Principles of Industrial Engineering
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Lecture-32
Production Planning and Control: Scheduling

Hello, I welcome you all in this presentation related with the subject Principles of Industrial Engineering. And in this presentation we will be talking about the scheduling which is used in under the production planning control for determining when particular type of operation will be carried out and where it will be carried out. So, we will try to understand the scheduling, the different techniques which are used, what are the advantages related and under what conditions it should be used, which method of the scheduling is to be used.

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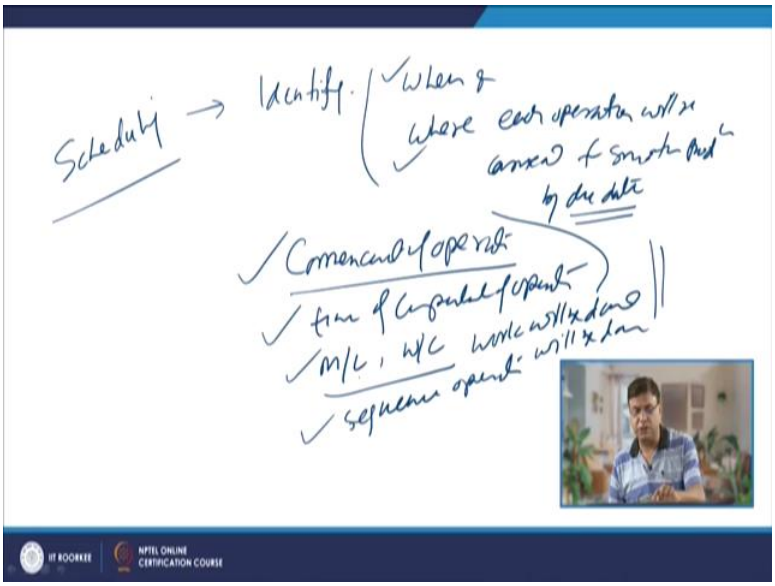

So, basically in scheduling, try to determine or identify when and where each operation will be carried out for smooth production, so that the amount to be produced is made available by the due date or the target is completed on time. So, basically when and where the operations will be performed, and this gives us the information about the commencement of the operation, the date or the time of the commencement of the operation and the time of completion of operation.

So, these are 2 details, at the same time, which machine, which work Center, where the work will be done, in addition, in which sequence operations will be done. So, these are the things which are specified under the scheduling. And what is considered when the schedule is established, to talk about when the production or the operation will commence and when it

will be completed, on which machine it will be done and in what sequence the operation will be done.

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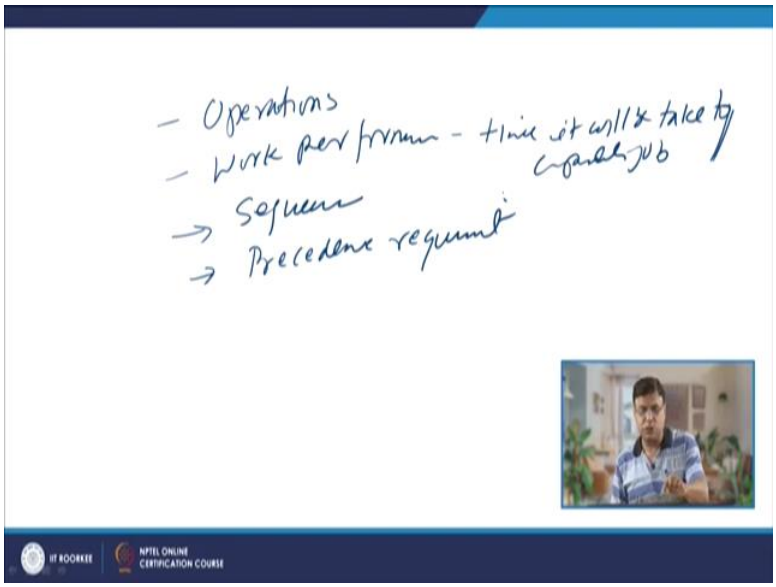

So, what are the inputs which are taken in scheduling? So, basically as per the design of the product, what are the different operations to be performed, so that the work is completed, that is identified. And then what are the work performance, which means how much time it will take to do a particular operation or a particular job. So, the time to complete the job, time it will take to complete the job that is about the work performance, machine performance, worker performance, etc.

Then what will be the sequence in which operations will be done, then what if there is any precedence requirement, like certain operations are to be completed first before doing the other operations. For example, the heat may be done at the end and before that all sizing and the shaping operations are performed. So, with regard to the operations, if there is any precedence requirement, that is also identified.

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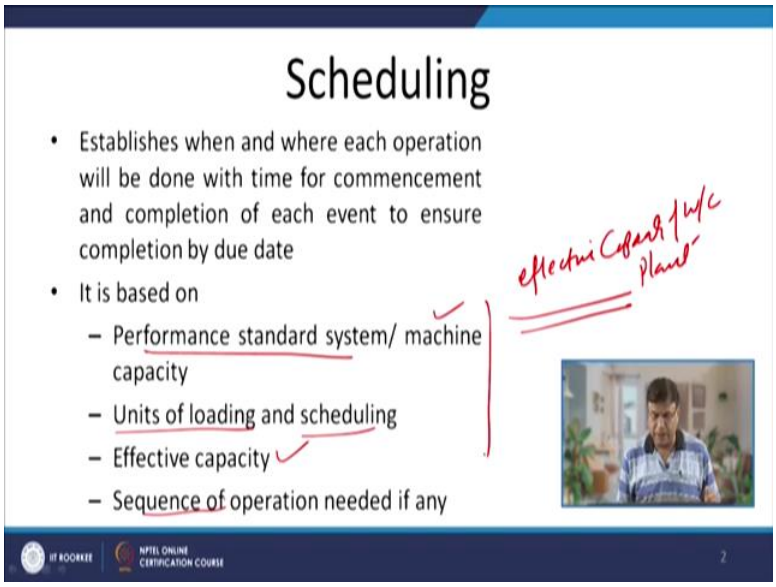

So, the inputs for the scheduling includes the performance standard, so this performance standard, like the performance standard, then the effective capacity of the work center or the plant that gives us the idea about how much time will be needed to complete the given order or to produce the given number of units. Then units of loading and scheduling, what is the effective capacity, what is the kind of time which will be needed to complete the job, what will the sequence of operations, so these are the different inputs which are used during the scheduling.

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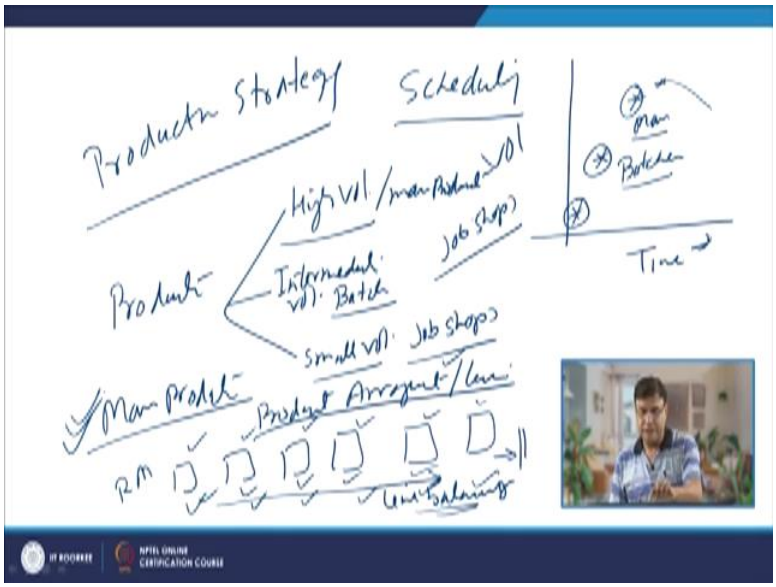

So, based on the kind of the production, which is production strategy being used, scheduling is done in different ways. So, the production strategy as per the product lifecycle we have

seen the time versus the volume, in the introduction stage the volume is very limited, in the growth stage volumes grow, so the batches are used, the production is done in batches and then volumes grow further, then the mass production is done and then it reaches to the maturity and thereafter a decline stage comes in.

So, here when the volumes to be produced are very small. This is the kind of the job shops kind of situation where very few units are to be made. When the volumes grow a little bit, the production is done in form of the batches and then when high volume production is needed, then mass production strategy is used.

So, we have 3 categories based on the kind of the production strategy, we have high volume production, where mass production strategy is used or the intermediate volume of production, where the items are produced in batches or very small volume which is realized through the job shops.

So, here very few units are produced. So, considering these production strategies in case of the mass production, mostly in mass production, basically the product arrangement or the product lines are used, wherein the machines will be arranged in the sequence of operations to be performed to complete the job. Like in cement and in the steel industry, the raw material will be fed and then it will be processed, passed through the different stages and at the end we will be getting the cement or the steel.

So, here the things will be moving in a particular direction through the different stages. In this case, as such there is no scheduling because path is fixed and the time to be spent by the raw material at a particular station is almost fixed and it is uniform. And if it is not uniform, then it is designed in such a way that the time is spent at each station by the material is almost uniform, so that the idle time is less and the efficiency of the line is maximum.

So, to deal with this situation basically, to get the desired target volume through the different product lines in case of the mass production, line balancing is done. Line balancing helps to design a production line in such a way that we are able to realize the target volume by the due date. So, of course, not much adjustments are possible in this case, but whatever is done, that is the line balancing related thing in case of the mass production situation with regard to the scheduling.

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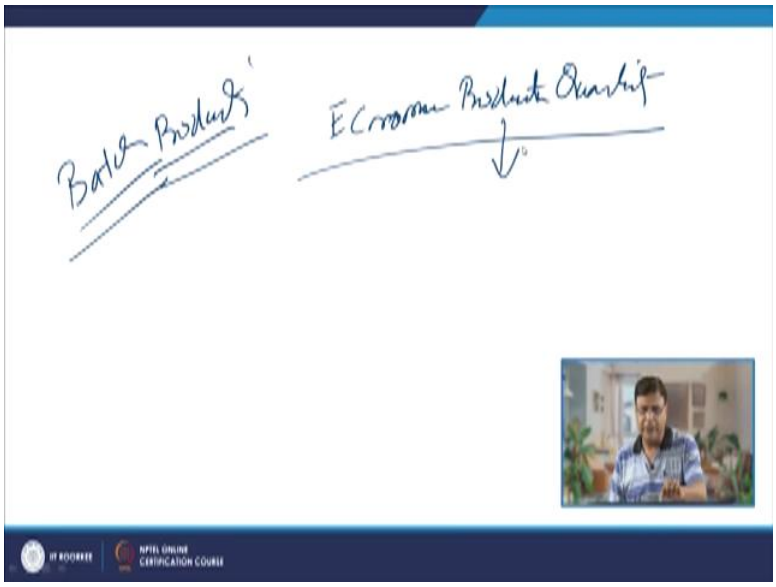

Then the second is when the batch production for the intermediate volumes are to be produced. In case of the batch production, basically efforts are made to produce the most economic production quantity like economic order quantity, which is used for ordering the quantity of the items to be procured in most optimum manner. Likewise, in economic production quantity, the quantity of the items is produced in such a way that it is the most economical.

So, in the same line, like the economic order quantity, the economic production quantity is also identified and here what we can see here, there is one typical case, which we can see here which is used in case of the batch process.

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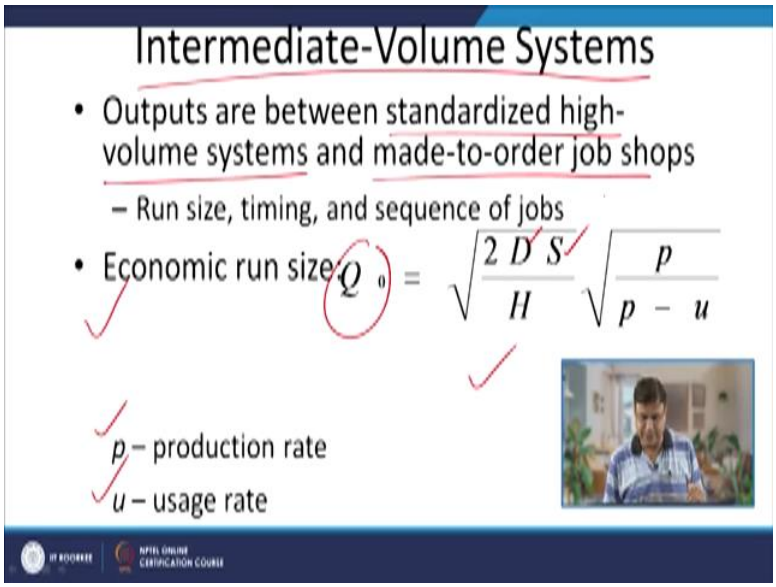

For intermediate volumes, what we will see, outputs are between the standard high volume systems and the job shops where items are made against the order. So in this case, the economic run size or economic batch size or economic production quantity is identified using this kind of formula. This is similar to that of economic order quantity, where p is the production rate, u the use rate, D is the demand to be produced, S is the kind of the cost which is related with the settings or the change overs.

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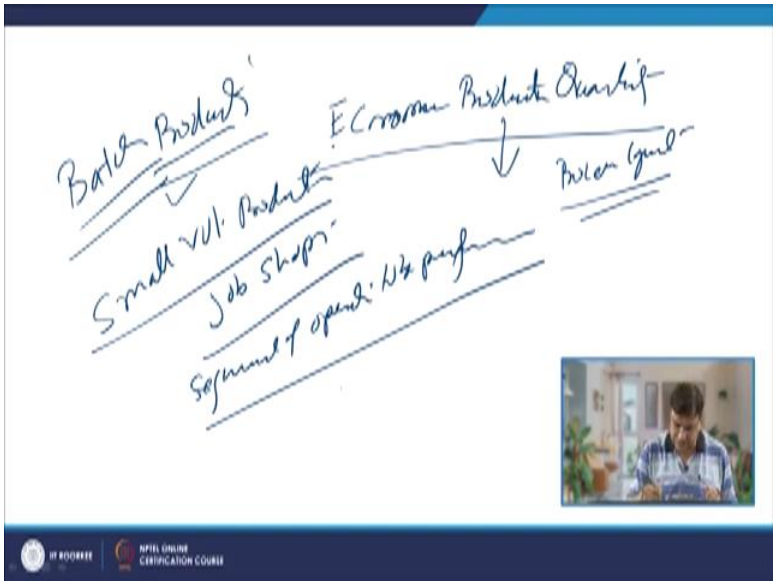

So, these are the things which are which are related with the batch production. So, here also not much of the scheduling is involved, because here the production system is arranged in form of the, like the process layout kind of thing here is used. Then we have the small volume production, basically applicable to the job shops, where items are to be processed, where the sequence of operations to be performed on the different machines or the different orders to be processed in a particular way, that is based on the kind of certain rules.

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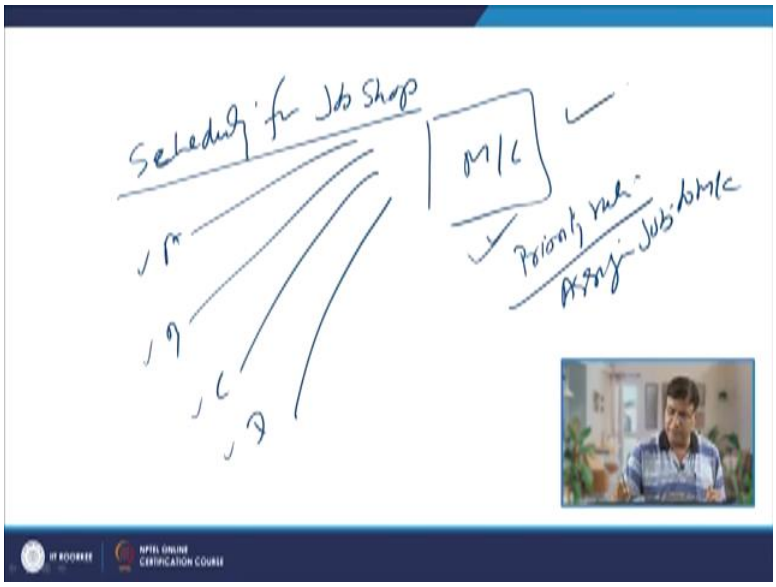

So, the scheduling for job shops, like where all the items are need to be processed through the certain machine. So, like say A, B, C, D, these 4 orders are to be processed or passed through certain machines. So, what will be the sequence in which these orders will be processed through these machines to determine that the certain rules are followed. So, this is the one aspect where we use certain priority rules to assign the jobs to the different machines.

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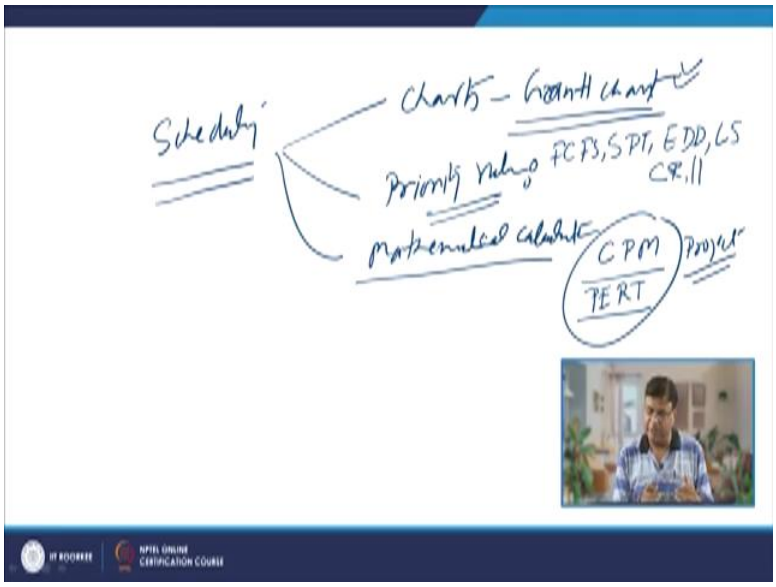

So, this is one of the aspects, apart from this scheduling is performed using certain methods. One is like use of charts, second is like use of the priority rules and third is mathematical calculations. The charts, the most commonly used is the Gantt chart and the second is about the priority rules when the certain jobs are to be processed through the certain set of the

machines, like first come first serve, shortest processing time, earliest due date, least slack then the critical ratio.

So, there are various rules which help us in identifying the optimum sequence in which the jobs are to be performed on the different machines. Then, the mathematical calculation based methods like critical path method and projector, PERT Project Evaluation and Review Technique. So, these methods for the scheduling are based on, are more useful for the project based companies and this is more suitable for the small job, where the certain orders are to be processed to the certain machines in for most effective and optimum utilization.

And the Gantt chart indicates the load which has been given to particular kind of the machine, how long a particular job will be done on a particular machine, how long a particular worker will be doing a particular kind of job, what are the different activities which will be performed by a particular machine or particular worker for a certain time? What are, the what is the planned activity, what are the actual activities which have been realized, and what is the current status with regard to that work.

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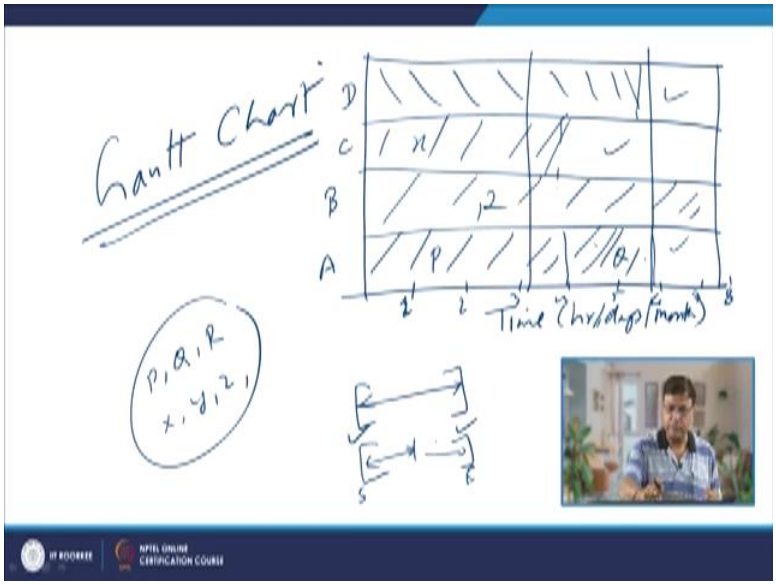

So, we will be starting with the Gantt chart. So here, Gantt chart is basically a simple chart only where we basically indicate, in y axis we indicate the time, this time can be in hours, can be in days, can be in months. And then in y axis we can mention the jobs. So, here 1, 2, 3, 4, 5, 6, 7 like this, we can mention like 1, 2, 3, 4, 5, 6, 7, 8 and then in y axis we can have number of subjects, which may be in form of the operations to be performed or the worker who will be doing the job.

So, here like say the worker A, B, C, D and he has got so many jobs to be done, which may be in form of like say x, y, z, P, Q, R, say 6 jobs are to be done by these 4 workers. So, here what we can say, the worker A will be doing the job p for first 4 time period and thereafter he will be doing the job q for another 2 periods. So, the p, the first one and then q the another one. Thereafter the worker B will be doing the job for the entire period, the R, the job R is being done by him throughout the 8 hours.

And then the workers C is doing say the job x for certain time, say for 4 hours in a day, then worker D is doing the job for say 6 hours. So, what it shows that the different workers are doing the different jobs and thereafter, the time for which they are free, they are not doing so. This is the time when they can be given the additional job. At any moment of time, we can see what is the status, we can draw a any line which will indicate the current time status for the different jobs.

So, here, if we draw this one, it will indicate that the kind of the job which has been done up to this stage or if it is left out, so that can be indicated in different ways. So, certain techniques are used like the bracket kind of thing, which will indicate the start and end and between these 2 we can put an arrow to indicate the kind of the job which has been done or between these 2 brackets where from it is starting and it is ending and only part of the work has been done and the remaining work is yet to be done. So, there are different ways to express how much job has been done and how much job is yet to be completed. So, now, I will show that portion related with the Gantt chart.

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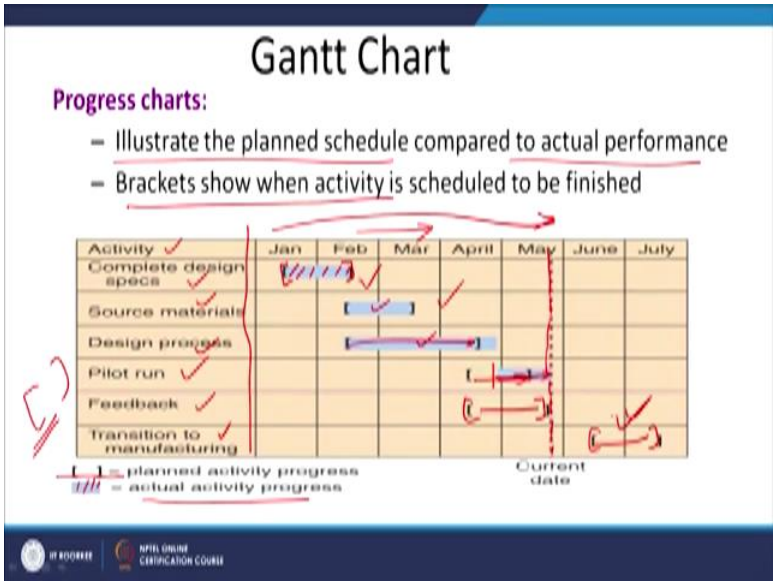

Yeah, here this is one typical Gantt chart which shows what are the various planned activities and it also shows the actual performance and the bracket shows the activity which is scheduled or which is yet to be finished. Let us take, like there are 6 activities, like complete design specification, identify the resource material design process, the pilot run, giving the feedback based on the pilot run and then implementing it and to the manufacturing.

And what it is showing, the bracket like this shows the kind of planned activity and between that we can put arrow or the shade to show the kind of actual activity which has been completed. So, like here, we have like the timeline showing January, February, March, April etc. And the activity, the first activity what it is showing that it has been completed indicated through this shade kind of thing.

So, the complete, the design specification that is over source material has been identified during the February and March, then design process has been completed during from the February to the April and then pilot run is yet to be completed. What we can see here although it is shifted, so what this indicates, the pilot run started late and this continued up to this current date.

And then this is the activity which is yet to be done, it is blank and this is the activity which is yet to be done is also a blank and this dotted line like this can be used to indicate the current date. So, what it shows as a function of time, what are the different jobs to be done, what is their actually status, what are the planned activities that can be easily shown with the help of the Gantt chart.

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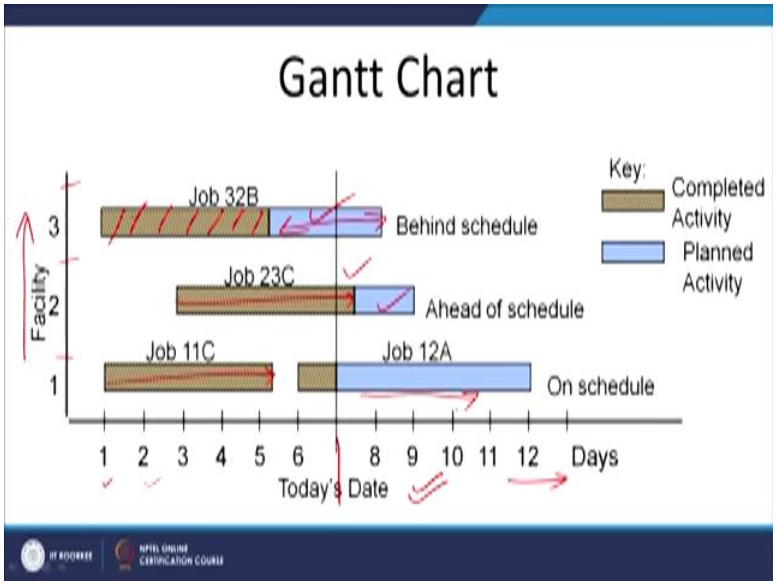

This is another way to show the Gantt chart, where in x axis, we have the timeline showing the today's date, this is the today's date and the other dates like first, second, third, fourth, etc. on the days. And at the different facilities what are the different jobs to be done, like say the status of the job allowance C from the first to eighth, this is the status. And then job 23 C, this is the status. So, what it shows, this is the activity which has been completed and this is the activity which is yet to be completed.

So, here it shows both the activities which are ahead of the schedule or the behind the schedule or the activities which are yet to be done. So, the Gantt chart in that way is extremely useful in indicating what will be the different jobs which need to be done, what is the plan, what is the portion which has been executed, in which sequence these jobs will be done.

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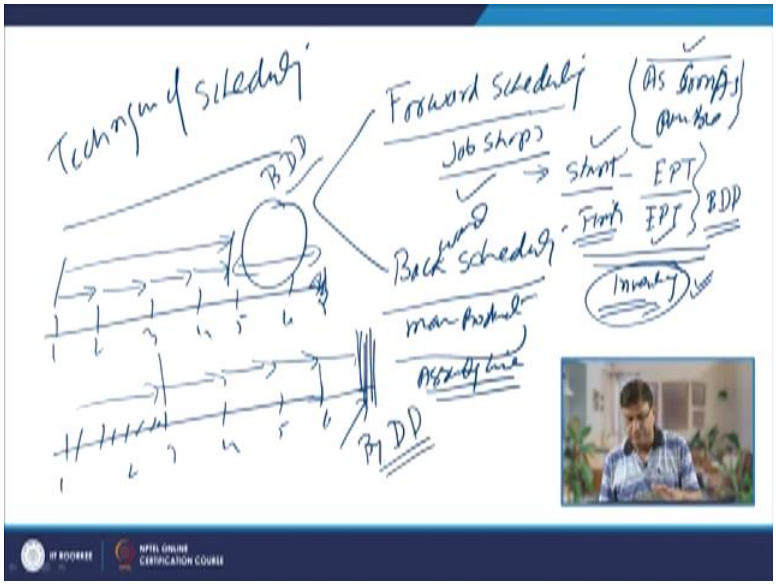

Considering these techniques related with the scheduling, there are 2 broad approaches for scheduling or we can say that techniques of scheduling. These are called like forward scheduling and another is backward scheduling. Forward scheduling is applied when the job is to be completed at the earliest possible, so as soon as possible. This is the first case, so when this is the case like customer comes gives the order and he wants that job is done as early as possible.

So, this is the case of the job shops where the things are made against the order in this case the order is required to be completed as soon as possible. So, for this situation the forward scheduling is done, in which case the start of the activity is done at the earliest possible time,

the activity or the operation is started and the earliest possible time for finishing the job in light of the time required to complete.

So in this case, most of the time the job is completed before due date. But this situation leads to the lot of the inventory in the system, because priority is given to the certain jobs which were in, the job is to be completed at the earliest possible. So, the scheduling is done in such a way that the certain jobs are given preference and the operation on those jobs is started at the earliest possible time and the jobs are finished before the due date.

This leads to the lot of in-process inventory situation. So, in that way, it will be leading to the lot of piling up of the things. So, in the first case, good for the job shops, when the delivery is needed as soon as possible. But this leads to the situation of the high in-process inventory. The backward scheduling is applied in case of the mass production, primarily in case of the assembly lines. So, in this case, the start of the operation is delayed as much as possible, but without delaying the completion of the entire order.

Means the order is completed before the due date, but we delay the start or the commencement of the operations as much as possible without delaying the completion of the job. So, in the backward scheduling, here I will give simple example like these are the different time slots available. So, this is 1, 2, 3, 4, 5, 6, 1, 2, 3, 4, 5, 6, 7. So, here what we do? So, this is the end.

So, in the case of forward scheduling, we start immediately and the jobs are assigned and the job is done at different stations and it is finished as early as possible. Well in forward scheduling the job is started and finished at the earliest possible. In another case, in backward scheduling commencement is delayed as much as possible. So, in this case the commencement can be delayed say by the 2 days.

Here we are completing 2 days earlier by the due date and here we will be we can delay it by the 2 days. So, we will start from here and then it will be completed after say by the due date. So, the it will be delayed by the 2 days and then it will be completed by the due date against the same time for the completion.

So, in both the, in the first case in forward scheduling the job is completed before the due date while in the second case the commencement of the operation is delayed as much as possible, but even in this case even the job is completed by the due date. So, there is no delay

as such. So, these are the like the 2 techniques which are used in case of the scheduling. So, I will talk about these scheduling techniques.

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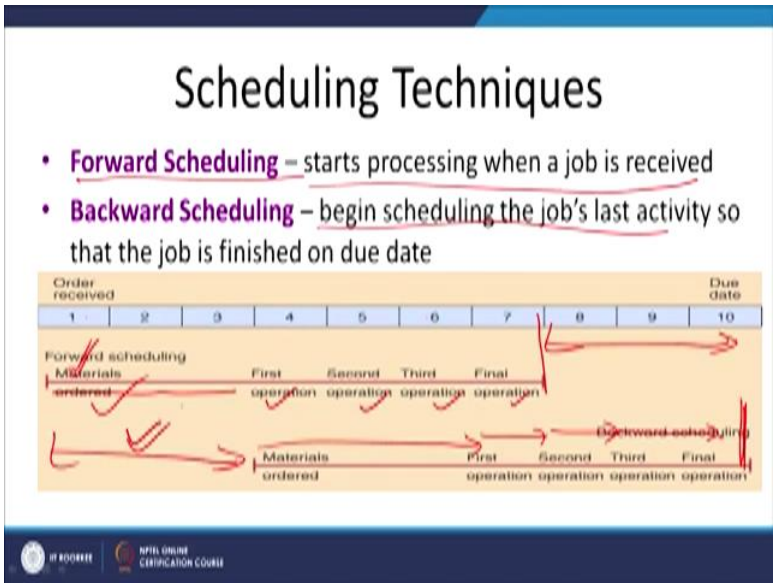

This is the typical example of the forward scheduling and the backward scheduling. In case of forward scheduling, it starts processing as and when job is received. And in case of the backward scheduling the commencement or the beginning of the job is done as much as, is delayed as much as possible. So, like say, in both the cases we will be giving the same time, means the time to complete the job maybe same like 1, 2, 3, 4, 5, 6, 7 it is taking 7 days and here also it will take the 7 days 1, 2, 3, 4, 5, 6, 7.

In any case, but here we are starting at the earliest possible, immediately and then the job is, material is ordered first operation, second operation, third operation, final operation job is done in seven days. While in another case, the job material is ordered after the 3 days and then the first operation is done, second operation is done, third operation is done, and then job is completed again on time.

So, in the first case, the job is completed 3 days before the day and the second case, the job is completed on the due date. But in this case we have delayed the commencement by the latest possible time without delaying the completion of the job. So, now I will summarize this presentation. In this presentation basically I have talked about what is the scheduling and what are the advantages of the scheduling and what are the different techniques which are used for scheduling when the different production strategies are used. Thank you for your attention.