Physical Ergonomics: Anthropometry

Work Systems and the Methods, Measurement, and Management of Work
by Mikell P. Groover, ISBN 0-13-140650-7.

Definition of Anthropometry

The part of anthropology (study of humans) having to do with measurements of the human body to determine differences in races, individuals, etc…

Source : *Webster's New 20th Century Dictionary* (1970)

Anthropometry is a science that deals with the measurement of size, weight, and proportions of the human body. It is empirical (experimentally derived) in nature and has developed quantitative methods to measure various physical dimensions. (Chaffin, 1984)

Anthropometry

- Empirical science concerned with the physical measurements of the human body, such as height, range of joint movements, and weight
- Derived from the Greek words anthropos (man) and metron (to measure)
- Usually considered a branch of anthropology
- Strength characteristics also sometimes included in the scope of anthropometry

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Anthropometric Analysis and Data

1. Static dimensions – body measurements while in a fixed position
   - Data are more easily determined, so much more static data are available

1. Dynamic dimensions – body measurements while performing some physical activity
   - Probably more relevant in design

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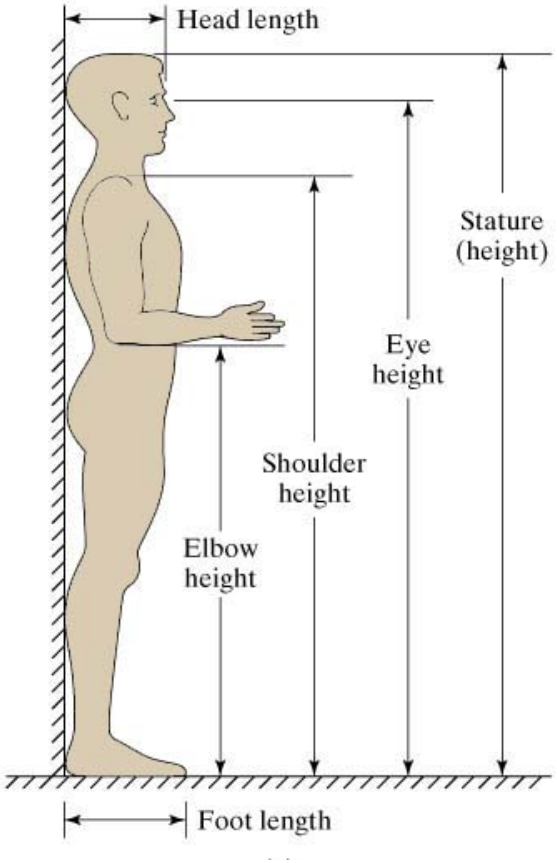
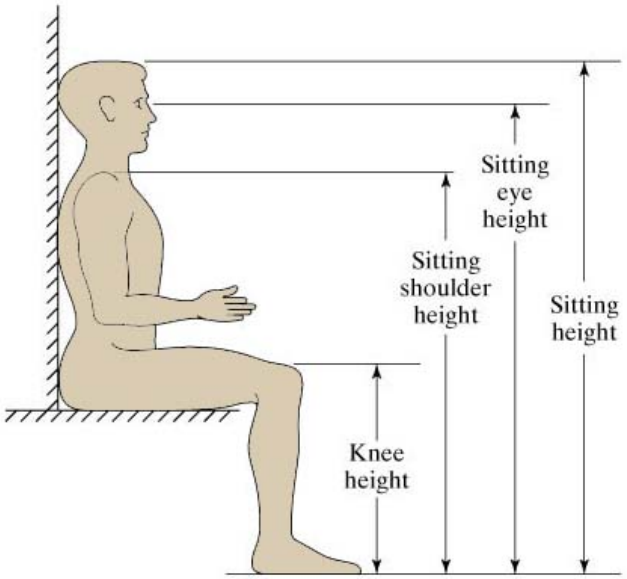
Human Variability

- Differences in body dimensions exist among people because of:
  - Ethnicity and Nationality
  - Heredity
  - Diet
  - Health
  - Sex
  - Age
  - Living conditions

Static Dimensions of Human Body

Standing





Seated

Standing Heights of Males and Females throughout the World

	Males		Females	
Region	Centimeters	Inches	Centimeters	Inches
North America	179	70.5	165	65.0
Northern Europe	181	71.3	169	66.5
Central Europe	177	69.7	166	65.4
Southeastern Europe	173	68.1	162	63.8
India, North	167	65.7	154	60.6
India, South	162	63.8	150	59.1
Japan	172	67.7	159	62.6
Southeast Asia	163	64.2	153	60.2
Australia (European)	177	69.7	167	65.7
Africa, North	169	66.5	161	63.4
Africa, West	167	65.7	153	60.2

Anthropometric Data

- Anthropometric data for a homogeneous population usually obeys normal distribution

- Published data indicate not only mean values but also some measure of dispersion
  - Percentile limits on the variable
    - 5^{th} and 95^{th} percentile points common
  - Standard deviation
    - Applies to specific anthropometric variable

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Normal Distribution in Anthropometry

Normal distribution for a given anthropometric variable of interest

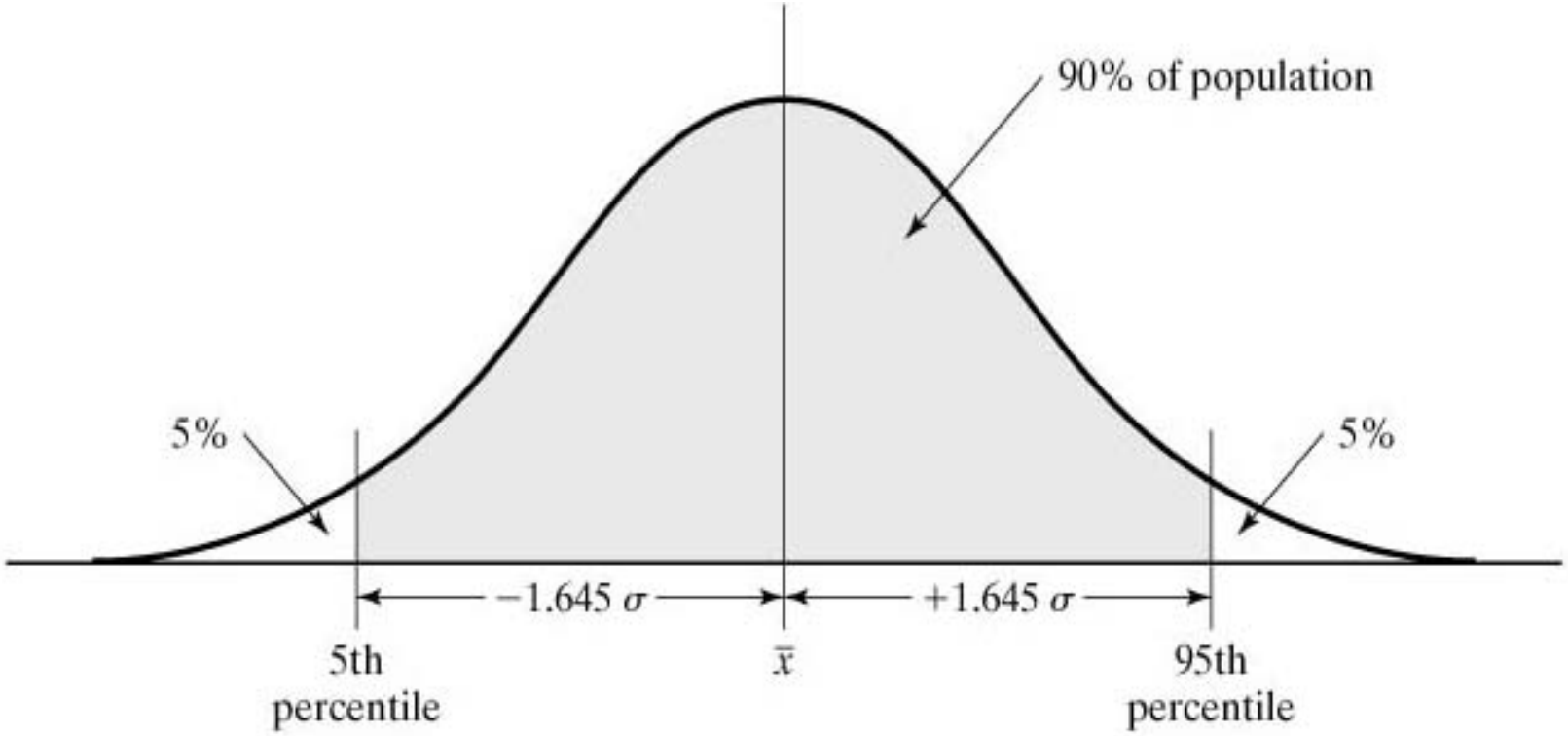

Table 15. Height in centimeters for females 20 years and over- number of examined persons, mean, standard error of the mean, and selected percentiles, by race-ethnicity and age : United States, 1988-1994

Race-ethnicity and age	Number of examined persons	Mean	Standard error of the mean	Selected percentile								
				5th	10th	15th	25th	50th	75th	85th	90th	95th
All race/ethnicity groups[1]												
20 years and over	9,067	161.8	0.15	150.4	153.1	154.9	157.2	161.7	166.4	169.1	170.8	173.1
20-29 years	1,867	162.7	0.26	151.7	154.5	155.7	158.0	162.6	167.7	170.2	171.7	174.3
30-39 years	1,863	163.4	0.26	152.1	154.7	156.3	158.8	163.5	168.2	170.4	172.2	174.9
40-49 years	1,371	162.8	0.28	152.0	154.9	156.6	158.6	162.6	167.1	169.6	170.9	172.9
50-59 years	1,009	161.8	0.32	151.5	154.0	155.6	157.5	162.1	166.1	168.4	170.3	172.2
60-69 years	1,177	160.2	0.30	150.0	152.3	154.1	156.1	160.1	164.7	166.5	168.5	171.2
70-79 years	988	158.0	0.34	147.2	149.8	152.1	154.0	158.2	162.6	164.8	166.1	167.9
80 years and over	792	154.9	0.39	143.8	146.2	148.2	150.9	155.1	159.4	161.8	163.5	165.7

Table 5. Weight in kilograms for males 20 years and over-number of examined persons, mean, standard error of the mean, and selected percentiles, by race-ethnicity and age : United States, 1988-1994

Race-ethnicity and age	Number of examined persons	Mean	Standard error of the mean	Selected percentile								
				5th	10th	15th	25th	50th	75th	85th	90th	95th
All race/ethnicity groups[1]												
20 years and over	7,942	82.1	0.38	59.7	63.7	66.1	70.9	80.0	90.6	97.5	102.8	110.8
20-29 years	1,630	78.3	0.62	57.7	60.9	63.1	67.1	75.0	85.3	93.2	99.1	107.7
30-39 years	1,481	83.0	0.68	61.8	64.6	67.4	72.0	79.9	91.3	98.8	102.9	112.7
40-49 years	1,226	85.1	0.76	61.5	66.0	68.6	74.4	82.2	93.9	101.6	105.7	116.6
50-59 years	855	86.0	0.80	63.4	68.2	72.0	75.7	84.1	94.0	100.7	105.3	114.3
60-69 years	1,175	83.1	0.65	61.1	64.5	67.7	72.8	82.4	92.5	98.4	102.0	107.3
70-79 years	875	79.0	0.71	58.5	62.0	64.2	68.8	77.9	87.0	93.5	96.1	103.3
80 years and over	700	71.8	0.74	52.0	56.2	58.4	63.6	70.8	78.7	84.1	88.0	93.1

Table 19. Sitting height in centimeters for females 20 years and over-number of examined persons, mean, standard error of the mean, and selected percentiles, by race-ethnicity and age : United States, 1988-1994

Race-ethnicity and age	Number of examined persons	Mean	Standard error of the mean	Selected percentile								
				5th	10th	15th	25th	50th	75th	85th	90th	95th
All race/ethnicity groups[1]												
20 years and over	8,598	85.5	0.09	78.8	80.5	81.6	83.0	85.6	88.1	89.5	90.4	91.7
20-29 years	1,837	86.1	0.13	80.2	81.5	82.5	83.6	86.1	88.5	90.0	90.9	92.0
30-39 years	1,837	86.7	0.13	80.6	82.0	82.9	84.4	86.6	89.1	90.3	91.3	92.5
40-49 years	1,338	86.5	0.15	80.8	82.1	82.9	84.1	86.6	88.9	90.1	90.9	92.5
50-59 years	981	85.5	0.17	79.5	80.8	82.1	83.4	85.6	88.0	89.1	89.8	91.1
60-69 years	1,107	84.0	0.15	78.6	79.9	80.9	82.0	84.0	86.2	87.4	88.4	89.5
70-79 years	894	82.4	0.20	76.0	77.6	78.7	80.2	82.8	84.9	86.2	86.8	88.0
80 years and over	604	79.6	0.24	72.9	74.5	75.6	77.1	79.6	82.4	83.6	84.6	85.8

Anthropometric Design Principles

- Design for extreme individuals
- Design for adjustability
- Design for the average user
- Design different sizes for different size users

Design for Extreme Individuals

- Designing for the maximum (95th percentile)
  - Doorway heights
  - Automobile door openings
  - Mattress sizes

- Designing for the minimum (5th percentile)
  - Heights of kitchen cabinets
  - Locations of levers and dials on equipment
  - Weights of portable power tools

Design for Adjustability

- To accommodate a wide range of users

- Examples:
  - Automobile driver seats
  - Adjustable steering wheel in an automobile
  - Office chairs
  - Worktable heights
  - Tilt angles of computer monitors
  - Lawnmower handle heights
  - Bicycle handlebars

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Design for Average User

- For situations in which design for extreme individuals and adjustability are not feasible
- Design for 50 th percentile
- Examples:
  - Stair heights
  - Stadium seats
  - Sofas
  - Heights of checkout counters at supermarkets
  - Lengths of shovel handles

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Different Sizes for Different Size Users

- When the only way to accommodate user population is to make the product in different sizes

- Examples:
  - Clothing
  - Shoes
  - Elementary school desks and chairs

Different Sizes for Different Size Users

Example: Men's suit coat sizes available from mail-order clothing store

Coat sizes	37	38	39	40	42	44	46	48	50	52	54	56	58	60
Short (under 5'8")	x	x	x	x	x	x								
Regular (5'8" to 5'11")	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Long (6' to 6'3")				x	x	x	x	x	x	x	x	x	x	x
Extra long (over 6'3")					x	x	x	x	x	x	x	x		
Portly short (under 5'8")					x	x	x	x						
Portly regular (5'8" to 5'11")					x	x	x	x	x	x				