

Human Factors Engineering
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Lecture - 32
Ergonomic Design Framework for Environment, Importance of Illumination System and Visual Environment

During this lecture session of around half an hour duration I will be discussing the Visual Environment related issues.

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Measurement of Evaluation of Physical Environment: Visual Environment

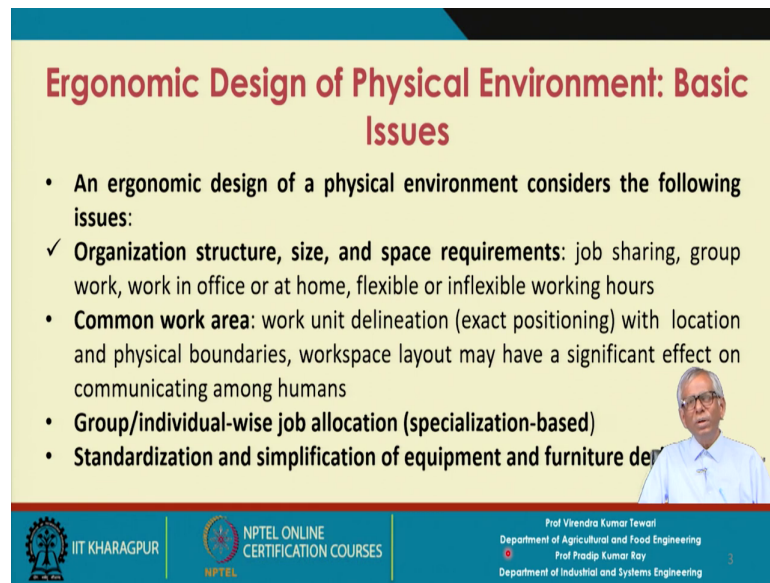
- ✓ Ergonomic Design of Environment: Issues and Framework
- ✓ Importance of illumination system and visual environment,

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So, let me first highlight some of the important issues and the framework for the designing ergonomic and environment then we will discuss the importance of illumination system and visual environment.

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Ergonomic Design of Physical Environment: Basic Issues

- An ergonomic design of a physical environment considers the following issues:
 - ✓ **Organization structure, size, and space requirements:** job sharing, group work, work in office or at home, flexible or inflexible working hours
 - **Common work area:** work unit delineation (exact positioning) with location and physical boundaries, workspace layout may have a significant effect on communicating among humans
 - **Group/individual-wise job allocation (specialization-based)**
 - **Standardization and simplification of equipment and furniture design**

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If suppose the visual environment is poor, what kind of the problems a person may face you should know and to what extent his or her health condition is dependent on quality of physical environment.

An ergonomic design of a physical environment considers the following issues:

The first factor is organization structure and organization structure can be of different types like line organization, stop organization, lining and stop organization, matrix organization.

So, in organization the size and the space requirements are very important. Job sharing, group work, work in office or at home; like, group work could be in the underground mining as phase drilling operation is there. For phase drilling you have to use heavy machine, one person just cannot do it, so it may be two to three person's jobs; so, it is a group work. So, there are many examples of the group work. Work in office is a normal practice, but for many types of jobs these days you will find that the persons are working from home.

Flexible or inflexible working hours. Like we say that in a week your total working hours would be 40 hours or 48 hours, but for many kinds of the professions these days you will find its flexible. The flexible working hours there are certain advantages for certain jobs, but there could be negative effects for others.

Common work area: there are certain places considered to be common work area such as work unit delineation (exact positioning) with location and physical boundaries, workspace layout may have a significant effect on communicating among humans. Group/individual-wise job allocation (specialization-based). Standardization and simplification of equipment and furniture design.

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Ergonomic Design of Physical Environment: Basic Issues

- **Flexibility in job design for fitting to changed human anthropometry and interface**
- **Psychological factors:** Motivation (ergonomic solutions/interventions may remove the barriers to effective human performance; motivation depends on work organization), job enlargement, job enrichment, shift work.

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And flexibility in job design for fitting to changed human anthropometry and interface. So, it is not that you design a job only for a specific person or a specific anthropometry so, while you design a job make sure that there must be flexibility depending on variability in the human anthropometry for a group.

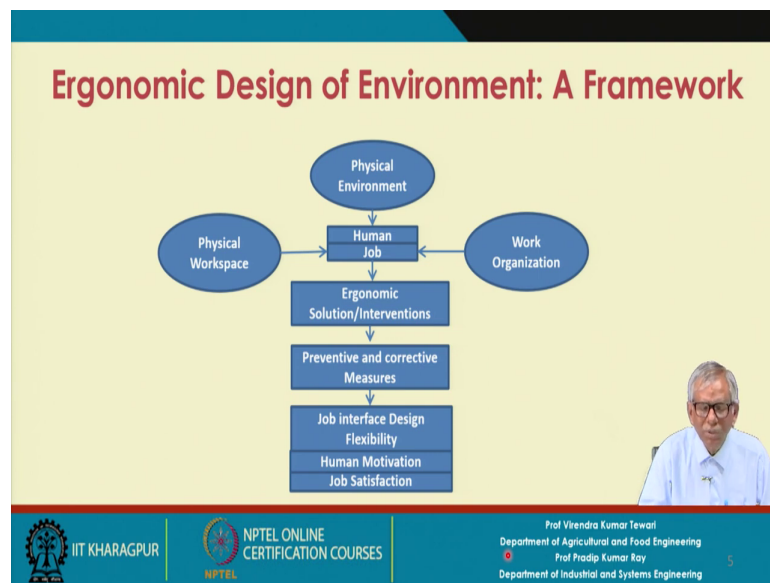
Psychological factors also you need to consider like if your visual environment is poor. Initially we will face lot of problems later on what might happen is that it might create physical inability and ultimately there could be some mental effect. So, you cannot avoid so and your motivation will be affected.

So, that is the kinds of assumptions we make. The general hypothesis is that if the visual environment and any type of the physical environment is acceptable to a particular person, he or she is intrinsically motivated to carry out the job.

For this you need the ergonomic solutions or ergonomic interventions. And if you have the correct ergonomic interventions then in all likelihood you will be able to remove the barriers to effective human performance.

And what we will find in majority of the cases these barriers are due to deficiencies in interface design. So ergonomic principles you have to apply. Motivation depends on work organization, job enlargement, job enrichment and shift work.

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Let us discuss framework of ergonomic design of environment. There are three types of components in an environment. First one is the physical environment, next one is the physical work space and the third one is the work organization.

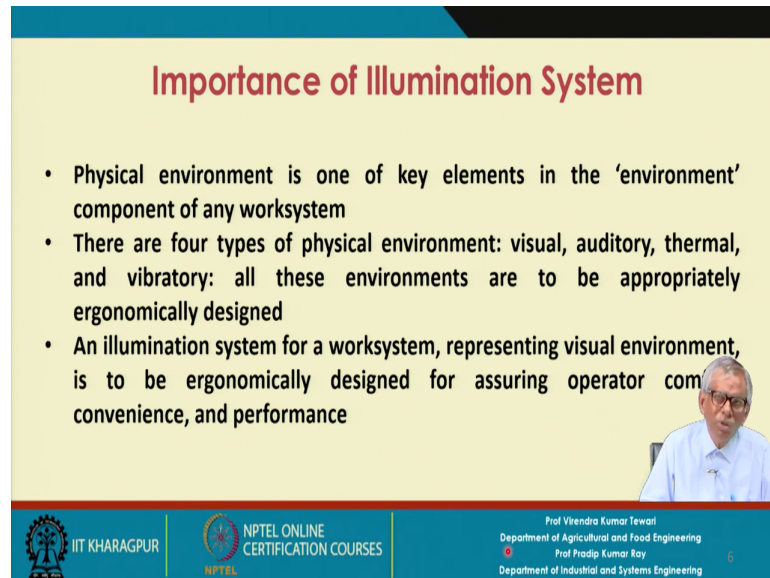
The design of the job is affected by all these three components as well as the human is on the job. So obviously, human performance or human efficiency is all dependent on these three factors.

Now so, once this information is made available with you what do you try to do; now you will go for assessment and the assessment is that what is your present level of ergonomic design which has always the scope for improvement.

So, there will be ergonomic solution or interventions that is your focus and you have identified as a number of preventive and corrective measures and how these are to be implemented; that means, there must be some implementation plan.

After that we will be focusing on four important conditions. First one is job interface design, the second one is flexibility. Third important conditions is you have to create goal that is the human motivation. If it is an ergonomically the design system the motivation means intrinsic motivation. That means, the motivation comes from within and at the end you will have the job satisfaction. Last one is job satisfaction.

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Importance of Illumination System

- Physical environment is one of key elements in the 'environment' component of any worksystem
- There are four types of physical environment: visual, auditory, thermal, and vibratory: all these environments are to be appropriately ergonomically designed
- An illumination system for a worksystem, representing visual environment, is to be ergonomically designed for assuring operator comfort, convenience, and performance

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Design of Illumination System/Visual Environment

- **Purpose of designing a visual environment is**
 - To allow people to recognize what they see
 - Not to just provide light
- **While we design such a system, we must be aware of negative effects of a poorly designed visual environment**
 - Visual discomfort
 - Headaches
 - Errors and inability to see details
 - Confusion, illusions, and disorientation
 - Epilepsy (seizure)

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the purpose of designing a visual environment is. 1. To allow people to recognize what they see. 2. Not to just provide light.

So, in many cases we will face problems in your visibility. If you are using say 60-watt bulb. So, why do not you use a 100-watt bulb? So, that is not the solution in many cases.

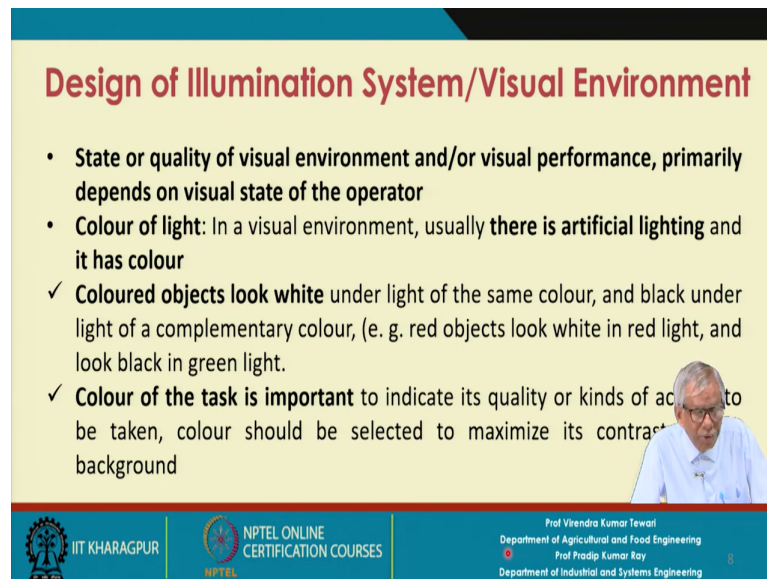
So, while we design such system, we must be aware of negative effects of a poorly designed visual environment that is the bottom line if suppose I do not bother about the designing a visual environment. So, I should be aware of what is this negative effect may not be observable today, but definitely after the one month or the few months this will be observable and then it becomes a problem; that means, getting a solution will be a problem.

While we design such a system, we must be aware of negative effects of a poorly designed visual environment, they are:

1. Visual discomfort
2. Headaches
3. Errors and inability to see details
4. Confusion, illusions, and disorientation

5. Epilepsy (seizure)

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Design of Illumination System/Visual Environment

- State or quality of visual environment and/or visual performance, primarily depends on visual state of the operator
- Colour of light: In a visual environment, usually there is artificial lighting and it has colour
- ✓ Coloured objects look white under light of the same colour, and black under light of a complementary colour, (e. g. red objects look white in red light, and look black in green light.
- ✓ Colour of the task is important to indicate its quality or kinds of action to be taken, colour should be selected to maximize its contrast against background

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State or quality of visual environment and or visual performance, if the visual environment is poor what do you expect the visual performance immediately, we assume that the visual performance is poor and if it is good; obviously, visual performance is also good. Primarily depends on visual state of the operator for a young person it will be one type for an aged person, it will be different.

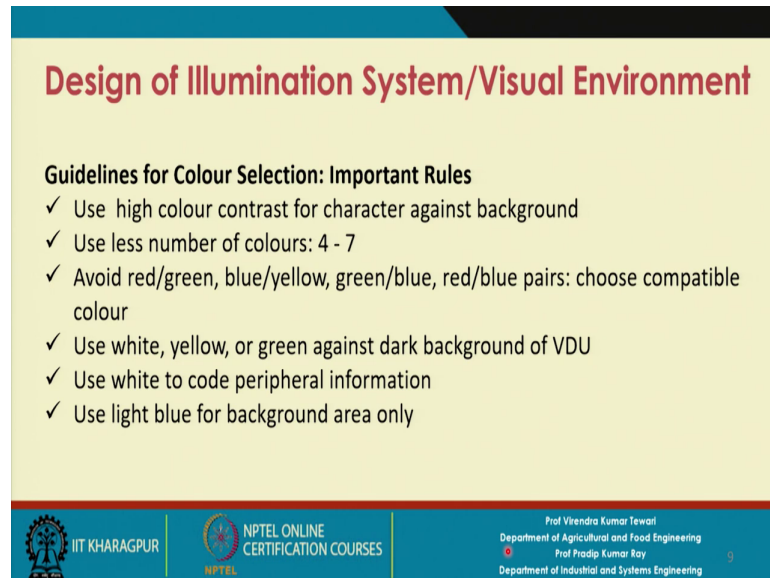
For a 25-year-old person who is in the prime youth, the kind of the visual state is much better.

Whereas, if someone is 50-year-old or 55-year-old otherwise he is a very good worker or the operator but still his visual state may not be good. So, the colour of light is also very important in a visual environment usually there is artificial lighting and it has colour but in certain cases in the open environment you will find the construction site maybe be it's a natural lighting, but mostly you will find in a factory system you will have the artificial lighting and there will be colour which is not like the sunlight.

Coloured objects look white under light of the same colours and black under light of a complementary colour.

Colour of the task is important to indicate its quality or kinds of actions to be taken, colour should be selected to maximize its contrast against background.

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Design of Illumination System/Visual Environment

Guidelines for Colour Selection: Important Rules

- ✓ Use high colour contrast for character against background
- ✓ Use less number of colours: 4 - 7
- ✓ Avoid red/green, blue/yellow, green/blue, red/blue pairs: choose compatible colour
- ✓ Use white, yellow, or green against dark background of VDU
- ✓ Use white to code peripheral information
- ✓ Use light blue for background area only

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So, this we will discuss in details later on with several examples how to measure the contrast ratio in many in many ways we can the define you can measure this contrast ratio. Now, first question is that how do you select the colour? So, there are certain rules you have to follow:

1. Use high colour contrast for character against background
2. Use a smaller number of colours: 4 - 7
3. Avoid red/green, blue/yellow, green/blue, red/blue pairs: choose compatible colour
4. Use white, yellow, or green against dark background of VDU
5. Use white to code peripheral information
6. Use light blue for background area only

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Design of Illumination System/Visual Environment

- **Key Questions:** given a worksystem,
 - ✓ (i) **how to design** an illumination system, and (ii) **how to assess and improve** quality of illumination in respect of human-job/task interaction?
- **There may be different types of problems a person may face while working with jobs or tasks in a given illumination system**, e.g. (i) reflection of light or glare on screen, (ii) poor visibility of objects, (iii) making errors in exacting jobs, (iv) error in visual inspection, etc.
- **While you design a visual environment, certain illumination system-related parameters are to be defined**, these parameters are: **illuminance, luminance, and contrast**

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There are some key questions we have given a work system such as: How to design an illumination system, and how to assess and improve quality of illumination in respect of human-job/task interaction?

There may be different types of problems a person may face while working with jobs or tasks in a given illumination system, e.g. (i) reflection of light or glare on screen, (ii) poor visibility of objects, (iii) making errors in exacting jobs, (iv) error in visual inspection, etc.

While you design a visual environment, certain illumination system-related parameters are to be defined, these parameters are: illuminance, luminance, and contrast.

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List of Reference Textbooks

1. Sanders, M. S. and McCormick, E. J., Human Factors in Engineering and Design, McGraw-Hill, Sixth Edition
2. Bridger, R. S., Introduction to Ergonomics, Taylor and Francis Group, Third Edition
3. Helander M, A Guide to Human factors and Ergonomics, Taylor and Francis Group, Second Edition



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