

Role of Ergonomics and Anthropometrics in Furniture Design

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Abstract:

In today's work style ergonomics and anthropometrics are playing dominant role in preventing from injuries in human. Injuries generally include muscle pain, repetitive motion injury, joint pains, swelling, cumulative trauma disorder, numbness, restricted motion, repetitive stress injury, musculoskeletal disorder. (1) Therefore in order to overcome injuries, to increase productivity, decreased mistakes, increased efficiency, decreased lost working days, decreased turnover, improved morale etc., ergonomics and anthropometrics principles are helpful, these principles develop good employee and employer relationship, benefit both employee and employer and establish a healthy environment of work. (2) In this paper, how furniture design is discussed in view point of ergonomics and anthropometrics considering human factor, in this connection the business and institutional furniture manufacturer's association (BIFMA) data is taken into account. (3).

Keywords:

Ergonomics, Design of furniture, Injuries, Anthropometry, BIFMA.

1. INTRODUCTION:

Ergonomics focuses on human beings and their interaction with machines, materials, information, procedures and environments used in day to day life. It emphasizes on human behavior to system, limitations, capabilities, tasks, with respect to work environment and in turn developing safe environment both to human beings and environment he interacts. (1) This paper focuses on design aspects of furniture, environment posture measurements while standing and sitting, ergonomic

chair, wheel chair sitting at work surface, visualization of BIFMA desk and work surface, work way clearances in viewpoint of human beings. Ergonomics in this word Erg is a rarely used measurement of work done it focuses on the efficiency of design. Onomics it is about effective management and minimizing of work done. Anthropometrics in this word Anthropos is a Greek word meaning man and Metrics is something associated with measurement. Measurement varies according to region, in some regions we come across short people and in some regions we come across tall people. According to survey Scandinavian population have tall people where as Asian are short people. (4).



Figure 1. The relative sizes of different percentile humans suggested by various scientists and hand books.

As shown in the figure 1 weight limits are 40kgs to 115 kgs and height limits are 1.3 meters (4feet) to 1.83meters(6feet) 1percentile women fall in weight limit of around 40 kg and height limit of 1.3 meters(4feet). 5 percentile women fall in weight limit of 45 kg and height limit of 1.53 metres(5feet). 95 percentile women fall in the weight limit 55 kg and height limit of 1.67 meters(5.5 feet). 99 percentile women fall in weight limit of 60kg and height limit of 1.7meters.(5.67feet) 1 percentile men fall in weight limit of 50kg and height limit 1.62meters(5.3feet). 5percentile fall in weight limit of 55kg and height limit of 1.67meters(5.5feet) 95 percentile fall in the weight limit 60 kg and height limit of 1.7meters(5.67feet). 99 percentile fall in the weight limit of 95kg and height limit of 1.83 meters(6 feet).

The 5th % value of a particular dimension (e.g. sitting height) usually represents the smallest measurement for design in a population. Conversely, a 95th % male value may represent the largest dimension for which one is designing. The 5th % to 95th % range accommodates approximately 90 % of population. (5) DISCUSSION : Environment posture measurement while standing and sitting:

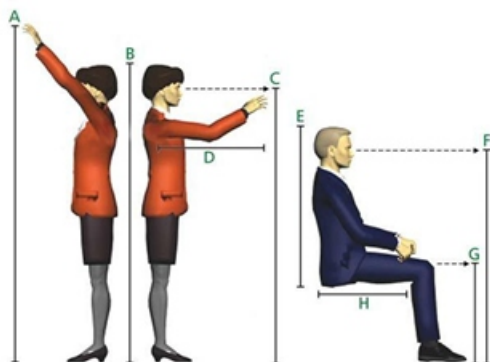


Figure 2 Measurements while standing and sitting

Measurement	Letter	Female	Male
Standing Overhead Reach	A	1.9- 2.2metres	2.1-2.4metres
Standing Height	B	1.53-1.74metres	1.65-1.87metres
Standing Eye Height	C	1.5-1.65metres	1.6-1.78metres
Standing Forward Reach	D	0.78-0.92metres	0.88-1.0metres
Sitting Height	E	0.8-0.9metres	0.88-0.97metres
Sitting Eye Height	F	1.0-1.24metres	1.2-1.36metres
Sitting Knee Height	G	0.5-0.58metres	0.55-0.63metres
Seat Depth	H	0.43-0.52metres	0.45-0.53metres

Figure 2 Measurements while standing and sitting
Table 1 Anthropometric measurement, All readings in metres

As shown in table 1 (4) anthropometric measurements in standing position and sitting position. Standing overhead reach for female is in the range 1.9metres-2.2metres whereas in male it is 2.1metres – 4 meters. Standing height for female is in the range 1.53metres-1.74 meters whereas in male it is 1.65metres-1.87 meters. Standing eye height for female is in the range 1.5 metres-1.65 meters whereas in male it is 1.6metres-1.78metres. Standing forward reach for female is in the range 0.78metres-0.92metres whereas in male it is 0.86metres-1.0metres. Sitting height for female is in the range 0.8metres – 0.9 meters whereas in male it is 0.86metres-0.97metres. Sitting eye height for female is in the range 1.0metres-1.24metres whereas in male it

is 1.2metres-1.36metres. Sitting knee height for female is the range 0.5metres-0.58 meters whereas in male it is 0.55metres-0.63metres. Seat depth for female is in the range 0.43metres-0.52metres whereas in male it is 0.45metres -0.53metres(4).

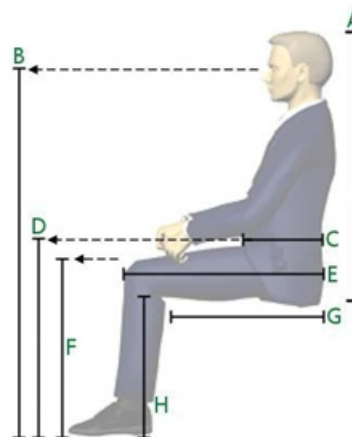


Figure 3: measurements while sitting for range 5%-95 % (Female, Male and overall range)

Measurement	Letter	Female 5 th - 95 th %	Male 5 th - 95 th %	Overall Range 5 th - 95 th %
Sitting Height	A	0.79metres- 0.9metres	0.85metres- 0.97metres	0.79metres-0.97metres
Sitting Eye Height	B	1.0metres- 1.24metres	1.18metres- 1.34metres	1.0metres-1.34metres
Waist Depth	C	0.19metres- 0.27metres	0.2metres- 0.29metres	0.19metres-0.29metres
Thigh Clearance	D	0.53metres- 0.62metres	0.58metres- 0.68metres	0.53metres-0.68metres
Buttock-to-Knee	E	0.54metres- 0.64metres	0.57metres- 0.67metres	0.54metres-0.67metres
Knee Height	F	0.5metres- 0.59metres	0.55metres- 0.64metres	0.5metres-0.64metres
Seat Length/Depth	G	0.43metres- 0.52metres	0.45metres- 0.53metres	0.43metres-0.53metres
Popliteal Height	H	0.38metres- 0.46metres	0.42metres- 0.5metres	0.38metres-0.5metres

Table 2 Anthropometric measurement for sitting position for ranges 5th -95th % for female, male and overall range. All readings are in meters.

As shown in the table 2 (4) anthropometric measurements for sitting position for ranges 5%- 95% for female, male and minimum to maximum range considering both female and male is as follows. Sitting height for female is in the range 0.79 meters to 0.9 meters whereas for male it is 0.85 meters to 0.97 meters and minimum to maximum range taking consideration both male and female is 0.79 meters to 0.97 meters. Sitting eye height for female is in the range 1.0 meters to 1.2 meters whereas in male it is 1.18metres to 1.34

meters and minimum to maximum range taking into consideration both female and male is 1.0 meters to 1.34 meters. Waist depth for female is in the range 0.19 meters to 0.27 meters where as in male it is 0.2 meters to 0.29 meters and minimum and maximum range taking into consideration both female and male is 0.19 meters to 0.29 meters. Thigh clearance for female is 0.53 meters to 0.62 meters where as for male it is 0.58 meters to 0.68 meters and minimum and maximum range taking both into consideration is 0.53 meters to 0.68 meters.

Buttock-to-knee for female is 0.54 meters to 0.64 meters where as for male it is 0.57 meters to 0.67 meters and overall range is 0.54 meters to 0.67 meters. Knee height for female is 0.5 meters to 0.59 meters where as for male it is 0.55 meters to 0.64 meters and overall range is 0.5 meters to 0.64 meters. Seat length/depth for female is 0.43 meters to 0.52 meters where as for male it is 0.45 meters to 0.53 meters and overall range is 0.43 meters to 0.53 meters. Popliteal height for female is 0.38 meters to 0.46 meters where as for male it is 0.42 meters to 0.5 meters and overall range is 0.38 meters to 0.5 meters.

Human range of motion at work place:

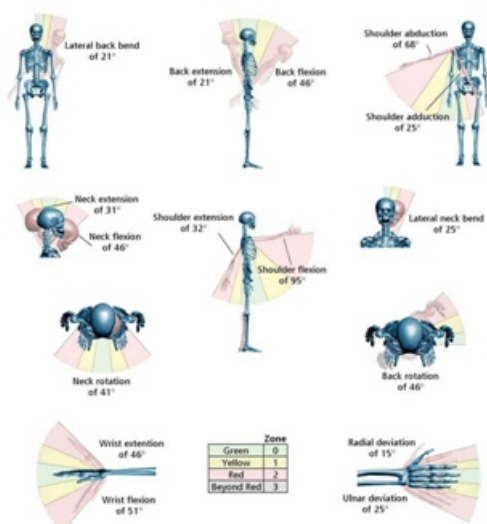


Figure 3 Motion of different joints in various regions(5)

The work place should be to the extent possible comfortable to user so that it increases productivity, efficiency, lower risk of injury and illness and less compensation claims after injury.

Every human body has certain range of motion, beyond the range of human lead to stress, discomfort, injuries and illness in human body. As shown in figure 3 there are different range of motions of human body for different parts of the body, for different parts of motion there are four different zones:

Zone A: (Green zone) which is preferred zone where in user will be comfortable to work which impart minimum stress on user.

Zone B: (Yellow zone) which is also preferred zone up to certain limitations, because after sometime of work performed by user it imparts stress as compared to green zone.

Zone C: (Red zone) which is not preferred zone, even if it is compulsory there should more rest periods for the user, this zone with in short span of time irritate user and lead to more injuries if rest periods are not given.

Zone D: (Beyond red zone) which is not at all preferred zone. This zone lead to injuries to user and lead to musculoskeletal disorders. Based on above zones it is clear that zone A and Zone B are convenient to user and comfortable zones of work which in turn will be fruitful to employee and employer (5).

ERGONOMIC CHAIR :

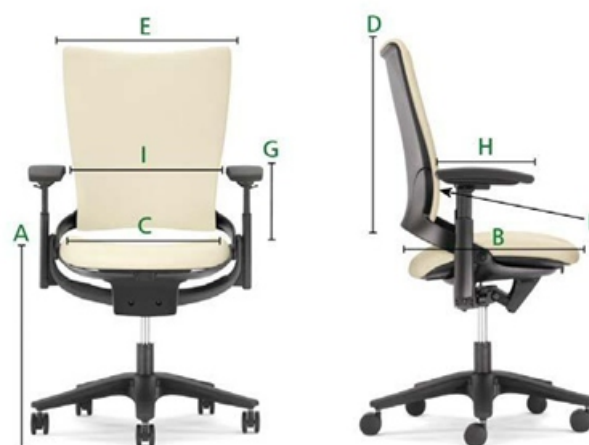


Figure 4 : Ergonomic chair designed as per BIFMA guidelines

		Specifications	
		Measurement	BIFMA Guideline
Seat Height	A	Popliteal height - Shoe allowance	381mm-505.5mm
	B	Buttock-popliteal length - Clearance allowance	No deeper than 429.3mm (fixed) 429.3mm included (adjustable)
Seat Width	C	Hip breadth, sitting + Clothing allowance	No less than 457.2 mm
Backrest Height	D	None	At least 310mm
Backrest Width	E	Waist breadth	360.7 mm
Backrest Lumbar	F	None	Most prominent point 150mm- 249mm from seat pan.
Armrest Height	G	Elbow rest height	200mm-249mm
Armrest Length	H	None	None
Distance Between Armrests	I	Hip breadth, sitting + Clothing allowance	457mm (fixed)

Table 3. BIFMA chair design measurements

Ergonomic chair with measurements are shown above .Figure 4 is ergonomic chair and Table 3 are the measurements both as per the Business and Industrial Furniture Manufacture’s Association(BIFMA)(4,5).As per the design seat height with show allowance and allowance in front of knee must be in the range of 381mm-505.5mm.

Seat depth can be fixed as well adjustable, for fixed seat depth should be 429.3mm for fixed as well as for adjustable depth. Seat width should not be less than 457.2mm. Backrest height should be at least 310mm. Back width should be 360.7mm.

Back lumbar should within limits of 150mm-249mm. Armrest height should be within 200mm-249mm.Distance between armrests must be 457mm.In general chair designed is comfortable for user who spends more amount of time on chair, it prevent defects in lumber joint, disc problems, and injuries which generally occur when it is not designed ergonomically. All care is taken about seat height, seat depth, seat width and backrest so that it is user friendly.

CONCLUSION:

With advancement of today’s technology ergonomics plays a dominant role in increasing productivity, decreasing compensation claims , right method of designs, improving styles by applying scientific principle in designing furniture , range of motion of human being ,good employee and employer relationship and healthy work environment It also helps in optimum utilization of men ,money , material and machinery. It avoids work stress, work related injuries, helps in good and best designing of equipment.

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