Mining Machinery
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Module - 11
Lecture - 59
Maintenance Management Information System

So, welcome students. Today we in the last class we introduced to about that what is a maintenance of mining machinery. Now, today we will be discussing another as a in general in a broad based manner because the total discussion on a management information system is a totally different orientations and lectures.

I will not be going into those details of a information system, but exactly what are the main vocabulary you need to know whenever you will be doing some maintenance management job.

Say as a mine manager when you will be engaging your mechanical engineer or electrical engineer or where you will be hiring a farm for maintaining your machines at the time you should be having a general idea or you must have a proper understanding of different terminology. So, for that I discuss today what is the Maintenance Management Information System.

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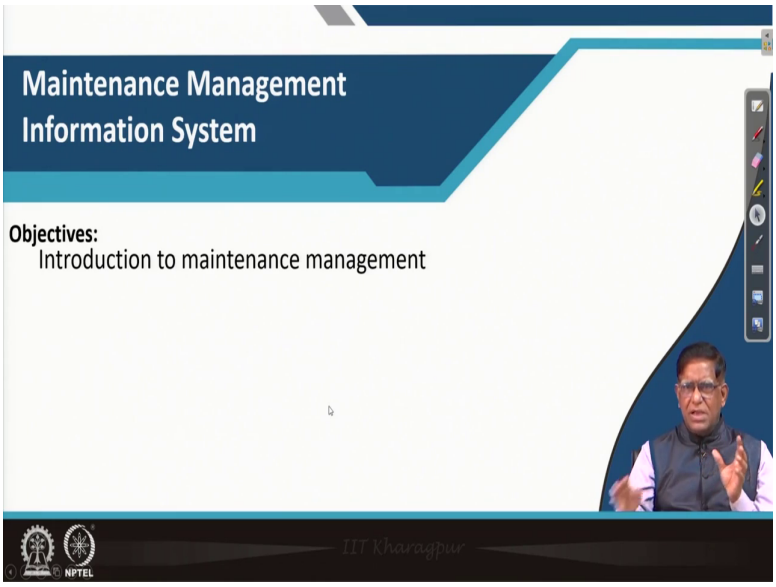

So, our job is to just a basic introduction of the maintenance management. So, it is a in a 1 hour class I will not be able to tell you the whole intricacies of it.

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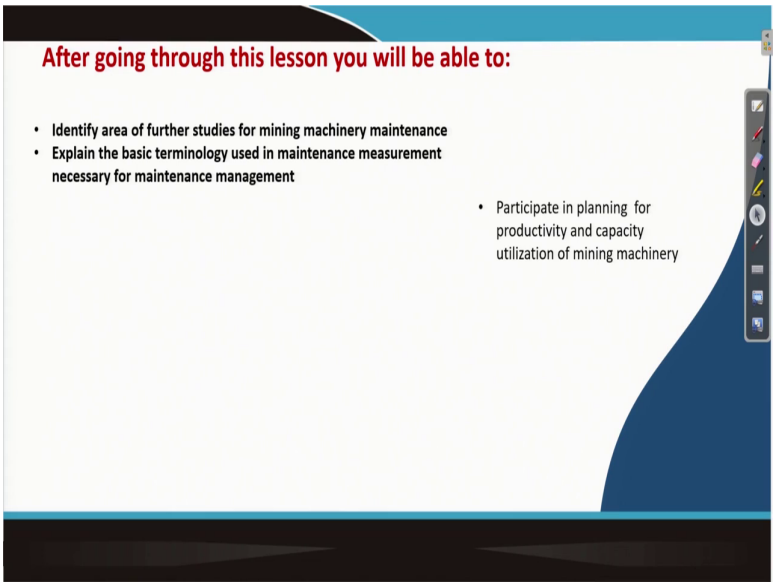

Just to give an introductions, we will be giving you that the after going through this lecture if you can identify the area for further studies for mining machinery maintenance that will be a good thing if you can motivate yourself. And then explain the basic terminology if you understand the what is the meaning of those terms that will be good for us. And then you should participate in the planning for privatizing, productivity and capacity utilization in the mining machinery.

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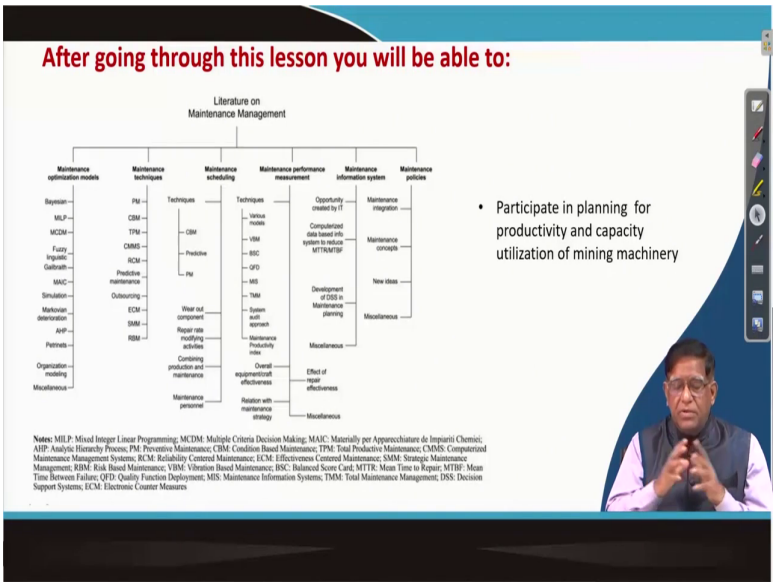

Now, you can see from this figure a little bit of what exactly you can get in the literature on maintenance management. There is a maintenance optimization models lot of people, on the who studies this quality, reliability, maintenance, industrial engineering, mechanical engineering they have many this optimization models they have developed that is your which is a Bayesian model the statistical model.

Then there is a mixed integer linear programming. There is a multiple criteria decision making. There i s a fuzzy that is your fuzzy then linguistic that is a by that they say exactly which is normally looks like unquantifiable that they quantify and develop a model.

Similarly, they have got materially per approve that is your apparecchiature de impiariti chemiei that is exactly a French method of the developing the analyzing the models. There is a simulation is everywhere it is used then this is a Markovion. This is again a system

engineering people they use. So, there are analytic hierarchy process. This is another methods where many statistically available data analyzed for develop a model.

Then there are petrinets and all these are all operation research, industrial engineer they have given a lot of model for the maintenance engineering. Similarly, in the maintenance technique in our last class we told about the preventive maintenance, condition based maintenance, total productive maintenance that is your computerized maintenance management system.

Then reliability centric management, predictive maintenance, then your outsourcing maintenance these are different type of that is your Effectiveness Centered Maintenance ECM. If like that a any many new terms keep on coming it is a strategic maintenance that is your risk based maintenance which are now being used and that as I said that the prognostic maintenance, which are now can be diagnostic maintenance those are the different type of maintenance management approaches.

Then they do a maintenance scheduling that is how the operations in the field will be carried out. So, when it will be done a replacement when a wear out component will be taken, which will be repaired and when it will be overhaul those scheduling operations. Then maintenance performance measurement that is another thing is there where you need to use different technique that is your how you we will be measuring that is here say.

One of the thing is the vibration basement that is your maintenance where you keep on monitoring the vibrations over there. There are also balance score card they will be giving a score card by that we will be maintaining the measuring that units. Sometimes there is also the quality function deployment. There is a tool quality function tool they will be deploying over there.

So, like that there are number of maintenance performance measurement systems are there. So, then there is a the Total Maintenance Management TMM another way of doing and in that you apply different tools. And a dozer whether it is applicable for a particular mining machinery applications in a mines that need to be seen.

And once you deploy that after that the most important thing is your maintenance information system. How data will be acquired and how your data driven decisions will be taken once you get these information they will be put into that your maintenance optimization system models.

That these data generated acquired and putting into the model and from that model the result they will be measuring and that what is the performance? And on that basis they will be defining the action. So, this is how that in a maintenance information mainly the mean time to repair, meantime between failure, capacity, availability those type of things are very much done in your maintenance information system.

And then on that basis the company will be involving some maintenance policies. So, what is required in a maintenance management in a mining industry the whether it is a small query or it is a big open cast mines or a big underground mine or it is a mixed mine with open cast and underground or whether there is a machinery that is your processing plant or a coal washing plant.

The mining industry they need to do this maintenance management for that this is very important that maintenance policy. That the maintenance policy will dictate exactly what type of maintenance information system you are taking and that what type of maintenance information system is exactly the way you are measuring the performance and then your how you are exactly controlling the work schedules of the maintenance work. And then what are the main techniques you are applying for doing the maintenance.

So, this whole thing is done by a data driven model. So, once you identify these things that after going to this lectures you can pick up you can study this things you can note these points out because a mining engineer they do not have many fields for doing that research. In a real mining technology development research you will not find many things.

If you are studying your M.Tech or that you want to do a PhD in mining many people end up with only doing with some of the rock mechanics bringing a heterogeneous systems into and studying with a principle of homogeneous systems, very difficult challenging tasks are there.

But, the how the operations control will be there if your machinery deployment is not done properly, those research will not be giving you much result to produce the mineral. So, as a mining engineer you are producing mineral with the machinery you will have to take the mechanization decisions and for that exactly this is the area if you know you will be able to common in the industry.

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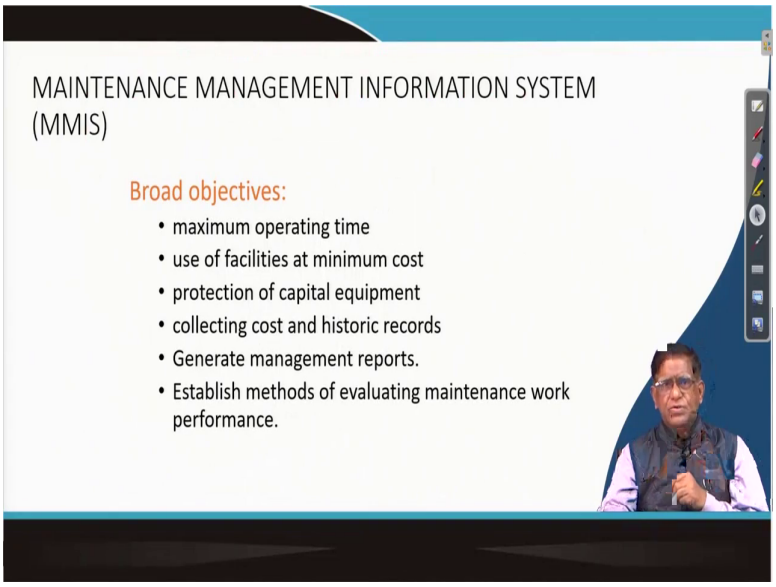

So, that is where you should take your point up. And maintenance management information system basically wants to maximize the operating time of the mines. Use facilities at minimum cost. So that means the total financial management of the mines. Protection of the capital equipment that is exactly your cap X planning is based on this.

Then collective cost and historic records so that is another area. Generate management reports that how exactly you will be preparing your reporting the annual reports. Established methods

of evaluating maintenance work performance. All these things are taken care of by that management information system maintenance management information system.

Now, many computer that is you are having a good knowledge of your the programming and then the data base. If you have done these two things and if you know any language and if you have learned the basic of database then you can yourself master over here. As a mining engineer you have got this field with you, the industry with you and those computer based applications can be developed and generated by you.

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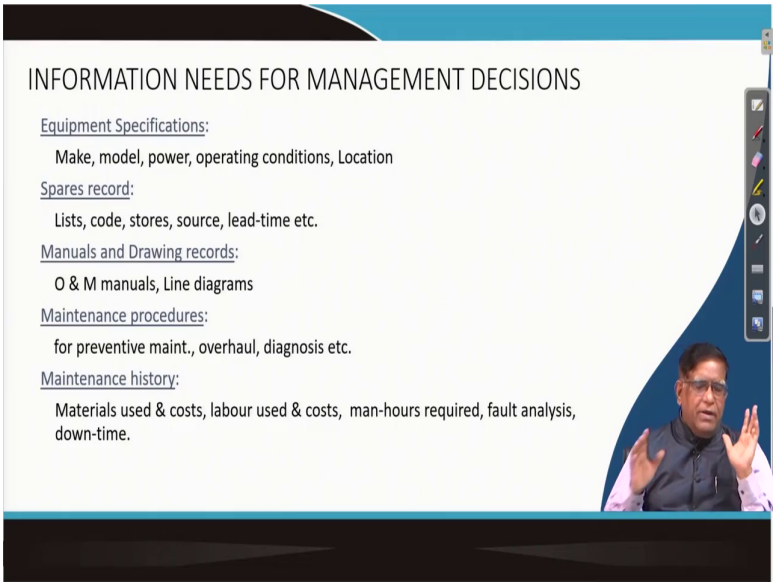

Now, information needs for management decisions in a mine mining operation is equipment specifications, spare records, manual; drawing, maintenance procedure and maintenance history these are the things you all need to get used to.

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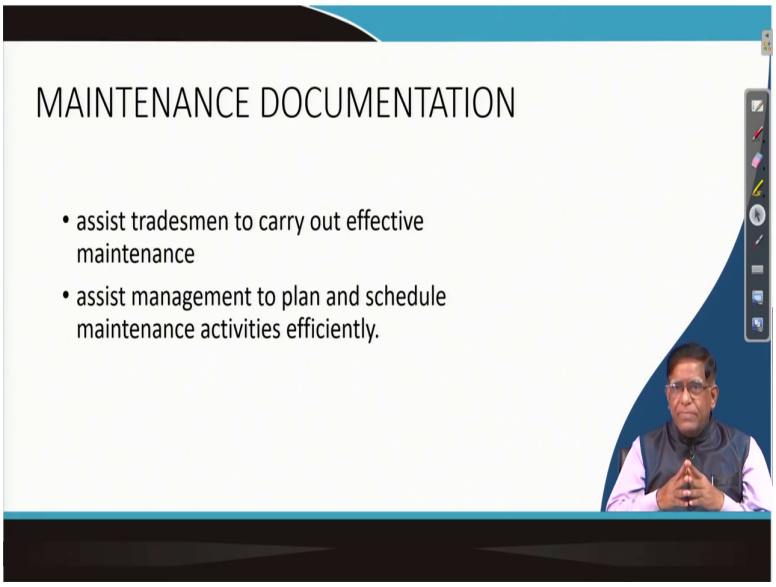

And then you will have to learn how to do the maintenance documentations. That documentations can come you can follow the international standards of these documentations of how your office record keeping and office file movement how it will be done that comes in your management systems.

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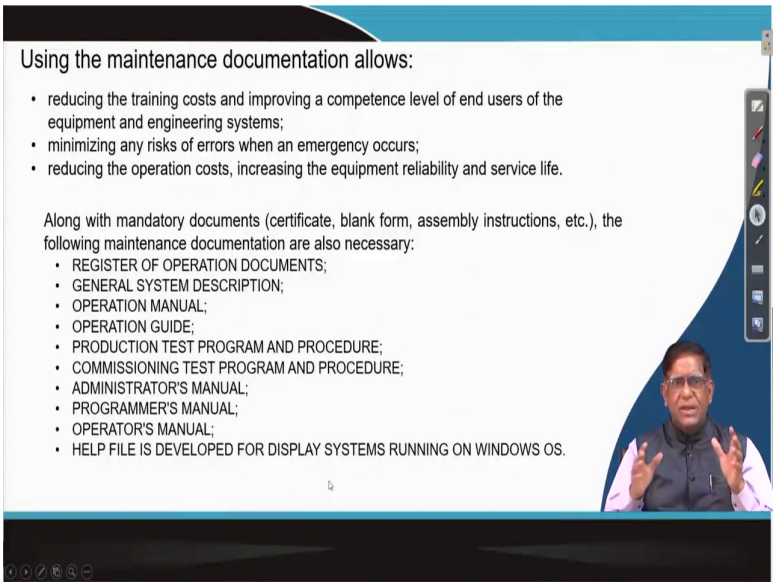

And then this the when you will be doing this documentation maintenance documentations you will be maintaining what type of registers you will have to do, what type of system how you will describe, how your operation manual and that your maintenance manual will be prepared.

And then how you will exactly administer your administrative decisions in the maintenance department, how will you manage; all this change in a documented form when you will be your maintenance department will be keeping. As a mine manager your overall mine management will become effective.

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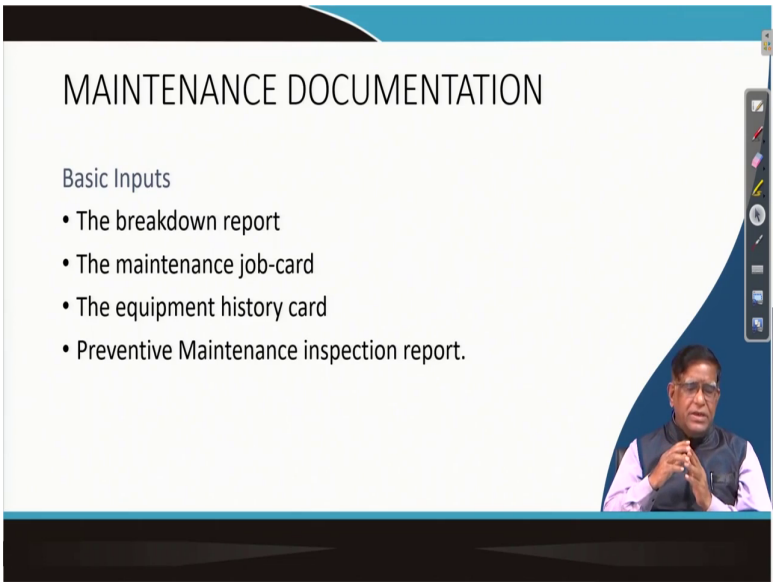

So, there is a maintenance documentations it requires that your breakdown report, your maintenance job card, how the job is given to do and then equipment history card and preventive maintenance inspection report. These are the basic input you prepare the maintenance documentation.

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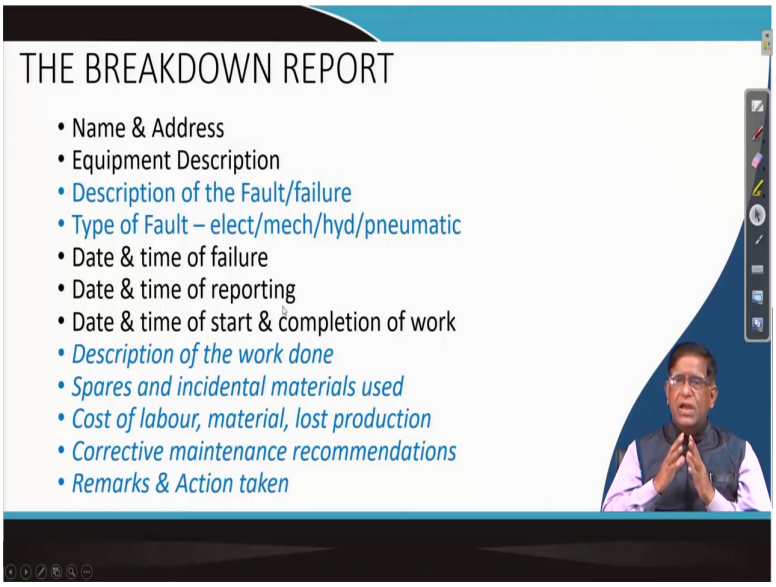

The breakdown report it is a your name and address of that exactly when you are doing a breakdown report who is preparing? This is the very the origin of that your the authority of the preparing report those thing should be accounted in the report. And then that equipment which you will be describing even when it was purchased, what is history, which company, their specification, what is that model all that equipment will have to be described and then you will describe that what is exactly the failure.

Say if it is say for example, the if a drill machine in the drilling may be that drilling stuck at the top it has got block that is you cannot add or you cannot add a drill rod to it. Whatever be the problem you describe the problem whether it is a electrical problem, mechanical problem, hydraulic problem, pneumatic problem a machinery may create a problem from different point.

And then what type of work exactly you have been doing and then what type of spares and material you have used, how many people you have engaged, how much time it has gone and then that what exactly is a corrections you will be suggesting those things are exactly given in a breakdown report.

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Similarly, there is a preventive maintenance inspection report. In a preventive maintenance what is done? So that, so you go and inspecting and doing some of the work. So, that it does not give a problem in future.

So, what work you have done if you do not record maybe while doing you have done some mistake. And because of your doing that preventive maintenance there is a situation which

may lead to failure of the equipment pre-matured. So, those type of things thatis why the preventive maintenance inspection report must be kept properly.

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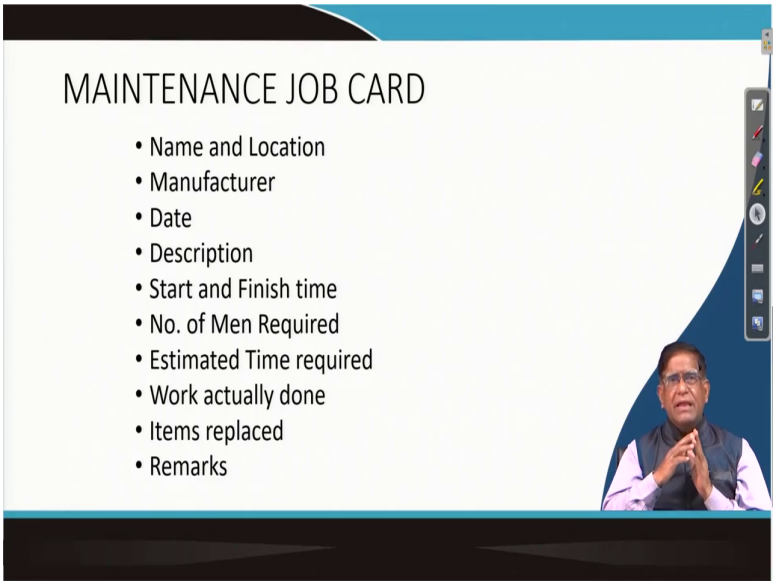

Then in a maintenance job card means if you have required that ok, these machines need to be maybe a crawler a pin has got broken and that crawler pin to be collected. So, that this, crawler chain do not spear it out. So, for that you have given the job to some particular persons to do it. So, you will have to keep a proper job requisition and the job card assignment to the operation.

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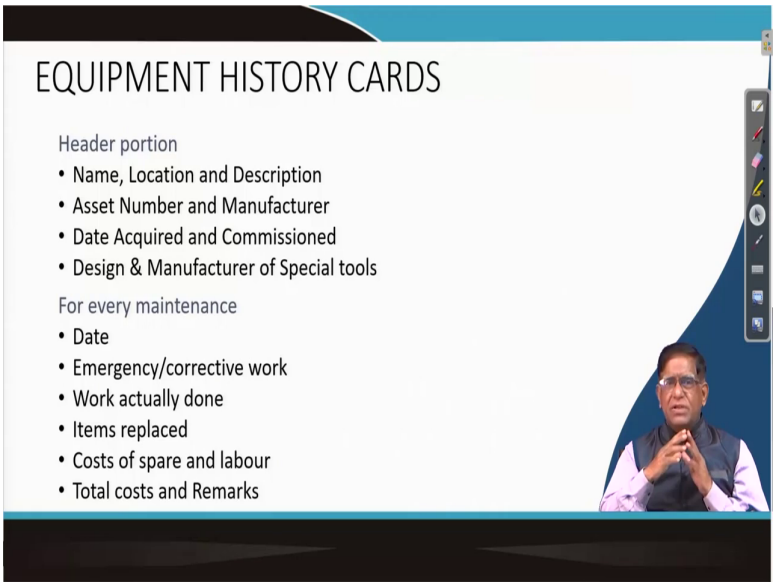

Similarly, the equipment history cards you will have to maintain that what type of work has been done on that. If sometimes a failure takes place in that failure history you maintain over there. Next time when a failure comes you can find out that this failure is because of that failure or it is a new failure or this failure may lead to another failure. So, for those things, that your history must be properly recorded.

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Then your how will you measure the maintenance, this is very very important in managing. In management one (Refer Time: 15:58) said if you can measure then you can manage. So, that what are the things you will be managing, measuring. One is this availability availability is a exactly the percentage of the total time it is available.

Say for example, your 300 days is a working day of a 365 days and now out of this 300 working days how many hours of the total working hours the machine is available to serve? It is not the utilization. Utilization is when the machine is really working and producing. Say for example, my car which is now at the garage at the car shed is available. For me whenever I want to go there I will be able to drive and go, it is available.

But, at this time when it is there lying in the garage or in the there in a car shed I am not utilizing it. So, my effective utilization or effective working hour of the engine in a day may

be 1 hour or 2 hour out of the 24 hours. So that means, I have utilized that 1 hour or 2 hour of the 24 hours, but it is available.

Suppose I say that between the every day morning say 7 to 7:30 it is half an hour this car will not be there I will be just checking the car whatever it is proper or not. That means, my car is available that 30 minute minus this 24 hour during that time I can use. So, my availability is that 23 and half hour, but my utilization is only they say 1 hour or 2 hour.

So, then if these hour we divide by the total exactly calendar hour the 24 hour then it gives a percent and that percentage value is the availability. So, similarly reliability of course, it depends on the overall availability of each and every components including that much and this reliability is express as a probability and that is a reliability is expressed in terms of this probability.

And maintainability is that the machine it is a design that designer, the manufacturer how it has manufactured that if anything goes wrong how quickly and how it a least cost it will be coming to back to its original position. If the maintainability is better that means, it will be coming back easily to its, It is something like your resilience.

As you say in a resilience system if any failure take place it will come down in quickly, but normally after a failure it will take some time again to come to the normal. So, similarly your maintainability means, your machine is maintainable that is if it has fallen down quickly it can come and again it will do.

So, that is how the maintainability and there are different way of expressing this maintainability there is an index called (Refer Time: 18:10) maintain maintainability index that we will have to do. And capability it is exactly what that machines capacity is.

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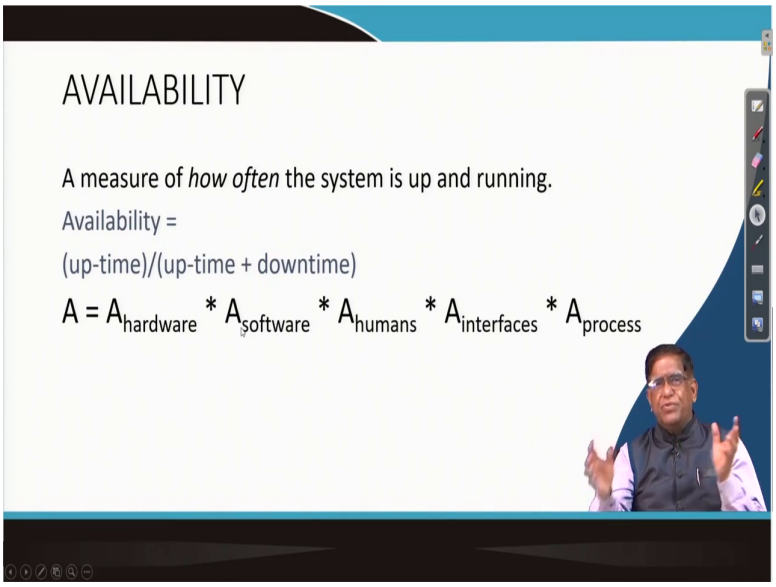

So, availability can be is a multiplicative factor of different type of up time. That availability is basically that up time when the machine is ready for work and then when the machine is ready and when it was not ready. So, your this total time is the down time. I can say it is a because of failure or because as a scheduled down time.

I have kept as a maintenance and all the thing or it can be an emergency down time because of the rain or because of the terrorist attack or because of a mob stopping. So, those are exactly a machine cannot work is down time. So that means, a down time components you can find out and you can calculate it out.

So, basic this concept of up time and down time this gives you an availability, but that availability it can be for the hardware, for software, for human, for interfaces process. The system availability could be it is affected by the availability of the everything. So, because

they are all linked together if anything is not working your overall availability is effected. So, that is why it is a multiplicative things.

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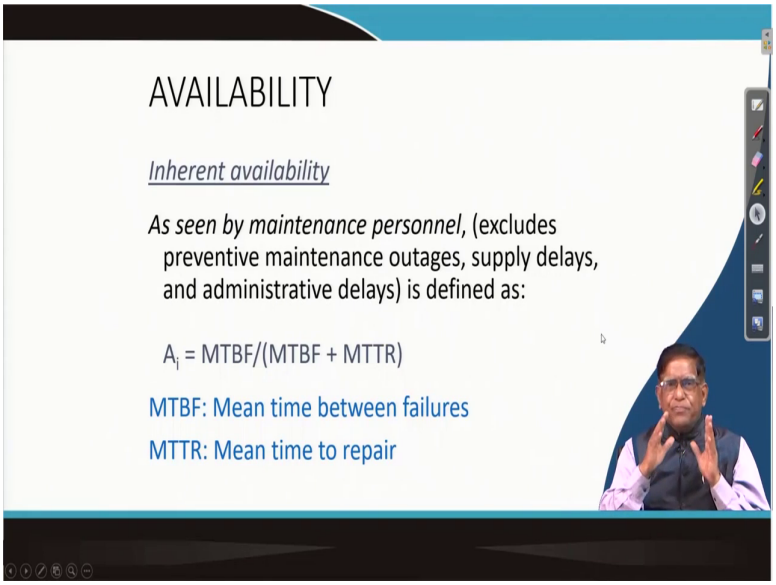

So, there is a thing called your inherent availability; that means, in a maintenance personal will look into how the machines is exactly going to perform that mean time between failure because suppose exactly today it has failed and then tomorrow it is again failed.

That means, between this say maybe the between the two failure the gap was 27 hours, but next time again that when it fail after say 3 days back, but in between this failure and the next failure was your say gap was say 72 hours. So; that means, you go on adding for a period these are the things the time between to failure were this much.

So, you can find out what is the mean time between this failure. Now, when the failure has taken place after that I can put the machine back into operation by doing a repair work. Say I have taken 30 minutes repair. Now, you take the next failure when it came it took 3 hour failure.

So, like that for the whole year you calculate that add this total time and you find out that is your average in a year that mean time to repair of the failure is this much. So, that is when your mean time between failure and then the ratio of this mean time between failure plus MTTR that gives exactly the inherent availability of your machines. I hope you understood this.

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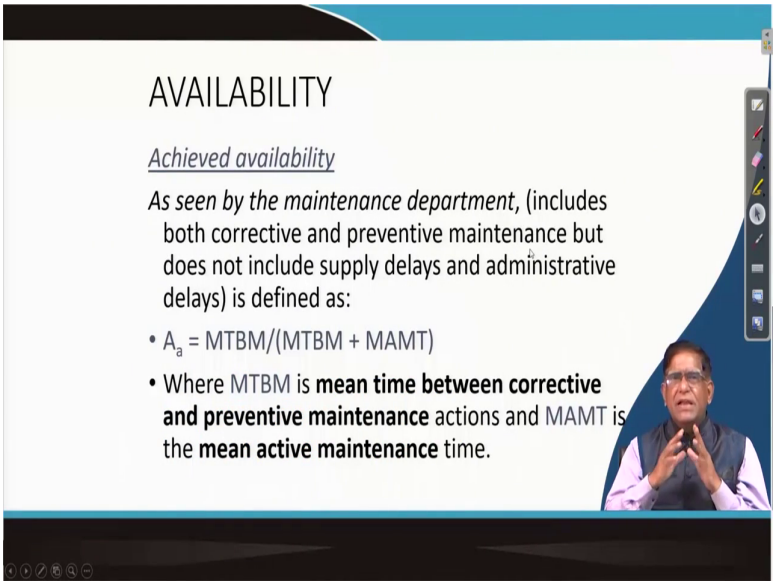

Then similarly there is a achieved availability. The achieved availability depends between meantime between corrective and preventive maintenance. Now, you do you have stopped the

machines for a preventive maintenance everyday 2 hours, but sometimes it again failed in that and it took about 5 hours to do the maintenance in 1 day.

So, like that the whole year or a months, you find out the total what is the mean time between the preventive maintenance between the corrective maintenance. And then if you find out that what is that active maintenance time, that exactly how much time it has maintained. If you take these two and their ratio this gives you achieved availability.

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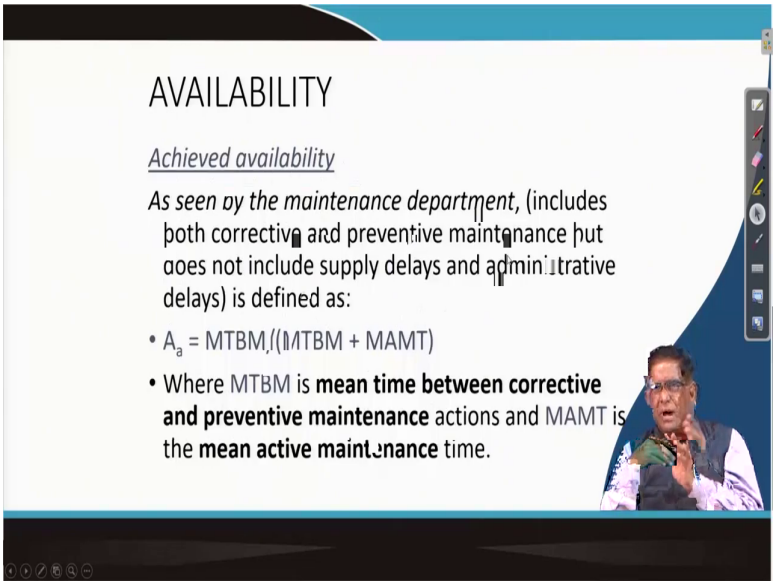

You can note it down and you can do sometimes when you go to the field, try to collect the data and see that this will be exactly expressing how the maintenance is performing. Now, this operational availability this is again in terms of you find it out this a mean down time.

Your all the down time is take average it out that is the mean down time. So, between this between the there a mean time between maintenance and then mean time between your mean down time they will be giving you your operational availability.

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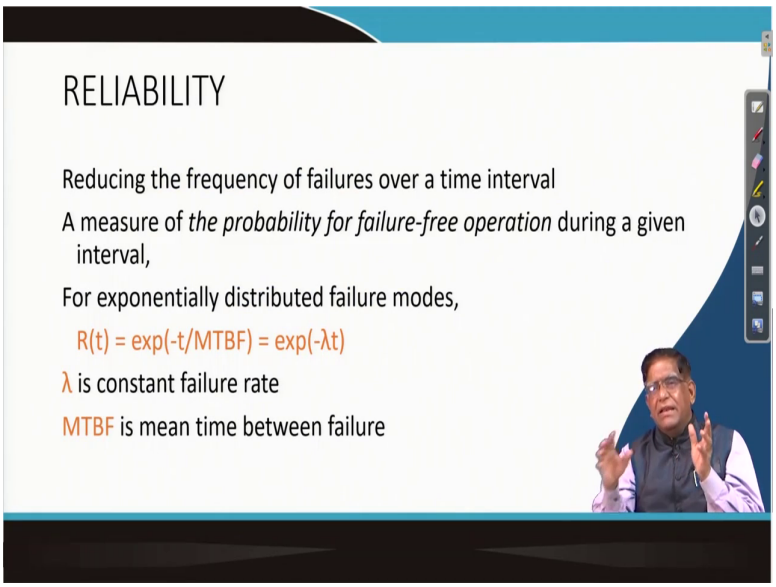

Then all the different availability you take it and then you multiply that gives your the overall this your maintainability. Now, this other term is your reliability which is expressed as e to the power minus t by MTBF. That is meantime between failure that is taken and by these expressions they express the reliability in a probabilistic term. It is that what is that exactly the expectations that you calculate it out.

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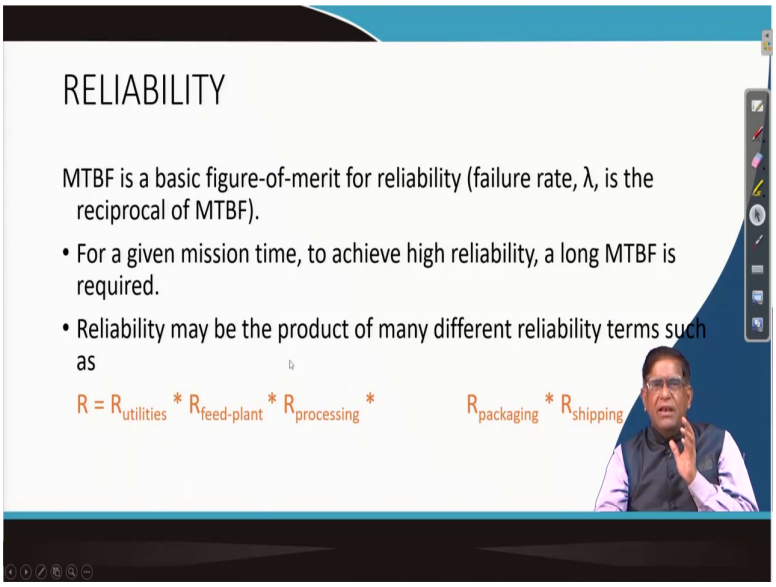

The reliability also is a component different parts. Their reliability will be multiplicative so that the overall reliability. If any of their reliability is less, the overall whole reliability will be going down.

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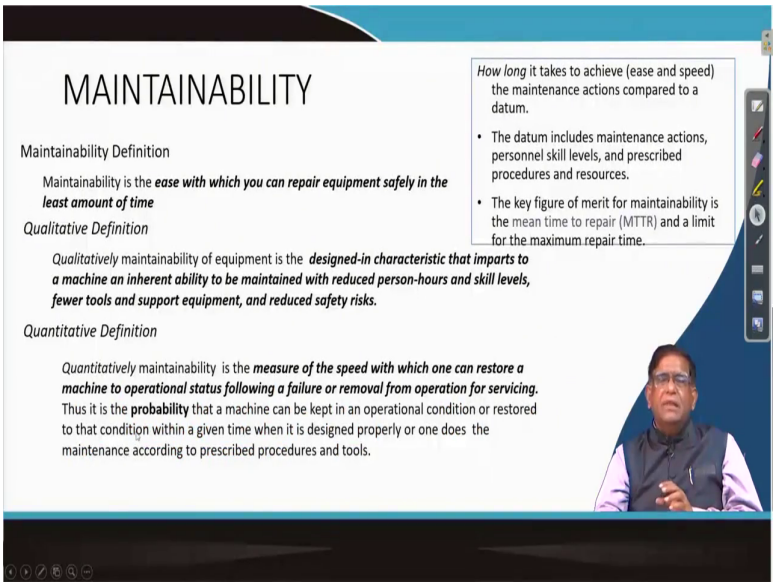

And then this maintainability, which we say about that their maintainability is the ease with which you can repair equipment safety safely in the least amount of time that is your a maintainable machine. Similarly, you can say that a qualitatively maintainability of an equipment is the designed in characteristic that imparts to a machine an inherent ability to be maintained, which reduced person hours.

That is you less may less man power used that and their skill level is also required less and then fewer tool up you need not buy a very heavy component or a machines to maintain it and support equipment [FL]. You are not going to buy any supporting equipment for maintaining it and reduce safety risk there is no risk while doing the operation.

So, that is the way you are finding out what are the attributes you are giving. So, that we are telling and measuring the maintainability of any equipment. And quantitatively it can be a

major of the speed with which one can restore a machine to operational status after any failure or that is after it is taken out of service. So, how quickly? So, that the time is a measurement of the maintainability.

So, exactly in the maintainability what you know? That is how long it takes to achieve that is how long at what with what difficulty. If you can; if you can this mean if a machines is a out of order not giving the service now how quickly and with what ease how easily you can bring back it to running conditions means your machine is maintainable. Our machines if fails and then it takes number of days to restore it; that means, it is not maintainable.

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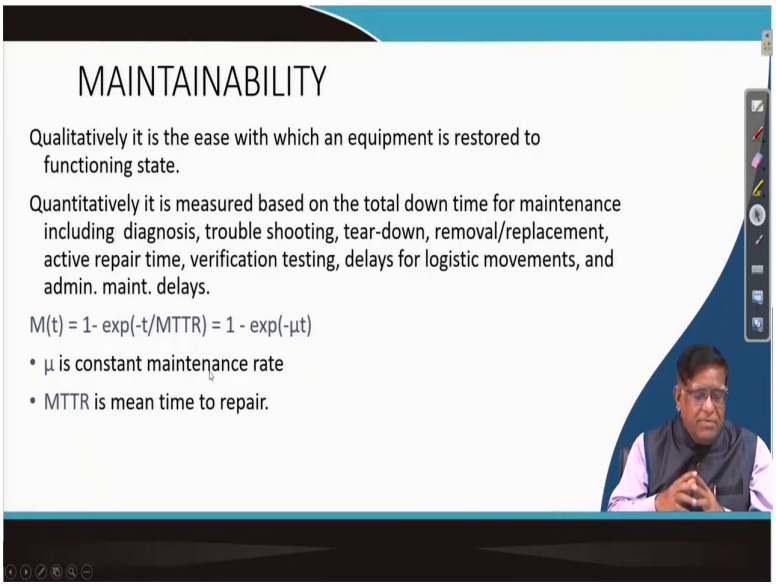

So, that maintainability is also statistically expressed and that expression that it is in between the mean time to repair that is how much the time to repair is required on that basis they have

given a formula for just only for quantifying. So, that everybody to use we can see the number and you can tell it over there.

But, the main thing is as it is there that concept you take that is how much time and what ease and the way you can tell your own way also sometimes. You can revise, but otherwise this is an index internationally people accept it then do it.

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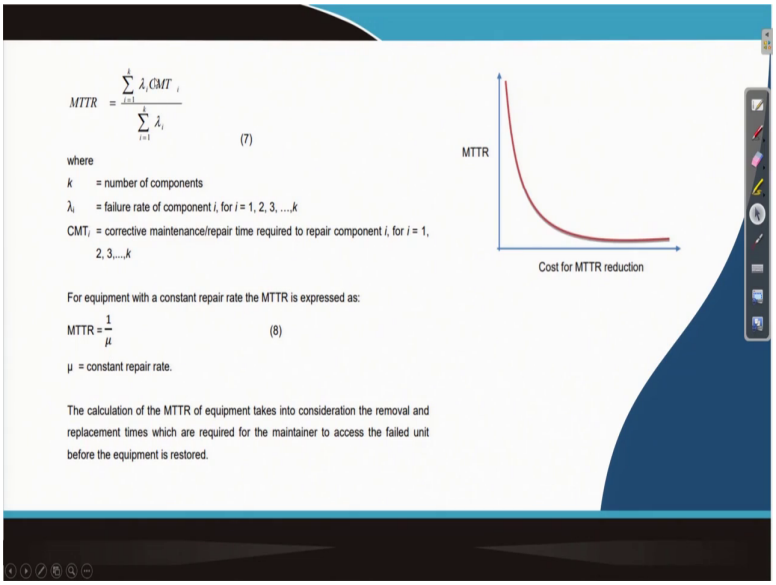

But you can see that your costs of the that is your cost for the mean time to repair if you reduce this and then your mean time to repair if it goes more. So, like that the mean time to repair can be calculated by the number of each and every component and there how much the failure rate it is given and the total sum.

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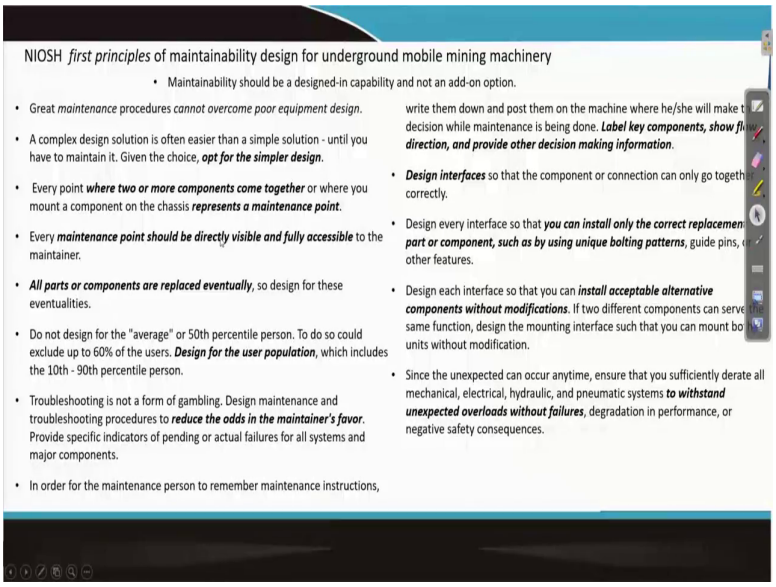

So, this is by statistically collecting the data you can calculate. Similarly, that is your NIOSH is that is your for operational the safety and health that occupational health they have exactly studied and a they this area lot of guideline standards are available. Here maintainability should be designed as they design in capability are not an add on. This is in the machine itself that how the maintainability can be improve. There are many important points are given in the guideline, you can see over there this in a this guideline.

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So, that is exactly, but to be very frank about in a nut shell that if you can see the part that there is a failure inspection easy. So, if maintenance will easier. If you are to remove a component, if that removal of component is very heavy and then you need to bring a person's to take it; that means, the maintainability is less.

If the access to part is so very instigated then it is not maintainable. I can tell you in every there is a high raised building there is a mean that is your electrical cable will be going or that the your sewage lines will be going there is a duct. Now, if the duct is very small and then you person cannot go then if any problem comes in that building it will take a long time.

So that means, those house has been constructed without considering the maintainability that is not a maintainable. Similarly, if your in a shovel say for example, that central pin on which

the swinging is taking place it is below. Now, below there you will have to a person's worker will have to go and then they will have to work in over there.

If that gap is not sufficient then you cannot do it. Similarly, you can find out in many time on the road side you can see a person's need to go inside that and then to make the nut on bolt. Now, those parts whether if you can provide a component that is exactly by putting from the outside it can gets hold of it and then from here you can do it; that means, you are making the parts more maintainable.

So, that is what is the basic concept of a maintainable and then you need to take certain precautions. When you are doing operation maintenance operation that your maintainability could should not get effected, for that also this NIOSH guidelines you must follow.

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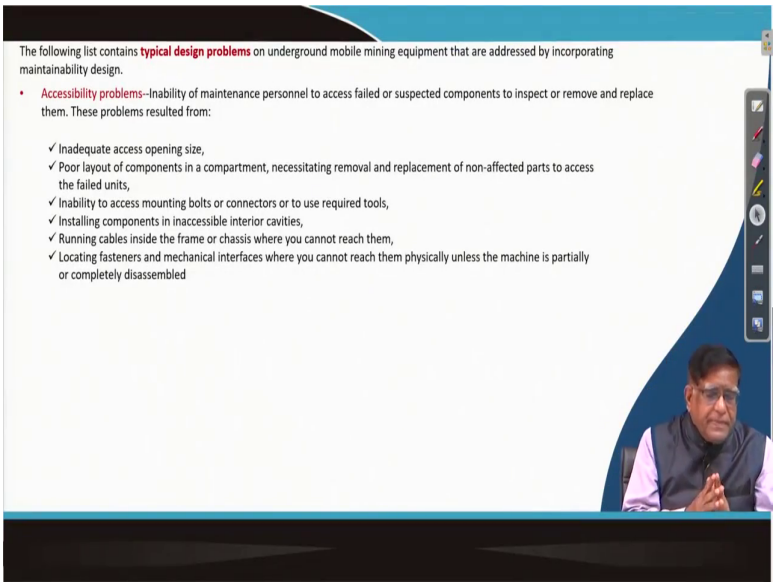

So, there is a there are different problems exactly when your equipment maintenance maintainability is low. If there is a problem of inadequate access of the opening size, a person need to go there, the door is less. So, you cannot get in; that means, your only, but if a operator is a if a maintenance person is very fat we cannot go and enter into a particular position of the machines that access is difficult; that means, maintainability is less.

So, if the how the components are placed that is their layout that is also very important. Now, after removing you will have to take it out and then put. At that time if you are if you are to hold a heavy things and come down on a step then also it is difficult. That means, if you are that type of if your system is provided a small that is your the for lowering it a winch is provided or not. By providing that winch that is the maintainability is increased.

So, there are many things are there related to the maintainability which are looked into in the design of the machines and also when operations they give the feedback accordingly they studied. You may find out many a time that is your that your cables some wires all these things are coming out from different places and then they cannot be.

If the system if your that you are when you are erecting a conveyer belt you will have to keep this cables, but if the conveyer belt supporting structures they have got a cable hanger then you can put the cable over there. So, during the maintenance or that during the shifting they will not entangle with the dozers and other and it will not get further damage and see.

So, that mean, the maintainability is more because they have provided with those hanger and it can be done. Similarly, if the drive head if it is coming on a already as skid mounted, so, that it could be easily pushed by a dozer then we can say that there is a maintainability is better operational ability is also better.

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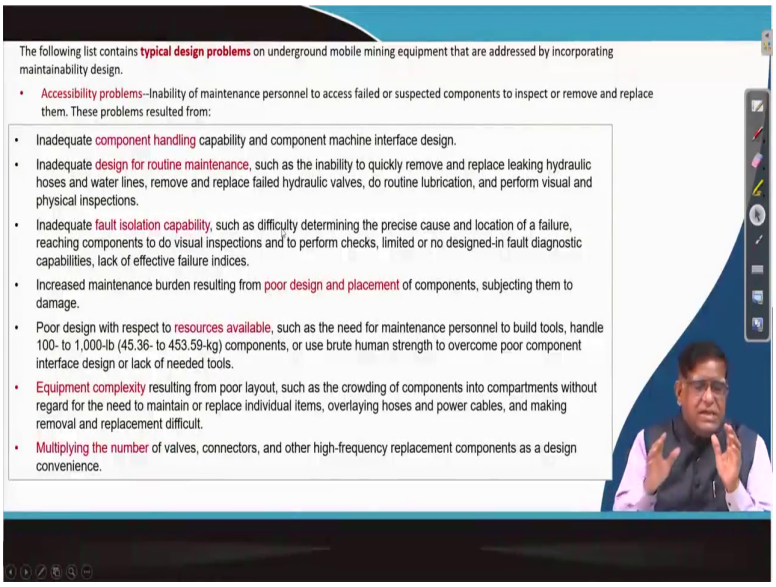

So, these are the things when you will be seeing each and every machines separately you will have to look into it. So, they typical design problems that exactly on an underground mining machines machinery. So, you will have to; how will you improve the maintainability? So, there in a if your machine is working in an underground mine and it is always a very difficult to bring a long parts and all.

If your maintainability is to be improved, the parts and components should be also a modular. So, that you can take it and fit it over there. So, that handling of the components for that fitting or taking it out that can exactly reduce the maintainability level you need to be careful. Similarly that is your how that fault can be isolated so that one fault should not create a problem for the another one.

You can find out many a times that if there is a one problem is coming into the machine that problem you run under that conditions, it will lead to a another problem. So; that means, that the fault isolation system is not designed at the time of designing the machine. So, that is what is exactly afault isolations. Then your which equipment component is kept where that is also sometimes can obstruct your maintenance operations.

So, that is again the more the complex a machine is there the maintenance problem also may be difficult. So, but this is a general philosophy. Though you are designing an each and every component has got a lot of engineering behind that why it is putting right from whether it is from the heat dissipations, whether it is a that is your heat management in the machines a thermodynamic principles or it is a fluid flow whatever it is there.

Say that means, if the we have to say for example, you are having a air cooled motor, but the parts coming to the air is obstructed then what will happen? Your motor will get overheated and there will be more maintenance problem of the motor. So, that why where the placing the components of the machines need to be properly looked into.

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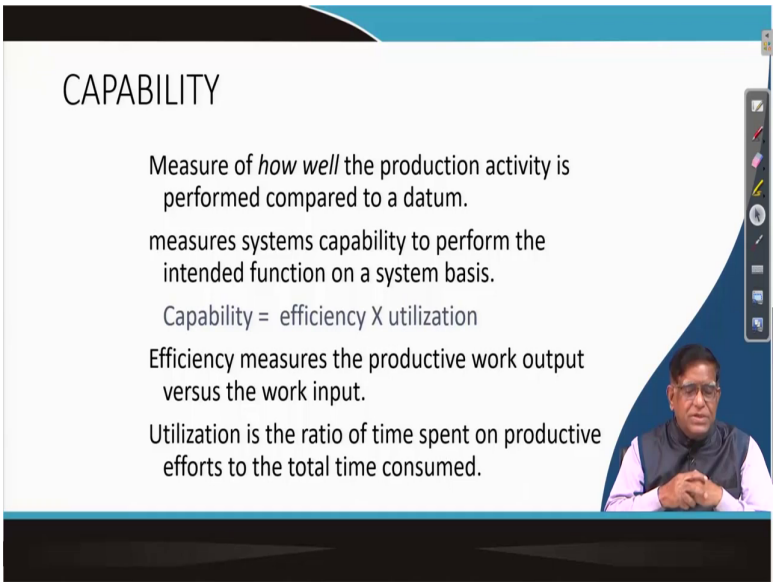

Similarly, the capability of a machine is a it is a how well the production activity is perform compared to a particular data on the basis of there is a basis on the basis of which you will be doing. So, it systems capability and then it is a exactly product of your efficiency and utilization.

And the efficiency measures the productive work output versus the productive input; how much input you have given and how much output you have get from there you find out the efficiency. And utilization is exactly the time which is exactly being used for that getting that work done.

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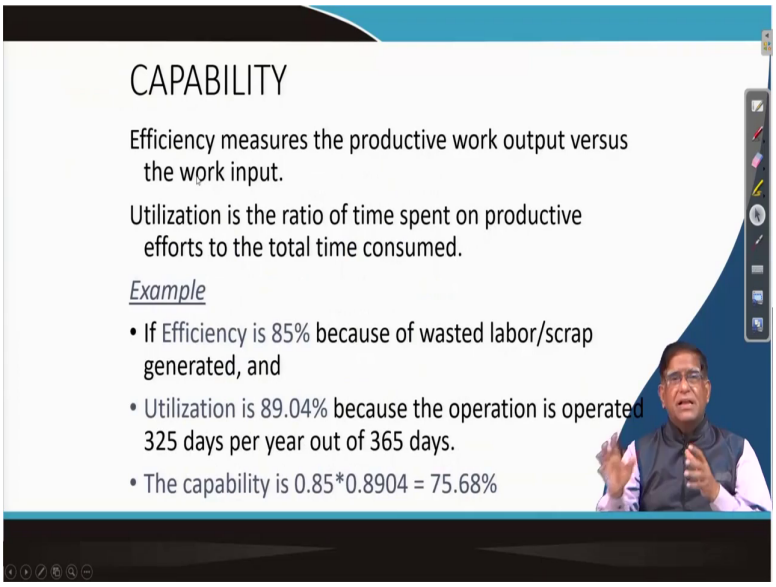

So, by this way you can express the capability and there is a the efficiency measures the productive work output versus productive input. And utilization is the ratio of the time spent on the productive effort. So, by that you can understand is that if your efficiency 85 percent because wasted labor scrap generated and utilization is 89 percent because of the operation is operate 325 days in the out of the 365 days.

So, that way you can change that your efficiency may be different, but if you capability is their product you can find out individually they had 85 percent and 89 percent, but when you see the capability this is coming down 75 percent. So, what exactly I told you that if there is a the any thing when a particular that is your measure is a productive any one low going down can make your system very unproductive. So, that is what we need to see.

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Similarly, the performance can be measured by the maintainability and capability. Their product give the performance of the systems. You know the; you know the capability is the efficiency and utilization. So, the performance of a machine or performance of your maintenance system you can say that performance is a product of maintainability, efficiency and utilization.

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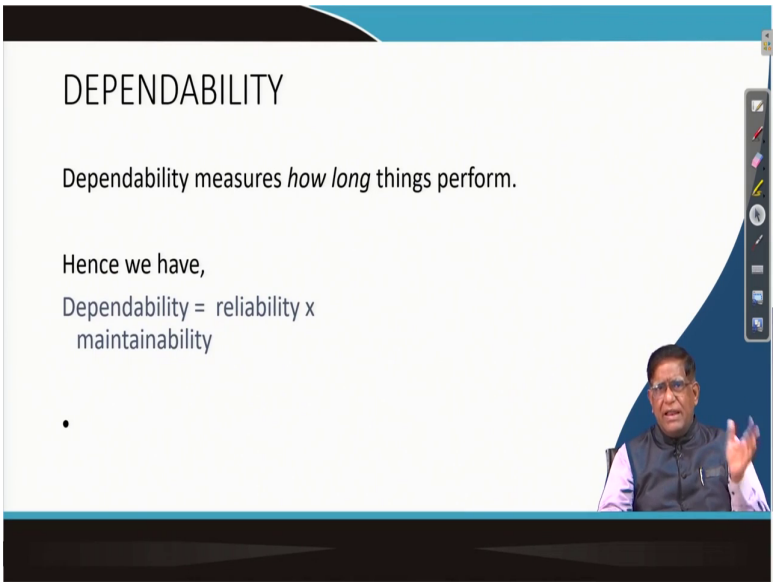

So, why I am telling this things if you want to do any project work going to a mines and taking out one machines and there you can study this parameters and you can give a clear picture what type of decisions will be there. And that dependability of how long things perform that will be the reliability and maintainability their product if you are highly reliable and highly maintainable will be giving you highly dependable system.

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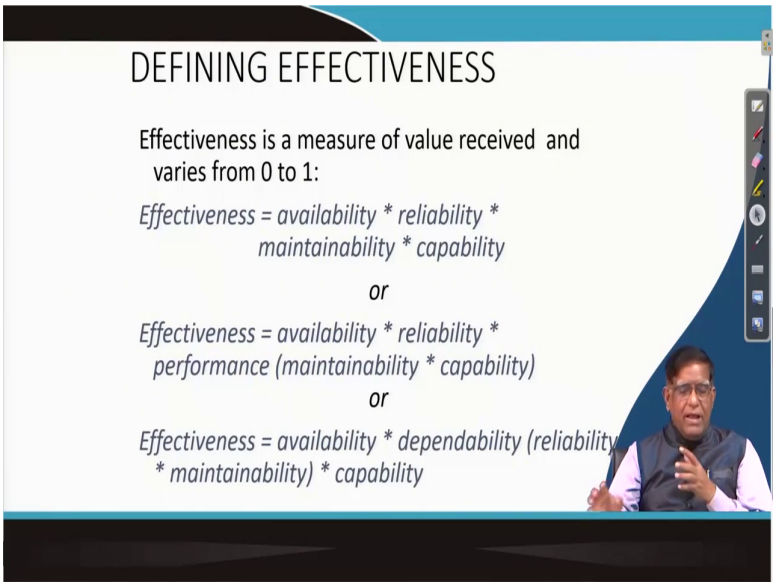

Now, effectiveness is another terminology which is meaning availability, reliability, maintainability and capability. These four figures if you are finding out an industrial way to measure it then you can find out the effectiveness. Now, the effectiveness can be it is a; it is a performance can be a function of your that maintainability and capability then you can the modify the equations accordingly.

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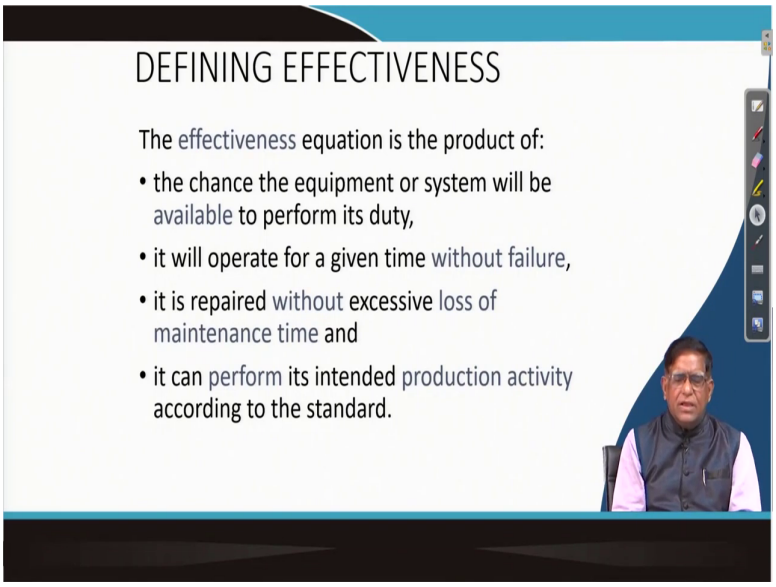

So, this effectiveness equation is a product of the chance of equipment system will be available and then how it will be operating without failure, how without any excessive loss of the equipment and how it is exactly the production activity is carried out.

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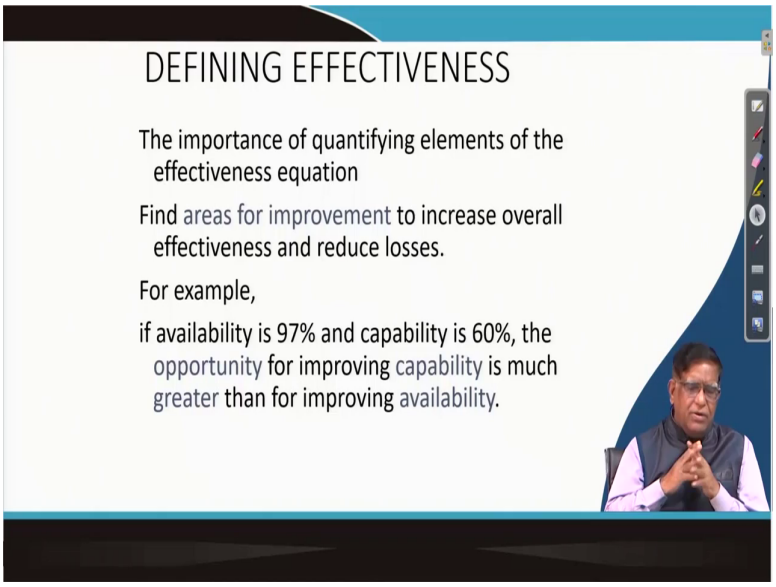

So, this is the way how you define your effectiveness and if availability is 97 percent capability is 60 percent, the opportunity for improving capability is much greater than the improving the availability. Because your availability if you product that will be reduced.

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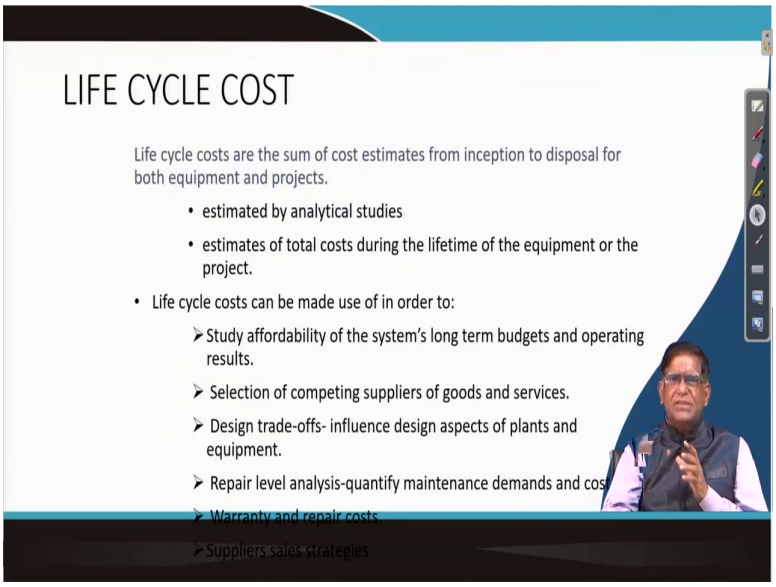

So, this type of some of the decisions will be necessary in maintenance management. The one thing is a life cycle cost. This is an area which is also very much needed in the mining industry, how to do the life cycle costs. And the mining life that itself is a variable term because of the it is such a market dependent and geology and the dependent phenomena in that, that is sure to get a profit of a capital investment need to do a very careful calculations.

And one thing is that life cycle cost that is exactly if you are procuring a shovel today and the shovel is life is normally given 12 years, but sometimes you are using the same shovel for 25 years and then you are having this maintenance and other things. So, that what is that?

If the mine is getting life for a 25 years and the same machine after require a procuring ones you are continuing it, then you can measure that exactly what will be the life cycle cost because of the maintenance repair, overhauling and all these things will be adding up that.

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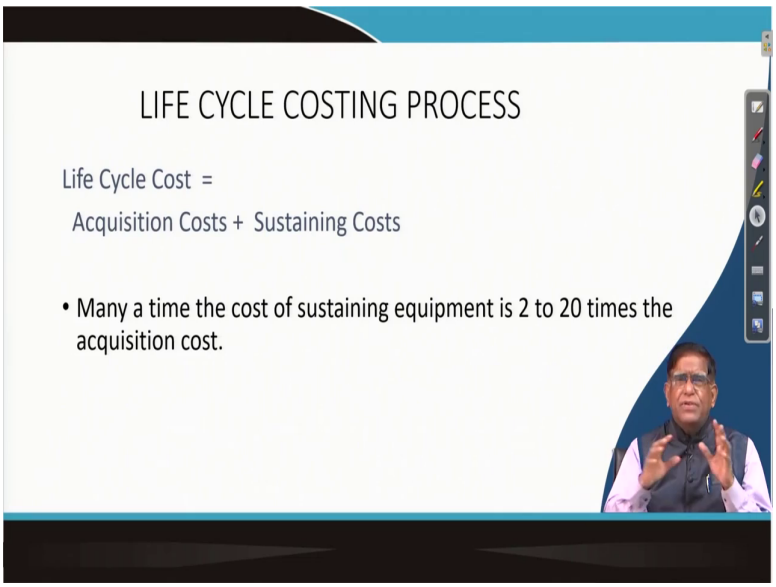

So, this is how a life cycle cost analysis is done. So, that life cycle cost it requires also the acquisition cost and sustainable cost. That acquisition cost is not only the original equipment acquisitions, but also that for the maintenance number of thing may be acquired during its life those things also taken into consideration.

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Basically these are the common science, but we will have to be very methodically you will have to document, correct and prepare and take decisions. So, there could be number of costs coming in that acquisition cost, research and development cost, nonrecurring cost, recurring cost.

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That is your schedule and the sustaining cost will been schedule and unscheduled maintenance cost. That facility usage cost, disposal cost.

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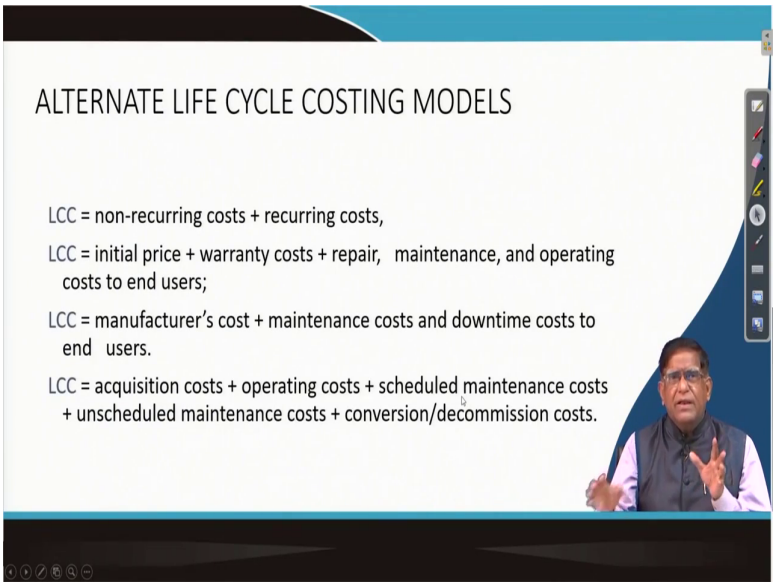

Different way that costs are made and then you make a life cycle costing by non recurring cost and recurring cost or there are these are different way of calculating. As you see the last one they are telling life cycle costing can with the acquisition costs, operating costs and then schedule maintenance cost, unscheduled maintenance all parameters brought in and you can do it.

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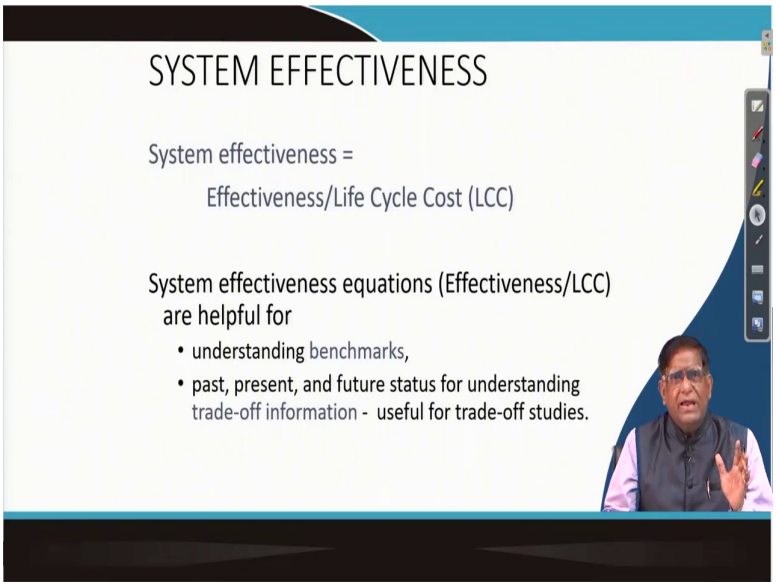

So, asa system effectiveness is another which is based on the life cycle cost.

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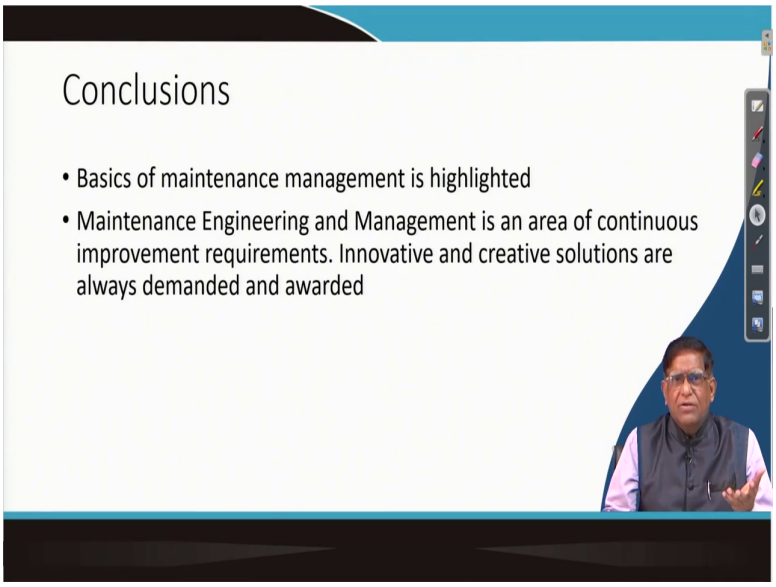

So that means, in a nut shell you have got a maintenance management system is basically collecting different parameters and then statistically putting it over there and then developing a model and on that you evaluate that how the system is performing. And the performance one of the most important parameter is the cost.

So, to do a life cycle cost analysis we will have to know that maintenance, operations as well as the external influence on the system. So, I hope you have understood now what is the maintenance of mining machinery and then how exactly the maintenance management is to be done.

So, with this I hope that is basic of maintenance management which highlighted is clear to you and the maintenance engineering and management is an area of continuous improvement and requirement because new machines will be coming and new systems will be introduced

new data analytic tools are coming. So, when you put that your innovative and creative solutions are always demanded and awarded.

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There are lot of researches and other papers are there that a maintenance engineering books are there. Some of you if you wish you can read my book on rudimentary of this maintenance engineering and management. A small book I think it was available it was published in 2000-2001 or so, with my teacher Professor R. C. Mishra who is no more now. So, that is a small book to understand what is the basic maintenance management and maintenance engineering is.

Though maintenance engineering itself is a different subject that where we need to know about what are how to do the testings and then how to exactly different type of your inspection tools need to be used. So, maybe with this we are concluding. One more lectures I

would like to talk to you on what are those Non-restrictive Testing in Mining Machinery. With that we will be concluding our mining machinery program with you.

Thank you.