Work System Design
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Lecture - 20
Operations Process Charts: Examples

Namaskar friends. Welcome to Session 20 in our course on Work System Design. And today we are going to wind up our discussion of the 4th week, today is the last session for week 4 and in week 4 our target was to introduce the concept of method study. Now what is method study, method study is a technique for developing a better method, the best method, the most efficient and effective method of performing the work.

How do we do that? We first analyze the current method or the method being followed using the various recording techniques and then using creativity, using different types of alternatives, analyzing the alternatives we try to find out one better method or a combination of methods which can help us to do the task in a much efficient and effective manner, productive manner, time saving manner and causing less injuries to the worker, so the methods must be safe.

So there can be N number of criteria which can guide us towards our endeavor, towards our efforts for developing the better method. So there can be large number of criteria which is a guiding force for developing a better method of doing the work. So just to have a brief glimpse of what we have covered, we had 2 weeks of discussion; we had in fact 2 weeks of discussion on productivity.

Then one week of discussion on work study, basics of work study and now we are finishing 1 week of discussion on method study. And in method study what have we covered till now, we have seen the basic definition; I have just given a layman's definition on work study in today's session. But otherwise we have seen that what is a standard definition of method study, so method study, I have introduced today also but the standard definition was discussed in the very first week, or in the very first session of week number 4.

We have seen what is method study, what are the application areas. In the second session, our target was to learn about the various steps that are followed during the method study approach. And if you remember in the last session our target was to understand the operation process chart and before that we have seen in session number 3, what are the various recording techniques that are used for performing the method study.

So starting from the basic definition to the application in terms of operation process chart we have developed the understanding of performing a method study. We, by now know what are the various techniques, if I ask you, maybe as a short assignment that name any 5 recording techniques that can be used for method study; I think each learner must be able to name at least 5 techniques that can be used.

One of them, obviously, is on your screen, that is the operation process chart then there can be flow diagrams, the cyclographs, chronocyclograph, there can be string diagrams then there can be flow process chart, so there are different types of charts which can be used. So just to have a brief summary of what we have covered in the method study till date, we have covered the basic concept, the basic definitions; we have covered the steps involved in performing a systematic method study.

We have covered the recording techniques used for performing method study and we have covered the basic aspects of operations process chart. Now coming on to the operations process chart we have covered that this will give us a bird's eye view of the operations, inspections, transportation happening inside the factory. So it will give us an overall broader picture of the work being performed, the sequence of operations being performed as well as we can get an idea that transportation of men and material also.

And we have seen in the previous session one standard operation process chart, today our focus will be to briefly understand that what operation process chart are is in context of the application point of view. So today we will see the examples that can be discussed in order to understand the concept of operation process chart. So let us start our discussion with household work that may be most of us may be doing.

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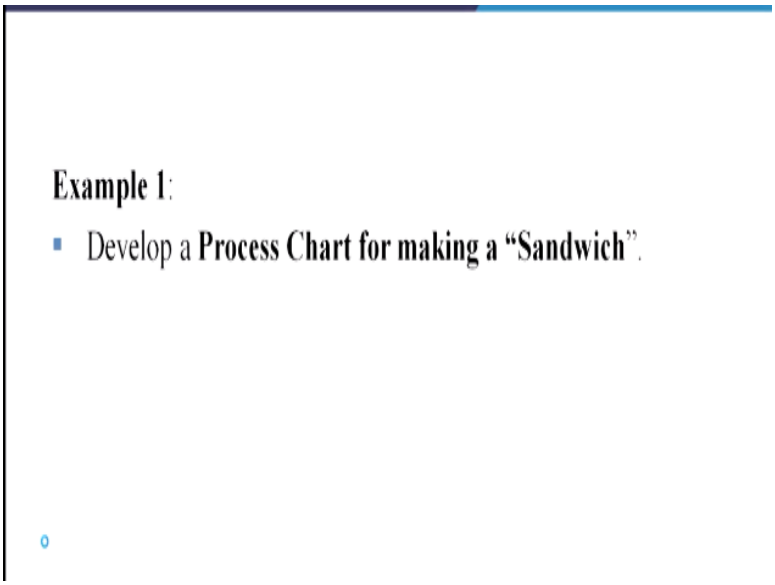

Develop a process chart for making a 'Sandwich.' So for a Sandwich what do we need to have, we need to have loaves of bread and then we need to have some cut vegetables and then we can stack them together or we can, I am an engineer so I am calling it stacking so you can lay up them or you can place them layer by layer and you can make a sandwich. Now how a sandwich be made and what can be the various operations or various processes that have to be followed to make a sandwich that we will try to see.

Now just to revise, what are the various process chart symbols that we use? So circle is used to depict the operation, square is used to depict an inspection, arrow is used to depict a transportation, inverted triangle is used for storage and which one is the 4th one? I think it must come to your mind that is very important that we want to eliminate in our process charts or in our processes that is the delay.

The delay we want to eliminate so that is represented by a solid D, so these are the 5 process charts symbols that we usually use to draw the ne2rks. Now this is a work at hand, so we have to prepare a sandwich, what type of flow chart or what type of process chart will be used, that we will see.

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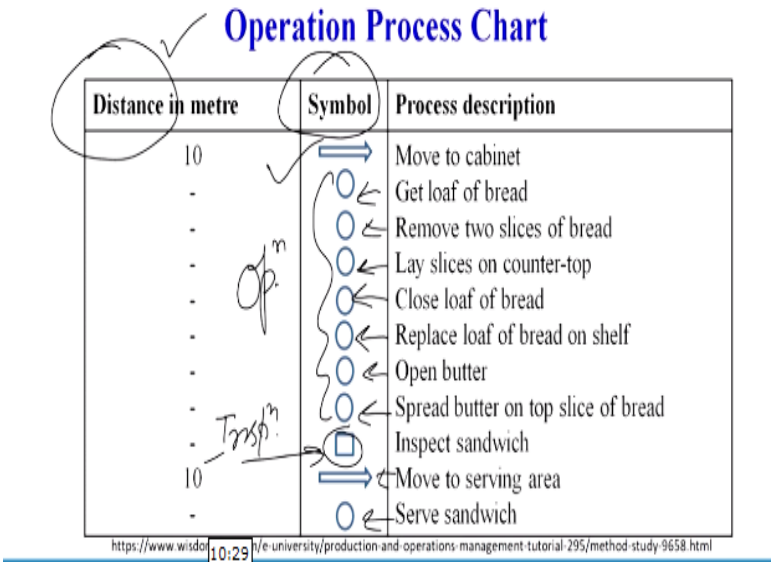

So on your screen you can see as we have seen in the previous session also the distance and time can also be included in our operation process chart or outline process chart. So here we are having one important thing and that is distance, symbols I have already revised today, this is for transportation, these are the symbols are for operation and here we are using 2 types of symbols only, transportation and operations so we are not performing any inspection activity.

So quickly I will read it for you is the process or the sequence to be followed for making a sandwich, move to the cabinet that is the storage space, get loaf of bread that is operation, remove 2 slices of bread which is again an operation then lay slices on the counter-top, operation, close loaf of bread, operation, replace the loaf of bread on shelf, operation, open butter, and spread butter on top slice of the bread then, Oh! sorry I think I have missed this part; we have an inspection also here.

So we have our operation, transportation and inspection, inspect the sandwich then move to the serving area and finally serve the sandwich. So there are 3 process charts symbols being used here, we are using transportation, operation and inspection. Many a time you will see that there will be a particular operation or an activity which you will feel a little doubtful about that whether I must put it in the operation or I must put it in the transportation.

So we have to use our mental faculties because the activities have to be represented on the chart and what is our target? Our target is to account for all the operations or the activities happening in the way we are performing the task so it has to be accounted for and it may play an important role when you are designing a newer method.

So that particular thing has to be accounted for. Even if we are in doubt we must account for that activity may be in operation or transportation as per our understanding or as per our way that we think the activity must be represented. So this is just one example.

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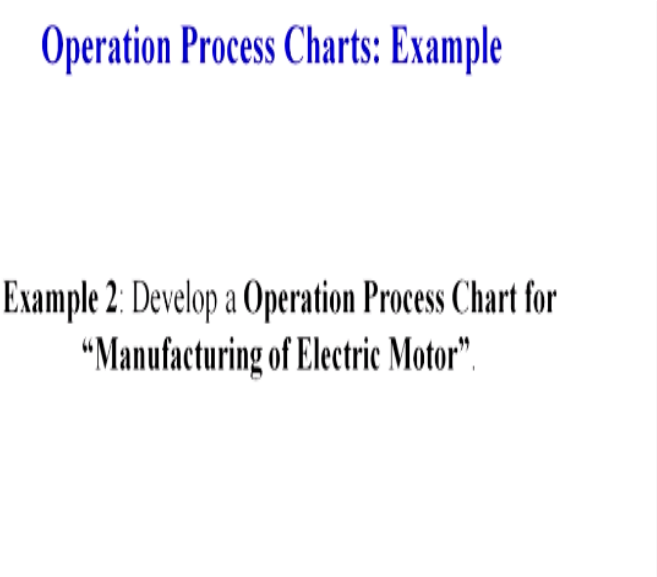

The other example is developing operation process chart for manufacturing of an electric motor.

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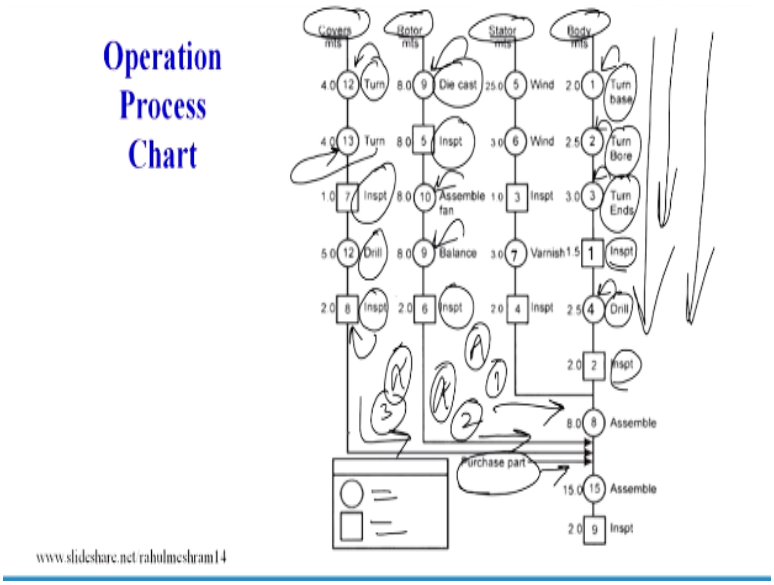

So this is another process chart. So for an electric motor if you, all of you may have seen, studied this in basic electrical so you have a move rotor, you have a stator and you have a main body of the electric motor and there are the covers. Now you see, turn is represented by the symbol of operation, this is again turned again represented by symbol of operation, and this is inspection then drilling then again inspection represented by square.

On the left hand side if you remember, it is given, MTs so this is, these are minutes so the time is also mentioned here and you can see the various operations and inspections are mentioned. So if we see in the last session, if you remember, we have seen that mostly in operation process charts our focus is on 2 types of symbols, which are these 2 symbols? Yes, operation and inspection. But in the previous example that we had taken, we had liberally used the transportation symbol also.

So here we see, if you remember in the last session we had seen that the main component, the major part or the major compound is taken on the right hand side of the operation process chart. So this is the major component on which the other parts will come and get assembled, this is the major component and the other one are, the other one are the sub-component or the sub-parts which will be assembled in to the main part.

And if you see all these 3 parts, stator assembly is getting assembled here, your rotor assembly is also coming here and then your covers are also coming here. So these 3 parts are getting added in to the main, main line or the main part that is the body. And then we have seen in the last session, if you remember a term called 'Buyout' so this is a purchased part which is also entering in to the main assembly.

So we have a main assembly line in which there are operations and inspections happening then there are parts which are also manufactured simultaneously and they are also having different operations and inspection and finally we are assembling the complete product. So here we can see, we can represent this, this is representing operation, this is representing inspection, how many total operations have taken place, what is the frequency and totally how many number of inspections have taken place.

So instead of going in to the details of each and every operation and each and every inspection, the important point is to understand that how to construct a operation chart. So you can take an example of your own and try to construct operation process chart.

So maybe you can think of making a mechanic pulley which has a wire bound on it which is used for taking water from the well so what can be the operation, what will be the main part, what will be the sub-parts or the subassemblies which will come and get assembled on the main part, so accordingly you can think of an example and construct a process chart. So let us see maybe for the body what are the various maybe one line we can try to understand.

The first one is turn the base which is an operation. Turn the bore which is again operation, turn the end again operation, inspection then drilling which is again operation and then again finally inspection, so all these operations and inspections are there on being done on the body in a sequential manner. Similarly, for the stator also the operations and inspections are listed. Similarly, for rotor you can see die-casting is an operation. Then there is an inspection.

Then assembly of fan which is an operation then you do the balancing which is again an operation, so maybe and finally the inspection. So for each and every subpart also there are

sequence of operations and inspection and for the main part also there are sequence of operations and inspections. So this way we can construct and we can also represent the assembly, we have seen there are assembly operations A1 then this is A and this is A3.

So 3 assemblies are taking place in this case, 3 assembly operations. Now this is the last problem that we want to discuss today.

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Source: Introduction to Work Study, ILO Geneva, {Third (Revised) Edition}, Oxford and IBH Publishing CO. PVT. LTD.

This has been adopted from the book from ILA Oxford and IBH Publishing Company Private Limited.

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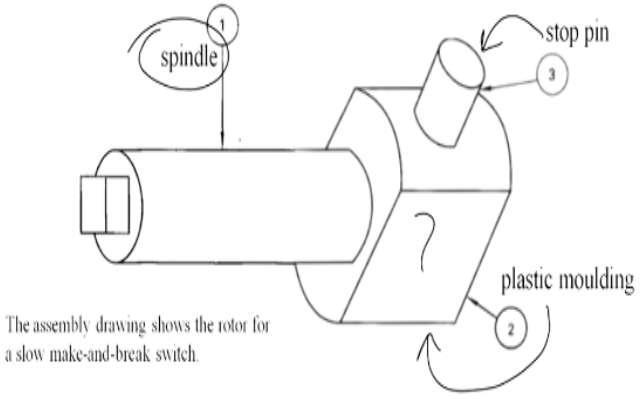
Operation Process Charts: Example

Example 3: Develop a process chart for "**Switch Rotor Assembly**".



The assembly drawing shows the rotor for a slow make-and-break switch.

Now this is you can say develop a process chart for Switch Rotor Assembly, so the product is a Switch Rotor Assembly. What are the various parts, there this part which is a stop pin? There is a plastic moulding this part, this part plastic moulding then there is a spindle, it is already highlighted. So broadly there are 3 parts here. The assembly drawing shows rotor for a slow make-and-break switch.

So we will see now how if we say that type of operation process chart will be here. Whatever we have discussed just prior where there was main body and rotor stator and then there was a cover. How we have constructed? We have seen what is going to be the main part of this product or of this assembly operation and what are going to be some part. So the main part within towards the right most corner of our operation process chart.

And the subpart or subassemblies will be on the left and if there are number of subassemblies they will be further off from the main line. So we have to first identify what is going to be our main part on which we are going to build up the complete product. So let us see how it will look like.

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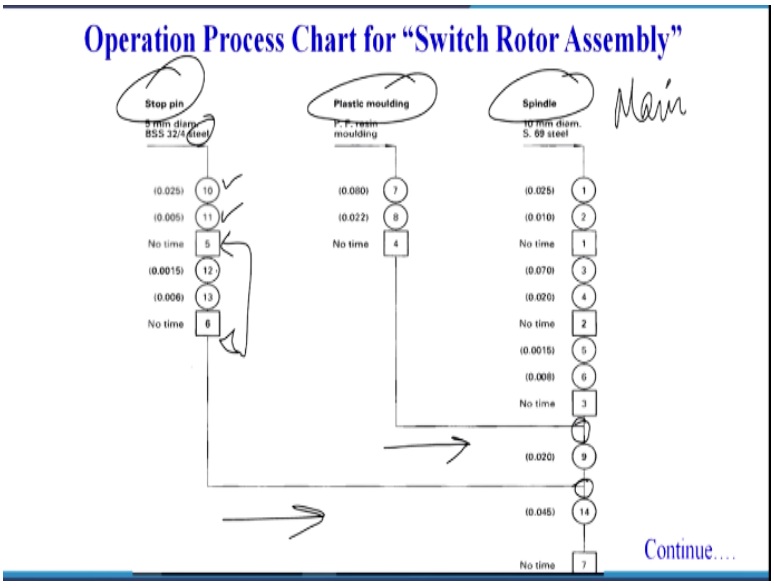

Now this is operation process chart for Switch Rotor Assembly on your screen. So in this case we are taking spindle as our main base on which we are going to assemble the other subparts. So our plaster moulding is getting assembled into the main and similarly our stop pin is also getting

assembled on the main line. So we are having 2 assembly operations one here and the another one here. So this is our you can say operation process chart for the switch rotor assembly.

Each one of this has further got number of operations and inspections. So you can see here, for the stop in the material is given it is still and then the different operations are given operation number 10, 11 then there is an inspection here. 2 inspections are taking place here number 5 and number 6 and then there are 2 operations here. So we can sequence the operations and inspections as there happening if you remember then we have to draw a operation process chart.

We must not rely on our memory, we must go and actually observe that how the work is being done and then try to plot it in the form of operation process chart. So here the numbers are given. Now these number these are representing certain operations and inspections. So the broader picture is clear that the main in line or the main part we have to identify and the subparts or the subassemblies also have to be identified.

And for each one of them we have see whether the sequence of operations happening where the inspection is taking place and then assemble the complete product. So let us take an example, not an example from here only we will try to understand that how we have drawn.

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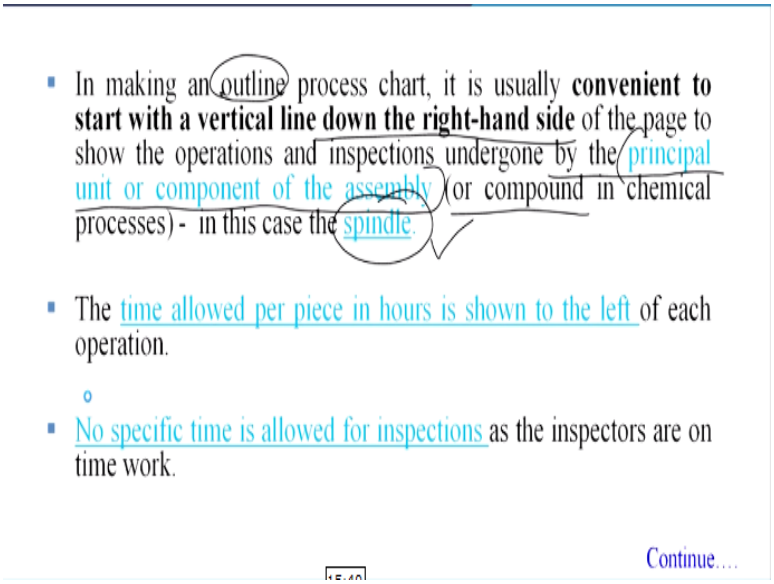

I have already explained that what I want to say now further, but let us quickly read and try to further reinforce our understanding of the operation process chart. So in making an outline process chart so we have seen that outline and operation is same. In making an outline process chart it is usually convenient to start with vertical line down the right-hand side, vertical line down the right-hand side, this is a vertical line down the right-hand side of our operation process chart of the page.

And it shows the operations and inspection undergone by the, now I have already I have called it as the main part but as per our slide we can also call it as principal unit or component of the assembly. So whatever is going to be the base the principal component of the assembly that we can start from the right-hand side vertically down in our operation process chart, and or compound in a chemical, this is another example.

So suppose it is a chemical reaction we want to draw operation process chart, so that can be it can be it be a compound in case of a chemical process. In our case, what we have taken, we have taken the spindle. So if you see we have taken here spindle, that is the main principal component and that we are drawing on the right-hand side of our operation process chart. The time allowed per piece in hours is shown on the left of each operation.

So you can see if we go back to this operation process chart, here we can see this is representing the time that is taken for each and every operation and inspection. And if you can see that for inspection we are saying no time, so why no time that we will try to see in our subsequent slide. No specific time is allowed for inspections, it is already highlighted as the inspectors are on the time work. So they are already present there.

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- In making an outline process chart, it is usually **convenient to start with a vertical line down the right-hand side** of the page to show the operations and inspections undergone by the principal unit or component of the assembly (or compound in chemical processes) - in this case the spindle.
- The time allowed per piece in hours is shown to the left of each operation.
- No specific time is allowed for inspections as the inspectors are on time work.

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The operations and inspections carried out on the spindle, which is made from 10 millimeter diameter steel rod, are as follows. Now if you go back just try to go back to our slide, if you see here only numbers are given, number 1, 2, 3, 4, 5 6 so operations are given here but we do not know what is operation 1, so for that we can see that what are the various descriptions, the descriptions can also be added as an appendix to the operation process chart wherever possible.

And if you go back refer back to our previous example that we have taken if it goes back to our previous example the operations were also mentioned along with the operation process chart turning, inspection, drilling, assemble fan, die-cast so wherever possible we can add a word or to related to the detailing about the operation and inspection. Coming back to again but here there are large number of operations and inspections taking place so we can have a separate appendix for that.

So here you can see, the operations, quickly we will see that what are the various operations, operation 1 is Face, turn, undercut and part of on a capstan lathe Even the detail on which the machines of operation has to be done also given and if you see the time required is also given. So we know that the operation number 1 in case of our spindle will be done on capstan lathe. What are the various operations w have to do? Facing, turning, undercutting and parting off. And the time required is given.

Operation 2, Face opposite and on the same machine another operation, same machine and time required is given which is also an operation. After this operation the work is sent to the inspection department. For Inspection 1, Inspect for dimensions and finish, so as we know in inspection we will try to compare the output in terms of certain standard output or the specification so that is we will try to inspect for dimensions and finish.

So no fixed time is allocated here that we have already seen. From the inspection department the work is sent to the milling section. So now we see whatever has to be done on capstan lathe has been done in the operation 1 and operation 2 then it has been inspected now it is going to the milling section. Now the next operation, third and 4th will be carried out.

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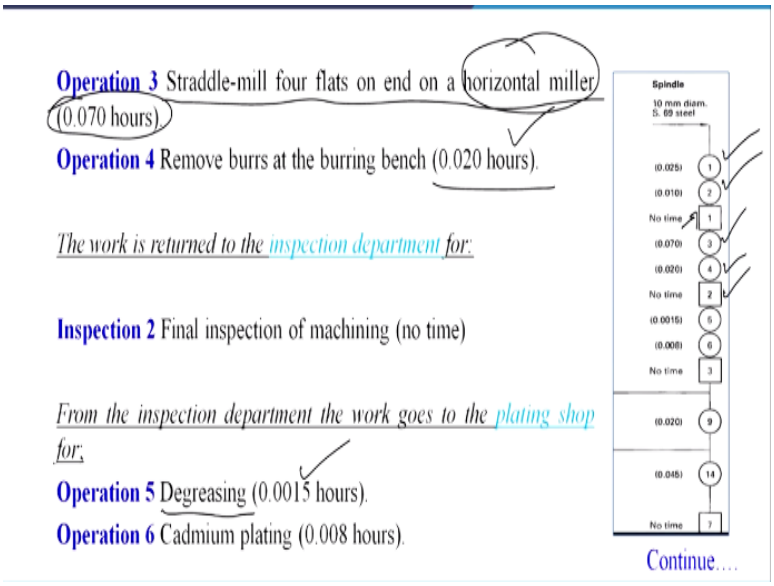

Now Operation 3, Straddle-mill 4 flats on the end on a horizontal miller, so horizontal milling machine is used, time is also given, then remove the burrs at the burring bench the time is also given. The work is returned to the inspection department for inspection 2, final inspection of the machining. So what we have done, we have used the capstan lathe machine and we have use a horizontal milling machine to perform certain operations.

And these operations we have represented in our operation process chart with a special not the special but the important operation chart symbol that is process chart symbol for operation that is a circle. And inspections have been depicted by square. Now the inspection 2 takes place you can

see, this was done on capstan lathe, inspection, straddle-milling of 4 flats the de-burring was there, remove the burrs at the burring bench and this is the inspection of the machining.

Now, from the inspection department the work goes to the plating shop, so now the fifth and 6th operation will be related to the plating section, so operation 5 when we see is degreasing, the time is also given and operation 6 is Cadmium plating. So operation 5 is degreasing and operation 6 is Cadmium plating.

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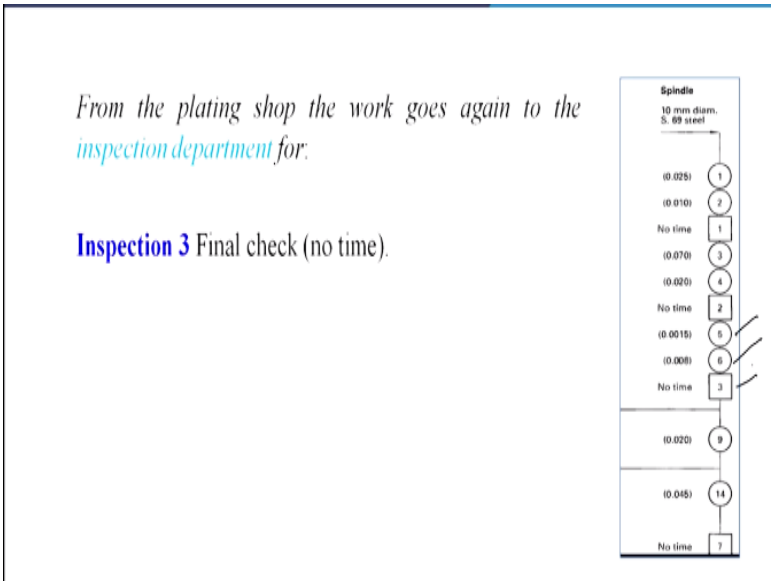

After that from the plating shop the work goes again to the inspection department. So we have seen 5th and 6th is this is degreasing, this is plating and finally this is the third inspection that is taking place. So this way we can see we can observe we can correlate that this is going to be the operation and this is going to be the inspection that is very easy, so then we can plot the main component and the subassemblies also we can follow the same process.

And then we can see where the subassembly is going to be added into principal component. So in our case that principal component is the spindle and there are 2 other parts which have to be assembled in this to make our final product.

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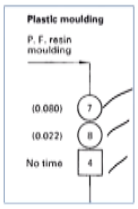
The plastic moulding is supplied with a hole bored concentric with the longitudinal axis.

Operation 7 Face on both sides, bore the cored hole and ream to size on a capstan lathe (0.080 hours).

Operation 8 Drill cross-hole (for the stop pin) and burr on two-spindle drill press (0.022 hours).



From the drilling operation the work goes to the inspection department for:

Inspection 4 Final check dimensions and finish (no time).

It is then passed to the finished-part stores to await withdrawal for assembly.

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Now the plastic moudling is supplied with a hold bored concentric with the longitudinal axis. So then this is the basic condition n which the plastic moulding is available. Operation 7, Face on both sides, bore the cored hole and ream to size on a capstan lathe again the machine and the operation is highlighted, time is also highlighted here. Operation 8, 7 and then 8, Drill cross-hole for the stop pin and burr on 2-spindle drill press.

So the machine is again highlighted, 2-spindle drill press and the cross hole drill the cross hole the operation is also. So we have the what operation is being done? On which machine it is being done? And how much time it is taking, is highlighted. Now from the drilling operation work goes to the inspection department and the 4th inspection will now be carried out. Now final check of dimensions and finish is done, that is the inspection 4th.

It is then passed to a finished–part stores to await withdrawal for assembly.

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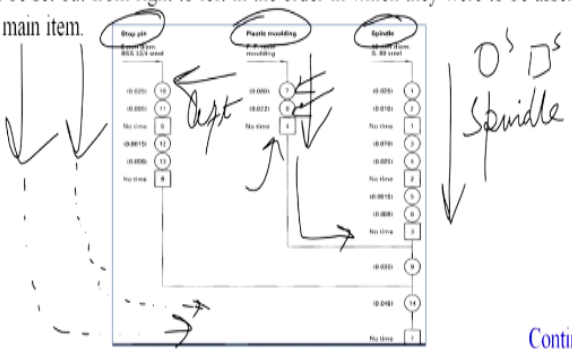
- It will be seen from the chart that the **operations and inspections on the moulding are on a vertical line next to that of the spindle**.
- This is because the moulding is the first component to be assembled to the spindle.
- The stop-pin line is set farther to the left, and if there were other components they would be set out from right to left in the order in which they were to be assembled to the main item.



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Now this is you can see the complete picture, this is plastic moulding and this is a spindle already we have discussed. It will be seen from the chart that the operations and inspections on the moulding are on a vertical line. So operations and inspections on the moulding. Now this is at the moulding so these are the 7, 8 and 4 are the operations and inspections being done, this is operation as we have seen the machine was also mentioned.

This is second operation and one inspection is being done that is inspection 4, again just to revise we can see there are 2 operations 7 and 8, so seventh is face on both side, 8 is drill cross hole, so both these operations 7 ,8 and inspection 4 are being done on the plastic moulding. Now this is because the moulding is the first component to be assembled to the spindle. So this is a first component.

If you see, this is getting assembled to the spindle, this is our spindle line. The operations and inspections being done on the spindle, so this is now finally getting assembled to the spindle. Now the stop pin is set further to the left, stop pin is set further to the left. Now this is the left direction from the spindle The stop pin line is set further to the left and if there were other components they would be set out from right to left in which they are to be assembled.

So if there are more number of component, here we have one spindle, one plastic moulding and one stop pin, so suppose there are other 2 components also which have to be assembled to the

main spindle and they are as per the sequence of assembly we will make their lines here towards the left-hand side and they will finally come and get assembled like this to the main part or to the principal part.

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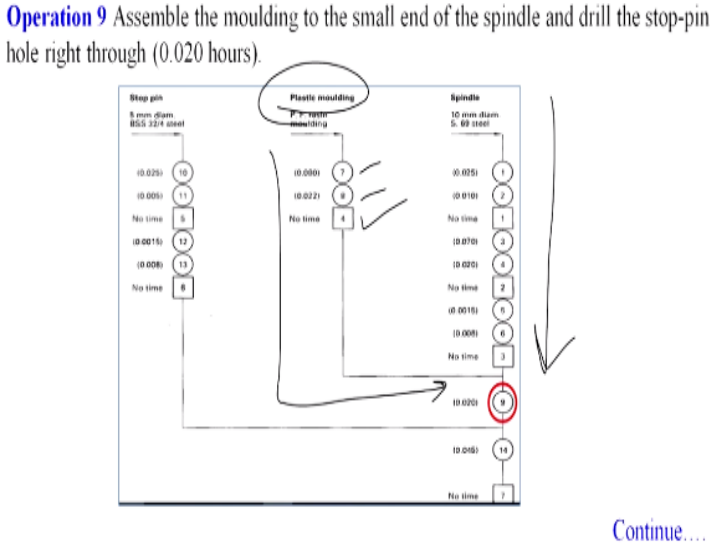

Now this is, assemble the moulding to the small end of the spindle and drill the stop-pin hole through the right hole, through hole right through. So this is the you can say one operation this is the operation number 9 which is, so this plastic moulding as we have already discussed after the 2 operations being done and one inspection done comes and gets assembled to the main spindle here and then one operation is done that is operation number 9.

And operation number 9 is assemble the moulding to the small end of the spindle and drill the stop-pin hole right through. So we are doing assembling and then drilling, the stop-pin hole, so this is one operation were drilling the hole through hole.

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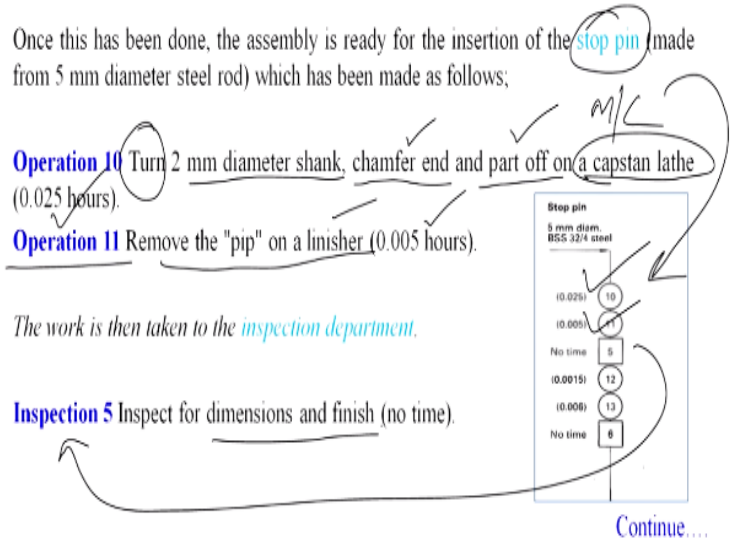

Now once this has been done the assembly is ready for the insertion of the stop-pin made from 5 millimeter diameter steel rod which has been made as follows. Now if we go back this is the stop-pin now up to this we have seen, the spindle what are the operations and inspections we know, plastic moulding what are the inspections and operations we know, finally it has got assembled and final operation has been done that is operation number 9.

Now we focus our attention on the stop-pin. Now for stop-pin also how many operations are there? 1, 2, 3 and 4, so we have 4 operations for the stop-pin and 2 inspections for the stop-pin. So what are these 4 operations and 2 inspections that quickly we will like to see. So after inspection the work—this we have already think seen. So now coming onto the stop-pin 10, 11, 12 and 13 operations we need to understand. So let us see now what are these 3.

Once this has been done the assembly is ready for the insertions of the stop pin, so let us now focus on stop pin and this is giving us the vertical line related to the stop pin. Operation 10, Turn 2 millimeter diameter, so operation s given, 2 millimeter diameter shank, chamfer and chamfer end another work, parting off another work, so this is one operation turn 2 millimeter diameter shank, chamfer end and part off on a capstan lathe, the machine is also given and the time taken is also mentioned.

So what is the operation or combination of operations on which machines and for how much time? Then operation 11 is remove the pip on the linisher the time is also given, then the work is taken. So 10 and 11, 10 is done which involves chamfering of first turning, chamfering of parting off then 11 also mentioned removing the pip from the linisher and then we pass onto the inspection. So this is the fifth part that is inspection. Inspect for dimensions and finish. After that now, we have to go to the 12 and 13 operation.

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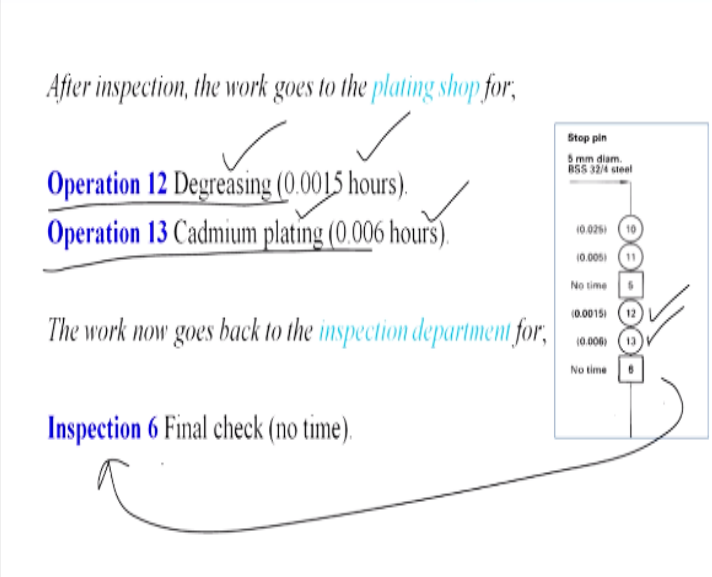

Operation number 12 is again we have seen earlier also operation number 12 degreasing and operation number 13 is Cadmium plating, the time requires is also given. So after inspection the work goes to the plating shop. The work now goes that to the inspection, so we have done degreasing, we have done Cadmium plating, now the 6th inspection is taking place that is the final check.

So now we have seen there is a main part, what are the operations and inspections then the moulding what are the operations and inspections then for the stop-pin what are the operations and inspections and finally this will be assembled to our main part. Now our main part or the principal part has now already the moulding assembled into it.

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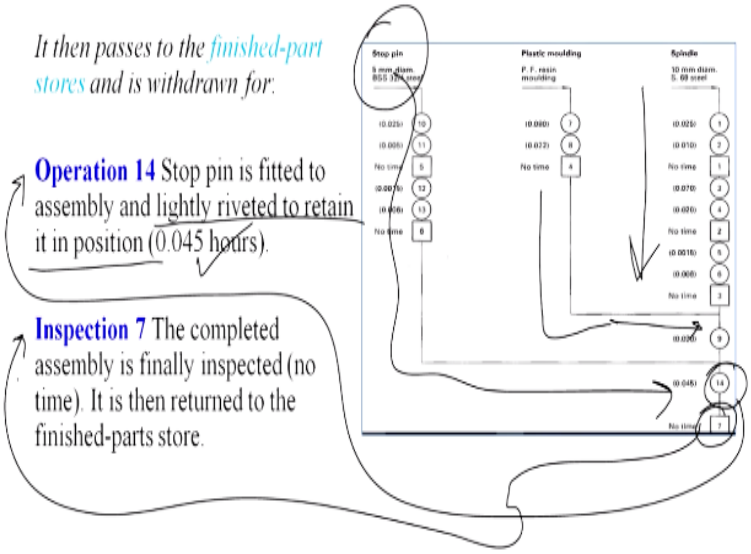

So this moulding is already a part of the main part, this is the main spindle, this is the moulding, plastic moulding and now finally the stop-pin is getting assembled here. And after that there is an operation number 14 which is mentioned here. Now what is operation number 14 we can see, operation 14, Stop pin is fitted to the assembly and lightly riveted to retain in position, so it is riveted to retain it in position, time is also given.

So after assembly the operation number 14 is done. And last 7th inspection it is there, 7th inspection is related to the completed assembly is finally inspected. It is then returned to the finished-parts stores. So finally we are able to complete our assembly of the 3 important part, the principal part is a spindle then the plastic moulding and the stop-pin, so we combined the 3 parts together and it is sent to the finished goods stores.

So this way we can draw the operation process chart for any complicated assembly also. So we can see that if we understand processes, if we understand that where the process is taking place where the inspection is taking place, very easily we can depict the complete maybe gambit of processes into and/or inspections into one very, very concise, precise, easy to understand chart.

And this chart is now maybe this chart is a A4 size chart but is going to give us a complete picture of all the operations, inspections as well as the sequence that is being followed to perform the work. What we can gain out of this, we can see that how much time is taken for individual

subparts that is one thing, how many operations are taking place, how many times we are inspecting.

Then we can try use our creativity to come up with alternatives which help us to achieve the objective of making this final product but with lesser number of operations with lesser number of inspections, with less time required with less manpower required. So once we have properly documented recorded the current method of doing the work, then we can be sure, we can discuss among ourselves, we can look forward to developing a better method of doing the work.

So with this we conclude the today's session on operation process chart and we have seen 3 examples, that how we can construct operation process chart. In our subsequent sections and sessions in method study as you all are remember that we have 4 weeks of discussion on method study, so we will be focused on other important recording techniques that are used for perfuming the method study. Thank you.