# Manufacturing Systems Technology

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**Module – 05**
**Lecture – 27**

Welcome to this module 27 of Manufacturing System Technology. Quick recap of what we did in the last module, we talked about the two different approaches of doing computer assisted process planning. One was the variant approach, where there would already be an existing well structured part classification into part families, etcetera in terms of the processes and good layout process for existing components and any components, which was bought from outside would be just a variant to that. So, the process planning, etcetera would happen according to the variance of the new component which would be added on to the system.

And then, we also discussed about the generative cap method, where it would be the formulation of the whole process plan avenue show by means of following certain decision logic tables and you know, technology algorithm, so on and so forth. So, here we want to just may be understand a little bit of how a decision table can be arrived at by looking at a problem statement.

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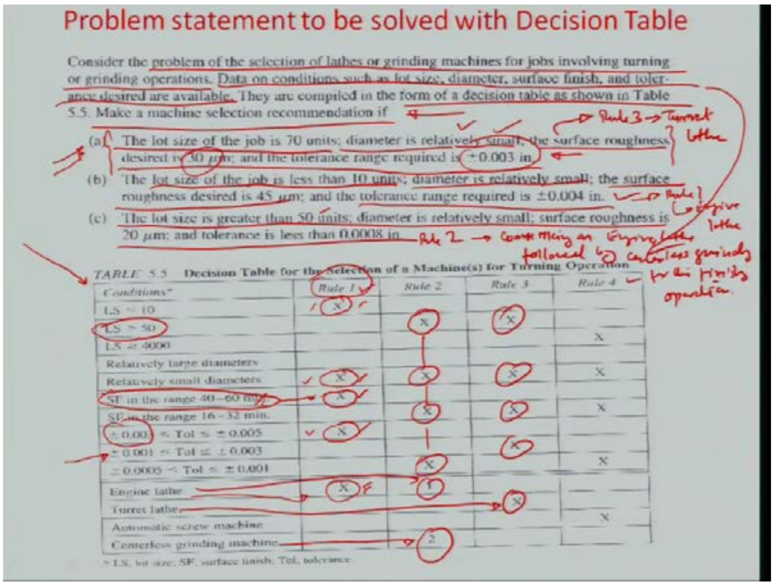

Let us look at this particular problem here. So, we are considering the problem of selection of lathes or grinding machines for jobs involving turning or grinding operations. So, what we mentioned is that in the generating cap process, the operator knowledge would be somehow be able to get recorded in the process plan. So, it is one step advantage over the variant cap in that, whatever is the hands on experience of the combination follow operators, manufacturing professionals who are already working in a process would get somehow updated us process knowledge in the plan and one of the reason why such decision tables need to be made.

So, you look at this example which talks about it. So, you have a problem of selection of lathes or grinding machines for jobs involving turning or grinding operations and the data on conditions such as lot size, diameter, surface finish and tolerance desired are available and they are compiled in the form of a decision table as shown in this table here, right here. I want to explain the table one by one and you will have to make a machine selection recommendation and you have been given some constraints here or conditions here, which are that if the lot size of the job is 70 units and the diameter of the particular sharp that you have probably machining on the lathe is relatively small and the surface roughness is desired is about 30 microns and the tolerance range required is about plus minus 0.003 inches.

So, in order to make this selection from based on the conditions and the rows which are provided in the table, let us just look through the table little bit and find out what are the conditions corresponding to this rules are being designed here. So, the tables says, that if the lot size is let us say less than 10 and then, the sharp diameter which is being machined as relatively small diameters. Also the total tolerance is in the range of plus minus 0.0032 plus minus 0.005, the surface finish is in the range of 40 to 60 microns as represented here.

So, in that event if all these conditions are obeyed, then the rule 1 follows meaning there by the selection would be engine lathe. Now, this is actually laid out on the basis of the operator experience, who is there in the lathe machine and he can actually look at these things and prepare this table accordingly. So, there are variety of such operations, whether the manufacturing enterprise where such decision tables need to be made out for doing this generative, this process knowledge based cap planning approach. So, this is the process knowledge which comes out.

Also there is another rule 2 here, which says that if the lot size is less or greater than or equal to 50 and then there are relatively smaller diameters or sharp that you are producing, probably the surface finish in the range of about 16 to 32 microns and the tolerance happens to be in the plus 0.005 to 0.001 range. Then, you can actually have two conditions one is probably the course machining operation which is being done on an engine lathe and followed by a centralized grinding machine, which gives the surface finish.

So, 1 followed by 2 basically means the operation 1 the engine lane comes first and the centralized grinding machine comes second. So, the rule two says that if so and so conditions are going to be placed, then automatically there is an engine lathe followed by the centralized grinding process, which is defined for obtaining you know such a conditional situation. So, let us look at a situation a here, we are talking about here a lot size of job 70 units which is; obviously, more than 50 greater than or equal to 50.

So, essentially it is rule 2 and rule 3 which follows it. So, one matching for condition a is rule 3, we are talking about diameter of relatively small size. So, therefore, you know even rule 2 and rule 3 both are significantly with the same kind, that which says that relatively small diameter, so this also matches. Surface roughness desired is 30 microns so; obviously, the study surface micron falls in this particular range again, which is again same more or less for rule 2 and rule 3.

And then, they are saying that the tolerance should be, is required should be a sort of plus minus 0.003 which; obviously, falls in this particular range here right here. So, here the rule 3 bifurcates as the obeyed rule and there is nothing in rule 2, which has to be followed. So, therefore; obviously, if these three conditions are meeting on rule 3, that is the lot size condition, the surface finish condition and the diameter of the condition, the surface finish condition and also the tolerance condition, then rule 3 says that use turret lathe.

So, by the operator knowledge it has been placed that, in these kind of cases you were used the turret lathe. So, for example, in this particular case when we want to use this decision table to choose this particular situation or this condition, we use the rule 3 and therefore, automatically turret lathe based on this rule 3. Similarly, let us talk about the second problem here, which is describing the lot size of the job being less than 10 units and the diameter is relatively small and the surface roughness desired is about 45 microns and the tolerance range required is about plus minus 0.004 inches.

So; obviously, if we look back into this particular texture here, lot size is less than 10 corresponds to rule 1 condition and the diameter is relatively small. So, again there is a validation here which happens; obviously, the roughness desired is about 45 microns which is actually in the 40 to 60 micron category here right here and then of course, the tolerance range is between as you know is plus minus 0.003, which is actually again close to what this has to report and therefore, automatically it means that the condition engine lathe is followed.

So, therefore, in the situation b the rule 1 is obeyed. So, in the case 3 again you have lot size of 50 units, meaning there by the rule 2 and rule 3 being followed. Diameter is relatively small, which means again rule 2 and rule 3 being followed. The surface roughness is about 20 microns, so surface roughness is again is in the range of 16 to 30 microns, again rule 3, rule 2 is followed. The tolerance range is less than 0.0008, which means that tolerance is actually in this capacity.

So, rule 2 is obeyed more than rule 3 in this particular case, meaning there by at this operation probably demands the course finishing or course machining operation using engine lathe followed by the centralized grinding machine, which does the fine finishing or the grinding operation on the top of this engine lathe. So, that is how you select and do the machine decision. So, therefore, rule 2 is obeyed here, which means that course machining on engine lathe followed by centralized grinding for the finishing operation.

So, now, you probably can understand how one uses the decision table, where the process knowledge is sort of organized in a manner. So, that selections for a certain condition becomes easy. So, now, you can make a machine relation, select recommendation for all the three cases case a, b and c, where a from the table comes out to be obeying rule 3, that is is turret lathe; b from the table comes out to be obeying rule 1, which is engine lathe and then or the third condition the c is obeying rule 2, which means that the engine lathe for course machining followed by centralized grinding machining for the finishing operation on that particular sharp. So, this is how you represent using decision table. So, it is very, very logical way of representation of a process knowledge, which happens to be coming or generated from the manufacturer or the line operator in such a system.

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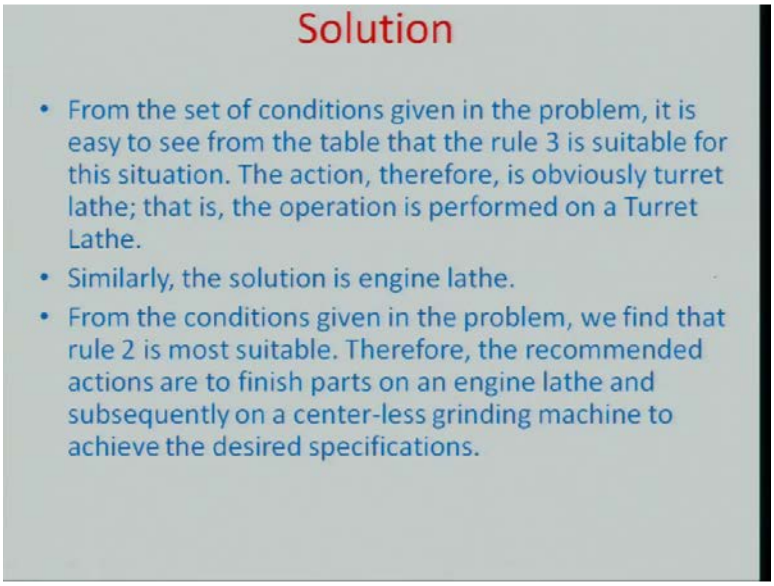


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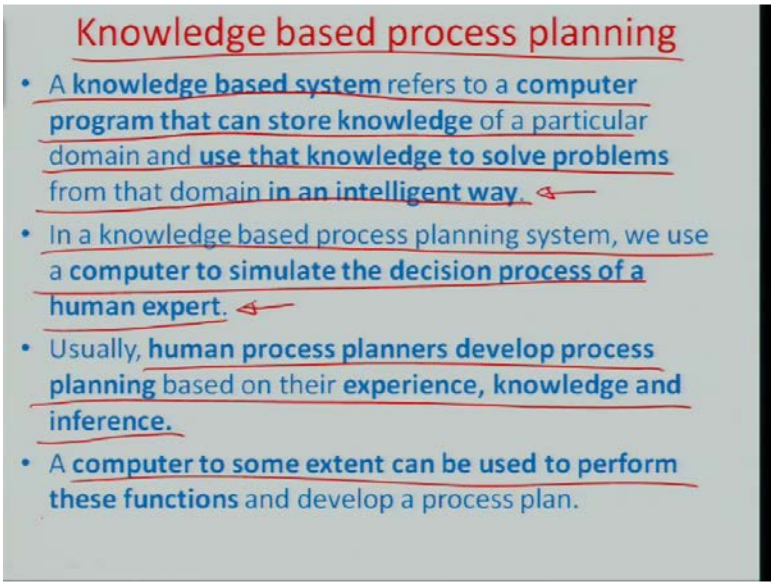


So, if you look at the knowledge based approach for process planning, a knowledge based system really refers to a computer program that can store knowledge of a particular domain and use that knowledge to solve problems from that domain and in an intelligent way. You already saw, how a problem can be stored as a decision table from where you can make a recommendation for a certain part, which arrives in.

In a knowledge based process planning system, we use a computer to stimulate the decision process of a human expert and the human process planners develop process planning based on their experience, knowledge and inference. But, a computer to some extent can use this information, can be used to perform these functions and develop a process plan. These logical tables or decision tables can be automated and left lone to a computer to take a decision about a certain part to assembly or sub assembly, which arrives in to a certain process where the process needs to be planned.

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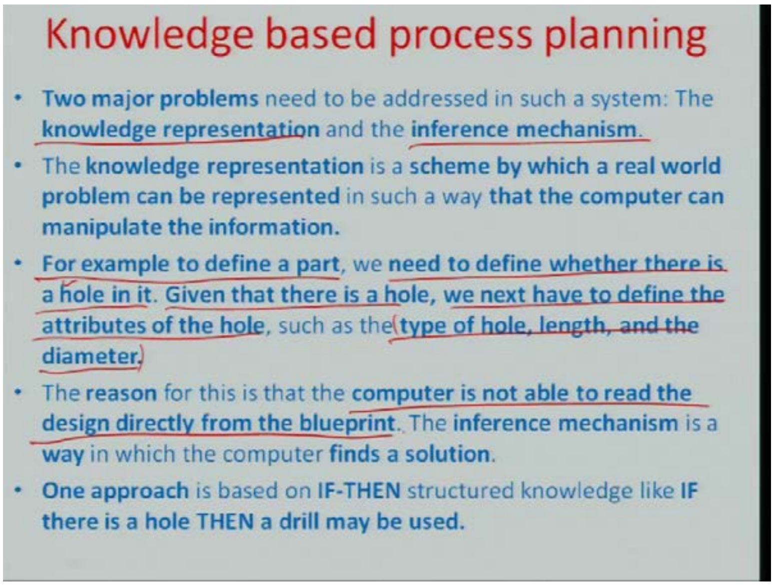


So, two major problems need to be addressed in such a system of planning, the first is of course, the organized way of representing the knowledge. So, how you can put the process knowledge in a form well, inference's can be drawn from such a knowledge. One of the inference drawing abilities was demonstrated in a problem example in a decision table, just about few slides back and the other one is the inference mechanism that how you basically arrive at the inference from such a knowledge representation.

So, any real world problem of course, can be used as some kind of a knowledge representation in an organized way and; obviously, there has to be a logic involved when there is a decision making which is automated, which has to be taken by a computer algorithm deserves the human intelligence. So, here it is basically all based on a quantitative comparison, where rout a or rout b or rout c can be obeyed. So; obviously, a logical table or a decision table is the only way to go for it.

So, for example, to define a part, you know if you look at it logically we need to first define, whether there is a hole in it. Even that there is a hole, we next have to define the attributes of the hole, such as probably the type of the hole, the length of the hole, the aspect ratio, the diameters, so on and so forth. So, once you have identified that there is a hole in a particular part, all the aspects of the hole comes out as a logical sequence of a hole being present on the part.

The reason for this is, that computer is not able to read the design directly from the blue print and the inference mechanism needs to be identifying a particular placement of a particular object in a certain section and therefore, somehow this identification mechanism needs to be embedded within the CAPP or Computer Aided Process Planning, where you can probably look at a certain feature or a texture within a drawing, look at the data representation around that particular zone in that drawing and infer about such representation, quantitatively to signify some feature or some part.

Like in a case of a part, let say this is a part here which has a hole right in the center here. So, if you look at the coordinate map of this which comes from the CAD and we have in fact, extensively done that over the last few modules, there are going to be certain co ordinates which are associated with this system and around this, there is a certain change in the coordinate, because there is a depth and there is a cylindrical hole which is going inside.

So; obviously, you need to develop an algorithm and intelligent way of judging that, whenever there is such a change, it would signify that there is some kind of a cavity or a hole of some kind present there. So, therefore, the very important aspect and that comes into a cam processes, how to really identify a drawing and signify where exactly a certain feature needs to be machined or is already present in the particular CAD file and for this, we use a variety of approaches.

One of the approaches we are going to discuss here following this slides is the attributed adjacency graph approach, which is an intelligent algorithm to specify the location or position of such small features on a particular part drawing in question. So, the reason that the computer is not able to read or design directly from the blue print makes the process really challenging and much more difficult and the inference mechanism has to be, which finds either a quantitative or a logic based solution for such problems has to identification of what is what in a particular drawing.

So, and then the other approach is that you have if then kind of a structure, that if there is a hole then a drill may be used. So, therefore, now once we have identified that there is a hole and there is a place where the hole has been curbed in a particular drawing, the next question is that if that such a hole is there then you need to use a particular tooling. For example, in case of a hole it is a drill or in case of a thread, it may be a drill followed by a tab.

So, this if then sequence would now choose the particular process plan associated with machining that part in the particular system. So, that is how the knowledge based process planning approaches actually work.

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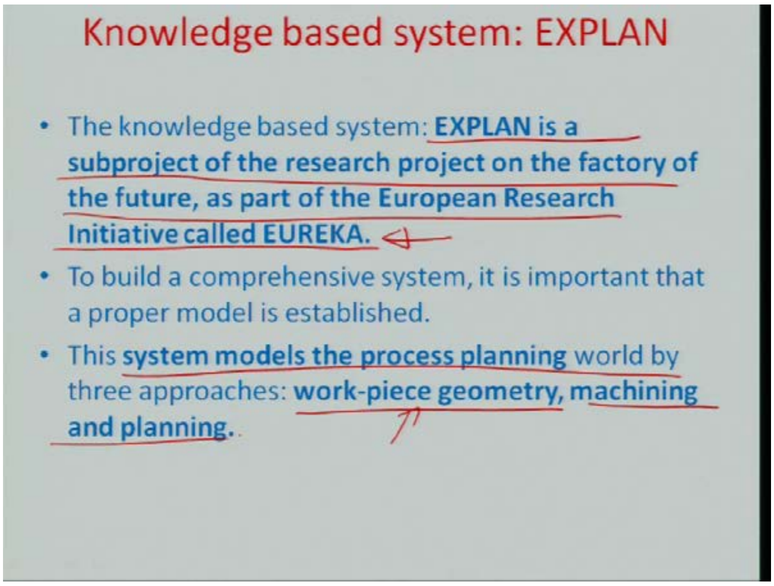


And you know just looking at some of the existing plans, one of the most widely used knowledge based plans or the EXPLAN, it is a sub project of the factory of future is the part of European research initiative called EUREKA and this is one of the most, you know visible I would say a computer related process planning, a knowledge based process planning systems being used process a lot of industries. And basically in this particular system, it models the process planning by three approaches; one is defining the work piece geometry and then, basically doing the machining and the sequence of the machining in a most logical way.

So, we are kind of towards the end of, what are the different planning approaches that can be used by using decision tables or logic tables or if then structures or again the part identification in a particular drawing approach. The question is, how you individually do these you know algorithmically, so that a computer is able to intelligently understand that issue we will revisit in our next module, where we want to identify a part mathematically based on some intelligent logic with dual around the at the particular part.

So, as of now we take home message for this module is that, there have been many variance of CAPP that you have understood. The first was a manual variant, then followed by the generative approach then; obviously, followed by the variant approach and then finally, the process knowledge based approach, which was actually some kind of planning and more a part of the generative approach.

But, then in that, you have seen that how you have arrived at a decision through a logical sequencing of the information, which is actually common place to a production process or more related to the personal knowledge concerned with those people, who are directly involved in a process. So, we close this lecture here with a note that, the next module will be totally dedicated to the part feature identification and the algorithm to do that in a intelligent manner. So, computer can understand, which is a part and which probably is not a part.

Thank you.