**Work System Design**

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**Lecture – 59**
**Case Study: Computer System**

Namaskar friends, welcome to the last but one lecture of our course on work system design and you can see smile on my face because we also enjoy finishing the things in a best possible manner and just to summarise what we have covered again and again, I summarise because this lecture may also be a standalone lecture, which is available to some of the learners or maybe to the worldwide community.

We have covered different aspects of work system design starting from productivity, measurement of productivity, causes of low productivity, productivity improvement techniques, calculation of productivity, then we have seen what are the techniques which can be used for improving the productivity, work study basic, work content, we have seen that how we can improve the performance of the workers or the systems using the method study, work measurement and ergonomic design of the systems.

In method study also, we have covered a number of different graphical tools, if you remember the learners who are doing the course you have registered for the course will appreciate that we have covered outline process chart, flow process chart, multi activity chart, 2 handed process chart, SIMO chart, therbligs, principles of motion economy, flow diagrams, string diagrams.

So, different graphical tools we have seen which help us to improvise on the current way of doing the work. Once the best method is found out, we have also learned that how to calculate the standard time required by an experienced worker to perform the task. Currently, in the last 2 weeks our focus primarily is on the ergonomic principles of designing the work systems and in the last week, this is a week number 12, we are focusing on the various work systems.

If you remember, we have already taken 3 discussion sessions on this particular topic of the applications of ergonomics and we have seen the design of office chairs which is a very, very

common example, then we have also seen the design of a tower crane cabin, which is specially related to an industrial scenario, then we have taken another example which is a common example of a driver's seat or a car seat.

And today, we are trying to focus on the computer system, now what is the computer system? Now, we; I take a computer system as a system in which a person or a man computer system we can make it a better terminology that a person is operating a computer system, how the computer system must be design or in the other way and or in the nutshell, we can say how the interface between the man and the computer be designed such that the person feels comfortable working on the system for long duration.

And these days, if you see most of us use computers in our day to day life, so how this interaction between a man and a computer can be designed, so that you feel comfortable after performing the task, so we will try to understand this and we will try to take few examples, we will try to see the certain data, guidelines which are already available and which helps us to design this interaction in the best possible manner.

Or to develop a good interface between the computer system and the operator or the computer professional who is using the computer system. There are so many standard guidelines which are still existing but still we are not able to use these guidelines in the best possible manner for example, it is advisable that we must use the system while sitting on a table and a chair but most of the time we see, when we go to the hostels or different institutes, we see students are lying on the bed.

And then using the laptop which may have an adverse effect may be for a day or 2 or a week, it may not; the symptoms may not be visible but if you do the same thing year and year, over and over again, the symptoms of MSD's may appear. Now, what are MSD's; that we have already covered. So, therefore it is always advisable that whatever are the standard guidelines recommendations for using a particular equipment or a device or a system, we must adhere to those guidelines, if we want to do the; or performed the work in a best possible manner.

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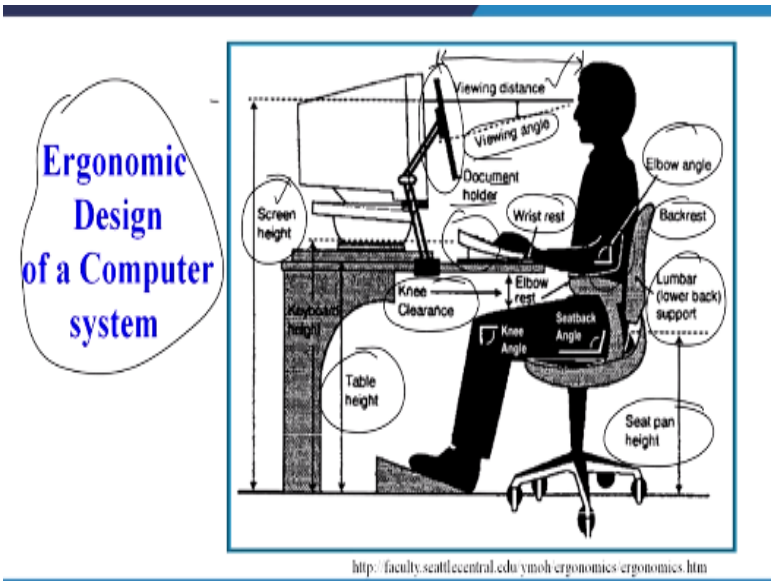


So, today we will try to focus on the computer system, the background, I have already introduced, now let us see the ergonomics design of a computer system, here you can see a computer system and a person operating the system, so let us start from this side, there is a screen height which is given here, this is a screen height, then the knee clearance is given here, table height is given here, seat pan height is given, lumbar lower back support.

This is the elbow angle marked here not very clearly, this is elbow angle, backrest, this is very, very important, the viewing distance already it is marked here, the viewing angle; the viewing angle can be adjusted by tilting the screen, then we can have a document holder also from where the person is looking at the data or the information, wrist rest is here, this is keyboard given, then the elbow rest is there.

So, basically we can see that there are so many different parameters and if you remember the previous session that we have taken on car seat, there were so many different parameters in car seat also, so when we are able to optimise each one of these parameter, our experience of using the computer will be much more comfortable, it will be much more relaxing but if we are not able to optimise on the combination of all these parameters, we may feel; we may feel tired after using the computer maybe even after 1 hour of duration also.

So, even after 1 hour we may feel that I am not feeling comfortable while using this computer, why; because some of these parameters are not well planned, well designed, so we can see that the screen height, if you do not have a proper height, so you may have to look like this, so your neck is always in a wrong position, in an awkward position. If the height is too much, you are looking like this again.

Your eyes or you can have strain in your forehead, even the shoulder and neck combination may also have a bad affect, so therefore it is important to focus on each of these parameters and there are standard guidelines already existing, so when we are designing this system or when we are maybe sometimes if we somebody starts a computer centre, he wants to put on computers in a line.

He must take into account all these standard guidelines that what must be the elbow height, what must be the height of the chair, whether it must be adjustable, what about the backrest, what must be the backrest height, what must be the backrest width, then what must be the knee clearance that has to be accounted for, what must be the distance between the eyes to the screen that is also equally important.

So, all these parameters have to be taken into account while you are designing your work system or designing a place, where a persons or operators or learners are going to come and use the computer systems. So, therefore, we will try to take maybe one by one, what can be the issues and what are the standard guidelines that must be taken into account, when this type of work system has to be designed.

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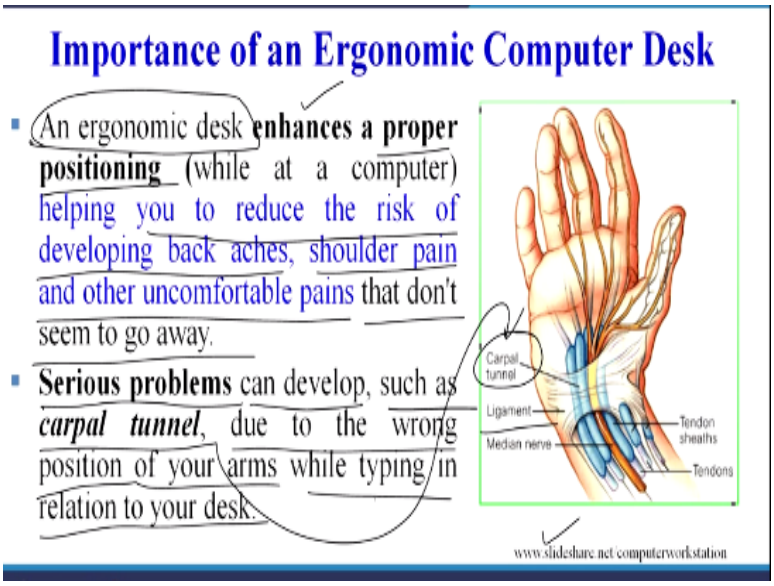


So, this is the importance of ergonomic computer desk, you can see here, the source is given, this is a carpal tunnel which is one issue, these are the ligaments, we can see an ergonomic desk enhances a proper positioning which will help you to reduce the risk of developing backaches, shoulder pain and other uncomfortable pains that do not seem to go away. So, an ergonomic desk will help us in ensuring a proper posture or a proper posture or a normal posture which will help us to avoid different types of pains.

May the pain may be in the back or it can in the shoulder, it can be in the neck region or it can be at any other uncomfortable; any other uncomfortable pain at any other part of the body, so ergonomic desk enhances a proper positioning, so it will enhance proper positioning, so it will help us to reduce the risk of developing backaches, shoulder pain and other uncomfortable pains that do not seem to go away.

So, we have to develop that ergonomic desk, now ergonomic desk will be design; there are certain guidelines; height, width, the distance between the head and the screen, the elbow, the knee clearance, all these parameters will help us to design the ergonomic desk. Serious problems can develop such as carpal tunnel which is already shown here, the carpal tunnel; due to the wrong positioning of your arms, while typing in the; typing in relation to your desk.

So, if our arms are not properly positioned while doing the typing continuously, we may develop this problem of carpal tunnel, so these type of problems can easily be avoided, if we use the ergonomic principles for designing the interaction between the human or the operator and the computer system, so easily we can take into account that what must be the elbow height, where must be the keyboard placed, how must be the design of the mouse, where the screen must be there.

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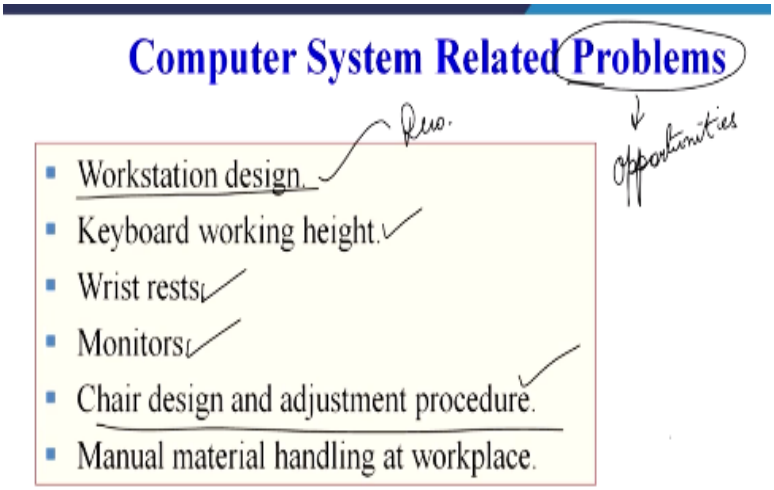


Whether the screen must be tilting forward or backward or at an angle, so if we are able to maybe design this interaction, such type of problems can easily be avoided, so let us see now, a computer system related issues, so maybe I must not say, problems here but we must say the opportunity is here that what are the opportunities of designing this system, so we can have a workstation design based on the various recommendations that are already available.

Keyword working height; yes, we can design it properly, wrist rests can be there, monitors; different types of new and new technologies are coming in the design of the monitors, so we can easily think of the monitors are the ergonomic design of the monitor, which is comfortable for the worker, chair design and the adjustment procedure, we have to avoid the backaches, the neck shoulder portion has to be taken into account while we are designing the workstation, the height of the screen of the computer system will definitely affect our performance in terms of our neck and shoulder.

So, the chair design and adjustment procedure must be there that you can; because we want to maybe if we go back to the previous slide, you can see once again I will go back, so here you can see the viewing distance is given, viewing angle is given, so this is an eyeball, this is a viewing distance, so this particular angle and this distance can easily be changed, how it can be changed?

It can be changed by chair design and adjustable adjustment procedure, so we can adjust the height of the chair or the distance between the system and the chair to properly manage that distance, so manual material handling at the workplace, so maybe where the document or the paper from which you are looking at or you have to look at while working on the computer, where it must be placed, at what angle it must be placed.

So, whether there has to be a handling device for that the paper may not flutter, so there are so many things that need to be taken into account when you are designing this work system, so let us further see the basic computer system workplace.

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So, how the things look like? So, here it is advisable there is a backrest here, foot rest also is given and there is a monitor stand, which is given here; monitor stand, this is a keyboard tray you can see and you can just see the position of the elbows and the position of the keyboard, so we

have to ensure that the person who is working on the computer feels comfortable while performing his or her task.

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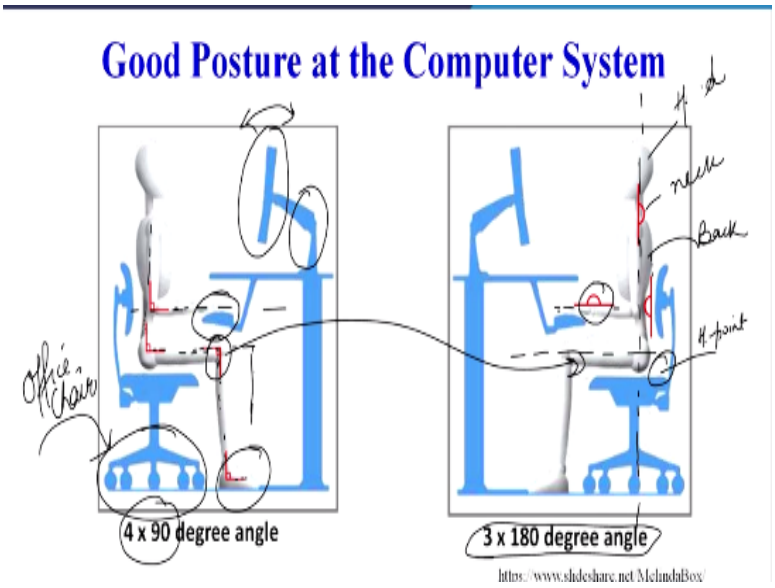


Now, this is again good posture at the computer system, you can see, this screen can be adjustable, it may be swivel or maybe tilted, this height may also be adjustable, you can see the elbows, again this is the keyboard which is being used and you can see this angle, this is the thigh and this is the leg, so what is the; what can be the angle foot firmly placed or the feet firmly placed on the ground.

And if you remember, we have seen the design of an office chair also, so you see this same thing we have seen in the office chair also, this case study already we have taken, so the important point is that these things are not in isolation or the design of the work system is not in isolation, it is an integrated design thinking approach, which means that the chair when we are designing to be used in an office that design has to be integrated with the computer system.

So, we have to see that what are the additional requirements of an office worker who is using a computer system and how these additional requirements can be integrated into the normal design of an office chair but the basic principle will remain the same that we have to ensure that the person who is using that chair feels comfortable, while performing his or her task. So, here specially, from the computer operator's point of view, we can have certain guidelines.

So, here we can see again angle is given here, this if I can drop a line from here, you can see what all are coming in the same line, so this is the head maybe we can have another diagram which can be shown to explain this, this is neck, so they are in the same line, this is back, alright so this is in the case of car seat, we have seen this was the H point, so these all are in the same line.

So, if you see the thigh and this angle already is shown here, so we can see that different angles have to be taken into account, so these are the 3 angles at 180 degree which are shown here. What are these 3 angles? This is the elbow and the keyboard, then the back and then the neck and the head, so these 3 angles are 90 degree and 4 angles are given as 90 degree. Now, what are these 4 angles?

Elbow, and the arm, the other angle is the back, lower back and the thighs and the another one in the leg and the thigh, this is the leg, this is thigh and another one is the leg and the foot, so 4, 90 degree angles and 3,180, this is the ideal posture and I believe maybe to be very, very practical in nature, all these 7 angles are very, very, very, very difficult to maintain, as learner of work system design, all of us may be using, all of us may be using the computers in one way or the other.

Now, suppose we sit on a table desk arrangement and we are using a computer system, I do not believe that anybody can maintain these 4 +3 angles as per the recommendation and if you look back our previous discussion about the office chair, a person changes 53 postures, so every now and then we are changing the posture, so therefore there is a kind of irony here that recommendations do exist.

But then we may not be able to adhere to these recommendations maybe in totality, so therefore there has to be certain degree, certain element of flexibility which ensures that the worker when he is performing the tasks, he is feeling comfortable, these are the good posture at the computer system or we can say the ideal posture at the computer system.

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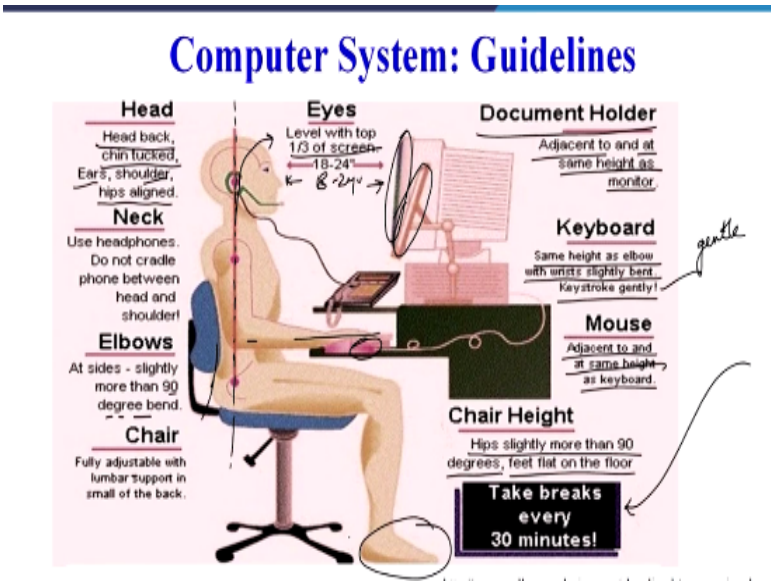


Now this is again giving us; the previous slide was giving us the broad guidelines but here you can see few recommendations are also there, one of the most important recommendation is here, take break every 30 minutes, so continuously you must not be sitting on the work system or on the computer system, so basically you can see that there are different guidelines, so even if we are able to maintain the ideal posture.

The ideal posture you have seen in the previous slide, I will again refer back to that so, there are 4 angles at 90 degree and 3 angles at 180 degree, so this is maybe our back must be straight, head and shoulder must be at 180 degree which is shown here; head and neck angle, so if we are, sorry the head and neck angle, sorry; the neck and the head must be at 180 degree, so if we are able to maintain these 3 * 180 degree angles and these 4 * 90 degree angles, we may have to take a break after 90; sorry, after 30 minutes as is given in the previous slide as a recommendation.

Now, let us see, take a break every 30 seconds now, what are the other guidelines or recommendations, let us start from one by one. Head; head back, chin tucked, head back, we must this head must not be in the bent position, so head must be back straight because we have to maintain that angle of 180 degree between the head and neck, so that is important. Chin tucked; ear, shoulder, hips aligned, so we can see these are the ear, these are aligned, so this is head, then ears, then neck, then shoulder and then the hip.

They are all aligned, so this is one thing we can ensure. Neck; use head phone, do not cradle phone between head and the shoulder, this is another guideline. Elbows; at sides, slightly more than 90 degree bends, so it is shown, the guideline. Chair; fully adjustable with lumbar support in small of the back, so this is a maybe this is lumbar support arrangement given here, eyes level with top 1/3rd of the screen.

And this distance you can see is given here, 18 to 24 inches, so this was an important thing that we have seen in the beginning of the today's session. Document holder; where have to; where we have to place the documents, so which the operator is going to look at, adjacent to and at the same height as the monitor, so this is the monitor here and these are the document holder, so they are; they need to have at the same height, they must be at the same height.

Keywords; same height as elbow, so this is the elbow and the same height at the elbow with wrists slightly bent, keystroke must be gentle, so this is very, very important, the keystroke must be gentle, you must not require lot of force to press the keys, so keystroke must be gentle and wrists must be slightly bent. Mouse; adjacent to and at the same height as the keyboard, so the mouse also must be at the same height as the keyboard.

Chair height; hips slightly more than 90 degrees feet flat on the floor, so feet flat on the floor and hips slightly more than 90 degree, so you can see that different recommendations are there which if we keep into account, we will be able to design this system in a much more effective manner and the operator or the worker or an engineer or a scientist whosoever is being a part or is a subject of this type of a work system where a person is operating a computer.

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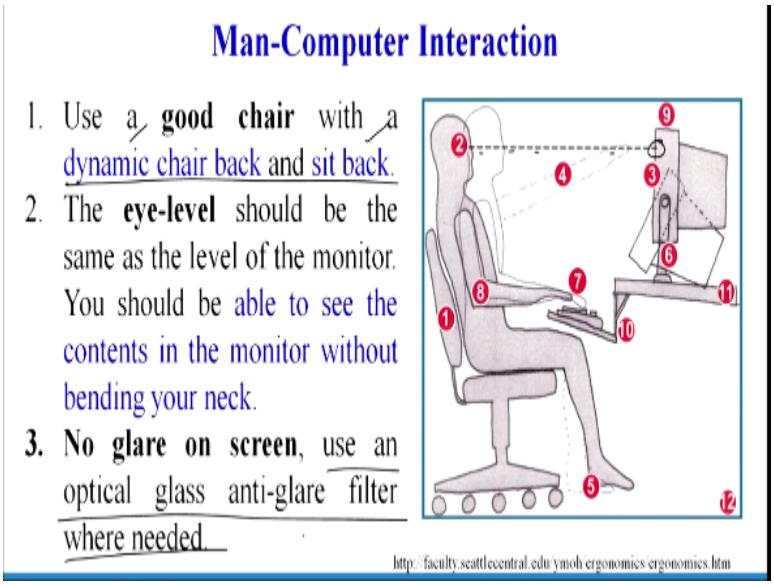


He will feel comfortable and he can work for long hours without being tired. Now, these are man computer interaction, same things are there, more or less but we will just read these points for you. Use a good chair with a dynamic chair back and sit back, so these are the 2 options; sit back options must be there, dynamic chair back. The eye level should be the same as the level of the monitor, so this is eyelevel and this is a level of the monitor, a second point.

You should be able to see the contents in the monitor without bending your neck, so without bending the neck we must be able to straight look into the screen and maybe read whatever is written or you may be able to refer to the contents of the screen without bending our back in upward or downward direction. No glare must be there on the screen, use an optical glass antiglare filter wherever needed.

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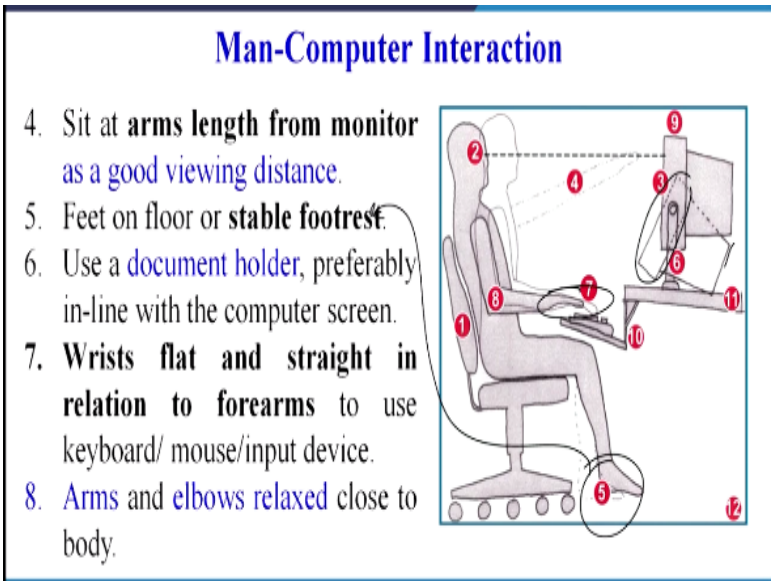


So, the different types of antiglare screens are there these days. Sit at arm's length from monitor as a good viewing distance, so it is given arm's length away from the computer is a general rule of thumb that each computer professional must follow, ait at arm's length from monitor as a good viewing distance, feet on the floor or stable footrest, so which is given here number 5, you can see feet on floor or stable footrest.

Use a document holder preferably in line with the computer screen, so gain the document holder is shown here, this must be in line with the computer screen. Wrists flat and straight in relation to the forearms to use keyboard, mouse or the input devices, so the wrists we can see they must be straight in relation to the forearms, number 7. Arms and elbows relaxed close to the body, arms and elbows must be relaxed and they must be close to the body, number 8 recommendation.

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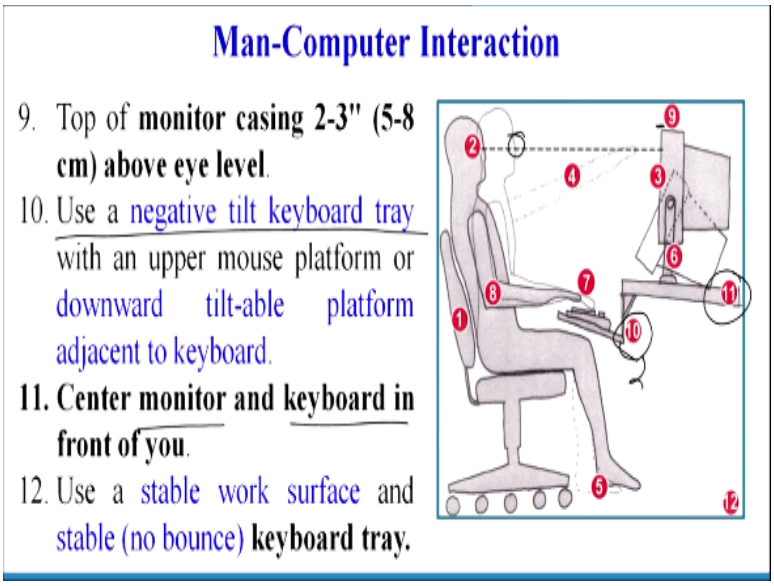


Top of monitor casing that is the monitor casing top 2 to 3 inches above the eye levels, so this is the top of the monitor casing, this must be 2 to 3 inches above the eyelevel, so this is the eyelevel shown here. Use a negative tilt keyboard tray with an upper mouse platform or downward tilt able platform adjacent to the keyboard, so which is given here you can see, use a negative tilt keyboard tray, so this is the keyboard tray, number 10 which is shown here.

So, use a negative tilt it is given, a negative tilt is shown here, use a negative tilt keyboard tray with an upper mouse platform or downward tilt able platform adjacent to the keyboard, so this is guidelines related to the tray on which we are going to place the keyboard. Centre monitor and keyboard is in front of you, so the monitor and keyboard must be in front of us, we must not work like this that the system is here, my body is facing this direction and my neck is turned at an angle.

So, the monitor must be in front and the keyboard must be in the centre, so centre the monitor and keyboard in front of you that is 11 number guideline, this is 11. Then use a stable work surface and a stable keyboard tray, so there must be no bounce in the keyboard tray, it must not bounce when I am pressing the keys.

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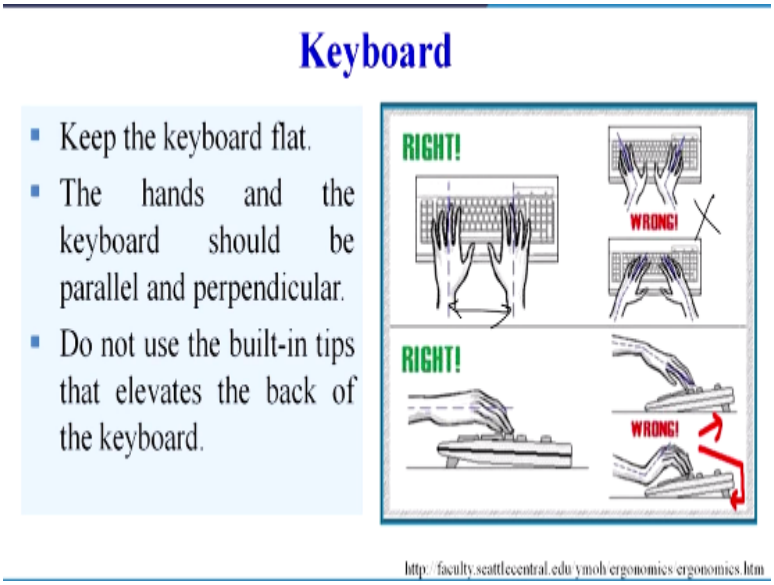


Then quickly let us see now, keyboard; keep the keyboard flat, the hands and the keyboard should be parallel and perpendicular which is given here, these are parallel here and they must be perpendicular, this is wrong, we must not do the typing like this, do use the built in tips that elevates the back of the keyboard, so this is not required.

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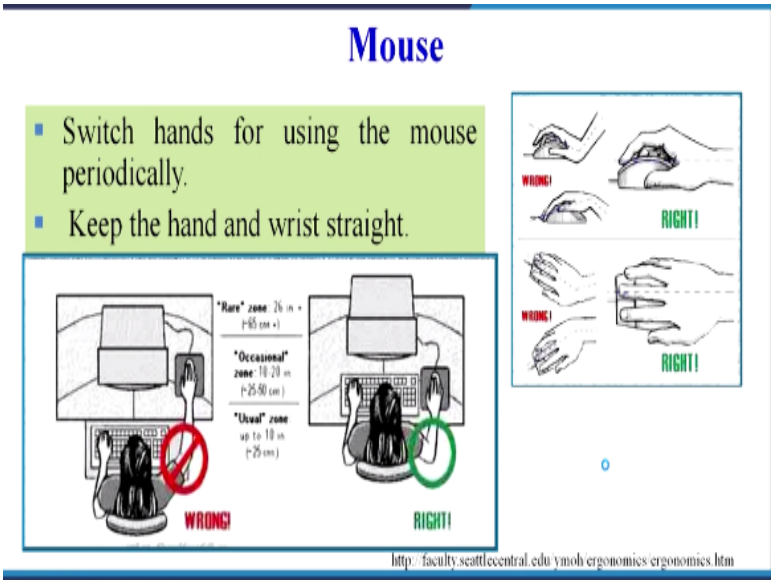


So, this is a mouse, may be some of the systems we see that but then there may be some further adjustments which makes the use of such type of keyboards comfortable, so I cannot comment on this particular point that whether they must be there or they must not be there but if they are there they have to be designed ergonomically, so that the person feels comfortable working for long hours.

Then, switch hands for using the mouse periodically, keep the hand and wrist straight already this is right, hand and wrist straight, so this is wrong because you have to reach that point, so we can see it is better from the top view, it is shown, we must not use the mouse like this, we must use the mouse like this, it is a given here and even the usual zone; occasional zone is given and the rare zone is marked here and even the recommendations are marked in terms of the distances.

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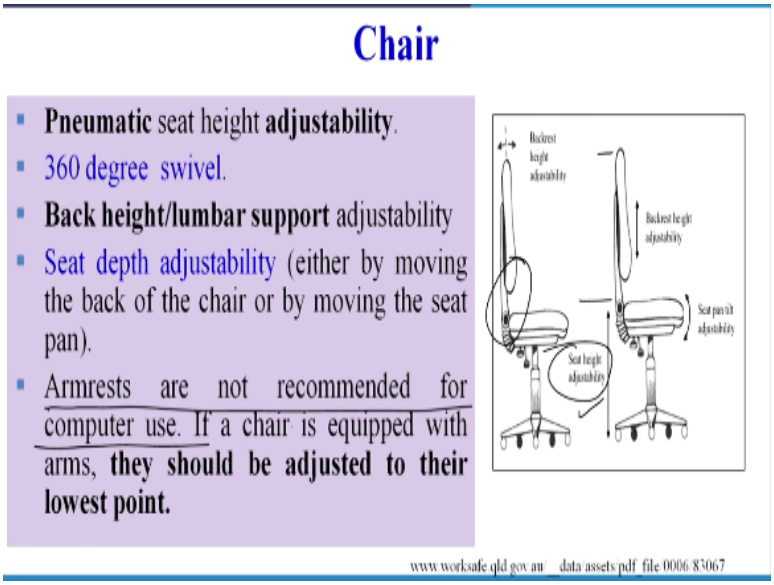


The chair, already pneumatic seat height adjustability, already for the office chair we have already seen that back height lumbar support adjustability, back height is also very, very important, armrest is not recommended for computer use, if a chair is equipped with arms they should be adjusted to their lowest point, so it is an important recommendation, armrest are not recommended for the computer use.

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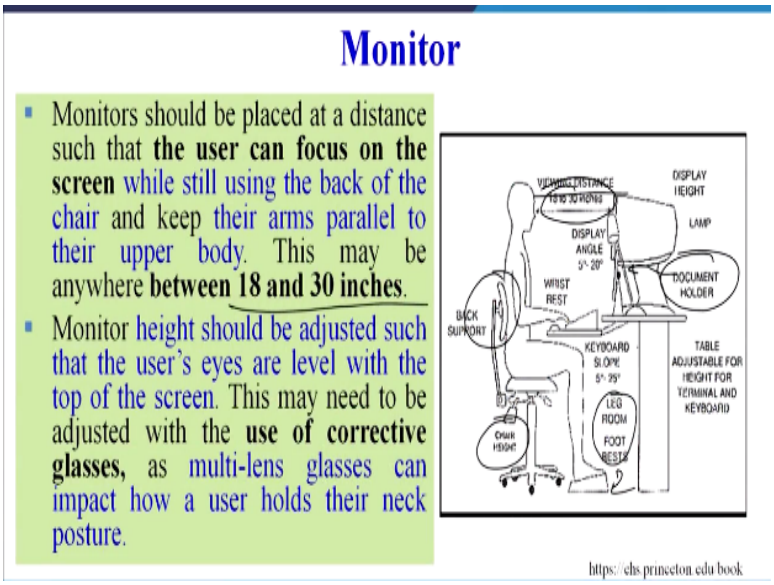


Because you have seen that we have to operate the mouse and the keyboard, so the armrest may be kind of a hindrance for a computer professional. Then the monitor also, a viewing distance you can see it is clearly recommendation is 18 to 30 inches display height, then the document holder again, we again it is coming into picture, so the height back support is marked here, chair height is adjustable, so leg room, footrests are mentioned here.

Leg room must also be there between the table and the person who is operating the computer, so monitor should be placed at a distance such that the user can focus on the screen while still using the back of the chair and keep their arms parallel to their upper body, so we; person must be able to focus on the computer system without his arm sorry, without his back getting away from the back support.

So, with the back in constant contact with the back support of the chair, the person must be able to easily focus on the computer systems, so this distance has to be adjusted and just a rule of thumb was an arm's length is sufficient enough, so this maybe anywhere between 18 to 30 inches, so the distance must be placed at a distance; the monitors must be placed at a distance from the user.

Monitor height should be adjusted such that a user's eyes are at level with the top of the screen, this may need to be adjusted with the use of corrective glasses as multi lens glasses can impact

how a user holds their neck posture, so maybe if somebody using the glasses though they need to be designed in such a way that the person holds his neck straight as we have seen in the previous guidelines and the gap or the distance between the monitor and the head or the eyes is maintained.

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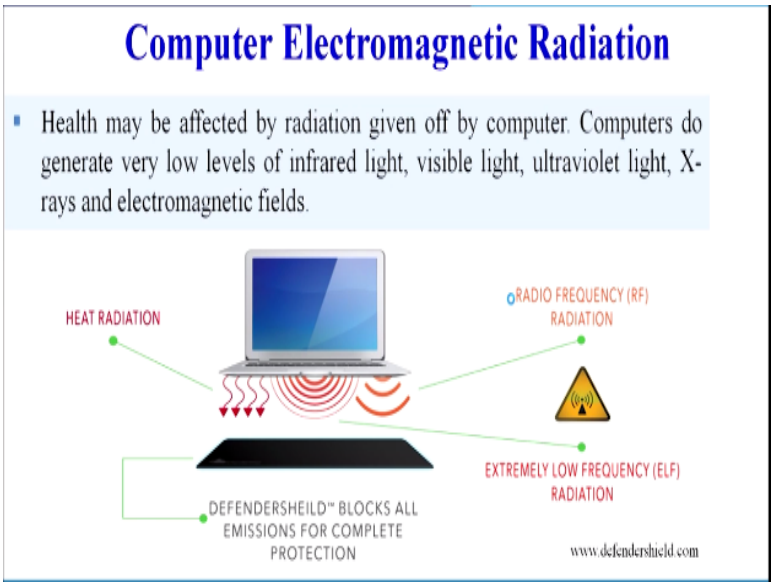


So, he need not bend his or her back in order to adjust the focus on the monitor, so then computer electromagnetic radiation; health may be affected by radiation given off by the computer, so the computers do generate very low levels of infrared light, visible light, ultraviolet light, x rays and electromagnetic fields, so these can be must be taken into account while we are designing the work system, where a person is operating a computer.

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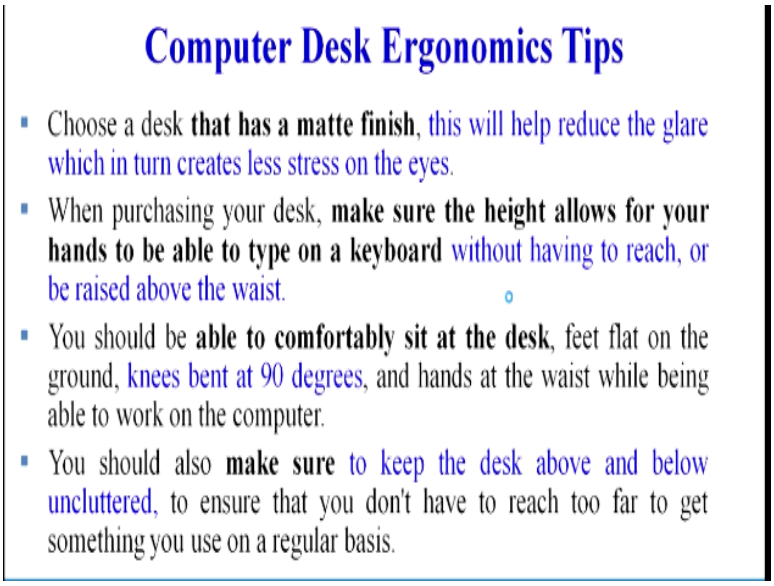


So, this is the computer desk ergonomic tips, already I think, we have seen most of these and there are a few conflicting things like the level of the eyeballs with the computer screen maybe sometimes the top of the computer screen panel may be an inch or half an inch higher than the eyeballs, so there are number of; we can say guidelines which we must but the major objective is that the general guidelines are much more; much more useful as compared to very, very specific guidelines.

So, the general guidelines or ergonomic tips are given here, choose a desk that has a matte finish, this will help reduce the glare which in turn creates less stress on the eyes. When purchasing your desk, make sure that the height allows for the hands to be able to type on the keyboard without having to reach or to be raised above the waist, you should be able to comfortably seat at the desk, feet flat on the ground, knees bent at 90 degree and hands at the waist while being able to work on the computer.

You should also make sure to keep the desk above and below uncluttered, to ensure that you do not have to reach too far to get something you use on a regular basis, so these are just very, very standard guidelines, the specific guidelines we have already seen in our previous slide and this is I will stop here.

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# General Guide: Ergonomic Guide to Computer Based Workstations

Source: Workplace Health and Safety Queensland, Department of Justice and Attorney-General
Guide: Ergonomic guide to computer based workstations PN11334 Version 1

https://www.worksafe.qld.gov.au/__data/assets/pdf_file/0006/83067/guide-ergo-comp-workstations.pdf

Because this is a general guide, which is ergonomic guide to computer based workstations and this has been the source is given, The Workplace Health and Safety Queensland, Department of Justice and Attorney, General guide, ergonomic guide to computer based workstations and there is a checklist which is available.

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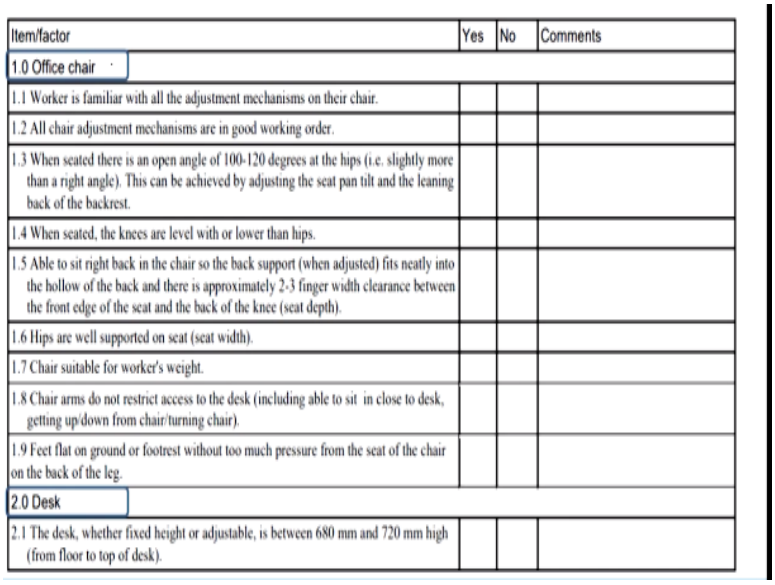

| Item/factor | Yes | No | Comments |
|---|---|---|---|
| 1.0 Office chair | | | |
| 1.1 Worker is familiar with all the adjustment mechanisms on their chair. | | | |
| 1.2 All chair adjustment mechanisms are in good working order. | | | |
| 1.3 When seated there is an open angle of 100-120 degrees at the hips (i.e. slightly more than a right angle). This can be achieved by adjusting the seat pan tilt and the leaning back of the backrest. | | | |
| 1.4 When seated, the knees are level with or lower than hips. | | | |
| 1.5 Able to sit right back in the chair so the back support (when adjusted) fits neatly into the hollow of the back and there is approximately 2-3 finger width clearance between the front edge of the seat and the back of the knee (seat depth). | | | |
| 1.6 Hips are well supported on seat (seat width). | | | |
| 1.7 Chair suitable for worker's weight. | | | |
| 1.8 Chair arms do not restrict access to the desk (including able to sit in close to desk, getting up/down from chair/turning chair). | | | |
| 1.9 Feet flat on ground or footrest without too much pressure from the seat of the chair on the back of the leg. | | | |
| 2.0 Desk | | | |
| 2.1 The desk, whether fixed height or adjustable, is between 680 mm and 720 mm high (from floor to top of desk). | | | |

And you can see there is a checklist regarding the office chair, there is a checklist regarding the desk, there is the checklist regarding the computer monitor, checklist regarding the keyboard then the mouse, then if we are using the laptop, then the desktop items, the seated posture, so there are a number of guidelines, which are available which must be taken into account, when we are designing this system.

So, we will not go into the each and every aspect but you can refer to these guidelines that these guidelines must be met to ensure good working experience, excellent working experience for computer professionals who are working in these types of work systems, so with this we close the today's session, thank you very much.