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Ergonomic Design for Manufacturing and Assembly
Lecture - 49
Maintenance in Manufacturing/Production System-Important Ergonomic Design Issues: Part-I

Dear students and participants, in 10th week we have already taken three lecture sessions related to Ergonomic Design for Manufacturing and Assembly. And the ergonomic design of a work system must also consider the Maintenance aspects the serviceability aspects.

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During the fourth lecture session as well as fifth one, we are going to discuss an important issue related to ergonomic design and we call it Maintenance in Manufacturing or Production Systems. You cannot think of any manufacturing system or the production systems without maintenance and servicing.

When you carry out maintenance related activities or service-related activities you need to consider the different types of the interfaces. With respect to those interfaces you need to consider several ergonomic design issues.

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More or less related to a particular product design or particular work station design with respect to the operations you carry out with the help of the work systems or the processors.

You find that many sorts of the jobs you have to carry out related to maintenance or service against a particular product, against a particular work system or work station. Such jobs cannot be designed in advance. First, you have to observe, related to a particular maintenance of the job, what are the actual activities you have to carry out? Under certain conditions you do your maintenance work in such a way that they will have in a the less the down time and the repair time should be as minimum as possible. And, many a time you will find that this maintenance related to the jobs are essentially manual jobs or labour intensive.

You have to consider the ergonomic design aspect as well as you have to check whether human factor related principles are being used or not, and the kinds of advantages you get in ergonomic design. Maintenance is an essential activity at any workstation- you cannot avoid.

You cannot think of any manufacturing system, production system or service systems without maintenance. We use another term called maintainability. Maintainability refers to how quickly an equipment or a product gets back to its original acceptable state.

Whatever may be the sophistication of the system, whatever may be the design level, whether you use the state of the art technology or not, but there is no guarantee that in the next point in time whether your system will work or not. There is uncertainty. Entire problem is referred to as problem under uncertainty.

In the next point in time something happens which is unpredictable and the system stops functioning. So, you should be ready and in advance you also must know that in how many different ways a system may fail. You may call it a breakdown; but the breakdown may occur due to different reasons. Sometimes it is called the fault and corresponding fault identification.

Against the failure of a system, you have to carry out certain tests for knowing the causes of failure. This is referred to as the fault identification. Now, you respond very quickly, you take minimum repair time and you carry out the maintenance activities in such a way that the system or the product or the workstation gets back to its original acceptable state.

In working mode you have to get that state with necessary repair work done after the equipment fails to work and you will find that the repair work you carry out is labour intensive. You are controlling the job quality and the job related the parameters.

Maintenance work is usually labour-intensive and quality of maintenance work is dependent on the interaction design or interface design.

While designing an equipment or a product, activity required to be carried out for maintenance should be known in advance. That is basically called planning. As you are the designing a product, you look into the operations aspect, the kinds of operations you should get from a particular product. But, along with that what sort of maintenance activities and service-related activities you have to carry out that also you must know in advance.

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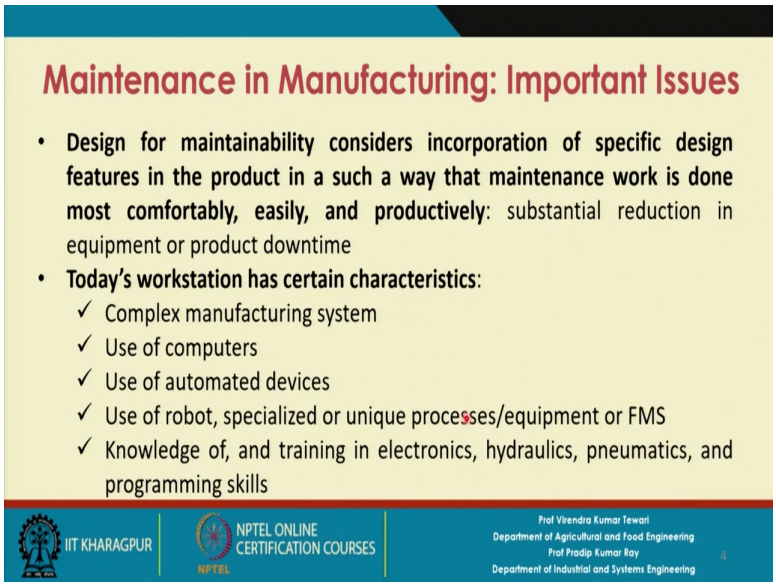

You carry out the repair work in such a way that it becomes again as good as the old, if not as good as the new. Any equipment any system we talk about there is an economic life, and you go on maintaining, you go on repairing the failures. But, at certain point, maintenance is not possible; that means, there is a failure and it is not possible to repair. So, first you have to check whether it is repairable or not.

Then another aspect is- there are work systems where there are workstations where the impact or failure could be very severe. You cannot afford to have a situation where the system is not working and there is no impact. So, before it fails you first the check that whether the all the subsystems, all the parts in the systems are in acceptable condition or not.

So, that exercise you carry out at regular interval all at irregular interval there are many types of norms we follow. So, that is referred to as the servicing and in certain cases you go for overhauling. All these activities are essentially labour intensive, the manual work and the person concerned will be using different types of mechanical aids, but the job is manual.

Design for maintainability considers incorporation of specific design features in the product. You can carry out this maintenance activity or service-related quite quickly, accurately as well as comfortably.

You must incorporate certain design features in the system related to the maintenance activities and this design features you include in the system in such a way that maintenance work is done most comfortably easily and productively. Substantial reduction in equipment or product output time is possible.

What is the impact of cost of downtime? In majority of the cases, when the equipment is an essential one, if the equipment fails, the workstation fails or that particular product fails, the downtime cost could be very high.

There are many quantitative models related to the downtime cost. What are the factors affecting this downtime cost that also you must know. But, one thing you will find that if these activities are economically designed, even if the system fails very quickly you can repair it. You remain very highly productive. Another important thing is- if the repair work is done correctly, the probability of the systems failure or the product failure also gets reduced.

While you design the job, you design in such a way that those principles you have to apply. Then the repair work will be very good and possibility of getting another failure of the system will be very less. This is the advantage.

What are the characteristic features of the today's production systems or the work system? Manufacturing system has become very complex.

There are two types of the work system simple and complex. The second aspect is while you design a manufacturing systems, different types of the considerations you have to do.

You must have knowledge in several disciplines. That is why we say that most of the manufacturing systems even at the machine tools have become very complex this ways. Use of computers you cannot avoid.

The computer has been designed in such a way that it has become robust, it can be used in any kinds of environment. The effect of uncontrollable noise factors on the performance of a computer is minimum and this way we define a robust system.

If you make it an ergonomic design, then any work system you have another advantage. In all likelihood, you will find that the work system has become very robust. Use of automated devices there are many kinds, you cannot avoid.

Like mechanical aids and certain automated devices also you can use; use of robot, specialized or unique processes or the equipment or FMS. FMS you can use in certain the manufacturing systems like the mid-volume mid-variety. FMS has got several physical subsystems and it has many kinds of the control sub systems.

It is a central computer controlled 100% automated system. Depending on the kinds of manufacturing system, whether NC, CNC or DNC or adaptive control machining, there are varieties, whether it is a hard automation flexible automation or FMS, you have to consider several kinds of jobs, several kinds of activities, varieties of activities. Knowledge of and training in electronics, hydraulics, pneumatics, and programming skill as a maintenance worker maintenance operator.

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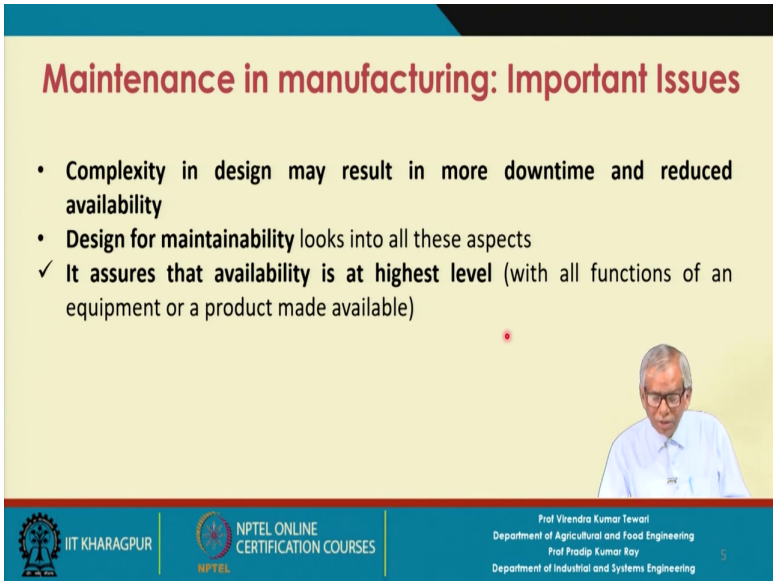

But the problem is when the failure occurs in a particular machine tool in a particular workstation. This knowledge may not be of any use.

This knowledge is a must for increasing your potential, but when you talk about the capability, that means with this knowledge is there any guarantee that you will be able to

identify the types of faults that has occurred or what whether you can go for troubleshooting or repair work.

The sufficient condition is that I must first know, given a particular machine tool, how many different ways it might fail and against a particular failure what kind of activities I am supposed to do. And whether the design is permitting me to carry out all these activities most comfortably as well as most easily.

Then you say yes, the entire the system or work system related to a particular repair work or the interface with respect to a particular repair work is ergonomically designed and its impact is positive. The complexity in design may result in more downtime and reduced availability.

If you bring in new technology based system, you do not bother about this complexity, you do not bother about the design for maintainability – you will find that even during the trial run you cannot do it properly. So, before you certify a particular production system for regular commercial production, you go for trial run and during the trial run you identify the appropriate settings of the machines, and then with respect to that you list down what are the types of failures it might occur and against each kind of failure how do you respond what kind of repair work you do? And, against each repair work you have to know the document the entire thing. Repair work. What are the specific activities you carry out? What is work cycling?

Design for maintainability looks into all these aspects. It assures that availability is at the highest level.

If the down time is less o, the available time will be more, that is the condition you have to check.

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So, any maintenance work involves the following specific activities to carry out:

1. Fault Identification.
2. Testing followed by trouble shooting or repair.
3. Access and manipulation as needed for maintenance work.

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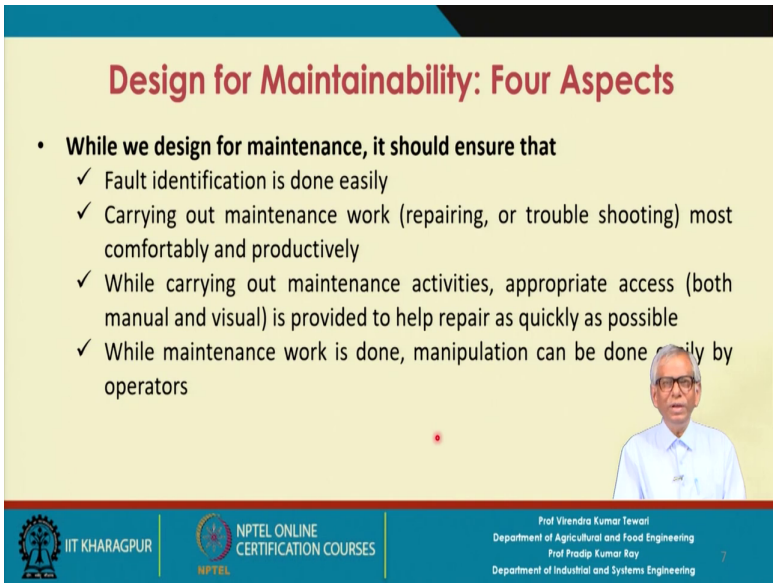

So, while we design for maintenance, there are certain the conditions you have to assure. It should ensure that

A. Fault identification is done easily.

B. Carrying out maintenance work (repairing, or trouble shooting) most comfortably and productively.

C. While carrying out maintenance activities, appropriate access (both manual and visual) is provided to help repair as quickly as possible.

D. While maintenance work is one, manipulation can be done easily by operators.

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With the limited space you have, you can have a posture, but that posture could be a cramped posture. In the cramped posture, you cannot work comfortably and your performance will be affected. So, to what extent you can avoid this type of posture? Before you define those activities you are identifying those activities you check whether the work posture is acceptable or not.

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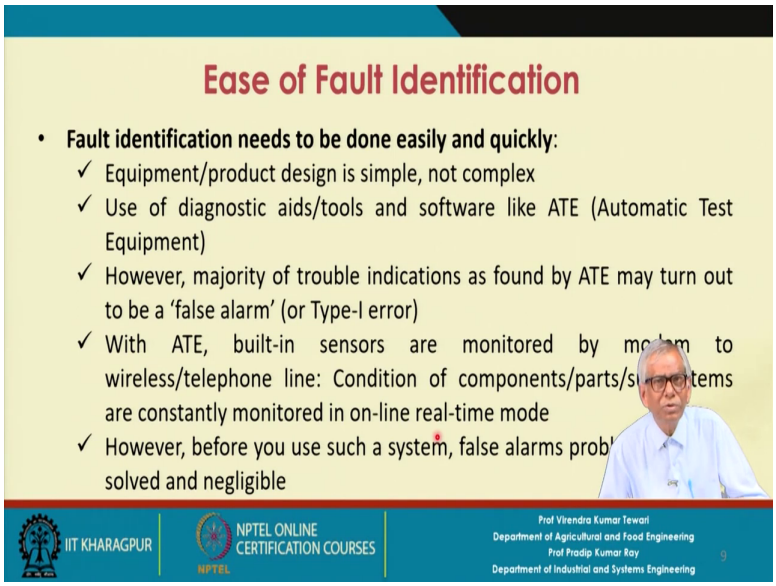

So, these are the four aspects you need to consider while you consider design for maintainability. The first one is the ease of fault identification that condition you have to ensure, followed by the level of the testability, whether the testability is acceptable or

not. There are certain the test equipment you have to use and by using the test equipment you get the results.

The results you interpret and when you take action, the troubleshooting, you find that these results are really helping them in taking perfect or acceptable repair initiative. Manual and visual accessibility – that condition you have to check and the last one is whether the manipulation you can do easily or not.

Now, let us talk about ease of fault identification equipment or product design. Use of diagnostic aids or the tools or the software. ATE (Automatic Test Equipment) that you have. But the problem with ATE is the majority of the trouble indications as found may turn out to be false alarm.

The ATE might say that there is a fault has occurred and there is a condition you have to immediately check. Now, after investigation you find nothing has happened, it is a false alarm: the Type – I error. But it shows that the machine is going to fail quickly and the condition has changed the state of a particular part or the subsystem.

You find that the condition remains absolutely alright. Previously the fault alarm was as high as say 80%, but now it has come down to 10%. With ATE, built-in sensors are monitored by modem wireless or telephone line.

The condition of components parts or the subsystems are constantly monitored in online real time mode. However, before we use such a system false alarm problem should be solved and negligible.

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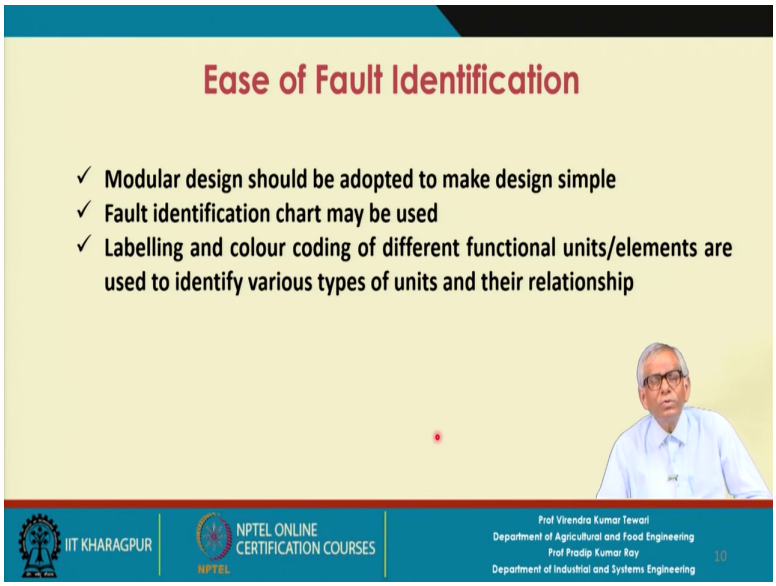

How quickly you can do that and how easily you can identify the fault? You go for modular design.

Fault identification chart may be used labelling and colour coding of different functional units or elements. They are used to identify various types of units and their relationship is very common. You just look at any the machine tool or you will find there will be labelling and there could be colour coding.

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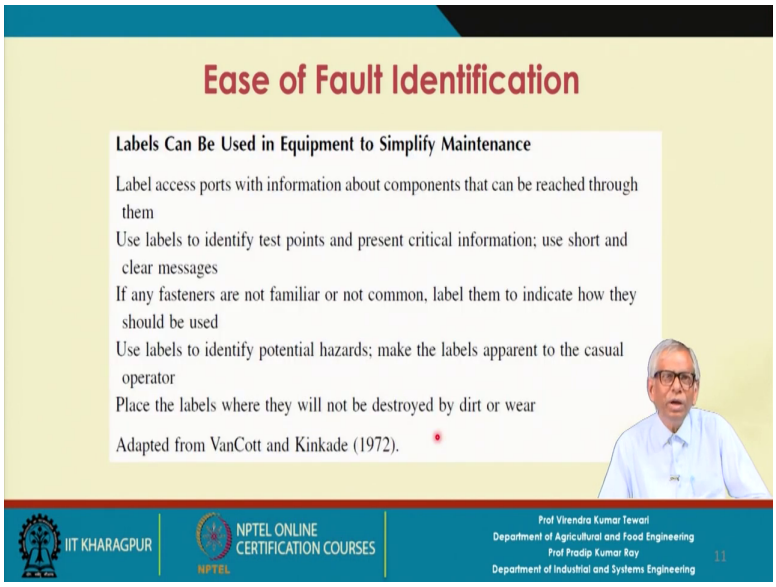

These are the labels normally in general they use. Like say labels can be used in equipment to simplify maintenance.

If any fasteners are not familiar or not common, label them to indicate how they should be used. They will not be destroyed by dirt or wear- that is a typical workstation.

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