

Human Factors Engineering
Prof. V. K. Tiwari
Prof. P. K. Ray
Department of Agricultural and Food Engineering
Department of Industrial and Systems Engineering
Indian Institute of Technology, Kharagpur

Lecture - 54
Major Ergonomic Issues and Problems in Shift Work Design: Part - 1

Dear students, participants and other practitioners who have joined this course on Human Factors Engineering. Over the several weeks, we have been discussing various factors related to human being which are actually important and very much responsible in actually contributing towards the output of any system.

Whether the system is a production system in a great workshop or a small workshop or any construction work or any service work, everywhere the human being is involved.

Whatever be the level of automation, human being is involved in the automation itself. They are involving their mind in developing the automation and then they are governing the automation as well.

While it has happened that the higher level of automation is requiring minimal physical human beings, but there is a requirement of intervention of the human being. And therefore, we have to think of the human being's capabilities, limitations and thinking power, its abilities in various kinds, at various situations, and various conditions of the system wherever they are.

In fact, everybody is a different, some people are tall, some people are short, some people are thin bodied, some people are heavy bodies. This has been the course of discussion in the human factors engineering that we have taken for last 9 to 10 weeks.

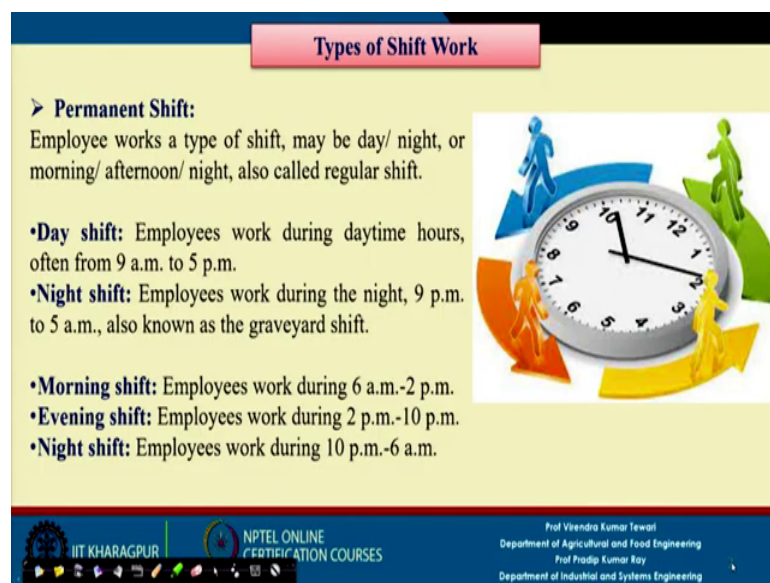
We have discussed several aspects along with my faculty friend Professor P K Ray. We have picked up many things. Now, today I will be talking of a very important factor which is called the shift work.

Keeping in view the requirement of the person is limitations and abilities, the shift work is designed because the work has to go to factories, the production has to go on without interruption. And therefore, people are required to be working in different shifts.

In this context, we have certain aspects to be considered. And as I said that human being has certain limitations in their thinking power, their ability. We want them to be always agile, throughout the 8-hour day.

So, through the several slides that have procured from various locations, including the work done in the industries, even the mines, in various other service sectors etc., I have picked up things together to show to you to discuss with you as to what are the importance of this shift work.

(Refer Slide Time: 03:58)



Types of Shift Work

➤ **Permanent Shift:**
Employee works a type of shift, may be day/ night, or morning/ afternoon/ night, also called regular shift.

- **Day shift:** Employees work during daytime hours, often from 9 a.m. to 5 p.m.
- **Night shift:** Employees work during the night, 9 p.m. to 5 a.m., also known as the graveyard shift.
- **Morning shift:** Employees work during 6 a.m.-2 p.m.
- **Evening shift:** Employees work during 2 p.m.-10 p.m.
- **Night shift:** Employees work during 10 p.m.-6 a.m.

The slide features a central illustration of a clock with four stylized human figures in blue, green, orange, and yellow, each standing on a curved arrow pointing towards the clock, representing different shifts.

IIT KHARAGPUR | **NPTEL ONLINE CERTIFICATION COURSES**

Prof. Vinendra Kumar Tewari
Department of Agricultural and Food Engineering
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering

We must know what are the different type of shift work. Regular shift, generally, we call it as permanent shift. But employees work as a type of shift, may be a shift which is done in the day time which we call day time or night time or morning, afternoon, night. These are the regular shifts which have been designed over a period of time for a long duration whenever in the system started.

Now, when we talk of day shifts, a day shift employees work during day time.

(Refer Slide Time: 04:40)

➤ **Split shift:**
Workers perform their job duties during two separate shifts on the same day, might work during 8 a.m. to 12 p.m. and from 4 p.m. to 8 p.m. with a four-hour break between the shifts.

➤ **Swing shift:**
Employees start their day during the afternoon.

➤ **Rotating Shifts:**
Same employee work in different types of shifts, can work afternoon shifts one day, night shift another day and morning shift the other day, also called irregular shifts, clockwise or counter clockwise.

➤ **Continuous shift:**
Also includes weekend, Monday to Sunday or may be shifts that are the same type throughout the week, night shift every night for a week, and then changes to day shifts for a week, then changes to afternoon shifts for a week.

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES
Prof. Virendra Kumar Tewari
Department of Agricultural and Food Engineering
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering

Employees work during daytime hours- often 9 am to 5 pm. And the night shift is from 9 pm to 5 am, sometimes it is called graveyard shift.

Morning shift, when you talk of the employees you must have seen security people who are working or even in the factories; those who have seen the factories they will realize and appreciate. That, morning shift is from 6 am to 2 pm. Then, afternoon shift or evening shift which is called 2 to 10 pm and night shift which is from 10 pm to 6 am.

Now, these are the different types of shifts which have been designed over a period of Split shift:

Workers perform their job duties during two separate shifts on the same day, might work during 8 a.m. to 12 p.m. and from 4 p.m. to 8 p.m. with a four-hour break between the shifts.

Swing shift: Employees start their day during the afternoon.

Rotating Shifts: Same employee work in different types of shifts, can work afternoon shifts one day, night shift another day and morning shift the other day, also called irregular shifts, clockwise or counter clockwise.

Continuous shift: Also includes weekend, Monday to Sunday or may be shifts that are the same type throughout the week, night shift every night for a week, and then changes

to day shifts for a week, then changes to afternoon shifts for a week. Time keeping in view various aspects of the job.

(Refer Slide Time: 09:50)

The slide is titled "Shift System Design" in a pink box at the top. Below the title, there is a section header "Direction and Speed of shift rotation:" followed by a list of bullet points. The bullet points are: "Forward rotation (Morning-Evening-Night) is less fatigue", "Internal push from circadian cycle to run slightly longer than 24 hours is comfortable?", "Speed of rotation: none (fixed shifts) to very slow (three to four weeks) to rapid (every two to three days)", "Worst rotation: four to seven nights continuously and shift to day shift which should be avoided.", and "Slow shift rotation is desirable for safety and productivity of workers". The slide footer contains logos for IIT KHARAGPUR, NPTEL ONLINE CERTIFICATION COURSES, and the names of Prof. Virendra Kumar Tewari, Prof. Pradip Kumar Ray, and the Department of Industrial and Systems Engineering.

Shift System Design

➤ **Direction and Speed of shift rotation:**

- Forward rotation (Morning-Evening-Night) is less fatigue
- Internal push from circadian cycle to run slightly longer than 24 hours is comfortable?
- Speed of rotation: none (fixed shifts) to very slow (three to four weeks) to rapid (every two to three days)
- Worst rotation: four to seven nights continuously and shift to day shift which should be avoided.
- Slow shift rotation is desirable for safety and productivity of workers

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | Prof. Virendra Kumar Tewari, Department of Agricultural and Food Engineering, Prof. Pradip Kumar Ray, Department of Industrial and Systems Engineering

Shift system design, when we are talking of designing of the shifts, direction and speed of shift rotation should be known. Well, when you are trying to design shift for a shop or a production shop or a regular organization where you want to have people in those and you know the nature of the task which is required for those people, irrespective of whether you are talking of only the workers who are involved or executives could also be involved in this. Because we have seen that the time zone, particularly the IT industry, our officers who are working those from home or even in the factory in the company, when they have to people discuss with people in different zones, there is a lot of things which need to be thought of.

But we have seen that these people are sitting here and going ahead till the date of night and even early morning, this needs to be looked into. Well, we are not talking of any shift for these people. But they do interact with people who are in different time zones.

In forward rotation, for example, morning, evening, night shifts are less fatigue. Now, already there are certain decisions which have been taken. We cannot argue with these decisions, but then I can say that forward rotation, so when you are talking morning, evening and night. This is the way we are talking of if you are talking of the anti-clockwise movements, say morning, evening and night, they say that is less fatigue. The

rhythm or understanding of persons biological system over the period of say about 3 weeks or for a duration when the shift could be in a position to understand better or accept better.

Internal post from circadian cycle to run slightly longer than 24 is comfortable. Now, we know that from when we are shift from a particular shift, like say morning shift to afternoon shift to night shift or from a daytime to night shift for example, 9 pm to 5 am to 9 am to 5 pm. when we are talking of this, there is an internal push in the sense that the either the organization is thinking of this or their system requires, it is supposed to be comfortable. This needs to be discussed and understood between the executive or the workers who are involved and the management.

Speed of rotation, fixed shifts 3 to 4 weeks, rapid every 2 to 3 weeks. Now, when we are talking speed of rotation people cannot be put into say for example, if there are 24-hour job.

There for example, suppose those who are there from 6 am to 2 pm and second group are working from 2pm to 10 pm and the third group is working from 10pm to 6 am. it is not possible for each one of them those who are in the morning from 6am to 2pm are well enough, those who are from 2pm to 10pm who could also be slightly better than 10 to 6, there has to be a rotation to complete all the 24 hours and equal level of opportunity and the rest that is required each of these group people is essential and hence to be given. Therefore, as a rotation has to be advocated.

Now, question is, how fast one should be rotating? It will depend differently on the nature of the task which you have, which the work workshop has or the level of a stress which is required. Therefore, the speed of rotation has a great bearing on the nature and the requirement of the task and the ability of the person as well. Sometimes, there is no fix shifts are there.

Then, you have very slow rotation that is 3 to 4 weeks. That means, every 3 to 4 weeks people could be shifted. Say those who are working from 6 am to 2 pm and those who are from 2pm to 10pm and 10pm to 6am, every 3 to 4 weeks there is a possibility.

Depending upon the nature of the task as an engineer or the manager of the system, you can always think of and have a permutation combination of these whether you want to

have 4 weeks or 3 weeks or 5 weeks depending on what you feel. But there has to be a rhythm in doing this. So, that persons or the biological system accepts this.

Worst rotation: four to seven nights continuously and shift to day shift which should be avoided. Slow shift rotation is desirable for safety and productivity of workers.

(Refer Slide Time: 18:01)

The slide contains the following text:

- **Time of shift changeover:**
 - Morning shift should start at 6 am to maximise sleep hour
 - Evening shift should end at 10 pm rather than 11 pm
 - should end earlier in weekends to increase social life
 - Night shift should start early to increase the hours of sleep during night time
- **Time off between shifts:**
 - Maximum of five to seven days work with adequate time off (at least 11 hours between shifts)
 - Reduction in time off reduces sleep time
 - Long working periods and consecutive night shifts increases accident chances

At the bottom of the slide, there are logos for IIT KHARAGPUR, NPTEL ONLINE CERTIFICATION COURSES, and NPTEL. On the right side, there is text identifying Prof. Viendra Kumar Tewari (Department of Agricultural and Food Engineering) and Prof. Pradip Kumar Ray (Department of Industrial and Systems Engineering).

Time of shift changeover: Morning shift should start at 6 am to maximize sleep hour.

These are some of the things which have been thought of and could be advantageous depending on a situation or depending on a type of task which is there. So, you will see the morning shifts should start 6 am to maximize sleep hour. Now, you are talking of later.

Then, evening shift should end at 10 pm rather than 11 pm. So, when we are talking of that it should stop at 10 pm, so rather than 11 pm that means, from 10 he has enough time to sleep and so that the mental makeup or the mental rest that he needs or the whole physical body rest is taken care.

It should end earlier in weekends to increase social life. Well, these are some of the things which people are thinking that there is a social life.

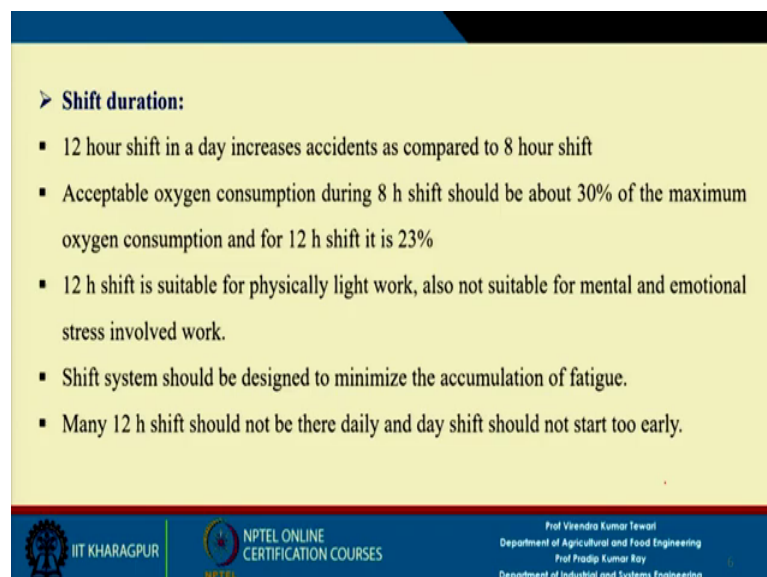
When we are considering the biological sleep of that person, we do need to consider also his social life as well. Because it has a strong component of keeping him mentally fit.

Time off between shifts. Sometimes it does happen that people are not given time at all and they go for continuous shifts. As some of the tasks which are very difficult for example, in the glaciers there is no question of thinking of shifts etc. but they do continuously, we know that continuous 3 months they have to be there and then after that there is a change. But there could have been change coming up we do not know. But the nature of job and the severity of the weather over talks of the changeover, immediate changeover is not very comfortable or not very acceptable. And therefore, they continue may stay for 3 months.

So, a time off between shifts is essential. 5 to 7 days work with adequate time of at least 11 hours between shifts. Reduction in time of reduced sleep time. If you reduce this off time which is given in between, enough off time is essential for this person to rejuvenate himself and get back to the work in the next shift when he is in long working periods and a consecutive night shift increases accident chances.


But long working periods and conservative night shifts increases in accident chances because the person is a certain aspect of boredom comes into play. And that is very essential one should have a look at these, depending upon the nature and the type of work that he is doing.


(Refer Slide Time: 22:00)



➤ **Shift duration:**

- 12 hour shift in a day increases accidents as compared to 8 hour shift
- Acceptable oxygen consumption during 8 h shift should be about 30% of the maximum oxygen consumption and for 12 h shift it is 23%
- 12 h shift is suitable for physically light work, also not suitable for mental and emotional stress involved work.
- Shift system should be designed to minimize the accumulation of fatigue.
- Many 12 h shift should not be there daily and day shift should not start too early.

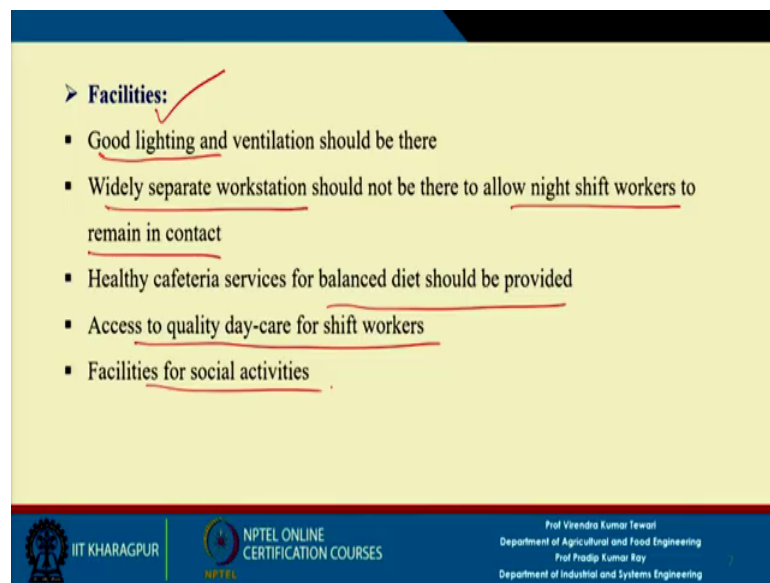
 IIT KHARAGPUR

 NPTEL ONLINE CERTIFICATION COURSES

Prof. Viendra Kumar Tewari
Department of Agricultural and Food Engineering
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering

Shift duration. 12-hour shift in a day increases accidents as compared to 8-hour shift. Acceptable oxygen consumption during 8 h shift should be about 30% of the maximum oxygen consumption and for 12 h shift it is 23%. 12 h shift is suitable for physically light work, also not suitable for mental and emotional stress involved work. Shift system should be designed to minimize the accumulation of fatigue. Many 12 h shift should not be there daily and day shift should not start too early.

(Refer Slide Time: 24:05)



The slide features a yellow background with a blue header and footer. The main content is a list of facilities for shift workers, with a red checkmark next to the heading 'Facilities:'. The list items are: 'Good lighting and ventilation should be there', 'Widely separate workstation should not be there to allow night shift workers to remain in contact', 'Healthy cafeteria services for balanced diet should be provided', 'Access to quality day-care for shift workers', and 'Facilities for social activities'. The footer contains logos for IIT KHARAGPUR, NPTEL ONLINE CERTIFICATION COURSES, and NPTEL, along with the names and departments of Prof. Virendra Kumar Tewari, Prof. Pradip Kumar Ray, and Prof. Pradip Kumar Ray.

➤ **Facilities:**

- Good lighting and ventilation should be there
- Widely separate workstation should not be there to allow night shift workers to remain in contact
- Healthy cafeteria services for balanced diet should be provided
- Access to quality day-care for shift workers
- Facilities for social activities

IIT KHARAGPUR | NPTEL ONLINE CERTIFICATION COURSES | NPTEL

Prof. Virendra Kumar Tewari
Department of Agricultural and Food Engineering
Prof. Pradip Kumar Ray
Department of Industrial and Systems Engineering

Some of the things which are essential are as follow.

1. Good lighting and ventilation should be there.
2. Widely separate workstation should not be there to allow night shift workers to remain in contact.
3. Healthy cafeteria services for balanced diet should be provided.
4. Access to quality day-care for shift workers.
5. Facilities for social activities.