Applied Ergonomics
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Module – 01
Lecture – 03
Productivity Measurement

Welcome to this applied ergonomics lecture 3 on work system design. You are talking about some basic issues related to productivity and how it is very difficult to measure productivity, because of the variability of the inputs or even the at times the outputs which are driven particularly by economic forces and markets. And the best and the first estimate that can be made in this area is to take the human component, and try to define something called labor productivity index. Which is actually the measure that compares the input and output ratio from one year to the next.

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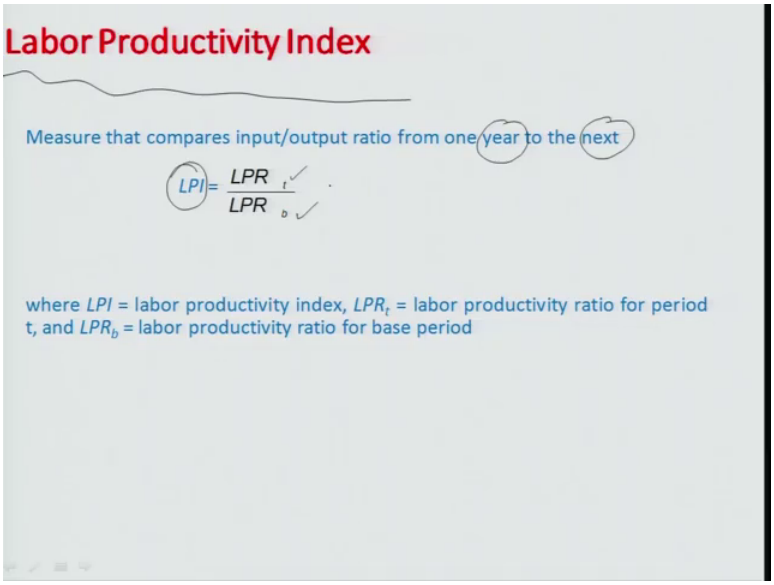

So, this gives a kind of feeling that up to so many people are involved in a work system, is there a increase in the productivity between year 1 and year 2 ok

So, this is something that would give a very good parametric for the work management staff to see, whether the counter measures which I have been taken. In terms of addition

of technology, in terms of addition of knowledge base, in terms of addition of let us say, even capital investment. They are really leading to this outcome of improvement in the labor productivity. So, an index which is probably let us say, more than one would mean that definitely the productivity is getting increased or decreased ok.

So, between 2 different time zones or maybe 2 different years, or even 2 different set of number of years you could really map depending on the implementation times of some of the let say improvement in the systems, how the productivity is changing as a function of that. So, LPI or the labor productivity index is defined as the labor productivity ratio, for the period that we are considering with respect to the base period. The base period could be the previous year the period that we are considering could be the next year. Or the base period could be the previous 10 years and the period that we are considering will be the let us say the, the current years or let us say after passing 10 years what would be the increase in the productivity that kind of a thing and always be there on records.

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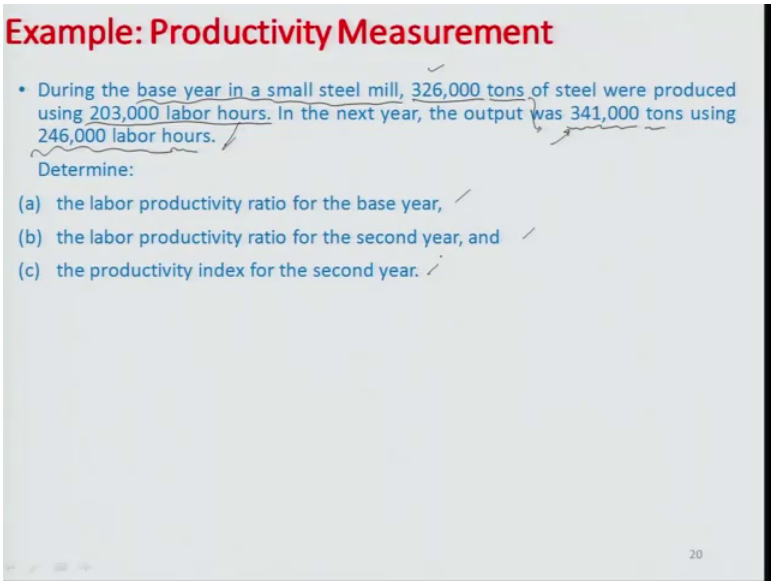

So, let us look at some sort of numerical estimation of such productivity measurements. So, let us say during a base year in a small steel plant, we had steel mill we had a production of about 326,000 tons of steel. And this was produced at the behest of spending about 203,000 labour hours, and the next year the output changed. So, this 326,000 improved 341,000 tones.

So, basically the production has really improved over the years, but let us look at whether really the productivity has improved. The labor productivity is improved, because this 434,100 tones is at the behest of spending about 246,000 labour hour. So there is the substantial increase in the labor hour as is in the production. And so, we have to really see whether the ratio gets maintain or there is a change in the productivity. So, you want to determine what is the labor productivity ratio for the base year; we also want to determine what is the LPR for the second year. And then we want to determine what is the index for the second year. And so, let us say for the base year, if I calculated LPR in terms of the number of work unit. So, number of output divided by the number of labor hours ok.

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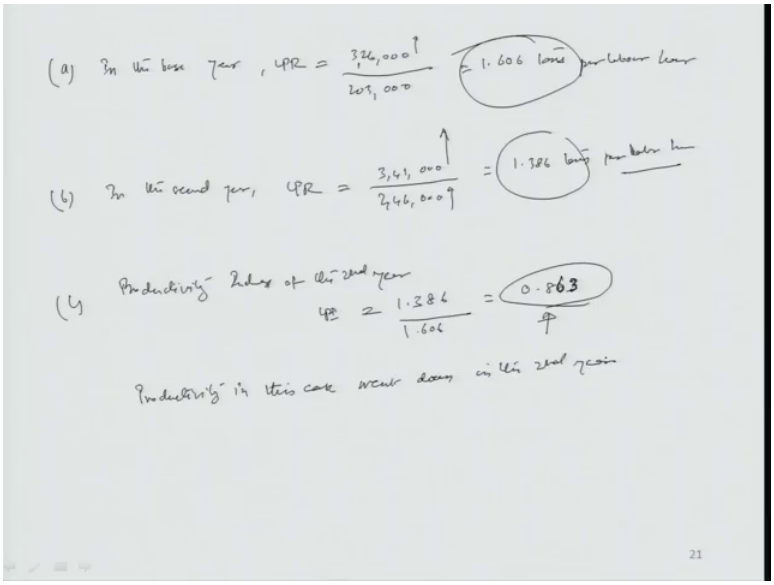

So, the work units say here a 326,000 tons of steel which has been formed produced and the total amount of hours which has spent do that 203,000 hours. So, is typically about 1.606 tons per year or per labour hour so that is how your productivity or labor productivity indexes of the base year. In the similar manner if I wanted to do in the second year, the labor productivity index also labor productivity ratio LPR could be counted as the current number of tons that you producing of steel from the work system. And divide that by the current number of labor hours which go into producing this 341,000 tons of steel. And so, the ratio comes out to be about 1.386 tons per labour. So, you see even though the production is increasing from 326,000 all the way to 341,

because the number of hours have increase substantially also the overall productivity is going down ok.

So, the labor productivity ratio is in fact, going down and if I wanted to calculate this index. So, the productivity index of the second year let us say, LPI could be in terms of the LPR for the second year per unity the LPR for the first year, which is about 0.863. So there has been downfall in the productivity, and has actually changed by about 14 percent. And it has gone down from year the base year to the second year. So, no matter how it is measured the productivity really went down in the second year. So, we can conclude that the productivity in this case went down in the second year.

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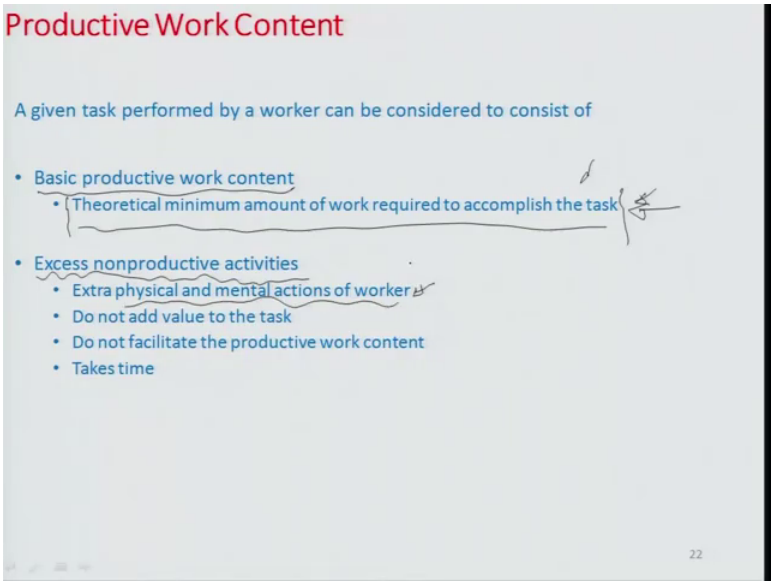

Now, let us look into some of the work contents and how we can classify the work as waste full work and use full work, and a productive work and non productive work. And it is very important to mention that when we are talking about human subjects associated with the work system, and considering that human beings are not machines there is going to be a difference in the way that deliverance happens between one human subject to the other. And therefore, the way that work is delivered by somebody can be either more efficient or less efficient. And because there maybe some underline reasons we you could avoid from his work style so that this efficiency does not go to different ok.

And So, the role of an engineer the role of a technologist is really to look at that aspect to see if I can make some improvements so that the efficiency between 2 human subjects

are the more or less similar, not much varying. So therefore, the first classification that one has to have in mind is to sort of make you know a list of such tasks that a human being is doing on to a work system, and try classify the task as once which are productive task and one which are non productive task.

So, as the name suggests productive tasks are one which would add value to the particular output the product the service whatever is being generated by you know the system to the society, and non productive ones are where there is typically no value addition or very less value addition to the overall work system. And so, the basic task are classified into the basic productive work content which really means the theoretical minimum amount of work required to accomplish the task. And you know this is really the theoretical limit meaning there by that ideally in an ideal kind of a situation time not more than what is supposed here in this theoretical limit should be taken by any normal individual to accomplish the number of tasks that are mentioned or let us say the quantum of the task which is classified in this information.

Then there are excess which are there over an about the basic productive work content which also known as the non productive activity. This could be in terms of let us say extra physical and mental actions by the worker. For example, I will like to just draw your attention again to an automotive assembly. Let us say there is a activity in the trim line of an assembly where you have to fit let us say a gearbox console on to be on to the main car body. So, consol is basically an interior part.

It is just a you know, small box like entity which is to be fitted in the place where the gear lever really comes up from the transmission side which is actually in the under body or the front under body area. And the lever is operated from interior of the car. So, it should be like interior. And in order to fit this console and maybe in order to fit some of the other associated things like wiring harness of break pipes. A person concerned has to go inside every car, sit in the car and go along the assembly line on this car till he completes his tying up work and then comes back.

So, typically in automotive assembly is because of increase, speed it is important that the you know the screwing of (Refer Time: 09:40) screw or let us say even a nut bolt is done through, either pneumatic guns or electrical guns. So, you have to carry a gun every time you do that. And then let us say there are different fasteners which you want to use for

the console for the break pipe, which is actually fitted on the interior of the car or let us say for the roofs the wiring harnesses which are actually pasted on the interior side of the car. So, every time you need do that there are different fastener which are there, and this guy he decide to carry the fastener every time he does not operations. For example, he goes into the car once and fits the console, then he goes again and if it is the break pipes and this way he does discrete activity. Now every time he is coming back to his base station, in order to pick up a fastener and go back into the car and this is a very un productive operation.

So, maybe a simple system like a carrier tray which has all these different fasteners. And all these different mechanism which are used for mounting all the 3 components that he has into picture, will save is offered in terms of going into the car and coming out every time. And that way may be the quantum of the work that can be done by the individual may be increased. This unproductive extra physical labour or motion, which is there just by virtually of the fact that he has to carry out fasteners every time he goes along with the gun, makes his tuff the task very tuff. And so, some how you have to make the task easy so that he can do more amount of work in terms of value addition to the car, and cut off some of these extra work that he is doing in terms of carrying fasteners etcetera. You know you have to really identify those tasks we should not add value to the particular car. For example, let us say in some of the older car assembly is there is this concept of dents which come on the car doors. And in order to prevent the dents there are door covers which are used. From the beginning station you know the moment be painted body comes and sort of is laid out or laid over slat conveyor. There are covers which are put or added to all the 4 doors So that it avoids any a dents or impacts during the assembly process which may otherwise happen if the cover is absent.

Now instead of doing this if I have an intelligent way of let us say disassembling the door. And assembling the door in a separate sub assembly. So, as the painted body is coming from the paint shop, let us say we look at the car and then pull out all the doors which are there and make a door sub assembly line. And as the car has been completely assembled and is gone to the final line, this is the place where you actually go ahead and fit the doors on the car.

So, you are avoiding the re worker associated with dents which would otherwise generate because of so many people involved in the assembly process, you are also

avoiding to make major extent problems which could have been avoided because of simplistic operations. And the door quality or the quality of the components which are interior to the door or much better because now there on a focused sub assembly line, rather than getting an different lines and different places along the whole assembly line.

So therefore, you have to really look at the aspects which can probably by thinking process, or by let say intuitively intelligent processes change the overall task structure so that there is the extra physical and mental action of the work removed, worker removed. So, always there has to be a sort of a primary goal in mind of people who are looking into real ergonomics studying of the work places about the general easing of the workforce which is involved in deliverance ok.

So, overall that has to be the goal. And sometimes it may mean more work per person, but then the overall issue is that the productivity level would go up because of that. So, do not facilitate productive work content because it is already productive. So, you do not need to put this in the excess non productive activities, and you know then the excess non productive activities take time ok.

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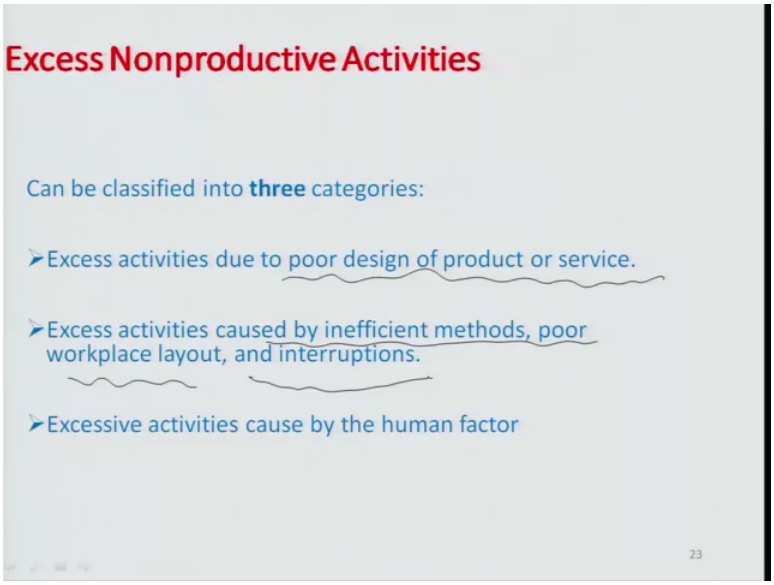

So, you have to somehow reduce on the time part on that. So, this is how you are dividing the work into productive and unproductive type. And In fact, if I wanted to classify the excess non productive activities. It could be excess activities due to poor design, a product or service or maybe even to some extend the production system layout

or the way that processes the carried out. It could be excess activities caused by inefficient methods, poor workplace layout interruption sometimes lighting in a particular area is very important. Let say we are looking at subassembly where very small fasteners are in place and they have to be a subassembly into the product, and the overall lighting associated with that area is less.

So, because of less emunation there is always and interchange on exchange of fastener, which may cause damages in terms of hole sizes increasing or decreasing particularly in self fasting screws inside the let say car or something. And this may in a way generate lot of rework associated which is the extra activity it is a non valuated activity. So, it we were done at right at the first place where the right fastener was used the right place, then this unproductive work would have been eliminated ok.

So, these excess activities caused by in efficient methods, poor workplace layout, poor interruptions or an interruptions should be sort of eliminated. They form a part of excess non productive activities. And then of course, excessive activities is as mentioned caused by human factors. Sometimes you know it is not in your control what a human being does. For example, a person may be used to working on a car and using a part of his productive time to just go and chat with somebody else who is on the same assembly line.

Now, you can not stop him from chatting. But let us say if I identify that he has excess time and he has the time to go ahead and exchange views with somebody else which is not related to the actual value addition to the work. There maybe a possibility that it if you task him a little more than that particular time that he does. Otherwise maybe in terms of value adding to the component now. That does not mean that a person should be deprived of his relaxation time. You have to understand that when we are talking about a proper ergonomic design, relaxation or let say the ability of a person to get to do a high quality job in the next run is needed. And this comfort level needs to be there in place in all the task planning related to a person. But things which will be completely unproductive to the components that you are producing or value added to the to the overall product. Those things can be eliminated in analysing the human factors and trying to establish the synergies between such unimportant activities done by such human factors.

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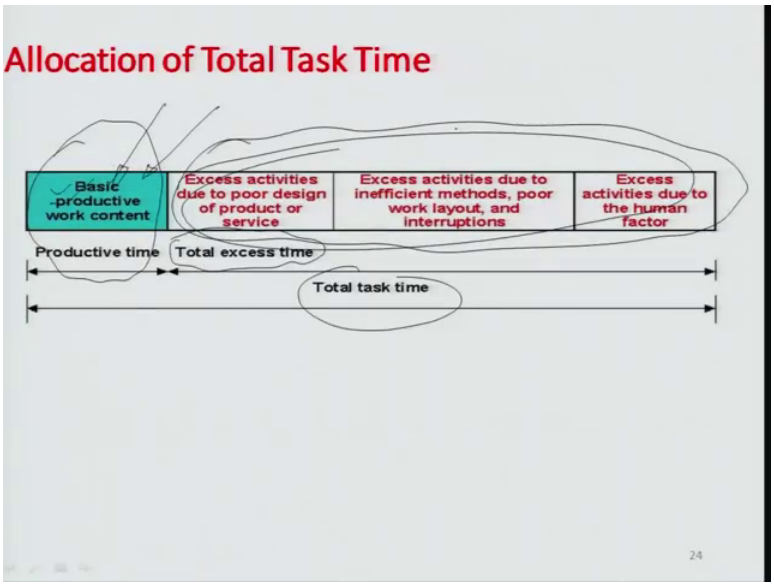

So, this is what excess non productive activities is. So In fact, if I looked at the total allocation of task times. The basic productive time of a task is this small. You know if I really wanted to emphasize the need for ergonomics in, and this is the problem in all the task designs. At the basic process or the dis let us say, the basic process would have a very, very less amount of actual productive work content. And most of the other time that is spent is in terms of this excess activities. Due to poor design product service excess activities due to inefficient methods poorly out, interruptions excess activities due to human factors.

So, a total amount of excess time in all work and this is the underline theory of all ergonomic design is very, very high. And this needs to be completely eliminated if possible and if not then at least reduced to substantial amount so that the basic productive work content percentage in the whole work time goes high. So, the total task time should have more of the green and lesser of these white blocks. That are being mentioned in this particular figure. And so, that should be the purpose of a job designing engineer or task planning engineer.

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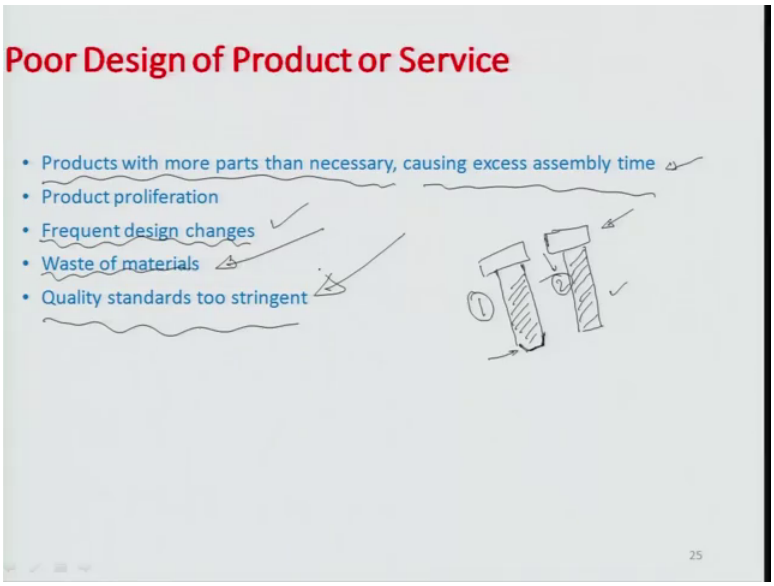

So, let us look at some of the unproductive factors in a little more appropriate manner. For example, poor design of products or services products with more parts than necessary. Causing excess assembly time are unproductive there is a design for manufacturing an assembly which is not taken off in this particular module, but probably will be discussed eventually is about that how you can gauge the assembly efficiency of a process by looking at modularity.

So, if 2 parts which are adjacent to each other and may not be limited because of there in a you know mismatch in thermal behaviour, or electrical behaviour, or kinematics motion with respect to each other there are certain clauses. If they do not do those clauses or follow those clauses you can modularize them. And so, if I had more modules and less of you know assembly at the behest of the operator who is in the assembly line, and maybe these assemblies are sort of again uploaded to some other source for which it would be a smaller tasked to do.

So, then that efficiency of assembly because of the modularization, modularization of the input material which is coming in would be more efficient than what it would take otherwise to assemble part by part. And every bit or every fraction by fraction. So therefore, very good design or robust design in terms of what could be modular what could be part level? And also in terms of let say orientation of a particular part before assembly or the amount of time that the part needs to be inserted into an assembly the or

the amount of time that it would take to rotate or reoriented, according to the direction in which it has to be assembled.

So, if these things can be studied uniquely and define then may be by design itself. You could make the parts assemble in a much faster manner. So, when I say poor design these are the underline aspects that you have to look in order to change the factors associated with how a part is carried out and how it is assembled on to a line. When we talk about poor design a products or services; obviously, we also involve concepts like frequent design changes. That itself maybe a cause of such you know process dis balance if I am changing the design, as per the needs of a consumer within a very shorts time span and then the design keeps on changing. With smaller spans obviously, the process will have a certain inertia and it may not modified to an extent that is needed for getting the product assembly the new product assembly ergonomically fabricated.

And so, if enough relaxation time is not given on to the production layout side or the process side, and we just simply keep on changing the designs of the products. It may also lead to poor design or it may also lead to less amount of productivity. It may also be sort of you know if there are the products of design poorly it may be a lot of wastage of material. For example, let say if there is a need to orient a certain screw into a certain nut. And there are 2 different modules of the screw one which has a guide let say for example, there is a conical guided structure here on to this particular bolt, you know which is there. And the other one is a straight bolt and this is by design again. Which one do you thing will be a better idea in terms of insertion into a hexagonal nut.

So obviously, this design would be better. Because it have a self guiding feature which will ensure that the threading that it has, or let say the thread assembly that it has into the nut would be much more appropriate in comparison to this design. So, case one is definitely better then and case 2. So, if I had case 2; however in my design then I would be wasting a lot of material because there will be a lot of problem because of cross threading of nuts or may be cross threading of such screws. And then also in terms of these are holding together dynamic parts what would be the performance of those parts. And this would couple on to loss of productivity ok.

So, if I can identify such areas through design changes were material wastage would be avoided that would be a very great bases to remove the poor design. And then sometimes

poor design products and services also are in terms of very high quality standards or expirations. Supposing I have a set of machines which has certain capability. And there is a certain process capability given by the manufacturer of those machines. I am not going to produce parts in that capability range with specifications which could actually easily go by as acceptable parts, through those machine. So, they are going to be more rejects based on that ok.

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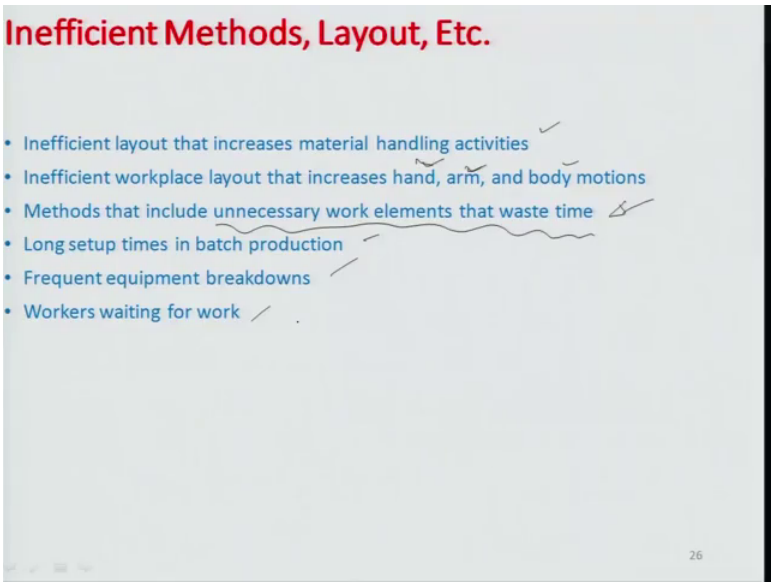

So, this is definitely one of the very important area, that how I can make design improvements and make the design enough robust so that productivity improvement may happen on to my system. There also some other areas which are of interest one is inefficient methods layouts etcetera. So obviously, if the layout were to you know to inflexible, or if the layout was causing repeated obstruction of man movement or material moment. That will lead to productive losses, if supposing it is a inefficient workplace layout in terms of hand arm and body motions. In the actual assembly of the product this is again going to be a very lousy kind of a mechanism for the productivity loss. Methods and include unnecessary work elements that waste time that could also generate lot of inefficient methods ok.

So, this some of the things which are mentioned here for example, long set up times in batch production, frequent equipment breakdowns workers waiting for work.

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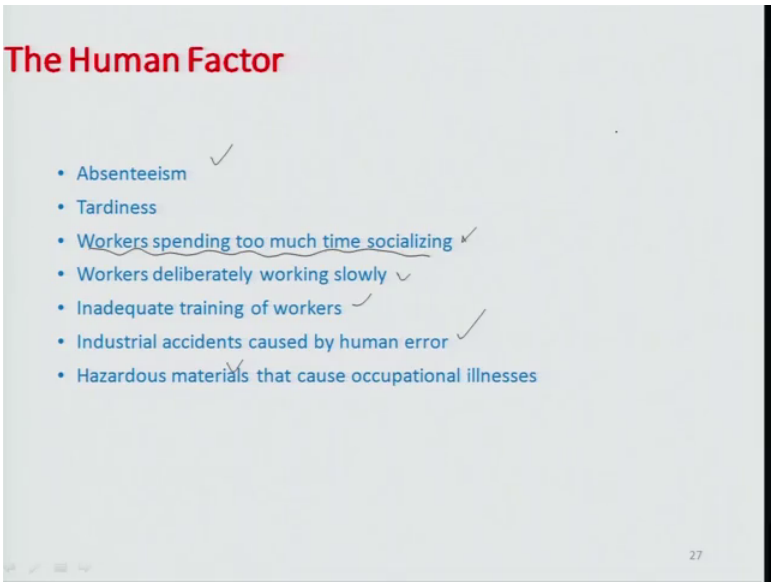

These are all part of how inefficient methods and layouts can contribute to loss and productivity. Further there are human factors which are about how the workers are contributing in terms of their slowness or you know there let say inadequate training or in terms of a unsafe practices in terms of ability to not deal with hazardous materials, which cause occupational in less or in also in terms of absenteeism etcetera. And also unproductive times spend by socializing etcetera.

So, these are some of factors we should be again taking down the productivity. So In fact, what we have in mind behind this whole area is somehow to identify on a case one case basis in a very organised manner some of these challenges associated with work systems. And if we can contribute by changing such challenges or by let say incorporating improvements to such challenges then; obviously, the productivity level would come up highly. So, I would like to close on this lecture here, and maybe in the next module we will continue further on other important issues like work study etcetera.

Thank you very much as of now, thanks.