Manufacturing Systems Technology

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Module – 04

Lecture - 24

Hello and welcome to this module 24 of Manufacturing Systems Technology.

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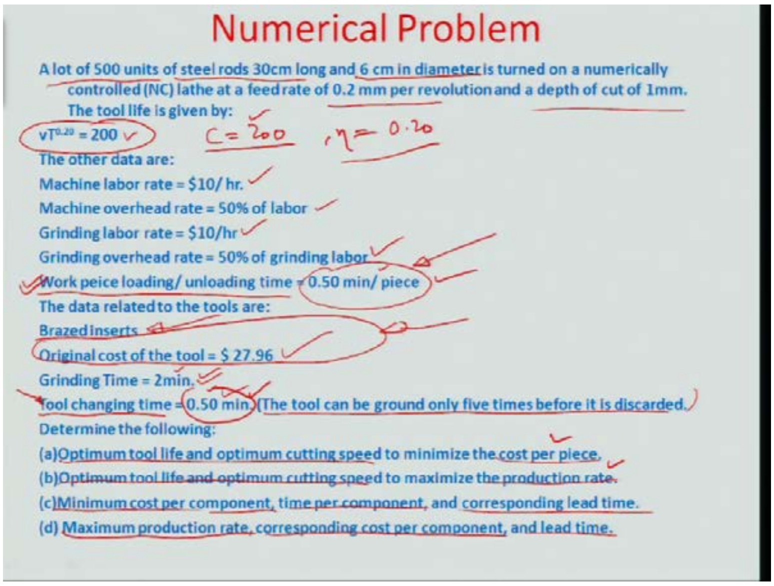

Quick recap of what we did in the last lecture, we started analyzing a problem where we wanted to estimate the optimum tool life and optimum cutting speed for both the conditions that is minimum cost per piece and maximum production rate per piece model. And we further found out the conditions subjected to the fact that the tool can be ground for about five times before it is finally, discarded. So, we were using one cutting edge of the tool for about six times and the original cost of the tool was recorded as 27.96 dollars and the total grinding time was given as 2 minutes, the tool changing time of about 0.50 minutes and work piece loading, unloading time to be again 0.50 minutes per piece.

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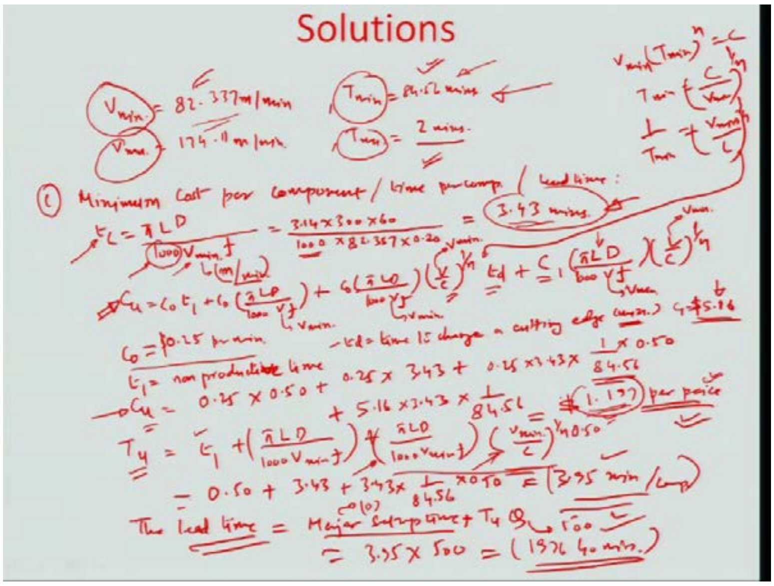

So, we obtained actually the values for the optimum tool life or optimum cutting speed for both the conditions, the V min for the minimum cost model came out to be about 82.337 meter per minute and the T min, the total tool life for the minimum cost model came out to be about close to 84.56 minutes. And similarly, the V max for the maximum production rate model was intuitively or it should be about double in this particular case and the T max, the maximum tool life model in that particular case came out to be close to about 2 minutes, so which is about 40'th from the T min.

So, the way that we calculated these different parameters seem to be justified or logical. The next step was; obviously, to calculate the minimum cost per component or time per component or even the corresponding lead time and then also the maximum production rate and corresponding cost per component and the lead time in both the models. So, we want to do that now. So, here let us say the first goal is to calculate the minimum cost per component and the time per component corresponding to the minimum production or minimum cost per unit model and lead time.

So, what we first do is to try find out what is the actual cutting time in this particular case that t c value, which can be represented as p L or pi L D or divided by 1000 V and this is because of the minimum cost, we use the velocity condition corresponding to the minimum cost model times up the feed f. And so in this particular case comes out to be 3.14 times of length of the piece, which is about 300 mm, the total diameter which is about 60 mm divided by the velocity minimum in terms of meters per minute, so that is why this 1000 factor comes in picture, 82.337 meters per minute times of the total amount of feed, in this case it is 0.20 millimeters. So, that is how the optimum tool life equation has been designed.

Remember the V min is always or the velocity is always in meters per minute in this particular tool life. The reason why in order to convert this into millimeter, this thousand factor comes in automatically in the tool life, I mean in the cutting time equation. So, this comes out to be roughly about 3.43 minutes, if you are considering the minimum cost per component model. And from this you can have an estimate of what time will it be needed for, what would be the cost per component which will come out in this particular case or what would be the time per component which will come out of as a micro fact what will be the lead time.

So, let us talk about the cost first, so C u the cost per component in this case is actually equal to the, I would say if you look at into the C u auction earlier, which we had done for calculating the cost to the minimum cost, we had a variety of things here which included c 0 t 1 plus c 0 times of pi L D by 1000 v f. Remember that is how we derived the cost model plus c 0 times of v L D divided by 1000 v f times of v by c 1 by n times of t d plus c 1 times of pi L D divided by 1000 v f times of v by c 1 by n.

So, this is how the cost per component was suppose to be and the c 0 was earlier estimated if you may remember to be 0.25 dollars ((Refer Time: 06:02)) of dollar per minute, just in the last problem or last part of the problem. So, we can use this value here right away, t 1 if you may remember is actually the total non productive time and if you really go back to the question ((Refer Time: 006:24)) we have the total non productive time as mostly, the work piece loading unloading time and that comes out to be roughly 0.50 minutes per piece.

So, that is how, this is the time during which you know it is not really contributing to the actual machining, but it is essentially evil it has to be there. So, it is a non productive time that is getting added here. So, here therefore, the final cost equation per components C u comes out to be equal to 0.25 per minute times of t 1, which in that case in this particular case is 0.50 plus again, if you look at the condition corresponding to the minimum cost model, v gets replaced by v minimum in all the places in the equation, where v has been reflected and if we add these or if we just replace these values in this particular set up, we have the next term here as 0.25 times of this whole term, which has earlier come out to be 3.43 minutes the total cutting time.

So, 3.43 plus again 0.25 c 0 times of 3.43 times of v minimum by c, in this particular case the v minimum by c value to the power of 1 by n is actually nothing but, sort of 1 by time minimum and time minimum is 3 point, you know you have already calculated it to be in particular value here as 84.56 minutes. So, we replace this by 1 divided by 84.56, again just coming back to this paradigm here you know that V minimum times of T minimum to the power of n is C.

So, here essentially what we are trying to do is to find out what is T minimum, which is you can say C by V minimum to the power of 1 by n. So, if I do 1 by T min this becomes equal to V minimum by C to the power of 1 by n which is nothing but, this particular value right here. So, you just substituting this by 1 by T minimum, T minimum has already been calculated for the minimum cost model earlier, derived earlier times of t d, t d; obviously, is the time to change a cutting edge in minutes.

This we had actually represented in the one of the earlier lectures, how t d is coming into this equation and so if you look back into the question the time to ((Refer Time: 09:40)) change tool in this particular case given here for example, is 0.50 minutes. So, therefore, the tool changing time in this particular case as you can see right here 0.50 minutes and that we want to just plug in here as t d as 0.50 minutes plus; obviously, the c 1 value which again was earlier found out, if you may remember in the optimum cost model or as the total amount of tooling cost which was 5.16 dollars.

So, c 1 actually was calculated to be 5.16 dollars, if you just go back into few modules and see, there is a way we assumed that there are six times that tool can be used with a new h and then grinding it five subsequent times and we accounted for the tooling cost per cycle of that six cycles and also we counted for the liberal over head charges per cycle times of the total amount of grinding time that would take for one edge and that way upper cycle we could estimate this particular cost of 5.16 dollars.

So, this c 1 is now substituted here, so we in place of c 1 here, so we have 5.16 dollars times of the t c value, because of the minimum you know velocity condition which again was calculated to be 3.43 as earlier times of V minimum by C in the same manner to the power of 1 by n which from the previous term here happens to be 1 by 84.56 minutes.

So, that actually comes out to be the cost per component in the minimum production model or if you just calculate that the total values sums up to be 1.197 dollars per piece. So, that is the minimum cost that can come out on the velocity optimum that is obtained for this minimum cost condition is about 82.33 meters per minute and the minimum time that is needed, that is a tool life that particular tool can be utilized is about close to any 4.56 minutes. So, it is pretty high and that results in the minimum cost per piece.

Obviously, this is one kind of business situation where you really ((Refer Time: 12:18)) the other can be mostly related to the maximum production rate driven, which we will do in the subsequent analysis. So, here the production time per piece assuming that you have a minimum cost per piece which is come out, the production time per piece can be T u. So, this can be represented as t 1, the total amount of time needed for loading, unloading the un productive time plus recurring actual cutting time, considering the minimum cost optimize to velocity condition plus the time to replace or do edge replacement etcetera, which is actually the cutting times of 1 by T minimum.

So, if this is the total cutting time per you know for a particular situation and this is the inverse of the total life time for the minimum cost condition, then cutting time by minimum tool life would actually represent the number of times of the frequency at which you can replace the tool and this multiplied by t d, which is actually the total tool changing time which is needed. So, you are basically changing at this frequency t c by capital T and multiply that with t d and the t d value here has earlier been obtained as 0.50.

So, that is how you actually do the time per component corresponding to the minimum cost model and this; obviously, the substituting the values here this is 0.50, this comes out to be 3.4325 from earlier equation let us just assume 3.43, not detailed calculations. Then, you have again 3.43 times of 1 by T min, which is 84.56 as you seen here times of 0.50 and this amounts to a total time of 3.95 minutes per component.

So, we now have two different values corresponding to the minimum cost model, where we see that the per component production time or the machining time is close to about 4 minutes and it is cost about 1.2 dollars per piece in the minimum cost condition. So, we can also try to find out or try to figure out the lead time for the whole batch. So, we have about 500 units that we need to produces here. So, the lead time is as you know involves the major set up time and then also reflects the time per component, times of the back size here the Q is 500 the back size we are using is 500 assume this to be negligible, because is not mention in the question.

So, we have per component 3.95 minutes times of 500 as a totally lead time for the whole the batch to get process and this condition it is about 1976. 4 minutes. So, corresponding to about close to 30 hours also. So, that is how you actually calculates the cost per component, the time of a production per component and the lead time as a regards the minimum cost model, minimum cost per component model I would also like to go further head and try to explain to you the condition the same parameters for the maximum production rate model.

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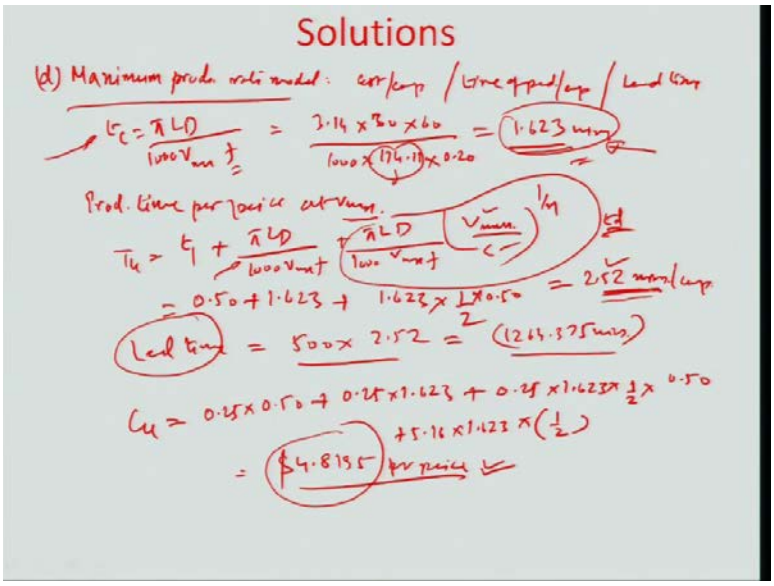

So, this is part forth of the question, you considering maximum production rate model and you willing to find out here the cost per component. Obviously, the time of production per component and the lead time in this particular case; obviously, we want to consider a cutting time t c by substituting value of v to be V max as derived in earlier equation and this is 3.14 times of 300 times of 60 divided by 1000 times of 174.11 remember this is the maximum velocity condition corresponding to the maximum production rate the optimum velocity times of 0.20 which is the fit here and this comes out to be 1.623 minutes, so that is how small it is.

If you just compare this with respect to the earlier cutting time, it was taking hell out of different it was like about almost twice in comparison to; obviously, because here the velocity is much slower and you can see here the minimum velocity here is 82.337. So, the maximum cutting time was recorded as 3.43 in that particular case here it is about half of that value, because obviously the velocity is quite to different about two times in this particular case.

So, the time of machining should change to almost half and that production time per piece at the tool velocity V max can be recorded as the unproductive time plus; obviously, the cutting time we see in this case you can substitute V max times f plus the total tool changing time in this case let say we assume just to be the total cutting time for the maximum production rate condition divided by the maximum tool life T max. So, this gives you an idea the frequency of change that is needed as regards the work piece times the t d which is the changing time, the tool changing time per cutting edge, you know which has been earlier given as 0.50.

So, here if I just substitute all the values 0.50 plus this becomes 1.623 minutes plus 1.623 times of V max by see in this case as you know this is about again 1 by T max and T max was earlier calculated to be something like 2 minutes. So, I have this recorded directly by 2 times of t d in this case t d is actually about close to 0.50. So, the total time per component comes out to be 2.52 minutes.

So, remember the earlier time per component was quite higher in this particular case it came out to be about 3.95 minutes, here this comes out to be about 2.52 minutes per component; obviously, because the production rate is add it is maximum in this particular equation. So, we can actually calculate the lead time in this case, in the same manner assuming of a 500 lots size as 500 times of time full component and it comes out to be about 1264.37 minutes which is lower then the 1800 minutes total lead time obtained earlier.

So, this batch because it is a maximum production rate model will be getting quickly process the lead time is shorter by about 600 minute in this particular case. And the optimum cost c u per component in this case again can be calculated by a similar formulation by just substituting in the value of the cutting time, the minimum cutting time or maximum cutting time in this particular case, which is 1.623 minutes.

So, I am just going to take the cost equation and just modify the time here to 1.623 adding also the cost, because of tool change just simply substituting the different values corresponding to this particular t c value and this comes out to be 4.81 or 4.82 dollars per piece. So, you can see here that because the production rate is the maximum or is added maximum the cost is increased quite a bit, because I think the tool cost here is contributing. So, it is become board of four times the cost per component in the minimum cost model.

So, has the time change significantly, the time has reduce because of the maximum production rate. And so logically whatever assumptions we are making are quite true in this particular case. So, as you saw here that this the very clear cut marcation of choosing the velocity conditions based on the maximum production rate or cost minimum cost models, where logically also they seem to be correct as for us the various comparative value, the numerical value is go in both the situations.

So, I would like to end this module and you know the computer assisted process planning would start from next module onwards.

Thank you.