

## Chapter 5

# Anthropometry

## Anthropometry

*Anthropos* (man) + *metrein* (to measure)  
The study of how people vary in

- Initiative
- Imagination
- Needs
- Dexterity
- Intelligence
- Visual acuity
- Determination
- Upper back strength
- Age
- Leg length
- And so forth

## Selection vs. Job Modification

- Two basic strategies:
  - Selection—fit the person to the job.
  - Job modification—fit the job to the person
- Follow the second: the key to progress has been to challenge the environment.

## Exclude as Few as Possible

- Minimizes the number of people excluded
- Tends to make the job easier for everyone
- Balance seriousness of exclusion with cost of inclusion

## Excluded Percentile

- May be:
  - Upper (a door tall people can't fit under)
  - Lower (a task requiring manual dexterity)
  - Both (intelligence test for factory job)
- Designing for the mean may exclude half the population.

## Population Dimensions

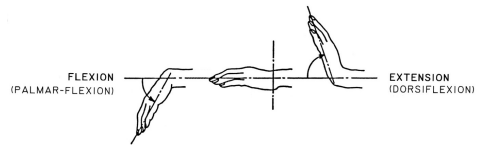
- Define the user population.
- Consider the source of population dimensions
  - Male/female
  - Military/civilian
  - Age
  - Ethnicity
  - Occupation

## Body Position Descriptions

- Planes
  - Sagittal (medial/lateral)
  - Coronal (anterior/posterior)
  - Transverse (superior/inferior)
- Limbs
  - Proximal
  - Distal

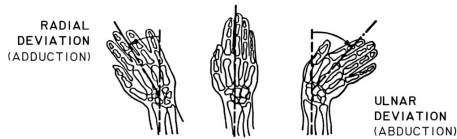
## Wrist/Hand Motions

- Flexion/extension



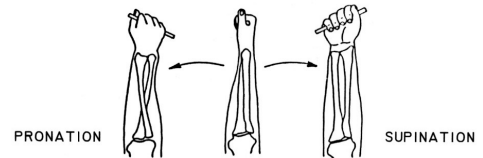
## Wrist/Hand Motions

- Radial deviation/ulnar deviation



## Wrist/Hand Motions

- Pronation/supination



## Body Dimensions

- Sample 95th percentile dimensions (cm) of nude U.S. adult civilians.

	Female	Male
Stature (height)	173.73	186.65
Eye height	162.13	174.29
Thigh height (sitting)	18.02	18.99
Forward reach	79.67	86.70
Hip breadth (sitting)	43.22	41.16
Weight (kg)	84.8	99.3

## Variations in Stature

- Depend largely on length of legs
- Do not predict other body dimensions
- Do not correspond to other measures (e.g., intelligence, dexterity)
- Female may be estimated as 93% of male if no data available

## Variations in Strength

- Females average 63% isometric strength of males.
- Strength of specific muscle groups varies depending on
  - Limb: Leg approx. 3 times strength of arm
  - Direction exerted: Strength may decrease by 50%
  - Preferred hand/arm/leg: Strength may vary by 40–50%
- Left and right leg strengths do not differ appreciably.

## Other Characteristics

- Weight and center of mass
- Manual dexterity
- Surface area
- Age
- Personal space
- Aisles/corridors/doors

## Body Dimensions

	% of total body weight	% of total body surface area
Head	7.28	8.5
Arm	4.9	9
Leg	16.10	18
Trunk	50.70	38

## Personal Space

- Intimate (0 – 18 in.)
- Personal (18 – 48 in.)
- Social (4 – 12 ft)
- Public (> 12 ft)
- Boundaries vary with gender, familiarity, and culture.
- Territoriality refers to long-term occupancy of space.

## Aisles

- One-way traffic, people only: 3 ft min
- Door opening into aisle: 6 ft min
- Doors opening on both sides: 8 ft min
- Aisles for people only need not be straight.
- Corridors (aisles with walls) must be wider.

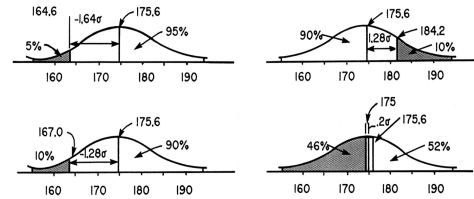
## Age of Workforce

- Birth rate is declining.
- Additional workers must come from
  - Immigration
  - Longer work hours
  - Delayed retirement
  - Older workers must be considered.

## Statistical Calculations

- Normal distribution provides a close approximation.
- Mean (average) is 50th percentile.
- Normal distribution is symmetrical.
- Absolute variability given by standard deviation.
- Relative variability given by coefficient of variation.

## Normal Distribution



## Distribution Calculations

- **To Find Percentile**
  - Find difference from the mean (subtract).
  - Convert to standard units (divide by standard deviation).
  - Use table to find percentile.

## Distribution Calculations

- **To Find Dimension**
  - Use table to find number of standard units from mean.
  - Convert to dimension measure (multiply by standard deviation).
  - Add or subtract mean.

## Design for Population or Person?

- If for population, what population?
  - Current employees?
  - Potential employees?
  - Everyone in the world?
- If for person, how?
  - Adjustability?
  - Discrete sizes?