Ergonomics for Beginners Industrial Design Perspective
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Module No. # 04
Posture and movement
Lecture No. # 21
Movement

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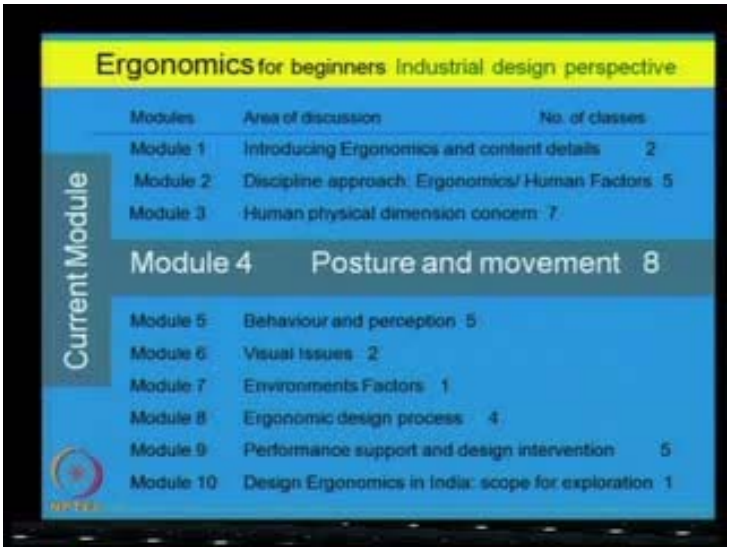

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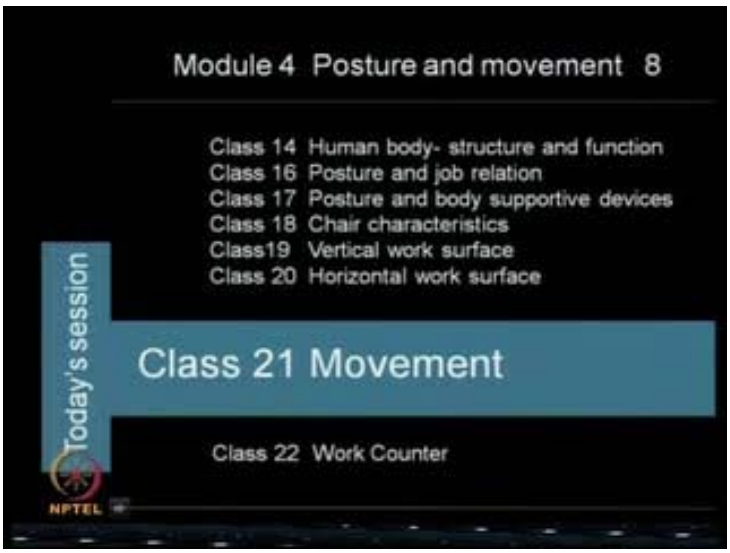

Welcome to this twenty-first session of Ergonomics for Beginners Industrial Design Perspective. Today, we are going to discuss, today's the current module, that is module

number 4; that is, Posture and movement. Out of 8 classes within this, today is the last but one class - that is, today's session is class number 21, that is movement and its performance relevance.

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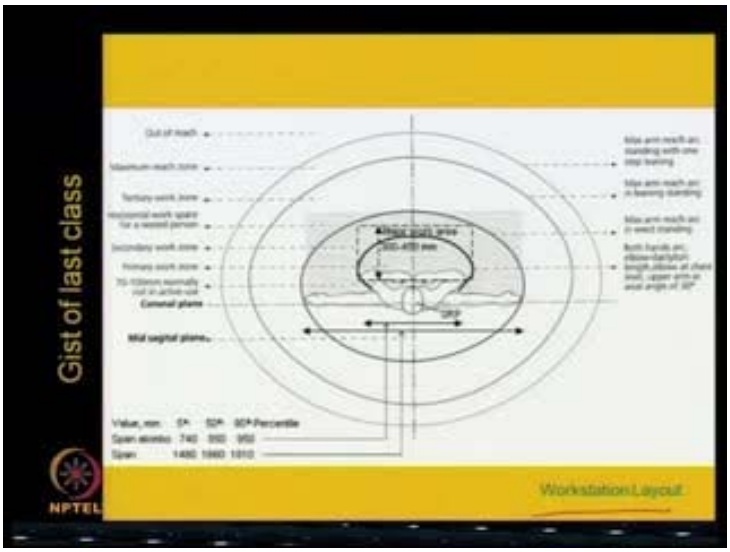

Now, the gist of last class - whatever we have discussed - that is, the workstation layout where we mentioned that for a standing person or a seated person the primary work area, especially a horizontal space in front with the palm akimbo length, the palm depth and the forearm depth - this much space is the primary work zone. This primary work zone can be extended with the span - total span - and the frontal one - forearm depth and then with total arm extended - with the full arm - the total area is covered; that is the secondary work zone. And with bending from side and back, it would be the tertiary work zone. For standing person with one step, the total reach values that arm arc is a maximum work this zone and out of that is the out of reach.

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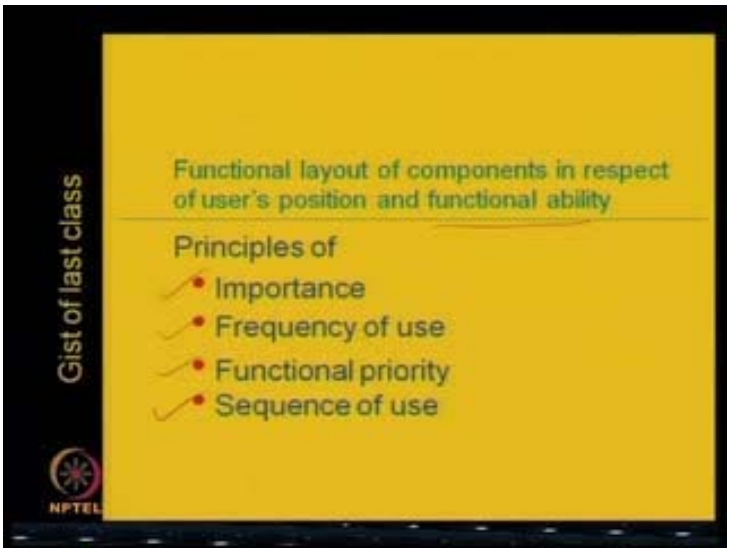

So, according to various importance like the functional layout of components in respect of user's position and functional ability based on four principles of component layout like: the principle of importance, principle of frequency of use, principle of functional priority and sequence of use principle, with that the work component should be placed within the specific work zone areas.

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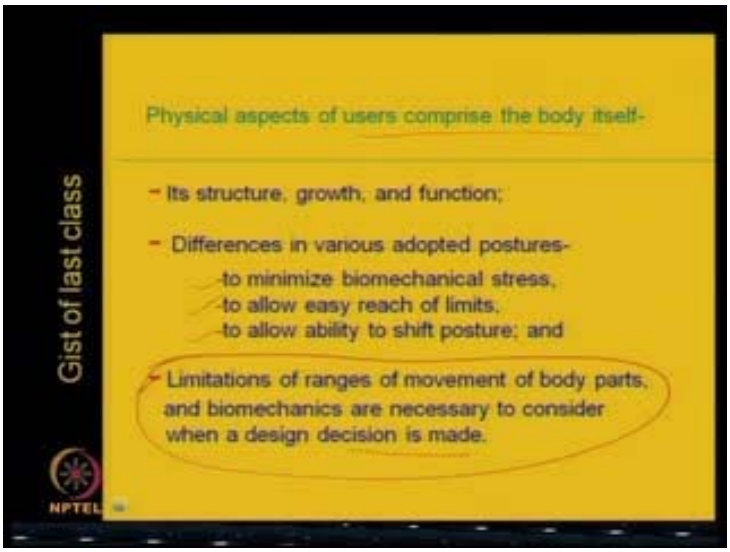

Now, physical aspects of users comprise the body itself; where we need to be concerned, it is structure, growth and function. Differences in various adopted postures like: to

minimize biomechanical stress, to allow easy reach of limits, to allow the ability to shift posture - if a person performs a task for a quite longer time in a single posture it would be tiring; so, it is advisable that one person should try to sit their postures; so, various postures. Maybe the workstation should have the facility for adopting, sitting, standing and some other postures that suit that task.

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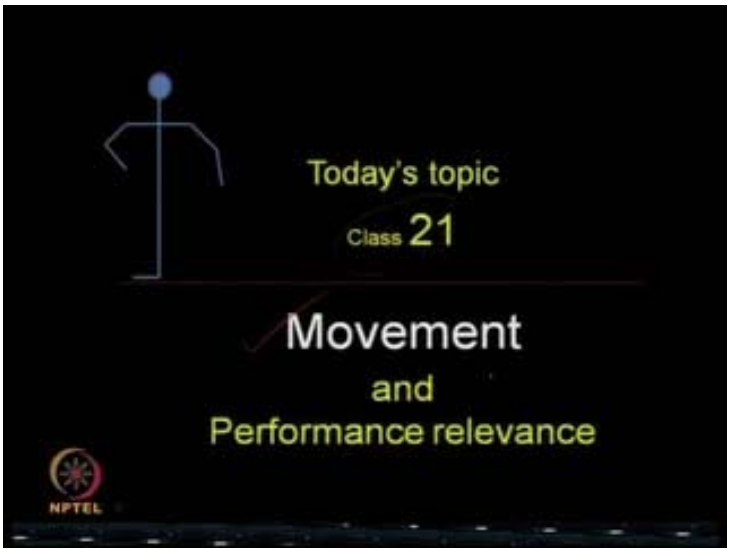

Now, the other thing is that the limitations of ranges of movements of body parts and biomechanics are necessary to consider when a design dimension decision is made. Now, this particular area we are going to stress today's. So, with this today's topic, the class number 21 is movement of human body according to task and performance relevance.

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So, movement: the dynamism of body parts - either parts of the body or body as a whole, and the task and space around. So, our today's discussion will be within these limits. Now, the first point we can say that being stationed at a point and stretching out means the person being stationed - the person is not moving - being stationed when he is stretched out to do a certain task. Then what are the concerns that we should consider in this class now? We are not going to give any design solution or in the specific essence here; we are raising some concerns and issues that we need to consider while making any design attempt.

Basically, based on the human body structure, behavior and movement ranges - now in this case what would be the design requirement? Whether we need to provide any specific support system here or we should do certain design thing. So, this latch can come down for our requirement; this type of studies we may do.

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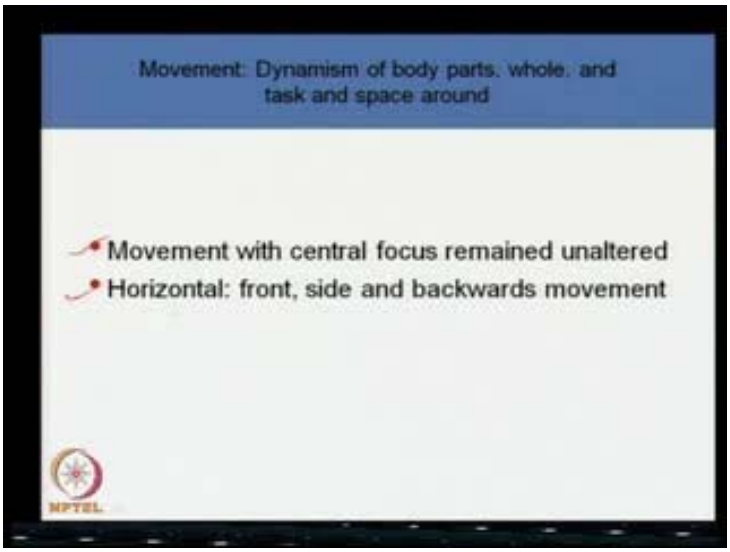

Now, next concern we can say is that movement with central focus remained unaltered: when we do certain work with the frontal attention, while we are doing if it is necessary to work upon some other areas and if we move and sit to that position, how fast we can come back to that original work area? How we are giving that facility needs to be provided. So, whatever the task we are performing, accessories we are handling, our main focus is to work on the central focus area; so that should not be unaltered.

Now, another thing is that horizontal work area: front, side and backward movement. Which one is better? Which one would be comfortable for us? So, accordingly the work area or a work surface should be placed. It is said that frontal work area is always better; sideways we can have, but backward it is better to avoid if the body movement facility is not provided. So, in that case, the location of the person means - how with minimum effort that body can move to touch all those points? That we need to consider.

Now, the placement of these things. Now, normally what is happen for our body axis the central body axis now our arm is placed in such a way that if we try to exert some act, if you want to do some task - handling some lever, if it is towards the central of the body line, then it is little difficult to operate. While operating, we need to provide a space so that this elbow can freely move. Now, then the back rest and it is back rest has to be considered accordingly, so that there should not be any hit in the obstruction of the elbow movement. It is better if we can keep an handle or a switch or a gear placed from

the central body axis at around thirty to forty five degree angle; this range - it will be easier to move. This elbow instead of going away from the main body, it will be closer to body. So, this type of movement is always better. This considerations we need to consider when doing some design activities.

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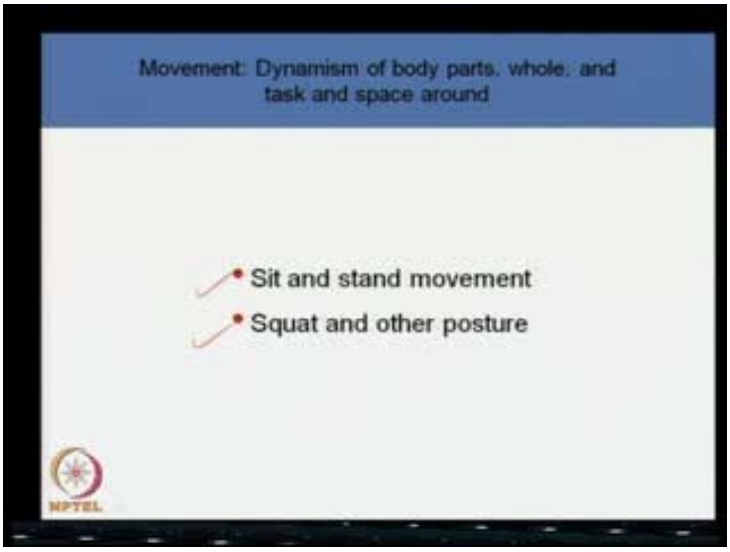

Now, just now we said that the sit and stand movement. Now, if a work area requires only sitting, then some provision should be made. So, the person can get chance to stand or they can get some chance to change the position, so that the working in a constant sitting position should not be fatigue.

Now, another thing is that squat and other postures. There are many activities in squatting and etceteraNow, for the squatting - earlier classes also we mentioned that for some body, support of devices should be provided and also some freeness of movement - means the situation should be made in such a way that person can choose his posture and can perform the task.

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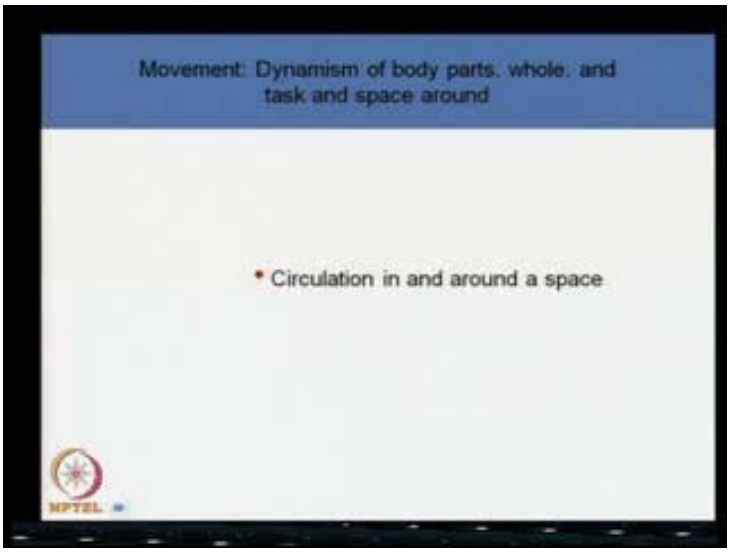

Then, circulation in and around a space. Circulation, what is happen? When a person moves – earlier we said that person has a specific volume in a space- Now, when he moves somewhere, that space also moves accordingly. If it takes any posture bent or some other changes, then that volume also takes the same set. Now, when he moves so, whether it will be a straight 90 degree angle movement or there should be a little circular end movement; that is necessary to be considered because man as per a normal behavior- it is when he move in a straight right angle way or he does not walk in a straight line. So, there will be always sway movement like that; that we will see now. So, all these things we need to consider. And the space around, there is also that is not only the physical space to work upon but also the psychological space filling, that is territory filling should be considered.

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Now, here if we see that not only the working area but in leisure time also the same aspect, we need to consider. Suppose, this is the house - the drawing room design. In this drawing room, how many persons we are expecting? How many visitors we are expecting? What type of interactions we will have? All these things we need to consider. Accordingly, the ease of going in and coming out from this space we need to think of it. Then the reach values and etcetera it has to be considered and then obviously the furniture dimensions are there.

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Now, mostly while making footpath or some special space, we think or we feel to move around or go. Then, what would be the total space? That needs to be considered and then the clearances. Now, whether only walking or walking with some equipment or object in hand or walking with an aid - that maybe some vehicle type of thing whether those things are necessary that has to be considered. Suppose, if this is a historical place and in this historical place all the archeological material are inside and it is fenced. Now, it is supposed to move around the fence and see the articles; but now- the old- the young man or normal common adult people they can move by walking. But, if there is an old person comes or any tourist- visitor- who is not able to walk, for them wheelchair or some kind of mechanized moving item should be used. Then, that facility whether it is possible or not that should be considered including the bending here and etcetera; what would be the arc? We need to consider in this case.

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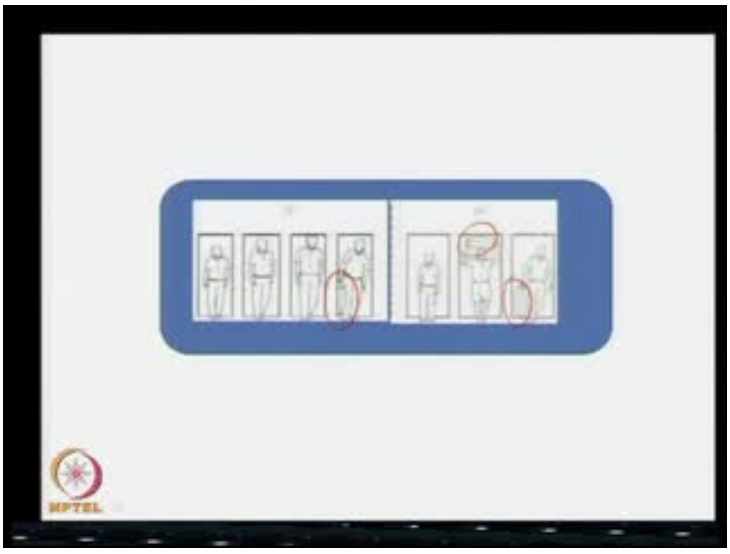

Now, for any space that where we need to cross over. Suppose the tall people, short people and the people are supposed to carry something; all these things we need to consider. Whether the things he is carrying? What type of material is one can or one is expected to carry? The carrying mode- whether on the head or hand or something that we need to consider.

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The office area - in this office area the circulation is that, this is the single workstation area where the table, and work material, and chairs are there; chair for the occupant and the visitors are there. So, what would be the total movement pattern here? Accordingly, the space we need to consider. So then, How many people are supposed to cross in this length? What would be the frequency? What is the timing for that? That need to be thought of there. Not only circulation, the persons are also supposed to do these type of activities - means the work also. Then when a person moves through this length, then only his body dimensions that in a standing depth, breadth are considered; then walking

area is considered. But, while performing certain task - suppose people also need to do this- Then, what would be the space special allowances required? That needs to be considered. Then whether supervisor needs to observe the whole area; then what type of furniture facilities required? That we need to think.

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Now, another area is that here the people are confined as they are attending one conference. In this conference, unless the delivery of the speaker is over, these people cannot come out. So, if this facility is provided that they may come out, then the space in between needs to be considered. What would be the consideration? The total seat depth and around the same space that we require to keep free in between two rows for the bench and the chair, so that one can come out without disturbing as for the whole group.

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Similar thing also can be considered in this community feast. Unless if someone wishes to come out, unless the other people finish, it is bit difficult to move out. So, then what would be the gap in between? This needs to be think. So, accordingly the space arrangement has to be developed.

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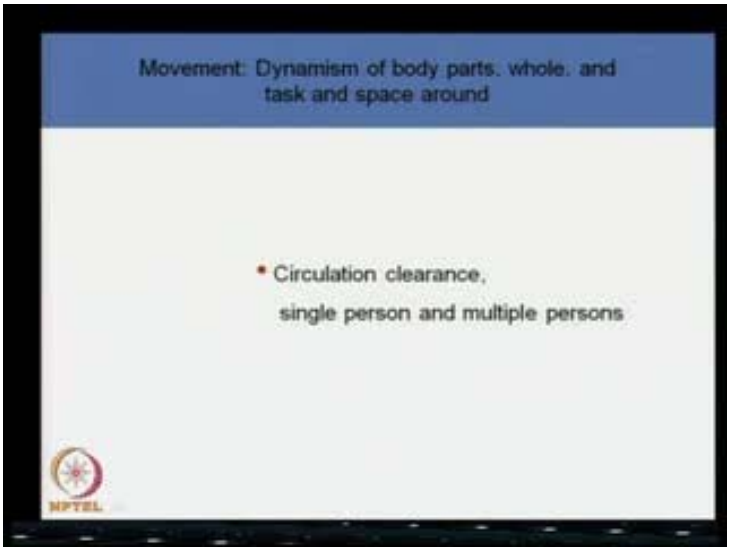

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So this we can say that circulation clearance is necessary; single person and multiple persons use. Now single person, if we see here a single person is walking, now we can say that whatever the total distance with the relaxed position from the total body breadth needs to be considered. So accordingly if we make a path, then it may not be comfortable because while walking the man cannot walk in a straight line. So, there will be sway; that sway we have to give clearance; otherwise it will psychologically troublesome.

Now, if two persons are supposed to cross side by side, then we can say that take a whole bench length. Suppose if this is a 1 unit, if the total depth distance is 1 unit, then we can say that this will be 1 plus 0.75. Why? Because, if the two persons walk side by side,then there will be some squeezing. If three persons walk side by side, then we do not require 3 times of this; there we require maximum 2.5 of the total- if it is one, then 2.5. Why? Because three persons if they move together, they will not move at a same line; they will be either one in front-back like that the arrangement will be there.

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Now, so this we will try to see in this case. Now, when the three persons are moving together, they will never walk in a straight line like this. There will be some front-back arrangement of walking; so accordingly that is the considerations.

Now, if we see this then now we will see one movie here, we will see that how it moves. Now, see the single persons movement. When she is moving, she is not following a straight line; the sway movement is there. So, this sway movement we need to consider. Now, another thing is that when male and female both walk, the female body size-they move at the hip; hip - it is moving like this way. But, whereas when a man moves, there the hip remains static, but their movement is shoulder movement, will be more. Now with that the ladies who have little heavy buttock, for them the sway movement is more; so, the straight to go in a straight line it is little difficult. So, for them the moving from the left and right side covering like this way from the central axis of movement is there.

Now, if we see this figure, here this movie this clip in this clip it will be now we can see that one man and his wife both are walking on a corridor. Now, see the movement pattern. The person - the man moves, the hip is not moving much but the shoulder is moving, whereas when the lady moves the shoulder remains relatively static; then the buttock movement. So, when the buttock movement is there, the more sway movement is also there. So, while walking or while designing some walking area or walk pathway, all these aspects we need to consider.

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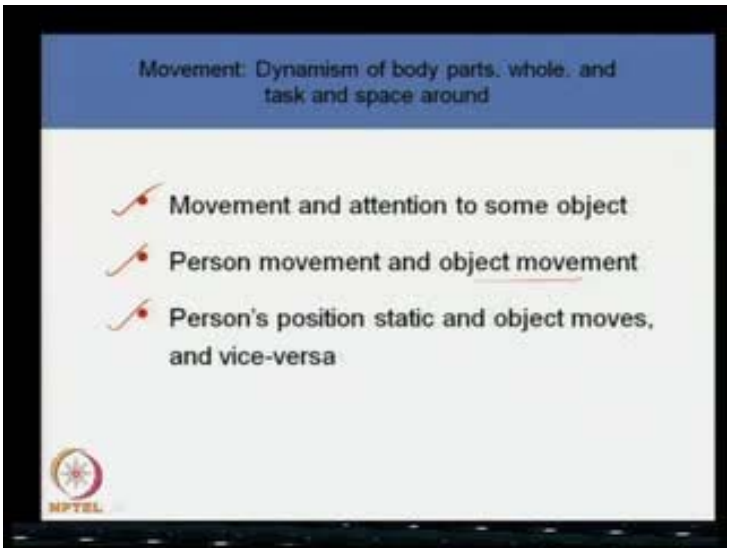

Now, the next step we can say that the movement and attention to some object. Suppose the person moves, the thing I want to see that remains static; then that one consideration will be there. Another consideration is that the person is static, but the object is moving. Another is that person is moving and object is moving at the same direction either with the same speed or different speed; then the visual interaction with them among these two. Another is that the person is moving in one direction but object is moving opposite direction with varied speed; then, what would be the perception of those items to see? So, in that case it would be like this. Now, we will see the three specific factors - movement and attention to some object, person movement and object movement, and person's position static and object moves or vice versa.

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Now here, this is a conveyor belt in an airport where the luggage is coming. So, person is standing and this luggage - this conveyor height is almost at the knee height; roughly, it can be said that as per your normal sitting height. Now, while taking out this luggage, the luggage is coming from this side; so they are all looking at the coming in position and they have to collect it and then transfer to the trolley. Now, while transferring this thing, the person has to lift this load in an awkward posture and then shift it. So, there is a design scope whether to lift that or that trolley can come very close to this and just only pulling it can be shifted. So, then it will be less tiring or less problem in this posture area. So, this is one type of task concerning movement.

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Another thing is that the person moves and the object of the work equipment also moves; he does not need to push. with that there is some Here, he is pushing but in some cases where the electrical power is given. So, that the work equipment moves and the person also moves he has to control like that. So, in that type of one movement then in this case we require to maintain the pace between this equipment and the person - not the surroundings. But, when they are moving and they are taking a turn, what would be the angle in this case? That needs to be considered. So, that the person's comfort is a concern here.

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Now, another thing is that design for whole body movement means whole body is moving on an object. Now, what would be the design considerations? There are varieties of considerations are there, but one thing I would like to say here that dimensions according to body movement requirements - this is the seat; suppose, this person has to sit on it, neither it is a body supportive structure. Now, this body supportive structure and the seat type of body supportive structure needs to be different. Here, what is happen? Not only sitting, this person has to pedal also. For this pedal, what is happen? The thigh movement space in these two area, it has been given a specific feature. So, it allows one person to move his legs that is the thigh area. So, this type of interaction is there. The interfaces between this object and the person's inner thigh movement has to be established properly. Then the angle of the seats and etcetera has to be considered so that with bending forward with using the body weight and it also helps in pedaling.

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Now, another thing is that with that same cycle when a person carries something; normally, we carry with a basket at the front cycle here or at the rare end at the carrier. Now, need is varied. So, if we keep our eyes and ears open in our surroundings, a lot of needs we can find out that can be addressed with design attempts. Here, he is a person; he is a faculty of Kanpur IIT. In this case, he has developed a special arrangement for his own son, that his son wishes to go out with the cycle with his father. So, what he has done? He cut these two areas here and put a special wooden board so that the person, that boy can sit here with the legs out; this platform can be used as a special footrest and then

it can be cycled; so, no problem. Now, this is a person's own innovation; now, whether this type of innovative ideas has real designed application that one need to consider. Here, what is happen? The person also moves; he is carrying someone; then there is a special context is required; then here a lot of continence of safety and then his body dimensions and etcetera all are there.

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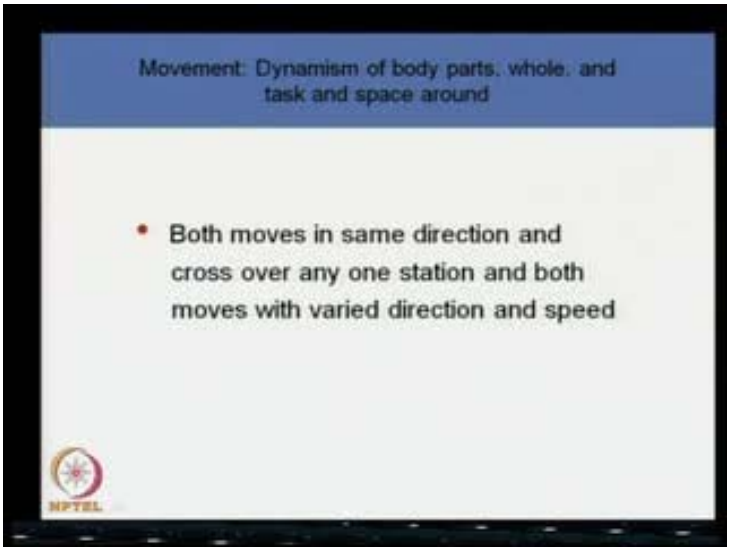

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Now, we can say that both moves in same direction and cross over any one station; both moves with varied direction and speed - person and the object. So, with that we can see

this airport horizontal conveyor belt. Horizontal conveyor belt system is that it reduces someone's walking load. Now, if we see here in this small film-let, then we can think that how it operates. In this case, we can see that the conveyor belts moves forward; persons are also walking on this. Now, the walking speed of this person in respect of time and space is a faster with this. Someone may not walk even on this; but it is seen that not only walking, person also carry some luggage with them in hand. Now, whether this space in between is enough or we need to do something else here; that we need to consider.

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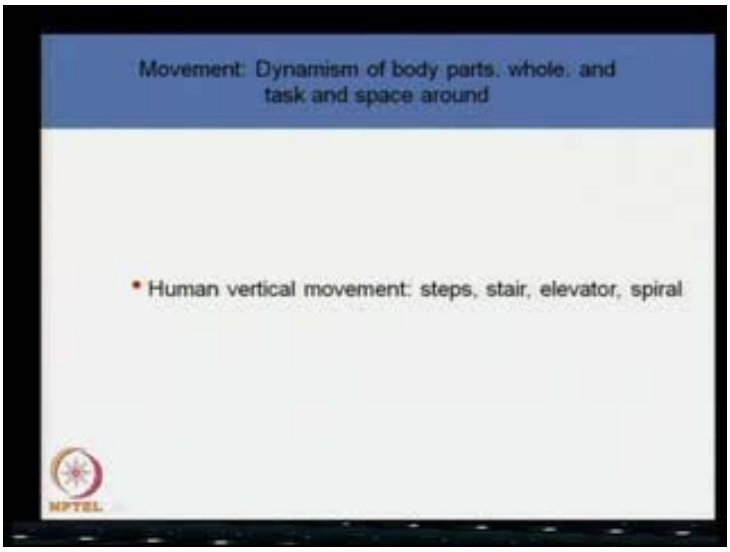

Now, specifically it can be said that now we are coming to the point human vertical movement. Now, this airport conveyor belt is at horizontal movement, and bending and etcetera. But, now the vertical movement: the vertical movement is that person can move vertically up, diagonally or in a spiral movement. So, what would be the considerations? like that the Steps, stairs, elevator and spiral.

Now, here if we would like to see the steps, the steps here it is not only the young person's steps but where the old persons moves; whether it is a forward movement. When you are climbing, you can hold some railings; you can get support. But, while coming down with the total body weight there is a problem; so, you require a good support; there should not be any toppling sense, falling down sense at home and etcetera. We know everything that - what is the step height? Normally, we say that if a

person's lower leg height- the lower leg height is one third roughly- it can be the stair height - steps height - so that it will be very less tiring on the thighs muscles. Now we know it at home; what is this? But, when we do not know in some public building or some spaces- we have seen now in some unknown places, then this would be considered. The special lighting and etcetera - it should be there; otherwise its problematic.

Now, another case is that for the movement when we normally walk, how much our foot comes up from the floor? It is seen that when you normally walk, around 4 to 5 centimeter only our legs come up from the floor. Now, if on a floor, if somewhere or something has to be laid and that we need to see, that it should not be buried under the floor; it needs to be visible. Then, what would be the height of that? If it is below 5 centimeter, it would not hit foot. You can walk over that without notice of any tension on your thigh muscles like that. So, these are the some considerations we need to take.

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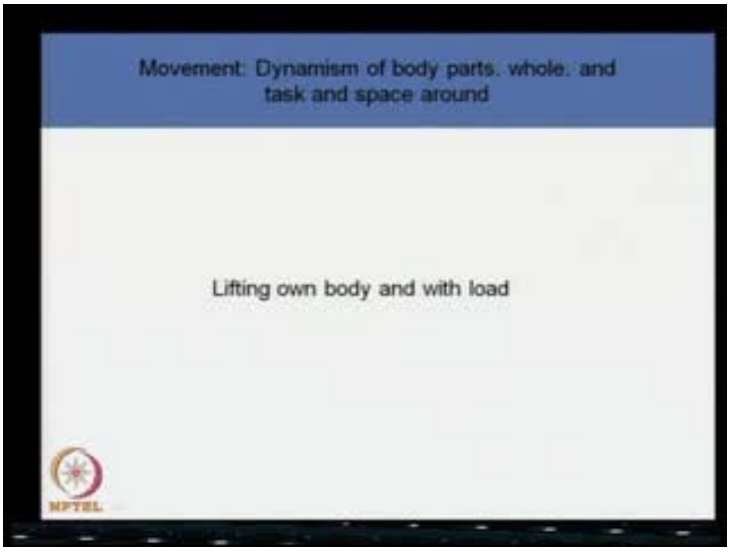

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Now, another aspect is that lifting our own body weight with load. Whatever considerations we said with or without load - but now if load is there, then a total requirement will change. Varieties of load: In this case, now the person's lady and person while climbing on it, there is no staircase and not even that while working; then, what would be the considerations for this? These things are also required. For design, we are not only designing the office area or any multistoried building but such cases we need to consider that the day to day aspects of our life.

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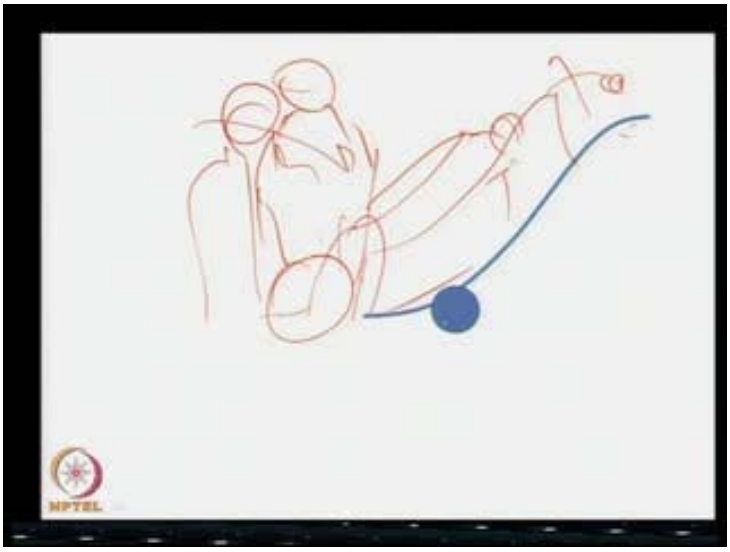

This is another area - that space or the garden ,versus tent area, going up, working, sitting like this; that space need to consider. Now movement and safety: For movement and safety, how the design can work? Now, she is pulling this. Now, only if they pull it - at home everybody has the problem- either we roll this cylinder or we use a special stand kind of thing. Now, for the stand it is like this with swiveling wheels, we put on it and then pull it; this is fine. But now, while putting on it the lot of problem is there; then to bring it down is also same problem. So, in that case the simple solution- there is a lot of solutions people have developed for carrying. So, what is happen? If it is like this; if it is

like this; this is the handle and etcetera; then the cylinder; you can bring it here and then push it like this. So, what is happen? The cylinder will face like this and then you can move it. Then while pulling it or while unloading this, makes it up; so, it will automatically come to this side and then it will stand like this. So, this type of development possibilities are there.

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Now, so for this type of development we need to specifically look into: how people work? How people demand? What people demand? Accordingly, designs are made. In this case the person is guiding; whereas, in this case he himself is adding load - the force to this; then this yak and etcetera - it is made for the cows bollox but not for person. So, if this types of activities is necessary, then either what type of design we should have? That we need to be considered. and so our so means What I would like to say that, we need to see what is happening in our surroundings: the movement force requirement and the task requirement. Accordingly, give some design solutions where man is the prime system component as per his benefit or as per his convenience; do the design.

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In this case, in a railway platform a long metal wire has to be shifted from one place to another place. Now, see the people are holding and pulling it. Can any design be given here either for method improvement; method of carrying this improvement or some other things?

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Now, we say the safety and the movement, and the work surface. Now, in this airport this person is cleaning the glass with different things and so the special tying things are provided here; so that he should not fall. Now here, which one is necessary to maintain

this slope? If it is there, then how it will be cleaned? and like this way so means then We have to decide - which one is priority? What is actually required? Then keeping that fixed, other alternatives we have to take care.

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The person inside here have lot of movement possibilities are there; lot of movements are necessary to come out, to go in, to operate the machines, the passengers going in and coming out; passengers age their range of movement whether they will be able to go inside or not. In that case, if he has to move like this - coming out and going in and whether there will be a fixed seat or the seat maybe movable, all sorts of concerns are coming in mind. So basically we need to know that - what is our normal body movement range? Now, we would like to see this.

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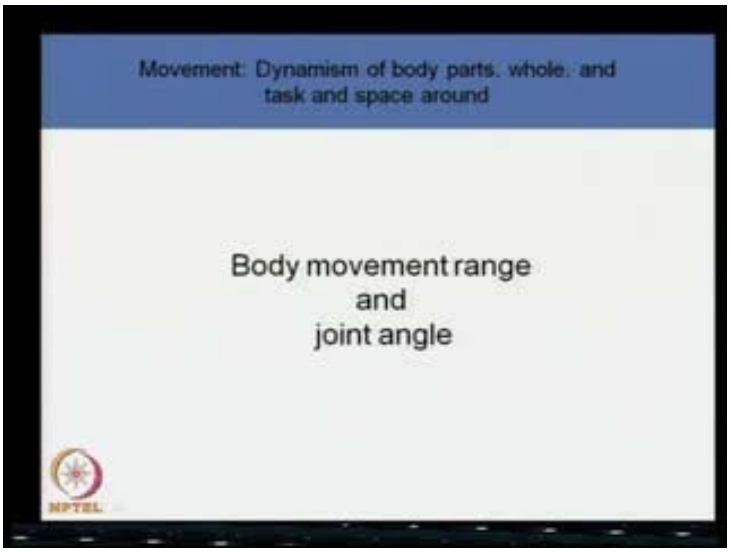

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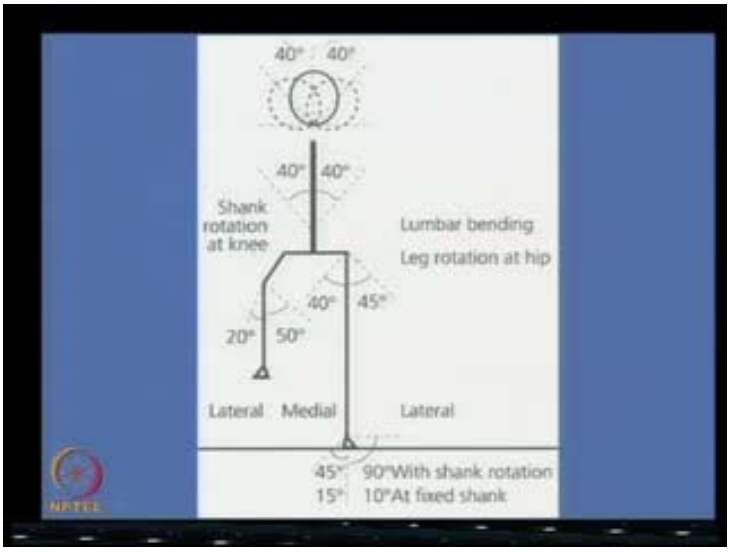

Body movement range and joint angle in normal. In this case, if a person stands - his head, body, hip, foot and leg. Now, head can go right side and left side around 40 degrees; at back means at around lumbar region; the body can bend 40 degree right, 40 degree left like that way. At hip area, the thigh or full leg can outer side means lateral side can go till 45 degree angle and inner side around 40 degree angle. At knee, inner side - it can bend around 50 degree; external lateral side around 20 degree. Here the foot, the lateral side it may go till 90 degree, and here around 45 degree, and 15 degree, and 10 degree at fixed shank and 45 degree and 90 degree with shank rotation.

Now if here the main trunk bends at 40 degree, and then head can bend another 40 degree, so then total movement with body bent and head bent maybe around 80 degree from the central axis like this. It has to be considered in our design that how we can move and etcetera.

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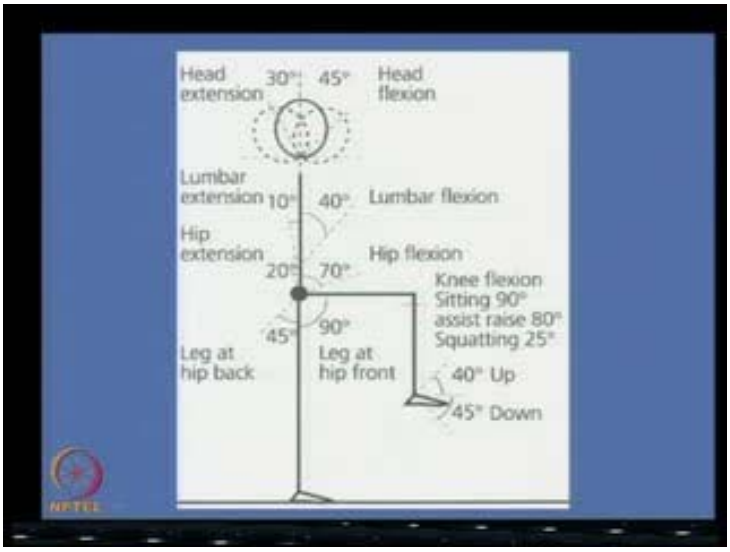

Now from the side plane- this is differ from the frontal- this is the side profile. Now, side also we can say that head can bent front around 45 degree and back around 30 degree. At lumbar region, frontal 40 degree and back around 10 degree lumbar extension. At hip, the body can go around 70 degree and 20 degree hip extension. Now here leg, the thigh, the full leg can go back around 45 degree-leg at hip back position; frontal, it may go till 70 degree and here around 90 degree angle at the hip leg front. The knee flexion sitting at 90 degree angle and as it raise it may come below this around 80 degree angle. Squatting it comes around 25 degree angle. Here, front frontal: upward 40 degree and lower 45 degree down.

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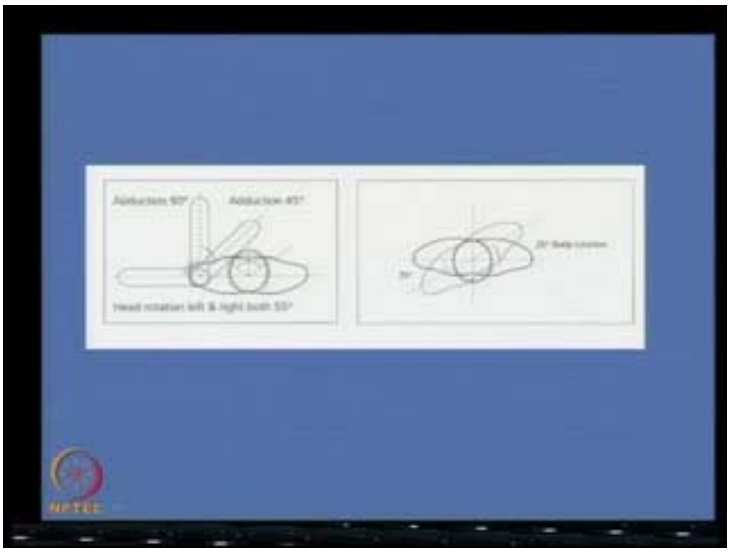

Now, the total body movement-the whole body at the arm-the inner side movement is called abduction around 45 degree it can come and then maximum it can go around 180 degree. Head rotation: left and right both at 55 degree -head right and left like this way it can go around 55 degree in one side. The total body movement like this way, it has 35 degree on this.

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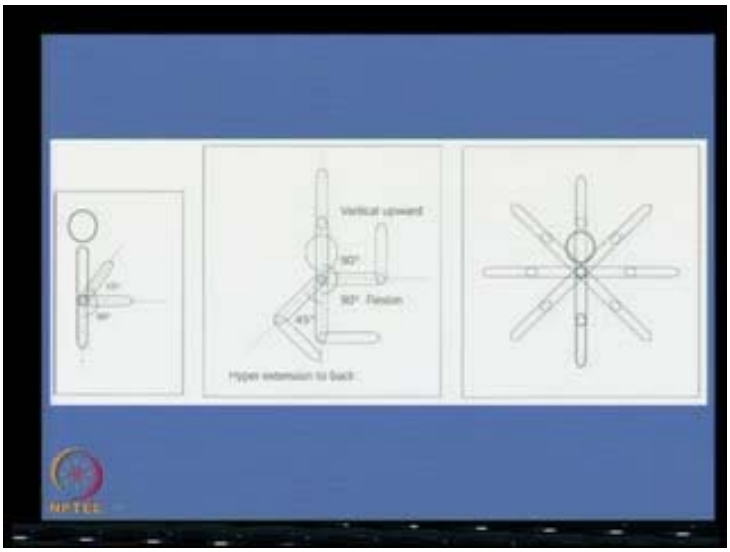

Now the arm and wrist movement: At an elbow around 55 degree and below around 90 degree these much around 55 degree it can go like this way maximum. Here the arm

movement in a circular way that vertical upward and vertical downward, and at this flexion- arm flexion is 90 degree, and backward arm and upper arm around 45 degree angle; so hyper extension to back. This is the vertical upward movement. Here, what is happen above the head? This whole three hundred sixty degree it can move, and from this like this total sideways 360 degree movement is possible

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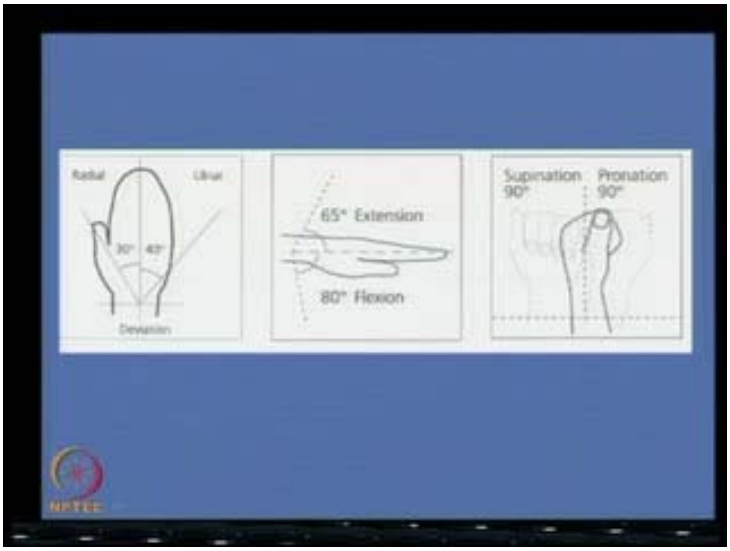

But all these are for a normal body. common able bodied But, there are physically challenging features and adults, they can and for the old people; for them it has to be considered; it is a restricted movement. Now, how much restricted? It will be varied and accordingly design has to be done. like this palm Palm movement: this side is that radial side is, the 30 degree and lateral side-ulnar side is the 40 degree-30 degree and 40 degree; palm up and down, it is at 65 degree extension top and bottom 80 degree. The fist movement like this in a fixed area - pronation is 90 degree and supination is also 90 degree.

So, these are the normal body movement ranges. Now, whatever movement we do and the design of the body supportive device or in the work equipment we design; so these have to be considered.

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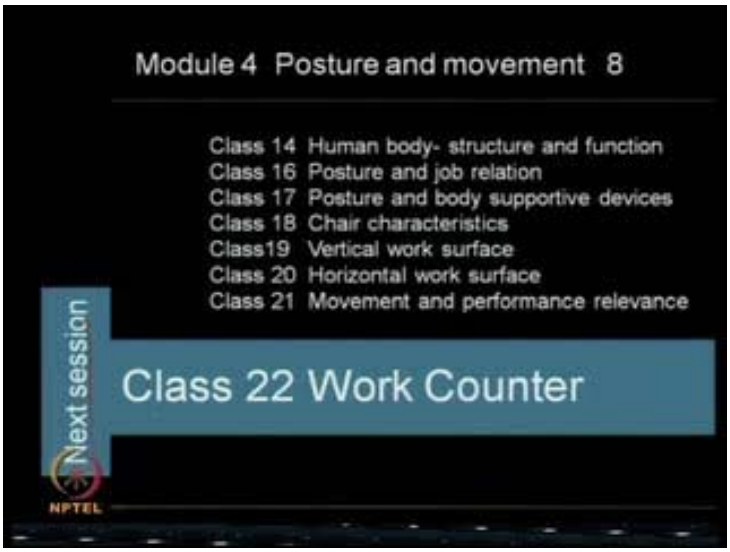

Now, this design application we will see later. We will discuss this now, with this we are concluding today's session of movement-human body movement and performance relevance. So, next session the class number 22 that this will be the work counter; work counter means for normal activities, height, length and breadth of a special work area where either horizontal or vertical, or slant or any combination of this work area are necessary. What would be their considerations? So next we will discuss the work counter so till then good bye and see you next.