Applied Ergonomics
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Module – 02
Lecture – 08

All are welcome to this lecture on applied ergonomics lecture 8. We were talking about on the various ways and technologies of recording the facts that you get out of some identified process or task or a job in general. And it is basically only related to or limited to an organized representation of all these in terms of symbols or arrows or flow diagrams so that you get a overall prospective and a very short glance about how the process would really look like that is only purpose of laying this all. And then we also did some time motion studies where we talked about time studies where we talked about what is the normal time and what is the standard time with (Refer Time: 00:59) factor included inside we did some numerical problems as well.

So, today we will be looking at how these time studies effect particularly sequential operations related to assembly line etcetera and for that I have the following example here.

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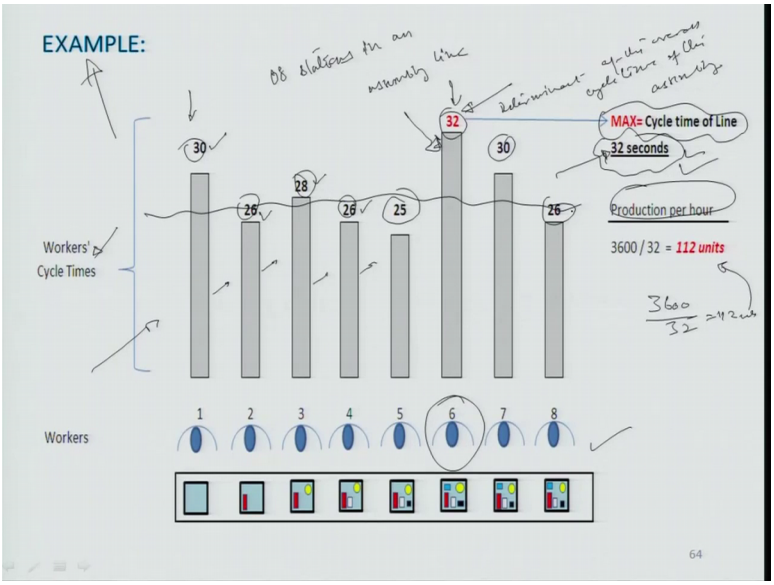

For example, let us we have an assembly line which has number of workers about 8 workers here and there are 8 stations on this particular assembly line. So, we have 8 stations in an assembly line and we have through any of these approaches including the stop watch approach or the cycle graph or chronocycle graph we have been able record the times of individual operators on such an assembly line.

So, let us say on the cycle time which is corresponding to the work delivered by an operator in one particular station. So, these are 8 different stations and each station has the certain cycle time associated with it meaning there by whatever operations are intended to be done by the single operator on one particular station are about there are 8 operation domains or let say operation subsets which would together integrate out to be the whole task on the assembly line. So, the first worker has the cycle time of 30 time units, the second is 26, third is 28, fourth is 26, so on so forth and this comes out of the regular observation through stopwatch or even some of these other techniques you know where using micro full beam motion you could accurately predict or estimate what is the kind of time involvement in such operations.

And here you are seeing that for all these different 8 stations which are there, there are close to 8 almost different times which are associated and the highest time that this operator right here operator number 6 takes on his particular station is 32 seconds. So, this is determinant of the overall cycle time of the overall cycle time of the assembly line because; obviously, this lowest step is the limiting step because that is the maximum time requirement.

So, the line has to run or operate only looking at the slowest operator or the slowest worker, so this is the situation given the situation if I wanted to look at what is the productivity of these particular line. So, you know that about 32 seconds is the cycle time of the line because if you move it more than 32 seconds then this operator here is not going to do its job completely and the assembly would be disbalanced or the line would be disbalanced. So, the production per hour really is at let say you know 8 stations 32 seconds together. So, per hour production would be about close to 112 units as has been represented here.

And what we can do now is try to split up individual task and try to combine recombine different tasks. So, that overall this time level kind of comes to a certain minimal value.

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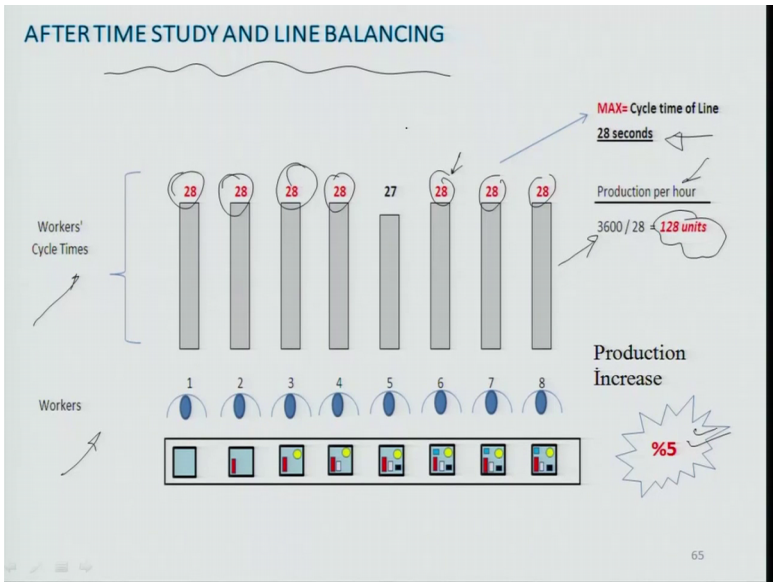

So, we do this with time and motion studies and we try to balance the operation then after a time study and line balancing. We see that now the new timescales which emerged in all these 8 stations have a maximum time of what 28 seconds of almost all the operators. This can be done only by virtue of some task adjustments between the stations.

So, one operator is probably doing more tasks you know; obviously, there are two aspects one is what is the operator performance another is what is the operator cycle time. These operator performance etcetera has been taken care in your standard times which you have plotted you know in the time study sequence. So, here the aspect is about how to redistribute the task among the different members so that overall level goes down to certain basic minimum level. Here it is 28 seconds for example; obviously, the productivity has increased because of this because now in one hour you can produce 128 units which is about 16 units more than what you have produced before. So, it is about a 5 percent increase only by virtue of time study and line balancing that you have done in this particular case.

So, that is the basic concept of line balancing. So, you adjust your task in a manner. So, that overall the slowest step of the assembly line or let us say we can call the higher cycle time step of the assembly line shorten back and there is always almost leveling of the work station in terms of the time scales so that you can actually now predict what is

going to be the maximum production rate this way. And this way the production rate can increase by cutting down all the slacks.

So, essentially what you are doing is by balancing the line properly you know working on cutting down slacks for this guy or this guy who have finish the tasks earlier. So, they are actually waiting till this guy accumulates or accomplishes the tasks. So, this waiting time has been slacked which is not a problem because you want the operator to work at full productivity and so as the case with machines as well.

Obviously, machines are more presettable and there are no psychological issues associated with machine. So, you have lesser degree of let say controlling situations, but in case of operator driven assembly and all there is a big psych issue which comes into picture where there is complete you know lack of control and lot of controlling needs to be done.

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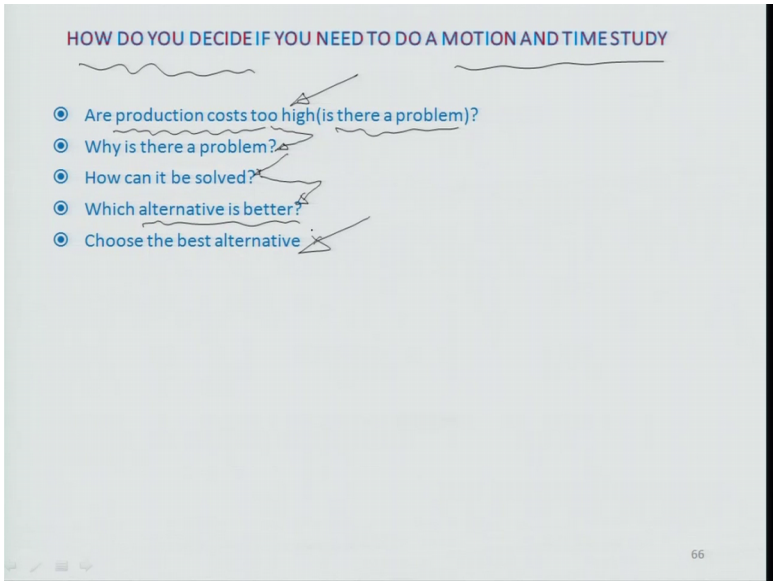

So, what really makes you decide why you want to do what you want to do in terms of motion and time study? So, the first thing that we look at key, what the first thing we look at is basically is the production cost too high is it something that is going to be a problem because you are selling in a market the fixed price and your cost comes out to be too high. So, your profit margin shrink because of that. So, then you look at if really this is the case in the production cost is high so can I actually identify why is there a problem, why is there a high production cost is it because the utilization of the system

that we have at hand is not effective or we are not optimizing the work system that is producing. So, this is something that we have to first look at.

Then we think about how to solve it. So, now, you basically split it up into various smaller groups of tasks and activities and associated timescales and then try to see by proposing some alternative where there are slacks which alternative would be better. So, you redesigned things so that your overall time scales go down you just saw the case of assembly line before how you could manage with the higher productivity at the certain point and there are several such lines into place when we talk about a big production system or a big work system so; obviously, all those slacks needs to be removed.

So, there are different alternatives that you would have assumed by redistribution of the tasks or by more balanced approach in continuing something or carrying out something so, that there is a best alternative which emerges and then that you implement and then you find out whether you are actually getting a lower production cost because of all these time and motion studies so, that is what is the algorithm that you follow.

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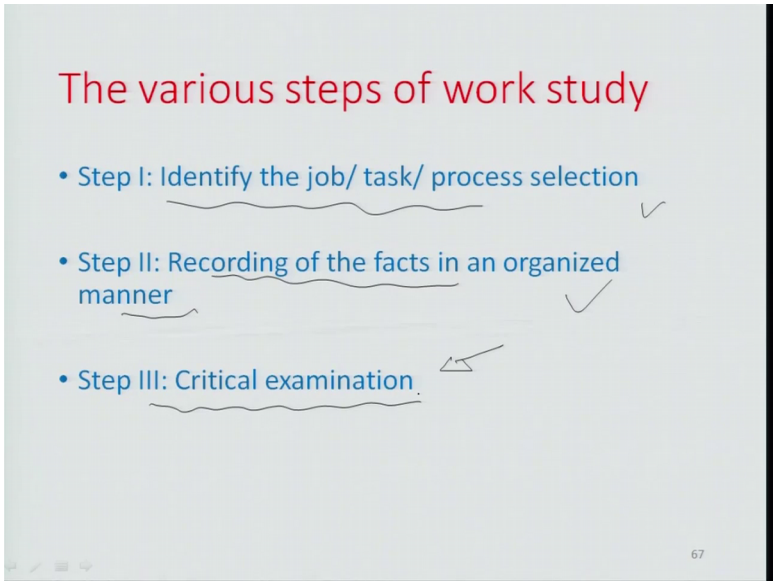

If you want to decide why you want to do a time and motion study so far we have covered these two tasks one is identify the job task process another is recording of the facts in a organized manner. The third thing which remains as a critical examination now because once we have recorded information as in step two you need to look at that

recorded information and try to take some decisions suggest some alternative so that there is a change in the overall operating parameter, so that your optimization carried out.

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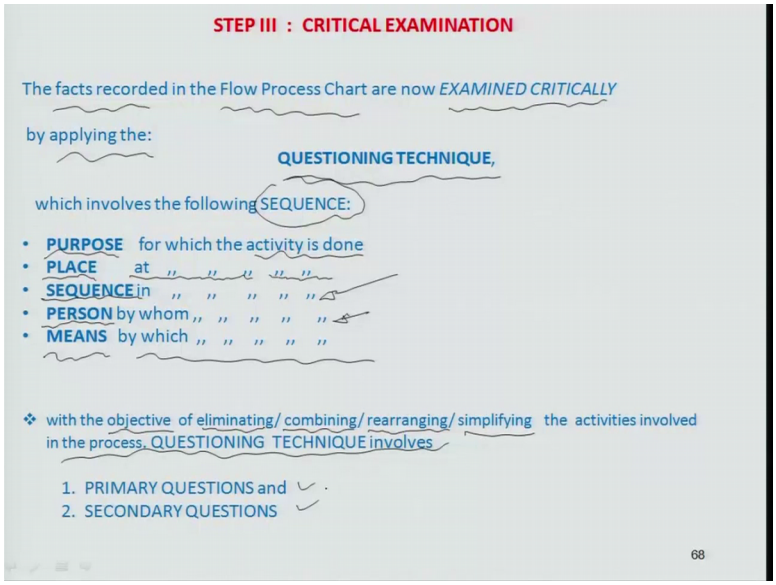

So, in critical examination step you basically look at all the recorded facts you know which are there in terms of flow process charts or different other representations that I have told you so far and you critically examine them all these facts. So, you have to apply a sort of questioning techniques to yourself which involves the following sequence. So, first of all looking at particular set of activities or a task you want to just define the basic purpose.

So, we have to identify what is the reason why the activity is done in a manner that it is done. So, the basic purpose for the activity is first question. So, you record that then you talk about the place. So, if this activity has a purpose which is contributing to the overall work system dynamics then we have to now record what is the place at which this work would be carried out; so place for which this activity is done at which this activity is done.

Then we talk about the sequence, sequence meaning there by that you know probably this is an activity which comes either later down in the sequence of activities or even earlier on the sequence of activities which are all carried out in order to meet a goal which is the output of the concerned work system. So, what is the sequence, what is the you know let us say start point or end point of certain activity in the domain of all these

activities placed in a sequential manner that is something which we need to then understand well.

Then we talk about a person we are associate with this particular activity somebody who does this activity or does this task or accomplishes this. So, this is the person or worker by whom this activity is carried out or is done. So, we associate where exactly. So, there is a purposeful activity which is there at a certain place in certain sequence with respect to the other activities done by whom is sort of address so far and then you talk about the means that the person uses by which this activity is carried out.

For example it may be loading unloading of material box from a truck which may be done by a forklift. So, you are using the means which is the forklift by the person who is doing the loading unloading and that is probably at some kind of a dockyard where this container or this you know part is stored. So, the place is defined the purpose is defined the sequence in which it has to be loaded and unloaded is defined the person by whom it is being done is also identified and then you doing the means. So, you means is by using the forklift for example, or a crane or a gantry system for example.

So, these are some of the basic questions that you need to address and these are also done in you know with the objective the overall objective of eliminating, combining, rearranging or simplifying the overall activity. It may be happen it may be very much imperative that you are doing an activity which could otherwise have been combined with something else and it would need not be carried out it need not be carried out if there is commentarial with something else. So, you basically try to now look at each activity and a sequence of activities in a manner so that can we combine two activities together or can be probably re arrange the activity so that something does not need to happen.

For example you are carrying out an inspection step prior to let say machining operation a and then again you know let say machining operation b. So, rather than that if we carrying out the inspection steps if it is possible after a and b is over, after machining a and machining b has been done to the overall totality of this part if it is doable then we better combine it. So, those kind of decisions has to be arrived at in your questioning technique.

So, you do this multiple times question yourself every time about the activity sequence and such question could either be primary or secondary in nature which are basically what are those primary questions.

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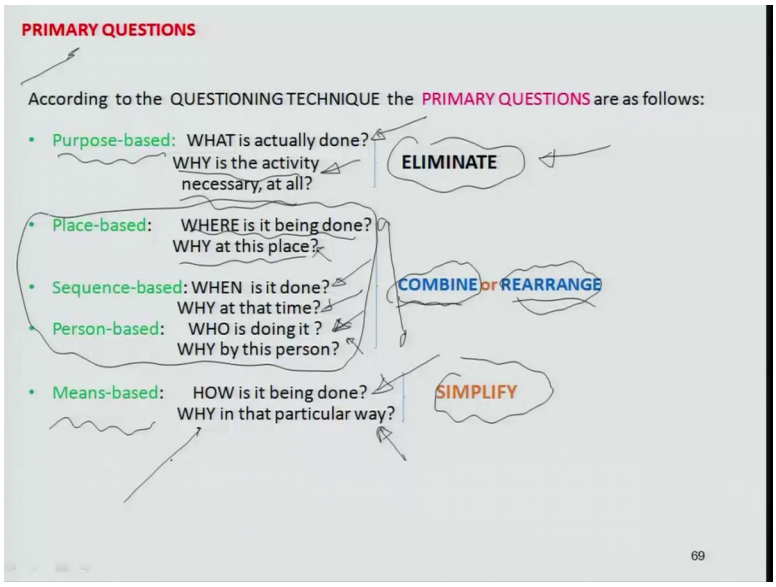

So, let see when we do this we are trying to now go the purpose for example, and trying to question what is actually being done, what exactly is the activity about and why is it really necessary at all. So, if it is not necessary it could be eliminated at this stage. So, if it is not necessary eliminate otherwise proceed. So, that is the purpose based question.

Now, it talks about a place based question where it is being done and why it is being done at a place can we have a different place where this activity could be done. So, that there is less movement of material or less movement of let say workers between the stations. So, basically when we talk about this place based and in live in combination of that we talk about that sequence based which talks about when its being done why at that particular time can it be done earlier in time or later in time.

So, something like this which would give you an idea of why this sequence of activity is there and the person who doing it and why this particular person is doing it can it be done by another person who was doing another job, these kind of questions you sort of combine together to take a decision whether the activity really can be combined or rearranged. So, some of the activities are eliminated which are not necessary and some of

the activities which are necessary and they have to be a part of the system combined and rearranged by these set of questions.

And then finally, we talk about the means by which this activity is being carried out where we again address a basic primary question is that how the activity is being carried out, what is the exact tool or what is the exact system which is being used for carrying out this particular activity and why it is done in a particular way why not a different way. So, if supposing you have combined rearranged and got into a point where no further combination or rearrangement or reallocation or elimination is possible this is the sort of minimum activity sequence which is needed for accomplishing of certain task what is that is happening.

Then we talk about how to simplify it. So, basically if something comes here saying that the means that is being done may not be a very good way because it could be possible if I involve a machine tool there I may able to get this job done much quicker or let say with more accuracy. So, we can simplify some of the means itself so that you have the activities now well balanced. So, these are the primary questions which anybody would ask in order to look at the chart and look at what is important what is not important what can be combined what can be rearranged and how it can be simplified these are the things which were sort of addressing.

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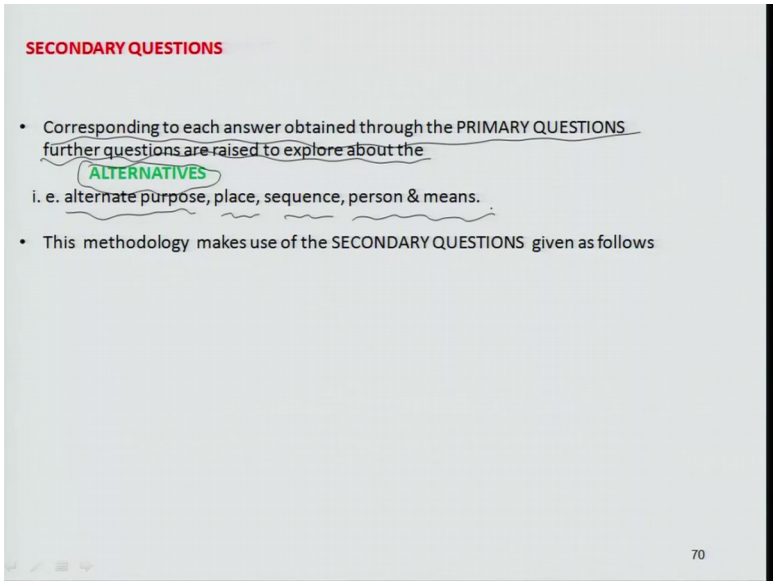

The secondary question come when we talk about corresponding to each answer obtained through the primary questions you could raise some questions which can explore about the possible alternatives. So, it may be possible that in somebody's mind through the primary questions something comes where there is an alternative of combinations I just mentioned about combination of two different inspection stations or let us say two different inspections routes which are possible after machining a and after machining b individually or combining machining a and b together and then inspecting the whole machine part. So, this is an alternative that you are combing all the machining systems together. So, that you are getting a part where there are remnants because of a remnants because of b which can inspect together.

If possible, if such a thing is possible you try to combine and try to do inspection at one particular step that is the generated alternative. So, these kind of questions of primary nature whenever you ask at the back of the mind you have to always see why not in this particular manner or why not using this particular alternative. So, once this comes the alternate purpose the alternate place the alternate sequence the alternate person and means then the methodology sort of gives you an idea about how you can control you know the sequence of the sequence of activities in the manner as follows.

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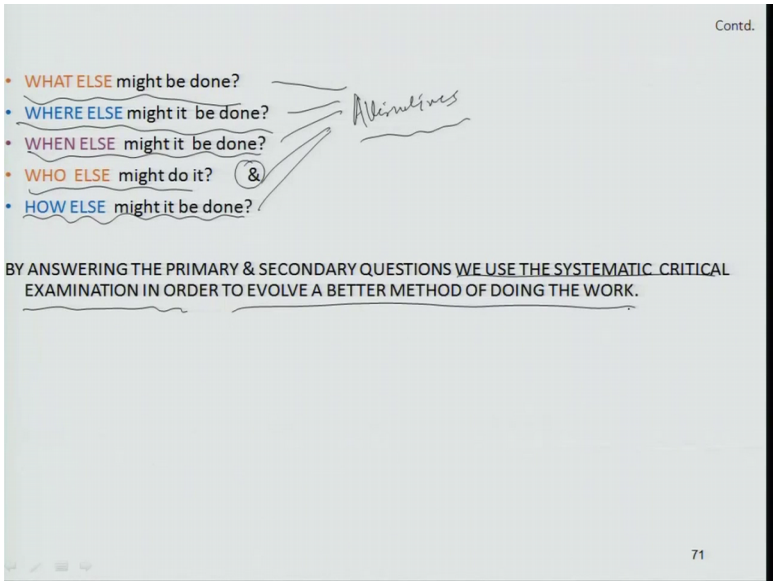

You will particularly ask what else might be done, what else might it be done, what else might do it, who else or how else might it be done or who else would do it. So, these

kind of questions would kind of give you the alternative. So, these are all the different alternatives which you have in mind while doing or posing yourself the primary questions. And these alternatives are very important because mind you when we are doing a process improvement when we are doing a improvement in the overall optimization by virtue of time and motion studies it is about those alternatives which you suggest so that you have overall betterment of the system in terms of its productivity.

The whole frame work is how you could improve the output input ratio and so therefore, this question of what is an alternative solution which is probably better half than what solution exists is very important for a person to sort of you know to get a feel of how to redesign the particular work system. So, by answering the primary and secondary questions we use the systemic critical examination in order to evolve a better method of doing the work and that is exactly what you want to implement and see what is the outcome or what is the result.

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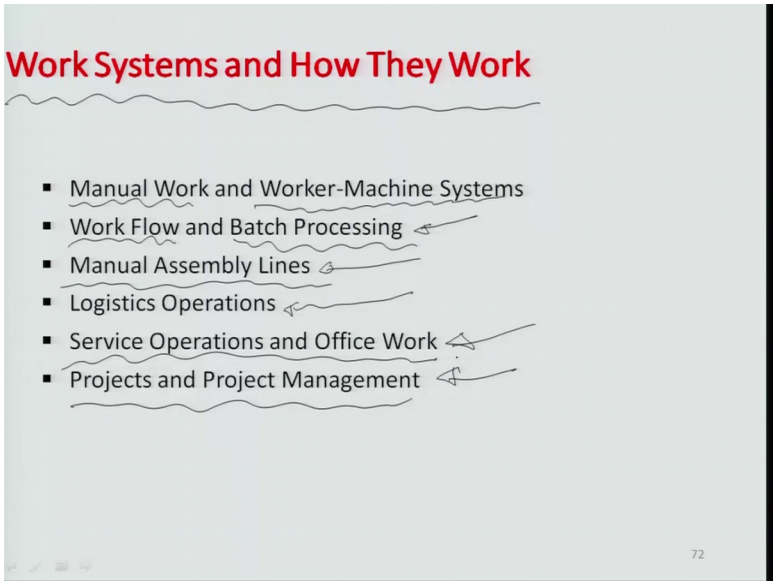

So, let me now change gears a little bit and look at what is the work ability mode of such work systems and what are the kind of classifications which are available for such work systems. So, typically work system could have component of manual work and it could also be classified as a worker machine system or a completely automated system. So, these are the three different classifications broad classifications into which we could actually put on layout all work systems. It could also be about you know let say either a

completely continuous flow process where you are having work continuously being done value continuously being added to a product as it moves along from an input to an output stage and alternatively there can be a batch processing where you have a lot by lot movement rather than one continuous movement where you are introducing component one by one. So, you have a batch processing by batch processing that could be another way or another alternative of looking at a certain work system in terms of how it works.

There could be manual assembly lines which you could look into for example, let say when we talk about a carline and when we talk about painted body storage. The painted body storage which actually goes into inspection and repair are basically done on trolleys they are no longer on a assembly line and these trolleys are all chained together and you could actually push those trolleys between the different inspection stations and repair stations, because particularly the associated problem with the paint repair is that the time scale is not known, it may be dependent on the extent of damage that is there or the extent of defect that is there and the time scale may be different. So you cannot put then on the assembly line by any chance. But then you could actually do a manual assembly line where you could actually move trolley by trolley and then try to analyze. So, that could also be a part or variation or a deviation of a work system.

There is of course, logistics operations particularly related to material flow etcetera associated with such work system based on also which we could classify there could be a different form of a layout of the material flow in comparison to as a differentiating mark between different work systems there can be service operation and office work that is also a sort of you know associated modality with the overall workability of the work systems and then of course, there can be projects and project management on a very very broad scale which could also be directly included into the way that work system would function or work.

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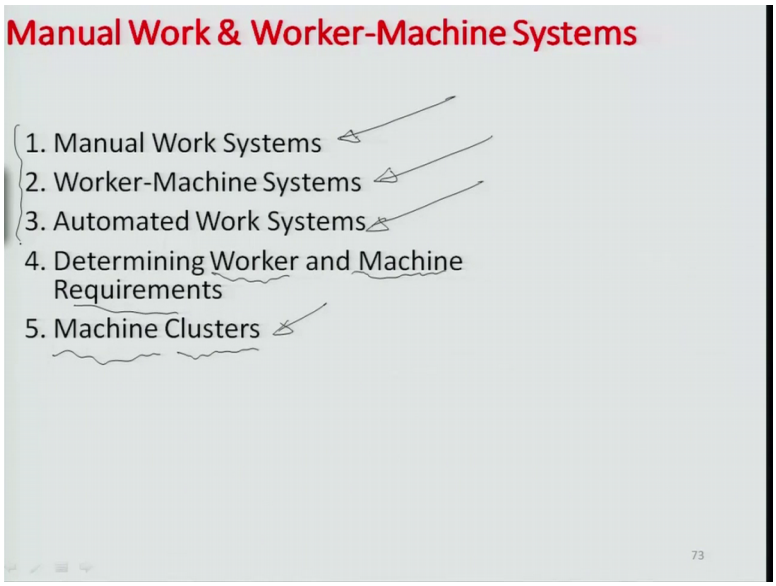

So, let us look at manual work and work machine system. So, you have again completely manual work systems where the worker could use either you know almost a manual approach or a slightly tool driven approach where there are certain hand tools which could be used by the operator to work on different aspects of work or a product. There could be worker machine systems; there could be automatic work systems I think I just mentioned about it fully automatic without the involvement of any human component. And here the idea would be that how do you determine the requirements of various people including the worker and machine requirements and then you know you could have a system with such requirements club together as clusters.

For example all the machining activities of one type could be clusters together machining activities of another type could be clustered together in this way you build batches of different kind of you know a let us say machining elements which would be clustered together in a particular manner to build up worker machine system. So, let us look at these in a little more details at least the first three in a little more detail this time.

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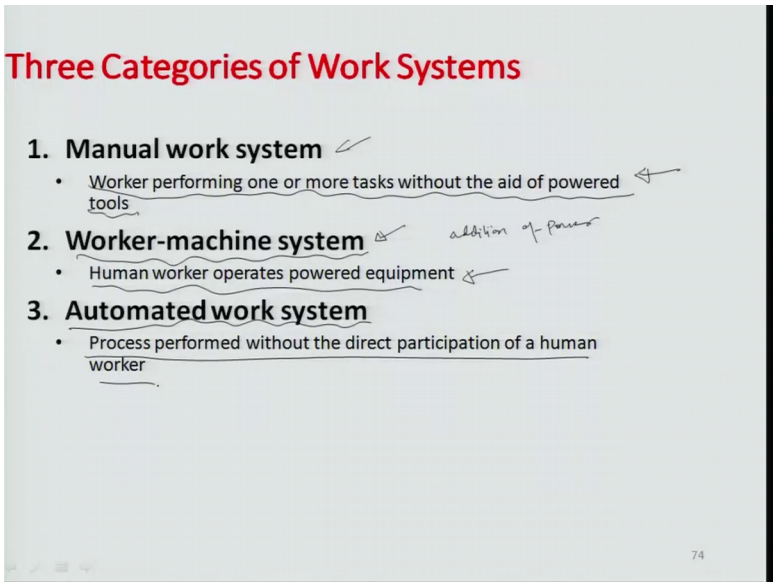

So, when we talk about manual work systems we are having worker performing one or more tasks without the aid if any power tool typically. So, as I told you that it could be either based on direct applications of hand in order to do the job or sometimes some tools which could be used as aids for doing a particular job so that could come over in a manual work system. We could also have a worker machine system where let say the human worker operate with the powered equipment for example, we are talking about using of a powered saw or a power cutter or a power drill or even you know in some cases a power hammer to work on concrete slabs or some things like that where there is a powered equipment which is available. So, typically the difference between the manual work system and a worker machine system is that there is now the addition of power. So, this makes the two systems completely different power machine tool along with the human subjects.

And then of course, the third category of work system is the completely automated work system where we talk about process performed without the direct participation of the human worker. For example, let us look at transport press, typically in a transfer press system in a auto line or automobile line it is a mechanical press system which is comprised of several work stations with different diapers whether a different operations including forming, punching, sheering none on those sheers to formulate a certain profile. For example, when we look at let say the roof side or the roof panel - the roof

panel is subjected to many pressing operations which should be done through different (Refer Time: 23:04) in a particular transfer line.

Once the loading of the pallet which will typically be used for pick up of the sample which is like a sheet flat sheet or blank you can call of a particular sheet metal is done then beyond that you leave it on to the machine how the machine picks up using vacuum assistance or vacuum assisted techniques and then stations the particular panel into different dice and between dice does it transfer and does in inspection. So, now, it is no longer in the human domain it is being completely taken over by cnc control or programming logic or probably the machine domain. So, those kind of a systems are called completely automated work system.

So, there is a different class of things where there would be a different approach which is followed for doing associated tasks with these kind of work systems.

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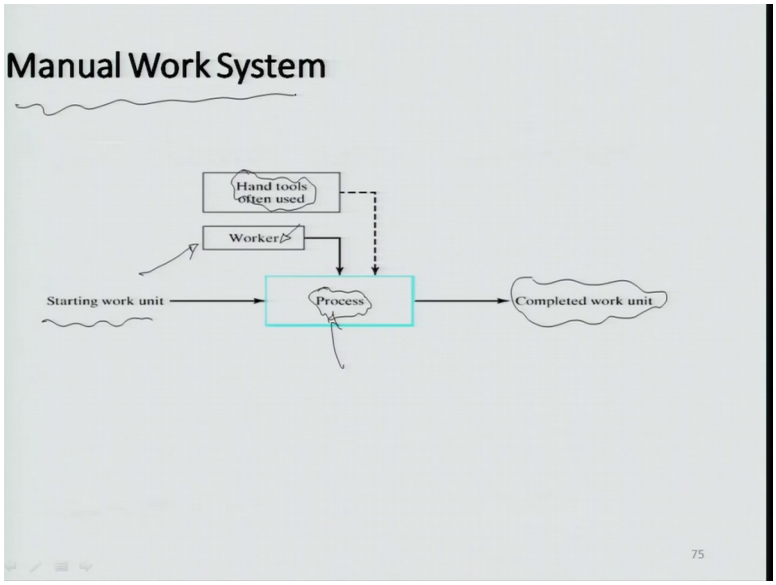

Let us look at in this in little more schematic manner. So, in a manual work system you could have the starting work unit where you can process this using either you know just applying force on it or power on it or something through human subjects. So, you have a worker who is working on a process and at the most you can use hand tools. So, that could help this worker to realize this process so that there is some kind of a completed work unit which goes out. So, this is what you call a complete manual work system.

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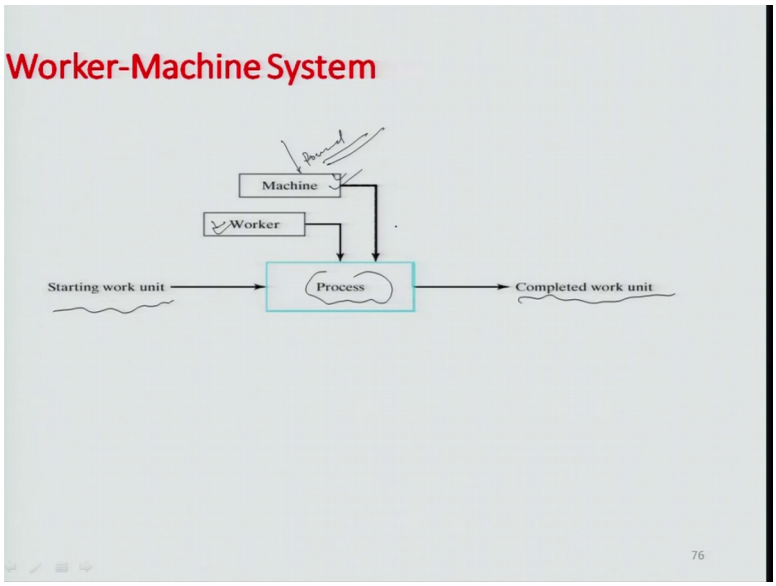

And then there is a worker machine system where you are having a worker working on to a machine which is powered and it is basically running a process which is actually starting the work unit and completing it into a certain finished job. So, you have this initial powered machine as aid to the worker for this work machine system.

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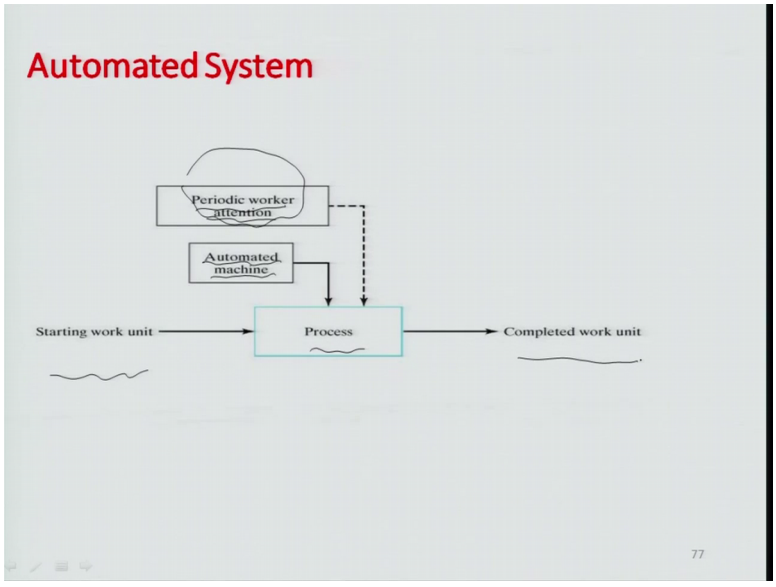

And the automated system of course, you have only a periodic attention like for example, in the transfer press line I mentioned attention has to be given when something goes wrong for example, or in terms of dye maintenance there is a schedule which is there

where you look at a dye and try to see how often this dye can polished or whether the profile the topology of the dye has worn out. So, there is some schedules where human subjects are involved.

And then also there are times where in such cases let us say there are that is a problem that is tacking has already been finished and you need to reload the material or this tacking has been on the output side has been overfilled and you need to put an empty pallet there where the worker would be seeking or the attention of the worker would be sort. So, otherwise if these initial conditions are made by enlarge the system is automatic itself it takes care of all the things on its own and so its starts the work unit on its own executes the process and completes the process with an automated machine. So, that is an automated system.

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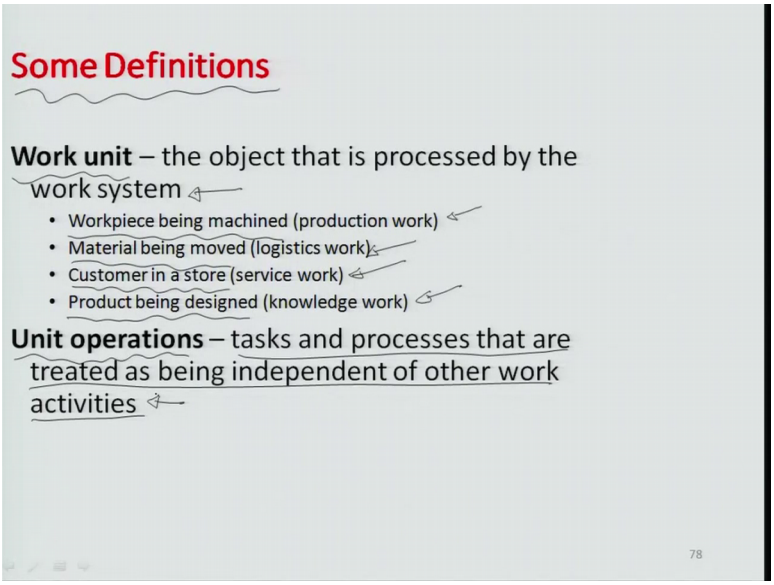

So, while we classify things into the manual the worker machine and the automated systems there are certain definitions which are useful which we could actually think about referring to when we try to gauge some of the systems. So, the first definition is about work unit which is the object that is processed by the work system. So, what can be called work unit is could be anything related to let us say a work piece, being machined for production work or some material which is being moved for the logistics work or some customer which is waiting in a store for a service work to do or some

product being designed which is the knowledge work to do. So, these are all different forms of work unit which could exist in such a work system.

And the other issue which is important for me to tell is the unit operations which talks about the tasks, the processes that are treated as being independent of other work activities, these are some units which are actually not work units, but the various things you do the work unit in order to complete or let us say finish the particular process. So, having said that we will look you know probably into the manual work systems and how they are defined and how work units and unit operations can be classified or measured in such system, but we will do that in probably the next lecture. So, we will finish this particular lecture.

Thank you very much.