Experiment #1
Anthropometry and Workspace design

Objective:

1. To learn how to use the measuring instruments.
2. To learn how to locate and describe reference points for taking anthropometric measurements.
3. To determine an appropriate set of anthropometric measurements to be able to design a workplace, a product or a tool.
4. To anthropometric measures in percentiles of any similar population for which data are available.

Background:

Anthropometry is the study of the physical dimensions, proportions, and composition of the human body. The objective in applying anthropometric data will be to improve the design of things and spaces for people to use so that they are more comfortable, efficient, easy to use and safer than previous designs.

Example: if a seat height is to be decided and for economic or other reasons it is not possible to provide any adjustability, e.g. Seats in public places or in public transport, then the most important dimension is popliteal height which is the vertical distance from the sole of the foot to the crook of the knee.

This distance is important to the sitter because if the seat is a little higher than his or her popliteal height then the foot cannot be comfortably placed on the ground and there may be discomfort due to the pressure on the underside of the thigh resting on the seat. For this reason, it is generally recommended that the popliteal height of the smaller members of the population is used to determine seat heights.

There are two primary types of dimensions:

1. **Static dimension**: taken when the body is in a fixed (static) position (Shoulder height).
2. **Dynamic dimensions**: taken under conditions in which the body is engaged in some physical activity where dimension vary with time, such as practical limit of arm reach.

Principles in the application of anthropometric data:

1. **<u>Design for extreme individual (Maximum or Minimum)</u>**:
   Designing for the maximum population value is the appropriate strategy if a given maximum value of some design feature should accommodate all people.

- Heights of doorways - Sizes of escape hatches - Strength of supporting devices

Designing for the minimum population value is the appropriate strategy if a given minimum value of some design feature has to accommodate all people.

- The distance of a control button from the operator - The force required to operate the

control.

2. **Designing for adjustable range**:
   Using a range from the 5th percentile female to 95th percentile male will result in accommodating 95 percent of a 50/50 male/female population, not 90 percent, because of the overlap between male and female body dimensions. An adjustable range is the preferred method of design, but of course, it is not always possible.

3. **Designing for the average**: In this principle, the design of products is formed based on people who have an average size. Meanwhile, people who have large or extreme sizes, they will be made with their designs.

- Access -----Max to fit
- Reach -----Min to fit
- Strength ----weaker to fit
- Weak----- stronger no damage to fit

Types of Variability in Anthropometric Data

- Sex differences
- Ethnic difference
- The secular trend (generations variation)
- Ageing

Confidence interval and percentile:

Since it is not usually possible to design workplace to suit the very biggest or the very smallest workers, we must be content with meeting the requirements of the majority.

Coefficient of Variance (CV):
CV = Standard Deviation / Mean x100%

- CV for strength data 10 - 85 %
- CV for Body dimensions data 3 - 10 %

Measuring instruments:

- Manuel instrument (ex: Anthropometer, Spreading caliper).

Anthropometer

spread caliper

- Photographic anthropometry, stereo photometry and holography.
- The use of films and videotapes
- Laser measuring devices.

Types of anthropometers:

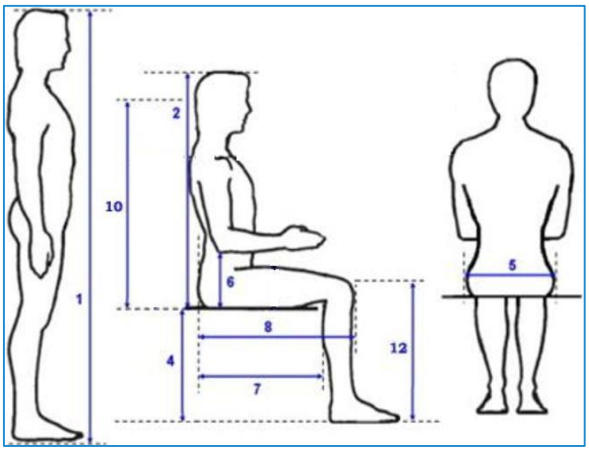
The **Large Anthropometer** has a range of 0 to 60 cm in 0.1 cm increments. Popular uses include measuring shoulder width, long bone length and chest depth for tracking growth and development of children or for use in motion analysis studies.

The **Small Anthropometer** has a range of 0 to 30 cm in 0.1 cm increments. Popular uses include measuring wrist, elbow, knee, and ankle widths, as well as measuring smaller muscle masses like the bicep and calf.

Procedure:

Each student should measure the following of his or her body:

1	Stature height (floor)
	Elbow height (floor)
2	Stature height (sitting)
4	Popliteal height
5	Hip breadth(sitting)
6	Elbow height (sitting)
7	Buttock-popliteal distance(sitting)
8	Buttock–knee distance(sitting)
10	Sitting eye height
12	Knee height(sitting)



Practical guidelines for work layout:

1. Avoid any kind for bent or unnatural posture.
2. Avoid keeping an arm outstretched either forwards or sideways.
3. Work sitting down as much as possible.
4. Arm movements should be either in opposition each other or otherwise symmetrical.
5. The working field should be at such a height that it is the best distance from the eyes of the operator.
6. hand grips, tools and materials should be arranged around the work place in such a way that the most frequent movements are carried out with elbow bent and near to the body.
7. Hand-work can be raised up by using supports under the elbows, forearms or hands.

Calculations:

1- Calculate the Mean, Standard deviation, the maximum and the minimum measured data, 95%, 50%, 5% and your own percentile for each measured data in reference to the selected population.

2- Calculate coefficients of variance and comment on.

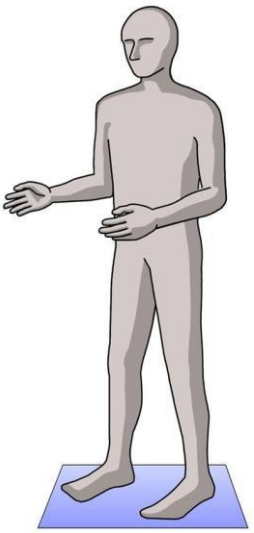
3- Compare male to female data within the selected population for all measured data.

4- Use your data to design a computer work station consist of the following parts taking in to account the designing principles used in reference for each measurement:

1- Disk
2- Monitor
3- Chair
4- Data entry devices (mouse, keyboard) height.

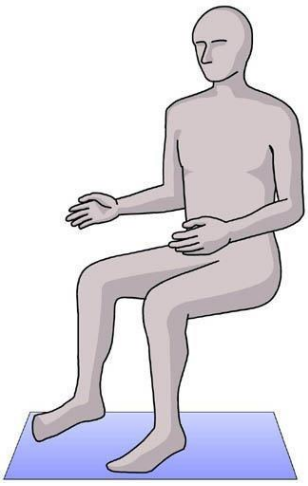
NEUTRAL POSTURE: Standing
Work position where your body is strongest and most efficient

- **Arms** loosely at your side
- **Forearms** parallel with floor
- **Hands** in the "handshake" position
- **Back** has a natural "S" curve
- **Knees** slightly bent
- **Feet** should be a shoulder width apart, pointing slightly outward
- **Head** looking forward, slightly downward



NEUTRAL POSTURE: Seated
Work position where your body is strongest and most efficient

- **Arms** loosely at your side
- **Forearms** parallel with floor
- **Hands** in the "handshake" position
- **Back** has a natural "S" curve
- **Knees** bent 90-105 degrees
- **Feet** should be a shoulder width apart, pointing slightly outward
- **Head** looking forward, slightly downward



Percentile p associated with X		
K	$X = \bar{X} - KS$	$X = \bar{X} + KS$
2.576	00.5	99.5
2.326	1	99
2.06	2	9%
I .96	2.5	97..'5
1.6b	3	97
1 . 28	1O	u‹›
1.Ci4	iS	85
I . 00	16. 5	83.5
0. B4	zo	X‹›
O. 67	25	7?
U	50	-so

TABLE 1-3. BODY DIMENSIONS OF U.s. CIVILIAN ADULTS, FEMALE/MALE, IN CM

	Psrce»t'ilcs			
	5th	3Uth	95th	SD
(/ af›uve floor. .s abovc seat)				
fituturc i“height”1 '	152.78 / 164.f›9	162.94 / 175.58	1 73. 75 / 1 hfi.fiS	fi.36 / G. J›8
L.yc height '	141. 52 / 152.8z	15 1 .6 I /1 O-5. 3•9	1 f›2. 1.3 / 1 74. 2•2	G, 23 / G. 5i7
S htittlder (acroiiaial) height'	124.09 / 154. 16	13.3. .3‹S / 144.2fi	l4?•. 2(I / 154.3f›	.S. 79 / 6. 20
Filbuw' height '	92.63 / 99. 52	99. 79 /107.2ñ	107.4tl / 1 I ñ . 28	4.48 / 4.8 l
Wrist height "	72. 79 / 77. 79	79. O3 / 84. GS	h i..5 i / 9 I .52	.3. hfi / 4. 1.S
£?r‹itch height '	7O.02 / 76.44	77.14 7 ti3.72	84..5f› / 9 1 .f›4	4. 4 I / 4. fi2
Height f sitt in#l‘	79.53 / 85.45	85.20 / 91 .39	9 I . 02 / •?7. I'9	3. 49 / .3. •ifi
Eye height I sit ting)'	68.46 / 73.50	73.87 / 79.20	79.4.3 / fi4.HU	3. 32 / .3.42
Shoulder (acrc›ruia l) height				
(Sf tt I Fly}'	50.91 / 54.Sâ	55.55 / 59.7fl	tO.-6' &4.&3	2.HG / 2.56
Llt›os height isitting)"	17.57/ IS.41	22.O.5/ 23.Ct6	26.44 / 27..37	2.EH / 2.72
Thigh height (sitting)’	14.04/ 14.56	1.5.89/ lfi.h2	16.02/ 18.99	1.21 / I.26
Knee heigh t (sitt ing)	47.40 / 51.44	51.54/ 55.88	56.02/ Otl..57	2.63 / 2.79
Pup'l i I cal height (st tting)'	35.13/ 39.4h	38.94/ 43.41	42.94/ 47.6.3	2..37 / 2.49
DEPTHS				
Forw‘ard I thurnbt IP) re ach	67. 67 / 73. 92	73.4fi / 8O. OH	7'9. €•7 .’ 8fi.70	3.fi4 / 3 .92
Buttiick-knee distance (sitting)	.54. 21 / .56.90	.58 . 89 / ft I .f›4	63 .98 / f›fi. 74	2.9f› / 2.99
Buttiack -popl itea I distance (sitt ink)	44.O0/ 45,8J	**48.17 /** 5tl.M	.52.77 / S4..SW	**2.60 / 2.66**
4.It›ow-fingertip distance	**.62/ 44.79**	44.2"9 / **4n.4U**	4R.25/ i2.42	2..34/ 2.33
C.'hest depth	20.86/ **20.96**	**23.94 /** 24..32	27.78 / 28.tJ4	2. I 1 2. 15
BR£iA MTHS				
F°‹›rcorni-ti›rearm brcadth	41. 47 / 47. 74	46. 55 / 54. 6 1	*2. R4 / e2. OF	3 .47 / 4. J6
H ip breadt h isitting I	34.2f / 32.67	38.45 / 1t.68	43.22 / 4t.1fi	2.72 / 2.5?
I fKA D DI M ENSIONS				
Head ci rctimference	**52.2s / 54.27**	**54.62 /** SP.77	ñ7.O.5 / **59.35**	1. 4f1 / 1..54
Head breadt h	**13.66/** 14.31	**14.44 /** **15.17**	1.5.27 i 1s.tl8	It.49 / tL.54
[nterpupill ary breadth	5.66 / **5.88**	**6.23/ 6.47**	6.8.5/ 7.1(i	0 3fi / tl 37