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Lecture - 22
Specifications of Computer Workstation Design Elements

In the first lecture session, I have referred to the different the design elements that you need to consider to assess the ergonomic design of computer workstation.
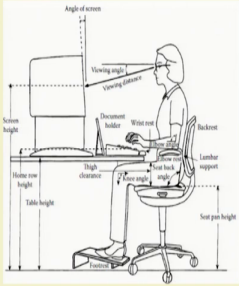
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Now, as we have observed that there are around 15 design elements. These elements are grouped into 5 categories, starting with work postures. And so, during the 2nd lecture session, I will discuss about the Specifications of Computer Workstation Design Elements.

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Refer to the sitting chair posture of the person looking at computer screen to carry out the task. We have already identified all these design elements and if you count you will find that there may be around the 15 design elements. There could be varieties of tasks you do while you work on the computer.

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Now, the first important the design element is the viewing angle. Viewing Angle: 25-35˚ below horizontal to eye height: screen centre is located below horizontal: neck does not bend backward (avoiding neck pain, neck strain, and muscle fatigue)
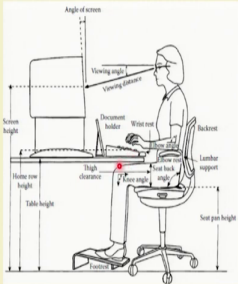
Keyboard and Thigh Clearance: low-profile keyboard and thin table top (3cm): horizontal lower arm, elbow angle 90˚ while typing, main problem: insufficient space between sitting elbow height and thigh clearance for even 5th percentile female operator.

It is found that muscle activity in shoulders and neck is found to be same for 70-90˚ elbow angle as recorded by measuring electromyographic (EMG) activity; 70˚ elbow angle is recommended (with enough space between leg and table top) for persons (using low-profile keyboard or not).

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That means if you refer to this figure you will find your elbow angle. So, lower arm should be horizontal, elbow angle should be 90˚. Now, this was assumed, you will have the horizontal lower arm, elbow angle 90˚ while typing with the keyboard.

What is the main problem? Main problem is insufficient space between the sitting elbow height and the thigh clearance. So, that is to be checked.

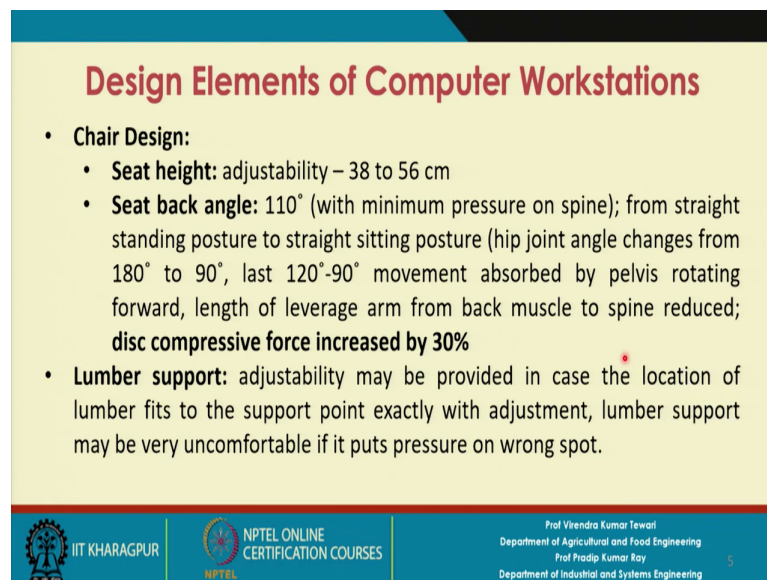What is the assumption? Assumption is your elbow angle should be 90º.

But then if you use the thin profile keyboard or low-profile keyboard. So, the thigh clearance for even 5th percentile female operator is such that you may not have sufficient clearance between the sitting elbow height and thigh clearance, insufficient space you will have.

So, this is a serious problem and you cannot sit comfortably. It is found that \the muscle activity in shoulders and neck is found to be same for 70-90° elbow angle as recorded by measuring electromyographic or EMG activity.

You get a flat level. But, later on it was found that not only for 90°, but also for this range; that means, 70° to 90°, you get that EMG at the flat minimum value with enough space between leg and table top.

If it is 70°; you will keep your table slightly higher level in the table top and from the ground; obviously you will have enough thigh clearance. So, even if you use low profile keyboard or not, the problem is solved.

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Chair design, the seat height should have the adjustability of between 38 to 56 centimeters so that the chair is suitable for mixed population.

Seat back angle should be 110° (with minimum pressure on spine); from straight standing posture to straight sitting posture (hip joint angle changes from 180° to 90°, last 120°-90° movement absorbed by pelvis rotating forward, length of leverage arm from back muscle to spine reduced; disc compressive force increased by 30%.

Now, another important design element is the lumber support. Lumber support actually is to be provided but, in majority of the cases you will find that the lumber support is not provided. Adjustability may be provided in case the location of lumber fits to the support

point exactly with adjustment, lumber support may be very uncomfortable if it puts pressure on wrong spot.

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Next is you need to consider the relationship between the compressive force on the disc this is a serious issue so that you design your chair in such a way that you will have hardly any back pain. One particular study I will be referring to the study related to determining the relationship between the disc pressure, the chair angle and the lumber support.

You use a pressure transducer at L3 L4 disc. I am referring to that particular study or experiments carried out by the researchers. So, the pressure transducers you use at L3 L4 disc and those transducers you insert, the body. Back rest angle varies from 120°-90°. The back rest angle and the varying protrusion of the lumber support.

What they have found like back rest angle α in degrees, back rest angle is varying, that is in x axis and y axis actually they are measuring this pressure in newton. So, now, there are two conditions, do not give any lumber support, no lumber support and the second one is a 5-centimeter length lumber support you provide.

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So, now when you carry out this exercise you get certain results.

i.   90˚ backrest angle, no lumber support: disc pressure in 670 N: with lumber support 470 N.

ii. 120˚ backrest angle, no lumber support: disc pressure is 370 N: with lumber support 120 N.

Conclusion is:

Do not sit in straight upright posture, leaned back work posture: in chair design, an adjustable back rest angle is to be provided.

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Now, hand or the wrist support you have to provide. optional for typists: soft wrist support can be provided as it puts less pressure on wrist avoiding CTS (Carpal Tunnel Syndrome).
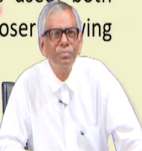
Arm support, it should fit to location of the table top, no interference arm support, short arm rest preferred, height adjustable arm rest to be provided.

Foot rest for short operators is not necessary if operators can rest feet on floor is it because if you use the foot rest; obviously, the stability is not guaranteed in a posture. But if can firmly place your foot on the ground you will have a stable posture.

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So, we have discussed design element one related the specifications. Next one is the design element 2. First one is the viewing distance. Three distances from eye are relevant, when you look at the characters at the at the centre of the screen that is one viewing distance. And, that is center of the screen and the distance you are looking at the document and the document holder and to the keyboard.

These distances may be kept same: refocusing not necessary, suitable for older operators (with presbyopia, inflexible lens).

Alternatively, focusing mechanism (accommodation) may be used: both visual fatigue and temporary myopia (due to adjusting to closer viewing distances for close working task) can be avoided.

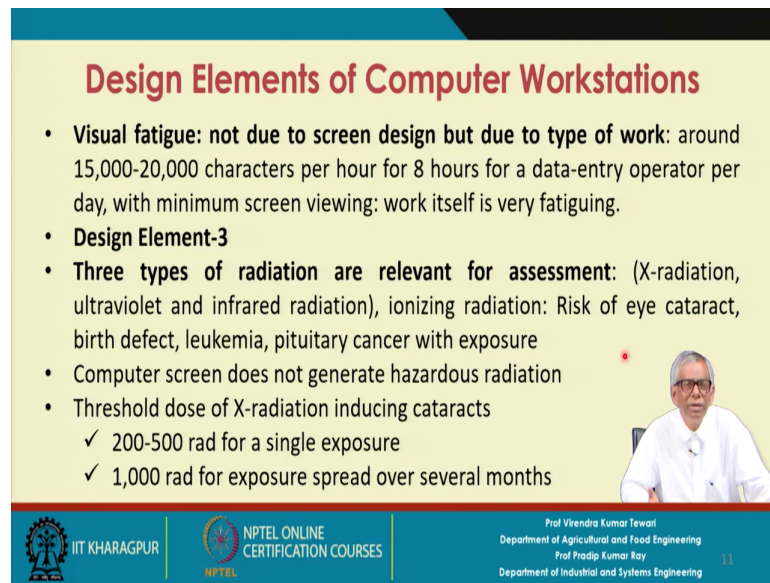(Refer Slide Time: 22:52)

So, what is the now long-term effect? Long-term effect: No negative effects: eyes do not become myopic, hyperopic, or presbyopic: however, compared to characters on paper (contrast ratio 1:40), screen characters are more blurred (contrast ratio may be as low as 1:8); reading speed is less, high-resolution screen is recommended to improve reading speed. And for individuals with eyeglasses issues are: Problems in using bifocal lenses (for older persons, viewing distances: 30 cm/400 cm): distance to screen is 60 cm usually: you bend your head back, move your head closer to screen: effects are neck strain, neck pain, shoulder pain; 'terminal' glasses may be used, lenses ground as per exact viewing distance of an operator.

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Now, the visual fatigue is not due to screen design, but due to type of work. It was reported previously, there is lot of visual fatigue but, later on it was proved that fatigue is because you have been working with your computer workstations. And, what actually are doing around 15,000 to 20,000 characters per hour for 8 hours for a data entry operator.

Design Element-3

Three types of radiation are relevant for assessment, first one is X-radiation, ultraviolet and infrared radiation.

The second one is the ionizing radiation which has the risk of eye cataract, birth defect, leukemia, pituitary cancer with exposure. So, if the exposure crosses the threshold value there is a high chance that you will have these kinds of diseases.

So, these researchers they debated a lot, and ultimately there is a firm conclusion that computer screen does not generate hazardous radiation.

Now, you should be aware of certain conditions like threshold dose of X radiation induces cataracts. For the humans only 200 to 500 rad that is a measuring unit for radiation, rad for a single exposure; 1000 rad for exposure spread over several months.

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A computer workstation operator is exposed to 0.01 mrad/h and absorbs less than 1 rad over a period of 40 years. Radiation is at a very low level which is even difficult to measure. Threshold dose of Ionizing radiation inducing birth defects which is more than 1 rad for acute exposure. A computer workstation operator may absorb 14 mrad over a period of 9 months. Brick walls, wrist watches, etc. may generate more X-radiation
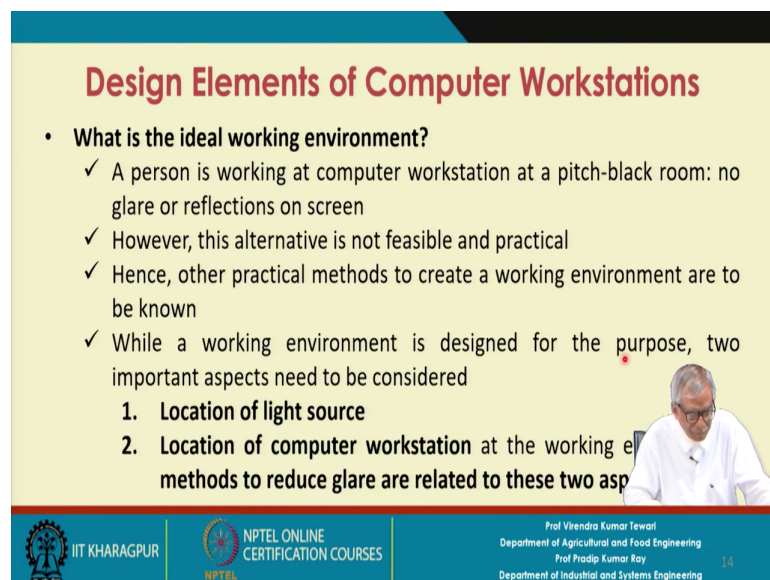
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Till date, researchers have not considered electromagnetic radiation as a radiation hazard for operators interacting with computer screen. Overexposure to such radiation may

result in health risk of leukemia and pituitary cancer: railway engineers exposed to overhead power lines and train engines.

Design Element-4-Glare/reflection on screen is a problem: difficult to read characters/texts on screen, error rate increases. The main purpose is to eliminate/ minimize glare on screen fully.

International ergonomic standards refer to a set of guidelines creating a work environment following certain rules and principles help eliminate/minimize glare or screen.

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So let us talk about ideal working environment. The ideal working environment is something in which a person is working at computer workstation at a pitch-black room where there is no glare or reflections on screen. However, this alternative is not feasible and practical. Hence, other practical methods to create a working environment are to be known. While a working environment is designed for the purpose, two important aspects need to be considered:

1. Location of light source.

2. Location of computer workstation at the working environment: methods to reduce glare are related to these two aspects.

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