Manufacturing Systems Technology

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Module – 04

Lecture – 23

Hello and welcome to this module 23 of Manufacturing Systems Technology.

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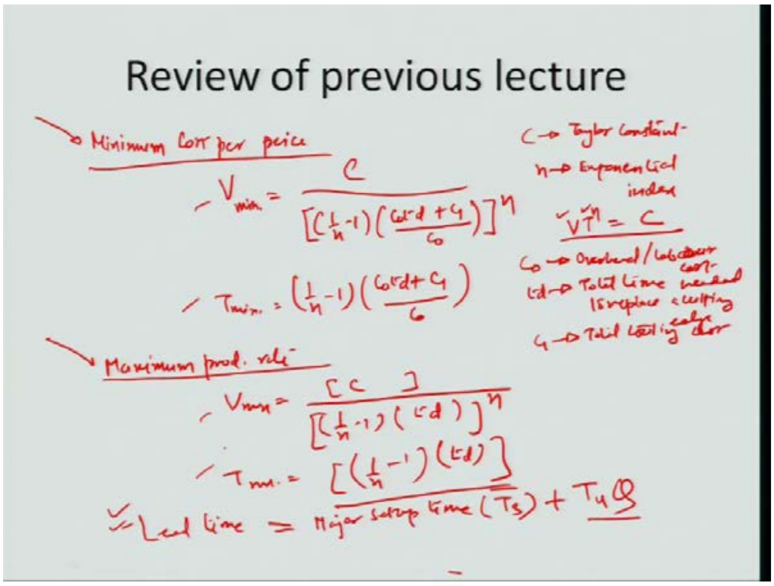

A quick recap of what we did in the last lecture, we were talking about the various optimization conditions for optimizing the cutting velocity and in that sense, we had evaluated two different modules, one was the optimum cost module and other was the minimum time of the maximum production rate module. And they are we could report, the velocity is the one of the end conditions of CAPP really, which had different steps and you know, starting with the analysis of part requirements, selection of raw work piece, after that determining the manufacturing operations and their sequences finally, the selection of the machine tools using process capability analysis to selecting the tooling's, the tool holders, etcetera and the final step of that process plan was about determining the optimum machining conditions, which we are kind of reviewing so.

So, here I would just like to illustrate that the modality that came out really in this process was, there were two set of conditions, one was considering the minimum cost per piece, where the V minimum or the velocity corresponding to the minimum cost piece was derived to be this expression C divided by 1 by n minus 1 times of c 0 t d plus c 1 divided by c 0 whole to the power of n and here; obviously the various terms c for example, was the Taylor constant on the tool life equation.

So, n is the exponential index of the Taylor equation, you remember the equation was V T to the power n was equal to the constant C, c 0 was considered to be the over head and labor cost, t d was the total time needed to replace a cutting edge and c 1 was a total tooling cost. Obviously, t was tool life, V was cutting velocity in this condition and c was a constant. So, having said that this was one of the criteria's for determining the optimum machining velocity for which the total tool life corresponding to minimum cost came out to be 1 by n minus 1 times of c 0 t d plus c 1 divided by c 0.

And the other criteria that was used was based on maximum production rate assuming minimum processing time of the particular part, where the total estimated velocity we called V max came out to be close to about this formulations c divided by 1 by n minus 1 times of t d to the power of n and similarly the tool life corresponding to the maximum production rate condition came out to be 1 by n minus 1 and this minus 1 actually is in the numerator. So, n minus 1 times of the total time needed to replace a cutting edge which is about t d.

So, having said that now the lead time which comes in to picture, assuming that the lot size is of q units would be really represented with this equation, lead time equal to whatever is the set up time, let say the major set up time associated with the process is some value, you can call it probably T s plus the amount of time of processing for one component amount of cutting time, which you call T u times of the lots size Q. So, that is how we actually calculate the average lead time in this particular case.

So, we want to now apply all these criteria's to determine the optimum machining condition particularly the velocity or the time corresponding to minimum cost per piece modular that corresponding to the maximum production rate per module in a practical situation.

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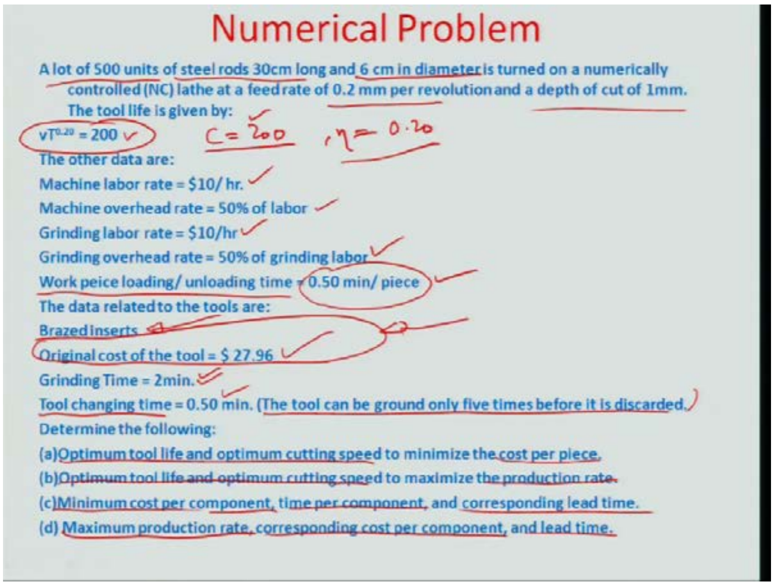

So, let us look at a problem example that I have formulated here for you. So, you have a lot of 500 units of steel rods about 30 centimeter in long, 6 centimeter in diameter as turned on a NC lathe, Numerical Controlled lathe at a feed rate given us 0.2 mm per revolution and of course, that depth of cut of equal to about 1 mm or so. The tool life data is given by this equation v t to the power of 0.20 equal to 200, meaning there by that the tool constant is 200 and the exponential in the tool life is about 0.20.

The other data that are given are the machine labor rate, which is about 10 dollars in hour, a machine overhead rate which is 50 percent of the labor rate. So, basically labor plus overhead comes out be about 15 dollars in 1 hour and so is the grinding labor rate, because you obviously need to first take the tool to it is complete life by grinding and regrinding the tool and using multiple number of times till the edge becomes ungrindable, that is the whole logic used in all the machining examples or all these machining.

So, here also the grinding labor rate comes out to be about same 10 dollars in hour with the 50 percent overheads charge, meaning there by the labor and overhead combined for grinding also is about 15 dollars in hour and we have some other parameters of importance, which would be enabling us to determining the optimum tool life, considering the minimum cost of the maximum production rate model and so on and also the optimum velocity conditions, so on and so forth.

So, we have the work piece loading, unloading time given as 0.50 minutes per piece and there are some other data related to the tools mostly the brazed inserts are the tools, which are the tooling's which are used in particular case. Remember it is a NC lathe, so you will have to have multiple tooling's, in a single check with multiple tooling's to do all the machining operation. The original cost of the tool comes out to be about 27.96 dollars and the grinding time of 2 minutes is recorded per cutting edge, meaning there by that before tool replacement is on, before a complete tool replacement initiates there are few steps of multiple usage of tools with grinding the edge of the tool for maybe two or three times.

And it has further been mentioned that in this process the tool can already be ground for five times before it is finally, discarded. So, the tool cost comes only at the end of the fifth cycle after five times the tooling has been used on the machine and the changing time, the tool is coming out to be about 0.50 minutes. So, we will have to determine the following, one is the optimum tool life and optimum cutting speed for the minimum cost per piece module and the same for the maximum production rate module and then, some other individual things like minimum cost per component or time per component and correspondingly, the lead time and similarly the maximum production rate or corresponding cost per component and lead time. So, all these needs to be calculated from the optimization criteria, which have been certain earlier.

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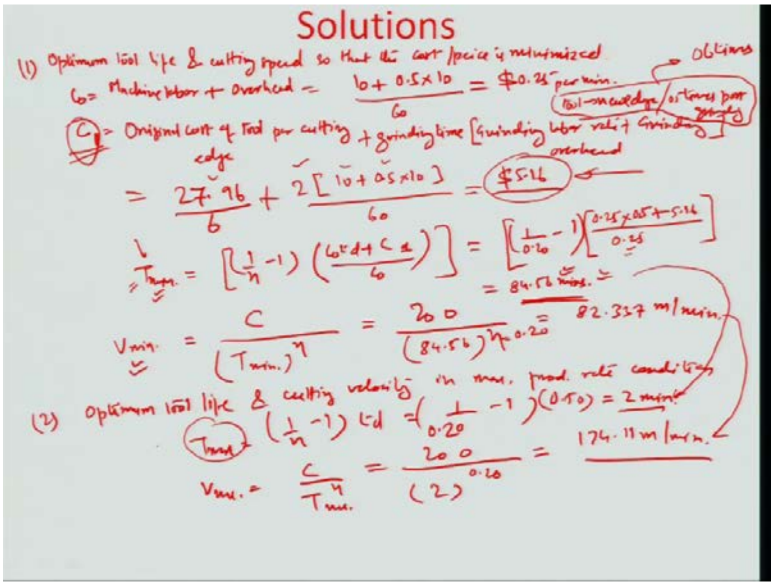

So, for doing this the first thing that we need to really mention or consider is that let us say the first case corresponds to the optimum tool life and cutting speed. So, that the cost per piece is minimized, so c 0 as we know is the machine labor plus the overhead. In this particular case it comes out to be 10 plus 50 percent of 10 and; obviously, that is given to be per hour units. So, if we really considered minutes as the basics unit, we divide this by this 60 to find out what is per minute. So, this comes out to be roughly about ((Refer Time: 10:08)) per minute 25 sense per minute.

And we also are interested in finding out the overall tooling cost which comes out, which also includes the original cost of tool per cutting edge, this is been provided to be set 47.96 dollars as illustrated in this particular data given in this problem statement plus now you have to considered the grinding aspect and the number of grinds etcetera. So, we can say that this is grinding times of the grinding labor rate plus the grinding overhead and if you really combine everything of here, there about six times that we can use one tool.

So, we want to find out what is the cost per usage or per cycle; obviously, you can take one tool which is a new edge and then you are carrying to use this tools five times post grinding. So, therefore, a total amount of usage of this particular cutting edge is about six times. So, we divide the 27.96 dollars by six in order to calculated the per cycle cost of the original tool per cutting edge and then you multiply this with the grinding time, which is given as in this case about 2 minutes from the data point earlier, the grinding time is 2 minutes on the tool changing time is 0.5 minutes.

So, here what we are going do this sort of calculate the overall grinding time by 2 minutes times of the labor and overhead which you utilize here. So, there are exactly 15 dollars in hour; obviously, should divide this in the interest of making it per minute by 60 and this is what you use for every single time that you grind. So, the 2 minutes of grinding time with the labor on the overhead cost gives you one cycle grinding time and dividing it by 60 because we want to do per minute.

So, therefore, the overall c 1 value the cost of tooling in this particular case comes out to be about 5.16 dollars. We already known that for the minimum cost per piece module that the minimum has been illustrated earlier has 1 by n minus 1 times off the c 0 t d plus c 1 divided by c 0. So, in this particular case the n comes out to be equal to 0.20. So, we have the t minimum here has 1 by 0.20 minus 1 c 0 which is a 0.25 dollars in minute plus the total amount of time per cutting edge which in this case for unloading and loading comes out to be 0.05 minutes per piece.

So, we multiply that with the total time per edge 0.5 minutes and then the tooling cost came out in the last equation per cycle as 5.16 dollars divided by the total c 0 value are the machine overhead and labor which is in this case again 0.25. So, the total time assuming the minimum cost module in this particular case which indicates the tool life time. So, tool life for the minimum cost module is about 84.56 minutes, similarly we also have a situation where we can calculate the minimum velocity and in this case the minimum velocity is again defined as c divided by the minimum tooling life in the tailor equation, which has been calculated in the earlier step to the power of n.

The c in this particular case has been illustrated as 200 as you can see from this tool life equation right here and as 0.20. So, we can have the we minimum has 200 divided by 84.56 to the power of n, n is 0.2 remember, why we are converting everything in to minutes is because the tool life equation also needs the time to being minutes as per the empirical derivation which had been earlier proposed by tailor.

So, therefore, we have to convert from hours to minutes, because to maintain the consistency in the tool life equations. So, here the v minimum then would come out to be equal to 82.337 meter per minute and we optimum tool life and cutting speed again to maximize the production rate would be again done in identical manner, where we can find out the optimum tool life and cutting velocity in maximum production rate condition as T max equals 1 by n minus 1 t d in this case it is equal to 1 by 0.2 0 minus 1 times off 0.50. So, it is about 2 minutes the maximum production rate condition.

And the v max the velocity for the maximum production rate condition; obviously, c divided by T max to the power of n. So, 200 divided by 2 minutes to the power of 0.20 comes out to be 174.11 minutes. So, think of it that from the minimum cost module were you are using the tooling optimally to the maximum production module, the velocity has come down significantly on the time really as also come down significantly per cut. So, therefore, you cutting at a much faster phase, because you want to have a maximum production rate and you not worrying about the tool rate really, which is the fact I mean that is how the different essentially comes between the minimum cost module and the maximum production rate module.

So, we are line with that logic that total tool life reduces drastically about a 40'th in the maximum production module, the tool life is the 40'th T max is the 40'th of the minimum cost per piece module and the velocity is also most about double in the case of maximum production rate module. Because; obviously, the cutting velocity more means the maximum production rate is being obtained.

So, that comes to the end of this particular session and in the next session we will take a the two other calculations related to the maximum cost per component and time corresponding to the lead time and then also the maximum production rate and corresponding cost per component and lead time in the next session.

Thank you.