Human Factors Engineering

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Lecture - 04
Modern worksystems, FMJ vs FJM

Dear students and participants. In the third lecture, we discussed the ergonomics human factors Engineering and ergonomics as applicable to different tasks. We have talked of the various complexities, we have talked of the machine component; we have talked of the environment component and how all these things come into play while we are thinking of getting maximum out of a human machine system, environment system.

Now, we will talk of how best the three players are taken care of. The three players are the human being, the machine and the environment. While we may not have so much of control on the outside environment; inside environment can be controlled. For example, in a workshop if the work is going on, how best we can control the illumination level, the dust level, the noise level and the other immediate environment at the task.

The next important ones are the machine and the human being. How best we can fit these people?

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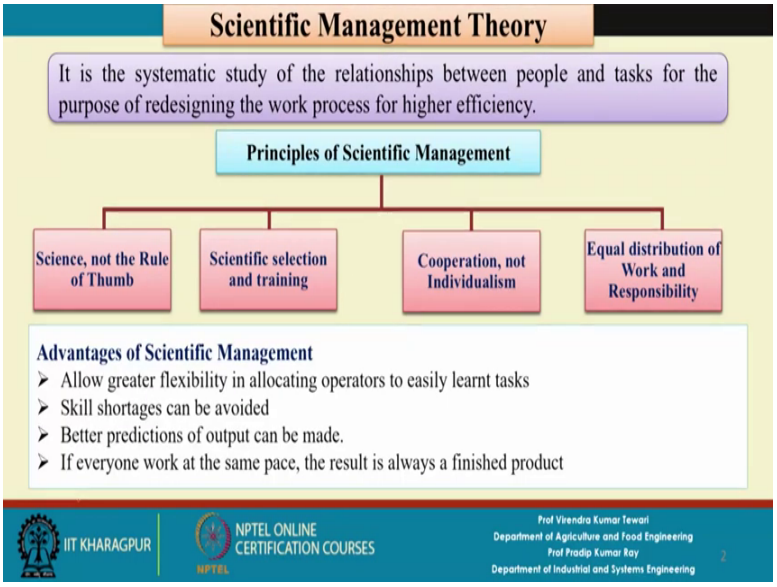

If you want to do a work in an orderly manner, you will have to follow certain rules, certain principles, certain ways of doing things. For example, you will not have each time a rule of thumb, but you will have certain science-based rules, science-based principles.

If you say a task has to be performed then you would like to have some sort of a training. Every task before you take up you require to acclimatize yourself. Acclimation vary on the level of training that you have on a similar task earlier, how best you are selected for the task or how the task and the human are matching.

And then cooperation; it is said that when you are talking of a human-machine environment system, it may involve many such people. Suppose, you are talking of assembly line; there several people are involved doing their different task individually, but then ultimately it is a task of the whole team. Therefore, we would like to have the distribution of the task in such a way that there is appropriate distribution of the work and the responsibilities which are to be given. The advantage of such thinking is that it will allow greater flexibility, skill shortage can be avoided, then better prediction of output can be made.

When you think of human machine and environment, you need to manage these three major components and each will have its complexities and simplicity. Within that you will have subsystems, you will have subgroups, you will have some subitems.

In scientific management, all these parameters have to be taken care of when you are thinking of designing a man or human machine system.

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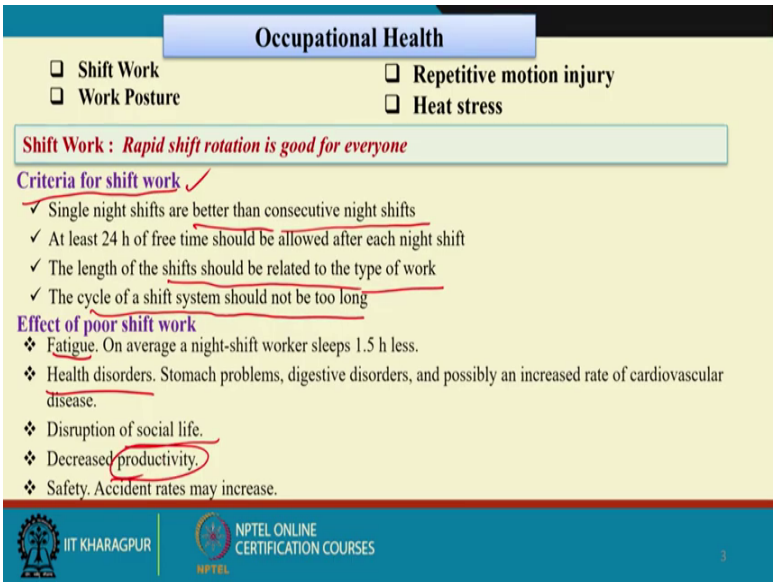

Occupational health, welfare and safety of the person has to be considered paramount.

You must have heard the name of Frederick Winslow Taylor and he was on a task and he found that some sort of shoveling task was going on and after some time the workers who were there started absenting themselves, complaining of certain difficulties in pain in the body and all that; and ultimate and slowly the participation went on decreasing.

He was thinking as to what may be the reason. Possibly, he has talked to some of the people and they say that, I work this in this posture or fashion and then I was feeling tired I felt some pain in my back and that is why I want to take rest. He thought that there is something wrong somewhere; it may not be wrong in the person because he is otherwise physically fine and he was doing the task earlier.

But there is a problem; the task which has been given to him, the tool which has been given to him could be a question mark. He thought that let me change the size of the shovel; the shovel was 14 kg carrying 14 kg now made is 7 kg.

Immediately, when he did half of that he saw that the output increased and the absenteeism because of the people not coming to the work and the complaints of pain and other aspects of their body got reduced. So, the design of the tool which the person is handling has a greater role in influencing the total efficiency and the occupational health of the person.

While, the person is there in the occupation or the task or the job on which he is performing maybe 8 hours or a day; his health has to be taken care of. Therefore, what is the type of job which you require here? Sometimes in occupational task in some of the industries we talk of the shift work because people work in 3 shifts. You have to have the 24 hours the company does not stop production; its product production has to go on for 24*7; and for that the 3 shifts are 8*3.

In each shift the person have to be there. Now, how these persons should be well organized in the shifts? Because everybody has to work in daytime shift, in the mid-day shift and then the night shift as well because there has to be proper of the work.

What is the repetitive motion injury? If you are doing a repetitive task then sometime this repetitive task, if it is not properly organized, will lead to some sort of a physical injury to the person.

Some of the information which is given here shift work; rapid shift rotation is good for everyone that is that somebody has done this study and on the basis of that he talks that may be rapid shift rotation is good for everyone; but then they are also talked that the cycle of a shift system should not be too long.

This cycle should not be too long, maybe he should be able to get some time for his other activities. The length of the shift should be related to the type of work. This is another factor which must be considered while you are designing or you are talking of the criteria of the shift work. Single night shifts are better than consecutive night shift. It depends on how best you should utilize the capabilities and the limitation of the person.

Effect of a poor shift work: if you do not have then there will be fatigue, then the health disorders will take place and then disruption of social life. Then, productivity; and ultimately the safety and accident may also take place because of this. So, while we are talking of the man or human in the system of human and machine these are the aspects which need to be considered properly.

This is where is the need for human factors engineer or an ergonomist in a production system or in any service sector wherever you can think of, there is a role for him.

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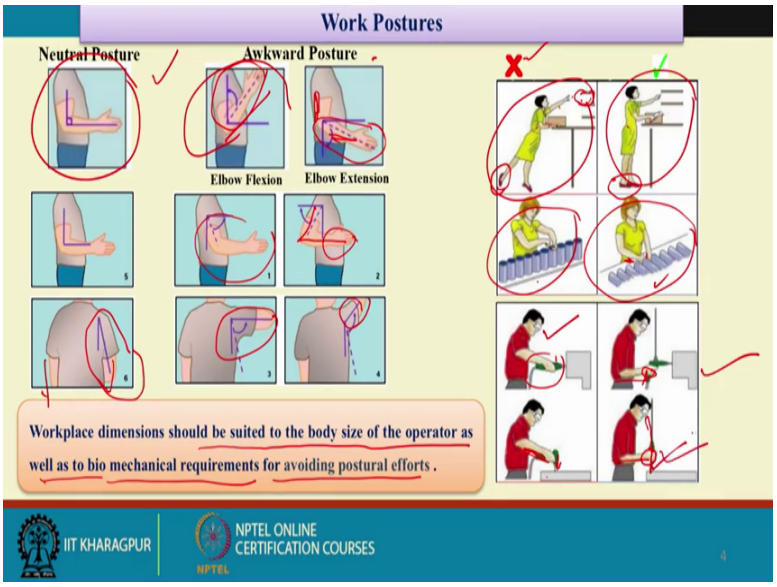

You see here is the work posture. It is very important for us to show you how we talk with respect to the postures. If you are working in that posture, you will definitely feel it first-hand. You can see here the neutral posture, but the awkward postures.

These biomechanical aspects of the human body are made in such a way that if there are stress on the muscles over here or here, then you will not be able to operate these for a long duration of time.

Similarly, the various other postures are shown here. What will happen if you operate like this, if you are doing a task which is look like this or a task which where you have to pull it here and then operate, what will happen if you have to maintain this posture for a long duration, if to maintain a posture like this what will happen where the hand is this where this hand is turned for doing certain task.

These work workplace dimensions should be suited to the body size of the operator as well as to biomechanical requirements for avoiding postural efforts or postural discomfort. When we are talking of the neutral postures, we are talking of the awkward postures, we are talking of the various such postures which are assumed when the person is on a task.

You have seen the lathe operation, you have seen the tractor driving operation, you can see the car operation, you can see the bulldozer operation or the JCB that you talk of. if those are not properly designed; the person has to take lot of risk while doing this.

Proper work posture is must for that; for example, on this side this position is not correct whereas, this posture is correct; in the senses that here she has to reach to this point, but there is a gap here and you see the position of the leg here. In this case the correct one is this side; that means, her legs are also on the base.

This is in a standing posture; she can reach here as well without any interference of this object with her body. You see here the body is more or less close; if she goes here there will be closer. She can get hurt because of this as well as it will be difficult to stretch her hand up to this to get this material.

Therefore, when you design the cupboards particularly in the kitchens, you must see how the carpentry people take care of that. Sometimes, the ladies are shorter, then it is difficult for them to reach up to that cupboard; how to keep the essential things at which location.

When you are evaluating you must take care of that the height of the lady or the height of the person who will be working there, the size of the person and the other capabilities. Similarly, you see here how this second task, how this is comfortable here. Because some support she gets over here as well as in this while doing this particular task where this is not the one.

Similarly, see the posture of the hand, how he is trying to do whereas, if this posture is in this fashion and he is gripping over here then he will be doing a better job as compared to this task. Similarly, the tool is in the vertical direction here, but see the hand position.

Since this is in vertical position, let it be held like this and the grip is here. Vertically the job will be done. This is a posture which is perfect for that. Your body and the hands and legs stretched in such a way that the posture is a better posture to assume for the task which you are asked to do.

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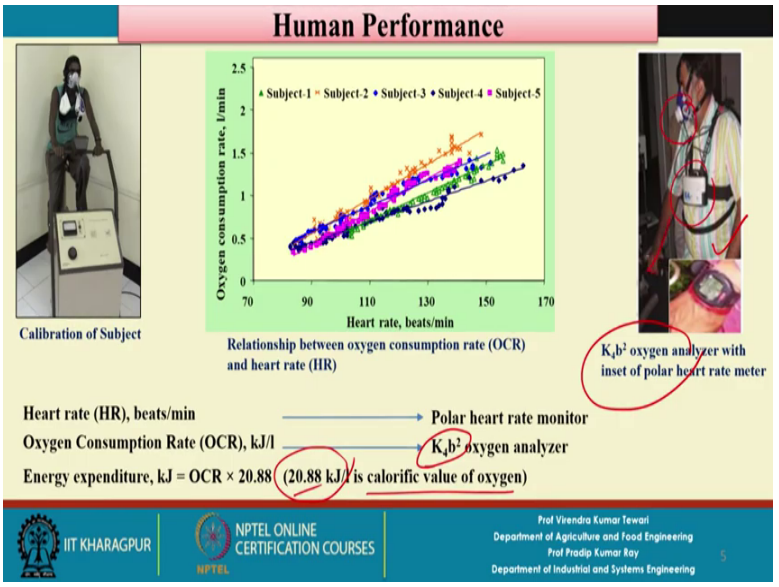

Human performance: how do you take the performance of the person; how do you record the performance of the person. A person has to be selected for a particular task.

Now, we need to calibrate the person, we need to understand the physiological part of the person how much of oxygen and how much of energy that he can spend, what will be the level of his or her heart rate. These are essential physiological parameters of the person in the task are essential because they should not shoot up.

Here we are talking of the heart rate, we are talking of oxygen consumption and the resulting energy that we are talking of. Per liter of calorific value of oxygen is 20.88 kilo joule and therefore, every liter of oxygen that you consume, you release an energy of 20.88 kilo joule.

Oxygen consumption rate is to be measured through a device. We have given K_4b_2 oxygen analyzer which is shown over here. It is connected to the mouth of the person while he is doing the particular task.

There will be a variation in these parameters of heart rate. The heart rate is plotted from this to this, you will find that this is the how the whole circle is seen, whole variation is seen with respect to subject 1, subject 2, subject 3, subject 4 and subject 5. If there are five subjects and if you have taken their oxygen consumption and heart rate and try to plot, this is how something will happen.

It will depend on the capacity of the person; it will depend on the training that the person has taken before the task. The calibration of the person in the task is very essential under varying conditions. This is a bicycle ergometer here, we can maintain a certain level of speed of the wheel which he is trying to operate at certain load.

We know how much is this load and how much is the speed at which is he or she is maintaining. We can know about the physiological cost of that person, in the form of oxygen consumption, in the form of heart rate and the related energy released. This will also have further effect on the body heat. There will be heat generated and there will be change in the body pressure of that person.

While we think of the human being and the task in front of him under a varying condition, we have to think of how best he or she is utilized so that all these physiological pattern parameters are within the capabilities and limitations of that person.

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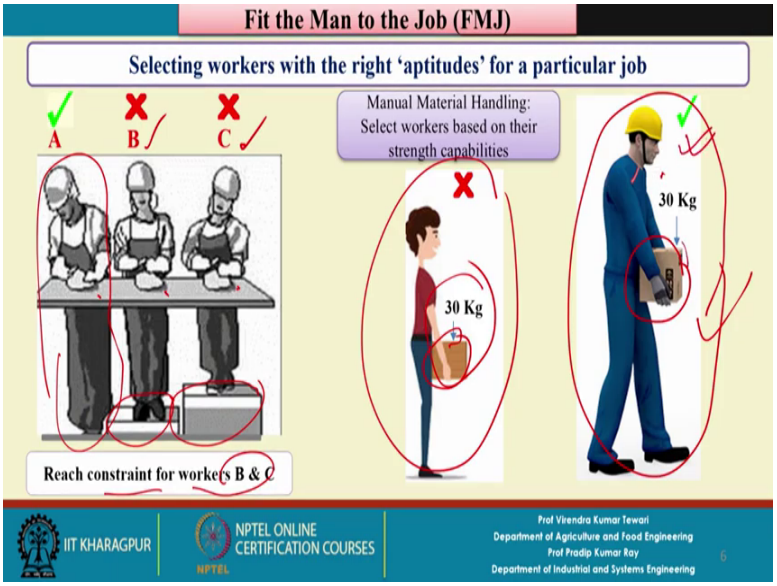

These are two players- the machine and the human being. How best you should put them together so that the best is obtained, keeping in view that the environment is same in all the conditions?

It does not happen because there is a mismatch between the human being and the machine; either the machine has been given more importance as compared to the human being or human being has been given more importance as compared to the machine.

There has to be a compromise between these two and therefore, we say that either the job has to be fitted to the human being or the human being has to be fitted to the job.

In some cases, it is not possible to always fit the task to the human being, but may be that we will have the compulsion of fixing the human being to the task. There may be certain disadvantages, but that those could be taken care of by giving proper work residuals, proper motivation and other aspects of the management which you can take into consideration so that the people will be happy and the output will be better. For example, you see here that B and C are not correct. They have reach constraints here; that means, they are not in a position to reach and that is why this has been given to them; whereas, this person is of course, there is no problem it has gone.

There are constraints-a shorter person has to be thought of as to how best he should reach the same table; a middle person how he reaches to the same table and do the same task. When we consider this, we need to know as to how best we fit the physiological parameters like the anthropometric data, the strength capabilities, his muscle power, his cognitive power. Other things you have to be taken care of while you are trying to fit the man to the job or job to the man or the human being.

Manual material handling: This has a greater role or greater appliance in the material handling. A lot of material handling tasks take place in the industries of various kinds while moving equipment or moving certain materials finished products or raw materials from inside factory to outside factory when you talk of the output products.

During that material handling lot of tasks are there and those tasks many a times are of the industry 1.0; where the human being has to pull up say for example, like this.

Now, the capacity of the person is not within his capable capacity or he cannot lift a 30 kg. So, there will be a problem. A person must have enough strength and training and capability to understand how to hold it properly. Even holding this properly is very important while you are thinking of the output.

You have to think that how best the persons capabilities and limitations are taken while this task of lifting and shifting it to another location is concerned. Therefore, we need to have a compromise, a tradeoff between what is acceptable and what is not acceptable, what is within

the acceptable range at the same time not very much compromising the quality of the output as well as the total output of the system.

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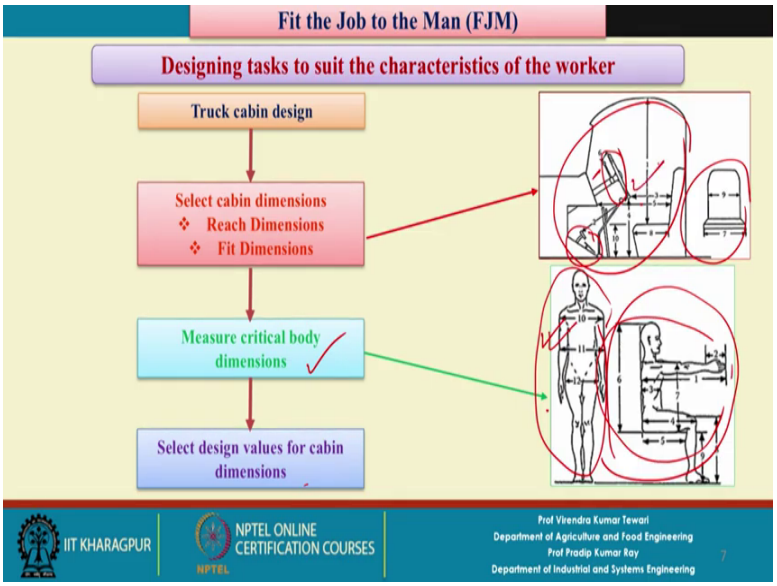

So, you fit the job to the man. For example, a truck cabin. This is the design of a truck cabin; this is the seat over here. Then you know the anthropometric dimensions of the person, and then how best you can fit him in such a way that he is in a position to operate the levers which are there for the leg, some of the levers which will be there for the hand and this is the feet.

How best the critical body dimensions which are measured are employed in designing of these selected designs for cabin dimensions. They are the ones which take place because of the initial information you have got from here and trying to utilize this for the cabin design.

Designing the task to suit the characteristics of the worker exactly, what are the characteristics of the physiological characteristics of the worker, the strength capabilities of the worker, his training level, his cognitive mind thinking power, etcetera.

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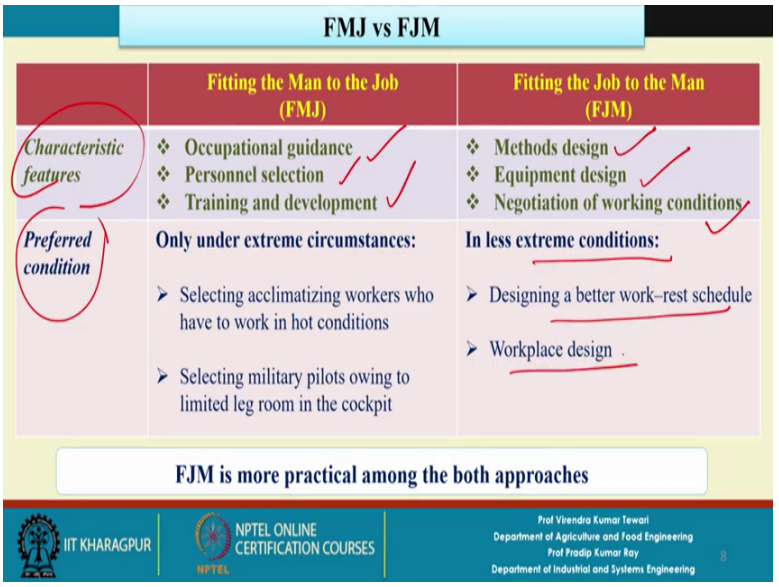

Fitting the task you have the characteristic features here, preferred conditions here. You must look into the occupational guidance, personal selection, training and development these we need to have.

Similarly, methods design, equipment design, negotiation of working conditions; in less extreme condition than designing a better works rest schedule workplace design.

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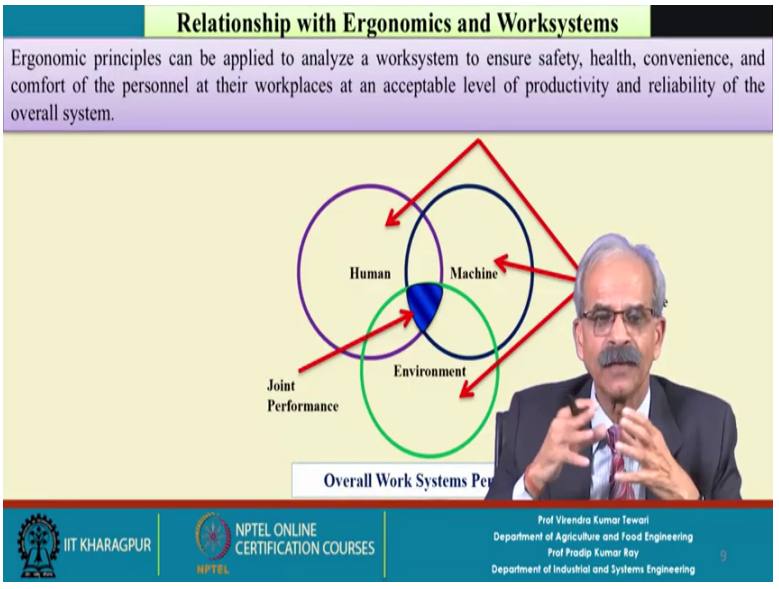

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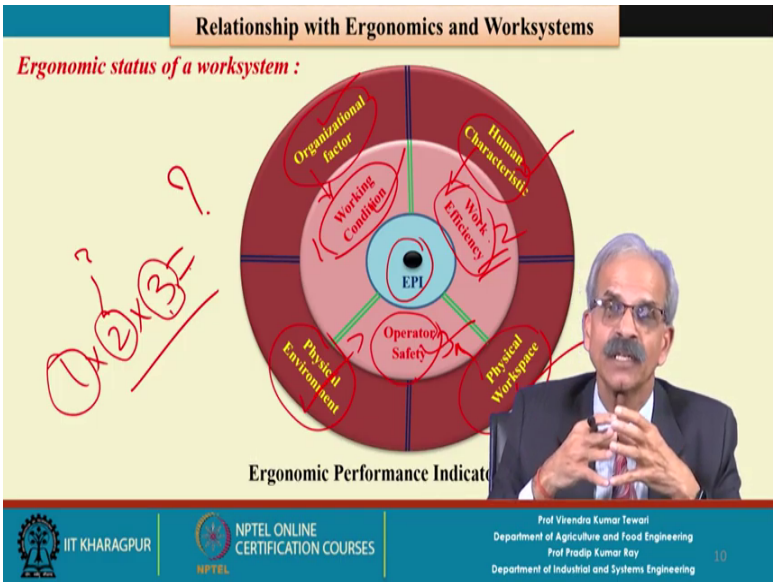

Suppose you are talking of a system where the organizational factors the human characteristics, then the organizational factors then physical environment and physical work space are very important.

While, we are talking of the bullseye; the complete performance of a person you will have to think of the physical work space, you have to think of the human characteristics, organizational factors and then the physical environment. Once you take, these are the outside factors which are to be considered when you think of the relationship between ergonomics and work systems while man is at the center; and the output is the prime importance.

Once it enters into these circles, you will find something else. Operators' safety is paramount; you have to think of the operator safety while he is doing the task. If you want him to deliver with maximum output in a given period of time; you have to think of his safety, you have to think of his comfort, you have to think of his capabilities to be best utilized in this.

Then, the working condition, what is the working condition you are giving him? if you are not giving him a congenial working condition how do you expect him to do a job properly and with maximum strength and maximum level of motivation. The work efficiency will be affected if the operator safety is not taken care of, if the work condition is not congenial, then the work efficiency will get depleted or work efficiency will come down.

So, 1 × 2 × 3, the output will be a question mark. The efficiency which we are talking of item 2 here will be affected by on 3 and 1 where work condition and the operator safety. If this safety is not proper or not to the extent which must be given you will find the output is not commensurate with what the investment has been made.

Therefore, I have just given example of ergonomic performance indicator that we had designed and we have used this in various industries to know how best ergonomically matured a particular work system is. Whether you are talking of mine condition or you are talking of a production system or you are talking of a man-machine particularly in open environment like say large number of people are working in say desks and tasks particularly open offices where people are there.

How best is the interference of one's work with respect to the other because you must have even seen that people are seated about 4 and 4 feet away and each one is not in a position to see the other one, but everybody is doing his or her task properly is an open office system. So, we need to know as to what is the ergonomic maturity of the system.

And therefore, we think what is the environment, working there, what is the type of tools and devices which are given to the people and how best the get with other workers, because the output of individual output is not the prime importance; the teamwork is prime importance. The camaraderie between the various workers is very essential. How you have created that environment for the people who are working for you; otherwise, you will not be in a position to get the maximum.

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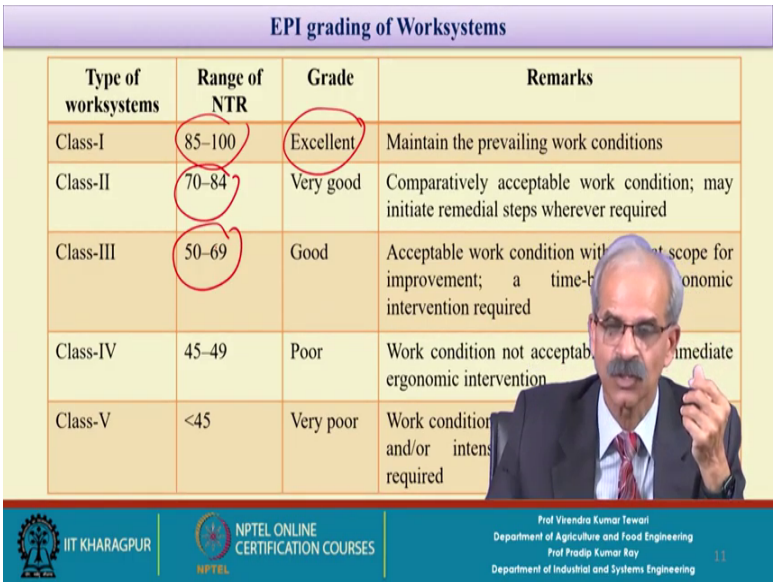

Some sort of a grading has to be given. Suppose, you know the ergonomic maturity of a particular production system or a work system where you want to know as to what is the level. We have given here, where the grade is excellent- say 85 to 90, it is the net EPI grading that we are giving.

Accordingly, class II is 70 to 80, class III is 50. This EPI grading is one of the ergonomic performance indicators, grading of work systems which we have done and employed in various work production systems in various industries.

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