Product Design and Innovation
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Lecture – 11
Physical Ergonomics Principles and Issues (Part 1) – Anthropometry

Hello, today we will start the next part of talk and take that is,

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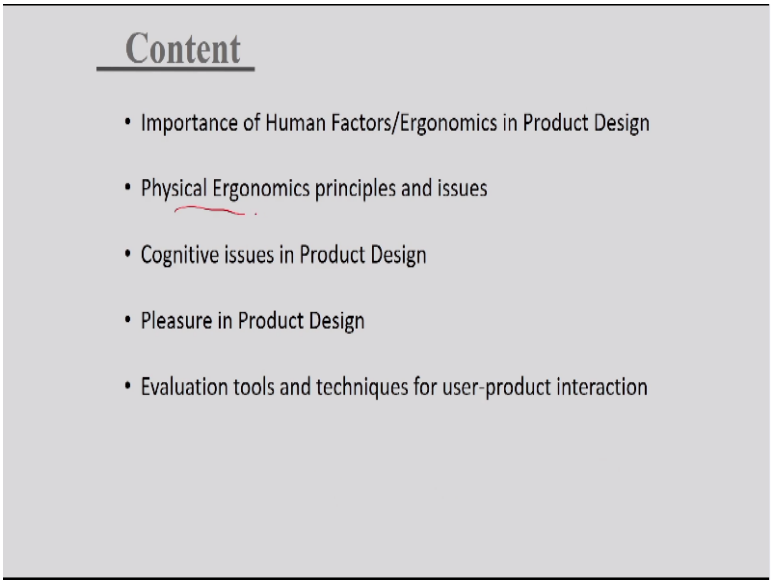

Physical ergonomics principles and issues. So under these physical ergonomics principles and issues we will mainly covered anthropometry, biomechanics related to the posture, awkward posture, problems related to that and how we can intervene the design to take care the physical compatibility after user with the product.

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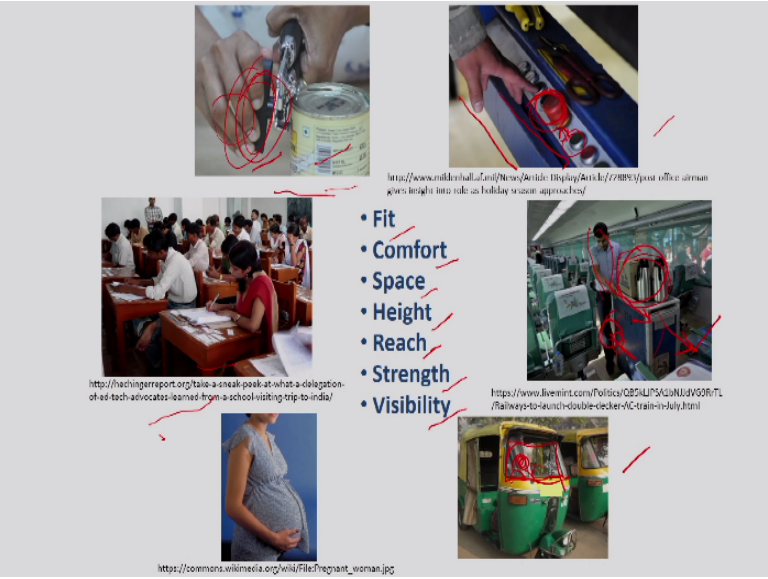

So next what is physical ergonomics? Let us take few examples from our daily life if you go one by one so this is very common picture everyone of us are around through this exam hall and studying in the classroom. So first thing after sitting a bit long time we will feel problem in your body and you will feel a bit awkward and you need to change your posture a bit to release those thing and then you are feeling bit comfortable.

So there is a point that the furniture is bit comfortable to the user. So this is very much related to the physical compatibility of the person with the furniture. Next picture is to open a can we use usually this type of can opener that product. So we need certain force to use that. We will elaborate this problem later on so that is also a fitment should be there with the hand dimension and the interface what we are using to open that can.

Next use a very common example in control panel or where we have certain switches like car dashboard or something like this all these products. So in this case it is very obvious that first thing that switch is enough big that this finger is compatible to the switch dimension. Next is, it is very important that once you are manipulating 1 switch it should not interfere with the other switch of the control.

So it is very important to keep distance in between these 2 controls. So from the point of view of fitness with the control panel and the user hand dimension it is very important. Next is, whenever

we are traveling in a train we have seen this type of thing and product and usually we have seen that is paddle operated. The person is the brake is through this leg operated paddle and the person once he wants to stop it he is operating that break with his limbs.

So in this case it is very important to see that at what level at what height is the paddle will be there so it will be very comfortable for the person to use it to put certain force so that he can manipulate it very easily and comfortably because he has to do simultaneously 2 activities, 1 is it is going, it is moving from 1 place to another place and again he is breaking it and simultaneously he is serving this thing.

So to take care of all these activities it is very important to have a physical fit of the person so that the person can do it very comfortably and easily without any error. Next is, we have seen and we are travelling in those type of auto rider. So where you have seen the driver is sitting here and he should be able to see all the roads so that there would not be any mishap it is happening. So in this case this part is very important and at which height this will be blurred so then the driver can easily see without any barrier and next is the physical fitness.

Whenever we are going to have some dress the first thing is the fitness on the dress with our body dimension. So this is very important always in these 6 pictures what we have discussed just now so this is the overview why we need physical fitness, why it is important body dimension, why it is important also the force they need and what is the visual clearance they want and the posture and the strength of the person here.

So in all these cases we are taking care few physical aspects of the user to make it compatible with the product. So mainly issues we will cover in this case is the fit. Here it is fit without person in all these cases fit is very important and you cannot neglect it anyway comfort which is once it is currently fitted with the person it will be comfortable, space, height, reach.

Reach in this case, the paddle should be easily reached by this user when he is doing this activity moving towards and simultaneously he is serving this thing. Reach when strength you need certain strength in this case, strength, visibility, in this case it is visibility so all these issues are

discussing under physical ergonomics and mainly we will first discuss anthropometry. So, what is anthropometry?

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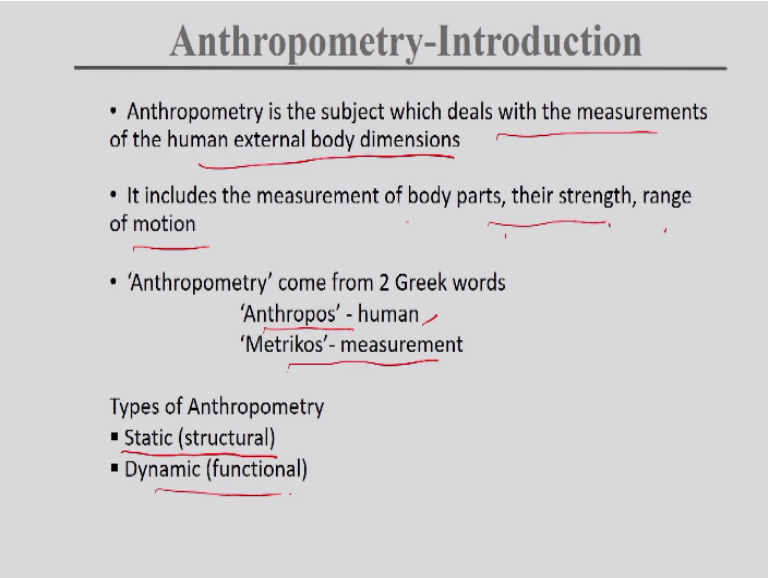

Anthropometry is a subject which deals with the measurement of the human external body dimensions. So external body dimensions it can be handling every each and every body parts when included. So it includes the measurement of body parts, their strength, range of motion. We will discuss this later on in the presentation. So anthropometry has come from 2 Greek words that is, Anthropos, that means human and Metrikos means measurement.

So measurement of human external body dimension is anthropometry. So, if you consider when we are sitting or doing something even near static or near in dynamic condition. If you consider this case, it is mostly a static condition or here if you see he is in the dynamic condition. This is in motion. So anthropometry, there are 2 types that is static anthropometry which is structural and dynamic that is functional.

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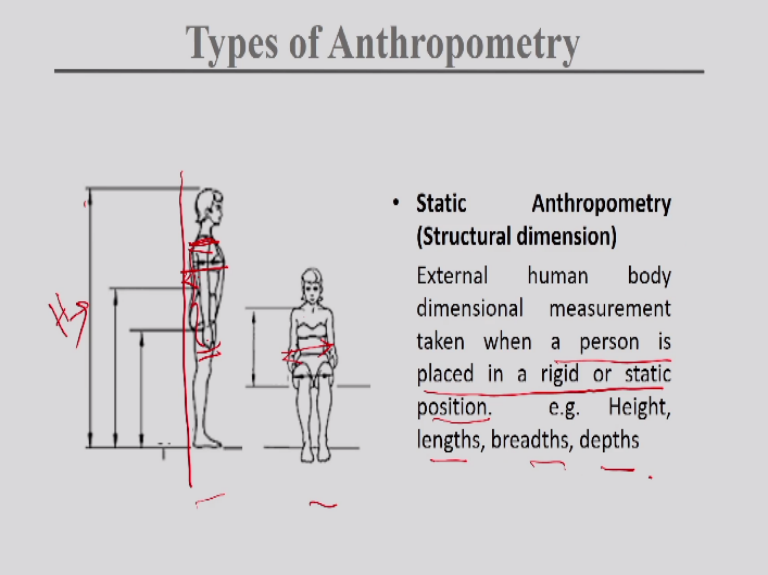

So now what is static anthropometry? Here we have seen we have 2 figures here 1 is erect and another is sitting. So, mainly external human body dimensional measurement taken when a person is placed in a rigid or static position. Then we are taking static anthropometry. It is mainly height of the person, this is the height of the person, this one, next is length, breadth, and depth. So breadth is this is breadth, so this is breadth.

Length can be from here to here to further from shoulder to this knuckle that can be the length of this hand and depth is this way. So once if this person is standing against a wall so this is the depth of the body. So mainly we are considering this height, length, breadth, and depth. So, how it is relevant? How it is important and why it is important to consider the anthropometry.

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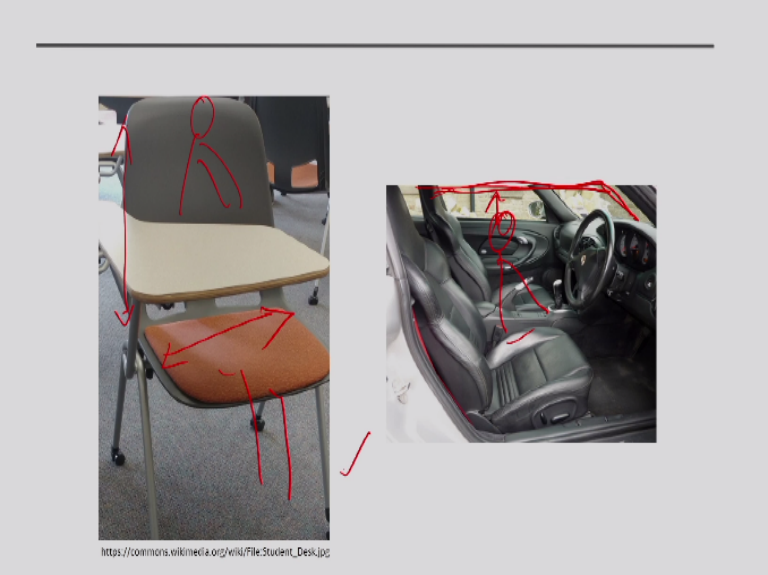

Let us take 2 examples. This is a chair what we are sitting in a classroom when we are studying. So if we consider the person when he is sitting here so it is mainly like this and then we need this dimension to understand what will be this height. Another thing we need this breadth to design this breadth. So in this step of cases we need the static anthropometry. When the design is actually when a person is in static condition you need that type of product.

Next another example can be the car seat when we are in the driving position or when we are sitting in the car mostly your body is static. In these cases, the driver is here top of the car wall is here so then if the person is sitting here you need certain clearance in the top of the head. So in these cases it is very important to measure what is the height when the person is sitting on a seat and when you can consider what should be the clearance.

So in this case you need this height. So these are the few examples of static anthropometry and how we can relate the static anthropometry dimension in design.

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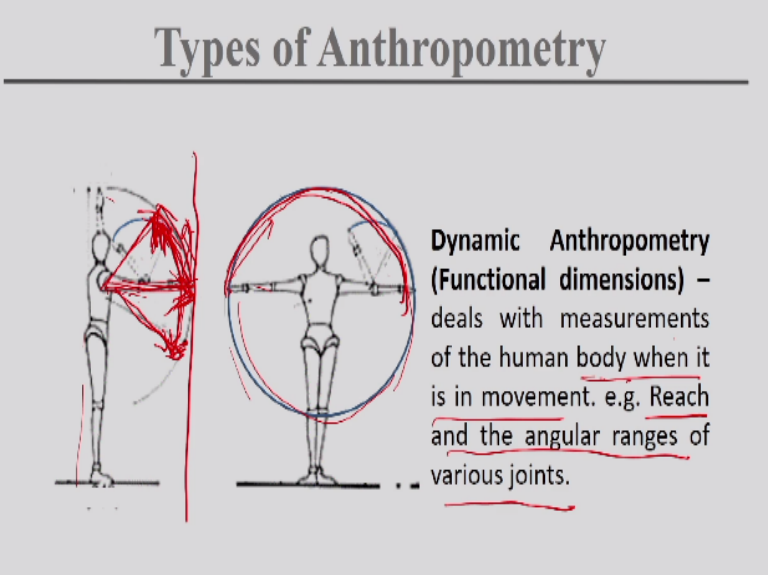

Next, going to the second type of anthropometry, that is dynamic anthropometry. Dynamic anthropometry is mainly functional dimension. Mostly, we are always in motion hardly we are sitting static. Though we are sitting in this chair also we were not static. We are moving may be we are moving our hands; we are changing our legs like this. So we have to understand what is the dimension when this person is moving on dynamic condition.

So, mainly dynamic anthropometry deals with the measurement of the human body when it is in movement. For example, when you have something in your shelf in cupboard, so you extend your hand to reach that and to grab that product. In this type of cases, the example is reached and the angular range of the various joints that we are measuring in dynamic anthropometry. For example, if the person is standing so then you want to reach something then you extend your hand so that is not in a static condition.

So then and if you want to take something from an above shelf or below then you need to put your hand like this then you can move it this way or this way. So that is the angular range how you can move your hand along this angular range of this. In case of dynamic anthropometry, we measure when in this condition when this is completely horizontal to the floor then what is the distance the person can cover or what is the reach the person has and when he is in this condition as our body is curvilinear that means it is not like this.

Once you move in this condition, it is something angular. So it is not like this, but it is like this. So whenever moving your hand in this direction your reach is getting decreased. It is not that much getting decreased or in other way if you are putting your hands down then same thing is happening your reach is getting decreased. So in this condition you need dynamic anthropometry.

Another issue is if you have to do some activity in front of your whole wall may be you have some control design or something to manipulate in machine or something bigger product. Then you need to use the whole dimension may be from here you need to change something here. Then you are moving. So this is the range of motion what the person can use to manipulate something. So, all these functional dimensions are under the dynamic anthropometry.

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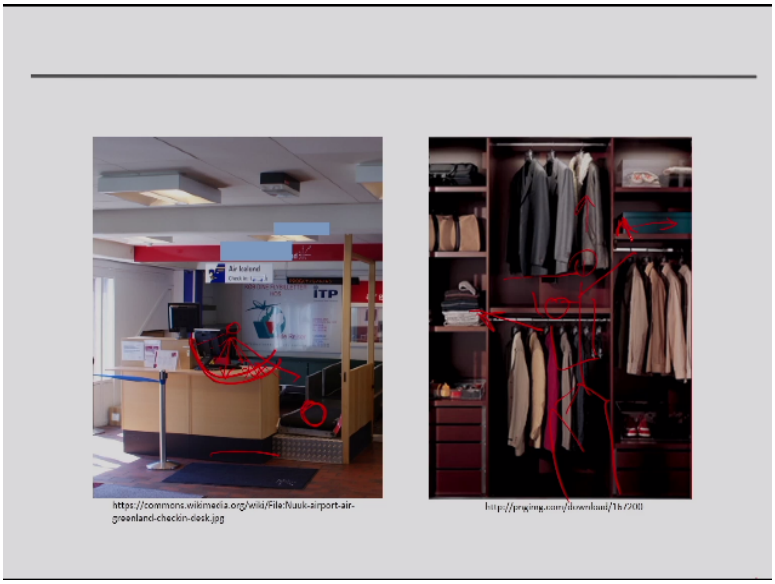

So now take few examples. This is one example from Air Company and this is the boarding reaching where the person is sitting and issuing us boarding pass and taking the luggage in the conveyor belt and viewing the bag. So if you see here when the person is sitting he or she is doing so many activities simultaneously. So first he or she will take care of your pass or ticket and then we will match he or she will match that and she will give you the tag or something and he will check the weight and then he or she will keep your luggage here and tag it.

So in this condition the body is in full dynamic condition. In this case you have to take care when the person is in static condition what is the dimension? Again, when he is extending to get your boarding pass what is the dimension? Again, when he or she is putting this luggage or something or checking the monitor to check the weight of the luggage then what she or he is adapting the posture. In this case, dynamic anthropometry is very much important.

So when you are designing something workstation or this type of modular furniture design you should take care the dynamic anthropometry of the person what can be the limit and ability of the person. Next example is the cupboard so when the person is standing so if the person is this height so then so if the person whether the person can reach this very well or he has to reach this thing and whether if he is standing here then there he can get these products.

So in these cases also you need to understand the dynamic anthropometric dimension of the user. So when you are doing this type of design it is very important also to know what should be the depth of the cupboard. So if you extend the hand it should reach the extreme point of the cupboard so that if you keep some product here it should be easily accessible by the user. So dynamic anthropometry and in this case reach is very important to consider to finalize the depth of the cupboard. So these are 2 examples.

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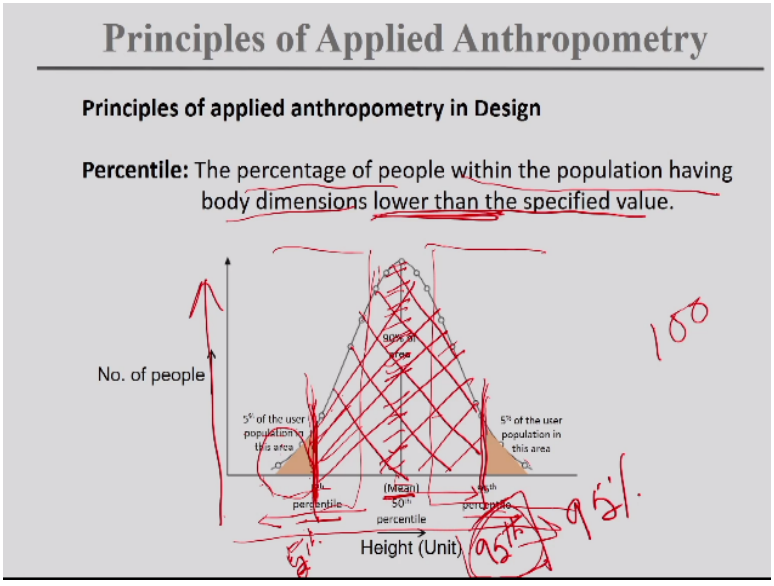

So now what are the principles of applied anthropometry? When you are measuring the dimension is fine so after that we need to apply in design because if we see everyone of us are not in a similar or identical height so if he sees somebody is very fat, somebody is very thin, so when we are making some design like scissor when we are taking this type of product when it is a universal product.

So it is not customized for a range of people so it is for a range of people who can be kids, who can be adult person who also can also be a feeble and weak elderly. So in these types of cases or you cannot in this type of cases you have to have some dimension what can fit to a range of people, not in very particular section of people like only adult or only kids, only elderly like this. So the principles of anthropometry are like this so you just take an example.

So here we have plotted assume 100 people you have so we have plotted the 100 people's height, height in this axis and how many people have this that type of height, frequency of the person for a particular height in y axis. So once we have plot this data, we got this normal distribution curve. So only if we consider this normal distribution curve so we have 100 data is present under this. When you are designing a scissor or a can opener for him you will design that for whose dimension you will take.

No being mostly we are telling that it is for average, but if you see if we are this average is here as it is a normal distribution curve this is the mean. So your average is here, but if you design it for the average population then hardly you will cover this part of the population. If you see we are not considering this range of population and this range of population so in this case that product won't be comfortable to this section and this section also.

That is why when we are making any design and we are considering the principles of applied anthropometry we are usually not considering the average. We are considering the fifth percentile or 95th percentile. What is fifth percentile and 95th percentile? When we are approaching from 50th percent or the average and it is normal distribution curve here 50% data here and 50% data this side. It is more than the average and it is less than the average.

So if you consider this 5th percentile and here the 95th percentile then we will cover this whole section. This whole section we will cover if we take this data and this data instant of only average. So when we are taking this and this actually this is called fifth percentile and this is called 95th percentile. So actually fifth percentile what does it mean. Actually 5% of the user population you are excluding. So 5% of the user population has height dimension below this height.

So the percentage of people within the population having body dimension lower than the specified value. This is very important and lower than the specified value. So when we are taking fifth percentile value then, 5% of the user population is lower than this value when you are considering 95th percentile then 95% of the population has height lower than this 95th percentile value. So this is the importance of taking percentile instead of average.

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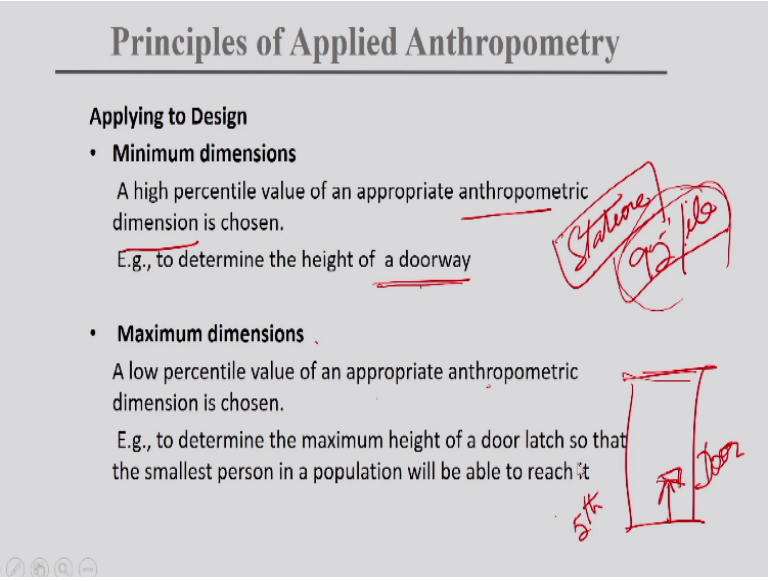

Now we will see 1 or 2 examples how we can use. So when we will consider fifth percentile and when we will take 95th percentile. So take few examples. So when we are designing a door may be you are designing a door and all of we know the height of the door how to design. So if we consider the average person may be who is weight or he or she will be unable to cross the door very easily. He or she will have hindrance. So now, what value to consider.

Then you have to consider 95th percentile value. So if you take 95th percentile value of the height dimension then 95% of the population can go through the door very easily. So, minimum dimension of the door should be 95th percentile of the height. So from minimum dimension a percentile value of an appropriate anthropometric dimension is chosen for in these case of doorway design it can be the stature height of the person so that is the anthropometric dimension we have chosen.

This is the dimension we have chosen and this is the percentile we have chosen. So to determine the height of the doorway first we have to finalize what is the dimension that is in this case stature and what is the percentile that in this case it is 95th percentile. So like this we can use this in case of design. Now coming to the next point, when in this case, we have used high percentile for a minimum dimension.

So the doorway should have a minimum dimension of this 95th percentile. Now, going to the next one that is the maximum dimension. For example, we have a door and you want to make a handle of the door so that the person who is very small height he or she also can able to operate that thing. In this case what you have to do? You have to take that fifth percentile data so that you will only if you go to this graph if you take fifth percentile of the data you are only excluding this part and you are taking care the whole rest of the graph.

So if you are taking 5th percentile on table if the person of height below than this that part you are excluding that means you have the smallest section < 5% you are excluding. Rest of the people will be able to manipulate. So a new percentile value of an appropriate anthropometric dimension is chosen to determine the maximum height of a door latch here that is the door latch so that the smallest person in a population will be able to reach it. So, these are the 2 application how you can apply the percentile.

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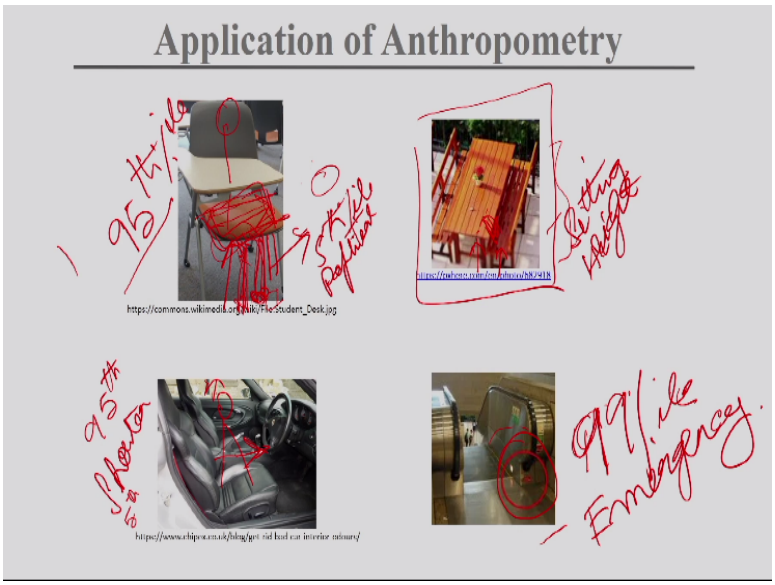

Now here are few more examples. It is not as simple as this like this that just early the door height you have to decide or he has to decide your door latch so if you take these products like this is a chair. You have so many dimensions. When the person is sitting so the person is sitting like this his legs are here and so in this case also the person has certain breadth. He is sitting this part.

So in this case, dimension will be so many dimensions you have to consider to design for example the hip breadth of the person need to consider when you are designing this seat breadth so that the person will be able to sit here. Another thing is the sitting height. So because from the knee the legs will be dangle here so you have to take also the from knee to floor that is called popliteal height.

So that popliteal height also you have to consider so that person can rest their feet in the ground when the person is sitting on a chair. So in this case when we are deciding this seat break you have to consider 95% percentile value of the hip breadth data so hip rate is the dimension you are taking and 95th percentile.

If you are taking that means 95% of the population will be able to sit here, but in this case if you take 95th percentile of the popliteal height then for smaller person it will be happen like this then legs will be up to this height and they have a shorter height they cannot reach so their legs will

dangle. So in this case for these dimensions for this popliteal height for this height dimension you cannot consider 95th percentile. In this case you have to go with the shorter person.

So in this case you have to think of the 5th percentile value of the popliteal height dimension. So in this product for seat belt you have to take 95th percentile, for seat height you have to take 5th percentile of the popliteal height data. So similar thing if you think of this bench so in this type of complex dimension if you make it for shorter person, taller person will have difficulty to have food in this desk so they will have some angular posture will be there for very taller or shorter person or shorter person cannot reach this height.

So in this type of complex reason, we should understand the table height, the seat height and also the sitting height of the person. So these 3-dimension need to be consider when we are deciding something like this dimension which is former complex. In this step of cases also it is important to take care this reach distance obviously it should be from the pointer view of shorter person because if the shorter person can reach this steering wheel then obviously a taller person can reach it.

So you can take this fifth percentile dimension of these data but in case of this sitting height thing you have to think of the 95th percentile of the height data because if you can accommodate the taller person obviously the shorter person can use. So this is the implication of percentile in your product design, but for few things and design is very context specify. If it is something emergency switch or something like this, we have to take in that 99th percentile.

So that 99% of the population should use that thing very easily if the person is in wheelchair because it is an emergency switch. In emergency switch you cannot reject any dimension so it should be like this that 99% of the population should use that. If the person is also wheelchair bound, he or she should have that opportunity to use that. So it depends on the context of the design what you are doing.

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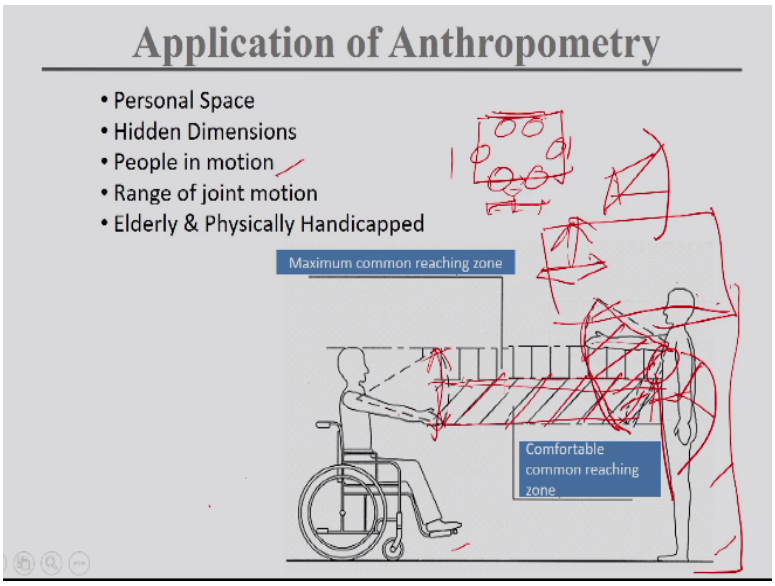

What are the issues we need to care take when we are doing those anthropometry thing? One is personal space. Personal space when you are sitting we have a personal territory. We are not seeing just side by side. We have certain space in between 2 persons. That is the personal space hidden dimensions for example when you have this table of 6 persons, 2 persons, 2 persons, 1, 1 then when we are sitting we have in between some space.

So we have certain space like this is called hidden dimension. So when we are designing some table or something we only cannot consider the hip breadth of the person and 2 persons of the hip breadth. We should consider the personal space and hidden dimension and all these personal spaces hidden dimension is very much depending on the culture and the persons who are sitting and the characteristic of the person all these things need to be considered when you are designing these things.

Next is people is in motion. When we are designing something exit door or something like this may be a auditorium or multiplex then we should take care how many person can simultaneously go and whenever the person is in motion so how much space they need. So whenever the person is in motion it is definitely more than the static condition. So that is called you will have to take care when the person is in motion that dimension also we should consider.

Another is range of joint motion. We have considered that for the case of shelf and all those thing how much for shelf it can be for any control panel what is there so how much joint range of joint motion you have if the person is standing here so if the person is standing here so it is extending so what is the range of motion he can have so that is another important. Another is elderly and physically handicapped.

So if we consider this picture so if we see here this is the physically-abled persons and this is the wheelchair bound person. So in 1 home if you are designing some shelf or something what you want to be used by both the person so then we have to think that what is the common reaching zone of the wheelchair bound person also the able bodied person. In this case though the physically able person have a range of joint motion and reach area.

This much this much but in this case as the person is wheelchair bound this person have a reaching zone like this limited. In this case, we need to find out what is the common reaching zone. So this can be the maximum common reaching zone and that can be the comfortable common reaching zone.

So if you want to put something which is every each and every time you are accessing very frequently you are accessing that we should put in the common reaching zone and next to that second priority less accessible thing can be put in the maximum common reaching zone. By that thing you can optimize this design for what his person, able bodied and now wheelchair bound.

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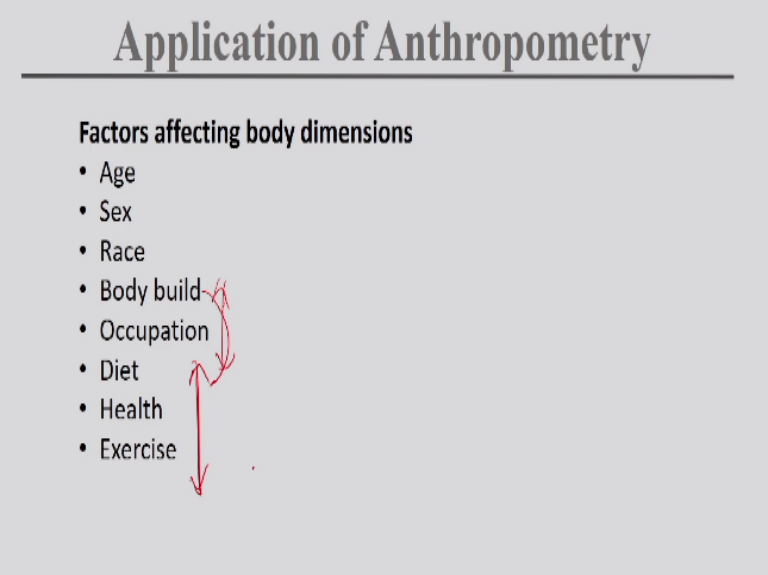

Next is what are the factors which affect the body dimension? One is age, sex, race. So ethnically we are very different from 1 population to another population. Anthropometry dimension is getting changed and body build and occupation if the person is very physically active then the body build will be different. Also these body build and is also very much dependent on the diet of the person, health, and whether the person is doing exercise or physically fit.

So these are the few important factors which we need to consider when we are applying this anthropometry in product design

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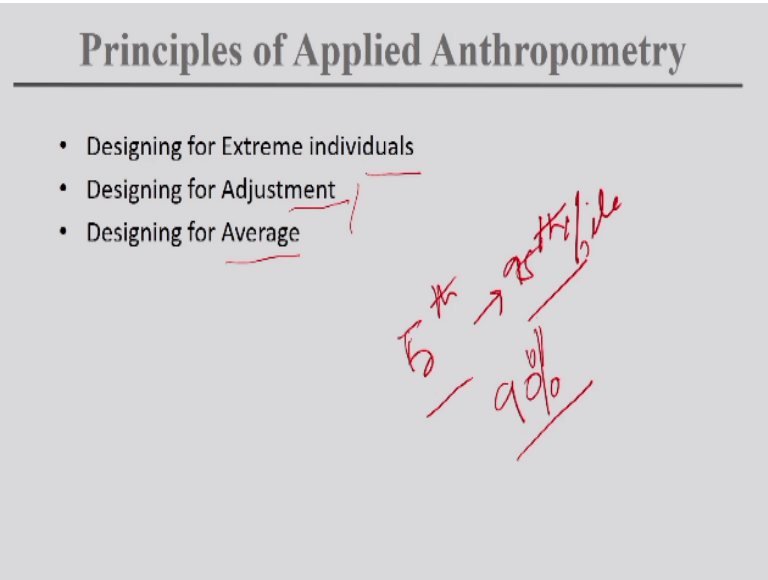

And when there are mainly 3 issues that is therefore whom you are designing it is the designing for extreme individuals. So when you are designing for may be door height, door latch, then you should take care all the persons. So extreme individuals also you should take care. Next is design for adjustment. Designing for adjustment where you can give the range of adjustment in your furniture.

May be you are giving a chair design, change the height of the seat, then you can give or adjustment from fifth to 95th percentile so that you can make it accessible for 90% of the population, but simultaneously you are giving the adjustment. So according to my height and comfort I can change so that always it is not possible to give the adjustment it depends on the context and the product you are designing.

Next, is designing of average. Designing for average the whole product you really never be designing for average, but few dimension can be designing for average in a product not all the dimension will be for average people. Definitely few dimensions will be for fifth and 95th percentile, rest 1, 2, or 3 dimension can be formed designing for average in any product.