HUMAN FACTORS IN ENGINEERING

UNIT-2

UNIT 2 - SYLLABUS

ANTHROPOMETRY:

Physical dimensions of the human body as a working machine, Motion size relationships, Static and dynamic anthropometry, Anthropometric design principles, Using anthropometric measures for industrial design.

ERGONOMICS AND PRODUCT DESIGN:

Ergonomics in automated systems, Expert systems for ergonomic design, Anthropometric data and its application in ergonomic design, Limitations of anthropometric data, Use of computerized database.

ANTHROPOMETRY

Anthropometry is the **study and measurement** of human body dimensions. The word anthropometry is derived from two Greek words: anthropos ("man") and metron ("measure").

The **size and the proportions** of the human body have been the subject of study for artists, anatomists, doctors, and land measurers for a long time.

ANTHROPOMETRY

- **Adolphe Quetelet**, a Belgian statistician, first applied statistics to **anthropological data** in the middle of the nineteenth century, and this was regarded as the beginning of **modern anthropometry.**

- In designing workplaces, equipments, and various products **for human use**, engineers have gradually realized the importance of anthropometric information.

- The **measurement** and **use of anthropometric data** in engineering design is **the primary concern** of engineering anthropometry.

ANTHROPOMETRY

- Anthropometry deals with the measurement of the dimensions and certain other physical characteristics of the body such as height, weight, limb length, volumes, centers of gravity, inertial properties, and masses of body segments.

- In ergonomics, anthropometry is used to **design tools, equipment, and workstations** that accommodate the physical characteristics of the human body, with the aim of optimizing worker comfort, safety, and performance

ANTHOPOMETRY

- **Anthropometric data** are used to develop design guidelines for heights, clearances, grips, and reaches of workplaces and equipments for the purpose of accommodating the body dimensions of the potential work force.
- Examples include the dimensions of workstations for **standing or seated work, production machinery, supermarket checkout counters, and aisles and corridors**.
- Anthropometric data are also applied in the design of consumer products such **as clothes, automobiles, bicycles, furniture, hand tools**, and so on.

ANTHROPOMETRY

Anthropometric data can be classified into two types: Structural data and functional data. Structural data are also called static data; functional data are also called dynamic data.

The **two types of data** serve different purposes in engineering design.

ANTHROPOMETRY

Structural anthropometric data are measurements of the body dimensions taken with the **body in standard** and **still (static) positions.**

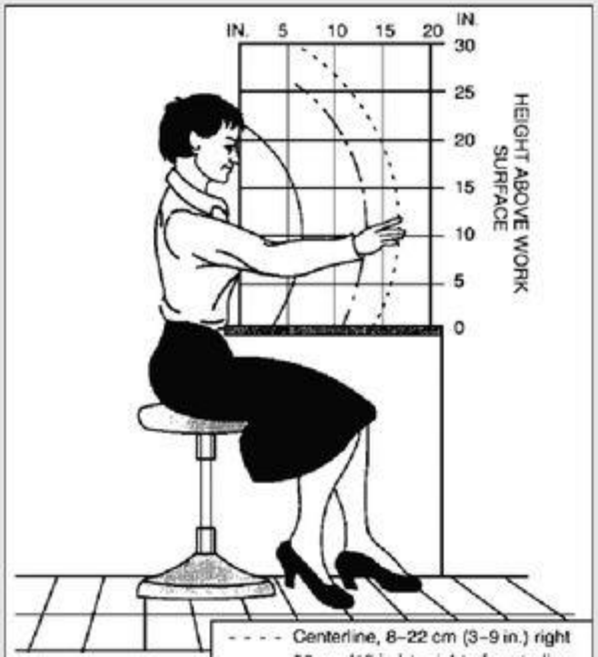
Examples include the stature (the height of person), the shoulder breadth, the waist circumference, the length of the forearm, and the width of the hand.

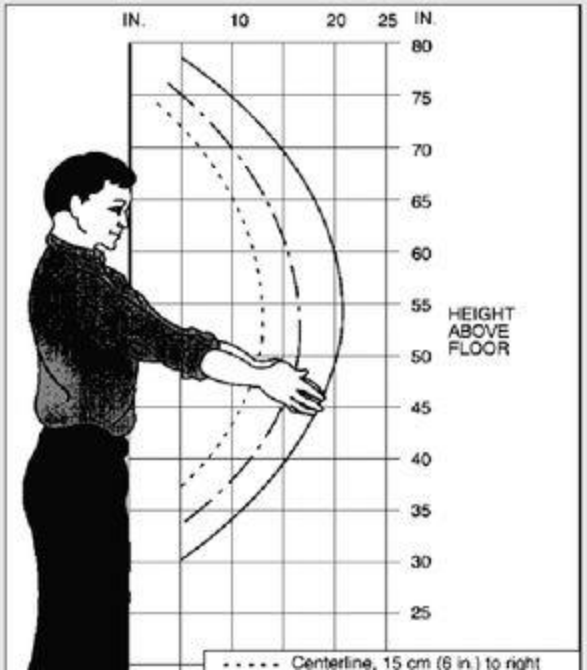
1.STRUCTURAL ANTHROPOMETRIC DATA

- Structural anthropometric data are measurements of the bodily dimensions of subjects in fixed (static) positions.

EXAMPLES

- To specify furniture dimensions.
- To determine ranges of clothing sizes.





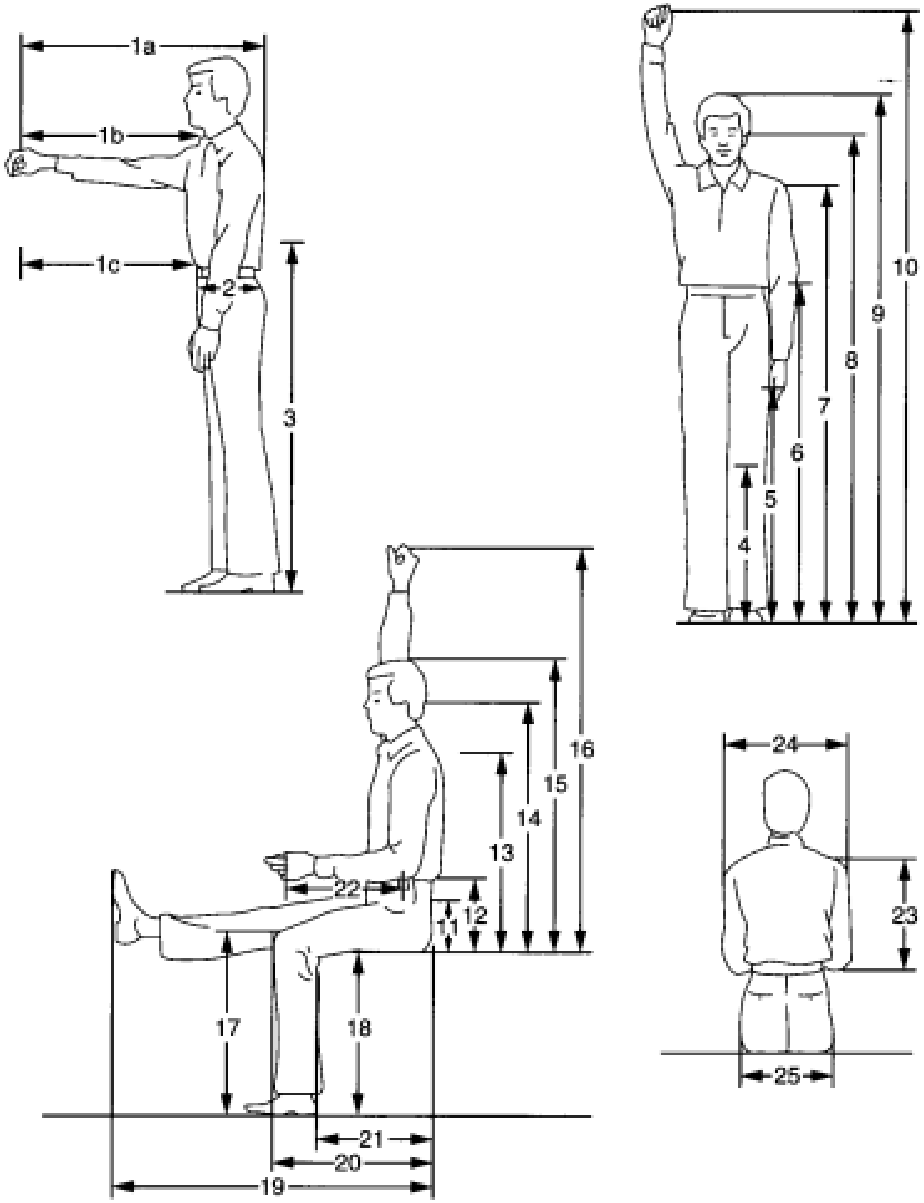


Fig: Anthropometric measures: standing and sitting.

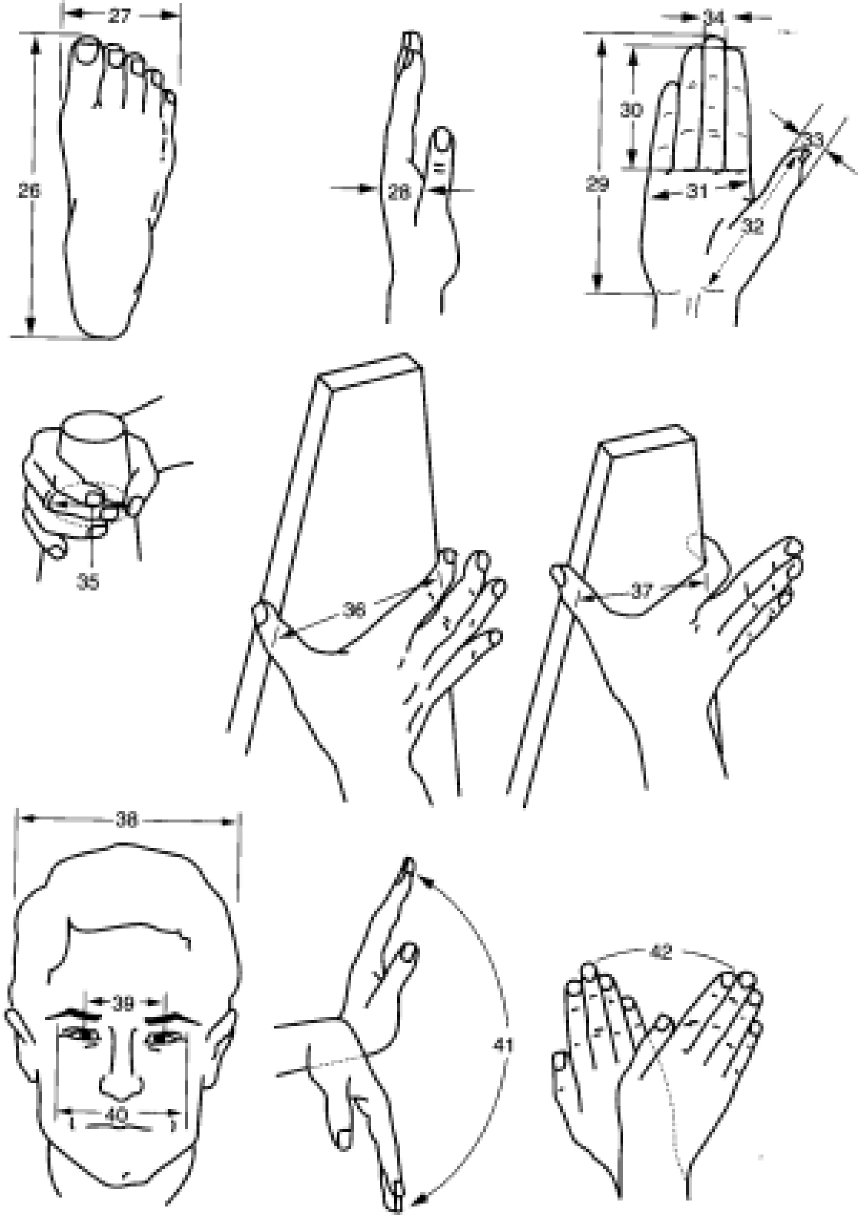
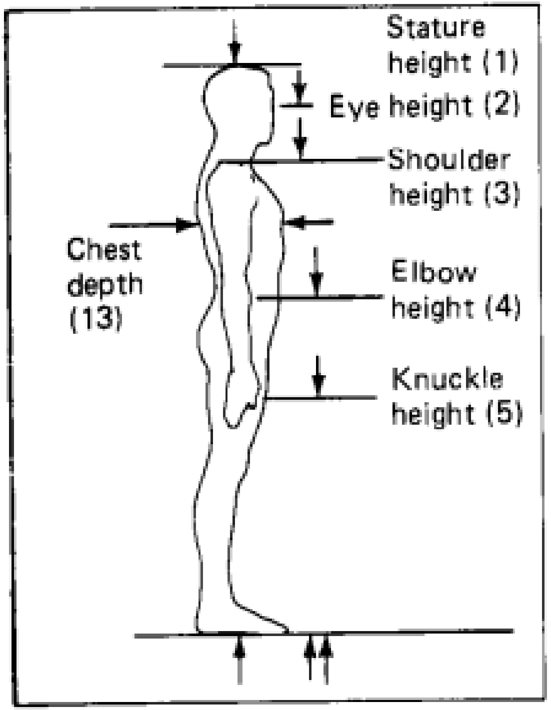
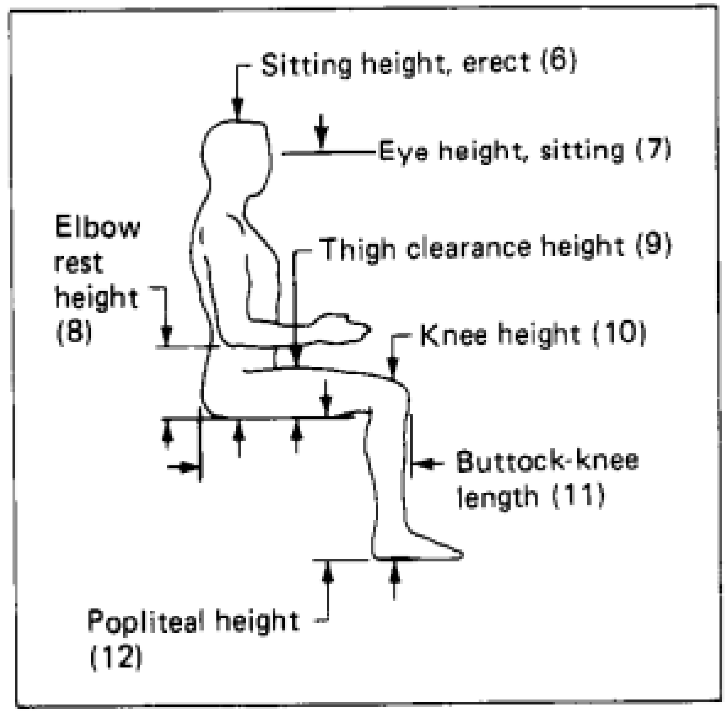
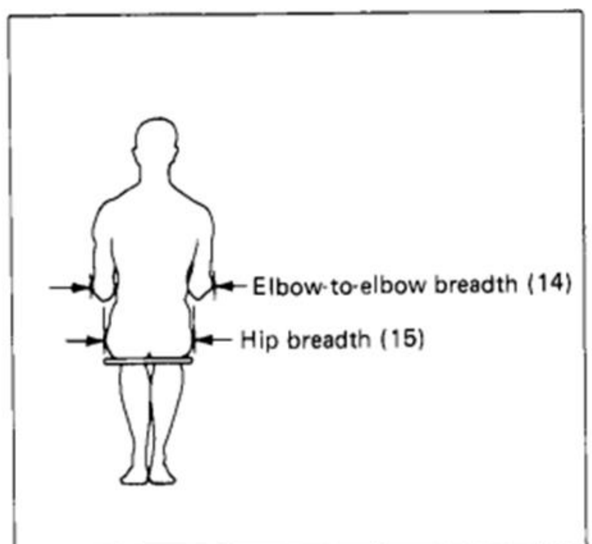


Fig: Anthropometric measures: hand, face, and foot

Fig: Structural body features







SELECTED BODY DIMENSIONS AND WEIGHTS OF U.S. ADULT CIVILIANS*

Body dimension	Sex	Dimension, in			Dimension, cm		
		5th	50th	95th	5th	50th	95th
1. Stature (height)	Male	63.7	68.3	72.6	161.8	173.6	184.4
	Female	58.9	63.2	67.4	149.5	160.5	171.3
2. Eye height	Male	59.5	63.9	68.0	151.1	162.4	172.7
	Female	54.4	58.6	62.7	138.3	148.9	159.3
3. Shoulder height	Male	52.1	56.2	60.0	132.3	142.8	152.4
	Female	47.7	51.6	55.9	121.1	131.1	141.9
4. Elbow height	Male	39.4	43.3	46.9	100.0	109.9	119.0
	Female	36.9	39.8	42.8	93.6	101.2	108.8
5. Knuckle height	Male	27.5	29.7	31.7	69.8	75.4	80.4
	Female	25.3	27.6	29.9	64.3	70.2	75.9
6. Height, sitting	Male	33.1	35.7	38.1	84.2	90.6	96.7
	Female	30.9	33.5	35.7	78.6	85.0	90.7
7. Eye height, sitting	Male	28.6	30.9	33.2	72.6	78.6	84.4
	Female	26.6	28.9	30.9	67.5	73.3	78.5
8. Elbow rest height, sitting	Male	7.5	9.6	11.6	19.0	24.3	29.4
	Female	7.1	9.2	11.1	18.1	23.3	28.1
9. Thigh clearance height	Male	4.5	5.7	7.0	11.4	14.4	17.7
	Female	4.2	5.4	6.9	10.6	13.7	17.5
10. Knee height, sitting	Male	19.4	21.4	23.3	49.3	54.3	59.3
	Female	17.8	19.6	21.5	45.2	49.8	54.5
11. Buttock-knee distance, sitting	Male	21.3	23.4	25.3	54.0	59.4	64.2
	Female	20.4	22.4	24.6	51.8	56.9	62.5
12. Popliteal height, sitti ng	Male	15.4	17.4	19.2	39.2	44.2	48.8
	Female	14.0	15.7	17.4	35.5	39.8	44.3
13. Chest depth	Male	8.4	9.5	10.9	21.4	24.2	27.6
	Female	8.4	9.5	11.7	21.4	24.2	29.7
14. Elbow-elbow breadth	Male	13.8	16.4	19.9	35.0	41.7	50.6
	Female	12.4	15.1	19.3	31.5	38.4	49.1
15. Hip breadth, sitting	Male	12.1	13.9	16.0	30.8	35.4	40.6
	Female	12.3	14.3	17.2	31.2	36.4	43.7
X. Weight (lbs and kg)	Male	123.6	162.8	213.6	56.2	74.0	97.1
	Female	101.6	134.4	197.8	46.2	61.1	89.9

ANTHROPOMETRY

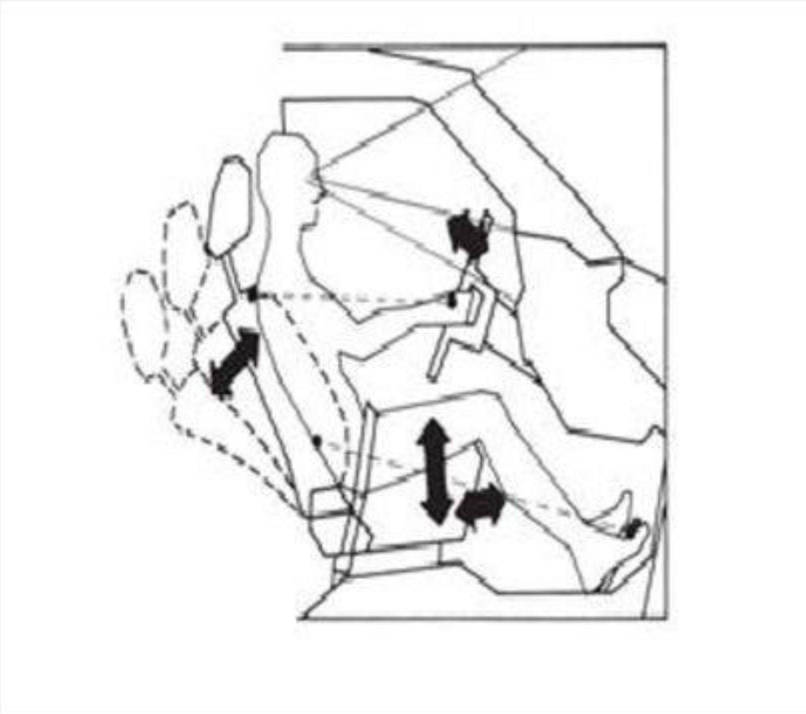
Functional (dynamic) anthropometric data are obtained when the body adopts various working postures (i.e., when the body segments move with respect to standard reference points in space).

For example, the **area that can be reached by the right hand** of a standing person defines a "standing reach envelope" of the right hand, which provides critical information for work-space design for right-handed standing workers.

2.FUNCTIONAL ANTHROPOMETRIC DATA

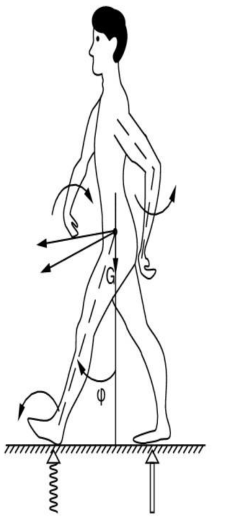
- Functional anthropometric data are taken under conditions in which the body is engaged in some physical activities.

EXAMPLES



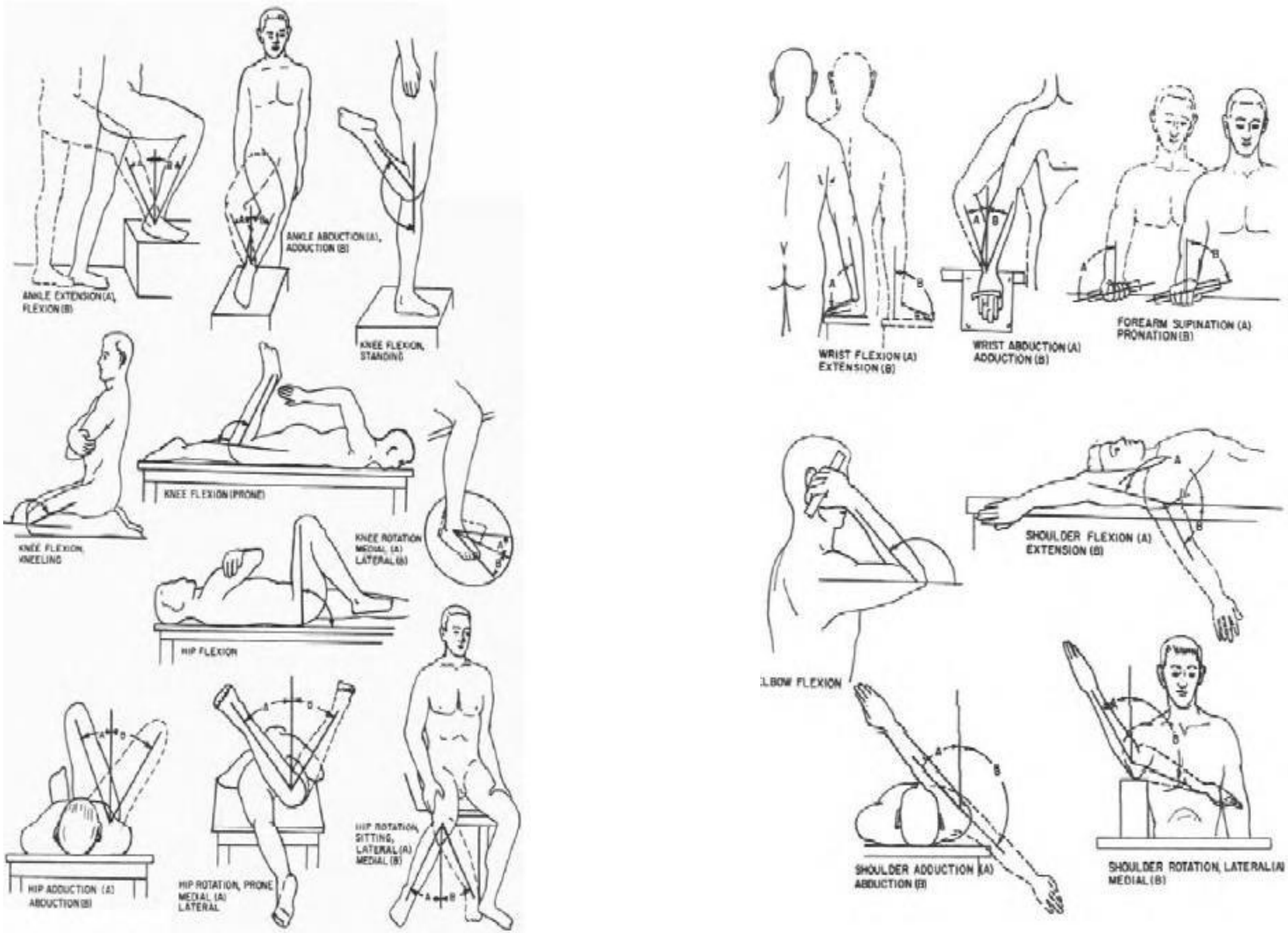
- Design of crane cabs
- Design of vehicle interiors

- Some of the measurements taken in dynamic anthropometry include joint angles, joint movements, muscle activity, and body segment velocities.

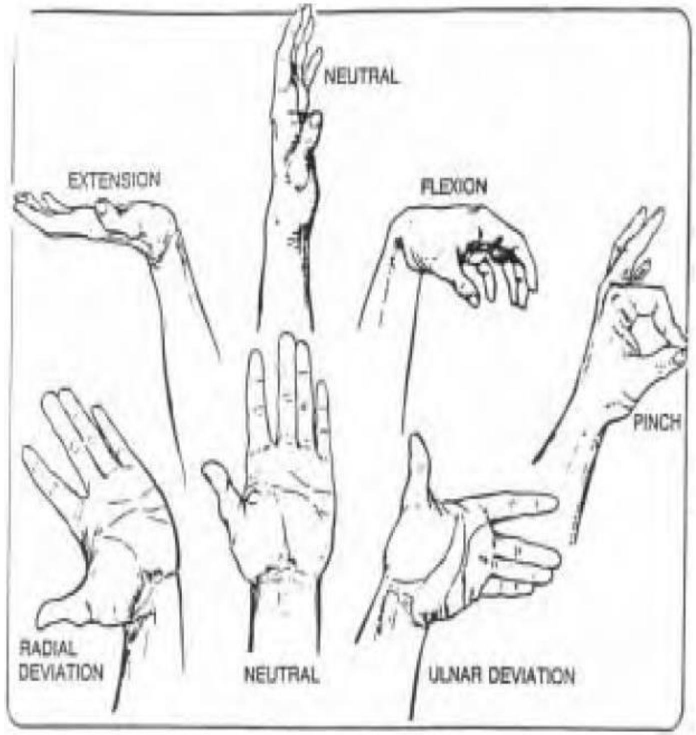


- Motion capture technology and other advanced measurement techniques are used to capture and analyze these measurements during dynamic activities.

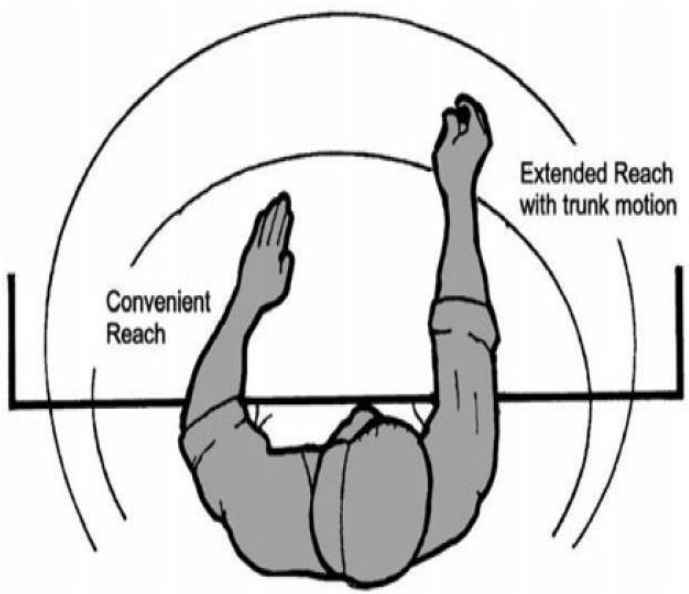
- Dynamic anthropometry provides a more comprehensive understanding of human movement and body dimensions, allowing for the development of more effective designs and guidelines that accommodate movement and promote comfort and safety.



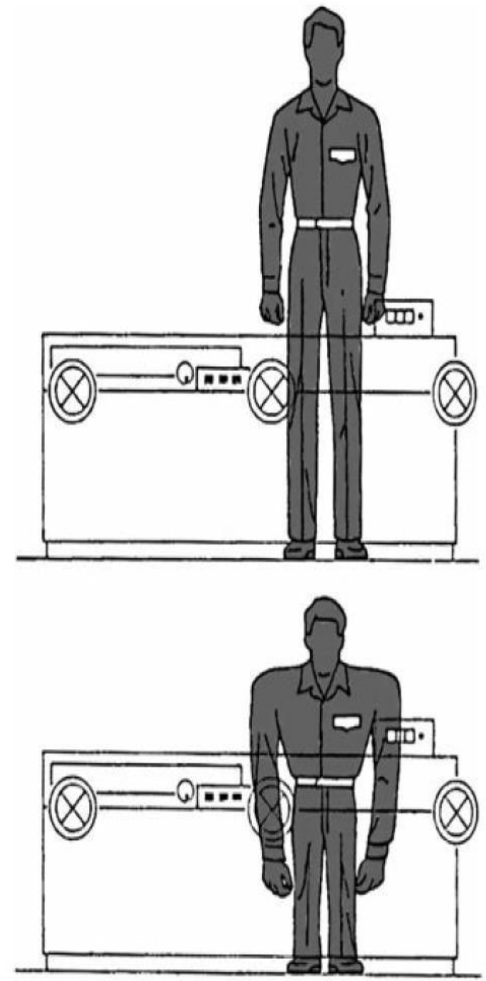
Figures: Various movements of human body



Hand Wrist postures



Reach of the hands while sitting

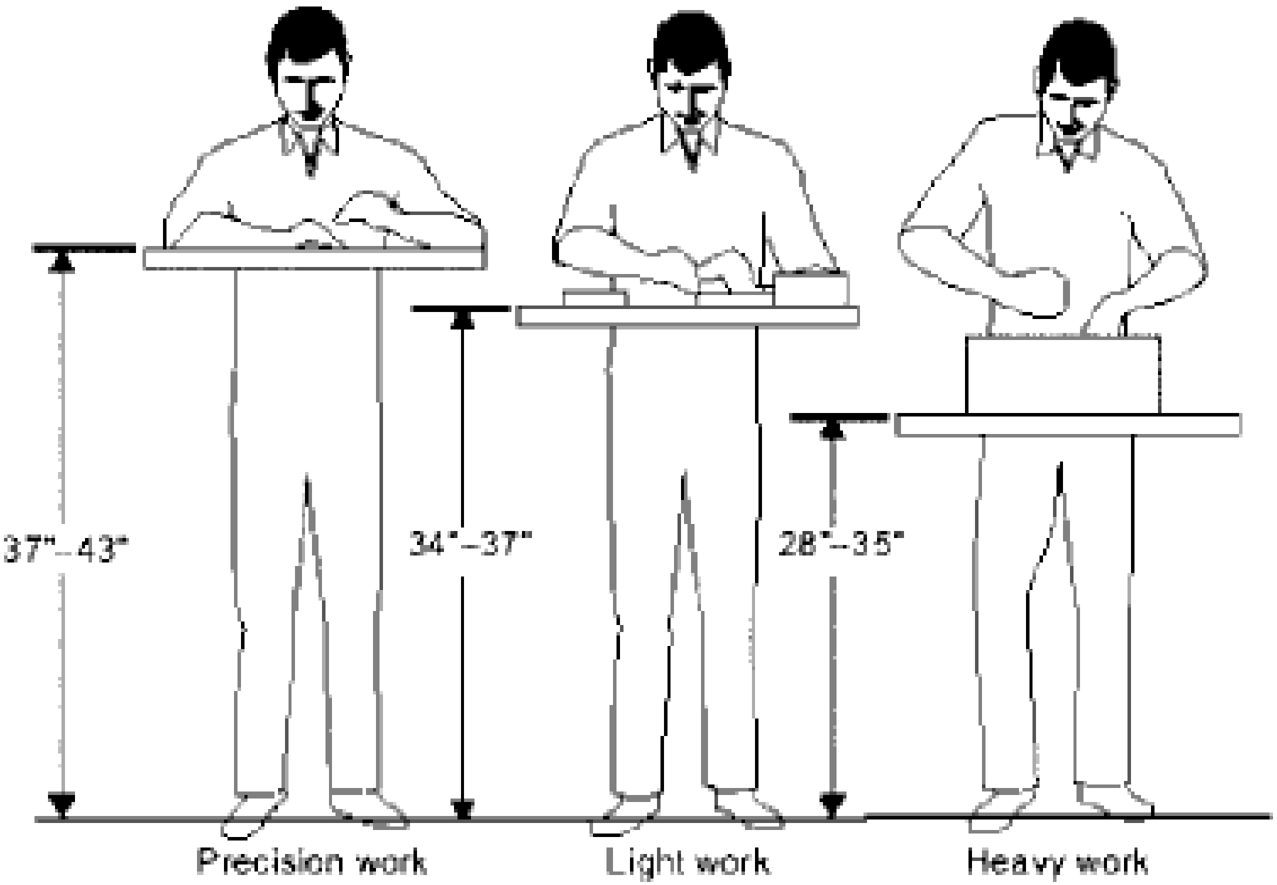


Design of lathe machine

- It is not always economical to design work space for different persons separately

- In such cases design can be done in view of a particular gender or height and for others the height can be adjusted using stands or heights

- In this case the danger of stumbling
  must be taken into account



Adjusting the height of the work bench to the size of the operator and the work task

DYNAMIC DIMENSIONS

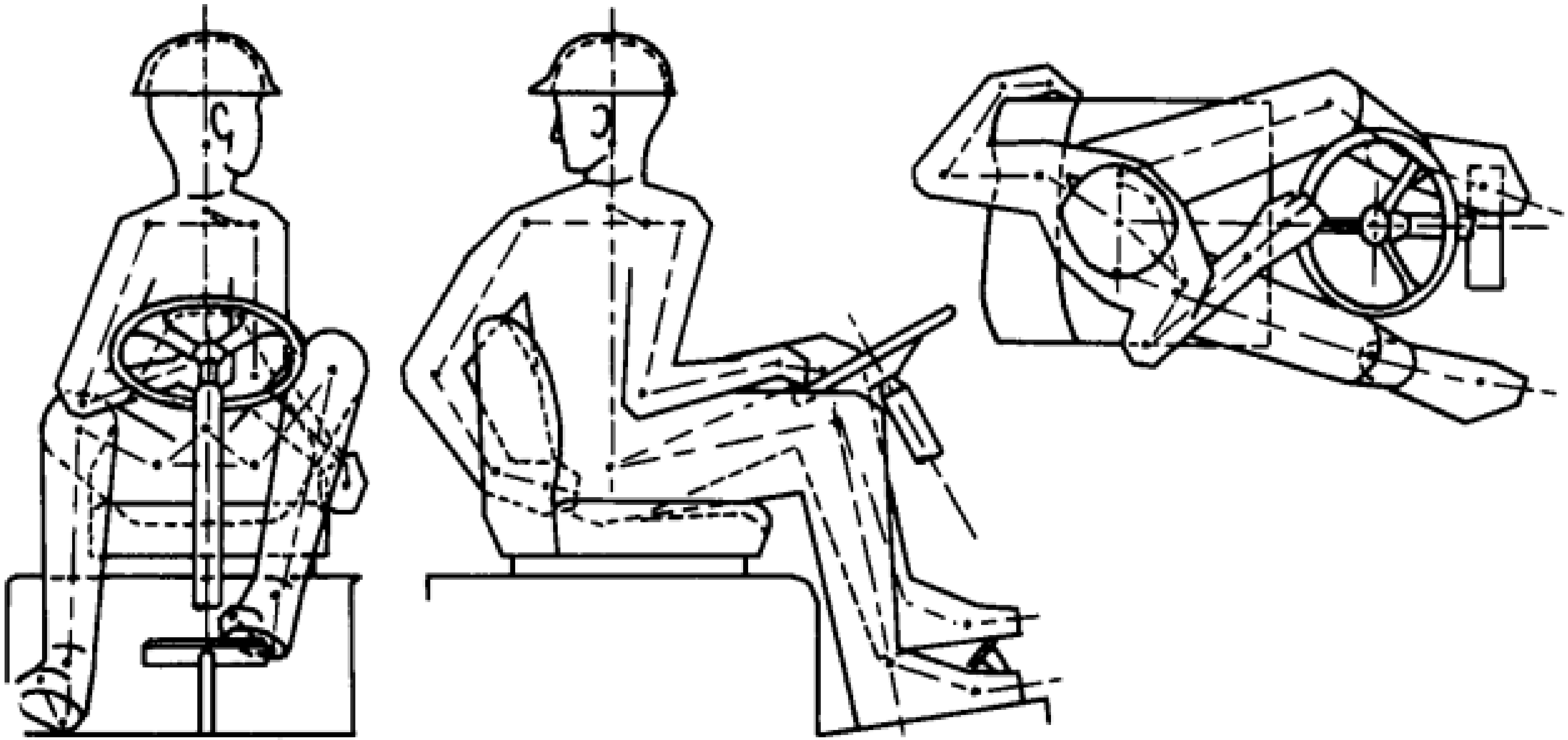


FIGURE
Three views of an operator of a forklift truck that illustrate the interactions of the body members. Such views represent what is sometimes called *somatography*. (*From North*, 1980.)

CONVERSION OF STATIC TO DYNAMIC ANTHROPOMETRIC DATA

Most **anthropometric data are static**, although work activities can be more accurately represented by **dynamic data**.

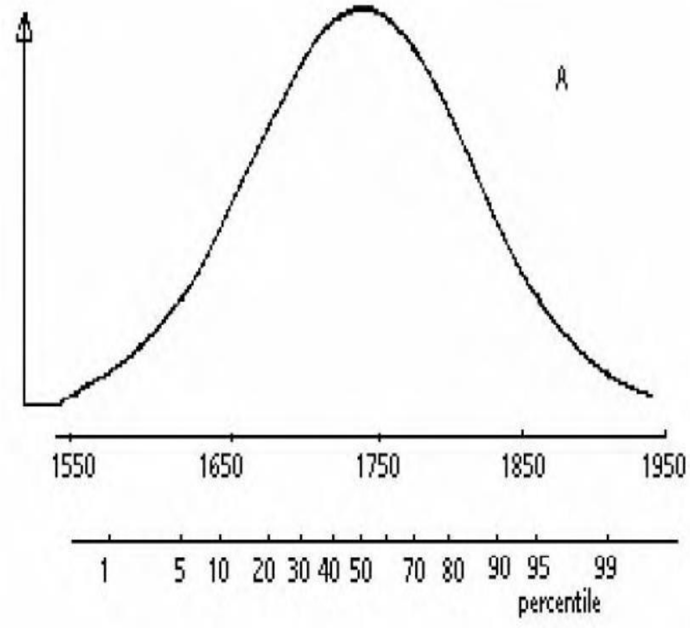
Because standard methods do not exist that allow one to convert static into dynamic data, the following procedure suggested by Kroemer (1983) may be useful for designers to make estimates:

1. **Heights** (stature, eye, shoulder, hip): should be reduced by 3 percent.
2. **Elbow height**: requires no change or an increase of up to 5 percent if elbow needs to be elevated for the work.
3. **Forward and lateral reach distances**: should be decreased by 30 percent if easy reach is desirable, and they can be increased by 20 percent if shoulder and trunk motions are allowed

PHYSICAL DIMENSIONS OF THE HUMAN BODY

The physical dimensions of the human body include:

- **Height:** The vertical distance from the top of the head to the soles of the feet.
- **Weight:** The force exerted by the body due to the pull of gravity.
- **Body mass index (BMI):** A measure of body weight relative to height.
- **Limb length**: The distance from the shoulder joint to the fingertips in the arms, or from the hip joint to the toes in the legs.
- **Girth measurements**: The circumference of various body parts, such as the waist, chest, and hips.
- **Body composition**: The proportion of body fat, muscle, bone, and other tissues in the body.
- **Foot size:** The length and width of the foot, which can affect the fit of shoes and the design of footwear.



Normal distribution of height of British men in mm

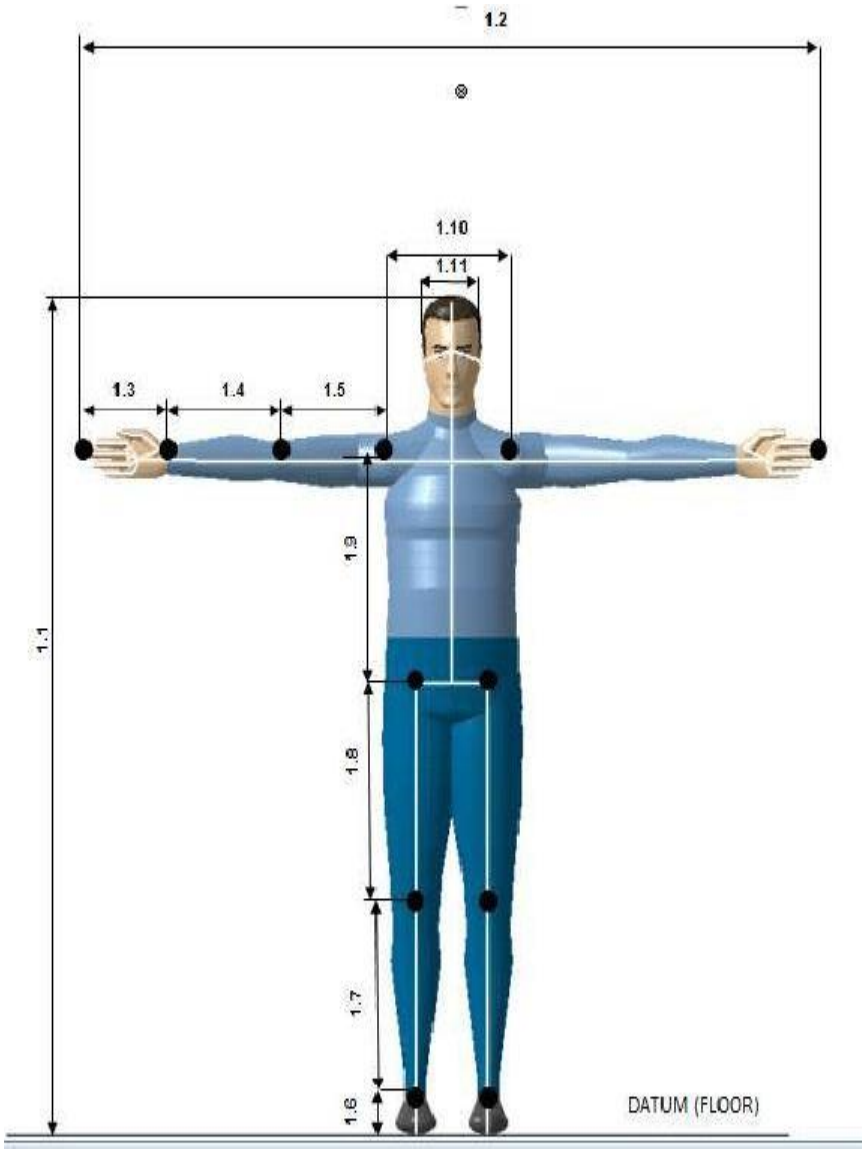
Age	Females	Males		
Years	Height (cm)	%Max	Height (cm)	%Max
1	74	46	75	43
5	110	68	111	64
10	138	86	138	79
15	160	99	168	97
20	161	100	174	100
35	161	100	174	100
40	160	99	174	100
50	159	99	173	99
60	158	98	172	99
70	157	98	171	98
80	156	97	170	98
90	155	96	169	97

Human height with age

STANDING POSITION MEASUREMENT

- Standing position measurement is a method for measuring various physical dimensions of the human body while an individual is standing in an upright position.

- This method involves using measuring tools such as tape measures, calipers, and inclinometers to take measurements of various body parts and dimensions



Height: The vertical distance from the top of the head to the soles of the feet.

Arm length: The distance from the shoulder joint to the fingertips.

Leg length: The distance from the hip joint to the floor or ankle.

Hip width: The distance between the two hip joints.

Waist circumference: The circumference of the narrowest point of the waist.

Knee angle: The angle between the thigh and lower leg at the knee joint.

Spine curvature: The angle of the curve of the spine in the sagittal plane.

SITTING POSITION MEASUREMENTS

Seat height: The vertical distance from the floor to the seat surface.

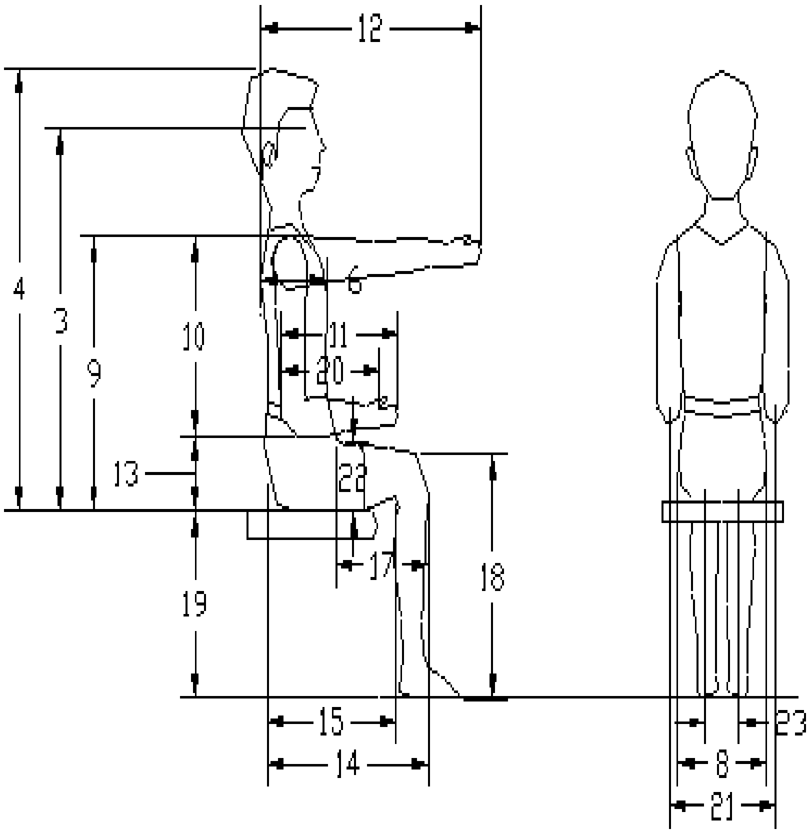
Seat depth: The distance from the backrest to the front edge of the seat.

Seat width: The distance between the two armrests. **Lumbar support:** The height and depth of the lumbar support for the lower back.

Armrest height and width: The height and width of the armrests.

Thigh clearance: The distance between the underside of the seat and the back of the knees.

Hip angle: The angle between the thigh and the torso.



Dimension	Men 5th percentile inch (cm)	Men mean inch (cm)	95th Men percentile inch (cm)	Women 5th percentile inch (cm)	Women mean inch (cm)	Women 95th percentile inch (cm)
Sitting height	33.5 (85.8)	36.0 (92.2)	38.0 (97.3)	29.5 (75.5)	33.5 (85.8)	34.5 (88.7)
Elbow height (above seat)	7.5 (19.2)	9.5 (24.3)	10.5 (26.9)	8.5 (21.8)	9.0 (23.0)	10.0 (25.6)
Buttocks (to the back of the knee)	17.0 (43.5)	19.0 (48.6)	20.5 (52.5)	16.0 (41.0)	18.0 (46.1)	19.5 (49.9)
Lower leg height	15.5 (39.7)	16.5 (42.2)	17.5 (44.8)	14.5 (37.1)	15.5 (39.7)	16.5 (42.2)
Buttocks width	13.0 (33.3)	14.0 (35.8)	15.5 (39.7)	12.5 (32.0)	14.5 (37.1)	16.0 (41.0)
Shoulder height (from the seat)	21.5 (55.0)	23.0 (58.9)	25.0 (64.0)	19.5 (49.9)	21.0 (53.8)	22.5 (57.6)

Table : Statistics for sitting male and females

PHYSICAL DIMENSIONS OF THE HUMAN BODY AS A WORKING MACHINE

- **Strength:** The maximum force that a person can exert.
- **Endurance:** The length of time a person can exert force or perform work
- **Power:** The ability to exert force quickly, or to perform a high amount of work in a short amount of time
- **Flexibility:** The range of motion around a joint, which is important for movements that require a large range of motion
- **Dexterity:** The ability to perform fine motor movements with the hands or fingers, which is important for tasks that require precision.
- **Posture:** The alignment of the body in standing or sitting, which can affect comfort, safety, and performance.

Other Factors to be considered are:

- **Gender:** Judging from gender, of course we all agree if generally men have a larger body dimension than women.
- **Age:** The size of the human body will develop from birth to 17 years. And finally it will decline when it is 60 years old.
- **Ethnicity (Ethnicity)** By being influenced by the geographical location where humans live, dimensional variations will occur
- **Work:** With the intensity of daily work also causes differences in the size of the human body.
- **Understanding these physical dimensions can help optimize the design of tools, equipment, and workspaces to accommodate the physical characteristics of the human body, with the goal of maximizing comfort, safety, and performance**

MOTION SIZE RELATIONSHIPS

Motion size relationships in anthropometry refer to the relationships between **body size and the way in which humans move**. Some of the most commonly studied motion size relationships in anthropometry include:

- **Stride length**: Stride length refers to the distance covered by one leg during a complete step. The length of an individual's stride is influenced by their leg length and the angle at which they walk.

- **Gait cycle**: The gait cycle is the sequence of movements that occur during one step. The length of an individual's gait cycle is influenced by their leg length and the speed at which they walk.

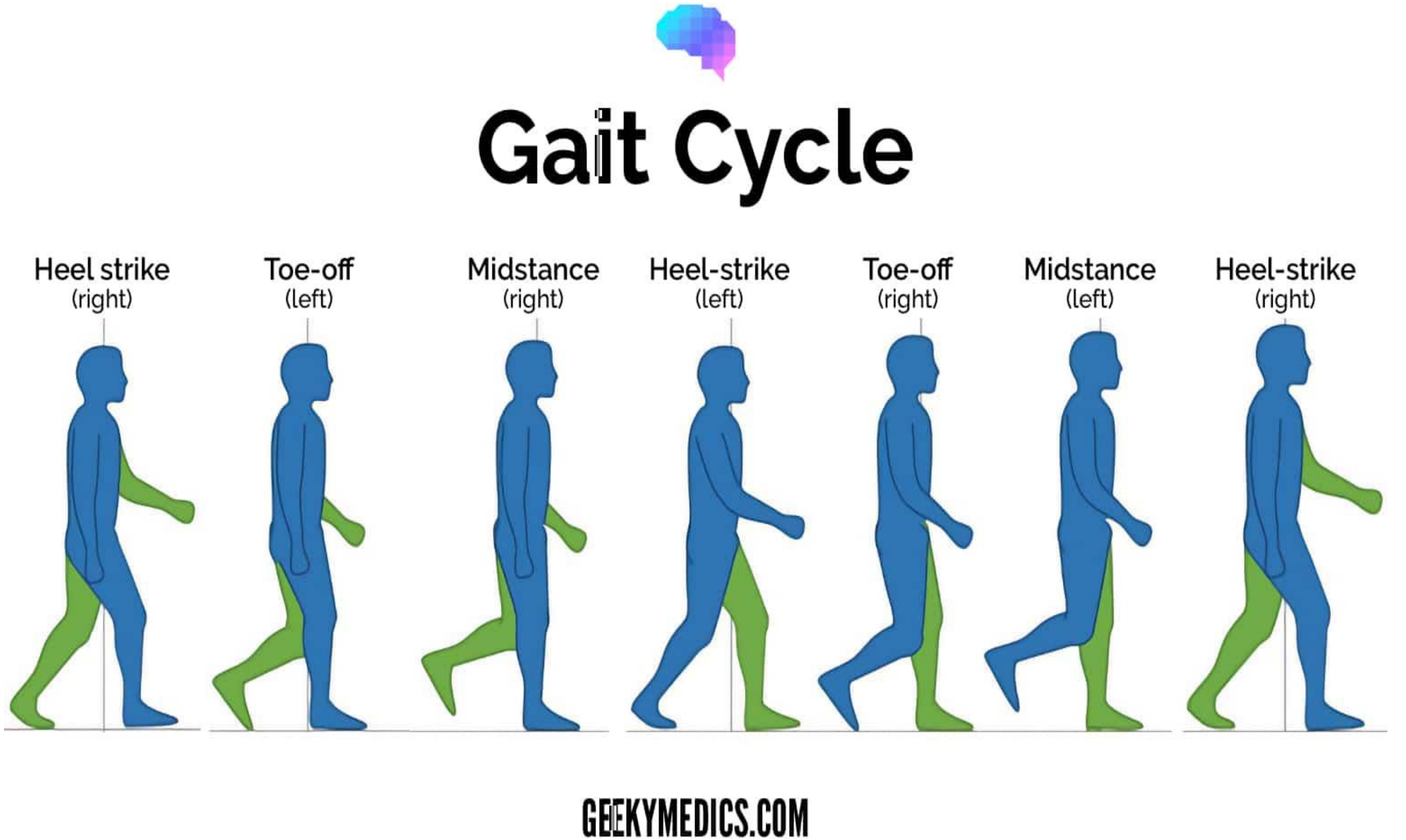
MOTION SIZE RELATIONSHIPS

- **Joint range of motion**: Joint range of motion refers to the range of movement available at different joints in the body. **The size of an individual's joints** is a factor that influences their joint range of motion.

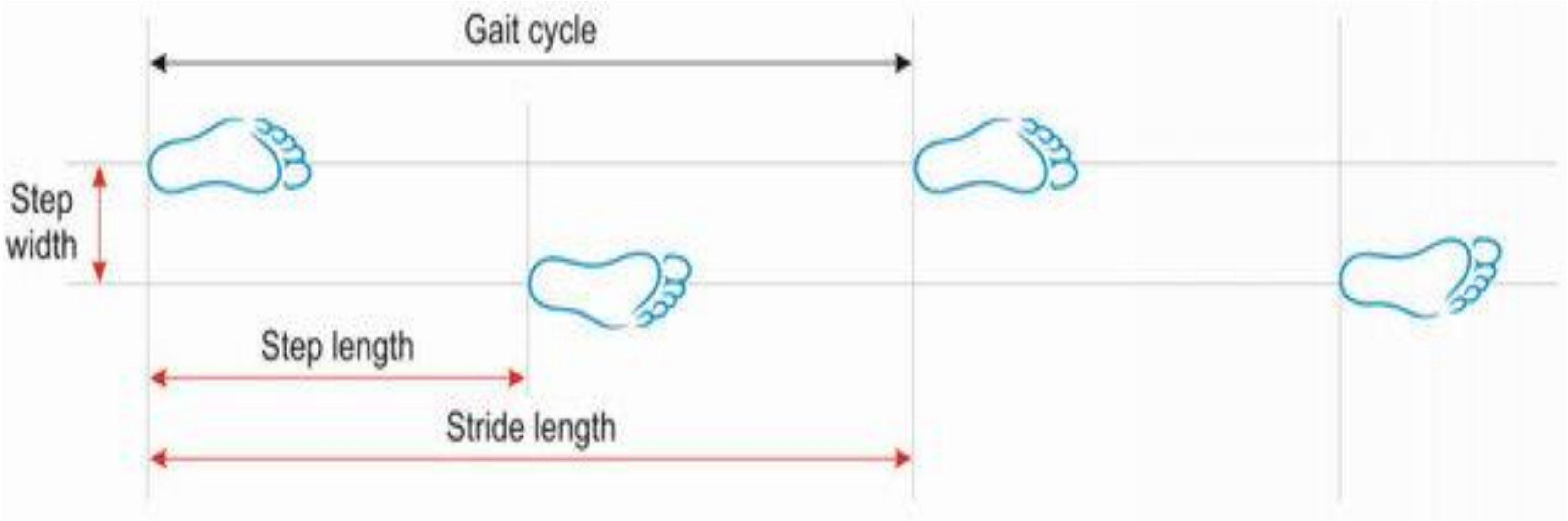
- **Center of gravity**: The center of gravity is the point in the body where the weight is evenly distributed. The size and distribution of an individual's body mass influences their center of gravity and how they move.

- **Muscle strength**: Muscle strength is influenced by the size and composition of an individual's muscles. Larger muscles are generally stronger and can generate more force, which can influence how an individual moves.

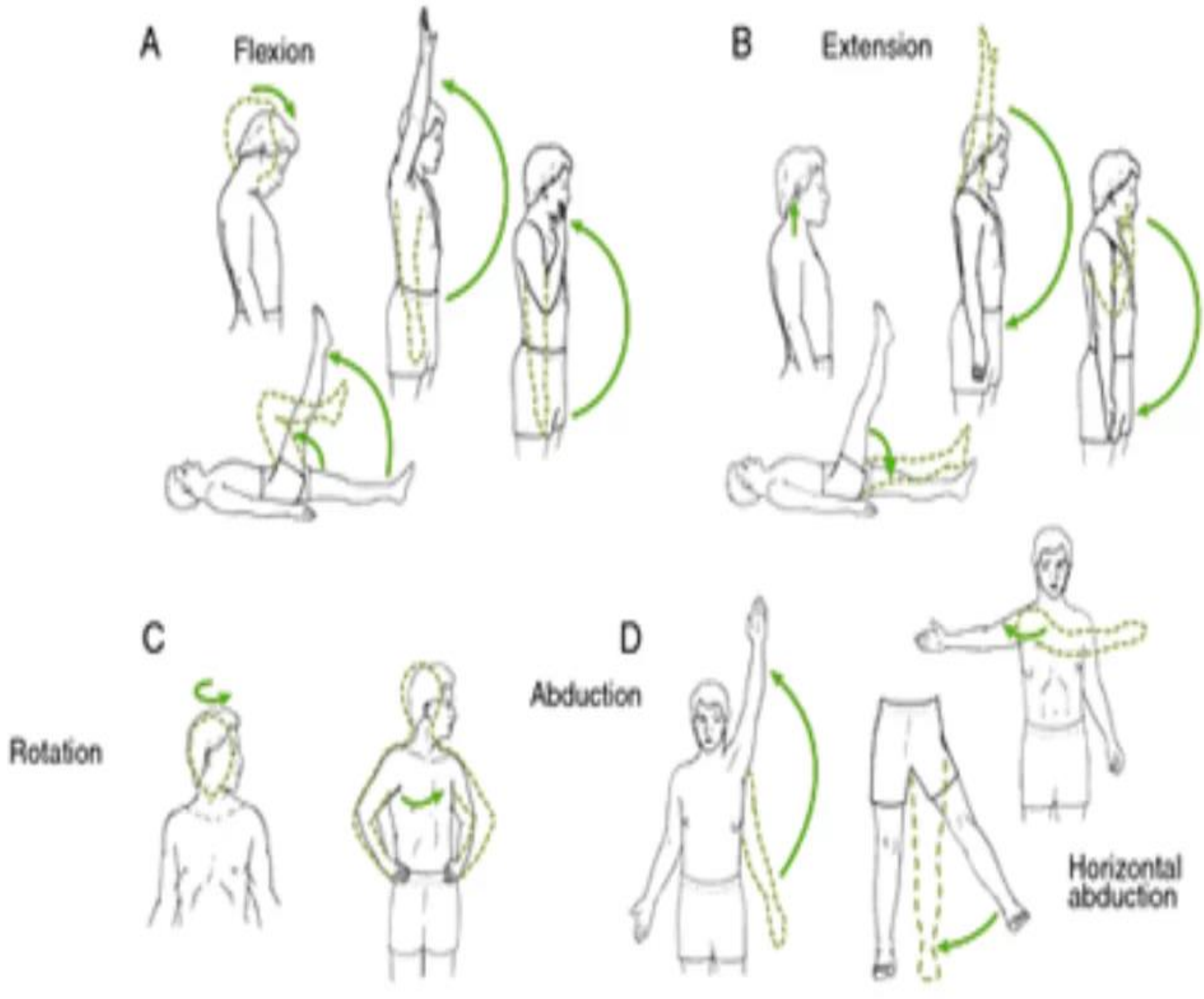
MOTION SIZE RELATIONSHIPS



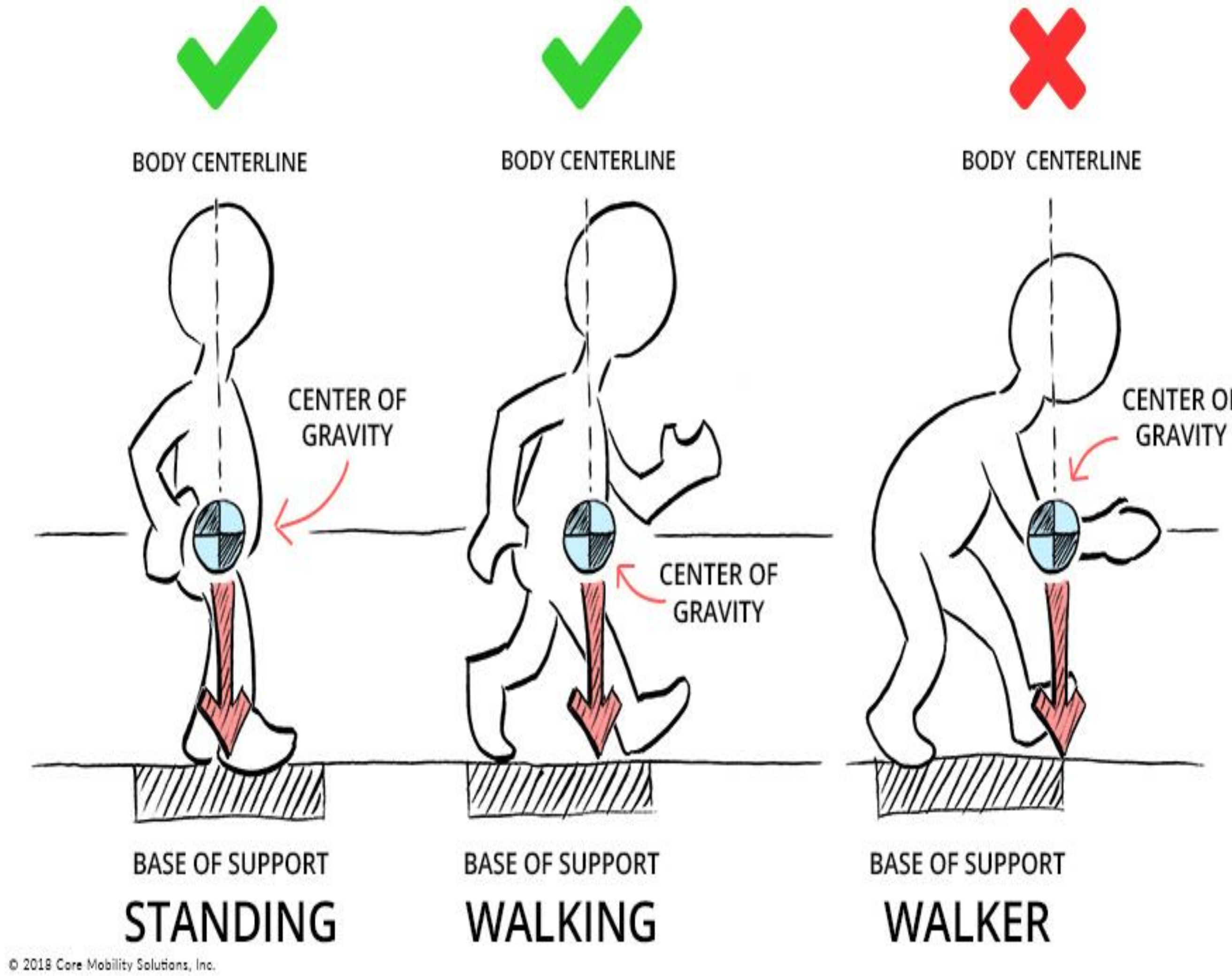
MOTION SIZE RELATIONSHIPS



RANGE OF MOTION



Motion size relationships



ANTHROPOMETRIC DESIGN PRINCIPLES

The three ergonomic design principles based on anthropometry are

1) Design for a range
2) Design for the extreme and
3) Design for the average.

Design for a range:

Designing for a range using anthropometry involves designing products or spaces that can accommodate a range of human body sizes and proportions.

Designing for a range using anthropometry is essential for creating products and spaces that are **accessible and comfortable for a wide range of users**

Design for the extreme:

Designing for the extreme using anthropometry involves designing products or spaces that can accommodate the smallest and largest users.

Designing for the extreme using anthropometry is essential for creating products and spaces that are **accessible and comfortable for users at both ends of the size spectrum.**

Design for the average:

Designing for the average using anthropometry involves designing products or spaces that are **optimized for users within the average range of body sizes and proportions.**

Designing for the average using anthropometry is important for creating products and spaces that are **optimized for the largest proportion of users**.

STEPS IN THE ANTHROPOMETRIC DESIGN PROCESS

- **Determine the range of body sizes and proportions:**

The **first step is to collect anthropometric data** to determine the range of body sizes and proportions that need to be accommodated. Anthropometric data can be **obtained from sources** such as **anthropometric databases, research studies, and design guidelines**.

- **Identify key design factors:**

Once the range of body sizes and proportions has been determined, the **next step is to identify the key design factors** that need to be considered. This includes factors such as **seat height, legroom, armrest height, and reach distance.**

- **Use design guidelines**: Anthropometric design guidelines can be used to determine the optimal design dimensions for different products and spaces. These guidelines provide recommendations for key design factors based on anthropometric data.
- **Consider adjustability**: Adjustable features such as seat height, armrest height, and keyboard tilt can accommodate a wider range of body sizes and proportions. Adjustable features can also improve comfort and reduce the risk of injury.
- **Test the design**: Once the design has been developed, it should be tested with a range of users to ensure that it accommodates the full range of body sizes and proportions. User testing can also provide valuable feedback for further design improvements.

ANTHROPOMETRIC DESIGN GUIDELINES

- **Consider variability**: Human bodies come in a wide range of sizes and proportions, so it's important to design for a range of body types. This means considering the **5th to 95th** percentile range for different measurements and accommodating different body shapes and sizes.

- **Match the design to the task:** Different tasks require different body postures and movements. Design should **take into account** the intended use of the product or space and the associated ergonomic needs.

- **Account for gender and age differences:** Anthropometric data shows that there are differences in body size and proportion between genders and across different age groups. Design should take these differences into account **to ensure that products and spaces are usable by all**.

- **Consider body movements and postures:** Design should take into account the ways in which humans move and interact with products and spaces. This includes factors such as reach, visibility, and posture.
- **Provide adjustability**: Adjustable design features can help accommodate individual differences and preferences. Examples of adjustable features include seat height and depth, armrest height, and lumbar support.
- **Ensure safety**: Safety should be a key consideration in design. For example, stair treads should be appropriately sized and spaced to prevent slips and falls, and edges should be rounded to prevent injury.
- **Allow for ease of use**: Design should make products and spaces easy and intuitive to use. This includes factors such as visibility, accessibility, and operability.

EXAMPLES IN ANTHROPOMETRIC DESIGNS

Design criteria	Anthropometric measure	Designed element	Design objective or requirement
Fit	Body size and shape	Clothing	Degree of looseness,
	Hand size and shape	Glove	Tightness, comfort, etc.
	Foot size or shape	Shoe	
	Head size and shape	Helmet	
	Nose size and shape	Glasses	
	Ear size and shape	Earplug	
	Finger length	Handle	Ability to reach fingers around the handle
Clearance requirements	Body size and shape	Door of car or building	Egress or ingress
		Aisle or passageway	Clearance between users
	Standing height	Overhead objects	Collision avoidance (bumping head)
	Finger size or shape	Button or key on keyboard	Inadvertent activation of keys
	Foot size or shape	Brake pedal	Inadvertent activation of gas pedal
Accessibility	Height	Height of work surface	Object within reach
	Length of arm	Location on work surface	
	Length of finger	Access hole on engine	
	Length of foot	Location of brake pedal	Pedal within reach

Design criteria	Anthropometric measure	Designed element	Design objective or requirement
Inaccessibility	Diameter of finger or hand	Guard	Prevent finger or hand from entering guard openings into hazard zone
	Diameter of child's head	Distance between bars on baby crib	Prevent head from entering though opening between bars
	Length of arm or finger	Separation distance from hazard	Prevent hand or finger from reaching the hazard zone
Posture	Standing height	Height of work surface	Reduce bending
	Shoulder rotation	Height of shelf	Reduce extended reaches
	Wrist deviation	Relative height of desk to chair	Eliminate excessive deviation
Visibility	Standing eye height	Location of sign	Vision not blocked
	Sitting eye height	Height of seat in car	Person can see over hood of car
		Height of screen in theater	
		Relative height of auditorium seats	Person can see over head of person sitting in front of them
Mechanical advantage	Grip strength	Handle length of scissors or shears	Person able to exert enough force to cut object
	Finger length	Handle diameter	Person able to grasp handle tightly
Adjustability	Variability of eye height	Car seat	Adjust height of seat for shorter people
	Variability of length of lower leg	Office seat	Adjust height of seat for shorter person or higher work surface

ANTHROPOMETRIC MEASURES FOR INDUSTRIAL DESIGN

Anthropometric measures can be used in industrial design to create **products and spaces** that are comfortable, safe, and functional for the user.

Ergonomic design: Ergonomic design uses anthropometric data to design products that are optimized for the user's body size, shape, and movement. This can include adjusting the height, width, and depth of seats, desks, and workstations, as well as the location of controls and displays to minimize discomfort and fatigue.

Accessibility design: Anthropometric data can also be used to design products that are accessible to people with disabilities or mobility impairments. This can include adjusting the height, width, and depth of controls, switches, and buttons to accommodate people with limited reach or mobility.

Safety design: Anthropometric data can be used to design products that are safe and reduce the risk of injury. For example, safety helmets, safety harnesses, and protective equipment can be designed to fit the **user's head, body, and limbs** to provide maximum protection.

Human factors design: Human factors design considers the user's physical and cognitive capabilities, preferences, and limitations to design products and systems that are easy to use and operate. This can include adjusting the **size, shape, and location of controls and displays** to minimize errors and increase efficiency.

APPLICATIONS IN INDUSTRY

Automotive industry: Anthropometry is used in the automotive industry to design vehicle interiors that accommodate a wide range of body sizes and shapes. This includes designing seats, steering wheels, and pedals that are adjustable to fit different users, as well as **optimizing the location of controls and displays for ease of use**.

Furniture industry: Anthropometry is used in the furniture industry to design chairs, tables, and desks that are ergonomically optimized for the user's body size and shape. This includes **adjusting the height, width, and depth of furniture** to accommodate different users, as well as optimizing the location of controls and displays.

Aerospace industry: Anthropometry is used in the aerospace industry to design aircraft interiors that are optimized for the user's body size and shape. This includes **designing seats and controls that are adjustable to fit** different users, as well as optimizing the location of controls and displays for ease of use.

Healthcare industry: Anthropometry is used in the healthcare industry to design medical equipment and devices that are optimized for the user's body size and shape. This includes designing hospital beds, wheelchairs, and other medical devices that are **adjustable to fit different users**, as well as optimizing the location of controls and displays.

Sports industry: Anthropometry is used in the sports industry to design equipment and apparel that are optimized for the user's body size and shape. This includes designing sports equipment such as bikes, skis, and golf clubs that are adjustable to fit different users, as well as **designing sports apparel** that is comfortable and fits well

Clothing industry: Anthropometry is used to design clothing and apparel, including sizes and proportions, to ensure that they fit and flatter the user's body shape.

ERGONOMICS AND PRODUCT DESIGN

ERGONOMICS IN AUTOMATED SYSTEMS

- Automated systems are becoming increasingly prevalent in manufacturing, healthcare, transportation, and other industries.

- Ergonomics in automated systems refers to **designing and operating automated systems** in a way that ensures the safety, comfort, and efficiency of human operators who interact with them.

- Ergonomic **design principles** should be incorporated into the **design of automated systems** to ensure that the operators can use the system comfortably and efficiently.

Work station design:

The workstation where the operator interacts with the automated system should be designed to provide adequate space, lighting, and ventilation. The **height of the workstation** should be adjustable to accommodate different body sizes and shapes.

Cont..

1. Everything available within the working zone

2. Bright and adjustable **lighting**, 2000 lx

3. Handling of manual loads

4. Adjustable working height

5. Adjustable **chair**

Controls and displays:

The **controls and displays** of the automated system should be designed to minimize physical and cognitive demands on the operator. They should be **easy to reach and operate without excessive force**, and the information presented should be clear, concise, and relevant.

Reducing physical strain: Automated systems should be designed to reduce physical strain and fatigue. For example, heavy lifting tasks can be automated, reducing the need for workers to perform repetitive and strenuous tasks.

Fig: Hydraulic scissor lift

Fig: Robotic arm for lifting

Fig: Material Handling Equipment

Minimizing cognitive load: Automated systems should be designed to minimize the cognitive load required of workers. This can include providing clear and simple instructions and user interfaces, as well as **reducing the need for workers.**

User interface design:

The user interface of an automated system should be designed to be intuitive and easy to use. This can include using **clear and simple language**, using familiar symbols and icons, and providing feedback to the user about the system's status

Safety:

Automated systems should be designed to be **safe for human operators to use.** This can include designing guards and barriers to prevent users from accidentally coming into contact with moving parts, **designing emergency stop buttons that are easily accessible**, and designing systems that can detect when a person is in the way and stop or slow down accordingly.

EXPERT SYSTEMS FOR ERGONOMIC DESIGN

- An expert system is a **knowledge-based reasoning** system that captures and replicates the problem-solving ability of human experts.

- Expert systems for ergonomic design are computer programs that use artificial intelligence techniques to simulate the knowledge and decision-making processes of human experts in the field of ergonomics.

- The expert system typically includes a knowledge base, which contains information about ergonomic principles, design guidelines, and best practices.

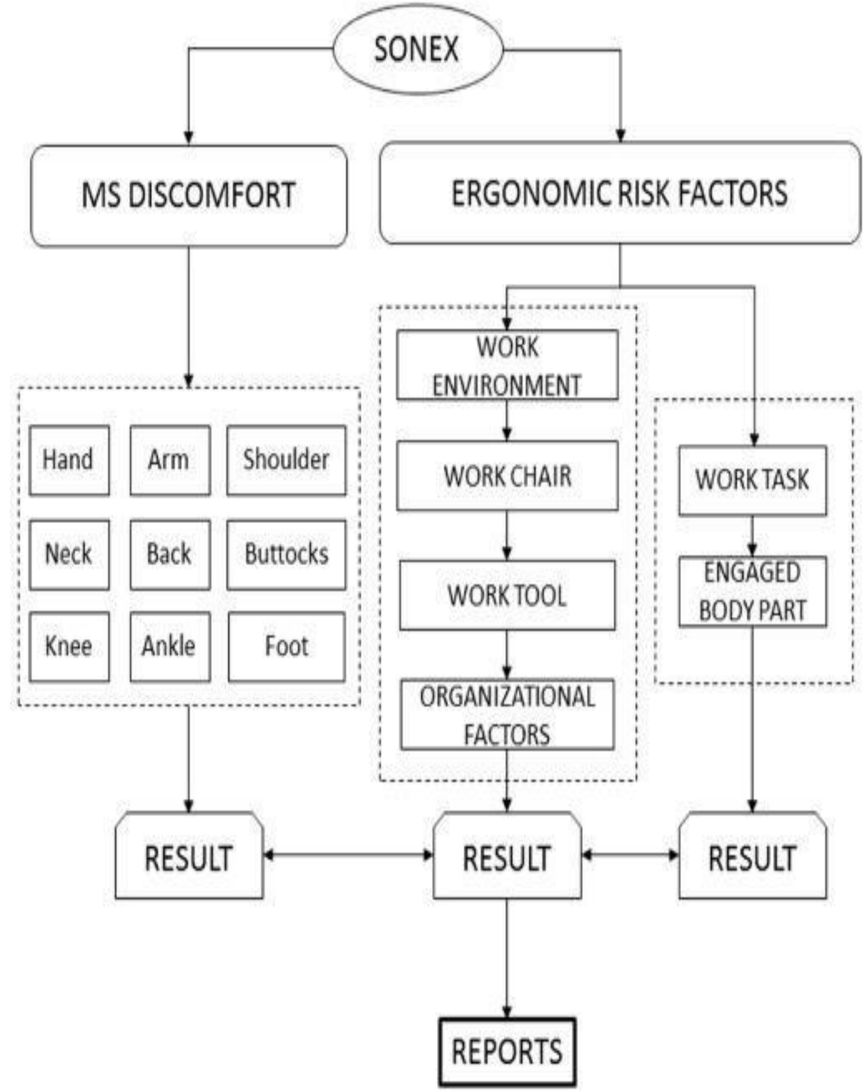
- Expert systems are developed to **capture knowledge for** a very specific and limited domain of human expertise.

BENEFITS OF EXPERT SYSTEMS

- Cost reduction
- Increased output
- Improved quality
- Consistency of employee output
- Reduced downtime
- Captured scarce expertise
- Flexibility in providing services
- Easier operation of equipment
- Increased reliability
- Faster response
- Ability to work with incomplete and uncertain information,
- Improved training, increased ability to solve complex problems, and better use of expert time.

- A computer-based expert system (SONEX) was developed to identify ergonomic risks for work-related musculoskeletal disorders (WRMSDs) in a wide variety of jobs and provide expert prevention advice

- This expert system is used to predict the risk factors of various people under different working conditions



Source: https://www.sciencedirect.com/science/article/pii/S016981411530055X

- SONEX can be used as a **diagnostic tool** for the ergonomic analysis of the work place, and that the software can be offered to different users as a tool that will enable early **detection and prevention** of a number of different WRMSDs.

Comparison of software diagnosed injuries with physician diagnoses

ID#	Work place/employee	SONEX result for chosen body part using discomfort module	SONEX result using ergonomic risk factors module	Actual diagnosed condition	Agreement
1	Tailor/female, age 53, works 30 years, smoker, in poor physical condition	Shoulder: Neck strain Neck/upper back: Cervical spondylosis	High risk work for hand, arm (elbow and shoulder) and back	Cervical spondylosis	++
2	Mailman/male, age 45, works 24 years, in good physical condition	Shoulder: Subacromial bursitis Lower back: Lumbar disc herniation	High risk work for whole body/arm (elbow and shoulder) and back	Subacromial bursitis and Lumbar disc herniation	++
3	Data entry/female, age 39, works 17 years, smoker, in good physical condition	Hand/finger: Carpal tunnel syndrome	High risk work for hand High risk work for neck and eyes	Carpal tunnel syndrome, irregular use of anti-rheumatic drugs due the pain in the neck	++

The expert systems developed like these are capable of predicting the possible conditions of discomfort and help in improving the work space design using ergonomic principles

ANTHROPOMETRIC DATA AND ITS APPLICATION IN ERGONOMIC DESIGN

Ergonomists use the following steps to design equipment based on anthropometric design principles

1. Define the population – who are we designing for?
2. Determine critical body dimensions – what allows use?
3. Select the percentage of the population to be accommodated (or excluded)
4. Select the anthropometry principle: Range, extreme, average
5. Locate data tables.
6. Adjust for clothing, posture.
7. Test.

Rule of Thumb: Design so the tall can fit and the small can reach.

STANDARD ANTHROPOMETRIC DATA

Critical Anthropometric Dimensions

Segment/ Body Dimension	Gender	5th Percentile	50th Percentile	95th Percentile
Stature	M	64.3	69.3	74.1
	F	59.3	63.8	68.4
Eye height	M	60.8	64.70	68.6
	F	57.3	60.3	65.3
Hip width (seated)	M	12.14	13.95	16
	F	12.29	14.34	17.22

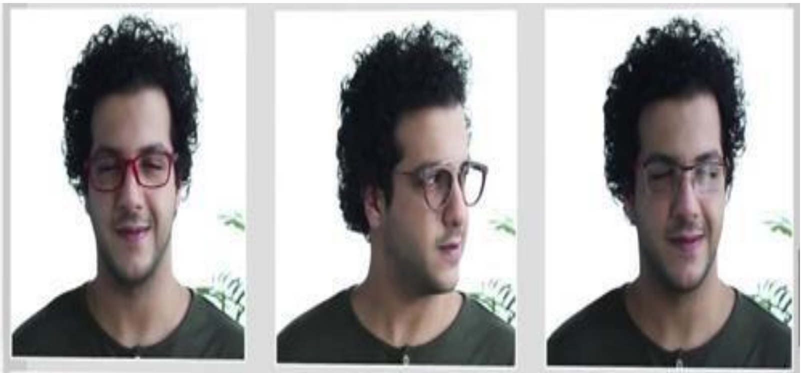
Source: Adapted from Helander (2005).

Example Use of Anthropometric Data Tables.

Adjustments to accommodate clothing include the following:

- 2.5 cm (1.0 in.) for standing height (or seated knee height) to reflect the presence of a shoe heel
- 0.8 cm (0.3 in.) for breadths (due to the bulk of clothing)
- 3.0 cm (1.2 in.) for foot length (to accommodate for shoes being larger than feet).

Expert system software using virtual AR



DIRECT APPLICATIONS OF ANTHROPOMETRIC DATA

- Industrial design and architecture (e.g., vehicle seating and cockpits)
- Clothing (e.g., military uniforms, sports uniforms)
- Ergonomics (e.g., seating)
- Medicine (e.g., nutrition, aging, obesity, sports science, and diabetes)
- Paediatrics(to access the growth of child)
- Medical Science(Radiology)
- Design of machine tools (Screw driver, hand saw, pliers etc)

LIMITATIONS OF ANTHROPOMETRIC DATA

- **Doesn't account for body composition:** Anthropometric data typically only measures the overall size and shape of the body, but doesn't take into account differences in body composition, such as the proportion of muscle, fat, and bone. This means that two individuals with the same height and weight may have very different body compositions and health risks.

- **Doesn't reflect internal health:** Anthropometric data only measures external physical characteristics, and does not provide information on internal health factors such as blood pressure, cholesterol levels, or insulin resistance

Doesn't capture individual variation: Anthropometric data is based on average values for different populations, and may not accurately reflect the unique characteristics of individuals within those populations. This means that some individuals may be misclassified based on their anthropometric measurements

Can be affected by measurement error: Anthropometric measurements can be affected by a variety of factors, including measurement error, variations in technique, and differences in equipment. This can lead to inaccuracies in the data and make it difficult to compare measurements across different studies

Doesn't capture changes over time: Anthropometric data provides a snapshot of an individual's physical characteristics at a particular point in time, but does not capture changes over time. This means that longitudinal studies are needed to track changes in body size and composition over time

Ethnic and racial differences: Anthropometric data is often based on standardized measurements that may not be appropriate for all populations. There may be significant differences in body composition and shape among people from different ethnic and racial backgrounds, which may not be accurately captured by standard anthropometric measures.

Inability to assess health risk: While certain anthropometric measures, such as BMI, are associated with increased health risks, they do not provide a complete assessment of an individual's overall health status or risk for chronic diseases

Limited applicability: Anthropometric data may not be applicable to certain populations, such as pregnant women or individuals with physical disabilities, as standard measurements may not be appropriate or may need to be adapted for specific conditions

USE OF COMPUTERIZED DATABASE

- The Anthropometric Database contains hundreds of measurements from numerous Anthropometric surveys.
- As new data collections are received, they are **integrated into the database**.
- The entire collection is managed using a computerized database system which allows the **user to access data** using a menu- driven system.
- Data may be accessed using a variety of **sort criteria** for each survey.

- Users also have the option of using statistical techniques to analyze the data
- **Computerized databases have revolutionized** the field of anthropometry by providing a more efficient and accurate means of collecting, storing, and analyzing anthropometric data.

BENEFITS OF USING COMPUTERIZED DATABASES IN ANTHROPOMETRY

- **Increased accuracy**: Computerized databases can reduce errors in data entry and calculation, ensuring that anthropometric measurements are recorded accurately.
- **Standardization:** Databases can help to standardize the measurement process, ensuring that measurements are taken consistently across different researchers, clinics, and time periods.
- **Time-saving:** The use of computerized databases can save time by automating tasks such as data entry, calculation, and analysis, allowing researchers to focus on other aspects of their work.

- **Large data storage**: Databases can store large amounts of data, allowing researchers to collect and analyze data from a large number of participants, which can lead to more reliable and statistically significant results.
- **Easy data sharing**: Databases can be easily shared among researchers, facilitating collaboration and allowing for meta-analyses and systematic reviews.
- **Customization:** Computerized databases can be customized to suit the specific needs of a research study, allowing researchers to collect and analyze data in a way that is tailored to their research questions.

WHAT IS THE DIFFERENCE BETWEEN ANTHROPOMETRICS AND ERGONOMICS

The **main difference** between anthropometrics and ergonomics is that **anthropometrics is the study of the human body and its movement, especially in terms of its measurements, but ergonomics is the scientific discipline that involves designing products and environments to match the individuals who use them.**

Anthropometrics and ergonomics are two highly related fields. Anthropometrics involve research that includes **measurements of the human body** while ergonomics involves using anthropometric data when designing products to improve user experience

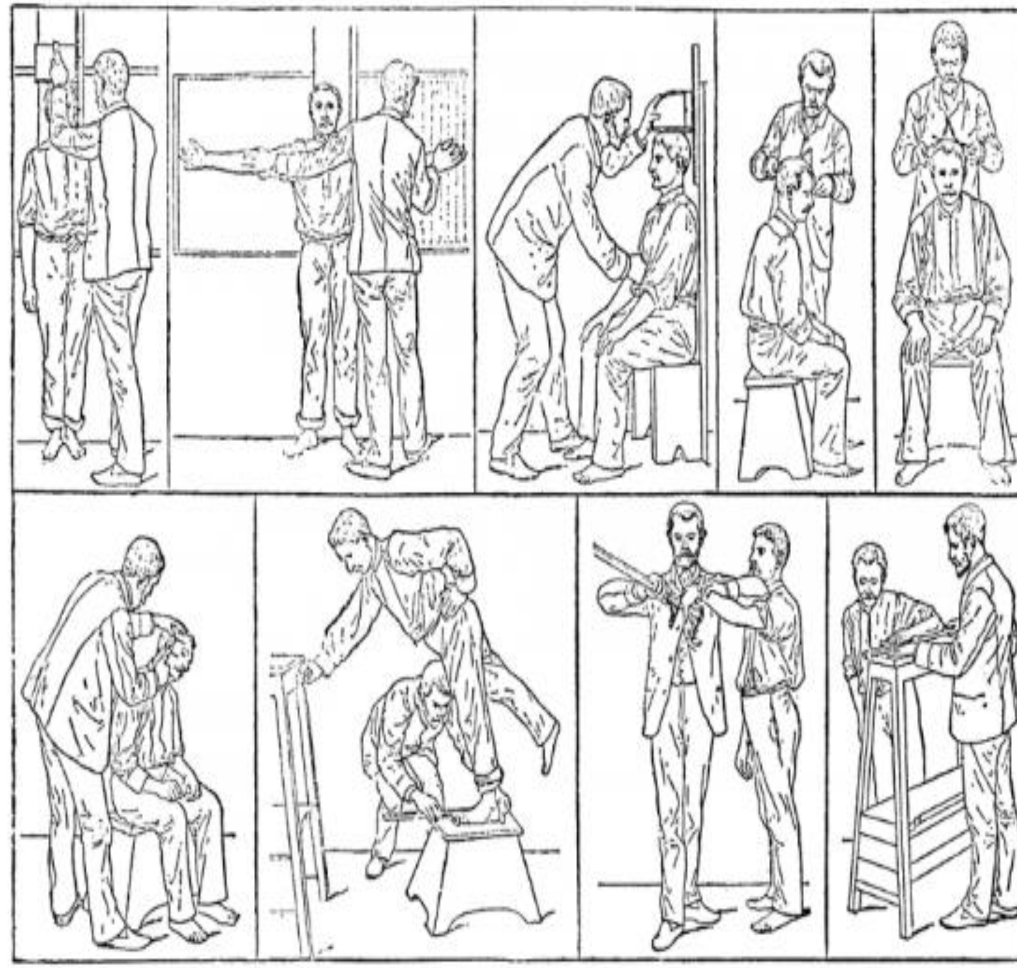
ANTHROPOMETRICS VS ERGONOMICS

ANTHROPOMETRICS	ERGONOMICS
Anthropometrics is the study of the human body and its movement, especially in terms of its measurements	Ergonomics is the scientific discipline that involves designing products and environments to match the individuals who use them
Involves the systematic measurement of the physical properties of the human body (height, weight, shape, arm length, etc.)	Involves incorporating anthropometric data in designing products and environments
For example, this may involve measuring the circumference of heads of a target population and obtaining an average value	Ergonomics may use this average head circumference value to design safety helmets

ANTHROPOMETRICS

Anthropometrics refers to the study of the human body, especially in terms of its measurements.

It involves the systematic measurement of the physical aspects of the human body, mainly measurements of body shape and size.



ANTHROPOMETRICS

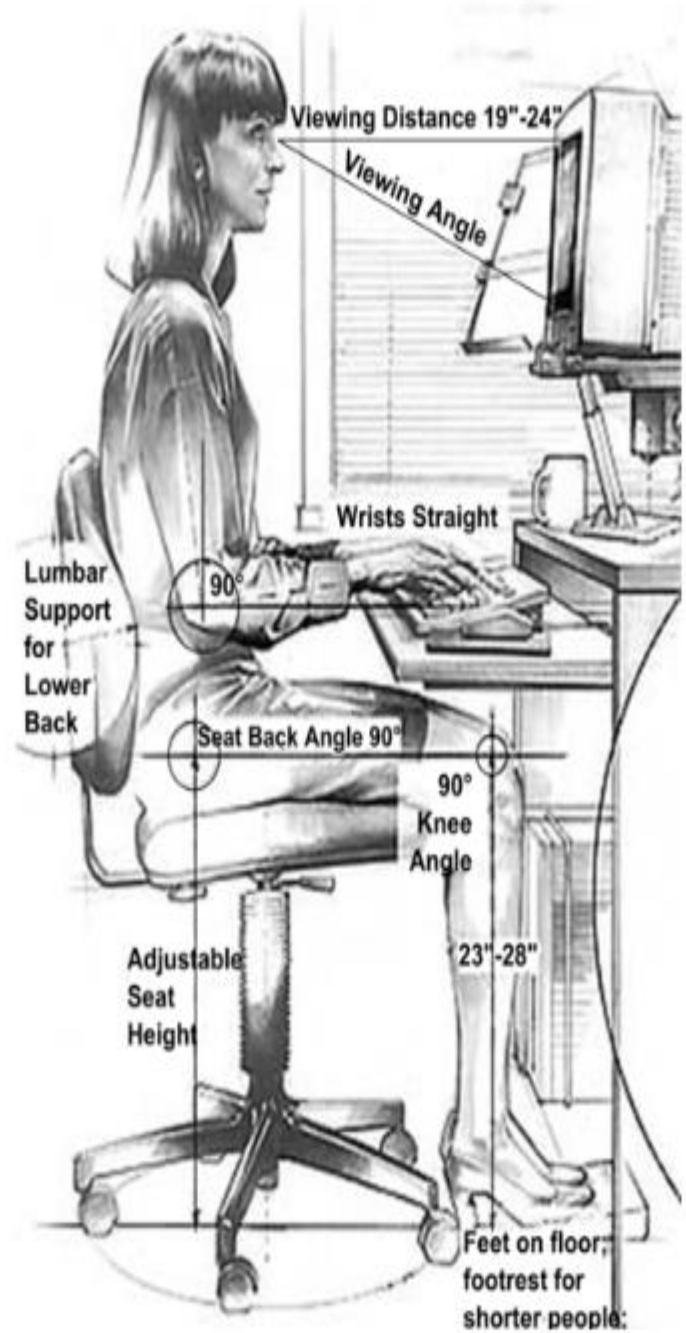
- Anthropometric data helps designers to design their product. For example, when designing a hairdryer, measurements like the **average height of users and length of average arms** become useful to decide the shape of handle and distance to be held from the head.
- When taking measurements form a target population for a specific product design, designers generally derive **an average value** (midpoint) as the final measurement.
- Anthropometrics plays an important role in various fields such as furniture design, clothing design, architecture, and ergonomics.

ERGONOMICS

- Ergonomics is the scientific discipline of **designing products and environments** to match the people who use them.
- It incorporates anthropometric data when designing products to improve user experience.
- For example, when you manufacture **a door handle**, you use the **measurements of the hand** to design the shape and size of the handle.
- The same theory applies to design various products such as furniture, vehicles, clothes, etc.

- If designers don’t use anthropometric data in designing products, it may lead to users’ discomfort, pain or even injury.
- Moreover, **size, shape, weight, the position of controls**, etc. are measurements that contribute to ergonomic designing.
- In addition to anthropometric data, ergonomics also uses data from several disciplines such as biomechanics (muscles, forces, strength, levers) and environmental physics (noise, heat, cold, light, radiation, etc.)

- The image shows **how ergonomics use** anthropometric data to optimize human interaction with equipment and workplaces.
- For example, the adjustable seat height enables the user to set the chair at a comfortable height, and height and angle of the monitor make it easy for the **user to see the screen comfortably, minimizing strain on the eyes and neck** while table height enables the user to reach the keyboard and mouse easily.



ANTHROPOMETRICS APPLIED TO AN HAIR DRYER

- Anthropometric data (measurements) are used to determine the shape of handle and distance to be held from head.
- Designed for **average size hand**.
- The length of lead is determined from anthropometric data (length of average arms and average height of users).
- The hair dryer is now ergonomically designed.