Human Factors Engineering

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Lecture - 56
Green Technologies and Near 0 Waste Processing

We have been discussing each and every aspect of ergonomics and human factors engineering. We have been thinking as to how best ergonomics fits into all the work systems whether we are talking of a production system or you are talking of any manufacturing system or you are talking of any service sector or the construction sector.

We have to go into details of what ergonomics is, how far the importance of human being is concerned in this ergonomics, what are the limitations and capabilities of human being? How those capabilities and limitations have been utilized in various work systems to get maximum out of a system or an overall system?

What are the various other parameters? For example, the environmental conditions; if you call it the physical environment, if you call the environment which is immediate to the person concerned at the nearby task, several aspects have been considered keeping in view always that the person is safe and he is in a position to deliver the best with this all consciousness at each and every point of time during the course of his work.

While we have been doing this over the system, we have also talked of what are the work systems in which person has to be given certain level of rest. How much is the upon level of rest that he has to be given, what sort of shift work that he does? It is very essential that many of the tasks which are done round the clock need to be done in shifts.

We have talked about the energy involved in various tasks when the human being is there in the systems, how best system could be fitted to the requirement or capabilities of the human being. We have also tried to fit the human being to the requirement of the system as and when required.

We have also tried to see that how best we can take care of his capabilities, particularly his physical capabilities in some cases and mental capabilities in other cases and so on

and so forth. Now the question raises how do we check the ergonomic performance or ergonomic maturity of a particular work system whether it is a production system, or a service sector or a common educational system or you are talking of a construction system or whatever in each of the systems, you need to know what is the actual ergonomic maturity of the systems.

It will keep the human being with all his factors and limitations intact; at the same time get the maximum out of the whole system. It is only possible if you get the maximum of the human being.

If human being has been properly taken care of and the machine is acting at its maximum and the physical environment is also excellently managed, then we will see that the system has performed to the best possible extent. While we are doing this, we need to know how best the system has been in place so far as the ergonomic maturity of that system is concerned.

How to find out that the ergonomic maturity of a system where you would like to see what are the parameters which have been talked of? What are the characteristics of human being which has been taken care of, while designing the system or considering the system for maximum output keeping in view all the essential capabilities of the person.

In order to do that we have to have some sort of a reaching scale. We would like to have the perceived exertion rating scale. Sometimes we give some other skills by which we are in a position to categorize the persons capability in some situation.

But we thought how best for a production system. So, let us take the case of a production system when a lot of production is going on or the assembly is going on. For say engine or various other parts of engine or for a car manufacturing company where the different components are being added at various locations and ultimately it goes for painting and then goes out for the storage or camping.

When we are thinking of this system what are the parameters which have been thought of and how we say that this particular work system or the production system is very well designed ergonomically? It is well placed ergonomically or it has the ergonomic maturity. In order to know that we have to think of certain parameters.

We have tried a concept long back about 15 years back and we have copyrighted that as well where we are trying to factor all the parameters which are essential. Some of the parameters which we call them as base parameters, some of the parameters which we call physical parameters where we will be in a position to identify how is the principal parameters or the base parameters will work in tandem in order to give the maximum output of the system. We had various examples of Tata Steel workshops which were tested and we came out with this particular parameter which we call as ergonomics performance indicator.

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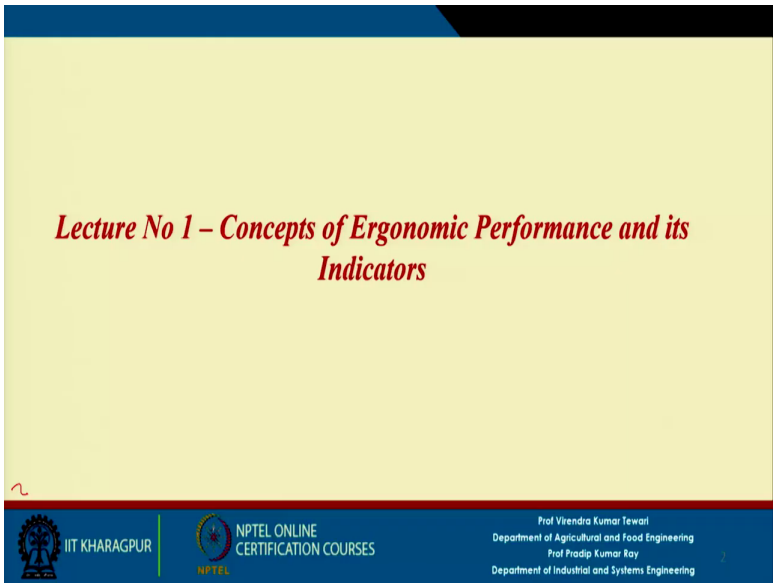

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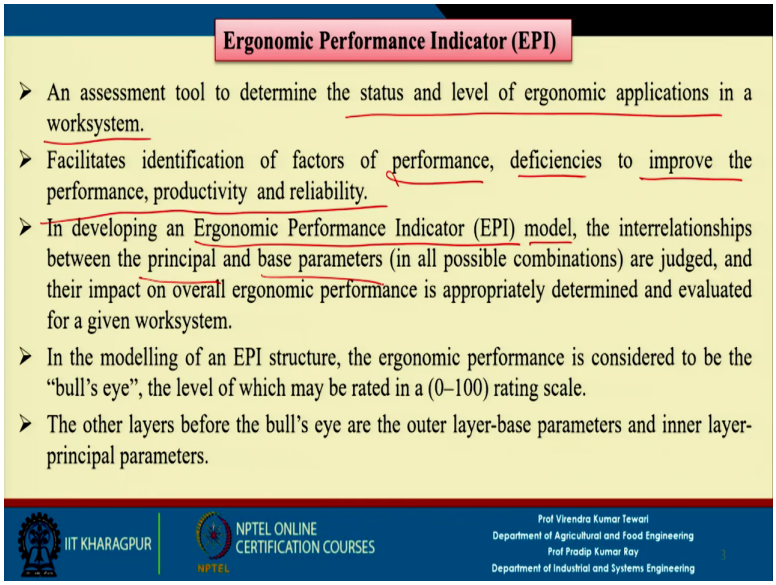

This ergonomic performance indicator has a certain parameter, certain virtues through which this has to be designed. Because we cannot say that this system is perfectly alright in all the cases, but there will be a certain level at which we can only say that it is alright.

To this extent a particular system is ergonomically matured and the ultimate result is that the accident will be minimum as all the possible stake holders premises are taken care of and the people are supposed to be safe while they are on their job.

We are talking of ergonomic performance indicator or EPI. It is an assessment tool to determine the level ergonomic application in a work system. Facilitate identification of factors of performance deficiencies and improve the performance productivity and reliability.

In developing an ergonomic performance indicator model, the interrelationship between the principal and base parameters must be known.

For example, in any objective rating we would like to have some sort of a quantifying parameters or quantification. We thought that there should be a quantification between 0 to 100. So, we would like to have a scale factor which will go between 0 to 100 and we will then define as to whether what will be 0 and what will be 100.

And what are the marks or the values which will indicate that the system is very good or does not need any improvement; only needs to be maintained at that level. Some of the system which could be yes, it is very good, but needs some improvement in some aspects.

The third could be that yes, its system is fair enough, but there are certain other things which need to be revamped. The other systems could be completely rejected. Keeping this in view we had thought of a 0 to 100 scale which we will quantify on the basis of the various parameters.

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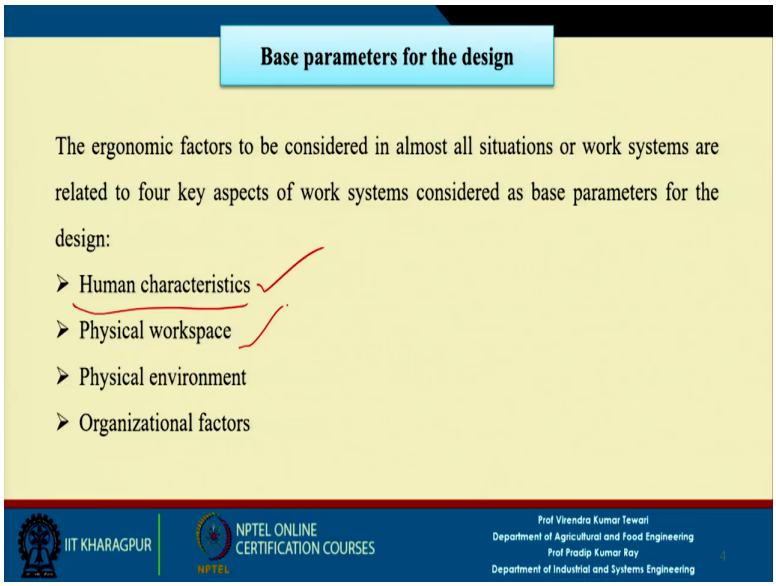

When we talk of this, we will have certain base parameters because we are talking of the human being. The characteristics of human being becomes an important parameters.

He can do a task at certain rate. He may not be able to remember many information at one go. He is not in a position to analyze until unless he is given training on that particular aspect. That means, human characteristics becomes one of the most important base parameters in the design. The person is involved, while he is doing the task, he is involved in a physical workspace.

Now these workspace does talk of his performance. Sometimes in a cramped situation and it will be difficult for him to do well.

Then we are talking physical environment. For that matter you have to give a congenial atmosphere or environment to the person to perform his activity, whether you are talking of a working on blade or welding or you are talking of doing any task in the production shop where a lot of other environmental factors are coming into picture.

For example, the dust, the noise and the illumination level which may come. The third base parameter is the physical environment. Even the organizational factors affect the performance of a person may be that.

If they are not taken care of properly with regard to their pay package or the remuneration which they get in lieu of the task that they do or the services that they

provide to the industry or to the organization where they are, how they are motivated to do more and more work and to meet the targets which are demanded demanding very much in the production system?

Therefore, we need to have organizational factors also as one of the base parameters. Wherein we should factor these parameters and come out with a value which will clearly indicate the actual maturity of the system. Now when we talk of these base parameters, we have to think of what are the other key parameters, which are the principal parametersm, which are mainly dependent on the basis of these base parameters, their performance of the whole system is dependent.

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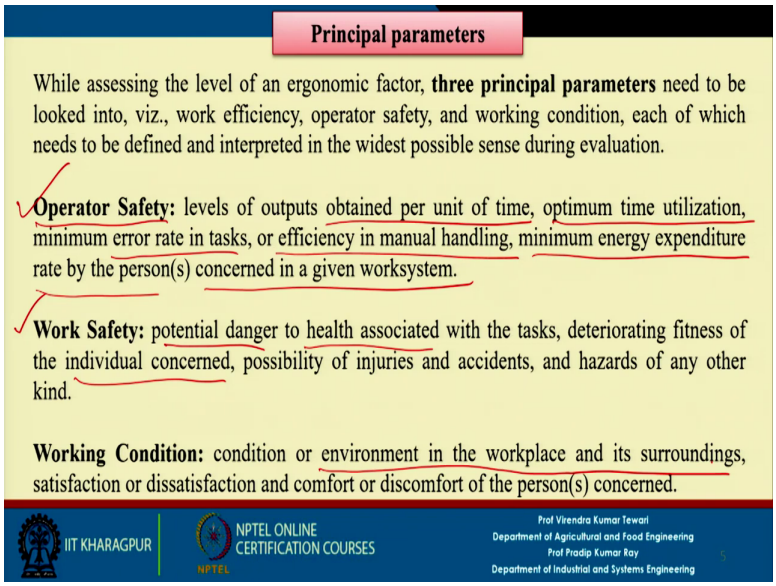

When we come to the principal parameters operator safety is prime.

When we are talking of operator safety it is very essential for the operator at the level of outputs obtained per unit of time. Say for example, if you are talking of a certain production, the operator safety while meeting that requirement must be utmost. Optimum time utilization. What is the time that utilization takes place when he is on the task? What sort of error in the task which occurs. Efficiency in manual handling minimum energy expenditure rate by the person concerned in a given work system.

So, we are talking of operator safety. While he is involved, the safety of the operator is prime requirement for us. Then work safety. When we are talking of work safety. What

is the potential danger to help associated with the task, this is important for deteriorating fitness of the individual concerned.

It may also happen that the work safety is not there; may be that his job or the condition in which he has been placed for completion of the job is not commensurate with his own capabilities. And therefore, it is very likely that individual health will deteriorate. Working condition or the immediate outside environment which will definitely affect.

Environment in the workplace and its surroundings because when we talk of this working condition under what difficult working condition he or she is working or what congenial condition which in he or she is working or what optimum condition in which everything is being performed.

We are talking of work safety and we are talking of working condition. Operator has been taken care of, but what is the level of operator safety is concerned, work safety when we are talking of human being involved in the system and then we are talking working condition.

Under what working condition and environmental condition- whether the illumination level is enough or not, whether the noise is fine or not, whether the protection devices are there or not. Therefore, working condition becomes one of the prime important factors in the design of ergonomic performance indicator.

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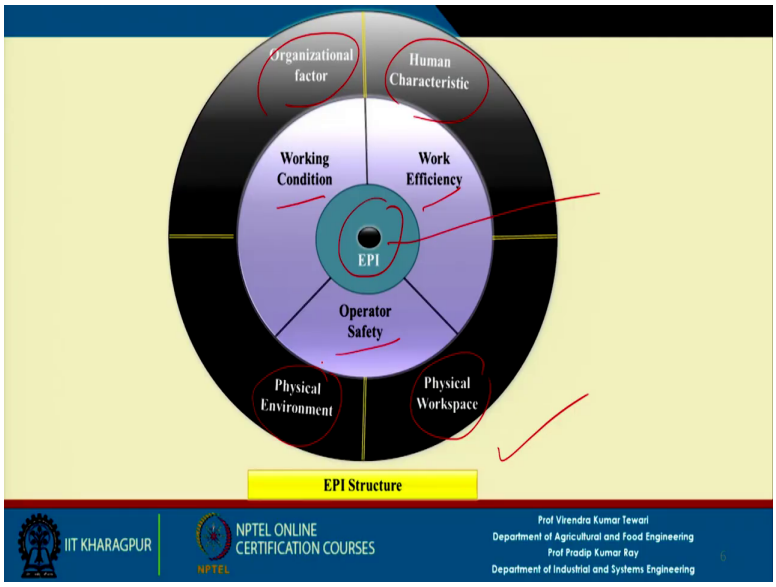

Therefore, if I now come down here is the EPI structure, you can see here the bulls eye is the one which is targeted that ergonomics performance indicator must be within a scale of 0 to 100. That means, we need to hit the bulls eye as much as possible in all the correspondence of the work that we are talking of- whether it is a base parameter or principal parameters.

When we are talking of the principal parameters, the work efficiency, working condition and operator safety come closer to the bulls eye. If they are taken care of properly, you are very close to the perfection of that system, you can see that the system is highly ergonomically matured.

Hence if tthat is fine then you can say that this structure is good and the work system is perfectly alright for long duration of work and there will not be any undue health effects on the operator.

Then we are talking of the other base parameters: organizational factor, human characteristics, physical workspace and physical environment. Here we wanted to show you the circle which definitely looks like as if we are trying to hit at the bulls eye while we are considering all the base parameters and the principal parameters.

We need to have 99% or 100% bulls eye EPI value that we want to have. This is just a structure to understand the parameters which we are craving.

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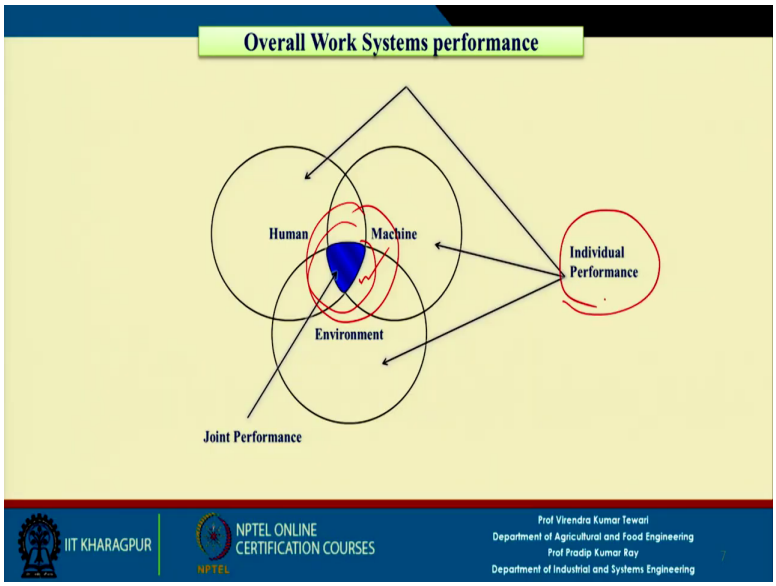

Ultimately, this need not be emphasized. Definitely we are talking of overall work system performance where you can see here that this portion is talking of the joint performance; where the human machine and the environment come together and that is the level which has to be maximized.

It is very important to look into this value that we need to maximize this part and that is only possible if we have the ergonomic maturity of the system while taking into consideration all the limitations and capability of the human being of the workspace and also of the environment and the task which is given and the equipment which is given. There should be compatibility between these two- then only it is possible and hence you will definitely get an individual performance of the system.

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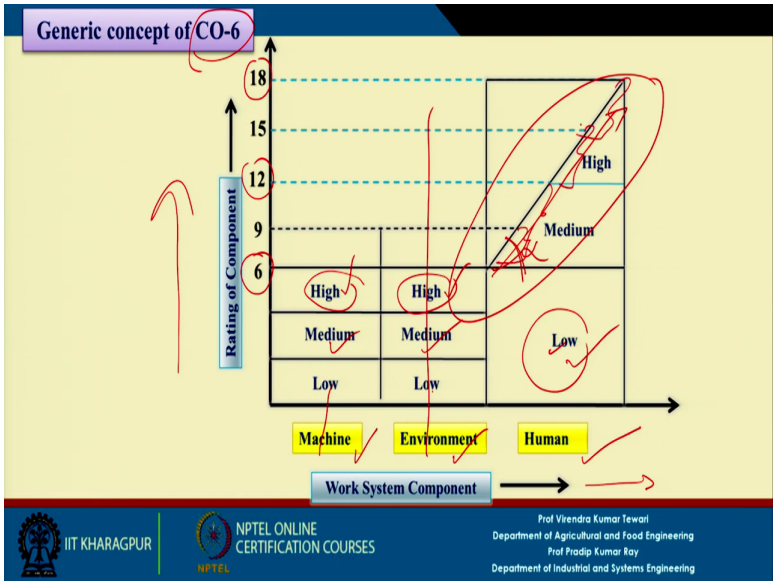

Now, we can start something between 0 to 100. If you can see that human factor engineering, we are talking of only three things. We are talking of the human; we are talking of the machine and we are talking of the environment.

When we have these what is the level of these at various conditions. We know that in a scale of say 0 to 100 or 0 to 10 you will find that there should be equal opportunity for all these parameters-the human being, the machine system and the environment and if you talk of a concept, it comes about 33%.

33 % of human beings, 33 % of the machine and 33 % of the environment are considered. Now if you assume that human being is not that much taken care of then the other two must be at the best level or other two must be taken care of.

If you consider that the machine and the environment which are well enough to take care of the human performance, then we find in a scale of 0 to 10 we get 6.6, that is 3.3, 3.3, 3.3. So, if two are taken together; that means, if you are thinking of high level of machine and high level of environment and the maximum performance machine is performing at its maximum, then the environment is also very much conducive to that particular task. If you consider this, then the human being is at the lowest value. Now in order to have a scale and to rationalize this, we consider the base level at which human beings are not being taken care of properly.

But machine and environment are perfectly taken care of. Instead of 6.6, we will have a start of concept of 6. Let us see the graph here -work system component on the axis. We have the machine, the environment and the human being- there is work system components which are given this way. Then the rating of those components we have given.

Initially the concept of 6 has come from that consideration. If you do not consider the human being virtually and its attributes are not taken care of that properly, then both of these machines and the environment are having maximum which we can say 3.3.

Instead of 6.6, to regularize or to have a convenient figure, we have taken 6 and that we are talking of concept of 6. So, when we talk of concept of 6, we are talking that the machine is its best performance, the environment is also best, but the human being at low. So, when you have this, we are talking that the value is low even it may happen that medium and then low- this will also be within 6.

What will happen is if you are thinking of going beyond this? How to best to utilize this concept of 6 and then say that if the maturity level is changing, if the machine parameters or machine is performing at its best or the environment is taken care of perfectly and the human being is also doing very well as compared to the effect where his contribution was not much or he was not his crisis were not taken care of properly then we will find that this is the way; there is a movement of the human characteristics. That means, there is a certain angle at which it moves as the performance of the machine and the

environment are taking place and therefore, we are getting a system like this. We are in a position to say something about the behaviour beyond 6.

In level 1, we are talking of a level where it is just satisfying the conditions. In level 2, it is satisfying, but something beyond that and the whole system is within the control of the operator or the person who is controlling the system.

The third level could be that everything is under control and he is in a position to manoeuvre the speed at which he can work or the task which can be performed by him. So, when we have these things, we say that this will be simply maturing above and we have said that it will go into 6, 6 and 6; that means, we are talking of a value of 18 and then we value of 12 and 6.

In between, these values are there. Now question is how do we get to that? For that we will have a different level of understanding of thebase and principal parameters then only we should be in a position to go ahead.

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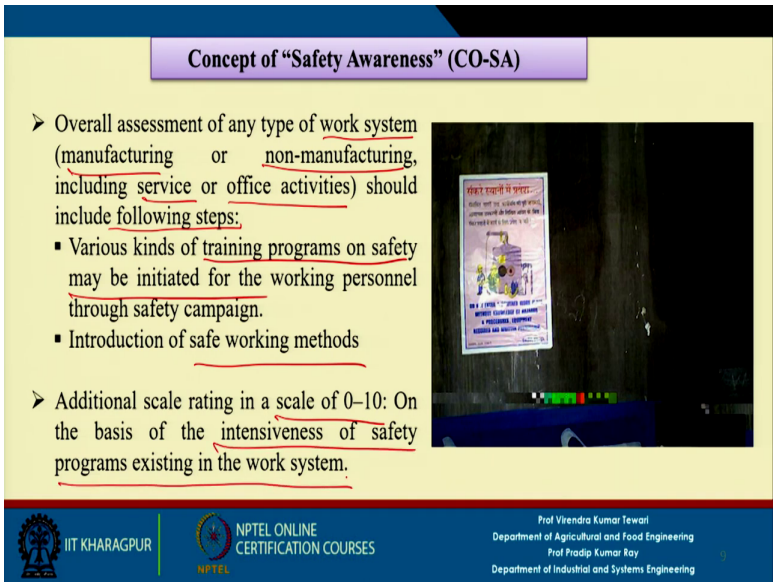

While we have visited several workshops where we find that these awareness about safety is not that much. Because you will not find even proper holdings, proper instructions or safety slogans not written at various strategic locations in the workshop.

Awareness is one factor which also comes into play. That is why we consider this concept of safety awareness as well while we were considering the details of the ergonomic maturity of a system and we are trying to quantify the same.

Overassessment of any type of work system will have manufacturing or non manufacturing services. Office activities should include the following steps. Training programs on safety awareness.

What sort of safety, what sort of precautions, what sort of attributes or safety attributes or safety equipment that you need to wear on yourself while you are doing a particular job whether the job is being done at a very high level or a gas which is emanating which is poisonous.

So, what sort of preparations you should take on yourself- may be using apparent. Sometimes noise is there. So, you have to wear the ear plug; that means, these certain aspects are to be shown to you and you are made aware of those.

We are talking of concept of awareness. The COSA introduced safe working methods. While we are talking of the system, we must know what is the safe working method and that safe working method has to be advocated while we are doing the job. Additional scale rating in a scale of 0 to 10 on the basis of the intensiveness of the safety programs existing in the work system.

We have also introduced concept of safety awareness within a COSA, within a framework of numerical's of 0 to 10. This will take care of if everything is fine, but there is no holding, there is no instruction, there is no training given to the people who are on the job because it may happen if they are not properly trained, they may make errors and those errors could be fatal in some of the cases.

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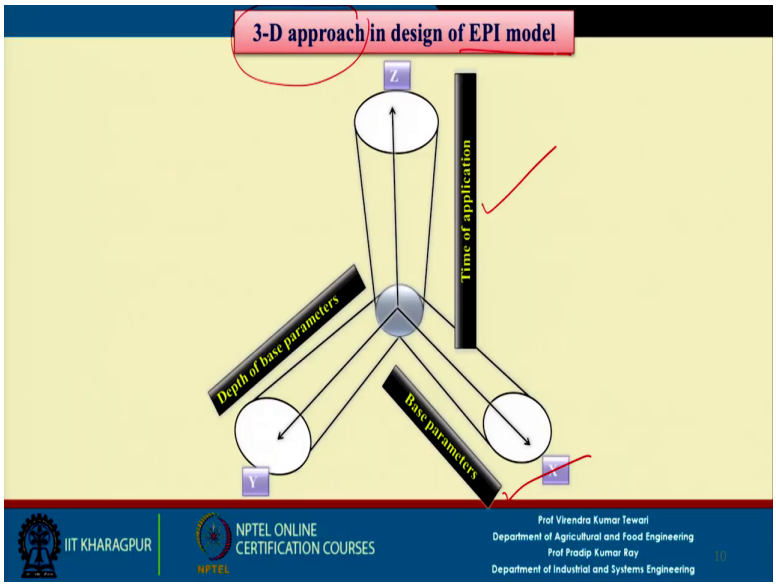

The EPI structure looks like something like this. You see it is a 3-dimensional approach. In this you can see that base parameters are in the X direction. Then depth of the base parameters. Those base parameters are important with regard to human characteristics, with regard to the physical workspace, with regard to physical environment.

What is the level of the depth at which these have been taken care of as the safety and the welfare of the person is concerned while he is on the job? The time of application is the third dimension which we have put in time of application.

For example, the depth of the certain base parameters and the time of application. You need to know at what time or how best these parameters are taken care of, what is the level of safety at various conditions.

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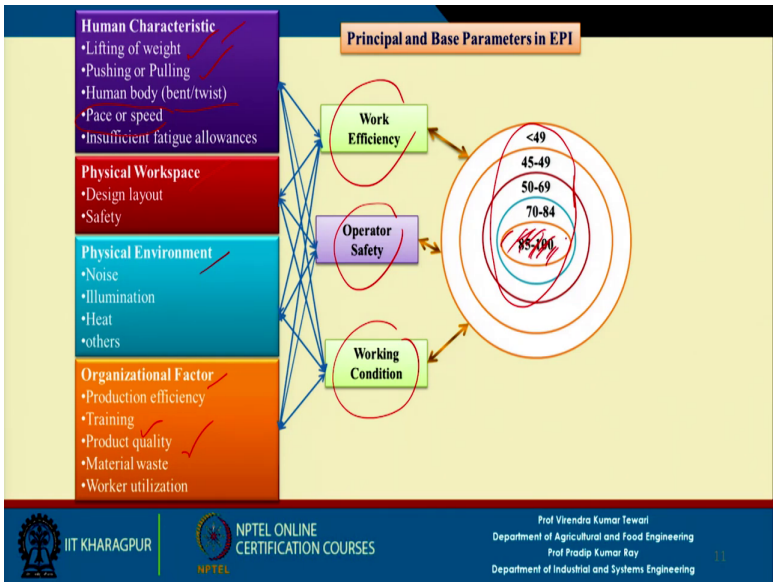

Then if we put them together, we have the EPI structure or EPI model where we have the bullseye. We can see that human characteristics, the physical workspace, the physical environment and organizational factors.

Some of the capabilities say lifting of weight; he or she cannot lift beyond a certain limit. If the job requires pushing or pulling of a cart or of a lever, it has to be within human body bent and twist.

What is the posture in which the human body while the person is on the job? So, it will talk of the twist. The pace and speed at which this task is being done.

We need to look at the work rest cycles. Until and unless you have a proper work-rest cycle, it is not possible to give enough fatigue allowance to the persons. You are not utilizing his full capacity human characteristics.

So, within this whole canvas the human characteristics will fall while we are thinking of a production system in which the human being is involved. Then well-design layout safety.

We are talking of physical environment. If it is heat, we would like to measure the temperature, we would like to measure the level of humidity, we would like to measure the level of noise. And then on that basis we will be able to predict the effect of the environment on the person's performance.

Production efficiency. There has to be a high level of efficiency of the production and in order to do that, the persons or the workers must be properly motivated and through trainings, through quality awareness about the product quality, materials waste, we should be there.

There should be orientation, there should be proper instruction to see that the material waste is minimum. Because that has to be thrown out of the factory or that will go into slag and then it may pollute the ground water and it may pollute the soil as well. Therefore, we are talking of the organizational factors where how best the worker is utilized in the production system.

When we are talking of base parameters again, we come to work efficiency, operator safety and working condition.

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