Applied Ergonomics

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Module - 02
Lecture – 06

Hello and welcome to this applied ergonomics lecture 6. We were talking about the various different steps involved in a; in studying the work study or a work system, where we actually looked into in principle three different steps: one was about the identification of the job or the process description of the process selection related to certain task, then we also looked at how to record critically through some different mechanism like the flow charts, out line charts so on. So, forth and then in the third phase, we do some critical examination of what has been laid out in terms of all different motion sequences even assigning time scales to those motion sequences and making the time study.

So, in view of that we would like to now start looking at the different charts which are there and how you can record different pieces of information in this current lecture. This would be followed by one or two case studies of work examples of how to solve or how to assign; let us say do a time cycle analysis or do a time study on a particular job. And then this will be followed by again; you know trying to understand some continuous flow process systems in terms of assembly lines etcetera were multiples such stakeholders or worker are associated.

So, that they are synchronous timing is very critical to sort of attain different levels of efficiency, that which assembly systems do operate; and followed by that we will try to get into individual types of systems where only manual labour is involved or man and machine is involved or let us say for example, all automated processes are involved.

So, let us first look at some of these recording facts and I would like to retreat again.

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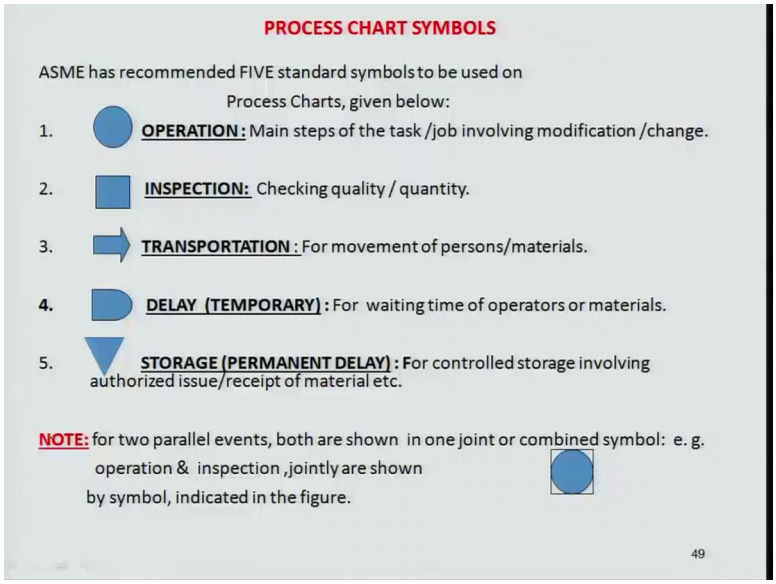

And this slide I had described in the earlier lecture just for the sake of recap; I have involved this once you are completely determined about identifying a job or a process through a pareto chart or some other mechanism through which you have the top 20 percent maybe; causes of delays or wastage of a system which is already identified, then the question is that you look at such a task or such a process which has been identified to perform the motion and time study to make it more optimized. And look at everything in terms of good representation or recording of the different facts associated with the motions and the time scales which are associated together in such tasks of you know pre identified tasks.

So, in light of that we had said that you know the recording can be done through something which is known as a process chart. And in the process chart there were various symbols which were describe for example, there was a symbol for the main operation, which would be the main step of the task for example, if I am doing a drilling activity or let say returning on a lathe machine. So, the basic operation there is the drilling or the turning etcetera which is there. So, then there is of course, an inspection which means that you know whatever you have done here in the job earlier that you are checking

And so there are different symbols which we attached earlier between operation, inspection, transportation of the material between the various work centers if there is any temporary kind of delay, because of operating because of let us say wedding time you know associated with the materials or the operators or some permanent delay, because of

storage issues for example, material not available etcetera. So, in that kind of in light of all this we had suggested that; there are many different kind of variations which are available in the way that recording can be done or facts can be laid out.

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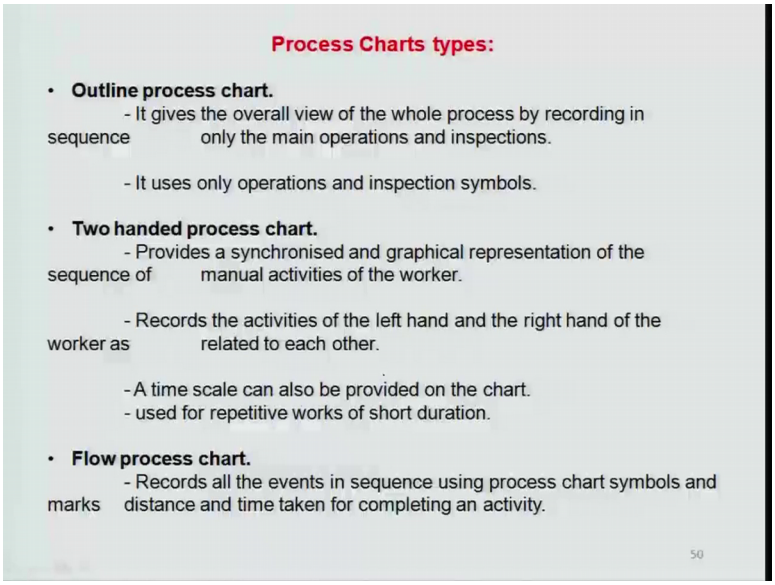

And so in that event we had the first type of process chart called the outline process chart which would merely combine two different kind of operations; namely, the op the main operation and the inspection ok.

So, this was what we meant by outline process chart. So, it kind of gives the overall preview of what is the process and what is the inspection which is involved in defining the whole process, then there is a two handed process chart which provides a synchronized and graphical representation of the sequence of manual activities of a worker. So, how individual hand is behaving of let us say the left side or the right side is being recorded in terms of different activity sequences and time scales are assigned to the same. So, that is another way of looking at. Then we have flow process chart which talks about you know recording for events and sequences using process chart symbols and you know marks the distance time taken for completing activities. So, what I am going to do in the next few slides is to give you an idea of each of these chats and how they are laid out in real systems.

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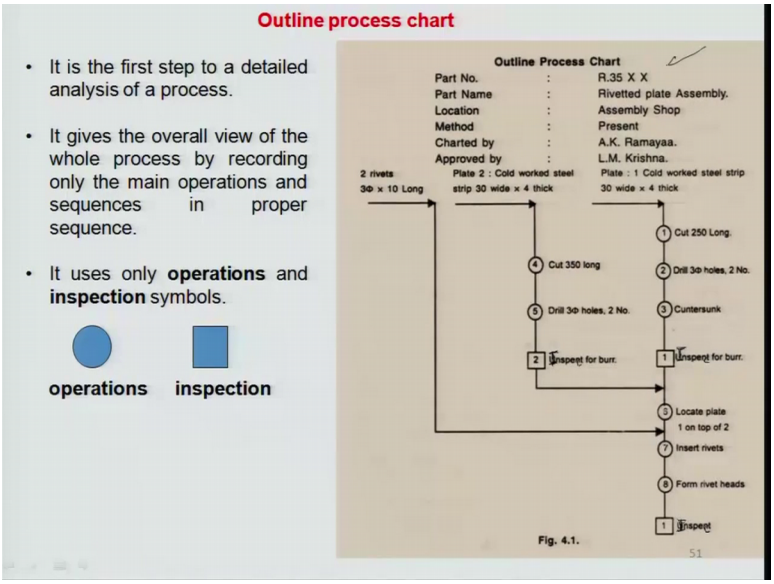

So, for example, let us say we talk about outline process chart, this right here show such a chart which is for a riveted plate assembly you know done for an assembly shop and so, typically; such a outline process chart first should be identified properly including, what is a part number that we are looking at? What is the part name that we need to assemble using this kind of an outline process chart? Then the location of the part, so, basically exactly where it is being assembled and also the method that is being used and also related to who has charted this whole process and who has approved the process; these are also very important things, because this is recorded somewhere you know with multiple purviews on multiple let us say views into place.

So, in this particular case the outline process chart typically; shows to two different sheets particularly let us say sheet 1 and sheet 2, we also known as plate 1 and plate 2 and the sheets have some particular specific dimensions and the idea is that we want to do a rivet assembly over these two sheet. So, take both the sheets keep you know sort of lap one on the top of the other and then use a sort of a drilling mechanism to drill for insertion of rivet and then farming the rivet head. So, that you have a proper lock between these two sheets in terms of a rivet.

So, this the whole operation and for doing this we are having three different things which are needed the sheet one which is actually coming out of a cold works steel strip sample which is about 30 millimeters wide and let us say 4 millimeters thick. And then there is a plate 2 again; which is again another cold works steel sample of the similar kind of width and length; width and thickness and both are cut at different lens. So, for example, the

first sheet is cut at 250 millimeters length, and the second is cut at 350 millimeters length.

And. So, basically it is just overlapping one and other. So, it an overlap between two sheets that will show later on as both the things assemble together. And then we have classified this whole process. So, what is the process like? So, you have one sheet which you are drilling separately, another which you are drilling separately, putting the two together; then bringing a rivet inside and farming rights. These are the difference steps associated with this whole task or this whole job.

So, I have now illustrated this in terms of circles which represent the operation and inspection steps which are represented by the square. You remember in the process flow these are the two different symbols which are being used as shown here. So, the first operation is cutting. So, cutting of plate one is at 250 millimeters long sample is cut out of the whole steel strap, and the second plate cut at 350 millimeters. So, you basically drilling so there is another operation which has let us say you know drilling where there is let us say certain hole size which is being drill and two numbers of this whole sides are drilled on both the sheets.

So, basically sheet one is drilled at two different locations and sheet two is drilled at two different locations as well, and then in the first one which is actually on the top we have also another operation of countersinking. So, basically the rivet head can go inside and there is a planarity on the surface, because of that we have done countersunk which we have machine on the top of the second head. And then we inspect both the samples that is plate one and plate two for burrs and so we are assembling plate one into plate two at this particular point where you just overlapping after inspection; the plate one which is cut with two holes and both the holes having countersunk profile and plate two which is only drilled at again concentrate locations where rivets can be inserted this way.

And the two rivets which are actually again few diameters long. Let us say you know in this case it is 3 mm in diameter for example, and 10 mm long these rivets are put together. So, these rivets comings in here in and are made to insert into the overlaying holes on the top sheet in the bottom sheet. And then we are inserting the rivets, because the rivets are coming all the way to this location and getting inserted here.

And, then we are farming the rivet head. So, that there is a lock on both sides and then again inspection happens. So, this whole activity; now listed into operations given by circles inspection unit is given by square. So, in this manner any particular task or any particular job can be recorded in a very organized manner and think of it the it is a huge owners it is a huge responsibility to record it in an appropriate manner and that is why a multiple purview for example, if you have charted something a process engineer charted something and it supervised by somebody else; including a let us say shop manager or something, it is actually multiple level checked documentation which is standardized in nature.

So, there will be multiple views put in each task, each activity associated with the process comes down to this kind of a; let us say a detailed presentation for you to construct the whole process of the assembly etcetera; where probably this component that I showed is only one and probably millions of other components which are going to get assembled. So, such huge amount of such process charts are needed for standardizing the whole process, but you have to understand, because we are talking about the top 20 percent areas which needs the process study improvement of the motion study improvement; you know that kind of limit is domain to slightly smaller size that way.

So, this outline process chart we have another two handed process chart ok.

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Two handed process chart

- Operation/Job : **To assemble two washers and nut to bolt**
- Part No. : .....
- Operator : .....
- Chart starts : Hand empty material in boxes.
- Chart ends : Completed assembly.
- Method : Present
- Charted by : xxxxx.

Left Hand Description	*Symbol (L.H.)*	*Symbol (R.H.)*	*Right Hand Description*
1 Move to bolt	⇒	⇒	Move to first washer.
2. Grasp the bolt	O	O	Pickup/grasp the washer.
3. Move to position	⇒	⇒	To position
4. Hold	∇	O	Assembled to bolt.
5.		⇒	Move to second washer.
6.		O	Pickup/grasp the washer.
7.		⇒	To position
8.		O	Assembled to bolt.
9.		⇒	Move to nut.
10.		O	Pick up the nut.
11. Move to box	⇒	⇒	To position.
12. Aside to box	O	O	Assembled to bolt

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Where again the same thing representing the right hand motion with respect to the left hand motion, this is a assembly operation that we are recording here for two washers and nut fitted to a bolt. So, there are certain part numbers associated, there are operators who are associated you can record them then you also give a time point which started the chart. So, the chart starts typically; when both hands are empty and materials are in their boxes.

So, that is how you define, what is the start of recording this process chart? And then the chart ends when the assembly has completed. So, this is giving a span of what exactly the process is from an up to what extent the process is? So, it kind of domains the process in to two different operations; you have a method which is being used which is the present method or current method being done by the operator; there is no change and then of course, the person who charted it and also supervised should sign such charts. So, in this particular case, as I understand this so, if supporting the bold is kept on towards your left hand side and the both the washers and nuts are on your right hand side.

So, the best idea would be to get both the right and left hand to simultaneously; move one to the first washer and one to the bolt, and then you bring it again all the way after grasping the bold and the washer to the position where you are assembling the bolt. Typically, this position would be probably in order to address you know time issues this position would also be probably just overhead or over the point where you are going to drop the assembly away going to use the assembly. So, you take the bolt and the washer and bring back to a convenient location. And then you basically trying to assemble it. So, how we represent this?

So, now, there are symbols again; symbols for transportation are given by this arrow. Again symbols for a particular operation is given by circles and inspection again is given by square and then there are certain hold positions etcetera which indicates let us say temporary delay in the sorry the permanent delay in the case of let us say the material has to be held somewhere for an operation to be performed. So, these are permanent delay in the sense that unless the process initiates the requisition for getting the material in the material has to wait ok.

So, there is some kind of a storage delay you can say of the material. So, in this case what we are describing is what the left hand is doing? So, you have the left hand moving

to the bolt similarly; simultaneously, the right hand moves to the first washer then you grasp the bolt, that is an operation and then pick up or grasp the washer, that is; the say another operation, and then you basically move to the position where assembly is being done.

And similarly move the washer as well to the position, where the assembly is one of the right left hands are basically doing the assembly. So, that is an operation assembling into the bold and then you basically hold the bolt washer assembly for the next washer and the next nut to come in. So, now, your right hand is only one moving and the left is not moving. So, this is a temporary delay; permanent delay which is being done unless you have assembled the washer and assembled the bolt ok.

So, then you move the hand again the right hand move to the second washer, pick up grasp the washer, come back to the position, assembled to the bolt, move to the nut again pick up the nut, again to the position assemble to the bolt and here basically presenting in this terms of transportation and operation. And one can probably do that when the nut is being tighten, during that time the right hand also moves to the position where you have to drop the bolt and there is an operation just aside to the box where the nut bolt assembly has to be dropped where you actually tighten and then simply drop by gravity or something. So, that the bolt nut assembly with the washer goes in to the package box which would again go for the further step. So, this is a 200 process charts

So just as you made an outline process chart earlier, you now are according the motion sequences of both hands in terms of transportation, operations, inspections, delays, if any in a very organized manner to split up this simple task of bolts and washer assembly.

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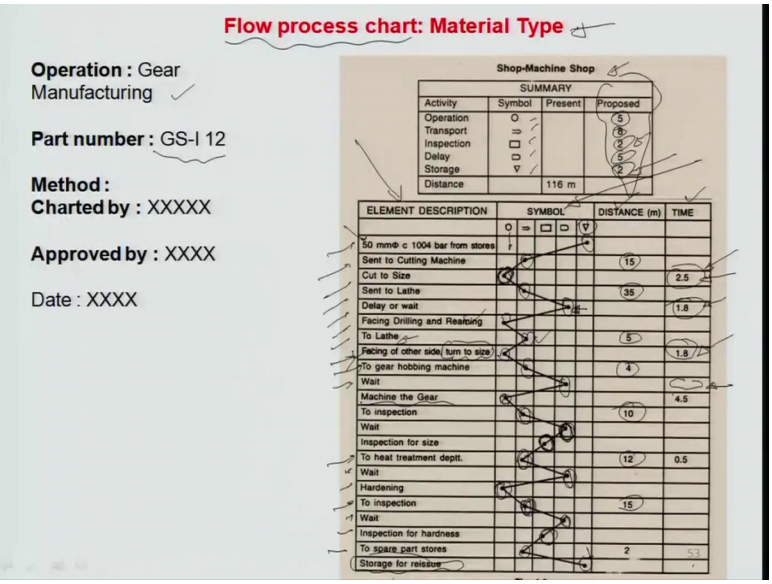

So, then there is also a; another kind of a flow process chart which is related to how the material flows between different stations. So, in this particular case; we talking about a gear manufacturing for example, and then there is a particular part number which is involved and the gear manufacturing comes from a bar, typically which is sent first to the cutting machine, then to the lathe, probably to a gear hobbing machine which actually cuts the gear lines on to the to the bar or the shaft and then you know do some kind of a process treatment, let us say heat treatment of the surface. So, that there is enough mechanical strength. So, that gear machine can be initiated between these two gears and then for example, inspect at various levels, what is the material property? What is the hardness based on these materials? And then storage spaces can be year marked for storing the part for further use or something like that.

So, basically this whole activity of taking a bar, turning it on or cutting it to a certain length turning it on a let us say a lathe machine followed by, you know again facing drilling reaming whatever; are the requirements followed by again the gear hobbing on the top of that stock bar followed by the hardness, this are actually a process sequence in which the material should flow. And material typically is that bar stock which is there. So, in this particular case also we are trying to summarize the machine shops operation in terms of again operation transport inspection delay and storage these few different process symbols which are used, what is important about the material type chart? Is that the flow process chart is that, it actually records both the distances that material is moving; as well as records the time scales which are needed for either processing the material or movement of the material or even waiting of the material.

So, for example, in this case you can see, that the proposed split up into the different operations are exactly 5 times operations are being done; exactly 8 times transportation are being done between the two difference; between the different stations multiple stations which are used for the gear hobbing process, and the exactly 2 times inspection is being done there about 5 different temporary the delays and two different's storage delays or permanent delays in the process.

So, if I looked at how this chart has been plotted you see there is an element description there is also symbol based you know whether it is an operation transport inspection delay or storage. So, it is a classification and the element descriptions of the different activities which are basically used, for the whole hobbing process. And while doing this symbol I can probably count and see that their about two different inspections sorry storage delays or let us say permanent storage which are; there in the process which is as dictated by the summary chart.

Then there are at least about five different operations which are 1, 2 you know these are the 5 different operations which are there on the particular material flow diagram. The exactly about 8 transportation operations, if I count at all these 1, 2, 3, 4, 5, 6, 7 and 8. So, there are 8 material transportation operations, similarly about 2 inspections you could record this here; inspection 1 and inspection 2 and then about 5 temporary delays which are again recorded by these different points.

So, you can see that the summary what is proposed here is what is from this chart coming out in terms of the different operations into which were splitting the whole task of the job. So, let us say we have 50 mm bar stock; which is somewhere in the store and we move this from the storage to particular machine which is used for cutting this bar into a certain size. So, basically this is sent to the cutting machine, the process we are moving about 15 meters and; then after that we take this all the way to the machine to cut the size.

So, the machine cuts the size and it takes about 2.5 minutes to do this cutting action. So, exactly, what is your requirement here is to sort of may be gauge, important time scales not all times are needed. Sometimes you can you know for example, I am saying it is a 15 meter distance. So, typically there is a certain rate at which material will move you are just not in able to do anything about it. So, in such cases when times are not

important just leave it aside, may be a distance and time are sort of year marking each other in a similar manner. So, again observing a time unnecessarily for this 15 meters fixed distance is something which is probably a reputation of the task.

So, we better avoid it. So, have to be judicious in your choice where you really want to mention the distance and time scales in this. Then the material moves from this cut machine to a lathe and they are about 35 minutes again which takes; moves about 35 meters again within the shop floor to go from the cutting machine to the lathe where it is basically again delayed by sometime. So, because the some other earlier operation which is happening on the lathe. So, it basically takes 1.58, 1.8 minutes of delay for the material load on to the lathe etcetera.

The lathe of course, performance facing of the bar stock drilling also and some dreaming activity on the bar stock; then it is again turned on the lathe system which is captain about 5 meters distance with actually faces the other side and also turns to the respective size what is going to serve as a blank for the gear the gear cutting machine.

Then it moves another 4 meters and so, therefore, there is a material movement here has been linked here to the gear hobbing machine, where it has to again wait for a few minutes. So, we not recording this, because this probably not a very critical step of waiting in any event, they do not have any issues with in this particular operation for a lot of free time is not really felt at the gear. So, gear hobbing machine so now, we machine the gear and that is an operation. And then again send this gear for inspection. So, the inspection is at a distance of 10 meters again. So, we are doing that material again moves to through ten meters and wait is there for some more time before the inspection can proceed and then actually there is some inspection done ok.

So, there is some temporally delay which is there, because the inspection probably is not ready for catering to the new gear system which has come; or the new gear you know unit which has come. So, the inspection is actually, now carried out and then this material is again sent back to the heat treatment department which is at a distance of about 12 meters and so, there is some wait period there as well in the heat treatment and then there is some hardening action been performed on the heat treatment.

Again it sent back to the inspection which is another 15 meters away probably this is a different inspection this inspection is associated with inspecting the quality of the heat

treatment and it the job wait is there for some time and then inspection is carried out with reference to the hardness and then again the material moves back to the spare parts were you know you can stock the gear that has been produced and it can be a probably seeking storage delay or a permanent delay till it is again up for reissuance to the next level.

So, there are different time scales assign for example, facing the other side would take about 1.8 minutes just as the delay or wait period happened on a particular lathe. And then there is a machining time of the gear which is about 4.5 minutes which is of critical importance heat treatment of about 0.5 minutes which is again of critical importance. And so typically the idea is that the total distance and the total time associated with such a process flow of material is being recorded in the way that the material flows between different stations. So, this in a way is important, because then you know the material movement can be a yardstick and the distances move can be either reduced or the time scales which are associated with the various activities like wait or even let us say processing of materials on certain systems those cannot be eliminated so that, you could have a proper idea of how optimization can be carried out of the material flow.

So, this is again a process flow chart. So, these are the 3 different kind of charts which are now practically also explain to you about outline flowchart, then again two handed process chart and then finally, the flow process chart for the material type as you seeing in the current slide. So, I would like to now close on this particular module. And in the next module we will look at, probably some more you know things related to let us say flow diagrams etcetera till until then goodbye.