Applied Ergonomics

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Lecture – 03

So, welcome to this course once again. Now we are going to start one new topic under this course which is human centered design. So, as the topic itself is suggesting that we had to take care of the human aspects, and we have to put human in as a centre while performing the designing. So, whether it be a designing of any product or any system. So, we have to take care of the user population.

So, we have to first specify the user population and then design to accommodate as wide a range as possible. So, normally we take care of the 90 percent of the users while specifying any design. So, in that user population the word population is used in statistical sense. So, and it refers to the group of people sharing something, something common something common in terms of job. Something common in terms of their ancestors something common in terms of occupations, geographical locations, age, age group hence and ethnicity so and so forth. So, in that context we will be inclining towards our topic towards human centered design, and in that context we will be covering the introductory part and then a new term that we will be discussing that is anthropometric data and analysis, designed principles human centered design Principles human centered automation.

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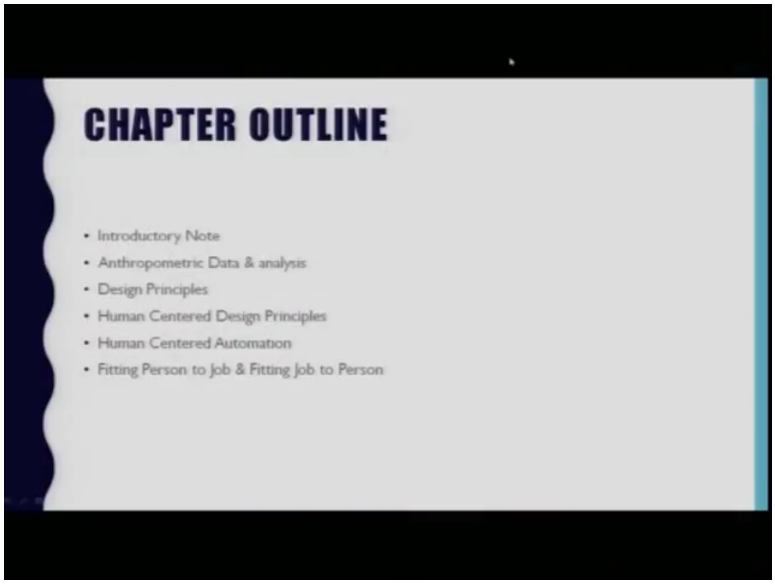

And some sort of fitting person to the job and fitting job to the person of the basic we have covered in the previous lecture.

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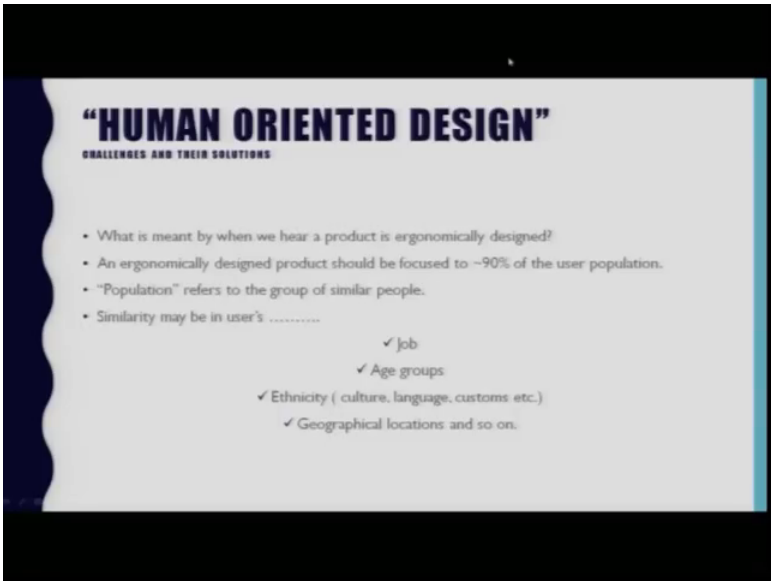

So now as far as the introduction goes, what are the challenges and solutions possible solutions of a human oriented design? So, the question that comes in mind that what is meant by when we hear a product is ergonomically designed. So, an ergonomically designed product should be focused to the 90 percent of the users. In fact, that population user population it refers to the group of similar people. As I have mentioned that it may the group may be of similar age group, languages or whatever is the problem statement towards designing a particular thing.

So, in that context that population is referring to and similarity may be in user s job age group ethnicity geographical location so and so forth. So, approach of ergonomics is to consider product dimensions in human terms in view of the constraint placed on their design to body size variability. So, we need to understand what is this human variability and what are their sources.

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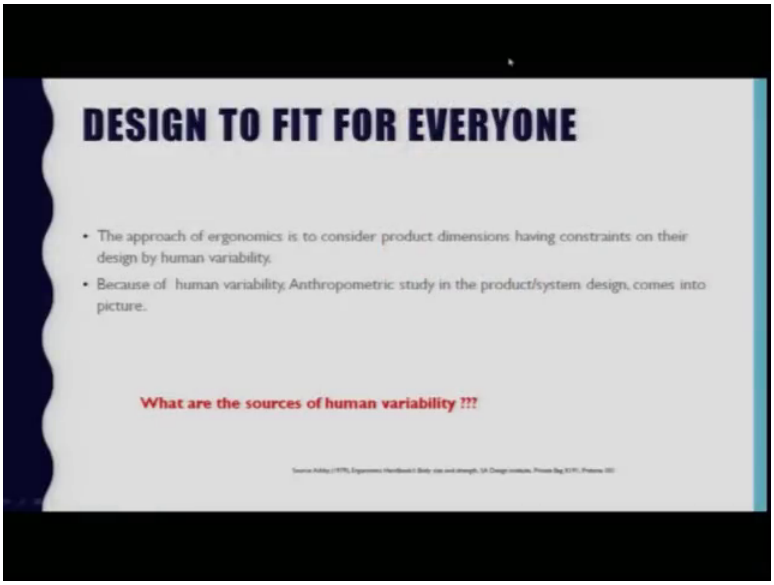

So, in that context body size and proportion vary greatly between different population, because u s citizen will be different from the Asian citizen. So, in terms of it is height, in terms of it is all the aspects. So, we have to take care of this human variability also. Because so, because of this human variability anthropometric study in the product or system design comes into picture.

So, we need to learn that what are the sources of human variability.

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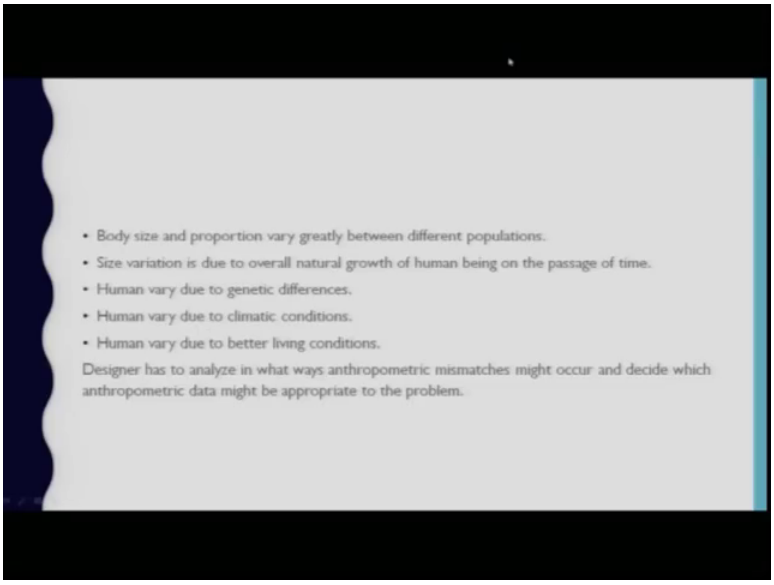

So, in that context body size and proportion vary greatly between different populations. Size variation is also due to overall natural growth of human being on the passage of time. Human also vary due to genetic differences, and human vary due to climatic conditions also. Human vary due to better living conditions also. So, designer has to analyze in what ways anthropometric mismatches might occur, and decide which anthropometric data might be appropriate to the problem.

So now we will try to learn what this anthropometry word is all about, and what are what are what are those anthropometric mismatches and anthropometric data that we have talked about in this previous sentence. So, we are starting this particular anthropometry explanation.

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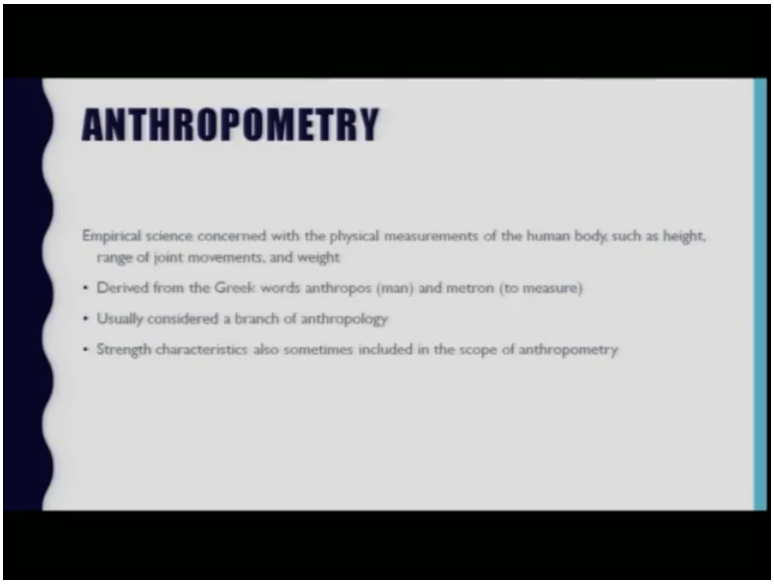

Anthropometry is again a Greek word is a combination of 2 Greek words basically. So, first is anthropometry anthropo and second is metron.

So, it means it means the measurement of human being. So, that is the definition of this anthropometry. And it is basically defined as a empirical science concerned with the physical measurements of a human body such as height range of joint movements and weight. So, as I have stated that it has derived from the Greek words anthropos and metron, and it is usually considered as a branch of anthropology.

So, it strength characteristics also sometimes included in the scope of anthropometry. So, as far as anthropometric variables and data is concerned, considerable amount of anthropometric data has been collected and published over the years. So, despite the significant expense in finding statistically representative subjects from the population performing the measurement and compiling the data. So, as per the anthropometric data.

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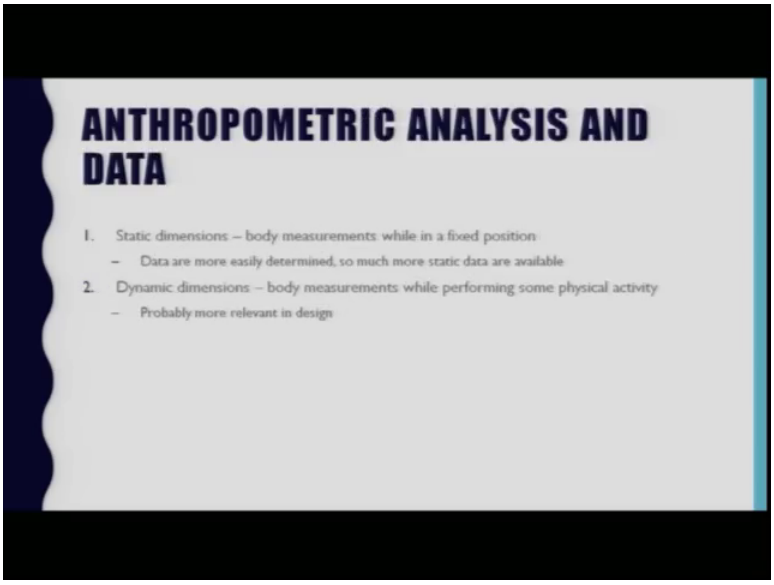

So, there are 2 types of dimensions we use to measure. First is starting dimensions and second is dynamic dimensions. So, static dimensions are those measurements which has been taken in a fixed position. Like if you are sitting and standing condition. So, there are various selected anthropometric variables and methods of measurement as well. So, those anthropometric variables are when you stand still and you measure your stature that is height.

So, the standing height is your anthropometric variable eye height. Eye height is the vertical distance between floor and inner eye corner with subject standing in the preceding. The shoulder height, elbow height, setting height, setting eye height, setting shoulder height, shoulder breath. So, this is the horizontal distance between right and left outer upper points of the shoulder blades, knee height, your vertical distance between floor and upper surface, and basically this knee height is the vertical distance between floor and upper surface of the thigh with knees, bend 90 degrees and length foot length head length. And forward reach forward reach is the maximum distance between vertical wall against which subject presses, shoulder blades and grip axis of hand your body weight which is subject standing still on weighing scale.

So, these are the anthropometric variables through which we predict the information about a particular person and a group of person. So, there are before going to have some various posturing conditions. Let us have a brief look over the human variability. So, differences in the body dimensions exist among people because of ethnicity, and nationality, heredity, diet, health, sex, age and living conditions.

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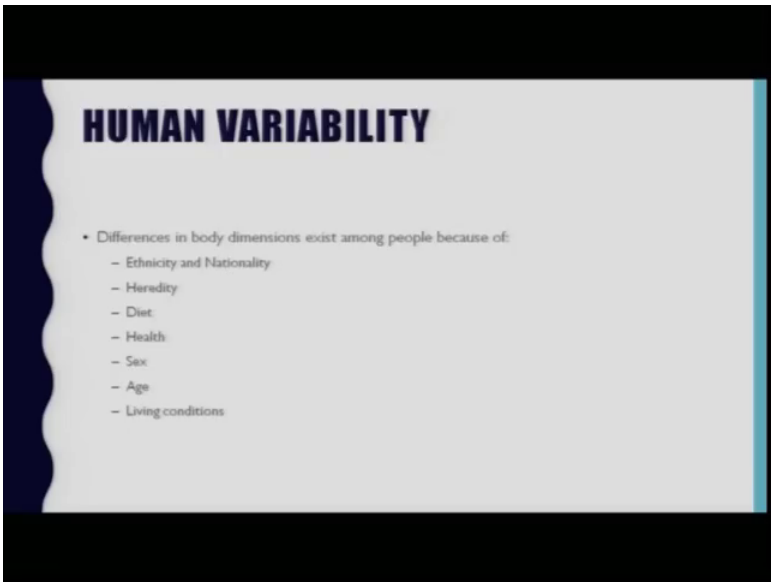

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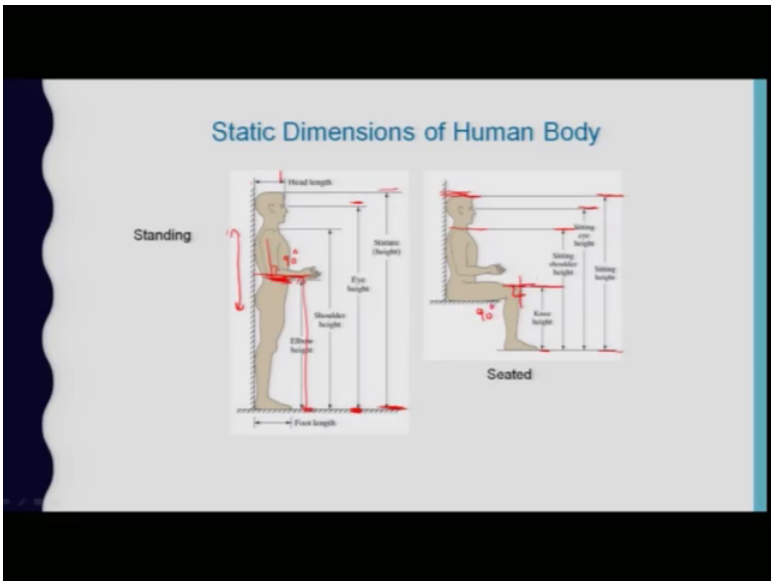

So now as shown in this slide, there are 2 persons. First is in standing condition and the right one is in the seated condition. So, the possible static dimensions of several anthropometric variables are as follows.

So, these are as you can see from this particular figure, that head length head length head length is the from the wall to this point to this point. And stature height is the total height, like vertical distance between the floor and the highest part of the head. With the subject standing erect. So, the erection is important in order to have complete height of

the particular of a particular body. In the same way the eye height. Eye height is often measured as a vertical distance between floor between floor and the inner eye corner, that is the inner eye corner and which subject standing as in the preceding. Your shoulder height is measured as a vertical distance between the floor and outer upper point of the shoulder blade with subject standing as in the preceding.

In fact, as the elbow height that has been measured here elbow height is defined as the vertical distance between the floor. And the lowest bony point of the elbow bony point this is the bony point, this one this one is the bony point of the elbow with the upper arm hanging freely with the upper arm hanging freely and elbow fixed at 90 degrees with the this is the 90 degree. So, in this way the possible anthropometric variable dimensions has been measured. And when you talk about the seating condition there are various heights that has been involved in predicting the several information, and which is helpful in the design of any product let us say designing of a chair. So, sitting height is the how we can define and how you can measure that particular sitting height. Sitting erect and that is vertical distance between horizontal sitting surface and the highest part of the head.

So, this is the highest this is the highest part of the head and this is the floor. So, distance between the floor and the highest part of the head, is known as sitting height in the same in the similar way sitting eye height is defined it is the vertical distance between horizontal sitting surface and the inner eye corner with subject sitting in the preceding in the similar way sitting shoulder height is defined. So, sitting shoulder height is defined as the vertical distance between horizontal sitting surface and the outer upper point of the shoulder blade. Knee height another thing is knee height which is the major concern.

So, knee height is again we can determine with the help of measuring the vertical distance between the floor. And the upper surface of this thigh, upper surface of the thigh with knees bend with bend as a 90 degree. So, these are the possible study dimensions of the human body.

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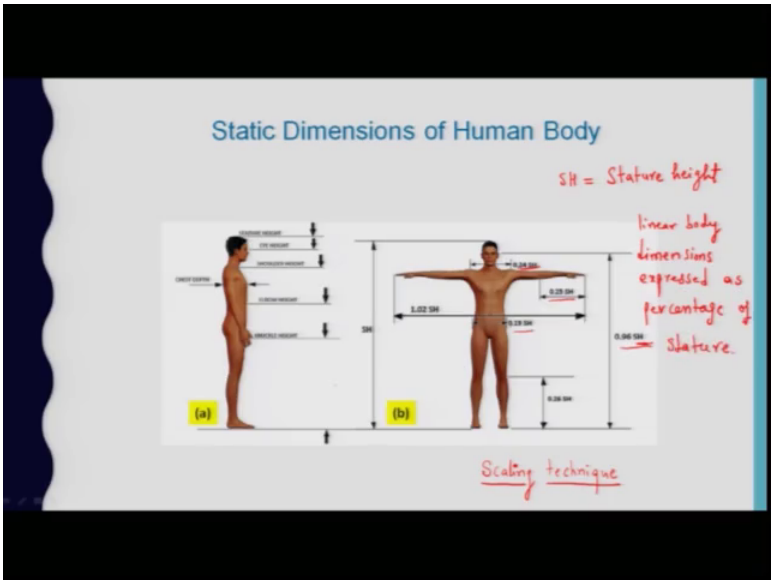

So, there is again another posture this a is the standing conditions, and this is the full arm condition. The b is a full arm condition in which one scaling technique has been utilized.

So, this scaling technique is utilized in order to have any measurement based product. Like if you are designing let us say if you are designing a (Refer Time: 13:05) cloth. So, for designing a cloth you should know completely the proportion of your hand with respect to the total height. Now as you can see from this figure a and figure b. So, in the figure b this particular ratios have been define as 0.2424 SH, 0.19SH with respect to the stature height. So, s h is the stature height.

So, this particular scaling technique is used when designing for users where or whose anthropometry is unknown. So, for example, a group of workers know to differ from the general population for some reason. So, for those scaling technique is helpful in evaluating the dimensions for designing a product. So, this is a most general condition where this every height and every length you can see is predicted on the basis of this particular with respect to this stature height.

So, the linear body dimensions expressed as a percentage of stature. So, all the linear body dimensions expressed as percentage of stature.

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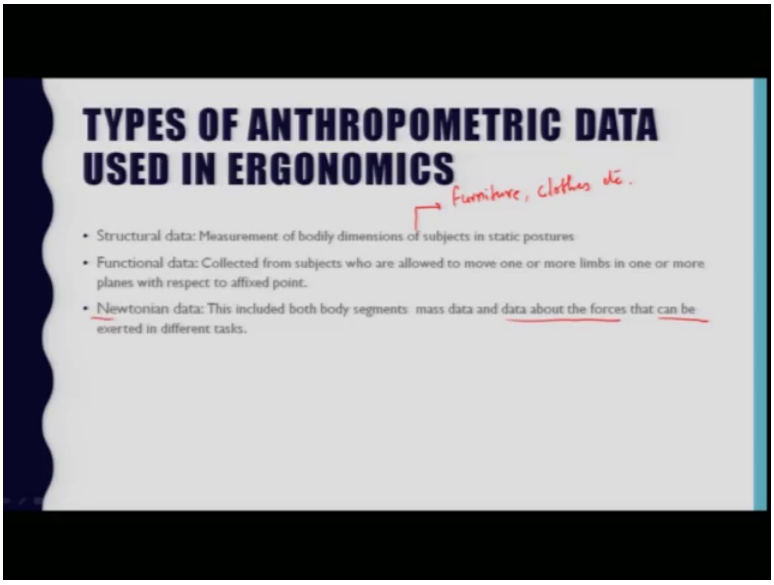

Now, we come to the types of anthropometric data used in ergonomics. So, there are basically 3 types of data. First is structural data, second is functional data, third is Newtonian data. So, the structural data in that structural data measurement of a body dimension of subject in study posture. So, that is typically used into optimize furniture. So, example of this structural data is utilized in furniture clothes and vehicle cab dimensions etcetera.

As far as functional data is concerned. So, the it is collected from subjects who are allowed to move one or more limbs in one or more planes with respect to a fixed point. So, shape of 3 d surface swept by moving the arm with the elbows extended or the amount of forward reach when the subject can bend at the hip bend at the hip. So, in this way that where the generation of work space envelops whose size increase with the number of joints allowed to move.

So, here that kind of data is known as functional data. So, as far as Newtonian data is concerned. So, it included both body segments mass data about the forces and that can be exerted in different task. So, so all sort of analysis aspect in which the calculation has been carried out in terms of force analysis. So, those things comes in the Newtonian data.

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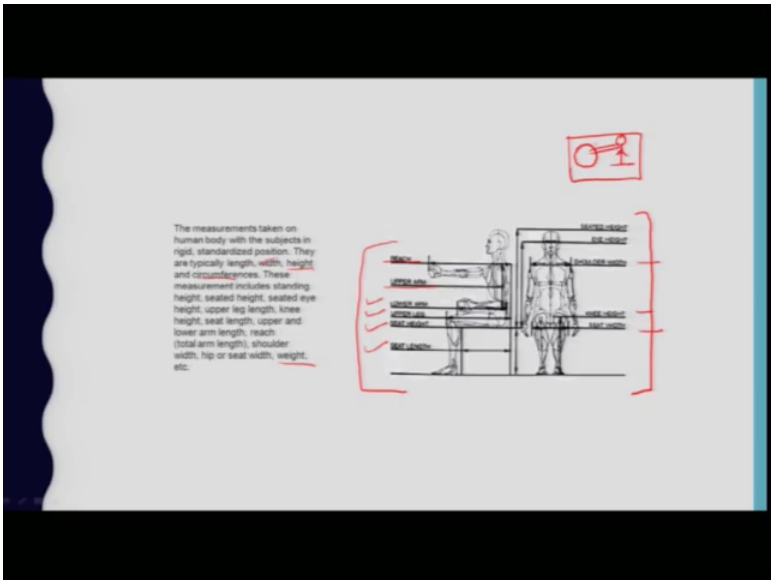

Another example or in fact, another thing that is we can take it as a different segments of measurements here.

So, here we can see that a person who is sitting. So, possible measurements we can take as a serious eye height, and we have also as well as in the front we have to take care of these aspects while designing let us say design a chair. And second thing is we have also have to take care how much reach of a particular person is has, and about this upper arm liberty lower arm liberty upper leg seat height and seat length. So, the measurements taken on the human body with the subjects in (Refer Time: 17:42) it is standardized position.

So, they are typically length, width, height, circumference, these measurements include standing height seated height seated eye height per length knee height seat length per and lower arm length reach, shoulder with tip or seat with etcetera. So, suppose if you are sitting inside a car in the driving seat. So, those aspect are very much important in order to design a proper work space in order to handle or to handle the steering wheel inside and of a person sitting.

So, that reach is also very important.

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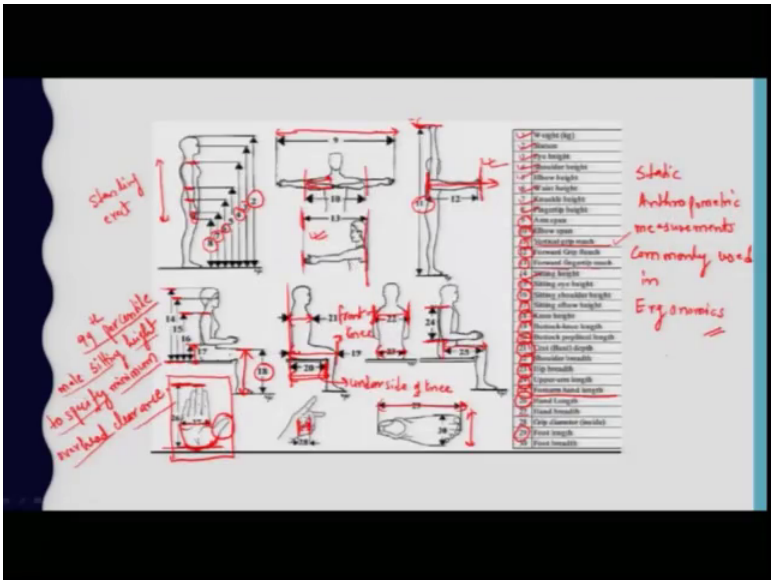

Now, again what are the other possible measurements that we take into consideration while capturing the anthropometric data. So, those data which you can visualize with the help of this whole figure which I have taken from one book are (Refer Time: 18:48). So, that is the first kind of thing is weight. Second is stature is nothing but the standing height standing height that is represented here as a tool. And it is expressed as a vertical distance between the floor and highest part of the head with subject standing erect.

So, he is standing erect. So, in that situation whatever the measurement is taking place it is known as stature. Third is eye height, eye height is again it is a vertical distance between the floor and the inner eye corner. Shoulder height, shoulder height is this number 4. So, shoulder height is vertical distance between floor and upper outer upper point basically this is the outer upper point of the shoulder blade. Again fifth is elbow. So, elbow height is again the vertical distance between the floor and the lowest bony point, again this is a waste height.

So, 6 wrist height. So, wrist height is this 6 one is the wrist height where from the where the wrist is starting. And that distance to the floor 7th knuckle height again this is the portion from where we have to measure the knuckle height. And this is the knuckle height 8 fingertip height. So, 8th one is the finger tip. So, from the point where this particular finger is ending that particular point is considering as a measurement point to the floor itself. So, this point is the fingertip point and touch yourself.

So, the possible length over which your arm can be stretched is known as arm span. So, ninth particular distance in a stretchable condition is total is giving you arm span. Tenth is elbow height, elbow span tenth is elbow span means if you are stretching while stretching only this portion and while confining the this portion in a in a speed way this particular height is known as this particular length is known as elbow span. 11 vertical grip reach 11 is the vertical grip reach.

So, in a vertical position if you are stretching your hand and the vertical and the top most point up to which your vertical hand your hand can be stretched out. So, from that point to the floor is known as vertical grip reach. In the similar way forward grip reach is also defined stretch your hand in a forward direction and you measure the distance from where your hand is originating initiating to the extreme point to which you're your grip can be reached So, that particular extension is known as forward grip reach.

13 point is forward fingertip reach. That you can see here as forward as a forward fingertip reach this is particular you have to stretch your fingers here. In the twelfth case you do not have to stretch your fingers here you have to stretch your fingers and the extreme point from the extreme point to the to the initiation of your hand. So, we have discussed weight stretcher eye height, shoulder height, elbow height, wrist height, knuckle height, fingertip height, arm span, elbow span, vertical grip reach.

So, we will describe about the vertical grip reach. In fact, this 11 point is the vertical grip reach. So, this vertical distance from let us say vertical distance from the floor itself to the extension to the top most point of at the stretching condition of your hand. So, this particular point to this point is known as vertical and grip reach. As far as forward grip reach is concerned. So, if you are not extending your fingers only extending your hand. So, up to the limit your hand is going is your forward grip reach. About the forward fingertip reach you can see this particular figure in which person is stretching along with his fingers.

So, stretching of the hands along with the fingers. So, at that tip of the fingers to the point where your hand has initiated has been initiated. So, this particular distance is known as forward fingertip reach. 14 is the sitting height. So, about the sitting height, this sitting height is number 14 and it is defined as the vertical distance from seat to the top of head. So, normally we use 99th percentile of the male I will describe this how we

will find out this percentile, and all just for the sake of your knowledge we use 99 percentile male sitting height to specify minimum overhead clearance. And In fact, we allowed to about around 20 millimeter if heart rate are worn heart heads are worn.

So. In fact, since this person is not wearing hat. So, we are not giving anything. So, as a allowance. So, 99 percentile may sitting height specify a minimum overhead clearance. So, again this 15th is sitting eye height. So, that sitting eye height gives the centre. This sitting height gives the centre of the visual field of a seated worker and maximum height of a visual display. So, after this 14 part we need to see what is that sitting eye height. So, in this sitting eye height. So, again it is a distance from the inner eye corner to the to the seat to the portion of the seat.

So, this particular distance is known as sitting eye height, and as far as sitting shoulder height is concerned. So, again it is the shoulder it is a distance from the centre of rotation of upper limb from seat. So, that is known as sitting shoulder height. And now sitting elbow height sitting elbow height is the is the seat surface to the under side of the elbow. So, you can see from this like sitting elbow height it is 17. So, sitting elbow height is 17. So, this particular distance is known as sitting elbow height.

The next kind of height is knee height. So, knee height is number 18 and 18 is showing here. So, 18 number is showing knee height which is the distance from the floor to the top of the knee. So, this is the top of the knee and this distance is known as knee height. Third is buttock knee length. So, buttock knee length is denoted as a 19th. So, this 19 particular is the buttock knee length it has been described as a horizontal distance from the wall let us say, from the wall to the under side of the knee to the under side of the knee.

So, this we have to specify the maximum allowable depth of a seed to accommodate let us say fifth percentile female or male. So, we have to take care of the maximum allowable depth of a seed to accommodate minimum percentile of the human being. Again the things are defined like buttock populated length it is 20 [FL] 19 [FL] 20 [FL] 18 [FL] start [FL].

So, this 18 is the knee height. So, it can be measured from the floor to the top of the knee 19 is the buttock knee length. So, buttock knee length is 19 and that is the distance basically it is the horizontal distance from the wall to the front of the knee. This is front

of the knee. So, and again this buttock popliteal length. So, buttock popliteal length is the horizontal popliteal is basically the lower portion of the of the of your leg. So, that s the horizontal distance from the wall to the under side of the knee.

So, this is particular let us say this particular portion is the underside of the knee. So, under side of the knee. So, this horizontal distance from walls to under side of the knee is known as buttock popliteal length. Again this chest depth is this is a sorry. So, this is as this is the chest depth basically and as you can see from this figure also. 22 is the shoulder breadth 22 is the shoulder breadth. And this shoulder breadth is defined as the horizontal distance between the right and left outer upper points of the shoulder blades. 23 is the hip breadth 23 is the hip breadth.

So, this breadth is known as hip breadth. 24 is the upper arm length. So, 24 is the upper arm length. As you can see from the upper portion to the knee this is known as upper arm length. 25 is the forearm hand length. So, the forearm hand length is known as this particular distance as you can see from this figure also. 26 is the hand length. 26 if you are just taking your fingers to the fingers and that particular hand portion. So, the overall hand length you can see that topmost corner to the in fact, you can say as a definition of head length. In fact, as a top distance from the topmost point of the lengthiest finger to the to the point where your hand is started. In fact, this particular portion is started. So, this is hand length, hand breadth is again with wise if you are measuring if you have to forget about your thumb just for the fingers breadth you have to take, and that is that will be considered as a hand breadth.

28th is the grip diameter the grip diameter if you are firmly holding something. So, at max how much diameter you can hold that is your grip diameter that is calculated as a insight dia, and as far as foot length and foot breadth is concerned. So, in the lengthwise if you are taking it is length and breadth. So, overall so, those dimensions and basically these are the static you can say the static anthropometric measurements commonly used in ergonomics. So, that is very much important in order to predict the mean and standard deviation of various parts in a variety of population.

So, that is chart that we need to become aware of what are the possible lengths and heights which can exist for various posture of human being. Now after having the

knowledge of various static and anthropometric measurement, we have to now see that how we can utilize this anthropometric data.

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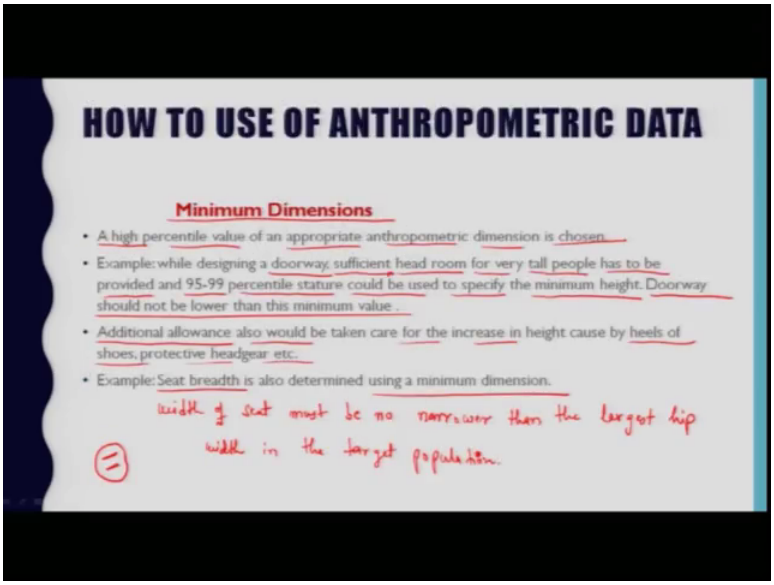

So, there are basically 2 consideration here in this anthropometric data. First is based on the minimum dimension, and the second is based on the maximum dimensions.

So, a high percentile value of an appropriate anthropometric dimension is chosen. So, let us have an example of a doorway. So, everybody is sitting on a room and that room is having a doorway. So, suppose if you have been given a task to design a doorway. So, what could be the possible measurement and what could be the possible criteria that you that you that you need to take care. So, the first kind of thing that you need to take care is sufficient head room for very tall people has to be provided, and 95, 99 percentile stretcher could be used to specify the minimum height.

The important point is the doorway should not be lower than this minimum value. And In fact, the doorway should not be lower than this minimum value, and additional allowance also would have to be made for the increase in the stretcher caused by the items of clothing such as heels of the shoes protective head gear so and so forth. So, as an example you can also take if you are going to describe this minimum dimension case, that seat breadth is also determined with the help of using a minimum dimension.

So, the width of a seat must be no narrower than the largest hip width in the target population. So, minimum dimensions are used to specify the placement of controls on machines door handles etcetera. So, the control must be sufficiently high of the ground. So, that tall operator can reach them without stooping. So, in this way. So, we describe the percentile which kind of percentile we have to choose in order to come for the final design. So, we will we will take that the calculation of percentile, and how we can perform the calculations in the in the forthcoming slides.

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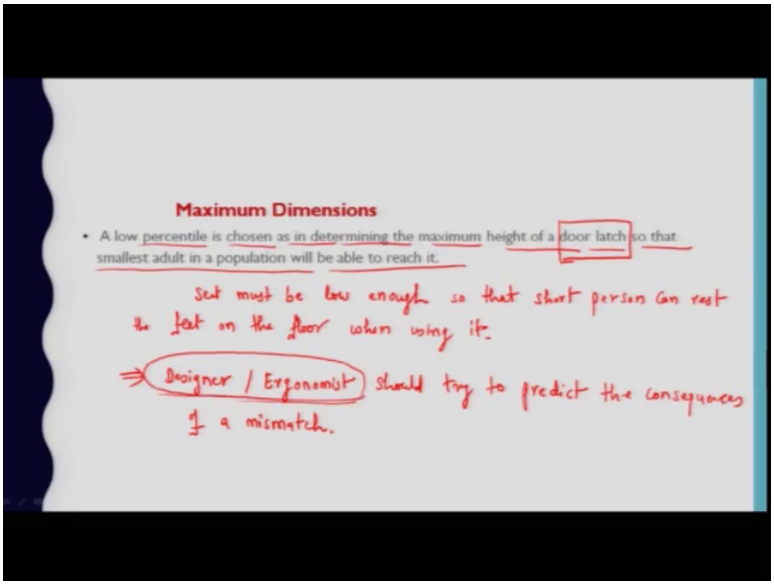

So, second case is choosing the maximum dimensions. So, in that case a lower percentile is chosen as in determining the maximum height of a door latch so, that the smallest adult in a population will be able to reach it. So, the latch door latch that we are talking about so, that door latch must be no higher than the maximum vertical grip reach of a small person. So, height of a non adjustable seats used in for example, public transport system and (Refer Time: 37:51) has also determined using this principle.

So, the seat must be low enough seat must be low enough so, that short person can rest the feet on the floor when using it. So, thus the seat height must be no higher than the first or fifth popliteal height in the population. So, so the anthropometric data must always be used in a cautious manner. And with the sound appreciation of the design requirements and the practical consideration. So, in particular designer should try to

predict the consequences of a mismatch. Like how serious they would be and how would be affected.

So, the first the most important point is designer or In fact, an ergonomist should try to predict the consequences of mismatch. So, in this way this designer or ergonomics plays a very important role, and in giving a system comfortable with comfortable in order to use it in a comfortable position or in order to use it for a maximum users with a greater satisfaction.

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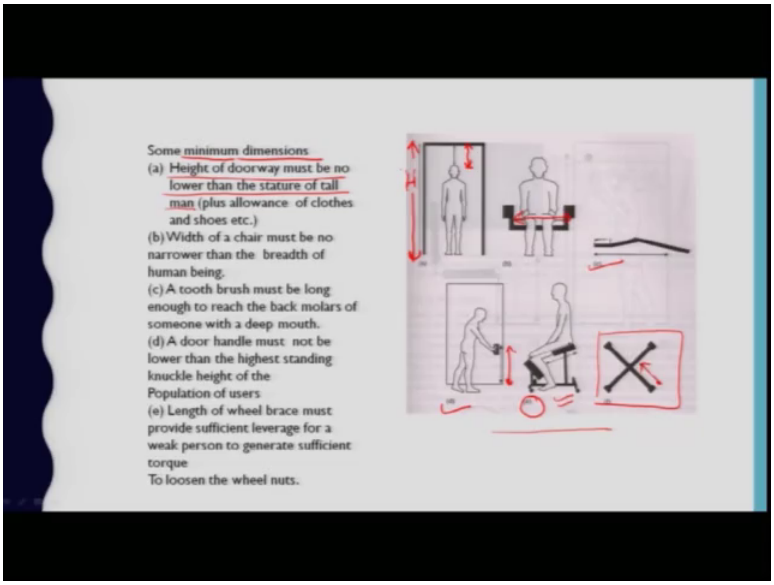

So, some of the examples that I have put in the slides you can have it. So, there are some examples of some minimum dimensions like the 2 things we have discussed before that a minimum dimensions and maximum dimension. So, in the minimum dimensions the height of the doorway must be now lower than the stature of a tall man. So, you can see that the height of the doorway. In fact, this is complete height; it should be no lower than the stature of a tall man. B is the width of the chair this is the width of the chair must be no narrower than the breadth of a human being.

See a toothbrush must be long enough to reach the back molars of someone with a deep mouth. Then example for the minimum dimension is a door handle must not be lower than the highest standing knuckle height of the population of users. E is an example of the length of wheel (Refer Time: 41:36) must provide sufficient leverage for a weak person to generate sufficient or to loosen the wheel nuts. So, these are the possible

examples through which and this particular thing you have to take care in mind that the height of it should be in a proportionate to the proper width of the this is basically the lower most portion of the of the rotating wheel chair.

So, that is that height should be optimized in order to have a proper balance of that particular chair. So, these are the all the aspects for example, live examples which you can which you face while going through the daily activities or daily basis faces. So, you can pick up those examples from your surrounding also and you can correlate with the ergonomic course also. Because the ergonomics is all about enhancing the systems performance or the product performance and products are in your surrounding.

So, you need to open your eyes in terms of identifying the objects and analyze objects in the form of it is efficiency and how much you can contribute towards adding some of the some of the points through which it is efficiency can be enhanced. So, another the criteria of like some maximum allowable dimensions.

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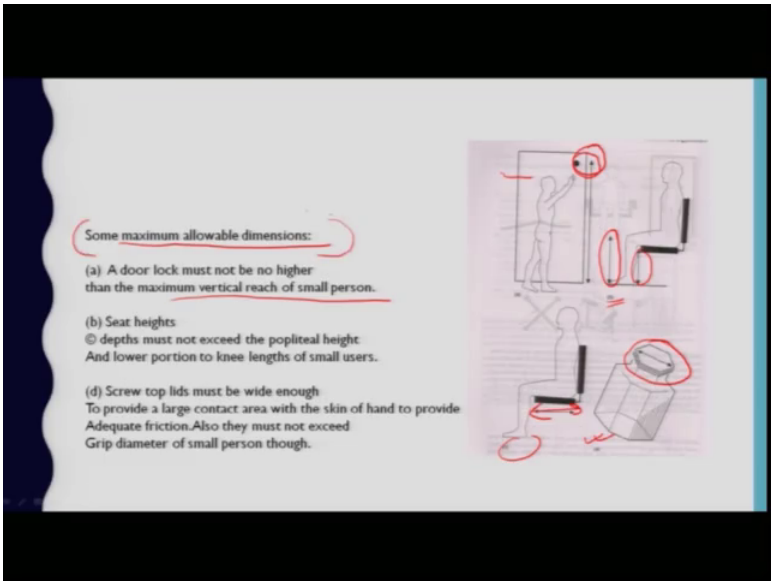

So, the one of the kind of example is door lock must be must not be no higher than the maximum vertical reach of the small person.

So, if this is like a door and the door lock is generally put at the topmost corner of the door. So, that door lock must not be must not be no higher than the maximum vertical reach of the small person. So, think of a small person and think of it is vertical height,

and it should be a the door lock should be attached at certain height at that particular height So that a smallest person can also reach at that particular point.

So, that is the maximum allowable dimension you have to give it to the door lock, second kind of example is seat heights. So, the depth must not exceed the popliteal height and the lower portion to knee lengths of small users. So, these 2 heights we have to take care in order to design a particular chair. The option all of you have must have seen this container. And so, (Refer Time: 44:26) of plates must be wide enough to provide a large contact area with the skin of hand to provide adequate friction.

So, also they must not exceed the grip diameter of a small person. So, the products in your surroundings you have to identify and to in order to have a better understanding of this course you can pick up any product in your surrounding. And you can correlate with the with the theory that we are learning here, what are the products that can (Refer Time: 44:54) into this minimum dimensional allowances and maximum allowable dimensions.

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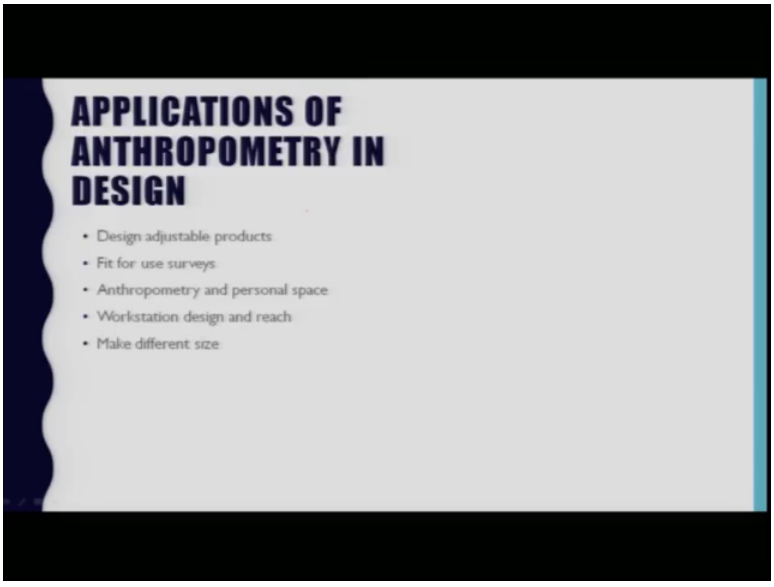

So now coming to the next topic that is application of anthropometric design. So, these are the design adjustable products, fit for used surveys anthropometric and personal space work station design and reach and make different sizes.

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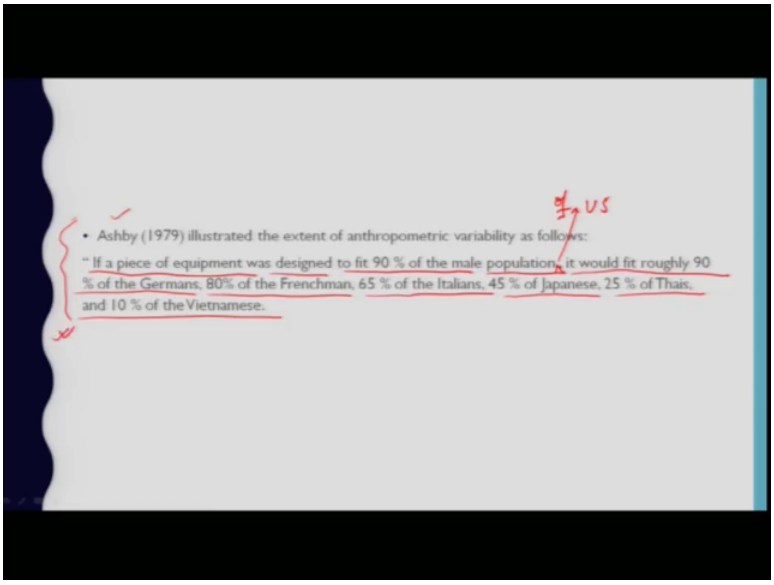

So, we will go in detail of these aspects. And just for the sake of a one sentence that I have taken from the reference, that has been 1979 illustrated the extent of anthropometric variability as follows.

So, it is a very interesting statement please notified that that if a piece of equipment was designed to fit 90 percent of the male population. It would fit roughly 90 percent of the Germans, 80 percent of Frenchman and 65 percent of the Italians, 45 percent of the Japanese and 25 percent of Thais. And 10 percent of the Vietnamese basically at tenth male percent of the u s this is a u s population.

So, it is missing here. So, I am adding that. So, if a piece of equipment was designed to fit 90 percent of the male population of the u s it would fit roughly 90 percent of the Germans, 80 percent of the Frenchman, 65 percent of the Italians, 45 percent of the Japanese, and 25 percent Thais, and 10 percent of the Vietnamese. It was very interesting fact that has come out and that has been predicted by this Ashby in 1979.

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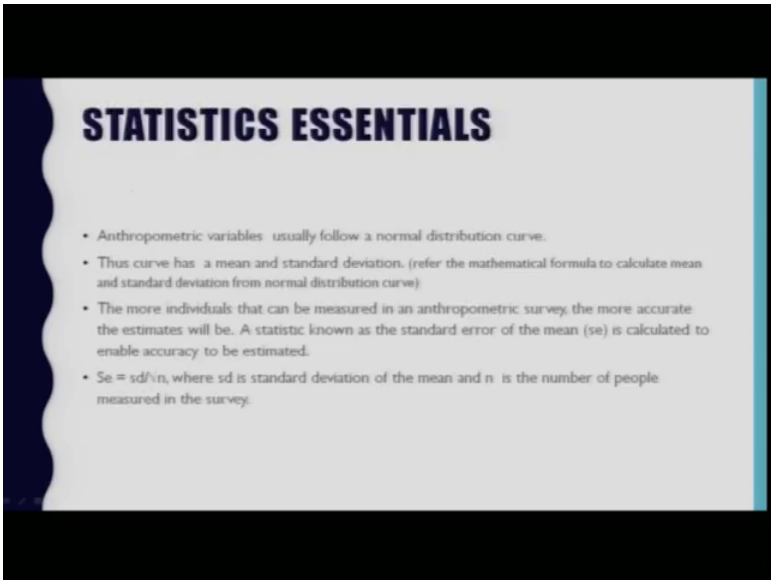

So, thank you very much up to this we have covered this anthropometric human centered design. We have discussed and anthropometry we have discussed. So, in the later in the next lecture we will be discussing about some of the statistic essentials, which are necessary for anthropometric calculations. And some of the numericals we will try to solve. And till then good bye.