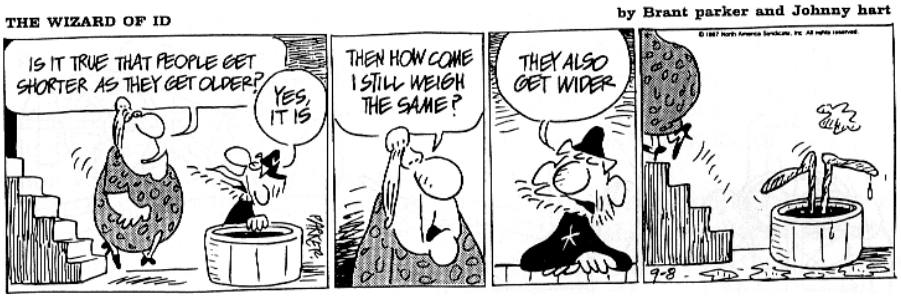
ANTHROPOMETRICS



ANTHROPOMETRICS

From the Greek: anthropos (man), metrein (to measure)

- ✓ Discipline that deals with body measurements: Body size, shape, strength and working capacity
- ✓ Helps answer:
  - How much weight can employees lift?
  - How far can they reach?
  - How much space do they need?

DESIGN ISSUES

- ✓ Enormous variations in body dimensions among individuals pose a great challenge for the design of equipment and workstations
  - ✓ E.g. Americans on average, are taller than Japanese and Chinese
  - ✓ Older people (over 50) tend to be weaker than those age 30
  - ✓ After 30, people begin to shrink in height due to changes in spinal disc thickness

DESIGN ISSUES

Should the design fit the average person?

DESIGN ISSUES

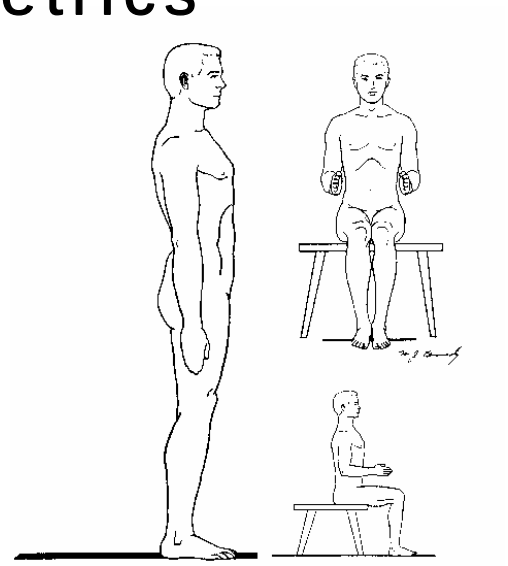
There are a few situations in which it is possible to design a product or workstation for a single user:

- ✓Custom made tailoring
- ✓Customized seats used by racing drivers
- ✓Workstations of astronauts

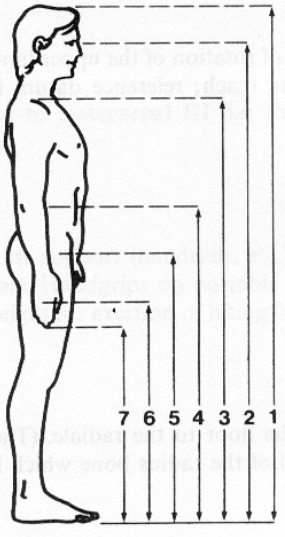
Differences in body size are related to:

- ✓Ethnic background
- ✓Gender
- ✓Age

Postures used in Anthropometrics

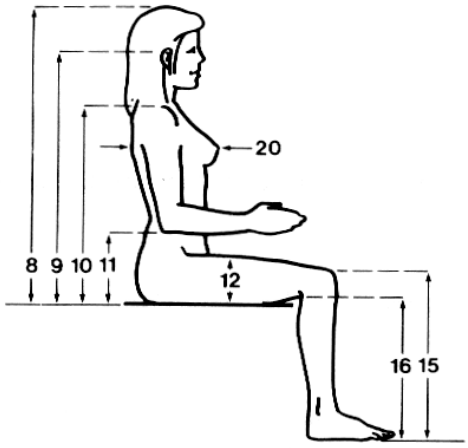


Body Dimensions



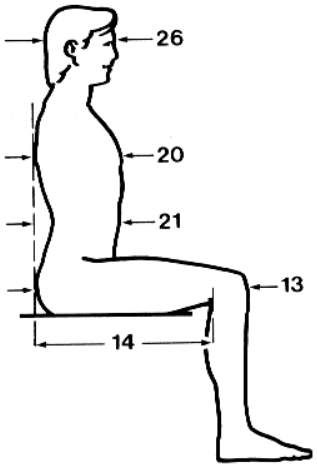
1 Stature
2 Eye height
3 Shoulder height
4 Elbow height
5 Hip height
6 Knuckle height
7 Fingertip height

Body Dimensions



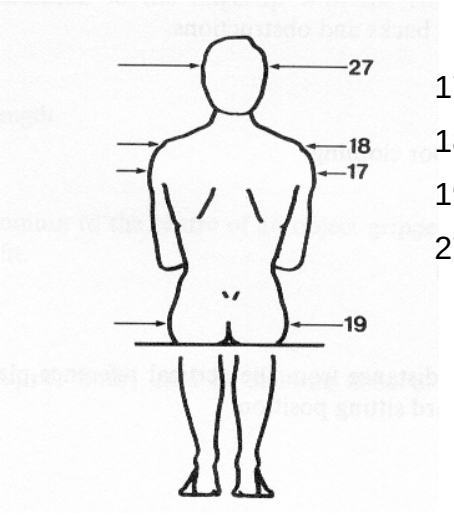
8 Sitting height
9 Sitting eye height
10 Sitting shoulder height
11 Sitting elbow height
12 Thigh thickness
15 Knee height
16 Popliteal height
20 Chest depth

Body Dimensions



13 Buttock-knee length
14 Buttock-popliteal length
20 Chest depth
21 Abdominal depth
26 Head length

Body Dimensions



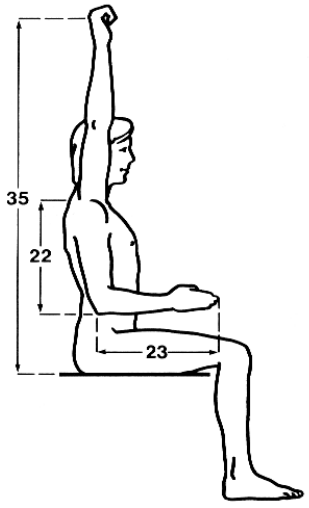
17 Shoulder breadth (bideltoid)

18 Shoulder breadth (biacromial)

19 Hip breadth

27 Head breadth

Body Dimensions

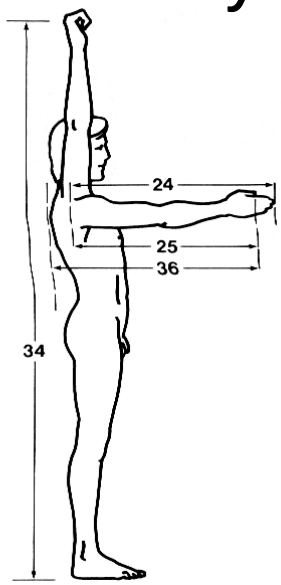


22 Shoulder-elbow length

23 Shoulder-fingertip length

35 Grip reaches

Body Dimensions



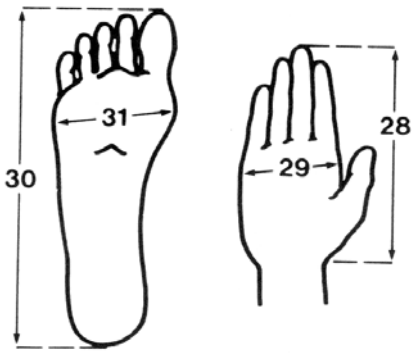
24 Upper limb length

25 Shoulder grip length

34 Grip reaches

36 Grip reaches

Body Dimensions



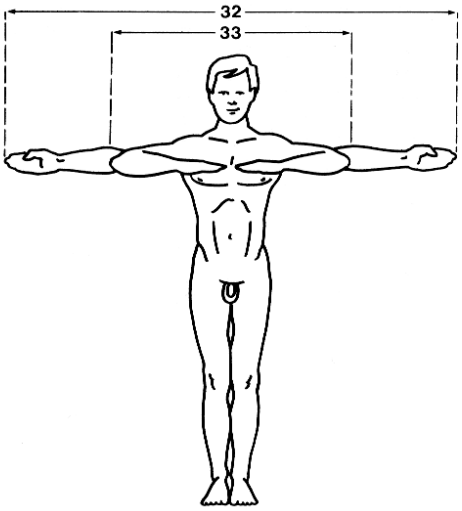
28 Hand length

29 Hand breath

30 Foot length

31 Foot breath

Body Dimensions



32 Span

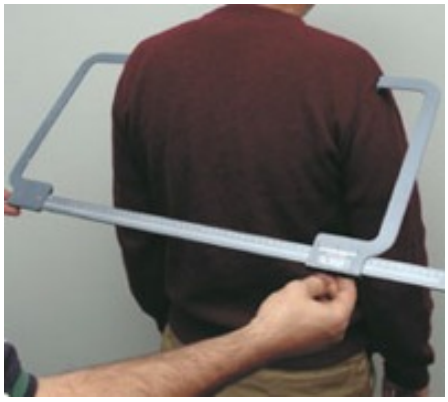
33 Elbow span

Anthropometric data sources:

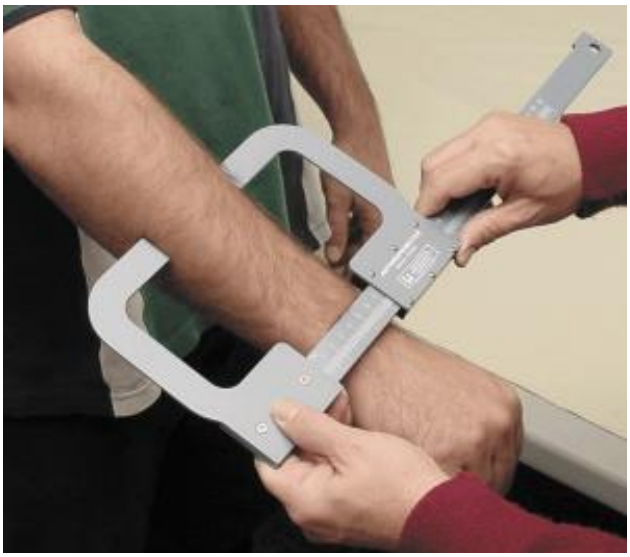
Anthropometric tables for:

- ✓Military standard tables
- ✓Civilian populations/adults
- ✓Industrial workers
- ✓Children

Anthropometric tools



Anthropometric tools



Anthropometric Constraints: Clearance

- When designing a work station it is necessary to provide adequate headroom, elbowroom, legroom, etc
- E.g. door height, manhole diameter, etc.
- Clearance dimensions should be selected to accommodate a larger member of the population
- Recommended: 95^{th} percentile male

Don't forget!

- When specifying clearance dimensions, allowances for shoes and clothing must be added
- There are standard values for allowances. Some depend on occupation, industry, etc

Adjustments to Anthropometric Data

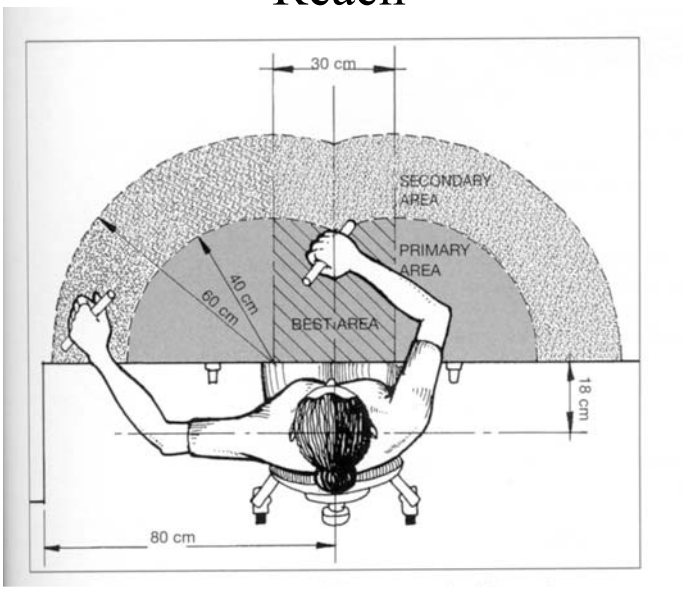
from Marras and Kim 1993

- Shoe height add 1 inch / 2.54 cm
- Shoe Weight add 2.0 lbs / 0.9 kg
- Clothing adds 0.6 inches / 0.8 cm to torso breadths
- Clothing (excluding shoes) adds 1.0 lbs / 0.45 kg to weights

Anthropometric Constraints: Reach

- When designing a work station it is necessary to locate all controls, storage bins, tools, etc. within easy reach of the operator
- The objective is to establish maximum acceptable reach requirements.
- Reach dimensions should be selected to accommodate a small member of the population
- Recommended: 5^{th} percentile female

Reach



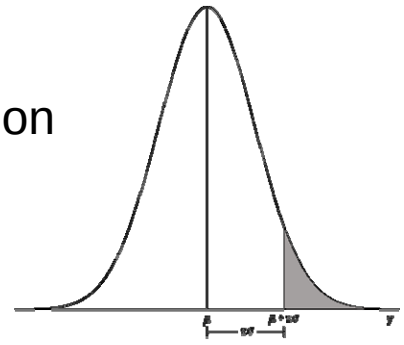
Anthropometric Constraints: Posture

- Certain features of a work station have a strong influence on posture
- E.g. height of a work table → too low: worker must flex his/her trunk; too high: worker must elevate the arms
- Recommended: adjustable

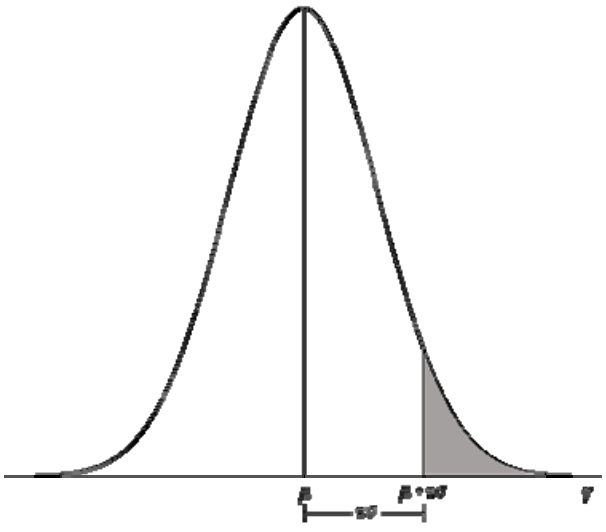
Statistical Procedures

What to do with anthropometric data?

- ✓The normal distribution
- ✓Mean
- ✓Standard deviation



Normal Distribution



Normal Distribution

- Based on a population for a specific measure
- Population mean is mu
- Population deviation is sigma
- For our purpose, we will be assuming normality of data
  - Substitute sample values in for population values
- Z Score
  - $Z = (x - X_{bar}) / sx$

Mean and Standard Deviation

- Formula for Mean
  - $X_{bar} = (x_1 + x_2 + x_3 + x_4 + \ldots. x_n) / n$
  - $= \sum x / n$
- Formula for sample standard deviation
  - $sx = \sqrt{(\sum (x - X_{bar})^2 / (n-1))}$

PERCENTILES

Percentile: a point on the distribution

$$X_{(p)} = \overline{X} + S \times Z$$

Commonly Used Z Values

- $Z_{.05}$ = 1.645, 5th and 95th percentile
- $Z_{.025}$= 1.960, 2.5 and 97.5 percentile
- $Z_{.01}$ = 2.326, 1st and 99th percentile
- $Z_{.005}$= 2.576, 0.5th and 99.5th percentile

Conversions we'll need

- 1 inch = 2.54 cm = 25.4 mm
- 1 lb= 0.454 kilogram
- 1 kilogram = 2.205 lbs