**Principles of Industrial Engineering**
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**Lecture 34**
**Production Planning and control: Priority Sequencing II**

Hello, I welcome you all in this presentation related with the subject Principles of Industrial Engineering and we are talking about the priority sequencing related with the scheduling. So, in this presentation we will see few cases related with the sequencing using the different rules.

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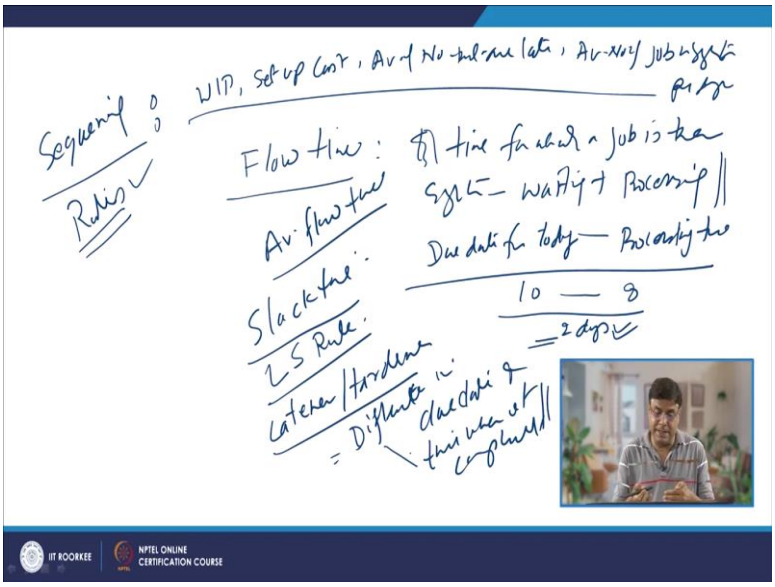


So, what we have seen the things which are important in sequencing, so that the customers are benefited, the efficiency of the system is improved like work-in process inventory is reduced, the setup cost is reduced, average number of the jobs that are late, average time by which they are late, average number of jobs in this system per day, so there are various parameters and the application of the rules, different prioritization rules they offer the different benefits.

So, as per the relative importance of the various, the benefits that are being looked into by the particular plant, suitable rule is applied because it is very hard to find the rule which will be giving all benefits and the few parameters which are used in this sequencing to determine these factors like the flow time, flow time.

So, flow time is the time, the time for which a job is there in the system which includes waiting time plus processing time. So for each job there will be flow time. When there are

number of jobs so each job will have the number of flow times for each job. We will be interested in determining the average flow time for these number of jobs.

Then there is the slack time. Slack time is about, it is the, like when the job is due, the due date from today and the processing time, difference of these two gives us the slack time. Like say, that the job from the today is due after 10 days and the processing time is 8 days. So, the slack time will be 2 days. So, the job which has got the minimum slack time is given the highest priority according to the Least Slack Rule.

Then the lateness or the tardiness, this is also termed as tardiness. The lateness or tardiness is the difference in the due date and the time when it is completed. So, that basically comes from the flow time. So, this difference will be determining whether there is any lateness or not. So, the tardiness or the lateness is determined on the basis of the due date and the flow time.

So, difference of the flow time and the due date gives us the extent of the lateness. When this value, when this difference regarding the tardiness or lateness, when this value is negative, means the due date is more than the flow time then this becomes a situation when there is no, actually there is no lateness or no tardiness means the job has been completed earlier than the due date. In the case when the flow time is say, 40 days and due date is 30 days, so means the job is late by 10 days. So, this is the case when there is lateness of the 10 days or the tardiness of the 10 days. So, these are the three parameters which are used.

In addition to this there is a critical ratio. Critical ratio also like the due date, ratio of the due date from today divided by the processing time. So, when the due date is more, say the job is due after 20 days and processing time is just 15 days. So, means this is greater than 1 which means if the job is done immediately then it will be ahead of schedule or ahead of the due date.

But, so means when the CR, Critical Ratio value is greater than 1 it indicates the job is being done ahead of the due date, when the CR value is less than 1 means it is behind, behind the due date or it is late, on the other hand when this value is equal to 1 means it will be done exactly on time. So, the lateness or the tardiness, critical ratio, slack time, these the flow time, these are the some of the parameters which are used in determining the suitability of particular rule.

Let us take one example. But before going into the example we will see what are the various benefits which are realized when we apply suitable rule for sequencing so that when a particular job will be started and when it will be finished, that can be established.

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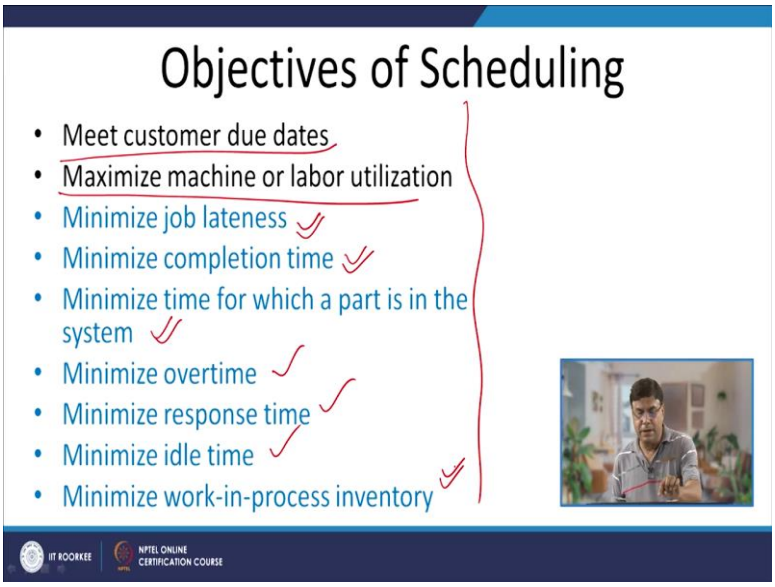


If the rules are established, suitable rule is used for sequencing so that suitable scheduling can be done, it can help in meeting the due date for the customers. It can help in maximizing the machine and the labor utilization. It helps in minimizing the lateness. It helps in minimizing the time to complete the jobs which are waiting in. It helps also minimizing the time for which a part is there in the system during the processing, minimizes the overtime, minimizes the time for response, minimizes the idle time and it also minimizes the work-in-process inventory.

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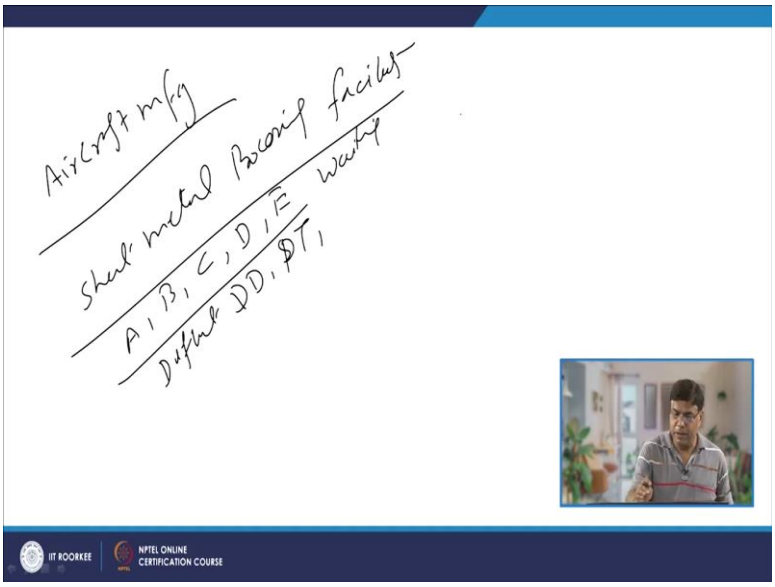


Now we will see, let us say there are different jobs for aircraft manufacturing sheet metal processing facility, is having 5 jobs to be done, like say A, B, C, D and E are the different jobs which are waiting to be done. For each job there is a different due date, different processing time, so what will be the sequence, appropriate sequence in which the jobs should be taken up for processing?

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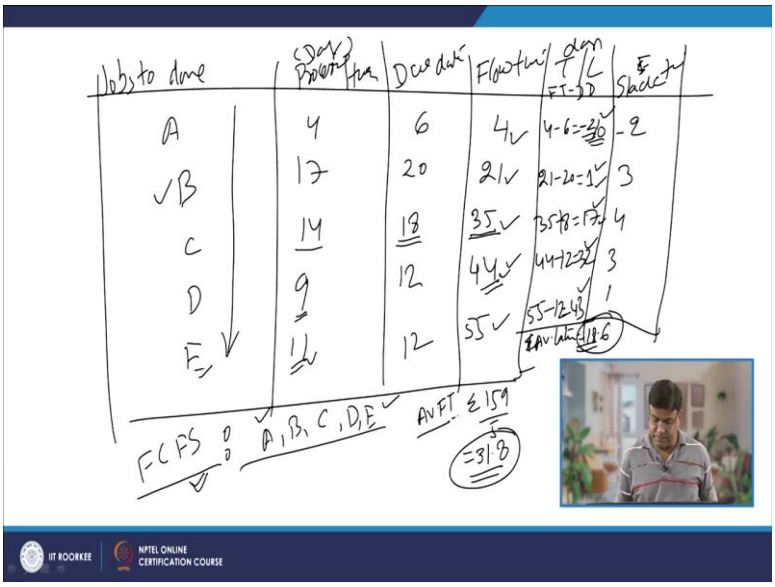


Let us say, so the different jobs, the jobs to be done here like say, A, B, C, D, E these are 5 jobs to be done. And processing time for these jobs, processing time for these jobs in, say days is say, for the A jobs it needs 4 days, for B jobs there is 17 days, then 14 days, then 9

days and 11 days. And based on this, say due date for these jobs, considering that the dates are given, due date is given from the current date.

So, the due date is after 6 days from today, 20 days, 18 days, 12 days and 12 days, so processing time and the due date. Now, we want to see the flow time. Obviously it will be in the days. So, flow time is what, the time for which a particular job is there in the system which includes the waiting time plus processing time.

So if we use the rule of the First Come First Serve, which means the order in which the job has arrived in the production facility. Let us take, let us say the jobs A, B, C, D and E arrived in the same sequence. A arrived first and E arrived at last. So, considering this if First Come First Serve rule is applied this will be the sequence in which these will be processed.

And these are the different processing time and this is very commonly used rule because it is very simple but it does not necessarily offer all the benefits company or the plant or organization may be looking for. So, now we see how to determine the flow time for the different jobs according to this First Come First Serve rule.

So, the first job, flow time for the first job, let us say it is, the job takes 4 time, 4 days to complete and it is taken first so the flow time, waiting time for this job is 0 and processing time is 4. So, flow time for A job is 4. And after completion of the A job as per the First Come First Serve rule, say next job to be taken up is B.

So, B will be taken up after 4 days and then it will take 17 days for completion. So, it will be complete, so the flow time for the B job will be the waiting time of 4 days and the processing time of 17 days, so it will be 21 days. Then after completion of the B, next job C will be taken up. So, waiting time for C job has been 21 days and then 14 days is the processing time and sum of these two will be 35 days for flow time for the C job.

After 35 days the D job will be taken up. So, waiting time for the D job has been 35 and next processing time for the D job is 9, so the total flow time for the D job will be 44 days. So, waiting time for E job is 44 days and thereafter processing time for E job is 11 days so total flow time for E job which will be waiting time 44 days plus processing time 11 days, it will be 55 days.

So the, so now if you want to determine the average flow time, average flow time means sum of flow time of all these jobs divided by the number of jobs, so number of jobs are 5. So, flow

time of all these jobs is 4 plus 21 plus 35 plus 44 plus 55, let us take sum is coming 159 and the number of jobs, how many these jobs are, like 5 so the average flow time for this one will be 31.8 days.

Now, we have to see the another aspect, the tardiness or the lateness in terms of the, of course in terms of the days it will be. So, the tardiness or lateness is the difference of the flow time and the due date. So, when the difference of the flow time is negative means there is no tardiness so the flow time, this is basically flow time minus the due date. So, flow time here 4 and the due date is 6 so that tardiness is of minus 2. So, actually there is no tardiness because the job is being done 2 days earlier the due date. So, there is, actually there is 0 tardiness. There is no lateness.

If we consider the another job, tardiness for, or lateness for the B job, the flow time is 21 days and the due date is 20 so the job is late by 1 day. 21 minus 20 is equal to 1 day, the job is, B job is late by 1 day. Then flow time for the C job is 35 minus the due date is 14 so the job is late by the 21 days, sorry not 14, 18 it is. So, 35 the flow time is 35 and the due date is 18, so 35 minus 18 is equal to 17 days. So, 35 minus 18 is equal to the 17 days.

Then the flow time, the tardiness for the D job is the flow time 44 days minus the due date is 12, so this will be leading to the 32 days lateness. And the lateness for job E, 55 days flow time and 12 days is the due date, so the lateness for this is 35 days. So, all the jobs if we see the lateness is 0 for the A job, for B lateness is 1 day, then 17 days, 32 days and 43 days.

Sum of all these jobs if we see, so sum of lateness of all these jobs divided by the lateness. So, here it will be giving us the average lateness which means sum of all these, lateness of all these jobs divided by 5. So, that will be giving us 18.6 is the average lateness. So, here if we want to determine, like say for this case, just for an idea if we want to determine the slackness, slack time then slack time is what, the due date and the processing time.

So, the slackness and the processing time here, it is 2 days, minus 2 days. Processing time here, the due date from today 17 and processing time is like say 3, 4, 3 and this is 11 and, 11 and 1. So, the different slack time values will be there in this case. Now, in this situation if we see the average flow time is 31.8 and 18.6 is the average lateness.

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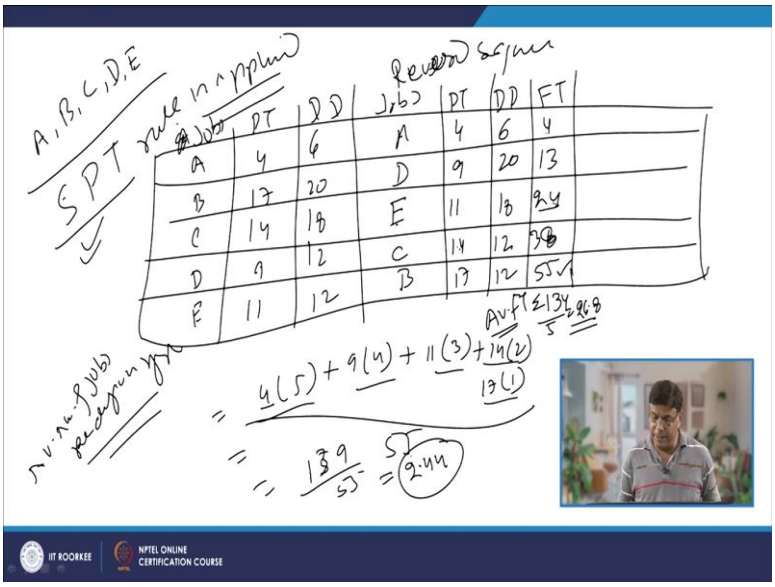


Now, if for the same jobs, like say A, B, C, D and E what if the Shortest Processing Time rule is applied then how the things will be affected. So obviously we have to change the order in which the jobs, the sequencing of the job was done. So, we will consider it again. Initially the jobs to be done, like the jobs to be done here A, B, C, D and E, and their processing time, processing time in days was like say 4, 17, 14, 9 and 11. And then there was due date. Due date was like say it was 6, 20, 18, 12 and 12.

Now, if you have to apply the Shortest Processing Time rule then the sequencing of the job will be done afresh, and for that we have to consider the job which is having the minimum processing time that will be taken up first. So, the minimum processing time job of 4 days is with the A.

Then the second minimum processing time is for the job D having the 9 days processing time. Then the third minimum possible processing time, the job with the third minimum processing time is with E 11 days thereafter we have C of 14 days and B of 17 days. So, this is the order in which the, this is the order in which the job can be processed in this, considering the Shortest Processing Time.

So, the revised sequence will be like this updated sequence will be like this. Here first of all we will be taking up A, thereafter we will be taking up D, then we will be taking up E, and then C and then B. Processing time is same, that is not going to change that is 4, 9, 11, 14, 17. Now, the due date the due date is also same, that is not going to change so 6, 20, 18, 12 and 12.

So, now flow time, let us see how the flow time is changing. So, the flow time is determined so we know, since the job A is having the processing time is being taken up first so the flow time for waiting is 0 and processing time for this A job is 4. So, flow time will be 4. Then after 4 days that job D will be taken for which processing time is 9, so waiting time for D is 4 days and the processing time is 9 so the flow time will be 13.

Then for E job flow time will be 13 plus 11, 24. Then for the job C 24, waiting time is 24 and the processing time is 14, so it will be 36. And then, it will be 38, 24 plus 14 it will be 38. And 38 plus, 38 is the waiting time for job B and 17 days is the processing time so it will be 55 days.

So, all jobs will be completing in this case also after 55 days that is the flow time for all 5 jobs is 55 days. But average flow time that will get changed. So, in this case when we determine the sum of all these flow times coming up 134 and 5 number of jobs so 26.8 is the average flow time for each job.

Now, if we determine in this case the another aspect, average number of jobs per day in the system, so for that what we have to see, initially if we see here for first 4 days there are 5 jobs in the system. Then for the next 9 days, 4 jobs are there. So, for first 4 days, number of job in a system, for these 55 days so for first 5, for first 4 days the 5 jobs are in the system, then next 9 days, 4 jobs are there. Next 11 days, next 11 days, 3 jobs are there. Then next 14 days 2 jobs are there. And for last 17 days just 1 job is there.

So, sum of all these jobs, sum of product and sum of all these values will be giving us the number of jobs which are there in a system but if you want to, for 55 days so average number of the jobs in the system per day will be giving us this. So, let us say the value is coming, again it is coming like say, 159. So, in this case it was 134 divided by 55, so this will be giving us the another value, like say 2.44 is the average number of the jobs per day in the system.

So, in this presentation basically I have talked about the effectiveness of the two rules, that is of the First Come First Serve and the Shortest Processing Time rule effectiveness with regard to the sequencing. Thank you for your attention.