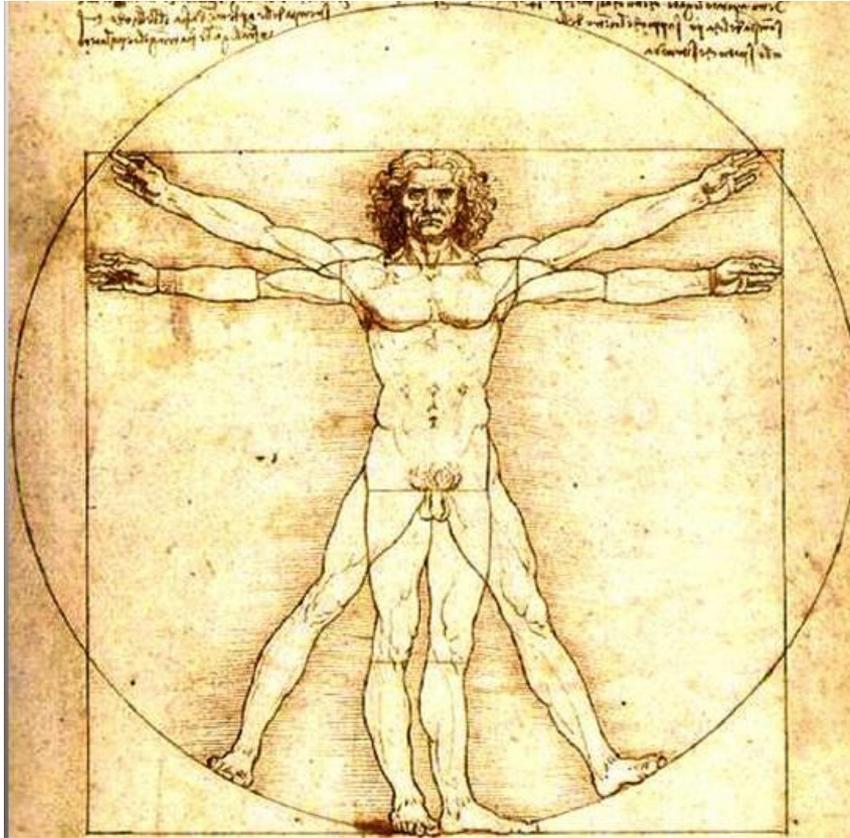


Forearm support for sustained work at the computer

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









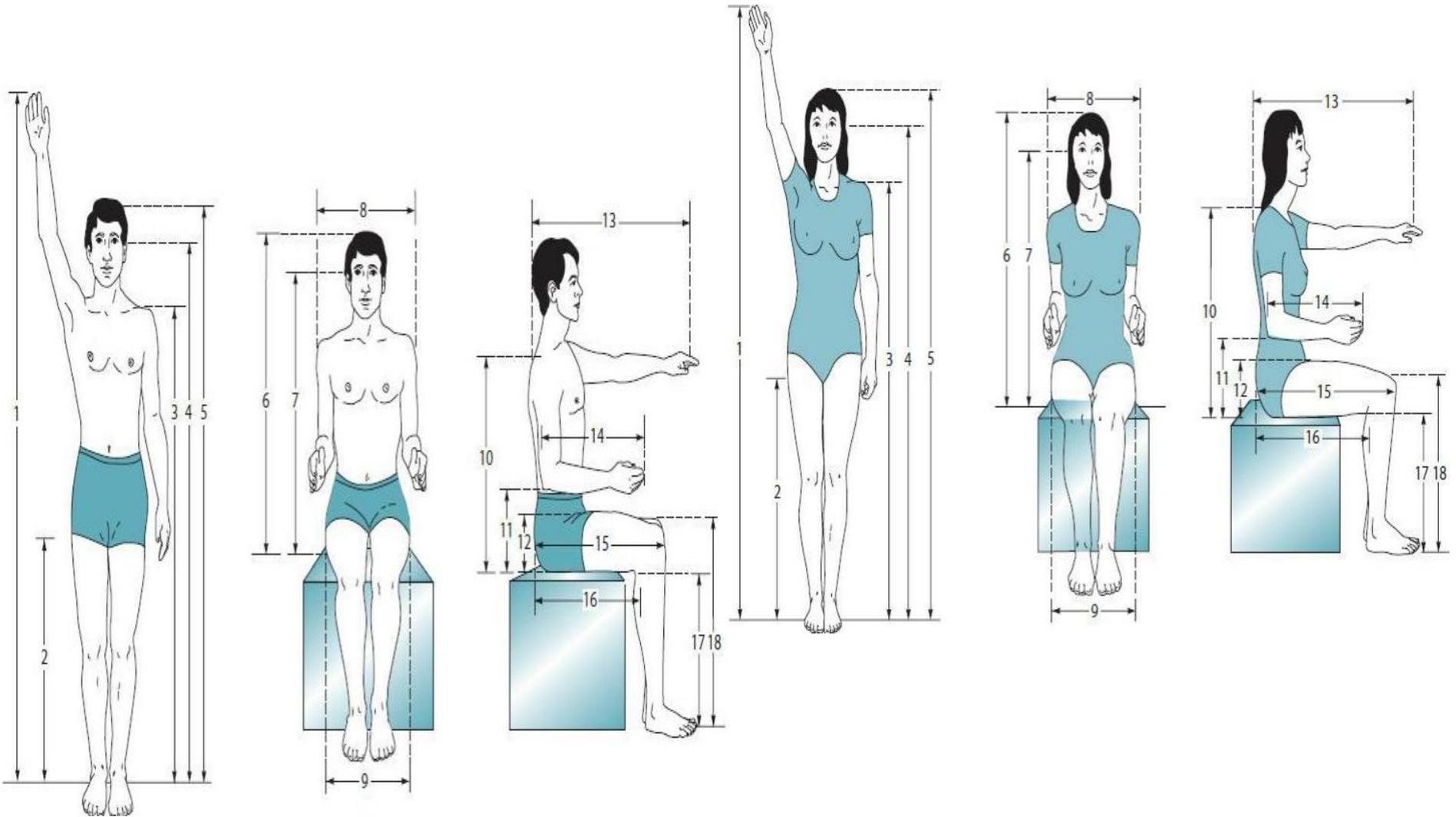




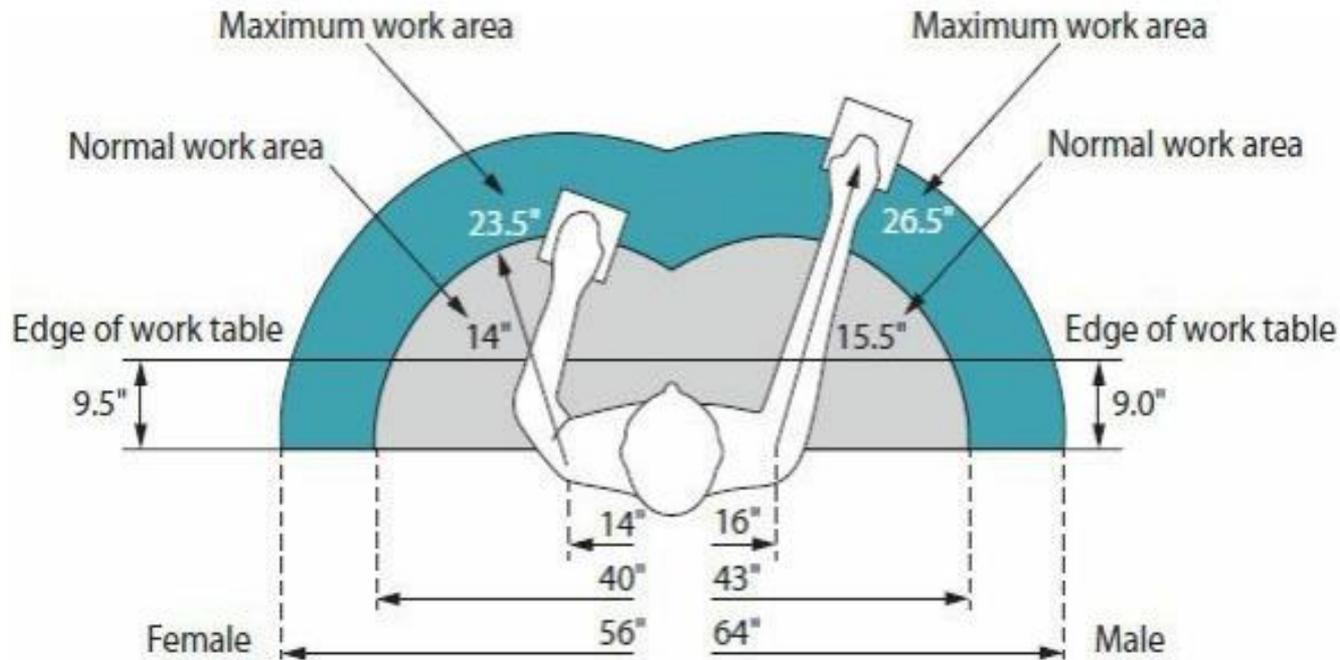
Male Body Dimensions (cm)

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





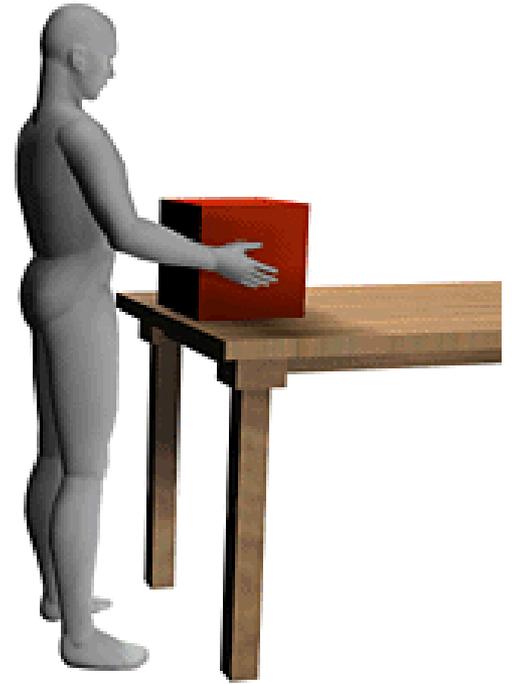
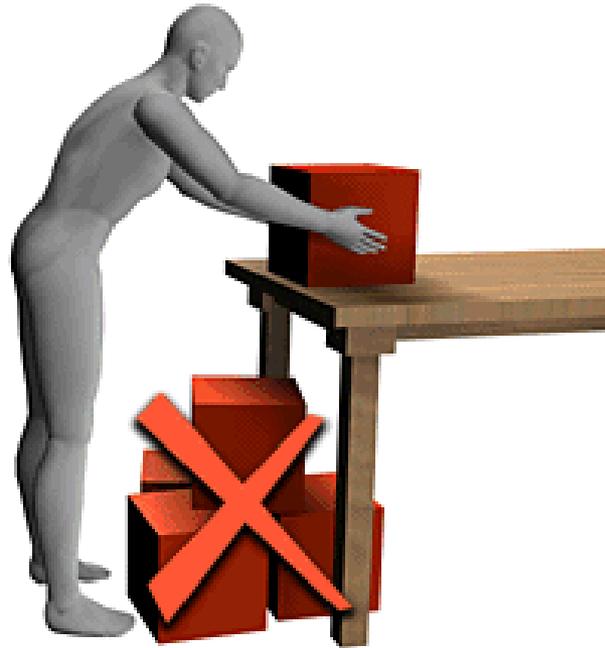
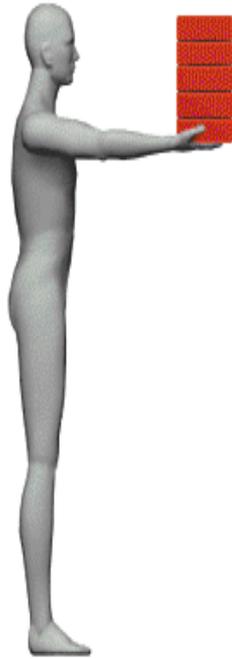


Forearm-only (preferable) and **full-arm (satisfactory)** reach limits for men and women in working areas shown in the horizontal and vertical planes.











Too low



Too far away



Too high

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

Too high



Too high



Too low

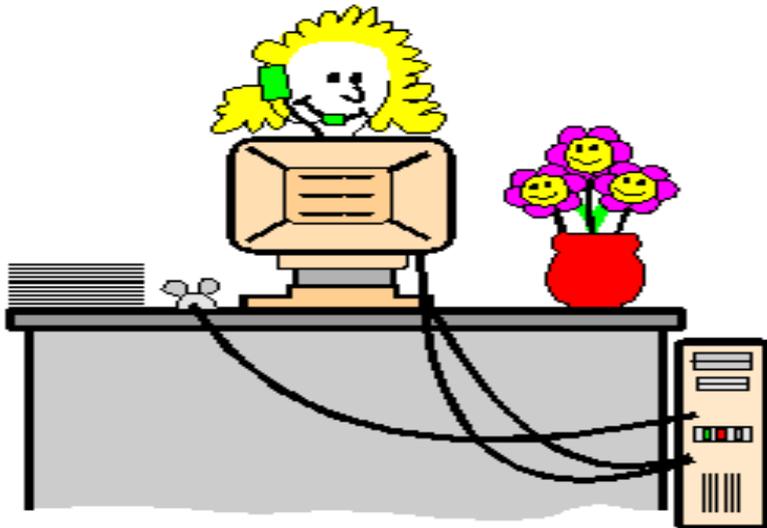
OFFICE ERGONOMICS



FROM THIS



TO THIS!



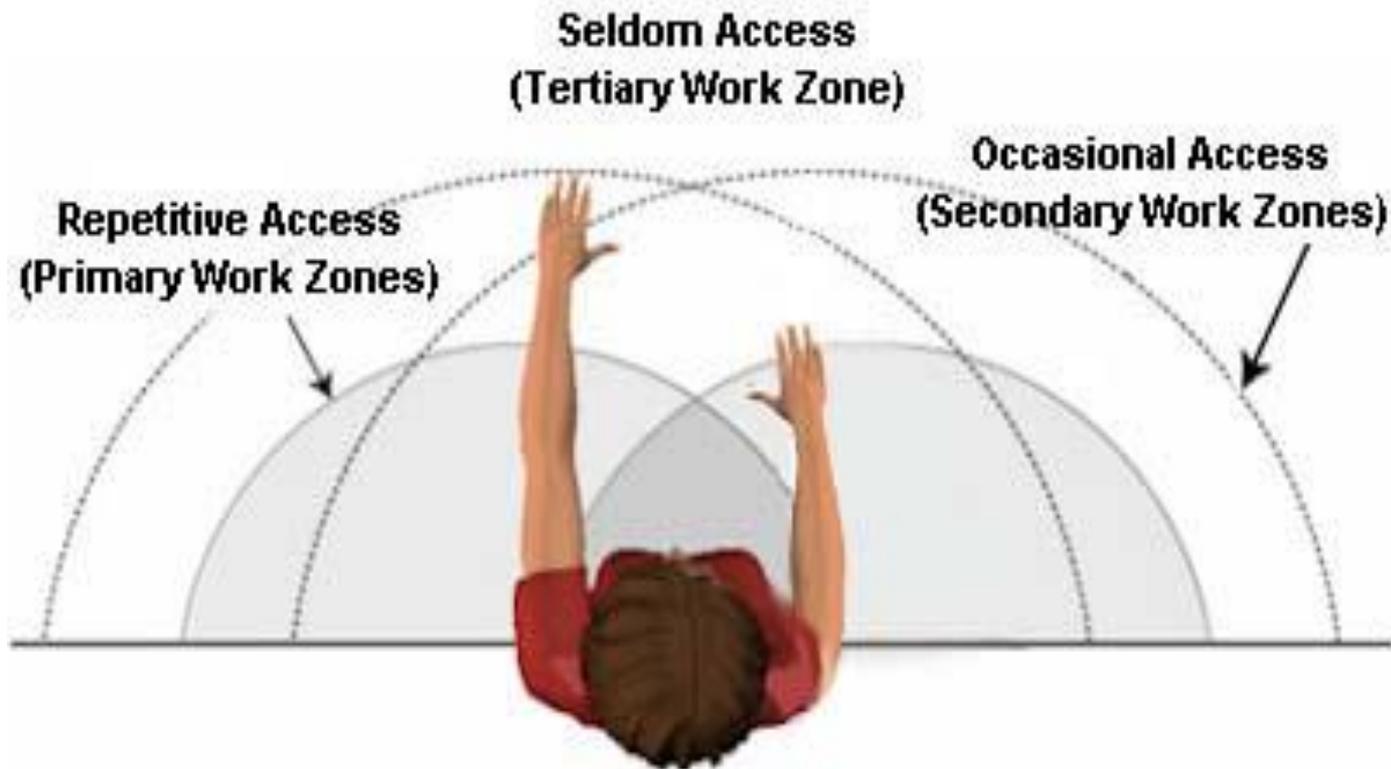
RATHER THIS!



THAN THIS

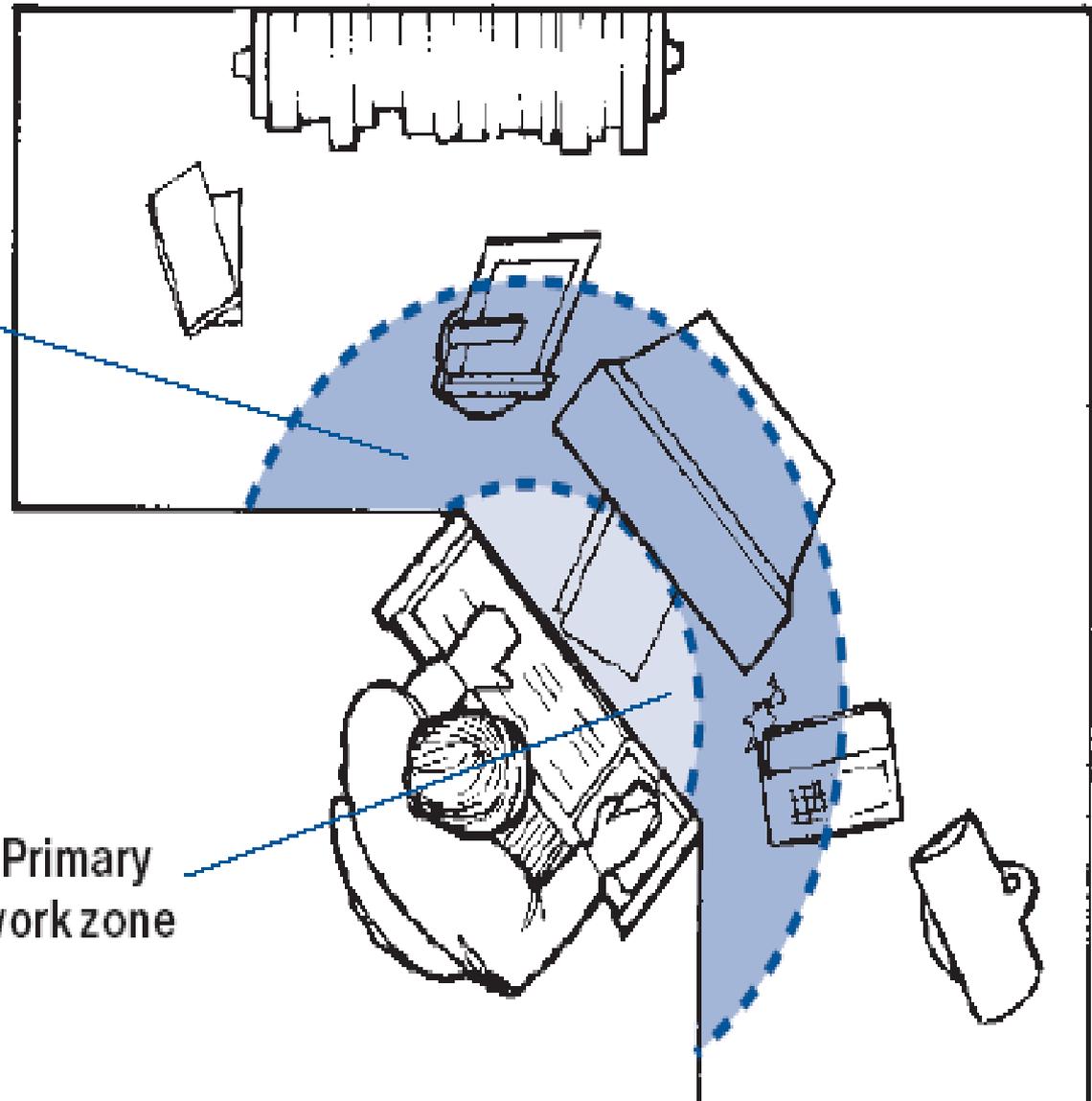
Logically Locate Controls & Displays

- ❑ **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









Declined Sitting



Reclined Sitting



Upright Sitting



Standing



Seat Pan



Seat pan length adjustment













Relaxed

**Armrest
too High**

**Armrest too
High & Wide**