Ergonomics for beginners

Industrial designPerspective

Prof. D. Chakrabarti

Department of Design

Indian Institute of Technology, Guwahati

Module No. # 04

Posture and movement

Lecture No. # 16

Posture and job relation

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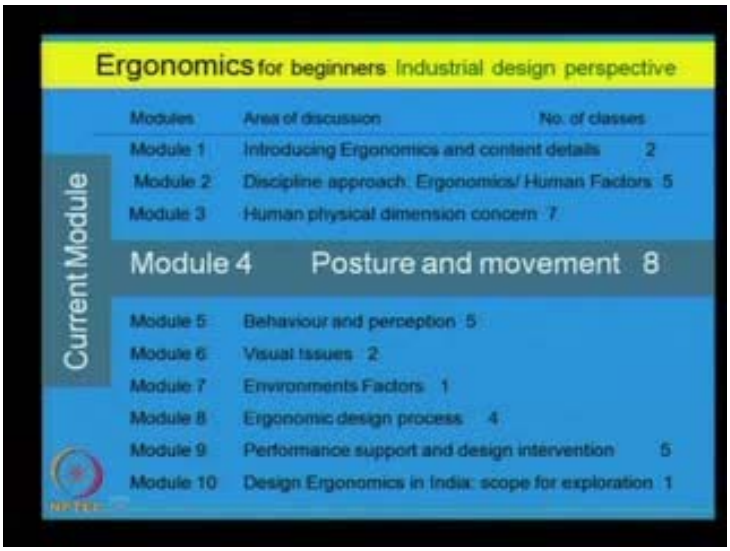

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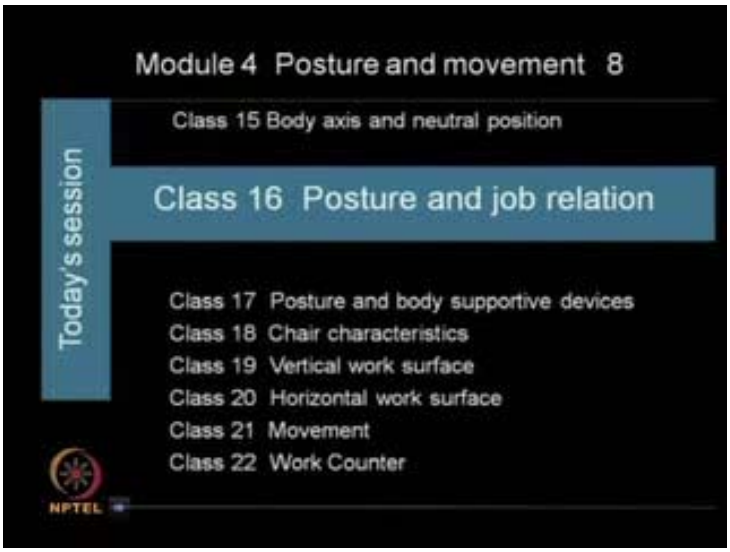

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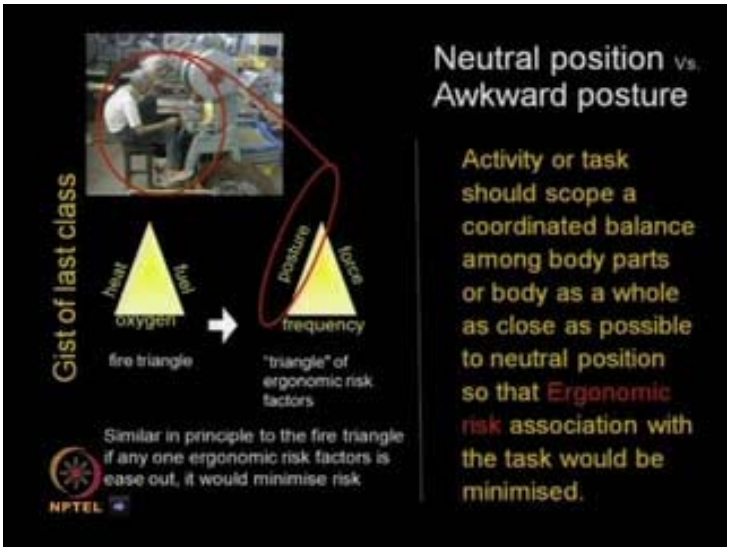

Welcome to this 16th session of Ergonomics for beginners industrial design perspective. Now, the current module is the 4th module that is posture and movement; within this posture and movement, today's session is a class number 16 posture and its job relation. Now, with this, just to recall the last classes, the gist of last class is that or if any work condition, we adopt some posture that is required by the task; and for that we adopt some different awkward postures, for different purposes.

Now, it can be said that like fire triangle, heat oxygen, and fuel, if any one element or in combination, it intensity is reduced, then the effect also reduces; like that triangle for triangle of Ergonomics risk, that the elements are components maybe posture force and frequency.

So, similar and principle to the fire triangle, if any one Ergonomic risk factors is ease out, it would minimize risk. Now, we are discussing this today's topic based on the postural requirement, and how we can improve the posture, and the relation between posture and work output?

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Now, in this, neutral position of body versus awkward posture, adopted for specific task. Activity or task should scope a coordinated balance among the body parts or body as a whole as close as possible to natural position; so that, the Ergonomic risk association with the task would be minimized.

In continuation to the gist of last classes, it can be said that if any movement or force we applied either using a part or the whole article, the direction of force apply application should go with the configuration of the human body, that is, it should synchronize with the human natural movement axis; so that, the maximum mechanical advantage could be achieved.

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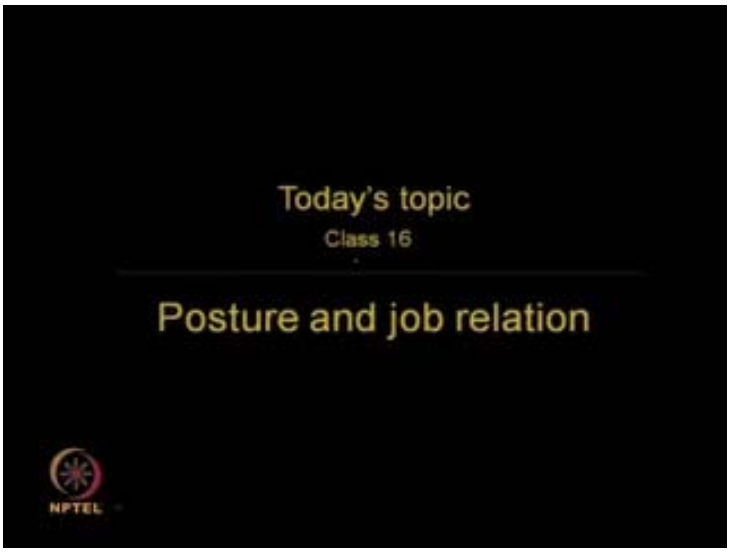

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Now, with this, and continuation, the today's topic class number 16 is that posture and its job relation. Now, the risk factors for any activity, it has shares of tools and equipments and materials: they are design materials availability and its quality. Workstation layout: all the work equipment, and body supportive devices to maintain a certain comfortable posture, and the space in between, and the links of different work components, and human operator or human users, that is the workstation layout. Awkward postures: required to be adopted due to certain problems. Forceful exertion: if someone has to apply force in a specific of posture, that is intensity, these also add to the Ergonomics

risk factors. Then repetitive motion: if a certain task requires to be performed with repetition.

So, to do that task, whatever energy we spend, we are not getting enough time to payback or to complete the date recovery; so, the repetitiveness or repetitive motion, it also adds to the risk. Then duration how long that task is performed in that condition. And the other physical environment, like if the lighting condition is not good or if clear is there, then to do the, to do a certain task, we require more energy or we can say that - it requires some extra effort, and sometimes it also requires postural attention.

So, all the things or the physical environment, like another thing, if suppose in a work area, suppose some heat generating object is there, and but we have to operate on that; so to avoid that heat, body may take a awkward posture, so that to avoid that heating, etcetera. So, all these point impact elements or this factors, they contribute to the Ergonomic risk of work. Now, here we would be discussing mostly on the awkward posture and others relation to that.

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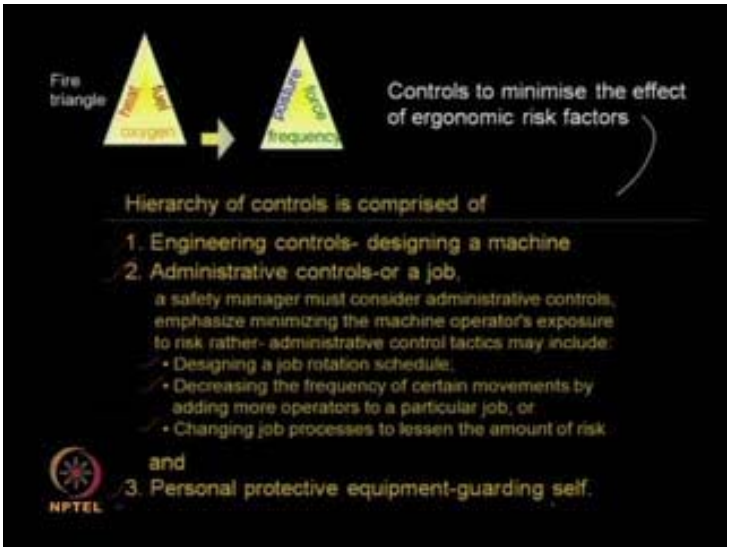

Now, again coming to this same thing that fire triangle and Ergonomic risk triangles; the hierarchy of controls is comprised of three specific areas; the first we can say that - engineering controls that is designing a machine or work tool. Second area is that - administrative controls or a job, meets a safety manager must consider administrative controls, emphasize minimizing the machine operator’s exposure to risk rather -

administrative control tactics may include: like a designing a job rotation schedule; decreasing the frequency of certain movements by adding more operators to a particular job; or changing job processes to lessen the amount of risk. And number third is that personal protective equipment - that is guarding - self etcetera. So, these are the controls can be used to minimize the Ergonomic risk factors.

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Now, Ergonomics risk not only in the production area or in office area, but if we see there are other activity areas, such as in this figure, we can it is showing that the person

himself is putting effort along with bullocks, to pull the cart with loaded cart; so, in this case, the position we can see here, it is not the right position; to give a full force or we can say that - he is controlling these two bullocks movement, with extended arms. So, this risk is there, this body pains, and etcetera, are all will be there.

Now, another area we can say that - the person here in a cycle is carrying coal bags. It is so loaded that he cannot sit on this chair, on this cycle, at the same time, to make it move the posture, he is adopting is a total, is not an very natural working posture or carrying posture. So, he is also adding strength, a force, to make this cycle stand as well as move. Now, when the person requires some rest or this cycle needs to be put on a stand, then the normal stand, here it is not effective; so, he is carrying a bamboo piece here, and this bamboo piece is using as a side stand for this.

So, now, in this if we consider this as an occupation, as a problem area, then this posture how we can improve? To accordingly, the design of a cycle is necessary or a specific accessories, can be added to a normal cycle or a different carrying vehicle to be designing to ease this postural problem, we need to think of it.

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Another example, it can be said the static load; now, natural posture when we see, if we stand we can say that it is close to natural posture, but if there is a load on head, whether that natural posture remains as natural posture or it starts stress on body; so, at the same time, when these girls, them dig sand from the sand pit, so there are complexity of a

various postures movements are there, and while carrying she has to walk here, over the soft sand that gives special resistance. So, to overcome that resistance is from additional load on body comes, so for that what type of design suggestions, can, one can develop that is a good scope of work is there.

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Now, the height of work lab of a platform, and the total task, as shown in this figure, whether it matches with body configuration or the requirement, are needed to be considered. So, the posture, in this case, it is not the simple bending, it is an angular bending is being taken, because of hurriedness and some other privacy purpose of whatever.

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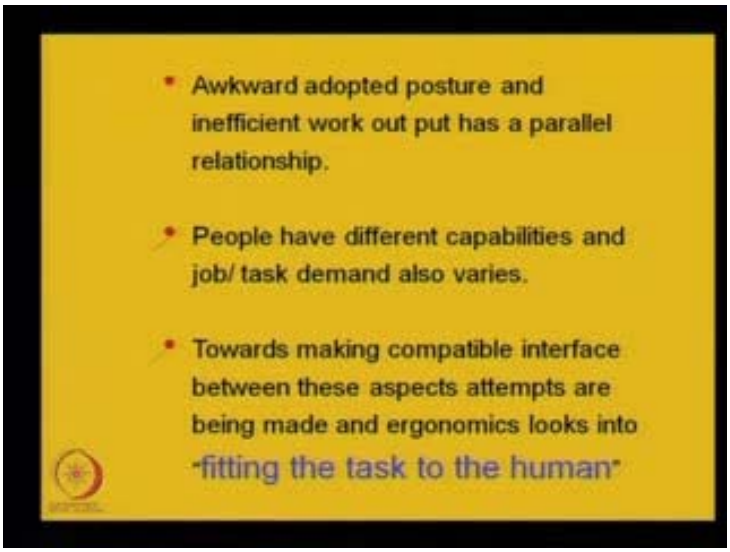

So, with this, it can be said that - the awkward adopted posture and inefficient work output has a parallel relationship. Second, people have different capabilities and job or task demand also varies. Third is that towards making compatible interface between these aspects attempts are being made and Ergonomics looks into it as fitting the task to the human, not like the fitting a man to a job.

In many ways, it is notice that while procuring some furniture or some work equipment, machines, etcetera, we first buy those things, we procure, then we booked in a place, we call it a workplace, then we ask person to work in that; so, that mismatch comes there. So, instead that it will be better, if we can find out what would be the necessity, the likely to be users or operators or workers capabilities?

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And accordingly, if we procure the equipment and build the works place environment, it would be good. Now, different postural adoption or different purposes that is not anticipated; like in this, the furniture probate is here, is for normal sitting and resting, but here we can say that - this lady is talking or using a mobile phone, and for that she is taking a this height of this arm, this backrest as a elbow rest, and so to use that her total body posture being taken in different way; so, it is neither standing nor sleeping, but she is getting a support here.

So, this furniture is not made for these types of postures, but she is adopting it. So, some physical problem may come here, and also we can see that different other sitting areas here, and how people are using, means, when we provide a facility, how those facilities are being used, and for that what type of postures we are adopting, and for as an result what are the Ergonomic risks we are facing, that we need to consider; and accordingly those facilities to be reviewed.

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Another very interesting case is that here the workstation, the seat desk, and the computer monitor, and keyboard, mouse, etcetera, this workstation is meant for an adult person, with his body posture, with his body dimension, and its others, but if other users like the small girl, they also use this facility, then her body structure does not fit with this, but to perform the same task, she has some additional postural stress is coming on this body. So, then what would be the additional support system, one can think of that needs to be considered.

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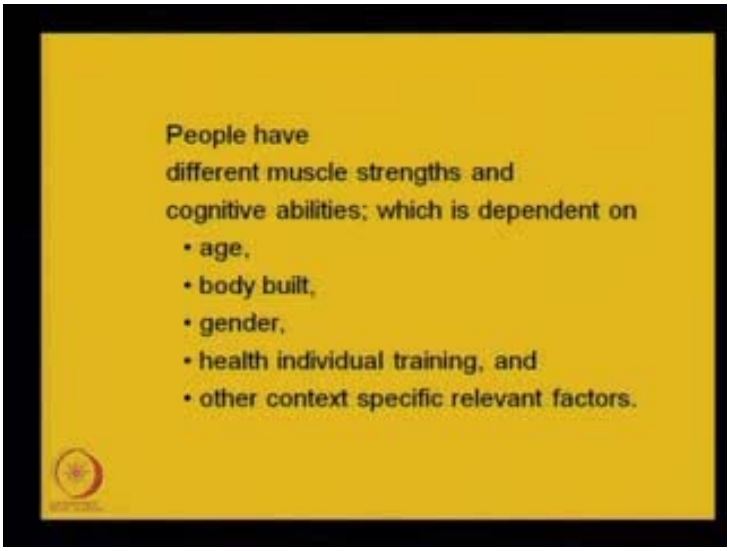

So, with this, we can say that people have different muscle strengths and cognitive abilities; which is dependent on: age, body built, gender, health individual training, and other context specific relevant factors.

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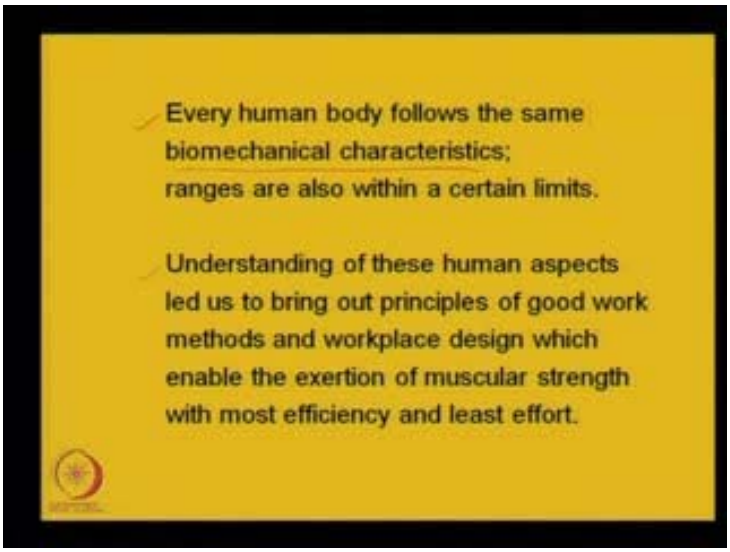

Every human body follows the same biomechanical characteristics; ranges are also within a certain limits. Understanding of these human aspects led us to bring out principles of good work methods and workplace design which enable the exertion of muscular strength with most efficiency and least effort.

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Now, the occupational stress: tea is a very common thing in our daily life, but if we see in a tea garden, how the tea leaf pluckers? They pluck the tea leafs from a tea garden, you get, they have a special a tea bush with a special dimension, sometimes it goes more than 1.5 meter in length and breadth that table; so, while standing in a corner and to reach the end of this tea table, so she has to take a extended arm position, but the load here the plant leaf store is the basket is tied or hanged, with a string or a strap over head, so the total load is here.

So, with that load she is taking this posture, and also in this posture, she has to retain this posture; for sometimes to pluck a certain area leafs, so here the repetitiveness; and duration of this postural hold and the load all are adding to the occupational stress. Now, if we want to reduce or improve this posture, then what can be done studies are necessary in this.

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Now, certain tasks that is not a fixed type work, like for this, in a car repairing shop, these people, they adopt various postures - standing, sitting, squatting, going under the this vehicle, so all these things. Now, a question comes to adopt this posture here, and to do certain task, whether we can give a sitting stool, if we provide a sitting stool here, then the next movement he has to stand up then it is not necessary or if he goes inside then we can have a special trolley, a special trolley we can develop; then this trolley would be a separate thing, this type of stool design maybe a separate tool.

So, like that, as per context we can develop some design, whereas in earlier case, here the task is almost same continued for a longer duration; in that case, the carrying mode can be designed to pluck easily, that from a specific device can be developed; so that, she does not need to stress her body. So, in this case, yes from specific design can be developed, so that many people can use that; whereas in this case for specific task specific type of design is necessary.

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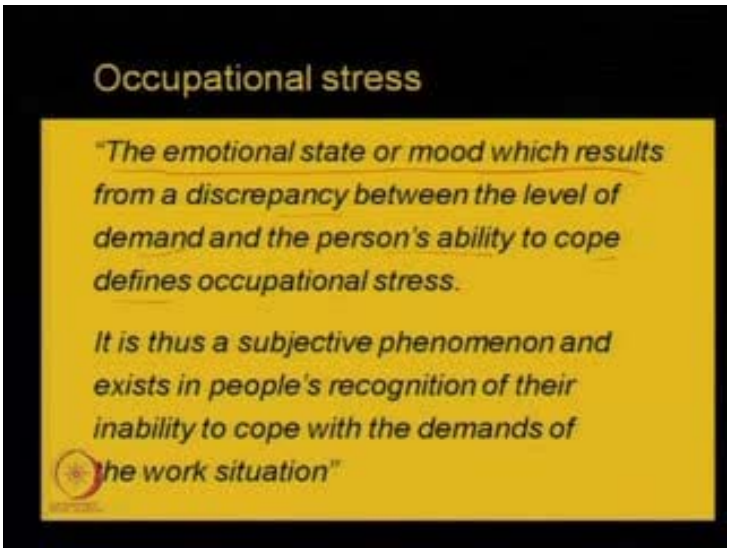

So, occupational stress: it can be said that the emotional state or mood which results from a discrepancy between the level of demand and the person's ability to cope defines occupational stress. It is thus a subjective phenomenon and exists in people's recognition of their inability to cope with the demands of the work situation. It is defined by Kroemer and Grandjean, in their book - Fitting the Task to the Human Taylor and Francis in 1999.

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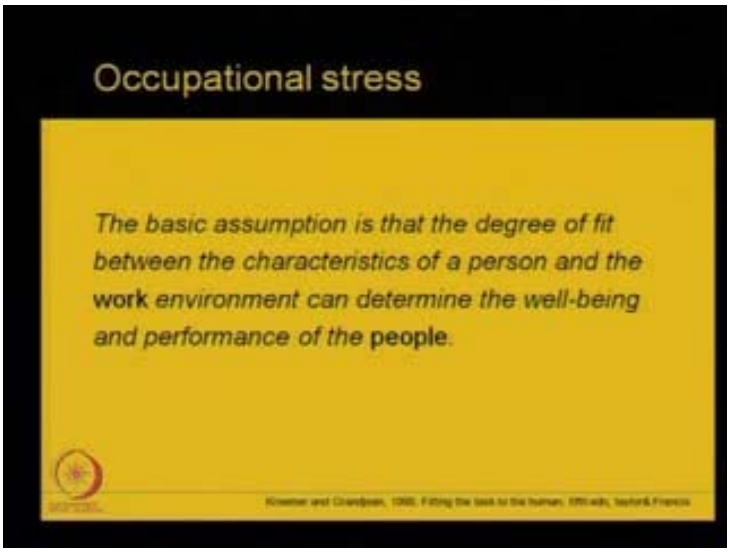

Now, occupational stress the basic assumption is that the degree of fit between the characteristics of a person and the work environment can determine the well-being and performance of the people.

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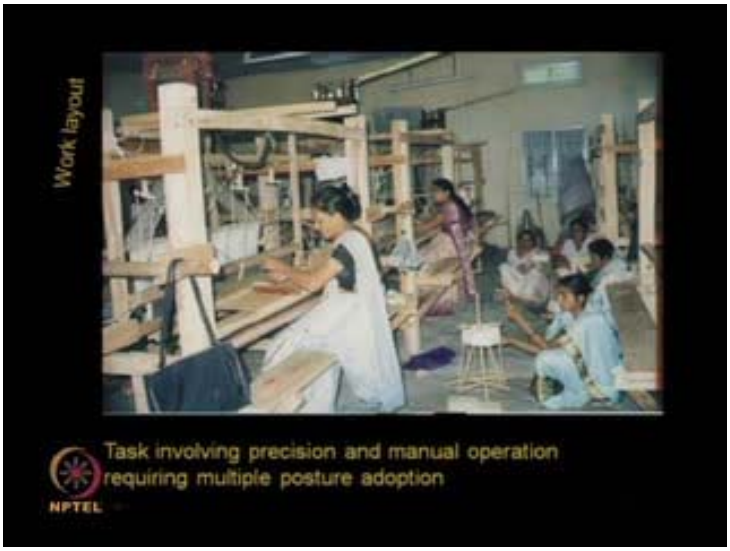

Now, work layout: with this work layout we can say that - if this is a weaving related workplace, where different components of weaving and related work will be performed, at various postures like squatting, heating, and then with a loom the frame, they are sitting like this.

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So, task involving precision and manual operation requiring multiple posture adoption. Another thing, while taking this posture, now it can say that - she has to concentrate on this area, but sitting somewhere here, so it can be say that - the sitting, if this is the male axis, so the variation is there, and she has to operate here. So, many bents at different angles are there, so with that and she also needs some kind of the rest pause, and then some structural support.

So, if it is, if without changing the main loom frame, if the special seating arrangement can be done then it may have a good effect on the body, as well as the performance the productivity. Like if we have a special backrest kind of thing that away from the main platform; so that when she needs to take rest, she can take a backrest. When she needs to bent forward, for activity here we may have a bent here; so that to operate on this table would be easier.

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So, like this some steps can be taken to improve the working posture, the static load; here, the machine has been developed to clean the weeds, this is a moving blade, he has to carry, and here some switches are there, that can be operated to control this movement, but so he has and this is the machine part.

Now, he has to hold this with open arm always and show though he is moving, and the main operation the cutting of operation is done by the machine part, but to operate this machine this person has to hold it, and so a static muscle load is there. So, now, if we can make some probation of, is here holding, so that bringing closer and wider and movement, as per his own, will it would be better. Now, how it can be incorporated in this task? That is good design thoughts are necessary.

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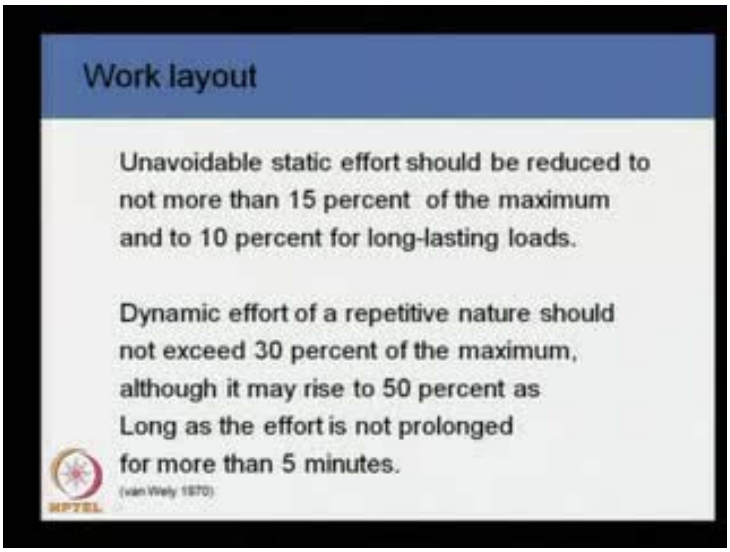

So, work layout: it can be said that static load on muscles led to painful fatigue; that are wasteful and exhausting. For this reason, a major objective in the design and layout of jobs, workplaces, machines, instruments, and tools should be to minimize or abolish al together the need to grasp and holding things. Unavoidable static effort to should be reduced to not more than 15 percent of the maximum and 10 percent for long-lasting loads.

Dynamic effort of a repetitive nature should not exceed 30 percent of the maximum, although it may rise to 50 percent as long as the effort is not prolonged for more than 5 minutes, as reported by manually in 1970.

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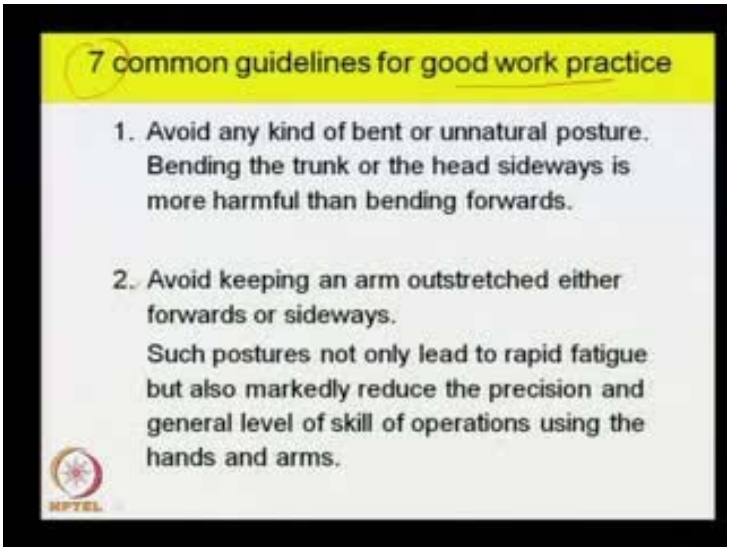

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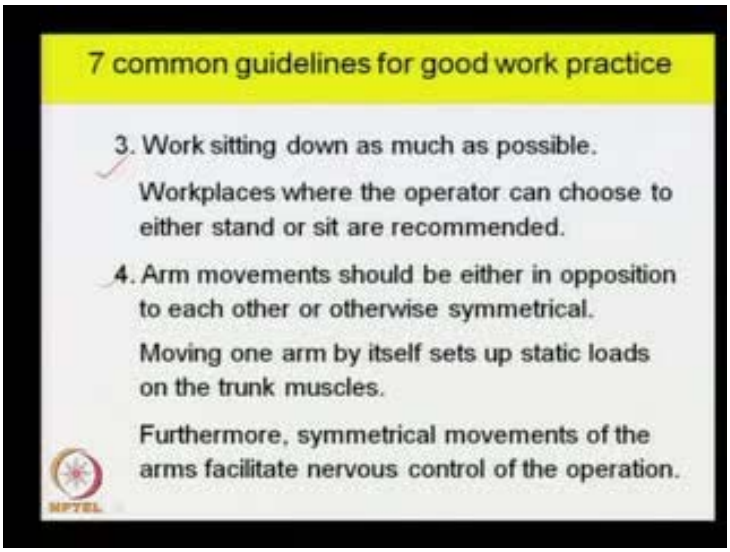

Now, with this work posture various work postures are being adopted here. With this, for good work practice there are 7 common guidelines as per available literature, the 7 guidelines of good work practice it says that - number 1, avoid any kind of bent or unnatural posture. Bending the trunk or the head sideways is more harmful than bending forwards.

So, with these guidelines, the workplace design should be done. Number 2, avoid keeping an arm outstretched either forwards or sideways. Such postures not only lead to rapid fatigue but also markedly reduced the precision and general level of skill of operations using the hands and arms.

Number 3, work sitting down as much as possible. Workplaces where the operator can choose to either stand or sit are recommended. Number 4, arm movements should be either in opposition to each other or otherwise symmetrical.

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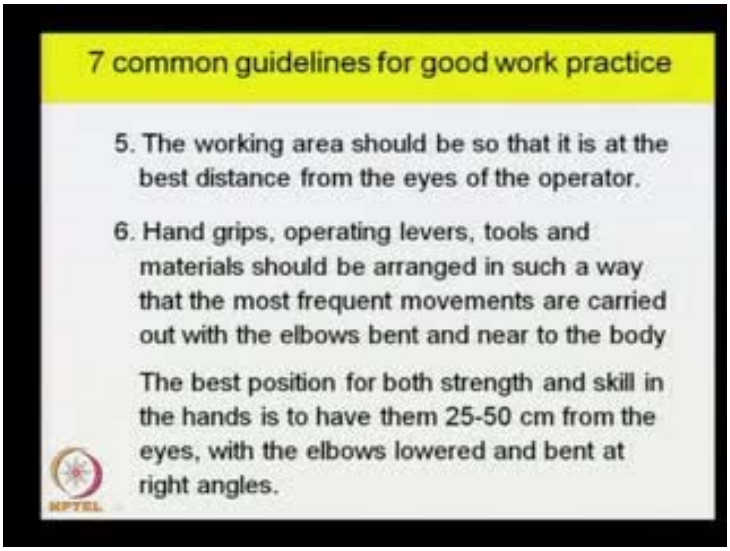

This type of movement one can do, this movement is possible, but one hand forward and one it, it is not possible, does not easier; some control movement that requires, such kind of movement is not advisable. Moving one arm by itself sets up static loads on the trunk muscles. Furthermore, symmetrical movements of the arms facilitate nervous control of the operation. Number 5, guidelines the working area should be so that it is at the best distance from the eyes of the operator. It is saying that from eye minimum distance around 13 to 15 centimeter before that we cannot make any focus; good focus till 30 to 45 centimeter ,we can see is the best; and around 65 to 75 centimeter from eye, we can see it with clear minute reasons. So, accordingly hand grips also should be there; so that come to hand control and vision will go together.

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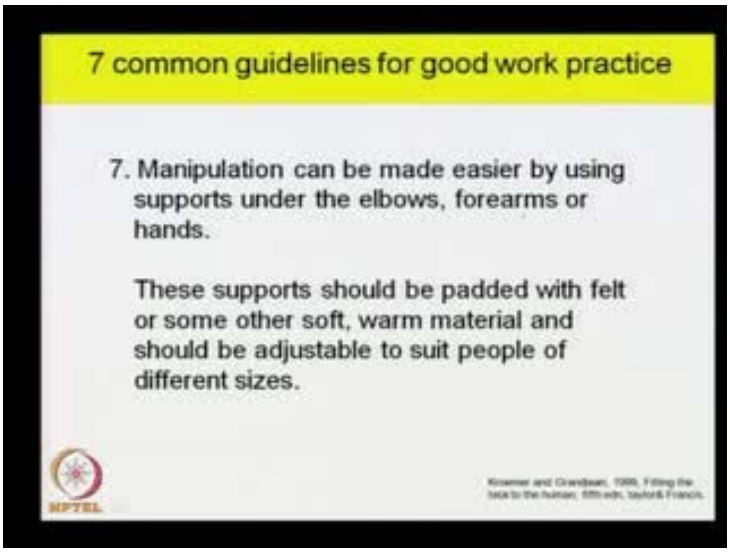

Now, the 6th the guidelines, we can say that - hand grips, operating levers, tools and materials should be arranged in such a way that the most frequent movements are carried out with the elbows bent and near to the body. The best position for both strength and skill in the hands is to have them 25-50 centimeters from the eyes, this is the range - comfortable range - with the elbows lowered and bent at right angles. Now, in the 7th guideline, for good work practice we can say that - manipulation can be made easier by using supports under the elbows, forearms or hands; with a suspended arm, any kind of work activity, it adds with the static load on body.

So, if we have a support either on the elbow or wherever working with this palm rest, it would be better. These supports should be padded with felt or some other soft, warm material and should be adjustable to suit people of different sizes. So, this literature are also taken from Kroemer and Grandjean as they done in 1999 from - Fitting the Task of to the man in addition Taylor and Francis; so, here whatever these guidelines are provided this is taken from this.

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Now, the carry, now simply in this figure, it is said that - to lift and carry the body is taken a special seven arm is at a bending anyway. So, for different body size, gender variation and the strength differ, so what would be the appropriate handle size? Like, in this box, this steering bucket, there are two handles, so to be cover to be carried by both persons, but actually the load it requires per three persons to carry. Then the purpose need, and the intended mode of carrying, if it does not match, then what type of approach or solution to be given? That it requires a context specific search.

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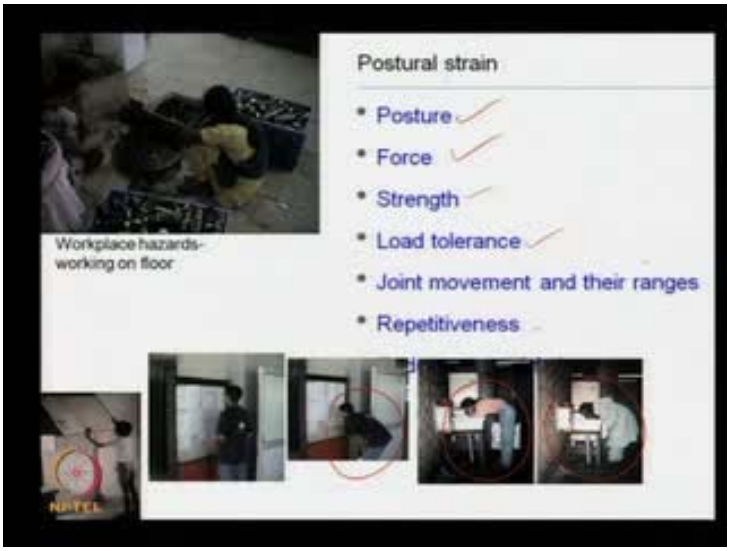

Now, workplace hazards - working on floor, and also in this figure, it is seen that while drinking water, the person has to bend, to bend, here also he has to bend to see a notice board somewhere; so, this is posture he has to take; so, this will be appropriate posture, but to see the lower most position, he has to bend, and for children it is little difficult to see it; so, the purpose remains same that is a reach eye and face.

So, the postural strain is there, now postural strain depends on various postures adopted, the force required, strength, tolerance - load tolerance, joint movement and their rangers, and repetitiveness; so, all these they at the constituents for postural strain.

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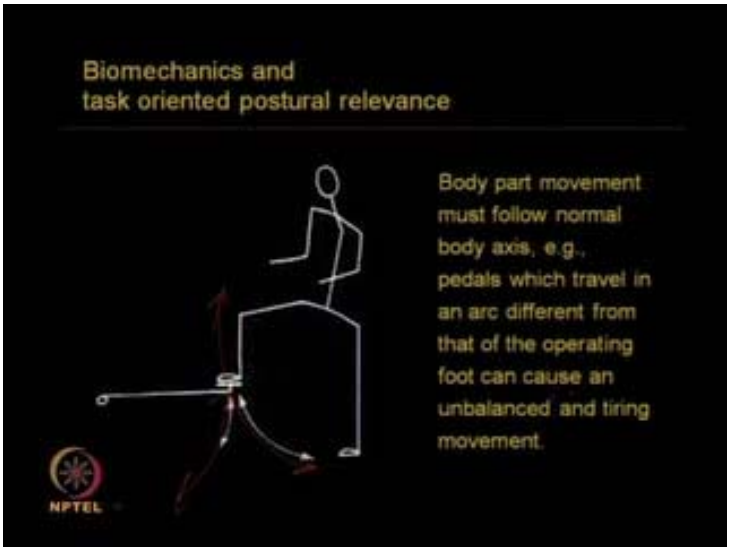

Now, biomechanics and task oriented postural relevance: it is said that - body part movement must follow normal body axis, as for example, pedals which travel in an arc like this person when he is making pressing it our foot movement is like this a foot movement. But if they it requires a different type of approach; then he has to extend the leg.

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So, it does not match with the normal body axis movement like this. So, pedals which travel in an arc different from that of the operating foot can cause an unbalanced and tiring movement, we must need to consider these points. With that, this is a waste cleaning system, where to the same type of benefit are getting from this operation, that is, it follow the normal body axis movement; with this normal body is a movement that pressing this button here, lever here, the box is tilted and can be cleaned.

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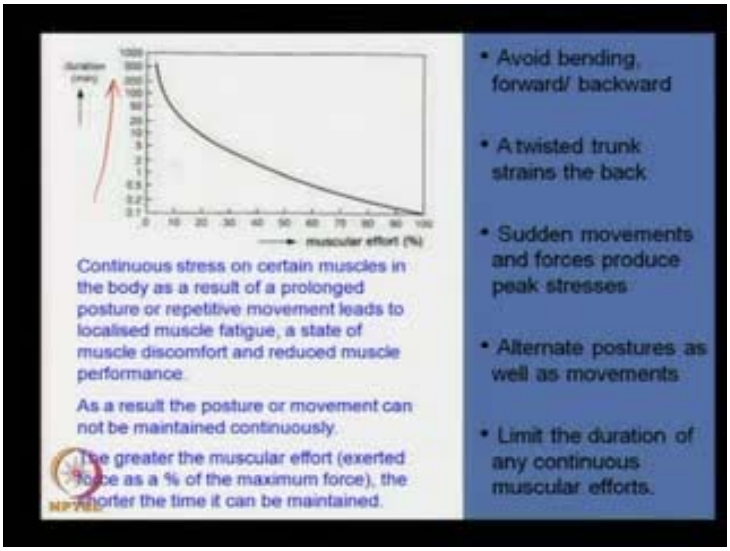

Now, if we see the muscular effort and the posture from literature the study it says that - continues stress on certain muscles in the body as a result of a prolonged posture or repetitive movement leads to localized muscle fatigue, a state of muscle discomfort and reduced muscle performance. Like here we can say that this is that duration in minute from 0.1 to 1000, and here if they master the percentage from 0 to 100, the graph is like this, means, if the muscular effort is more than the duration should be less. As a result the posture or movement cannot be maintained continuously.

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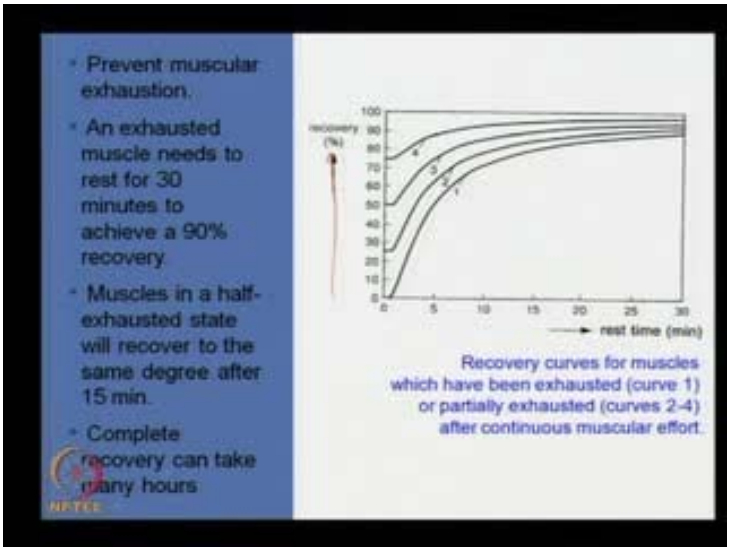

If the muscular effort is more and duration is also more; the greater the muscular effort exerted force as a percentage of the maximum course the shorter, the time it can be maintained. Now, with this we can say that - avoid bending forward or backward; a twisted trunk strains the back; sudden movements and forces produce quick stresses; alternate postures as well as movements if as much as possible; limit the duration of any continuous muscular effort. In continuation, it can be said that from the same literature, the recovery curves for muscles which have been exhausted, that is curve number 1. Suppose, this is the recovery percentage from 0 to 100, and this is from 0 to 30 minutes, the rest time, it says that if the must the rest time is more than recovery is also better.

So, recovery curves for muscles which have been exhausted are curve 1 or partially exhausted curve 2 to 4, after continuous muscular effort in this curve. So, from this, it can be said that - prevent muscular exhaustion, in any workstation or if any awkward

posture, has to be adopted; so, how to we prove it? An exhausted muscle needs to rest for 30 minutes to achieve a 90 percent recovery. Muscles in a half exhausted state will recover to the same degree after 15 minutes. Complete recovery can take many hours.

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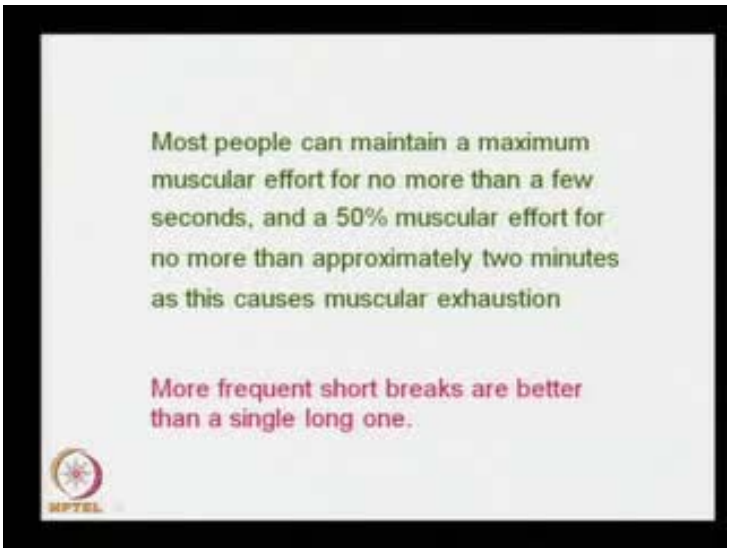

Now, what is a gist of this, most people can maintain a maximum muscular effort for no more than a few seconds, and a 50 percent muscular effort for no more than approximately two minutes as this cause muscular exhaustion. More frequent short breaks are better than a single longer one.

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Now, when we see this figure, here the posture, the task is performing here, the presence of this, it will gives a problem; so, instead that if we can have a pause, it is like this, so you can come closer and kind of done this or this maybe placed somewhere else. So, usability: that use ability the cognitive and physical hindrance; common body movement or position and design features component location and identity to be maintained.

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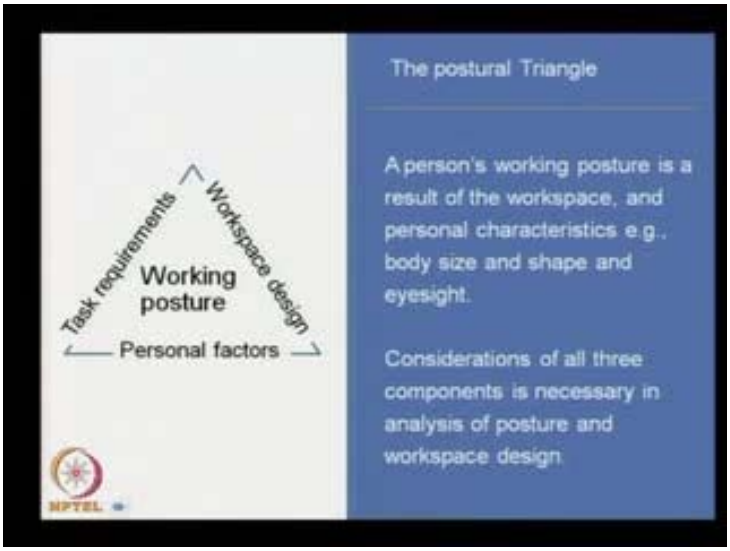

Now, we have discussed the Ergonomic risk factors and triangle, the force duration and posture. Now, here the working posture triangle, the working posture triangle it depends on working posture, on task requirement, workspace design, and personal factors, means, a person's working posture, is a result of the workplace, and personal characteristics, as for example, body size and shape and eyesight, etcetera. Consideration of all three components is necessary in analysis of posture and workspace design.

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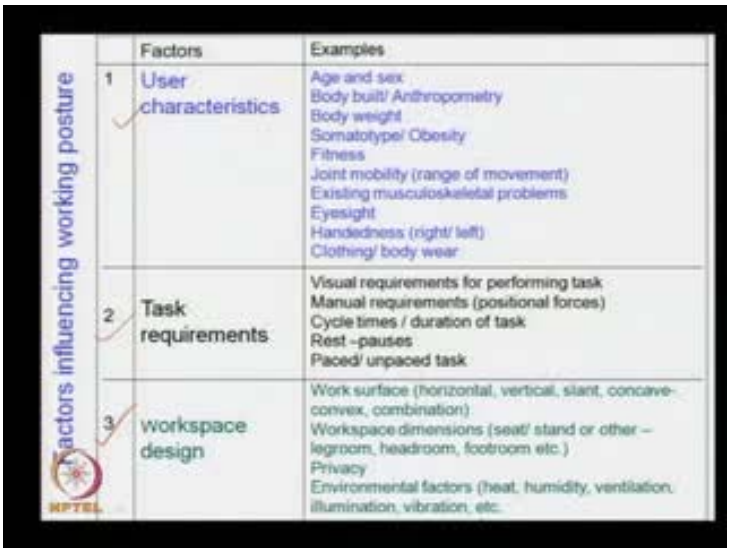

Now, the factors influencing working posture: if we see this table, here the factors and examples, there are three factors specifically, we can say the number one factor, is that, user characteristics, it depends on what so we can say that age, and sex body built and anthropometry, body weight, somatotype and obesity, fitness, joint mobility - that is range of movement - existing muscular skeletal problems if it is there, eyesight right handed and left handedness, if he is right handedness obviously the pro will be on that side, either left handedness accordingly the body posture will be there, and then clothing or body wear, it also affects this.

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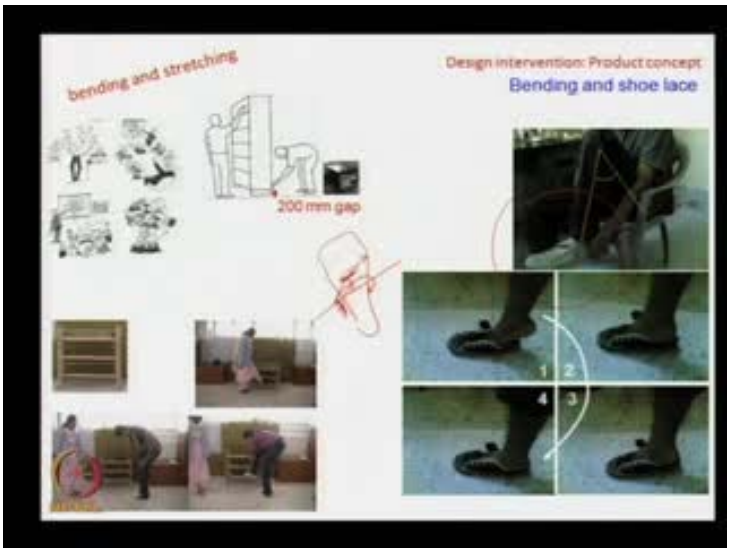

Now, the second we can say the task requirements, that is visual requirements for performing task, manual requirements that is positional forces, cycle times there is duration of task, rest - pauses, paced or un paced task; this continuous task or intermittent task and rest like that.

Number three, that workspace design, for that examples will be, work surface that is horizontal, vertical, slant, concave or convex, or in combination; workspace dimensions that a seat or stand, or others postures legroom, headroom, head space, free space, foot room, etcetera, whether it are there; then privacy is also big factor, based on this privacy some body posture takes place; environmental factors like heat, humidity, ventilation, illumination, and vibration, etcetera, if there is a vibration, then body also may change or stress will also be there.

Now, with this which just we are trying to give one design solution or trial what we made, that while lacing the shoe, in this case, we need to lift our leg and we need to lace something here; so for that, one need to bend and that bending is a problem specifically for older age or when you have obesity, probably big stomach, big abdomen.

So, for that the study after doing the study it say that - normally if the foot is like this way, then lacing here of a shoe, it gives you some problem; so, some kind of Velcro is attached, Velcro maybe fit somewhere here or reverse way, but it is a direct horizontal, so more bending is necessary, but if we can have little in front maybe around 30 degree away, 30 to 40 degree away, then the movement is a then the bending will be reduced.

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So, based on this philosophy some activity is done, some trials here it is seen shown that four types of putting operation, and while opening the shoe here or placing the shoe on a shoe rack, what type of movement it takes, based on this that trials, the strapping trails were made angle of strap. Then some trials were made to develop, what would be the appropriate strap angle, like to determine a comfortable range and position for the Velcro, newspaper strips were used to for this test. A piece of paper was then adjusted as a strap, and then the position of the base of the foot was extrapolated, towards the portion of the sole, above the sole.

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And finally this type of shoe is developed; so that if it is necessary to wear, it is as a chappal type of wear, then we make reverse Velcro; so, it will given an open, otherwise it may come and it can stop somewhere here. So, the shoe says that like that this angular is provided here, this angle is provided here. So, this a, with the posture keeping in mind a product is developed, it is a idea is developed; now, is final design solution is here to be carried out.

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So, advantages of this chappal, is that, it can be used as a chappal too simply, hold the strap to the same side of the shoe as shown alongside, this to make the shoe a chappal like this. This does not interfere with the other parts of the shoe. So, these are the total portion is shown here, that instead of direct vertically, it is just, angularly it is placed like that.

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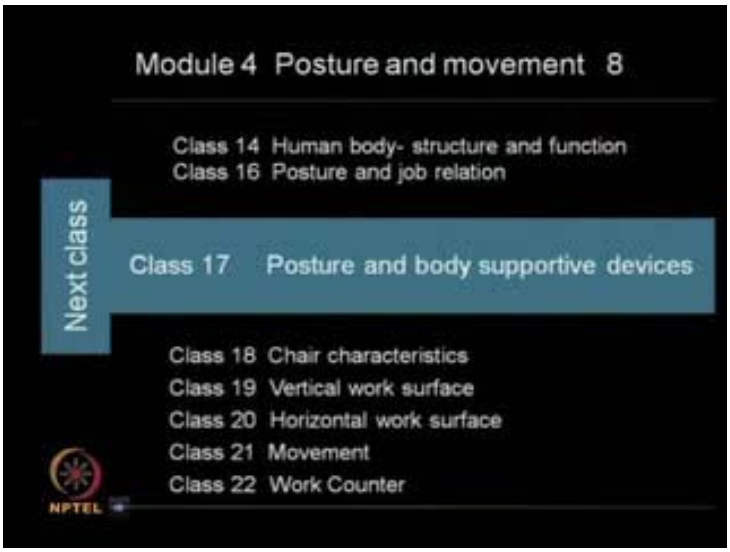

So, with this, we are concluding today's session that is a posture and the job relation and some design of a product possibility. So, next will be the class number 17 that is posture and the body supportive devices, that is maybe sitting standing support or a squat kind of livings our or while walking and etcetera, that stiff type of support or in a motion area, if we need to hold something to keep our body in a fixed position; so that type of body supportive devices, will discuss in next class.