Work System Design
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Lecture-53
Ergonomics: Anthropometry

Namaskar friends. Welcome to session 53 of our course on Work System Design. And now we are in the 11th week of our discussion and this is a 12-week course. So almost we are done with the course. So as we have planned the course in 4 modules. We have already finished our discussion for the first 3 modules. So in module number one we have focused on the basic aspects of work system or the work study.

And we have focused on productivity because improvement of productivity is one of the important objectives of each and every organization. So we have focused on productivity in module one. In module 2, we focused on an important technique that is used for work study that is the concept of method study. So module 2 focused on method study. Module 3 was on work measurement.

And the last module that is module number 4 is on Ergonomics. So when we are discussing ergonomics we have already seen the basic aspects of ergonomics, the definition of ergonomics, the types of ergonomics and then in the previous session our focus was on industrial ergonomics and if you focus on Industrial Ergonomics or if you remember what we have covered.

Our major focus was to see that what are the various problems such as the repetitive strain injuries or the musculoskeletal disorders that may happen due to repetitive type of work being done by the workers or the operators in any organization. We have tried to see that what can be the reasons, what can be the reasons of MSDs and how we can avoid them. So in the last session the time was over.

And we were left with just one or 2 important topics that how to control or what are the tips that we must keep in mind when we are thinking about controlling the MSDs or when we are planning to control the MSD or when we are maybe planning to mitigate the effect of the MSDs. So what are these so these tips we will cover and then we will come to the exact topic

for today which is on screen that is ergonomics with focus on anthropometry which is an important constituent of ergonomics.

Because once we have to design a system we have to keep into mind the Anthropometry data. For example, the design of a chair, so when we have to design a chair we must know that what has to be dimension of the seat, width of the seat, the length of the seat, the height of back rest, the height of the arm rest. So all these things have to be decided based on the subject, based on the customer, based on the person for whom the chair is being designed.

So the vital dimensions of the human body are an important ingredient for designing the work system and that is the basic purpose of our study today that is anthropometry in relation to the Work System Design or anthropometry in relation to the ergonomics which is an important aspect for the work system design. So let us first quickly refer back to what we have discussed in the previous session.

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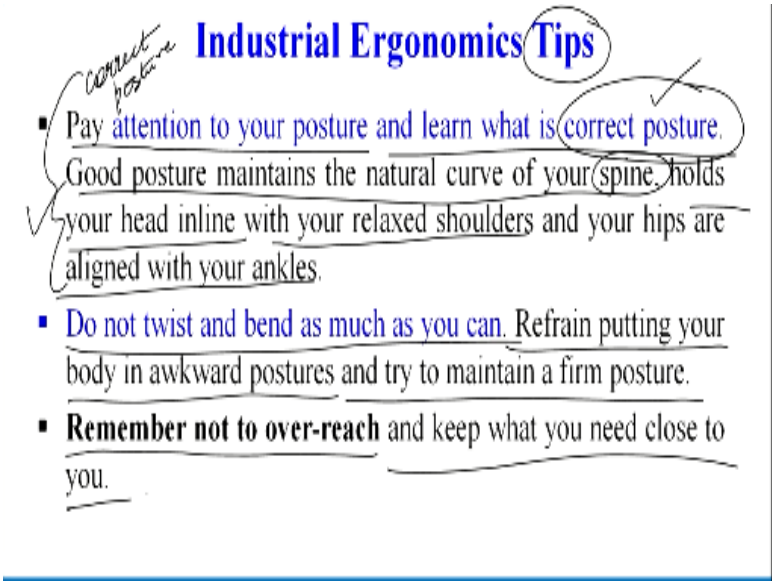

So in Industrial Ergonomics there are few tips that we must keep in mind. Now let us see them one by one. Pay attention to your posture and learn what is correct posture. So correct posture is very, very important and when we talk about the ergonomic data or the anthropometric data our focus will be to ensure to design the system in such a way that the correct posture is maintained.

So it is not something which we are studying in isolation. It is related to what we are going to cover today that is anthropometric data is also very, very important when we design a system

such that we ensure that the correct posture of the body is maintained. So pay attention to your posture and learn what is the correct posture. Good posture maintains the natural curve of your spine, holds your head in line with your relaxed shoulders and your hips are aligned with your ankle.

So 3, 4 important guidelines or tips have been issued here have been highlighted here related to the good posture or the correct posture. So that we can again see natural curve of your spine we have to maintain, holds your head in line with the relaxed shoulders, your hips are aligned with your ankle. So basically we have to maintain a straight posture or a natural posture which we may call as a correct posture.

But if our head is not in line with our relaxed shoulder it maybe incorrect posture and later on may lead to MSDs. This is first thing. Though the summary of this is that we must focus on the correct posture. The second is do not twist and bend as much as you can. Refrain, putting your body in awkward posture and try to maintain a firm posture. So do not twist and bend as much as you can.

So we must not put our body into trouble. So we must always try to work with natural rhythm with a correct posture if we do not hold a correct posture or do not keep a correct posture in long run it may create problems. In short run we may not be able to identify with the symptoms of MSD, but in long run that maybe a problem. So therefore we must ensure that we do our work in the natural rhythm without twisting or bending our body as much as we can.

Now remember not to over-reach and keep what you need close to you so that we will see in the anthropometric data will help us to design our workplace in such a way that the objects, equipments, tools that we are using more frequently will be in our working area. So we need not overstretch to take the equipment or a tool which we are using very frequently. If I am standing and working here and this pen I have to use it is in my working area only.

So if suppose if it is kept at a distance every time I have to use this pen I have to reach it like this so that is not advisable. So remember not to overreach and keep what you need close to you so that is another tip for Industrial Ergonomics.

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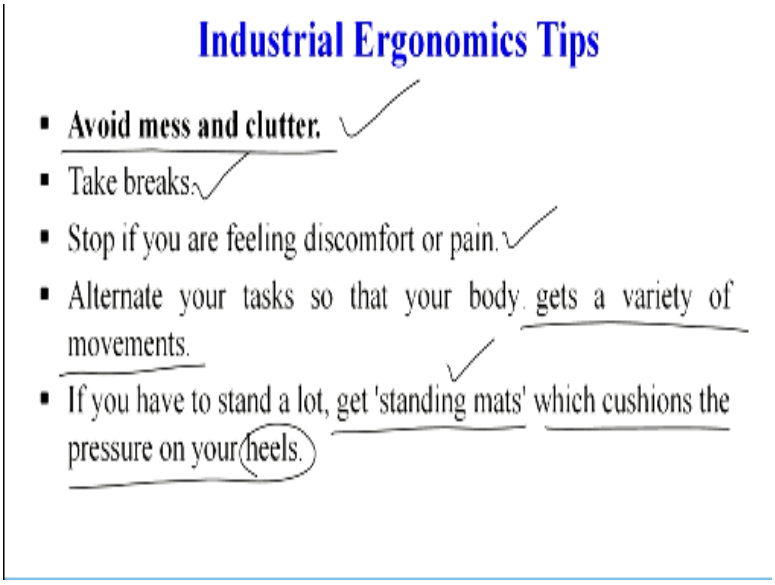

Avoid mess and clutter which is a very, very important point because it may lead to severe injuries also. Take breaks as we have seen in the previous session also that we must take break and maybe stretch our body so that our muscles are relaxed. If you have travelled, maybe if you have seen when you travel by air and it is a long distance journey maybe 8 hours or 10 hours you will see people getting up from their seats and just stretching in the aisles.

So that is a good thing to do that when we are traveling our body is at rest we may be sitting for continuously 4 hours or 5 hours it is always advisable that after every one and half to 2 hours we may get up and maybe do some stretching in order to relax our body. So we must take breaks after regular intervals of time, stop if you are feeling discomfort or pain. So we must not keep on working if we are having some pain or discomfort.

So alternate your task so that your body gets a variety of movement very, very important that we must keep on shuffling or doing different types of tasks or jobs so that our body gets a variety of movement. We are not doing same repetitive work over and over in 8 hour shift maybe 5 days in a week and maybe in a month. So we must try this is a good guideline for the administrators also that we may keep on shuffling the worker.

So that their body gets different types of movements during the week or maybe during the month. If you have to stand a lot get standing mats which cushions the pressure on your heels. So standing mats are one assistive devices which can be used to relax your feet.

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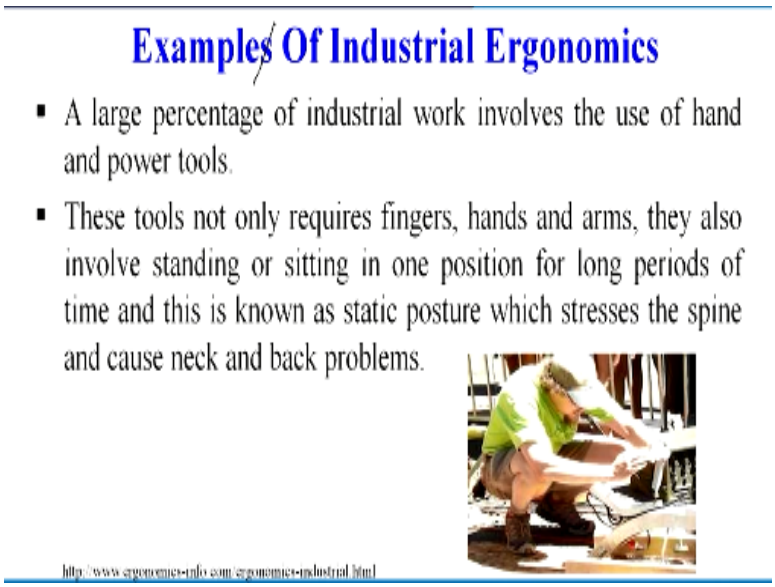

Now this is one example of Industrial Ergonomics. A large percentage of industrial work involves the use of hand and power tools. These tools not only require fingers, hands and arms they also involve standing or sitting in one position for long periods of time and this is known as a static posture which stresses the spine and cause neck and back problem. So when we are using hand tools the job involves sitting for long durations of time or long duration of time. Alternative sitting and standing postures are involved.

So we must be careful that we must not sit in awkward postures for long duration of time otherwise it will cause severe back problems to us. So this is just one example. So we have seen that when we focus on industrial ergonomics we must take into account all these tips which have been given and this is not a very exhaustive list. This is a very, very simplified list if you refer to the manuals for industrial ergonomics.

You will see a complete detailing of such guidelines that we must follow as industrial engineers, as mechanical engineer in order to ensure safe working environment for our workers. So this is maybe the overshoot of the previous session in which we were focusing on industrial ergonomics. Today our title is a standalone title is Anthropometry, but the Anthropometry is also an important ingredient of ergonomics because when we are designing the system.

For example, I am standing here the height of this dais has been designed as per the average height of the professor who are going to come and speak here or do the recording of their lectures. So this height has to be designed how to decide of this height. People if you go to

the kitchen you will see that there is a height of a shelf in some kitchens it will be higher slightly in other cases it will be slightly lower.

So how to decide that what should be the shelf height in a kitchen where you are going to place your gas stove. So that height has to be decided based upon the anthropometry data. Similarly, you can have different examples where the human body dimensions play an important role in the design of the work system. So that is basically the idea with which we have planned the today lecture in which we are going to study the importance of Anthropometry in design of the work system.

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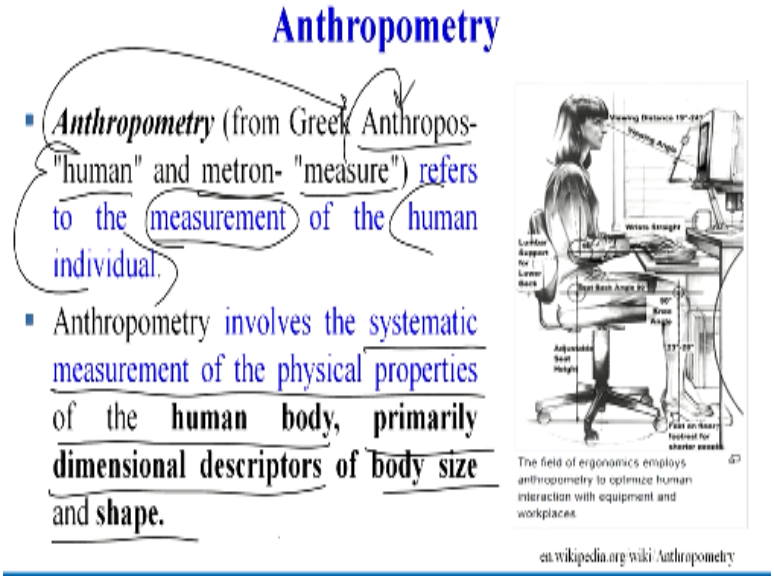

Now let us see what do you mean by Anthropometry? So Anthropometry which comes from the Greek Anthropos which means human and metron which means measure. So we have to measure something related to the human. So Anthropometry refers to the measurement of human individual metron means measure and human individual comes from the word Anthropos.

So basically you can see that Anthropometry refers to the measurement of the physical dimensions of a human being. So Anthropometry involves the systematic measurement of the physical properties of the human body primarily dimensional descriptors of body size and shape. So body size and shape is an important requirement, ingredient when we are designing the work system.

For example, the height of the chair if it is adjustable it is very, very good if it is not

adjustable some of the people who are going to use that chair may feel discomfortable while sitting on the chair. So therefore the dimensions or the human body dimensions are very, very important when we are designing the work system.

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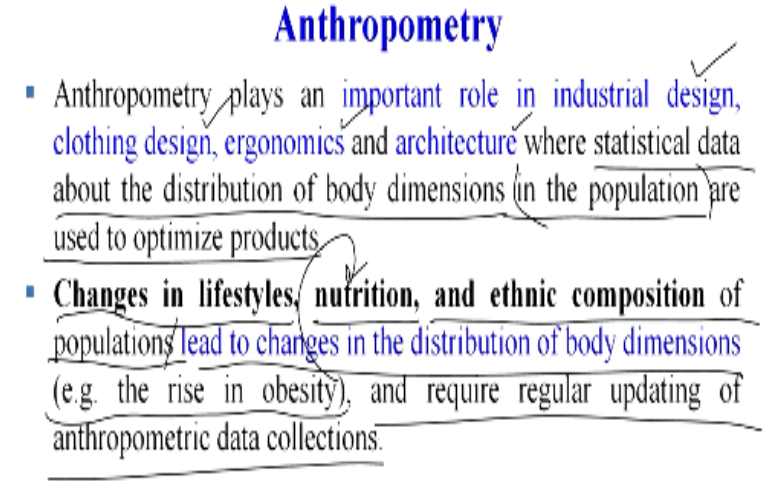

Now Anthropometry plays an important role in industrial design which I have already highlighted clothing design, ergonomics and architecture where statistical data about the distribution of the body dimensions in the population are used to optimize the product. So what is going to be used for optimizing the products. The statistical data about the distribution of the body dimensions in the population.

So distribution of body dimension sometime we do the design as per the average body dimensions, In many times we may like to design such that the farthest if suppose there is a control lever we will try to see that what is the average value of the worker or average reach of the worker who is going to use this and we can put the control or control panel or control lever at that place.

So that is basically an example which helps us in understanding that why Anthropometric data is important in the design of the work system. So this is important again I am reading this sentence for you. Anthropometry plays an important role in industrial design, clothing design. Now if the average dimensions are known the various companies or various brands will make the shirts or the trousers as per the dimensions or as per the physical dimensions of the population.

Then in ergonomics also Anthropometry plays a very important role as well as in architecture. For an architecture suppose we have to decide upon the height of the door through which the people have to cross so that will depend on the average height or the maximum or the minimum height of the population of that particular area and you will yourself appreciate if you travel across the globe or travel across the world.

You will see that in some countries the average height of the door maybe low and in some other countries the average height of the door maybe higher. So that depends upon the anthropometric data of the population of that particular country. So why there is a difference in the anthropometric data that is because of the changes in the lifestyle, nutrition and the ethnic composition of the population lead to changes in the distribution of body dimensions.

For example, the rise in obesity maybe dependent on the nutrition and require regular updating of anthropometric data collection. So there can be there are differences because of the environment in which we grow up because of our food habits, because of the tropical climate in which we are living because of the lifestyle that we follow. So there are n number of factors that may lead to the variation in the dimensions of human body across the world or across the various countries.

So the design has to take into account all these variations for ensuring that the person who is using the system or the person who is using the equipment is able to use the equipment in the best possible manner and he need not worry about the injuries or the kind of discomfort he may encounter when he is using a particular system. It can be a chair, it can be a tool, it can be mobile phone.

It can be any product which has been designed for use for the customer or for the population. So we have to take into account all these dimensional variation of the population when we are designing the product.

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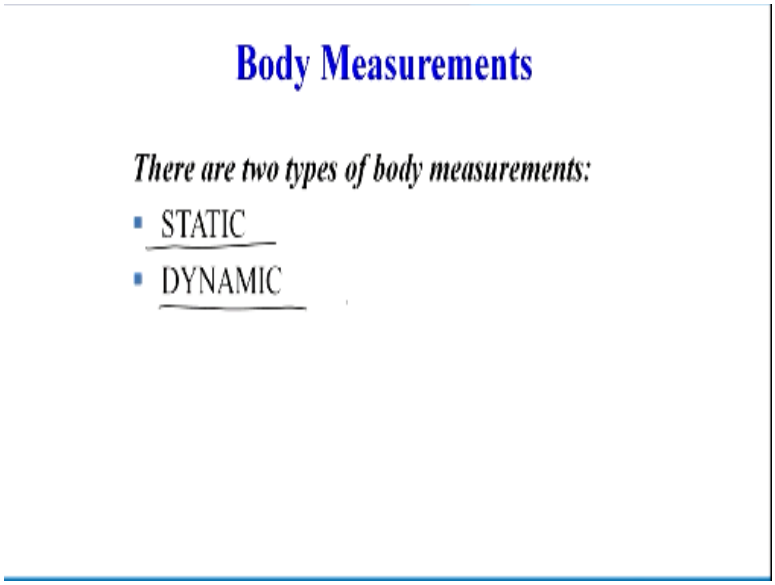

Now body measurements as we have seen earlier static and dynamic we will quickly try to understand the different between the 2.

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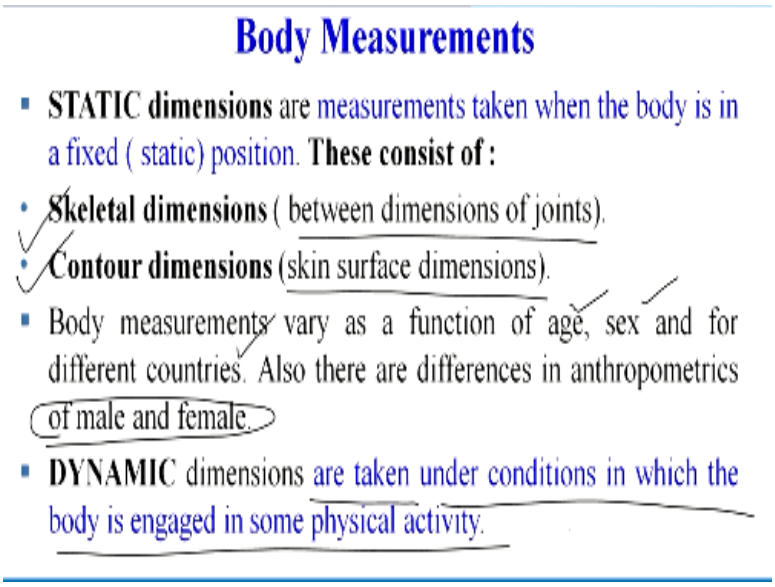

Static dimensions are measurement taken when the body is in a fixed or the static position. These consist of skeletal dimensions between the dimensions of the joint or contour dimension, skin surface dimension. So basically the static dimension are taken when the body is fixed or in static position and skeletal and contour dimension fall under the static dimension.

So body measurement varies as a function of age, sex and for different countries as I have already told. Also there are differences in anthropometric of male and female. So that is an important point to note that when we are designing a system where the male workers have to

work, we may design based on the anthropometry data for the males of that particular regions.

And if we are designing it for the female there maybe some variations minor variations that may have to be accounted for because of the variation in the anthropometric data between the male and the female population of the country. Now dynamic dimensions are taken under the condition in which the body is engaged in some physical activity. So we can have some dynamic dimensions also that when a person is involved in particular for example he is trying to reach to a particular job or tool.

So that where is the dynamic how much stretching can be done, how much of the human body can stretch without feeling discomfort so maybe then when our body is involved in certain kind of activity in that case we can take the dynamic dimensions. So when we design the system we have to design the system taking into account both the static dimensions of the human body as well as the dynamic dimensions of the human body.

Now principles in the applications of anthropometric data now there are 2 things. What we have already covered first thing is the importance of Anthropometry in the design of the work system. Second is what type of measurements or physical dimensions we can have, we can have static, we can have dynamic.

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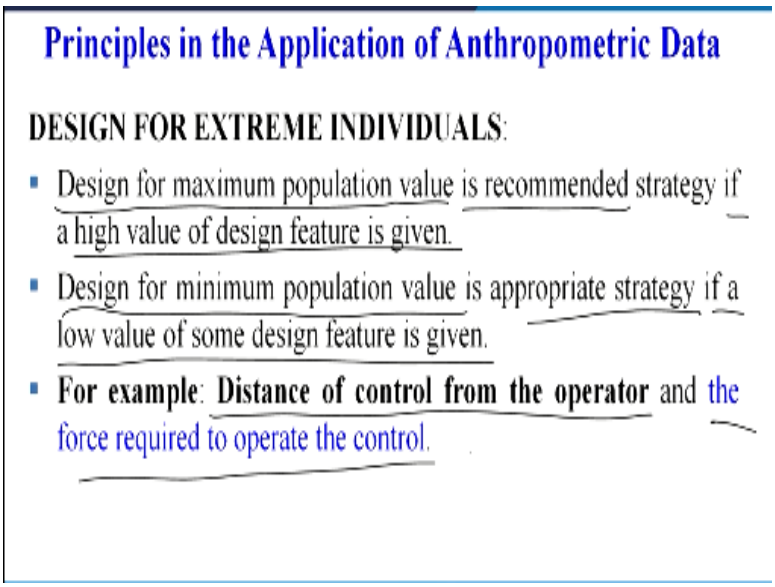

Third one is the principle in the application of anthropometric data that we have to follow when we are using this anthropometric data. Design for extreme individual. So first principle

can be designed for extreme individual. Design for maximum population value is recommended if a high value of the design feature is given. So there are 2, 3 important points to be noted here.

Design for maximum population value. Now maximum value can be the maximum number of people is recommended if the high value of the design feature is given. So high value of design feature. Now the example is distance of a control from the operator. So what can be the maximum distance of the control from the operator that we can design based on the maximum population value or the maximum value for the population for which we have found out the anthropometric data.

And opposite to that when we are designing for the minimum population value is appropriate strategy if a low value of some design feature is given. So low value of design feature can be the force required to operate the control. Now suppose we say that we have to ensure that the force required to operate the control must be minimum so that is the low value of some design feature.

So this is the low value that the minimum force has to be required to operate the control and that we will try to design for the minimum population value. So this is design for the extreme individuals.

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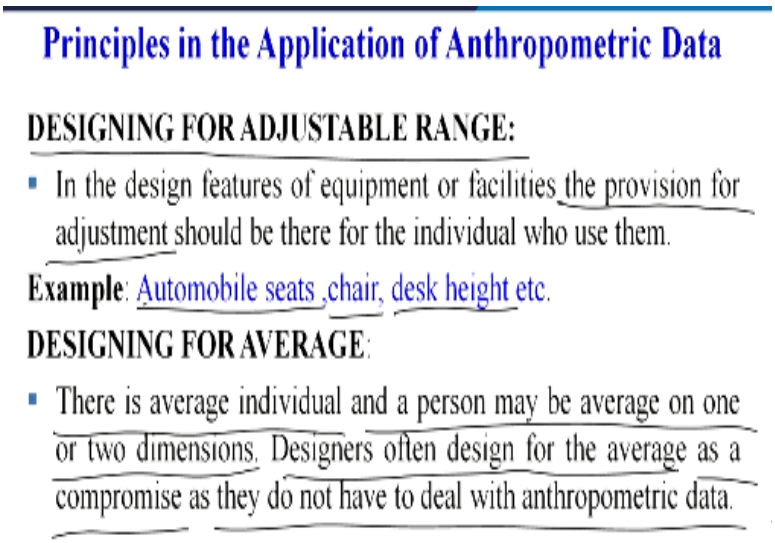

The second one is designing for adjustable range. In the design features of equipment or facilities the provision for adjustment should be there for the individuals who use them. So

this is very common we have seen the examples are also given. Automobile seats are adjustable you can move them front and top you can slide the back rest also. Chair are also adjustable.

You can adjust the height; desk heights are also adjustable in most of the companies where the worker have to work on the desk. So you can see that is another principle of how to use the anthropometric data is designing for the adjustable range. So in the design features of equipment or facilities the provision for adjustment should be there for the individual who use them.

So that provision for adjustment is the key word when we are designing the facilities. Designing for average there is average individual and a person maybe average on one or 2 dimensions. Designers offer design for the average as a comprise as they do not have to deal with the anthropometric data. Now there has to be average value of the anthropometric data so then we can design the system.

For example, I am using this dais. So this can be slightly better if it is adjustable to my height, but it is not adjustable. So this has been designed maybe based on the average height of the professors who are coming to speak and gets the lectures recorded. So this can be made adjustable so I can lift it slightly up and feel more comfortable or someone may like to bring it slightly down to feel comfortable.

So this is a fixed design maybe designed based on the average height of the people who are coming to work here. So therefore we can have different types of principles for the application of anthropometric data, we can design with average, we can design for the adjustable range and in the previous slide we can design for the extreme individual. So sometimes we may design for the low value of the design parameter.

Like the minimum force required to operate the control or we may try to think that this must be the maximum distance of the control which has to be operated by the workers. So that is the high value of the design feature. So let us see now the design of workplace with anthropometric data we have seen the principle design for our average or design for the adjustable feature or design for the maximum dimension again.

Because that is important again I would like to first highlights these points. Design for the extreme individual important principle, designing for the adjustable range second principle and designing for the average value.

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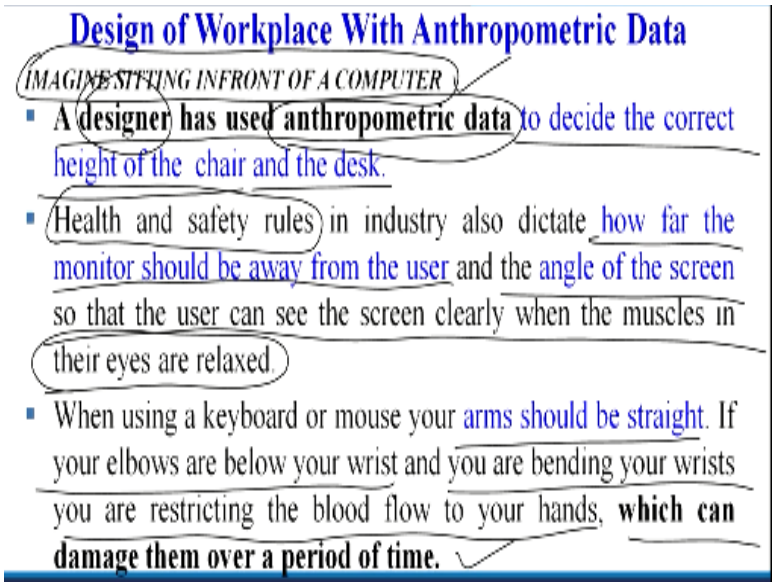

Now design of workplace with anthropometric data we can just go further in detail. Now imagine sitting in front of a computer one example. A designer has used the anthropometric data to decide the correct height of the chair and the desk. So when we are designing for a person who is going to operate a computer what are the various uses of the anthropometric data or how Anthropometry data is useful for design of this interaction between a man and a computer system.

So a designer has used anthropometric data. So to decide the correct height of the chair and the desk as we have seen that the designing of adjustable chairs or tables or desk is also falling under the important aspect of Anthropometry in ergonomics. So we as designer can use the anthropometric data to decide the correct height of the chair and the desk. Health and safety rules in industry also dictate how far the monitor should be away from the user.

From where we are getting this idea? We are getting this idea from the health and safety rules. So there are certain guidelines, occupational health and safety guidelines which guide us in this direction that we must ensure the work system does not cause injury or does not cause discomfort or does not make the work uncomfortable for the workers who are performing the work or doing the jobs.

So as per the health and safety rules how far the monitor should be away from the user is decided and the angle of the screen so that the user can see the screen clearly when the muscles in their eyes are relaxed. So it has to be ensured that we are able to work on the computer without causing any strain to our eyes. So there also what has to the distance between the eyes and the screen.

What has to be angle of the screen has to be decided. When using a keyboard or mouse your arms should be straight if your elbows are below your wrist and you are bending your wrist you are restricting the blood flow to your hands which can damage them over a period of time and cause musculoskeletal disorder. So we have to ensure that such type of design is not there.

So when such types of problems start to occur we try to redesign. We try to work on the data or the anthropometric data and try to design the flexible system design, the adjustable system which can be adjusted as per the requirement of the worker or the anthropometric dimensions of the workers and then all these problems can be avoided.

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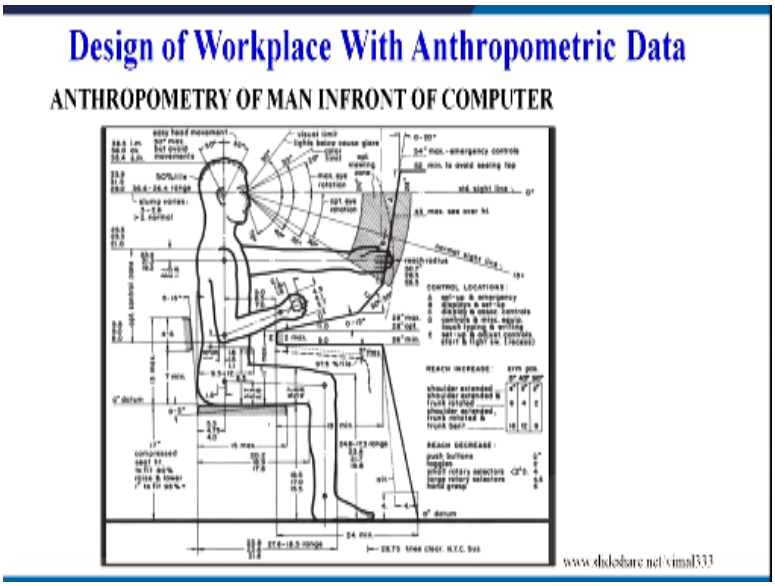

Now this is a example of design of a workplace with anthropometric data you can see a lot of information is there and if a person is able to perform the task sitting in this ideal or this correct posture as per the guidelines or the acts which have been established. The person will never have any problem related to the MSD and he will be able to perform the task to the best of his capabilities or to the best of human capabilities.

So I am not going to go into the details of each and every dimensions, but you can see that how the spine is straight, the head is held straight on the relaxed shoulders, there is adequate foot rest, the length of the seat has been designed properly, the back rest is at an angle. So all these things have to be taken into account when we are designing a system where a person is working on a computer system.

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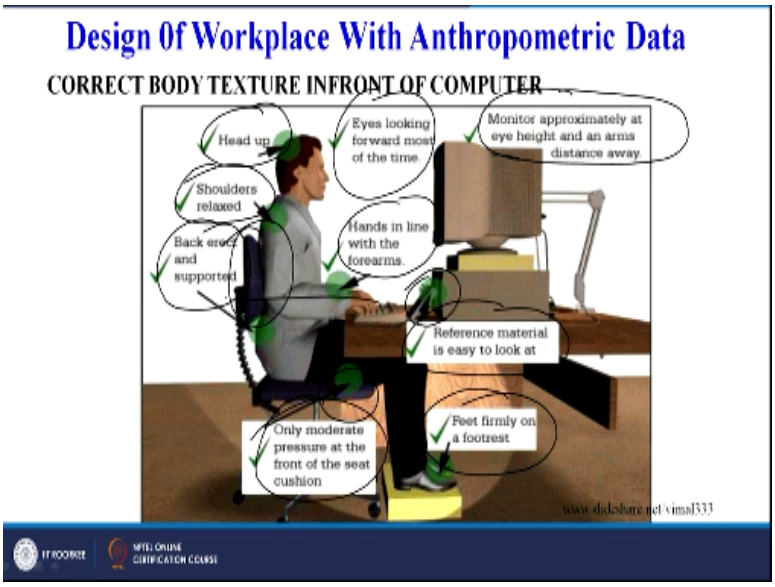

There is another slide which will make it slightly more clear. So here you can see design of a workplace with anthropometric data. Now correct body texture or posture in front of a computer I will read it for you the head is up, shoulders are relaxed, back erect and supported you can see the back is supported here. Then only moderate pressure at the front of the seat cushion this place moderate pressure is only there.

Feet firmly on the foot rest, reference material is easy to look at maybe the reference material is placed here where the user can easily look at monitor approximately at the eye height and an arms distance away. Eyes looking forward most of the times, hand in line with the forearm. So here we can see so if we are able to ensure this type of correct posture for the worker who is working on the computer system throughout the day.

I do not feel that he will feel tired, physically tired, but here he may be using these mental faculties to solve certain problems on the system. So mentally he may get strained or maybe drained out but physically he will feel comfortable.

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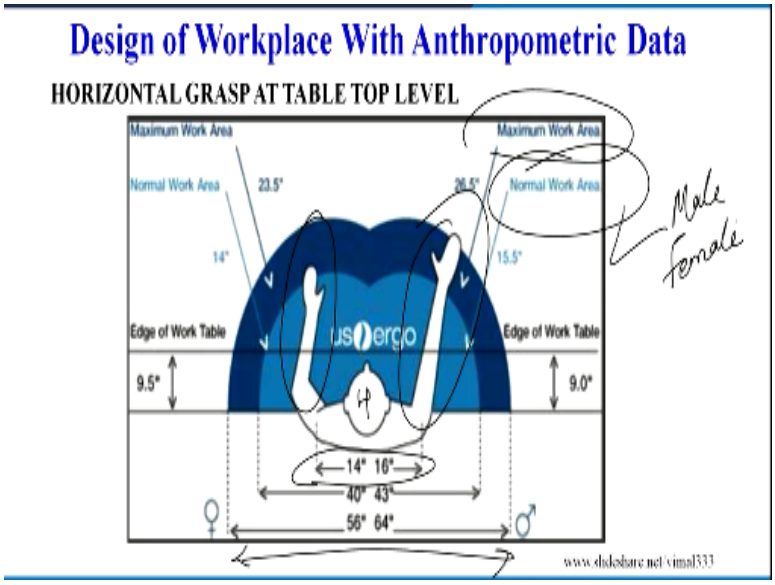

Now this is a design of a workplace for anthropometric data the previous case was related to a worker working on a computer system. This is another example in which the worker is working on the shop floor this is the dimensions given you can see 14 to 16 inch this is the head of the worker; this is the arm this is another arm. So we have a maximum working area. We can have a minimum working area and depending upon whether we are doing this analysis or designing this maximum work area and normal work area.

It will be different for male workers and it will be different for female workers as we have already seen. So accordingly we can have a maximum working area and a minimum area both for males as well as females. There will be slight difference, but the concept remains same and why do we define this maximum and minimum working area so that the tools that we are going to use most frequently are within our hitting range or within a holding range.

So that we need not sit and stand again and again to pick these tools. So we can define that for a male member this is the maximum working area this is the minimum working area. So the tools used frequently must be between the maximum and the minimum working area.

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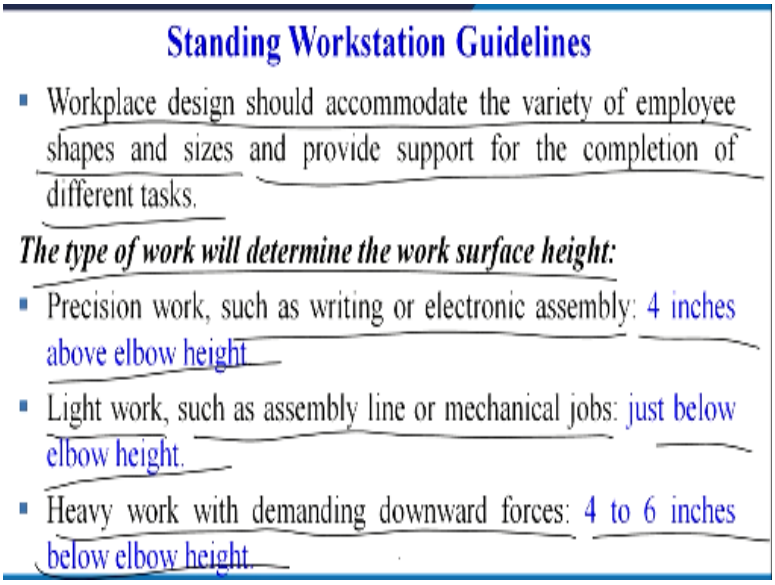

So standing workstations guidelines. Now I am standing and recording these sessions what are the guidelines for the design of the work system. Workplace design should accommodate the variety of employees, shapes and sizes and provide support for the completion of the different task. So variety of employees shapes and sizes must be taken into account as taken into account for design of this height of this dais.

The type of work will determine the work surface height. So this I will try to explain first with the help of a diagram.

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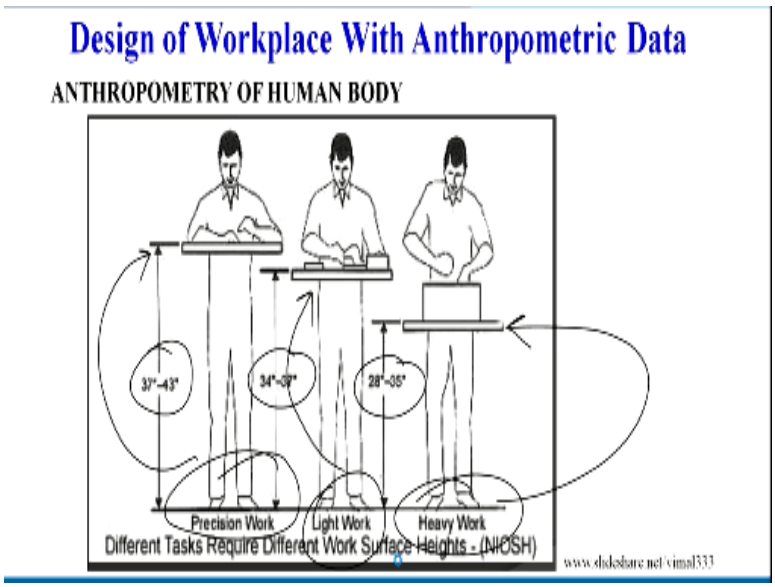

Here you can see then use of Anthropometry of human body. Design of a workplace with anthropometric data. If the precision work has to be done this must be the height of the table. And if the heavy work has to be done this has to be the height of the table. So if light work

has to be done this is the height of the table and if you see it is given in inches' values are there.

So you can very easily see that depending upon the type of work we can design the height of the table. Now this dais has also been designed based upon the type of work we are doing. So it is a light work so it is not a heavy work. It is a not a very precision work also. So therefore the height has been designed accordingly. Now let us see what are the guidelines? The type of work will determine the work surface height.

Let us see the precision work such was writing or electronic assembly 4 inches above the elbow height. So this is my elbow so maybe 4 inches above the elbow height. Light work such as assembly line or mechanical job just below the elbow height. Heavy work with demanding downward forces 4 to 6 inches below the elbow height so which we have already tried to understand with the help of these diagrams that how much height must be given to the table when the person has to work in the standing position.

So this must also be adjustable as per the height of the operator or the workers.

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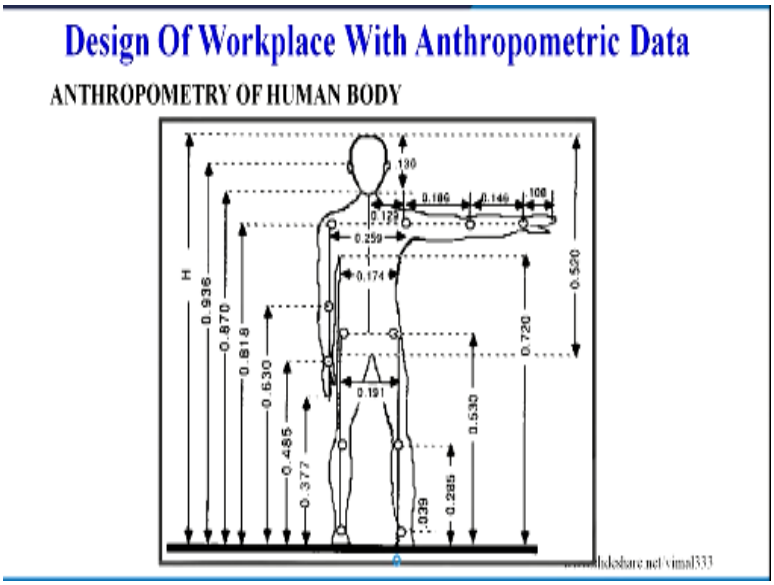

Now this is the design of the workplace with anthropometric data so many dimensions are given. So this is Anthropometry of a human body and based on that we can design our work space.

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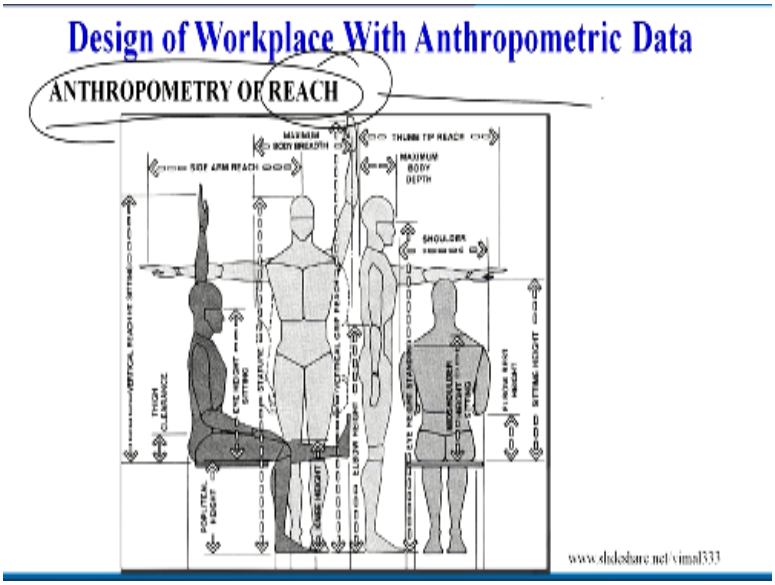

Now this is again the design of a workplace with anthropometric data Anthropometry of reach that if the person has to reach to a particular location to get the tool or the work we can see or make use of this Anthropometric data to decide the design of the work system.

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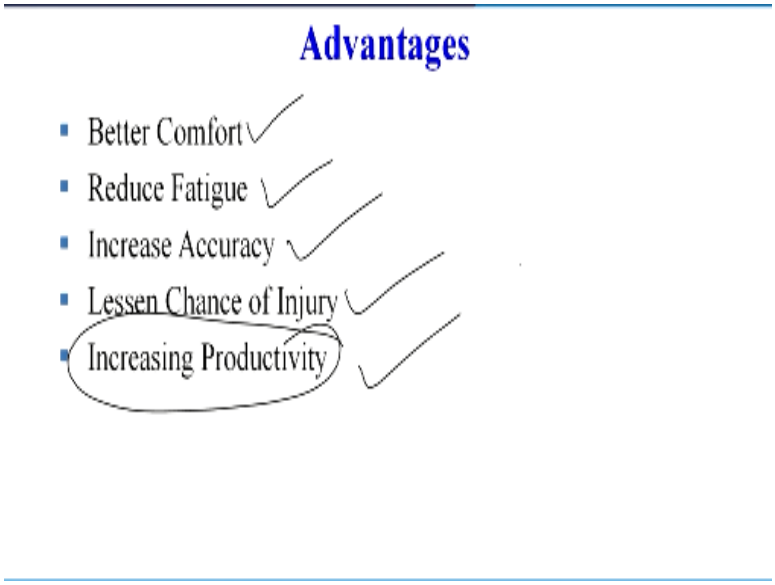

Now finally we come to the advantages that what are the advantages of this anthropometric data. It will help us to design a work system which will ensure better comfort for our workers, it will reduce the fatigue for the workers, increase the accuracy of their work, lessen the chance of injury and finally it will lead to increase in the productivity. So if the worker is performing the task in the best possible manner as per the capability of the human body.

Both physical as well as cognitive in that case the workers will be able to deliver in a much better manner as compared to ill designed work system. So a well design work system will be

based on the anthropometric data and it will ensure that the worker works to the best of his capability. So in today's session I think we have been able to highlight the importance of anthropometric data in the design of the work system.

In the next session we will see that what happens when the man interacts with the system or man interacts with the machine and what are the things or the aspects or the concepts that must be clear to us when we are looking at the interaction between the man and the machine. So with this we conclude the today's session. Thank you.