Work System Design
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Lecture – 27
Principles of Motion Economy

Hello friends, welcome to the session 27 in our course on work system. design and currently we are in the 6th week of our discussion on this topic and if you remember in the previous session we have started our discussion related to string diagram. So, basically we are trying to understand the various tools and techniques that can be used to conduct method study in a systematic manner.

And which are the techniques that we have learnt till date we have understood the operation process chart we know the flow process chart we have seen the multi activity chart we have seen 2 handed process chart, we have seen flow diagrams, string diagrams and today the title is principles off motion economy. So, why we are learning all these tools and techniques because we want to observe we want to record the current method of doing the job.

Or doing the work then we want to examine it we want to find out that can there be a better method of doing the same job. Can there be a better technique which can help the worker reduce his fatigue which can help the worker improve his productivity which can help the worker in improving his efficiency. So, we are trying to learn tools and techniques which are helpful in conducting these types of studies.

Today the title is principles of motion economy and in principles of motion economy there are 3 broad areas in which these principles have been developed very quickly we will try to have a brief review or a brief historical review that how these principles were developed. But before going to that or prior to that we need to understand why these principles have been developed.

So, if we take the example of this recording studio there are 3 important things which are important or there are 3 important things which we need to pay attention. First one is I am as a speaker I am speaking in this studio. So, human body is one thing second is the environment that

is being provided the workspace or arrangement of the workspace for example we have a dais here there is a display then there is a camera then there is a recording room adjacent to this room.

So, this is the work place in which we are working then the third is the equipment that we are operating I am operating this pen with which I am highlighting the things that I want to highlight I am using a pointer I am using it to change the slides there is a provision to change the slides here also I can show you we can change the next slide has come on your screen. I want to go to the previous slide it will go to the previous slide this is the equipment that I am operating.

So, we have 3 stakeholders basically the first one is the human that whenever some work is being done and what is the work the work is the recording of this lecture that is going on or the recording of this discussion that is going on. So, the human body is one part the arrangement of the workspace is another second part. And the third part is the equipment that we are using now if the 3 are in synchronization if 3 are going to help each other.

Or work in synergy the overall output will be better. But if they are not in synergy they are not helping each other for example human body wants comfortable environment bar the air conditioning equipment is out of order so the arrangement of the workspace is such that I am not feeling comfortable. Human body is not feeling comfortable because of nonfunctional air conditioner.

So, there is a repulsive effect between the 2 and therefore the quality of the lecture delivery will suffer or we can summarize that the output will not be as desirable or as desired. So, there has to be complete sync between this 3 stakeholder's equipment for example I want to highlight something on the dashboard or maybe on the display board but the pen is not working. So, the equipment is faulty I may not be able to explain the things in the better manner.

So, all these 3 things have to function in synergy so what are the 3 things once again the human body, the workplace arrangement and the mind that we are using. So, the principles of motion economy focus on these 3 things that is the use of the human body then the arrangement of the work place and the designs of 2 lined equipment. Must be such that the other kind of feels

comfortable in performing his or her task.

So, if all these 3 things are taken care of or if we follow the principles which have been laid out for the arrangement of the work place for the use of the human body for the design of tools and equipment automatically the system will perform better and in todays session it is difficult to explain each and every principle. So, I will read the principles for you there are a number of examples available in various books.

We have to summarize this topic in half an hour so that is difficult from the point of view of explaining each and every principle with the helpful of an example. But as a learner you must know that what is the importance of principles of motion economy in the design of the work system. We need to design the workplace in such a way that the human body feels comfortable and the equipment that the worker is operating also helps him in achieving his target.

Or achieving his objective or completing the work in the most economical and efficient manner. So, how the principles of motion economy were developed let us quickly go to that.

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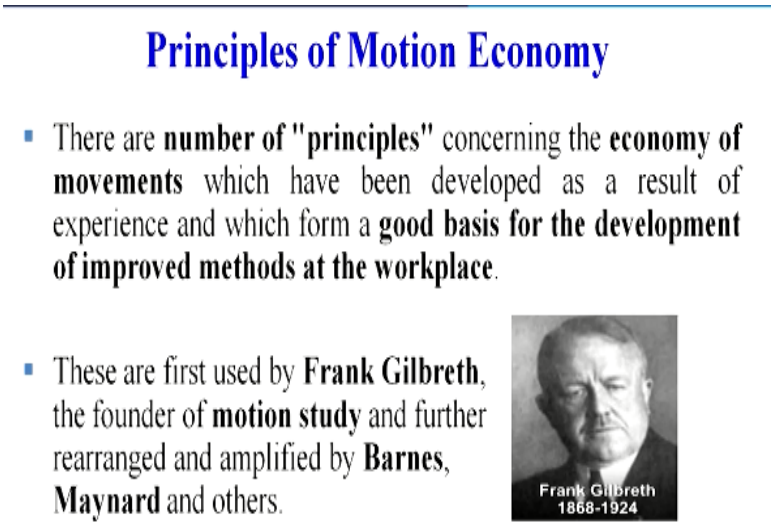

So, there are a number of principles concerning the economy of movements so before going to the economy of movements let us first focus on principles all of motion economy. If we go by the literal meaning of this, it means that we want to economize the motions being done by the

worker we want to optimize we want to maybe set the optimal combination or optimal sequence of functions.

Or optimal sequence of motions which will help the worker to complete his or her to task. So, we are trying to economize the motions and these principles will help us in that objective. So there are a number of principles which we will see in the subsequent slides concerning the economy of movement. So, we want to economize the movement that maybe the movement of the hands of the movement of a limb or the movement of the worker.

Which had been developed as a result of experience and which form a good basis for the development of an improved method at the workplace. Overall objective is to find out improved method at the workplace. So, again I will read this image is an important sentence there are a number of principles concerning the economy of movement which have been developed as a result of experience.

Which form a good basis for the development of improved method at the workplace. So, these are the principles which have been developed with lot of experience and who are the people who were responsible for the development of these principles these were first used by Frank Gilberth the founder of motion economy and further rearranged and amplified by Barnes and Maynard and others.

So, there are number of researchers in the world who have used their experience who have used their intellect to develop these principles and these principles form a sound we can say background for improving the current method of doing the work. So, if we follow these principles and analyze the current method certainly they will guide us they will advise us in the right direction.

And if we use this principle we will definitely be able to economize the movements of the worker in the shop floor.

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Principles of Motion Economy: Introduction

- Motion economy **helps to achieve productivity and reduce cumulative trauma** (excessive wear and tear on tendons, muscles and sensitive nerve tissue) at the workstation.

- The principles of motion economy **eliminate unnecessary motion, ease operator tasks, reduce fatigue and minimize cumulative trauma**.

Now motion economy helps to achieve productivity and reduce cumulative trauma we will see this cumulative trauma thing in slightly more detail in the subsequent sessions. So, what is cumulative trauma it is excessive wear and tear on tendons muscles and sensitive nerve tissue. So, if we follow these principles all these things that is cumulative trauma that is experienced by the worker doing a repetitive task again and again that can be minimized.

So, motion economy helps to achieve productivity and reduce the cumulative trauma is resultant of the reputed to have work being done by the worker on the shop floor. The principles of motion economy eliminate unnecessary motion. So, unnecessary motion is avoided ease the operator task so the task operator is doing becomes easier reduce the fatigue and minimize the cumulative trauma which we have already seen.

So, the cumulative trauma is avoided so we can see what do we are gaining eliminate the unnecessary motion, ease the operator task, reduce the fatigue and minimize the cumulative trauma. So, there are a number of advantages if we follow the principles of motion economy what are these that we will try to understand in the subsequent slides.

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Principles of Motion Economy: Introduction

- The principles of motion economy are **guidelines to be used when examining and designing workstation** and **workplace layouts**.
- The principles are based on a combination of simple **ergonomic principles** and **common sense**.
- They relate to both, the design of the **workplace** and the design of the **work**.

The principles of motion economy are guidelines to be used when examining and designing the workstation guidelines to be used when examining and designing the workstation and the work place layouts. We can see that when we have to apply the principles when we are designing the workstation, when we are analyzing the current method which the workers are following sometimes we may be able to observe the worker that how he is doing the task.

Is it in line with the principles of motion economy if there is a discrepancy we can advise the worker there no this is not the right way of performing this task. As per the principles of motion economy you must perform the task in this standard manner or we can try to help the organization in changing the layout or we can help the organizing organization in changing the workplace environment.

Maybe we might like to advise them regarding the illumination there they illumination is not proper we must put additional light so that the worker is able to work efficiently. So, basically these will help us in designing our workstation. The principles are based on the combination of simple ergonomic principles and common sense so that is what are the basis for developing this principle.

The first is ergonomic so that is how to expand our energy in the most economical manner that is one guideline that we must try to economize the energy being expanded by the worker who is

performing the job or at the workplace or on the machine. These are related to both the design of the workplace and the design of the work. So, we can focus on both we can focus on design of the work place we can also focus on design of the work.

So, both can be achieved or both can be targeted using the principles of motion economy. So, I think the things are slightly getting maybe more theoretical so if we jump on to the principles you will be able to appreciate that yes these are the principles if we follow them then automatically the objectives that are there that is the operator, the work becomes easier for the operator.

The workstation is designed in the most economical manner so we have seen unnecessary movements are avoided, the cumulative trauma is avoided. So, when we look at the principles you will automatically start to realize that yes if we follow these principles certainly the work will become easier and enjoyable for the workers. Now basically the principles of motion economy are divided into 3.

So, I started the todays discussion with the 3 major elements of any work that is being done with the example of this recording studio.

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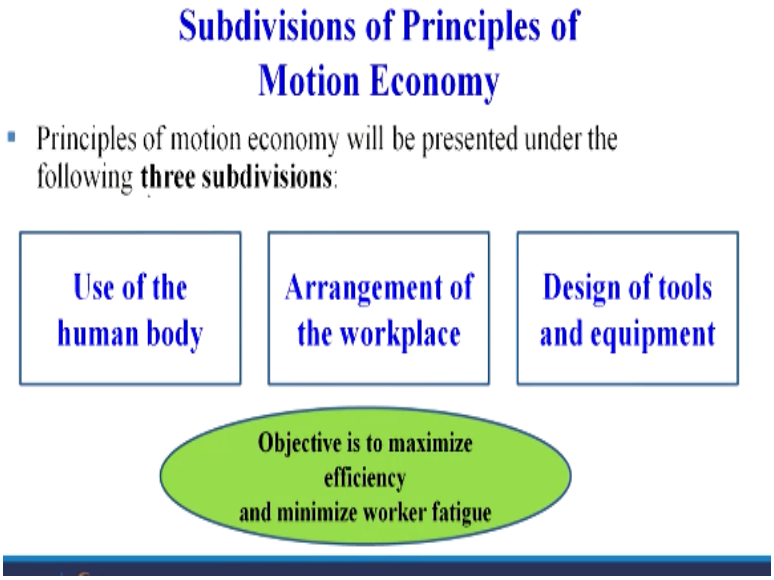

So, again coming back to that what are the 3 subdivisions first one is the use of the human body

second one is the arrangement of the workplace as I have taken this as arrangement of the workplace, third one is the design of the tools and equipment as I have shown that I can change the slide by pressing the point here also or I can change the slide using this pointer also this is a equipment which has been given to me to deliver this session.

So, this is a workplace equipment and the human body so when we are trying to optimize the work being done or when we are trying to redesign the work being done when we are trying to find out the better method of doing the work these are the 3 important things on which we have to focus. Now let us see one by one. First one is the use of the human body what are the principles that have to be kept in mind when we are designing the work for the worker. So, how the human body must be used when we are performing that task let us see here.

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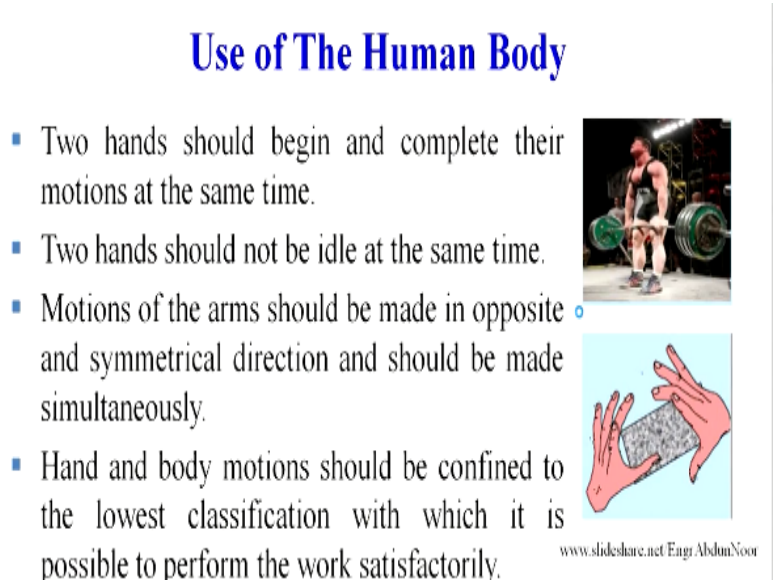

If you this is a good example given your use of human body weight lifter is lifting the heavy load. So, if you can see that there is a standard technique by which the lifter must lift the load if he falters or if there is a mistake it may lead to a very heavy injury also or maybe a very severe or injury can be there. So, that can be avoided if you follow the protocol if you use your body in the prescribed manner only.

So, as per the principles of motion economy we can see that 2 hands must begin and a complete their motion at the same time this is the first principle. The 2 hands are being used for conducting

a work so they must start and finish their motions at the same time 2 hands should not be idle at the same time. So, if you see I am recording this lecture if my one hand is at rest the second one I am you using to highlight what we are discussing.

So, the 2 hands must not be idle at the same time when the worker is on the shop floor his both hands must start and finish at the same time and at any time one hand must always be working. Motions of the arms must be made in the opposite and symmetrical direction and should be made simultaneously. This is another guideline regarding the motion of the arms if you remember we have taken an example of the assembly of nut and bolt.

With the 2 hand process chart so there you can see when a person is going to assemble the nuts and bolts how his human body must be used what type of motions must be given to both the hands. There must be symmetric or unsymmetric whether it must be a ballistic movement or a slow movement. So, all those principles can be listed here or listed here the third point is related to the movement of the arms.

The motions of the arm must be made in opposite and symmetrical direction and must be made simultaneously hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily. So, we can hand and body motions must be confined to classification means wherever we find our hands to be comfortable. Now suppose I am standing here this is my own perception about the lowest classification.

Now suppose these are the as per my height this is the level of the dais I feel I am feeling comfortable. Now suppose this is there at this level I may not feel that comfortable putting my hands like this. So, we must try to adjust the hands of the limbs or the body in its lowest class hand and body motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.

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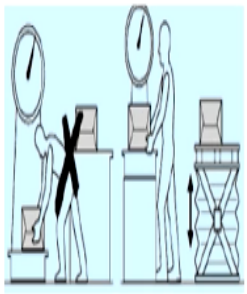
Use of The Human Body

- Momentum should be employed to assist the worker wherever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
- Ballistic movement are faster, easier and more accurate than restricted or controlled movements.



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Then momentum should be employed to assist the worker wherever possible one of that examples can be that when you are running a sprint or a fast 100 to 200-meter race or a quick race of 100 or 400 meter usually you will see that there is a starter equipment which is used by the runners. So, it gives an impulse or it gives a start to the run or to give them momentum to the runner to have a quick start.

So, that those type of equipment if possible can be given at assistive devices to the worker so that it can help them to perform their task in a better manner and reduce the fatigue. So, the momentum must be employed with his to the workers wherever possible and it should be used or it should be reduced to a minimum if it is it must be overcome by the muscular effort. If there is an opposite effect happening, then it must be avoided.

Ballistic movements are faster easier and more accurate than that restricted or controlled movement. So, if we see if we controlled movement means if I have to keep my hands straight like this or stretch controlled movement I will feel more fatigue or more tired after some time. But if it is a random movement I am putting my hands randomly and hands on somebody shoulder it is kind of curved movement.

So, my hand may not get tired that easily so basically the curved movement or the ballistic movement if we are picking the things in a ballistic manner is easier. But if I do it slowly maybe

it is more tiresome.

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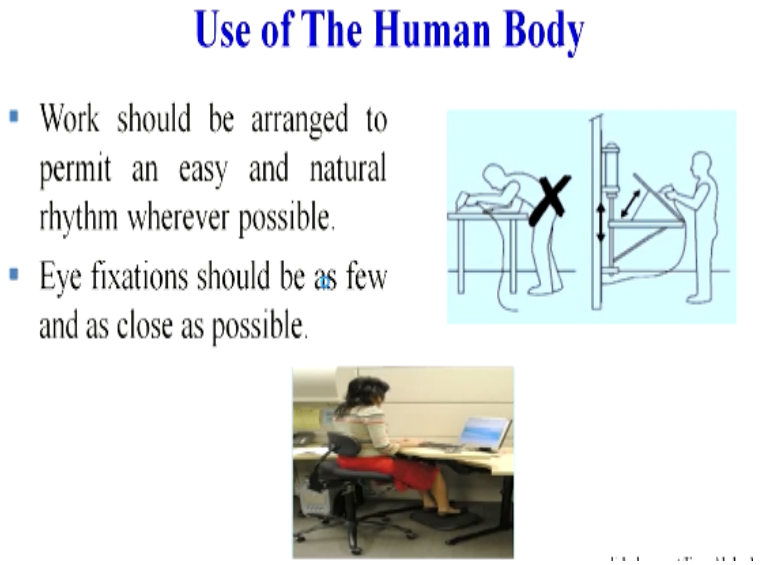

Work must be arranged to permit an easy and natural rhythm wherever possible so natural rhythm if you see here example the person can stand and perform this is better way of supporting the task instead of a person bending down and doing the work. So, work must be arranged to permit easy and natural rhythm wherever possible. Eye fixations must to be as a few and as close as possible.

So, if I am working suppose the simple example can be given if I am typing something on the computer by looking at a book. So the book and the screen must or the keyboard must not be at a distance so that the eyeball movement must to be restricted to the minimum within our close range only. Because if I have to change the eyeball movement to a maximum possible level the eyes will get tired.

So, the eye fixations must to be as a few and as close as possible. Now the first thing is how the human body must be used we have seen the use of the hands the arms the movement of the hands must be symmetrical ballistic movement, eye fixation. So, if all these principles are kept in mind while we are designing the work for the worker automatically he will feel less tired his fatigue will be less, the trauma can be avoided when he is doing a repetitive task.

And will help us to achieve the work or to perform the work in a more effective manner. Then second is the arrangement of the work place. That how the work place must be arranged so that it can be done in the most productive manner. So, quickly we will see.

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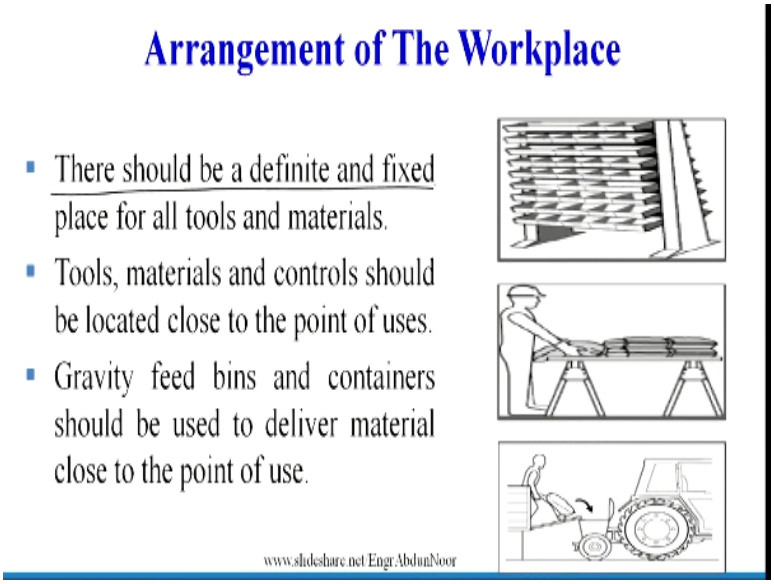

There should be a definite and fixed place for all tools and materials. So, this is not only their living to their industry this is relevant to our lives also so over toothbrushes must be at a particular place over clothes must also be at a particular place there can be a space for keeping the socks there can be a space for keeping the handkerchiefs. So, there can be specific place for specific things same is true in the industry also.

So, there must be a definite and fixed place for all tools and materials tools materials and controls should be located close to the point of use. So, if I am using it as a pen and if it is put at this point every time I have to use I have to pick this pen from a distance that can easily be avoided that if it is placed at a point close to the use. So, tools, materials and controls must be located close to the point of use.

Gravity feed bins and containers should be used to deliver the material close to the point of use. So, we may not require a mechanized conveyers wherever possible gravity feed bins can be used.

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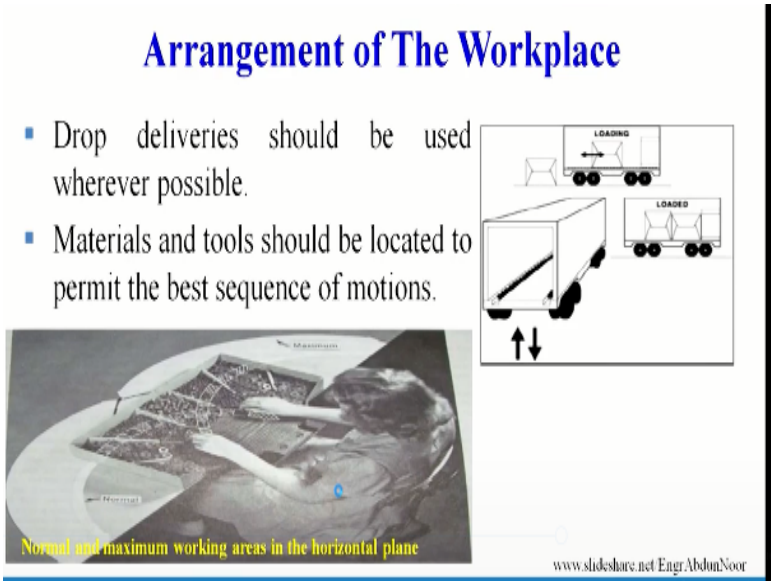

Drop deliveries should be used wherever possible a simple example can be if you go to a shoe store where additional shoes are stored on the first floor. Normally you may have experienced there is a person sitting on the first floor and there is an open window through that he really drops maybe a pair of shoes that you want to see. Suppose if I go there and tell 7 number and in ground floor only 8 number is available.

I want to see 7 from from the ground only he will tell that you need 7 number so they will drop down the box of the shoes. So, that just one simple example of use of the dropper deliveries wherever possible. Materials and tools should be located to permit the best sequence of motions this is giving one practical example that we can arrange the tools and equipment in such a way that we use them one in the sequence.

So, we know that for assembling this nut and washer and bolt this is the sequence that has to followed. So, the material can be placed in that particular sequence only.

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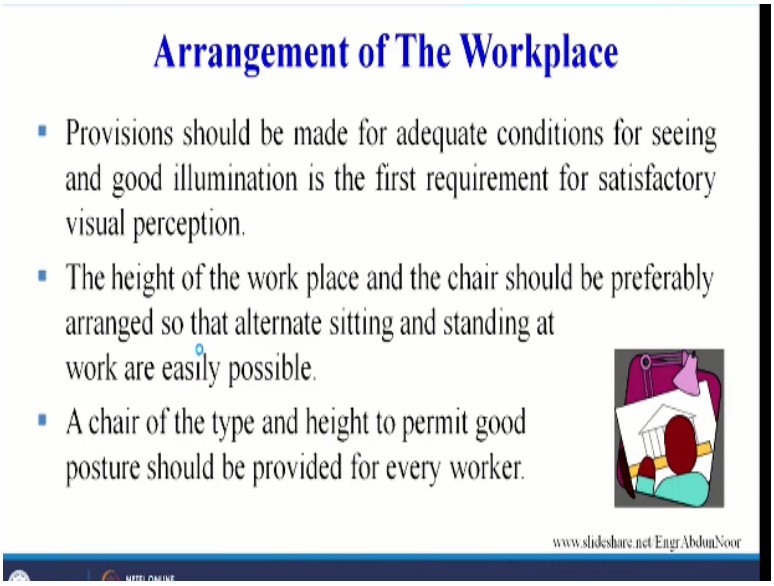

Provisions should be made for adequate a conditions for seeing and good I have taken an example of good and illumination earlier also. So, conditions of seeing good illumination is the first requirement for a satisfactory visual perception. So, we must provide good lighting arrangement wherever the work is being done. The height of the workplace and the chair should be preferably raised.

So, that alternate sitting and standing at work and easily possible work are easily possible we can provide such a situation the table and chair arrangement in such a way that if the worker feels that he is tired of sitting he can stand up and perform his work and maybe after some time if he again feels like sitting so he can sit and start his work. So, that kind of flexibility can be designed into the workplace so that the worker feels comfortable.

A chair of the type and height to permit good posture should be provided for every worker, so this is related to the ergonomic design of the chair which is to be given to the worker. Now this is related to the workplace that how the workplace should be. So, just to summarize the lighting arrangement must be proper the height of the table and a chair must be adjustable the chair must provide a good posture to the worker.

Drop deliveries must be used so we have seen that when we are laying out or when we are designing the workplace what are the principles that we must keep in mind that the last part is the

designs of tools and equipment. So, whatever tools and equipment the worker is using what are the principles now.

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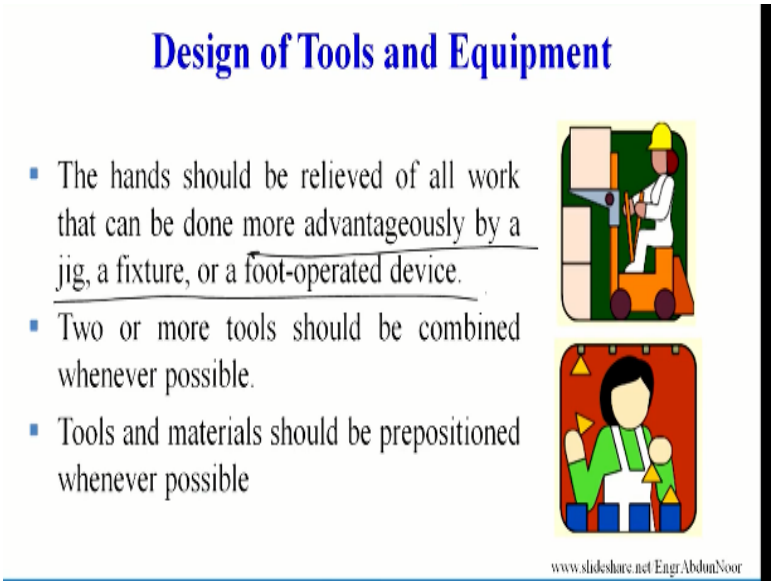

The hands should be relieved of all of work that can be done more advantageously by a jig a fixture or foot operated device. So, wherever possible we can distribute the work among the 4 limbs or among the over different limbs I have already given an example that when we drive a motorbike we can control it with both hands and it will with both feet. So, that is the given here that wherever possible we can use our feet to control the machines or equipment.

The hand should be relieved of all of work that can be done more advantageously by a jig, fixture or a foot operated device. 2 or more tools should be combined wherever possible and whenever possible. Tools and material should be pre-positioned wherever possible so there should be a proper location for the tool which is common with the previous you can say principles also for the design of the work space or design of the workplace.

Tools and materials should be pre-positioned wherever possible then we are each finger performs some specific movement such as in typewriting.

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Design of Tools and Equipment

- Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.

- Levers, hand wheels, and other controls should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest speed and ease.

This is one example and most of the people these days use mobile phones and the computer keyboards so such as typewriting so when we are doing typing on the keyboard the load should be distributed in accordance with the inherent capabilities of the fingers inherent capabilities of the finger. So, when I am typing on the keyboard I must distribute or make use of the fingers based on the inherent capabilities of the fingers.

Levers, hand wheels and other controls should be located in such positions that the operator can manipulate them with the least change in the body position and with the greatest speed and ease. Now what is the guideline for location of lever or hand wheels and other controls you can see here so that the operator can manipulate them with the least change in the body position this is the first requirement with the greatest speed that is second requirement and with ease.

This is the third requirement and how now this is a simple example can be when you are driving a car you have to change the gear so if you have to bend always to change the gear you may not feel comfortable for driving 100 or 200 kilometers. But if you see the design of the present day cars when a person is driving a car without moving his body or the torso he can very easily change the gear.

If you want to increase the volume of the music being played there are controls available on the steering wheel only. So, without changing their body posture you can control everything related

to the car. You have the accelerator you have the brake, the clutch in your feet you have the steering wheel you can manipulate the things or you can change the song with the controls available on the steering wheel only.

You can manipulate the gear without changing your body position. This driving a car is a good example of this principle of motion economy. Levers handwheels and other controls should be located so that they can be manipulated without changing the body position.

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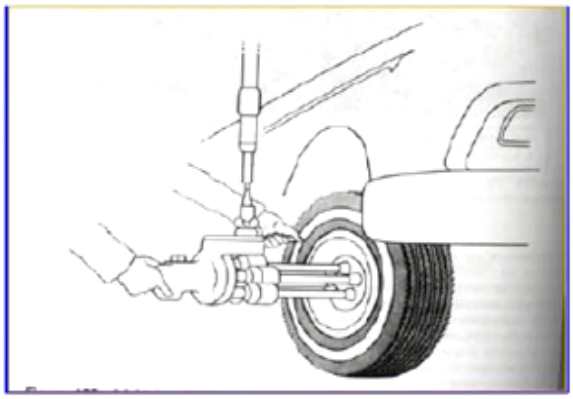
Design of Tools and Equipment



Multi-spindle air-operated nut runner can tighten all five wheel nuts at once

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So, this is one good example design of tools and you can see this is a multi-spindle air operated nut runner this can tighten all 5 wheel nuts at once. So, this is a device so all 5 wheel nuts can be done in a single operation only. So, such type of tools and equipment can be designed which can reduce the human fatigue which can reduce the worker fatigue. So, basically to summarize what we have covered today.

We have tried to cover today the principles of motion economy and 3 important elements are there that is how to use the human body, how to design the workplace or the arrangement of the workplace and thirdly the tools and equipment that is being used by the worker can be designed to make his work easier, simpler, economical, efficient, effective and productive. So, if we follow these guidelines or these principles we can design the workplace.

As well as the work in such a way that the worker will enjoy the work that he is doing as I have enjoyed the recording of this session with all of you. Thank you.