Applied Ergonomics
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Module – 05
Lecture – 22

Hello and welcome to this course on applied ergonomics lecture 22. This is actually going to be one of the last lectures, because after that one of my students who is also the TF for this course will also give you some illustration about different problem solving aspects in economics, for about one and half hours or so. So we were talking about the various joint motions.

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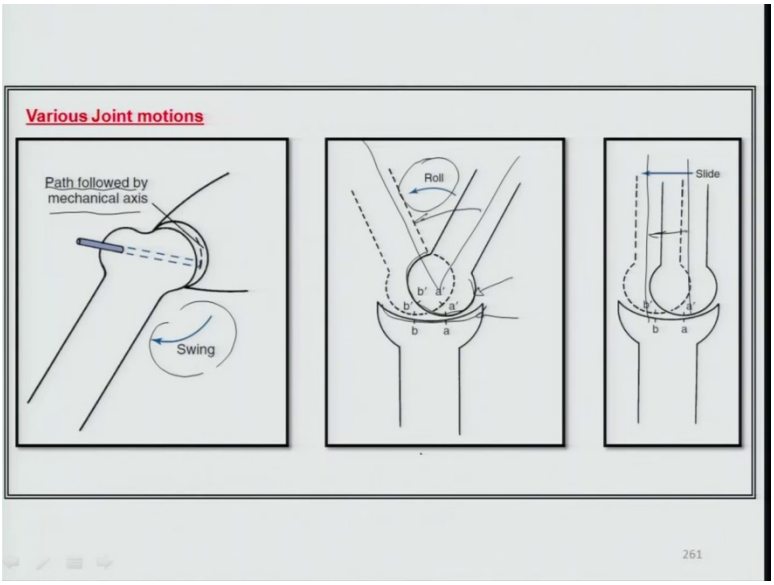

And in income in relation to that we discuss the various motions which were followed of human joint, particularly a knee joint, or an elbow joint. And as you can see here in this schematic the motion of one joint in terms of a swing with respect to the other joint is typically about an axis, the mechanical axis. And the path is followed by a rotation about this axis.

So, if I wanted to look at joint it would simply be comprised of a concavity. And convexity as can be seen here. And then there are two different principal motions which

can be there associated with the how the convexity moves with respect to the concavity, one is a rolling motion where the convexity moves over the concavity by shift of an angle. So, if I could consider the different axis of this. So there is a change of position in respect of these convexity over the concavity here. In terms of a rolling motion or a sliding motion where there is a physical displacement in a certain direction of the again the convexity over the concavity. So, these are the two different motions which are involved in describing the overall joint motion about which such swing etcetera can take place.

So, when we talk about sliding and rolling motions there are of course, different directions associated with this motion. And therefore, they have to be some preset rules which need to be applied for looking at the rolling and sliding motions so that it can give a idea of in which direction it is rolling as a post of sliding.

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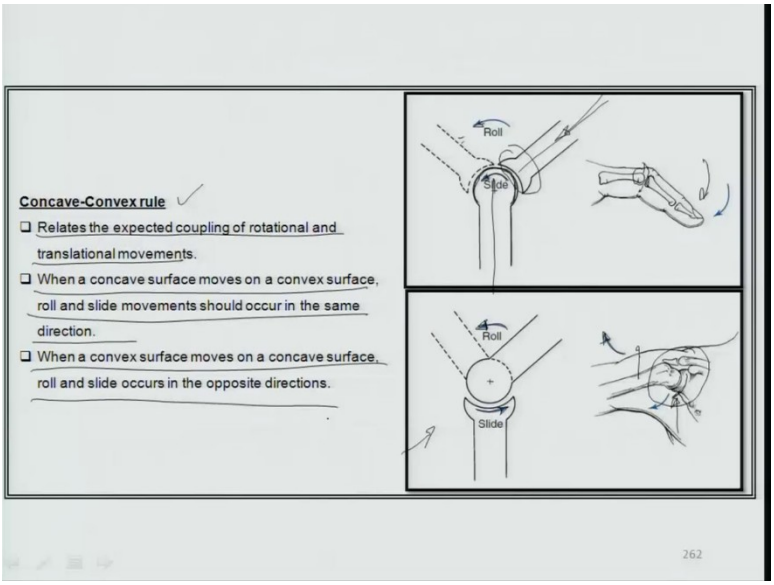

So, let us say we when we talk about you know such concavity convexity relative movements; there are certain rules which relate the expected coupling of the rotational and translational movements associated with such joints. So, if you are talking about a finger joint. For example, so obviously, as a one can see here there is again a convexity which is again going over a concavity or a convex concave portion. And as we are bending the finger downwards basically it shows that both the rolling and sliding motions are in the same direction. Where as if we looked at something like a moment of

convexity over the concavity or let us say if we talk about a shoulder joint here. For example, when the shoulder when the arm is moving upwards let us say the arm has been moving in the upward direction.

So, has you see here that sliding motion can be in the upward direction on the rolling is actually in the reverse direction of that. So, when a convex surface moves on a concave surface the roll and slide would occur in opposite directions.

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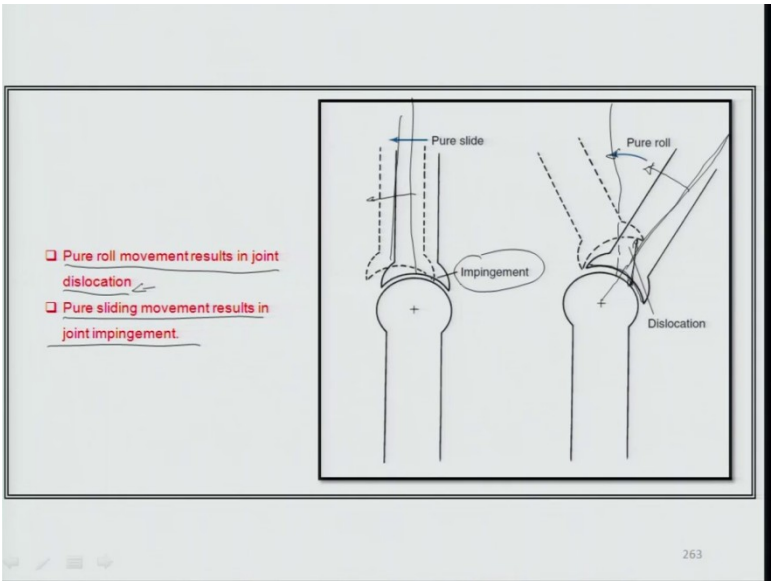

So, such movements or such rules are followed when we talk about one such concavity moving over the convexity or vice versa and this rule is obeyed more or less in all the joints of the human system. So there are also certain constraints that we have to impose otherwise there will be dislocations. For example, if we wanted to just purely roll a let say one joint over one portion of the joint over the other, it may result in joint dislocation.

For example, let us see if you are just rolling about this axis let us say, about the vertical axis let say and then there is a roll rolling motion of this particular joint which has this convexity here about the axis, without any sliding motion then; obviously, there is a separation which happens for the roll to continue in a pure roll manner. If there is no translational motion as such. So, the ideal situation would be that while rolling it also slides over one another so that such distance as you can see here otherwise because of pure roll does not get introduced. So, pure sliding motion can also sometimes result in

joint impingement for example, let say if there is no rolling action and only the sliding action of a concavity over the convexity.

There is always a possibility that there is an engagement of the concave part as you can see from the dotted portion with this convex part of the joint. So, we have So far given a sort of a more like an introductory overview about biomechanics actually the field of the biomechanics has a lot broader than what we have taught here. But because it is an introductory topic in a course of ergonomics. Therefore, I feel that whatever has been described so far has give you, given you sort of a purview of what does the kinematics or the dynamics associated with motions of the various system subsystems of the human body which would result in sometimes giving therapeutic systems as well as engineers and occupational therapist ideas and concepts about work design.

I would now move into slightly different direction detour from applications of from actually study of the fundamental biomechanics to the application of biomechanics. We would like to investigate certain guidelines or design principles which are available for designing sitting posture, as you are aware are aware that in the current context of the work systems the large section of the work systems really works with huge amount of data analytics, or even software development. Where there is a continuous need to sit and work. And so therefore, there are certain guidelines which have been generated from time to time across the world by different sort of you know standard organization or international standardization organizations. Related to even sitting posture because what has been found out that because of this large section of the human factors associated with work system which are related to so called handling large data across you know different computer systems or workstations.

There is a need there is an increased amount of health risk which is posed. And therefore, standard guidance needs to be given to designing of how even a person sits across in order to perform work in such work systems.

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So, the following would be a sort of overall purview of the discussion. So, we will have an overview of the standards particularly which are the organizations, which would provide such guidelines or standards for proper ergonomic design of computer workstations.

We would also focus on some of the inconsistency associated help the risks, which are available you know because of focus studies on some work groups which met such inconsistency of postures. We would also look at some suggestions for the modifications which can be permissible in the ergonomic standards, which are made from time to time associated with such sitting posture designs particularly for workstations. So, if you looked at all the different standardization organizations they almost all have now standards associated with designing of computer workstations. And so, some of the very lead players in this are international organization for standardization there is a guideline which is associated you know, which is actually the largest organization of standardization in organization for standardization in Europe or European countries.

So there is a ISO 9241 guideline which is actually used for such ergonomic designs. There are also national standards, and some Australian standards AS-3590.2 which are dedicated to how workstation should be designed how are different sitting postures, the associated with such workstations should be mandated across people who handle such equipments or work across the globe there also Canadian standards the particular

standard number is given here or American standards. Which are again done by the American national standards institution and there is HFES 100 which are prevalent across United States in terms of implementation for computer workstation design.

So, let us look at some of the posters and associated health risks and also some recommendations, which are made by almost all the standards whether there in any different part of the worlds. So, about the sitting posture there can be a major health issue of back pain associated with how a person sits for the longest time in such a workstation. And some recommendations which have does is that you.

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Now, there should be typically setting up straight or they should be some, you know. So, so there should be some guidelines for how much would be the working height, or how much would be the span of the height up to which this chair etcetera, could be adjusted there could be something related to reclining how much leaning back ward is allowed. There is also some tilt forward which is also allowed and the standards which would be associated with the sitting postures should typically address almost all these issues.

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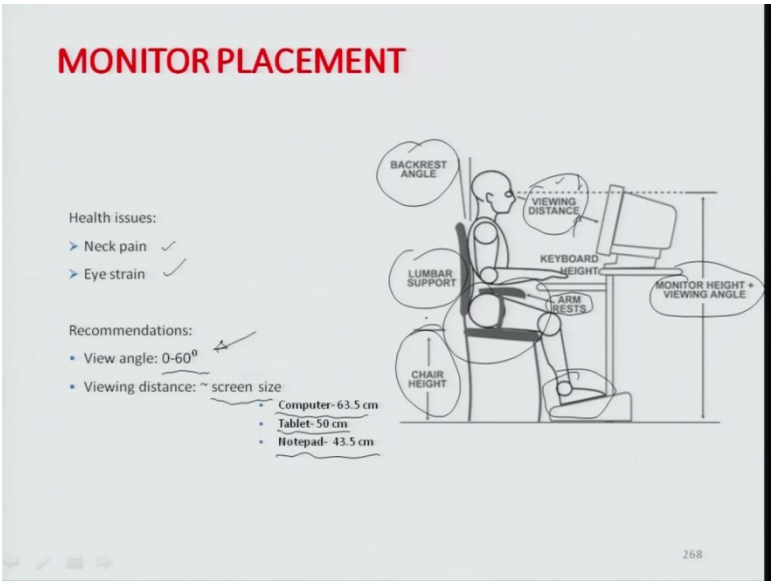

So, when we talk about you know the placement of the monitor, particularly computer work stations monitor. There are certain you know health issues related to that the major two are neck pain and eye strain. And there are certain again guidelines given in terms of recommendations given in terms of what should be the viewing angle what should be the viewing distance. And typically the recommendations that are generated across all these different standards are the viewing angle has been worked out to be most comfortable if it is between zero and sixty degrees. And that is with respect to the horizontal then even the viewing distance should be as good as the screen size. So, for typically computer based work stations is 63.5 centimeters.

For tablets it could be as low as about 50 centimeters or note pads it could be even lower 43.5 centimeters. And so, you know what viewing distance means here. So, if for a computer working professional was sitting in a workstation. You have associated standards with the monitoring or the monitor height, and the viewing angle associated with that a backrest tangle lumbar support you know there is also a chair height associated with such a person. And I will come to some of these recommendations later.

There is also something related to how an arm rests should be designed, or how the feet should be placed typically so that there is no health issue related to continuous use of this poster a certain operator sitting in such a station. So, when we talk about the health

issues related to the designing of the seat pan, right here and again there are severe issues indicated.

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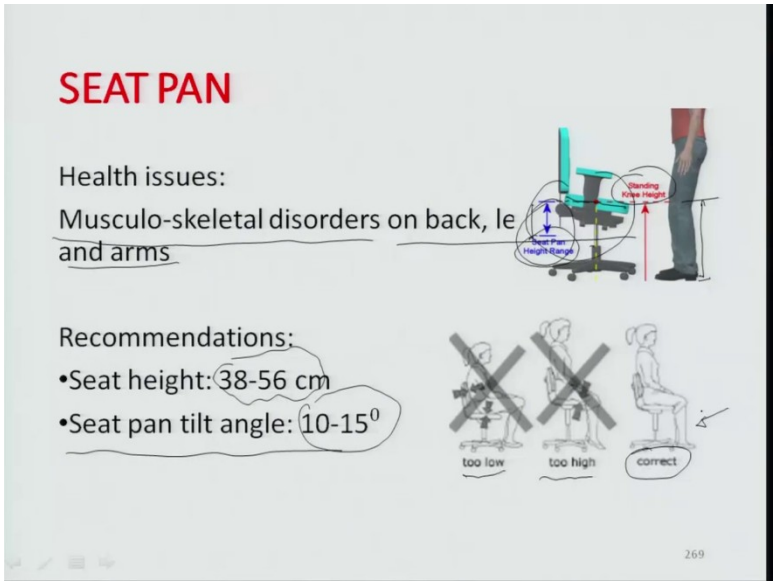

For example, that can be musculoskeletal disorders particularly on back on legs or even buttocks regions or arms of a person who is continuously using if it is not properly designed. And in respect of some of these health issues some guidelines have been setup some recommendations have been given with respect to what would be typically the seat height. So, the seat height range particularly starts from the knee height of a person. So, the standard you know knee height is taken to be the height of an applied standing person from the ground. And so, if I looked at the range of the seat pan height. It is starting from the new level all the way to some distance. And so, that allow distances about close to for the seat pan. The height range is close to about 38 to 56 centimeter.

So, this is in view of normal sort of you know the structure associated with the human factors of a work system. You know the seat height should not be too low it should also not be too high. It should be just about the right so that you have a proper posture and no stressing of the musculoskeletal system, while continually using for a long time or long duration such postures. There also some health issues and some recommendations related to the backrest design.

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For example, If the back rest is not properly designed there may be many health issues, because of inability to support the back in various sitting postures. You know, health issues could be related to again muscular disorders or body pain or you know, pain of the neck particularly. And so, the recommendations are the typically the back rest height should be in the range of 43 to 53 centimeter. This right here is the backrest height or there should be a tilt angle associated with the back rest, which is again varying from 90's degrees all the way to 120 degrees you know. So, this is again recommended for a good sitting posture.

There is also a similar kind of health issues and guidelines associated with the armrest design. So, if the arm rest are not properly designed it will generate additional loads muscular loads on neck shoulder and arms, particularly forearms and elbows, and also put a load to the spine which is definitely very serious matter.

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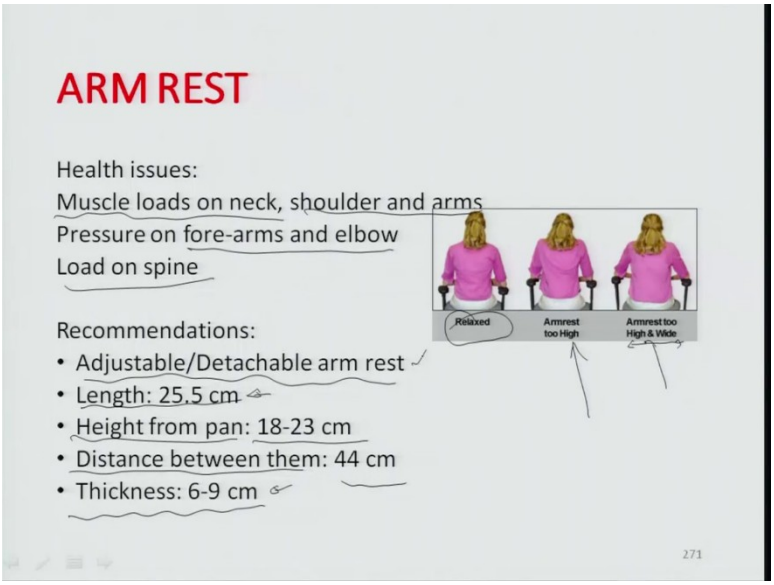

So therefore, there has to be some recommendations in that sense for the arm rest. And so, typically and the recommendations made by all the standard organizations are attachable detachable arm rest. So, lot of study has gone into all this in order to make these recommendations come up by the different standard organizations.

The typical length of the arm rest should have should be about 25.5 centimeters looking at generally the human systems or human factors associated with such work systems. The height from the pan should be about 18 to 23 centimeters of the arm rest, which is typically a comfortable posture for the arm to be just at the proper level. You know, associated with the user of such areas. So there should be something related to where you are placing the arm with respect to where you are sitting. So there is also a distance between the arm rest which spans about forty-four centimeter or So. Looking at all the different the requirements generated by different individuals heavier or lighter. There also thickness related to issues thickness are typically the breadth of the arm rest across which you are resting whole elbow. And so, they should span about six to nine centimeters. And basically you can look at this cartoon here to see how it may make sitting very uncomfortable if the arm rest is too high, or too wide and high in comparison to just about enough So that there is proper relaxation while sitting in this kind of orientation.

So, I having said that I have now retreated certain standard organizations which provide recommendations and the recommendations themselves. So, let us now just change gears little bit and look into what would be an approach that would be needed for in a very participative manner in an organization implementing some of these issues related to postures or you know mechanics associated to the human factors. Obviously, one thing that we realize is that whenever we implement. Something in this direction which is completely new it has to be more like a participatory approach where are you ask the stakeholders the human stakeholders associated with such a work system. What exactly is the problem? And what is their need?

So, once that is recorded somewhere which could be in form of questionnaire, or which could be in form of let us say certain you know associated principles. You can ascertain about what are the requirements in order to make life easier for human factors associated with such work systems.

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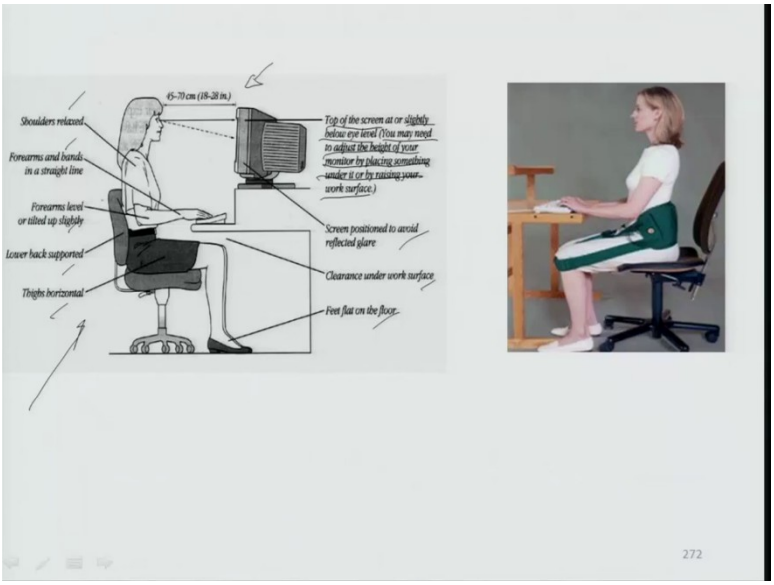

This is a small schematic which represents a sort of an ideal situation of how a person would be sitting in a relaxed manner. Shoulders relax for example, forearms and hands in a straight line lower back supported, or forearms level tilted up slightly or thighs horizontal. There should be sufficient clearance under the works surface, there should be flat feet on the floor there should be screen position to avoid reflected glare. And top of

the screen or slight you know the eye the vision angle or the view in distance could typically go all the way up to the top of the screen.

But it could be slightly given below the eye level, as well you may need to adjust the height of your monitor by placing something under it or raising if you really want to make a comfortable system for handling computer workstations. So, in this particular module we really talk about a participatory ergonomics approach to reduce mental and physical work load.

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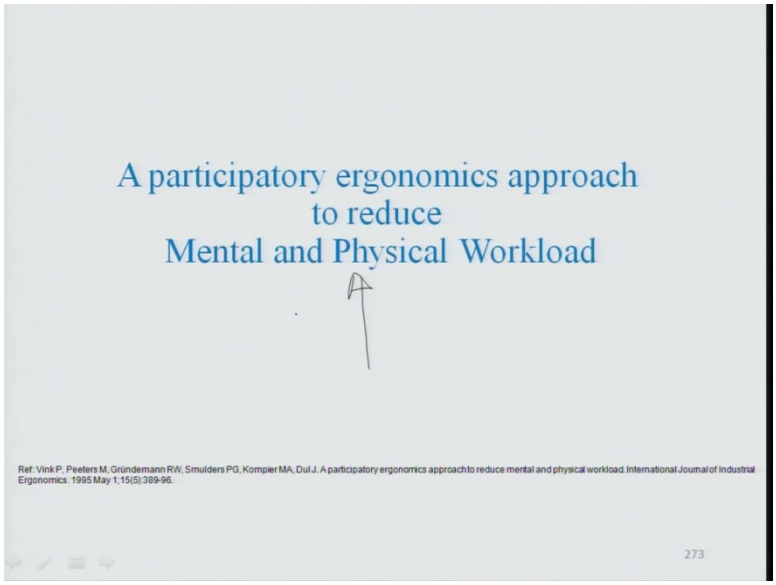

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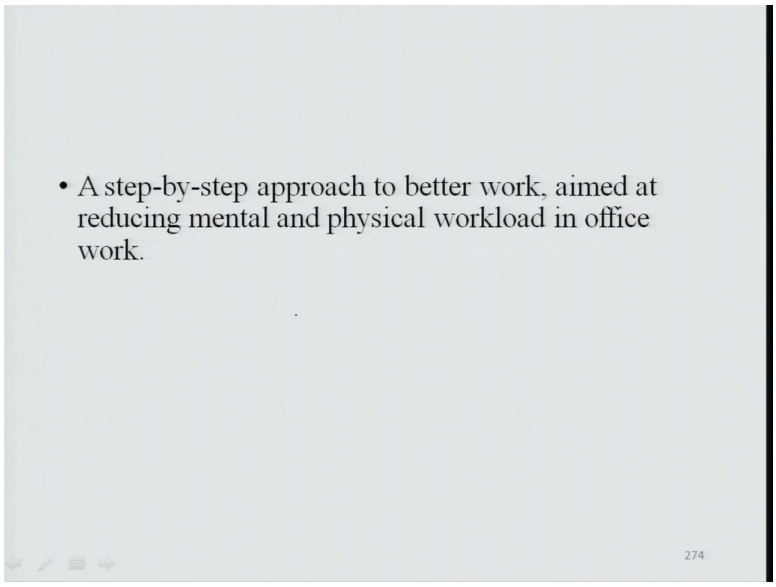

And it is a step by step approach to better work aimed at reducing mental and physical work load in office work situation. You know, there is some kind of an introduction Which is about introducing ergonomic improvements in company which can actually be very difficult.

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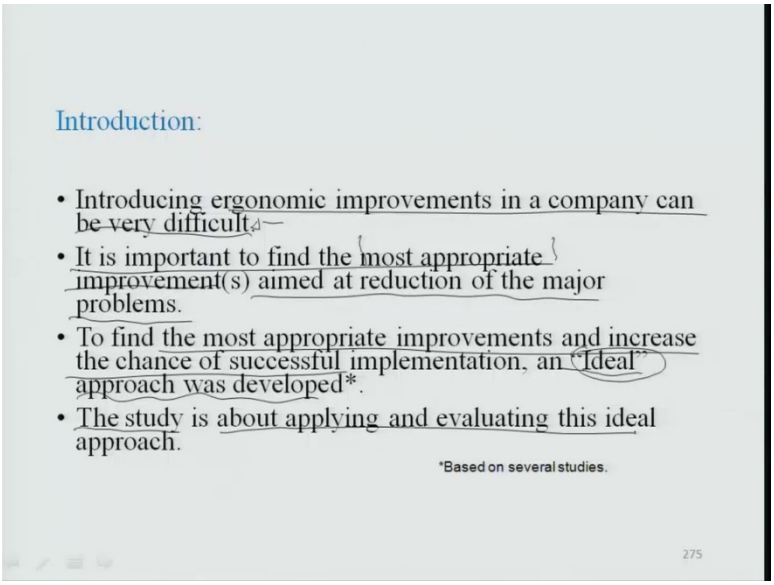

So therefore, someone participative study has to be done which also is known as the preparatory step of implementing certain processes related to such ergonomics improvements.

It is also important to find the most appropriate improvements. Once all the improvements have been suggested by all stakeholders who are human factors in that particular company or work system. So, you address only some of them, not all of them. Because some of them are not very prominent, and they may not really help in reduction of effort much. So, the aim should really be to do a proper job to reduce few problems. Rather than tackling all the problems at one time, also we need to find the most appropriate improvements and increase the chance of a successful implementation. There is approach which has been developed in this particular study where you know we talks about two different sections of people one is a maintenance worker section, another is an agricultural workers section. And then it is studies about what are the problems associated with various tasks with these two different work systems. And some

improvements made and then sort of gives a follow up strategy of what is a level of improvement in associated health risks because of these improvements which are made.

So, the study that is aimed is about applying and evaluating this ideal approach. On several such studies across you know different organizations.

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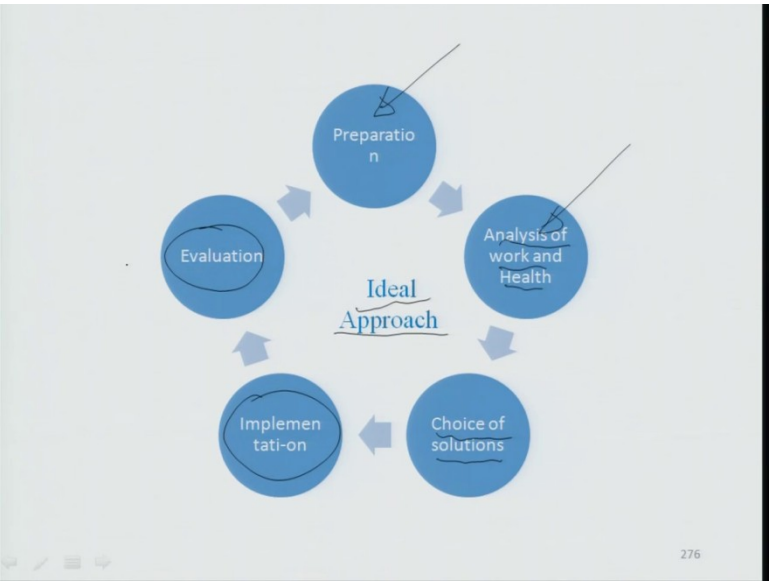

So, typically the approach that is being used in this kind of problems is a preparatory step which talks about finding out the need. The most important needs associated with comfortable work related to human factor. And then the analysis of if the work is done in a proper manner or not can it be changed is there health impact of that work. Because of the posture or the associated elements or task of that work and then can we do something so that they can improve the work in a substantial manner so that there are no potential health risks. And then those solutions which come out because we wanted to avoided the health risks. In order to do the work redesign, need to be implemented. And then after implemented some implementations some evaluation is needs to be carried out to see whether there is an efficacy of what has been implemented.

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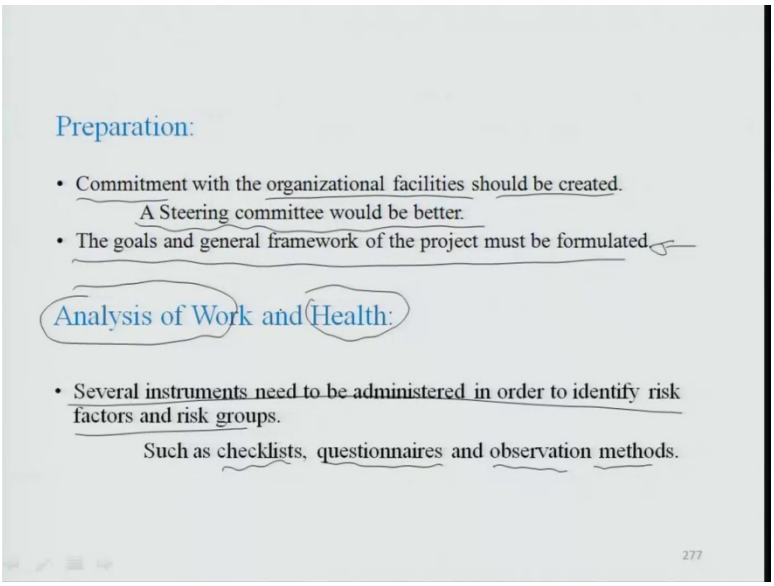

So, typically the preparation step would be in terms of maybe formulation of a committee, which could actually look at this aspect. And it can be a more like a concurrent engineering driven committee where there are participants from all different aspects related to the main work system of an organization. So there has to be some commitment to the organizational facilities that this committee should have in a way. And the goals and general framework of the project must be formulated after the steering committee is made. Then there should be analysis carried out in terms of generating checklist or questionnaires at various levels or even like physical observation methods of the associated task with the work system. Several instruments need to be administered in order to identify risk factors and risk groups. And based on this it will give or result in the complete analysis of work and related health hazards which are available in the various tasks which are intended to perform on a regular basis to maintain the work system in a dynamic order.

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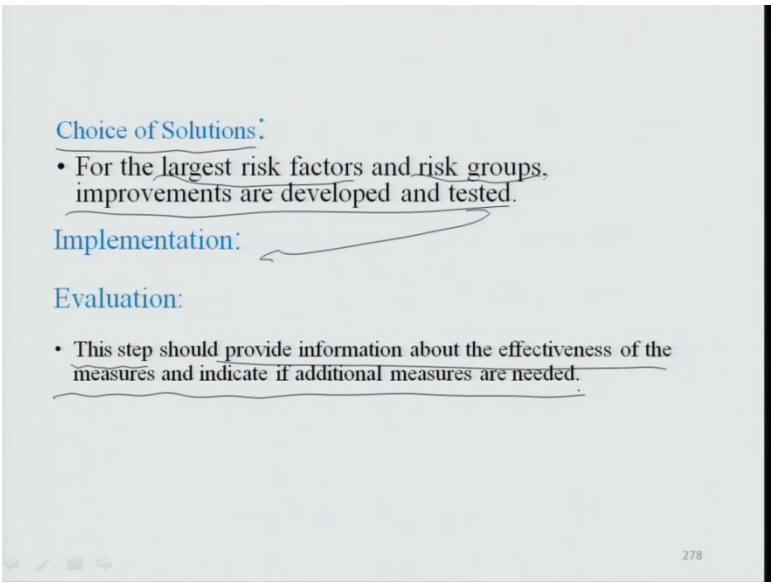

So there can also be choice of certain solutions, which are probably the largest risk factors, which could be focused and removed among the different risk groups. And some improvements can be developed and tested on that, can be implemented and then evaluations step must necessarily provide the information about the efficacy of such measures. And indication of additional measures if needed, in order to have the right set of solutions for such question at driven problem associated with different people of the organization.

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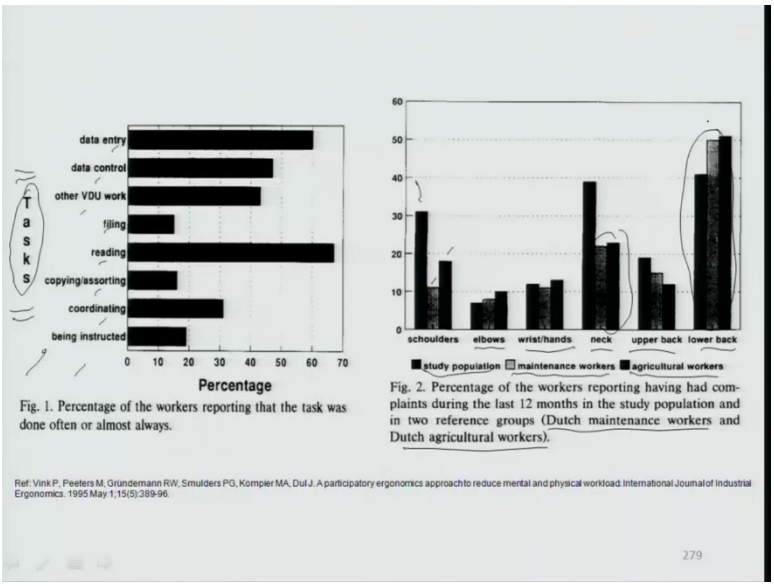

So let us look at some of the data that is associated related to how the steering committee prepare a questionnaire. So, in one of the aspects the questionnaire was prepared. As to what are the kind of major work that you feel are associated with these works? Particularly the work that was in question was for the maintenance workers on the agricultural workers. And generally you know the division of tasks as per the assessment of the people who are directly involved was that task could be related to being instructed or coordinating an event, or copying or assorting, even reading, filing, data control, data entry other VDY work.

So, these are some of the sort of percentages of responses about what are the kind of tasks, where improvement is needed, or from where maximum amount of this posture related problems get generated. And the study population was made the control population here, out of which there was one side which was of the maintenance workers another of the agricultural workers. And what the report is that out of all these different kind of tasks which have been suggested resulting in problems related to health risks. There are problems related to shoulders which is been suggested by the maintenance as well as agricultural workers their problems related to the elbows, wrist, hands, necks, upper back or lower back. And problems could be in terms of pain. It could also be in terms of dislocation damage so on so forth and then you know based on this kind of a study an improvement is sort out of the work place. And it was sort of deciphered that you know out of all these different aspects maybe the nut neck complaints apart from the complaints about the lower back who are actually reasonably important and needed to be solved among these focus groups.

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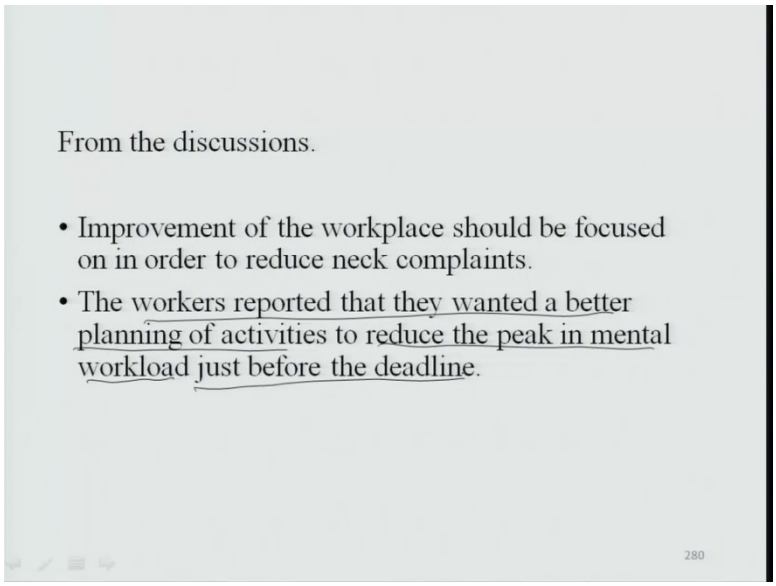

And also the workers reported that they wanted a better planning of activities so that they could reduce the peak work overload. Particularly mental work overload just before the deadline. So, the idea was that if in a plan manner the work could be implemented then such problems would not actually strike or it would not happen. So, about the mental overload what was figured out was that there was not enough information to plan.

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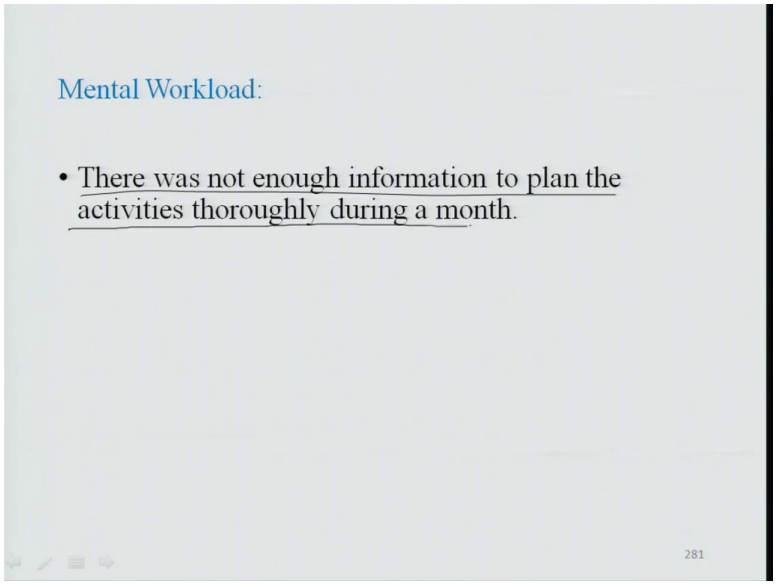

The activities thoroughly during a month and not much could be done about this. So, regarding implementation so after the accessories have the delivered.

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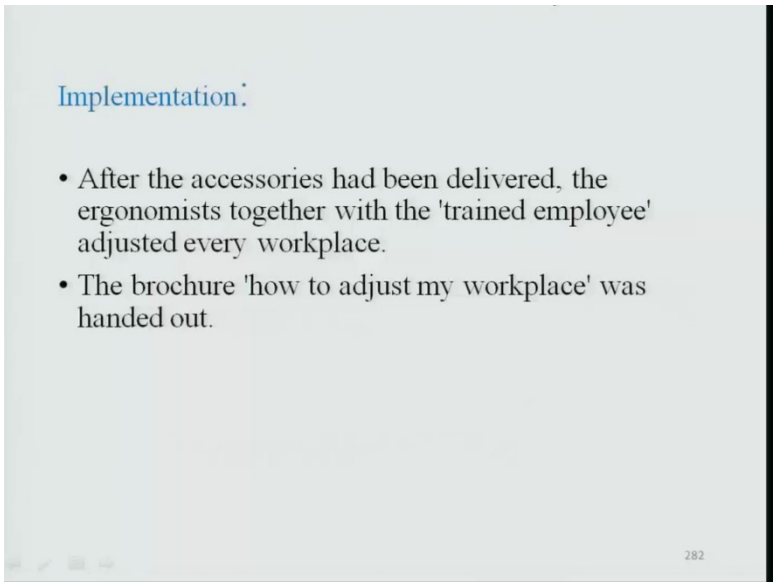

The ergonomist together with the trained employees in the organization, sort of adjusted into to every workplace based on such tasks which were identified earlier. And the associated postures or an associated physical effort. And a brochure was generated to say how to adjust my work place, which was handed out to almost all the people who are stakeholders in that company or human factors in that company.

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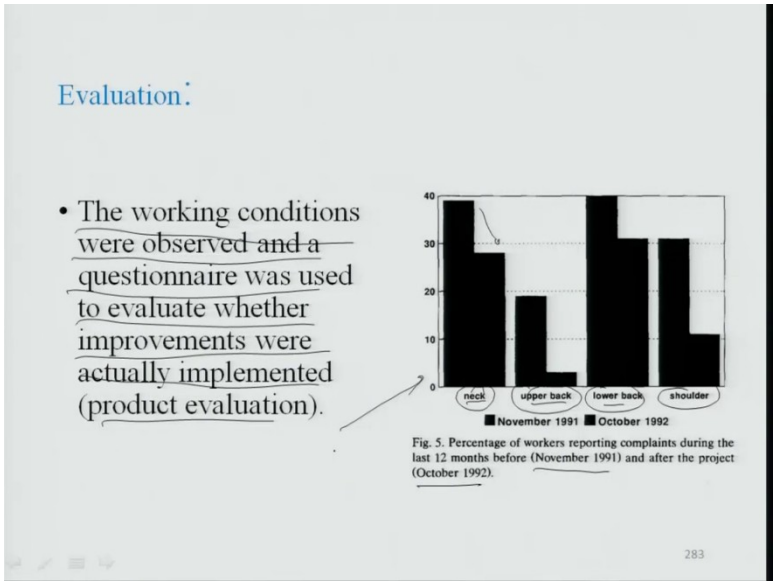

And there was an evaluation made on how much the complaint has reduced related to the different posture related problems. Particularly there was a reduction as you can see in

the neck region and almost all the regions upper back region lower back or shoulder. From what data was given before the ergonomic design was carried out to after the design was completed.

So, the working conditions were definitely observed question questionnaire was used to evaluate whether improvements were actually implemented, and the results so that there was an improvement in terms of percentage of workers reporting complaint. So, definitely this whole process of assessment of what you have done and how it really works out is important for suggesting overall ergonomic improvement of the task structure.

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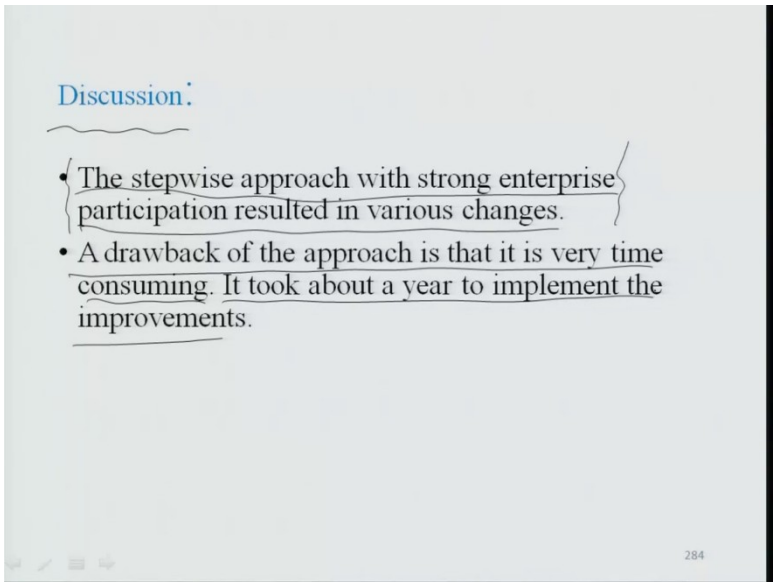

So there was discussion carried out. So, in this step wise approach with strong enterprise and participation resulted in various changes. So, some kind of a participatory involvement of people who are directly working is very important.

So, a drawback of the approach was that it is very time consuming it took about a years' time to implement all the improvements and try to evaluate what was the result of such improvements. And so, this is something that cannot really be eliminated. The best ideas are to keep on doing it on a continuous basis as and when needed so that there are no points point of times where the complaint have So out number that we have to start a fresh.

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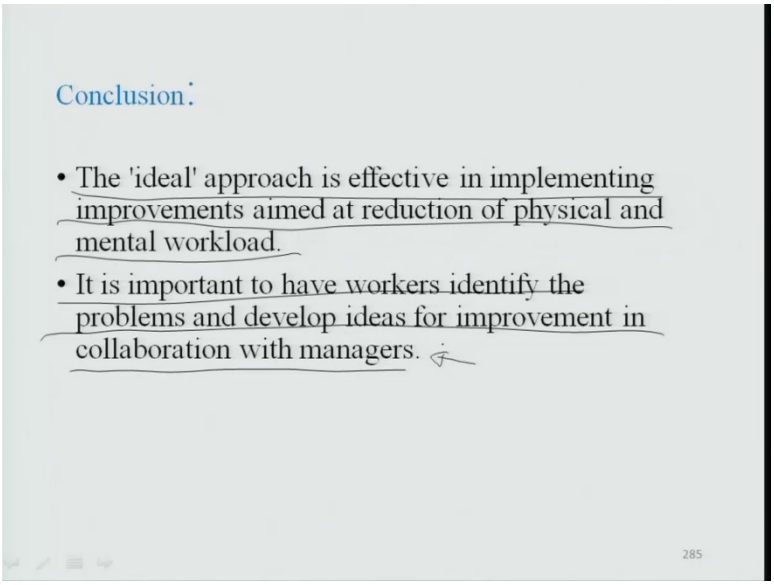

So, it has to be in a continuous space. The conclusion for this is that the ideal approach is effective in implementing improvements aimed at reduction of physical and mental overload. And it is important to have workers identify the problems and develop ideas for improvements in collaboration with mangers for the problems or the solutions to be effective in nature.

So, I think I will just close this discussion here, where I have given you a prospective of some of the internationally laid out standards or guidelines available for proper posture design particularly in computer work station. I have also talked about some basic principle of bio mechanics and then finally, I have talked about a particular case and some real data associated with 2 different kind of workers of a company, who report different problems associated with the disorders of the different body parts, because of different activities carried out during the task. And sort of discussed also a strategy which could be used for eliminating some problem in a very organized manner in different phases.

So, I would like to close the discussion here on this area of applied ergonomics. And the following three lectures would be done by Mr. Sanjay Kumar, who is it also a TA in this course who will talk about different problems on numerical problems associated with a better ergonomic design for workplace. So, thank you very much for being with us.

Thank you.