Design Practice
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Lecture - 12
Concurrent Engineering Approaches

Hello and welcome to this Design Practice, module 12, we were discussing about concurrent engineering approaches in the last module and we went through the deliberations of 2 successive meetings; in one meeting of course, the teams agreed to design a specification.

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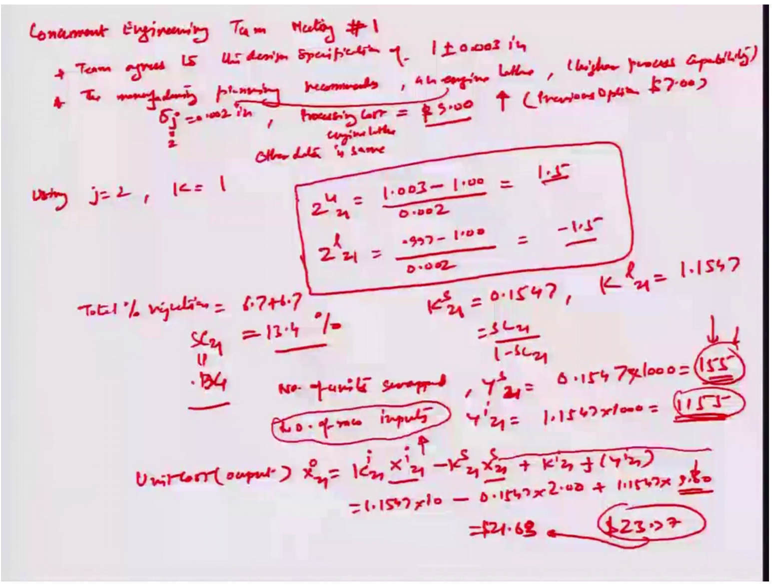

And then you know the teams looked at the various process capabilities and the mean machining capabilities of more than 1 systems of manufacturing processes, in which an output cost was created. In the second meeting again the quality and the purchasing departments over still not satisfied with the amount of scrap generated and also the unit cost you know, they basically wanted to do further deliberations by changing the tolerance limit to a slightly less tight or less slightly slack tolerance limit and then in that event as one could see the unit output cost changed it actually reduced because of that.

So, we will just proceed ahead with in you know another still another concurrent engineering team meeting 3. So, you can understand how this process at the very beginning at the very outset tries to balance the expirations of all the so, called team members in a cross functional mode.

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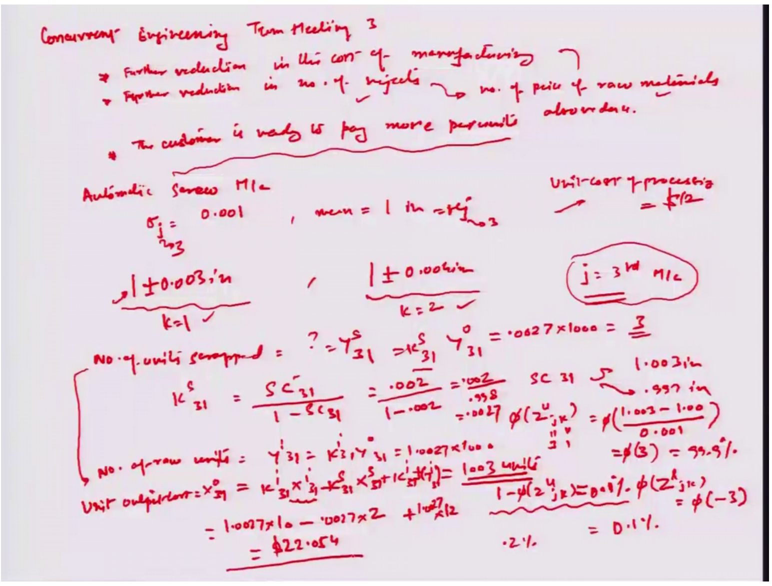

And how team meeting 3 one can actually in very limited steps be able to arrive at a final form of a design ok. So, in this particular team meeting, the cross functional multidisciplinary team compares the results of the 2 meetings and 6 reduction in the cost of manufacturing ok. So, the objective here is further reduction in the cost and also obviously, further reduction in the rejects because they are not happy with the level of rejects that happened over the last deliberation. So, further reduction in number of rejects and; obviously, if the rejects reduce it is a proper utilization and you can say that the number of pieces of raw shaft required also get reduced.

So, the marketing department comes up with the suggestion here and says that the customer is ready to pay more per unit, while keeping these into view that the number of rejects in the number of raw materials overall reduce, because of which the overall manufacturing cost may be lesser and we can probably think of going for the third option which is the automatic screw cutting machine.

This is a much better controlled option, it has a much lower standard deviation if you may recall in this particular case, the standard deviation corresponding to an automatic screwed cutting machine ASM, comes out to be equal to 0.001 ok. So, the sigma j in this particular case comes out to be 0.001 mean of course, is the same you know scrap dimension which was used in the earlier examples. So, the mean value for this whole manufacturing happens to be about one inch diameter ok.

So, the j in this particular case is corresponding to the third option ok. So, that is how we define the mean and the standard deviation for this particular option; and we want to somehow calculate we want to find out what is going to be the outcome of this particular decision of using the ASM. So obviously, the unit processing cost of such a machine is very high the unit processing cost here in this particular case, comes out to be equal to 12 dollars per piece. So, other data are pretty much similar as previous meetings, and in this meeting the team wants to know go ahead please. So, in this case although the unit processing cost is more it may happen that the overall reduction in the rejection may be higher, because of which the number of parts that you have to really machine may be lesser in order to get the required amount of parts for the manufacturing process ok.

So, in this particular case let us say in this using the ASM machine, the other data is same in this meeting the meeting 3 the team wants to know the unit cost of output number of units of scrap generated again the number of raw units required to produce 1000 finished pieces using the ASM system, and you can consider both the tolerances the slightly tighter tolerances which are in the range of 1 plus minus 0.003 inches and then you know based on the marketing feedback slightly loose set of tolerances, where this goes to 1 plus minus 0.004 inches and you can probably check on that in the you know this is called specification set 1 ok. So, let us say this is corresponding to k equal to 1 and this is called specification 2. So, corresponding to the j-th j equal to 3 a third machine, which is the ASM machine in the particular you know example problem you can check what is going to be the efficacy of using this specification and this specification on the third machine in terms of cost.

So, number of units scrapped needs to be found out using the third machine on the first specification Y s 3 1 and as you know this is equal to K s 3 1 times of the output unit Y 0 3 1 and we can find out the K s again by looking into just the scrap fraction ok. So, you know that K s 3 1 is also the total scrap coefficient 3 1 divided by 1 minus scrap coefficient 3 1 ok.

So, in this particular case we need to determine what is the scrap coefficient and scrap coefficient can be found out again from the upper and the lower tolerance limits. So, in this case corresponding to k equal to 1 the tolerance limits happened to be 1.003 inches and 0.997 inches and so, the phi of z upper tolerance j k j being 3 k being 1 is equal to 1.003 minus 1.00 divided by the standard deviation 0.001 ok. So, this corresponds to about 3 and if I looked into. So, phi of 3 phi of this whole term, and if I looked into the normal distribution tables for corresponding to what would happen if the z equal to 3. So, this corresponds to about 99.8 or 99.9 percent of the values ok.

So, its almost about 0.1 percent which is you can say they reject, because as you know the rejects in this case is 1 minus phi z upper j K i have explained to you in these last presentations about how this happens, this happens to be about close to you know 0.1 percent. So, that is how the upper tolerance unqualified number of pieces are or percentage of pieces are. Similarly if I had a lower tolerance you know unqualified percentage this corresponds to phi of minus 3, which is same as you know the 0 point 1 percent, an other words the total number of rejects here is close to about 0.2 percent ok.

So, 0.002 divided by 1 minus 0.002 which happens to be again a very very small percentage of almost 0.0027 ok. So, that is how the K s 31 is and so, this unit a number of units scrapped is actually equal to 0.0027 times of 1000 which is about 3. So, only 3 pieces are scrapped if you use the slightly tighter specification on the third machine automatic screw cutting machine and the number of raw units ok. So, let us find out the number of raw units needed, number of raw units is again based on you know Y i 3 1 which is equal to K i 3 1 times of Y 0 3 1 that is 1.002 times of 1000. So, you get about 103 you can say 27 ok. So, it is roughly about 1003 pieces approximately.

So, this is what you need to put in the system of the transformation for generating about 1000 pieces from the transformation and if I calculate the unit output cost in the case. So, the unit output cost in this particular case which is X 0 3 1 happens to be K i 3 1 times X i 3 1 minus K s 3 1 times of X s 3 1 plus K i times K i 3 1 times of processing cost for the output level Y i 3 1 ok. So, in this particular case it is 1.0027 times of the cost of the the input material, which is about 10 dollars a piece minus the scrap 0.0027 times of 2 dollars which is the scrap cost plus the processing cost which is about 12 dollars times of 1.0027 which is the K i 3 1 value. So, this comes out to be about 22.054 dollars ok.

Similarly, if I wanted to look at the other set of specifications, that is corresponding to K equal to 2 which is 1 plus minus 0.004 slightly looses specifications.

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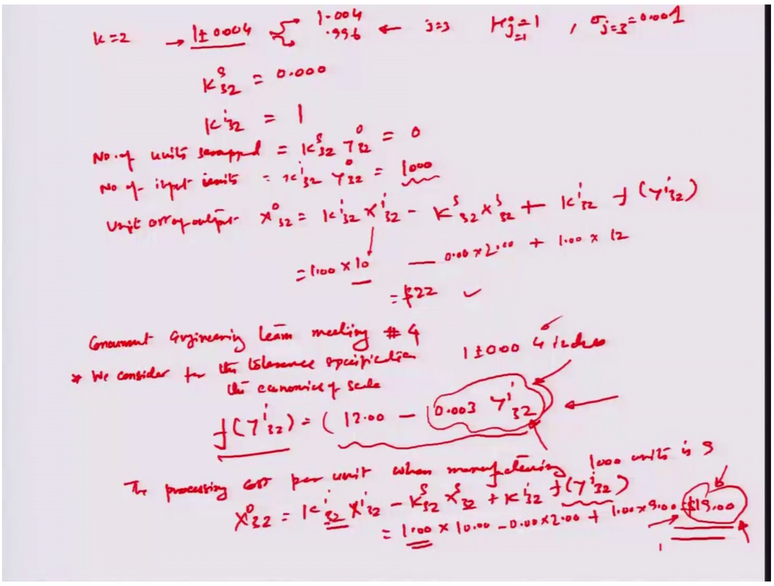

So, in this case it would vary between 1.004 0.996. So, you can actually find out for this particular tolerance limit, the value of K s happens to be around almost 0. So, its almost negligible in you know having a mean specification for j equal to 3 of 1 and sigma j equal to 3 of 0.002 ok. So, it is as good as almost having 0.001 I am sorry this is this for the automatic screw machine, the 0.001. So, it is as good as having almost 0 rejects ok.

So, in that case you can make both the purchase and quality departments happy because you have almost null rejects ok. So, in this particular case the K s 32 is 0 and K i 32 become equal to 1 and so, if I wanted to find out the number of scrapped units ok. So, number of units scrapped comes out to be K s 32 times of Y 0 32 Y o 32.

So, this is 0 similarly number of input units in this case would be K i 32 times of Y 0 32 which is actually 1000 pieces. So, exactly 1000 units would be produced from 1000 units sent into the transformation, and the unit cost in this particular case ok. So, the unit cost using the ASM case of output which is X 0 32 happens to be K i 3 2 X i 3 2 minus K s 3 2, X s 3 2 plus K i 3 2 function of Y i 3 2 which is 1.00 times of unit cost of the input 10 dollars. So, its 1.00 times of 10 that is the unit input cost times of the scrap coefficient 0 times of almost 0 there is no scrap sorry the scrap cost is 2 dollars, but there is no scrap ok. So, this component is 0 times of 1 times of processing cost which is again 12 dollars per piece. So, this happens to be about 20dollars 22 dollars per piece.

So, in the third meeting what was found out is that, if the customer is ready to pay a little more and if you are able to use a tighter specification on a you know automatic screw cutting machine, which is the most precise machine you can have a tighter specification. So, that making the quality people happy and you can have a relatively very low scrap, which can make the purchase department very happy because its not easy to get input scrap materials ok. That is the condition of the constraint and still you can do the job in very close cost to what cost was projected on the other 2 that is the engine and the turret lathe system. So, this decision making was actually resulted because of the initial participation of all the different members of the team of the concurrent engineering approach in the concurrent engineering approach.

So, let us look at a slightly different situation again, when we talk about another concurrent engineering meeting ok. So, in this particular meeting you know there have been we have seen dramatic improvements in product quality as well as manufacturing lead time as well as result of this cross functional team approach, and scarp has been almost reduced to 0 which address the concerns of the quality; in its earlier deliberations the team did not consider the influence of the economies of scale of production. So, now, we consider that situation and try to find out a sort of a cost which is you know cost of machining which is dependent on the total amount of input to the transformation process. So, a function of Y i 3 2 and then try to calculate this in terms of the number of the units or Y i 3 2 in terms of how many number of inputs are needed for the slightly slack specifications or low lower expanded specifications of 1 plus minus 0.004, as on the third machine equal to 3 that is the automatic screw cutting machine.

So, let us call it concurrent engineering team meeting number 4 and. So, we consider a fresh for the tolerance specification 1 plus minus 0.004 inches, the economies of scale. Let the processing cost depend on the input here as a functional relationship 12 dollars minus 0.003 Y i 3 2 this equation is based on more sort of objective studying of what is the actual cost including overheads labor etcetera to work on an ASM automatic screw cutting machine, if supposing there is a certain fix level of input material which goes into the system.

So, in this particular case the processing cost per into in manufacturing 1000 units is about 9 ok. So, the processing cost per unit when manufacturing 1000 units is 9 because; obviously, the economies of scale gets added or gets subtracted from the overall cost in this particular case and the unit cost of the output in that event which is represented in terms of K i 3 2 times of X i 3 2 minus K s 3 2 times of X s 3 2 plus K i 3 2 times of function of f Y i 3 2 considering the economies of scale becomes equal to from the last step for the slightly slack specifications on the ASM as 1 cross 10 plus or minus 0 times 2 dollars plus 1 plus 9 becomes equal to 19 dollars.

So, you are able to consider the economies of scale the requirement of the quality the requirement of the purchase and also being able to produce at the lowest possible cost ok. So, the last cost which came on an engine lathe where these considerations were absent in the second team meeting was about 19.54 units of currency. So, in this particular case as you see that cost is also reduced because of economies of scale because of this concurrent nature of the approach which is being followed.

So, this is the power of you can say the concurrent engineering. So, if I wanted to record everything in sort of a matrix form to arrive at a decision making.

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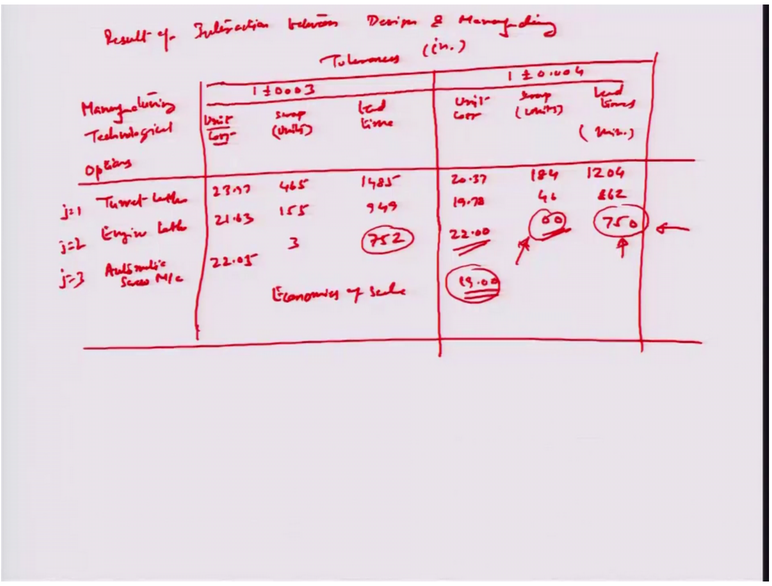

So, we would like to let us say call this the result of interaction between design and manufacturing and I would call this a sort of a decision table for finally, arriving at what is going to be the best process for process design of this component. So, for the manufacturing technological options, where we have tolerances in inches of 2 different kinds for example, in this kind you have the first set of tolerance which is 1 plus minus 0.003, and the second set of tolerance which is 1 plus minus 0.004 which was framed out on the advice of the marketing and we consider various outputs of the algorithm like unit cost of the processing of the material of the of the final material which came out from the transformation process the number of scrap units, which got generated and similarly lead time. You get a decision matrix based on which you could actually conclude about what would be a good process in a certain business environment similarly for the other set of specifications scrap unit, unit cost and lead time ok.

So, if all these possibilities are integrated together for the different options which are there. So, so you have the turret lathe as j equal to one option, the engine lathe corresponding to j equal to 2 and the automatic screw cutting machine corresponding to j equal to 3. So, the unit costs here are 23.97, 21.63 22.02 and units of currency. Similarly the scrap generated is 465 in one case, 155 in the other 3 in the other and the lead time again if we calculate using setup times as well as the processing times 485, 949 and 752. Similarly for the slightly slack specifications this cost happens to be 20.37, 19.78 and 22 units of currency scrap units happened to be 184 in one case, 46 in another and 0 in other and the lead times happen to be 1204 862 and 750.

So, based on the business environment which is there, either it could be a low lead time decision the lowest lead time being 750 minutes for producing the 1000 pieces and that to add a reasonable cost and for 0 units of scrap and as you know that if I take economies of scale here. So, if I add the economies of scale term here this cost further goes down to about 19 dollars.

o, at the lowest cost at the let us say lowest possible lead time with the highest possible quality and also making the purchase department happy you could do an operation in the most costly machine ok. So, this can only be possible because of this concurrentness in the approach of how you do the overall designing for the specification. So, in this manner all these specifications need to be determined for an engineering assembly, before getting into the manufacture phase. So, that there is an optimal angle to all the manufacturing.

So, I think I will close the topic here today, but then in the next topic we will compare between what you know the economies of scale would rhyme in the serial approach as opposed to this approach, and then we will talk something about product lifecycle as well so up till then, goodbye.

Thank you.