Manufacturing Systems Technology

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Module – 05
Lecture – 25

Hello and welcome to this Manufacturing Systems Technology module 25. Quick recap of what we did in the last lecture, we were actually trying to understand numerically how the minimum cost criteria and maximum production rate criteria per component could result in a set of you know estimates, regarding the cutting conditions, regarding the velocity, regarding the tool life, so on and so forth and that way we actually were able to arrive at the minimum cost per piece and the minimum time per piece corresponding to the maximum production rate model.

So, we today actually delve in to a little different area, where we are actually going to learn more about computer assisted process planning and how really the, what are the different approaches which are used in realizing the fully intelligent computer assisted process planning. So, whatever you have done here, so far has been components, independent components of a process plan or steps related to a process plan, some estimates have come, some values have come and you have recorded those and the methodology there in which is used.

Now, we have to together convert everything into a logical format with an algorithmic approach, where the interactions between the various members in the CAPP planning or the Computer Assisted Process planning would be enabled and then the idea is to generate a fully automatic process planning. So, there are many criteria and many decisions tables, there are many logical arguments which need to be scanned through for preparing such a plan, which we go to start today.

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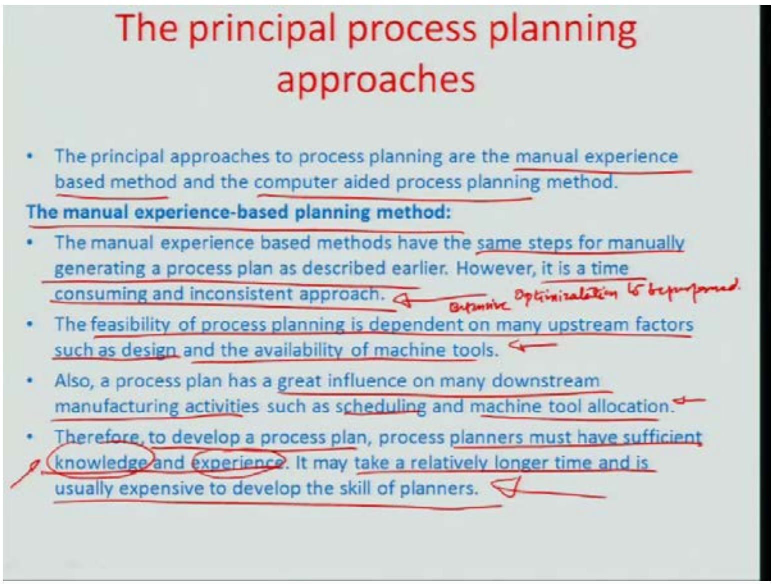

So, the principle process planning approaches which are things we have covered so far and also have learnt few things are the manual experience based method and the computer aided or assisted method. So, as we already have seen the manual experience based planning methods have sort of same steps for manually generating a process plan as described earlier. However, it is very, very time consuming and inconsistent approach, because every time you have to do optimization in the various parts, where related to building of the process plan.

So, I call it extensive optimization to be performed. So, the feasibility of process planning is really dependent on many upstream factors, such as design and the availability of the machine tools and it has a great influence on many downstream factors as well such as scheduling, let say all the manufacturing activities, machine tool allocation to a certain process so on and so forth. So, it is a central sort of it is a nerve center for all these activities, whether it is you know at the design phase or manufacturing phase or at even the costumer phase, everything is influenced in a way by the process planning.

So, therefore, to develop a process plan the planners must have sufficient knowledge and experience and you have to enable them to piggyback both the experience part and the knowledge part that they have from the manufacturing process to make a plan which is more realistic in nature. Obviously, it takes a relatively longer time and it is usually expensive to develop the skill of the planners and once this skill is developed, they are in a condition to sort of to do the planning, that time you identify them and ask them to generate a lot of data or lot of information regarding the various processes, manufacturing processes which are they are embedded in the system.

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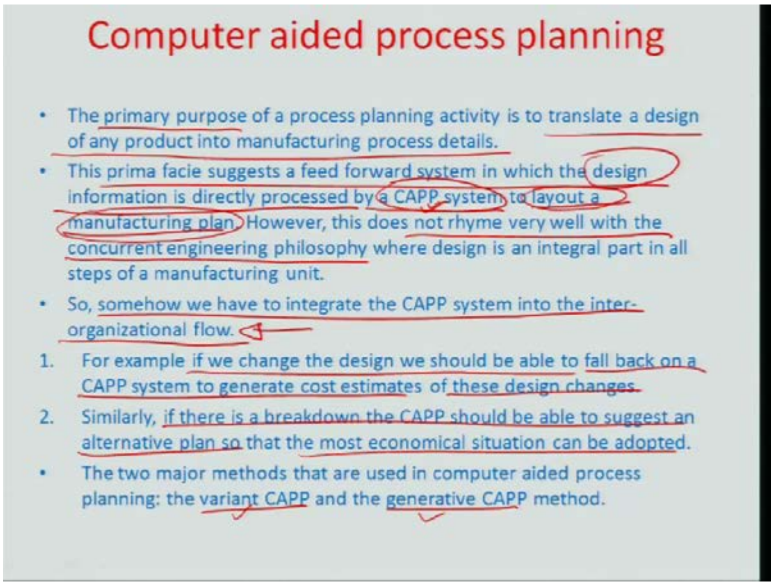

So, the computer aided process planning on the other hand is really having a primary purpose of a process planning activity, which is to translate a design of any to a manufacturing process detail. So, prima facie suggests a feed forward system, in which the design information is directly processed by a CAPP system and it is actually enabling the layout of a manufacturing plan. So, it is starting from the design and then you basically introducing this, you know CAPP systems, so the divine by the design, the CAPP system generates layout of the manufacturing plan etcetera.

Meaning there by that in a way the experience or the manual level recording of information that have been earlier carried out in the manual planning, which is really dependent on both the upstream as well as the downstream factors. And there is a lot of changeability in between is now getting more or less into a feed forward kind of a system.

So, once the design is ready, you have incorporated all the learning experiences in the design stage itself, so that there are hardly and variability's any more. So, from the design to manufacturing CAPP process to the plan of the actual manufacturing operations everything is like a forward feed. So, obviously, this does not rhyme very well with the concurrent engineering philosophy that we actually try to cover in the first few lectures, where we talked about the various interactions between the different wings of manufacturing system. So, that it becomes more customized or must customized in terms of it is output.

So, there that philosophy and this philosophy, because it is more design simple philosophy does not really rhyme very well. And somehow we have to integrate the CAPP system into the inter organizational flow. For example, let us say if we change the design we should be able to fall back on a CAPP system to generate cost estimates of these changes. So, that we can allow or disallow design change at a certain later process time or later part of the process, where the processes fully been established and maybe there is a need or definition of a need from the user, we changes some as per to the design of the particular product.

So, therefore you should be able to interact in a truly manner with a CAPP system. So, that every time there is a change in such a design etcetera, there should be estimating bases of whether this will be expensive to manufacture given the existing process, given all the infrastructure which has been laid out or not. So, if there is a break down the CAPP should be able to suggest an alternative plan. So, that the most economical situation can again get adopted and the CAPP system should be able to get back on track the whole manufacturing process in case of such a break down.

So, you know if we look at the various approaches which are followed for generating the CAPP processes, the two distinct approaches that come into picture are the variant approach and the generative approach of the CAPP. Variant of course, means that if you have an existing process plan and there is certain design change or certain modification to that plan can I generate the plus deltas everywhere along the manufacturing process to see on a criteria, on some criteria probably at time or a cost criteria, whether the new planning that comes out is really going to cost much of a difference in terms of these optimization criteria's.

So, that is the variant CAPP approach and the generative CAPP of course, is Abinitio generate the whole process plan based on some decision tables, logical formulations, etcetera, so that the whole plan can be newly laid out again as far as design change. So, the approach is really a modifying the existing as oppose to generating a new, you know that is the basic sub division or classification of both the process planning approaches.

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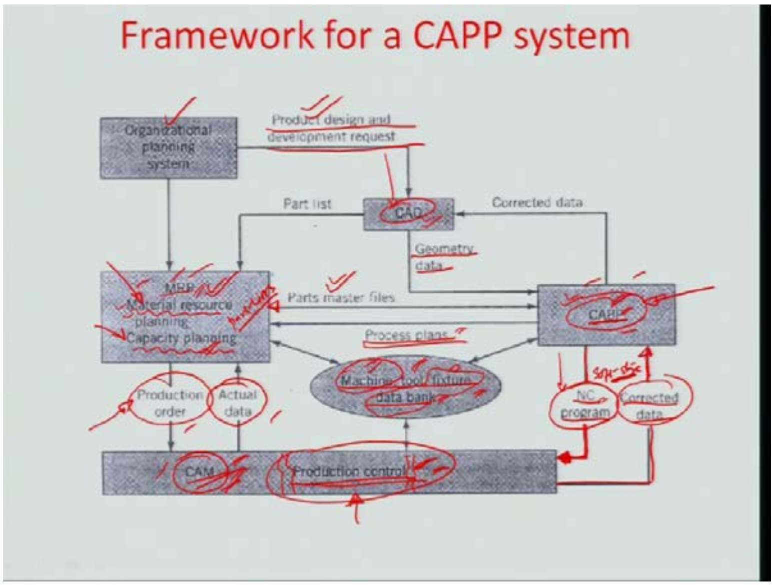

So, let us look now as a system how this process planning would actually try to work, let us actually focus to this particular slide here for example. So, in this logical flow analysis, you can see this is the CAPP system really, these are the almost of the geometric center of the now center of the particular organization everything is interconnected with the CAPP. And whatever may be the organizational planning system it gives the product design and development request to the particular, you know CAD wing or the computer aided designing wing of the organization which generates immediately almost geometry part, geometry data you know.

So, whenever there is a part requirement coming from the design section, the CAD first initiates the geometric data corresponding to that. I think we have already illustrated in great details, how this geometric data can be plotted and handled in the earlier sections. Once these geometric data comes to the CAPP, the process planning really starts and the CAPP starts creating the process plans. Now, there are several inputs that the CAPP would need for doing the process planning, one is that first of all it needs to know what material is there in the process.

So, supposing or the MRP of the Material Resource Planning wing there is some kind of a capacity planning which exist and there is a some kind of a part list which exists you know. So, those part lesson, part master files need to be translated back and forth between the CAPP and the MRP system. Because; obviously, when you try to incorporate a new design you would like to look at the part data base that you already have and design simply and assembly of such parts and some of the parts may be newly need to get created.

So, there is a regular interaction between the MRP and the CAPP here as your seen and master files have been translated back and forth between CAPP and MRP have another arrow in this direction actually pointing out to this translation process. And then from the CAPP you always generate process plans, runs it through again the material planning and capacity planning. So, here once the process plan is being generated, the capacity is a estimated and the planning of the material of the resources done by this MRP wing of the process and it gives a production order.

Now, this production order is actually given to the computer assisted manufacturing wing which I will just come in little bit you know when we talk about things like CNC programming or let say for example, in machined items we are just sending the order of the cad file which is needed to the machine reserves the one which there is already a part existing in the MRP system. So, those files needed to be separately run in to the computer manufacturing. So, that they formulate a coding scheme for the part to be manufactured on the NC machine or the Numerical Control machine.

So, there is some degree of production control here at this particular level. So, the production order actually goes to the CAM profile of the organization and the CAM; obviously, generates the actual data and there is a data exchange between the MRP and the CAM to just know what all need to be produced on the NC machine and what all are already available as full parts which can be some have integrated in to the assembly that we are trying to plan or the design that the process planning has given the process for.

So, now, the various interactions are there at every level with the CAPP or the MRP or the production as regards all the available machines, the tools, the fixture, the data bank because; obviously, when you are doing this planning process you need to know what machine with what process capability fits to what production situation or for example, what is the optimum tool life. For example, what are the fixture designs that you would like to know before certain designed part to be contain or there may be a data bank of fixture which you have and you just tried see and pick up the fixture that is needed for the particular part that the CAPP is going to generate a process plan fall.

So, that is the two way interaction between the CAPP and this particular data bank there is a two way interaction between this data bank and the MRP and also with the production control. So, this information as well as the MRP information is at more or less every part of the process including, the CAPP, the MRP as well as the CAM.

Obviously, what generates from the CAMM or again the corrected data of the NC program that has been initiated by the CAPP, the movement the CAPP has plan the process regarding what is the part geometry to be made ((Refer Time: 12:15)) what is the part which is locally available, the part geometry is are immediately converted into the NC programs and so there is some kind of a CAD to CAM interface at this particular level and this NC programs are suggested to the machining center. So, the production control centers all most immediately by the CAD system. So, that when the material comes in here, the machine should have already the list of NC programs which are needed to be used.

Obviously, in the CAM profile the validation of the NC program is a big issue, because right now it is a soft stage material, it is only a set of commands which you are sending from the CAPP to the CAM, but; obviously, when the command comes to the CAM center the question of you know processing the data identification of the zero errors, setting of the tool fixtures all these things in a NC machine to tailor and auto code tool the machine comes out very handy at this particular level.

So, therefore the NC program is validated, there is a path planning which is done. In fact, there are software which would these does do the tool path are the you know machining path planning and see whether NC code is validated to run on a machine and then if any corrections are needed the CAM system feeds forwarding to the CAPP system to correct the NC code and send the corrected version of the NC code. So, you can see here that actual process on the NC code generates from the CAPP system, CAM is nearly a validation far whatever codes have been generated by the CAPP a send in a correct data.

So, this the overall frame work or network which is utilized in a CAPP system. So, you have several wings, one is supposing there is a process design which has come up with the first of all you know it has to be laid out and parts the mentions and actual realistic you know part planning and then this part planning is send by the CAD to the CAPP with starts generating the process files after having inputs from the MRP as to what are the existing kind of a components which are there and what needs to be produce.

The produce components in automatically generate the NC program and center to the production control other camp wing with knowledge from the number of machines, the tools, the fixture data bank, etcetera and here is some of the things like process capability, etcetera ((Refer Time: 14:26)) you know on the CAPP system and then there is the interaction between MRP and CAM as per the actual production order in that actual data production. So, that automatically the MRP give some updating you know even the final products as well as the parts, which are there in the system and then there is re correction given by the CAM to CAPP center here which will keep on generating the modifications of the caps.

So, given this nerve center one approach can be to Abinitio make the plan another approach can be to just variate or provide a variation at the different you know part geometry local part geometry levels and see if there is on optimize condition gathered from this particular design. So, that there is a validation whether this process plan which would be needed to be variate because of a changing design is really optimum or not.

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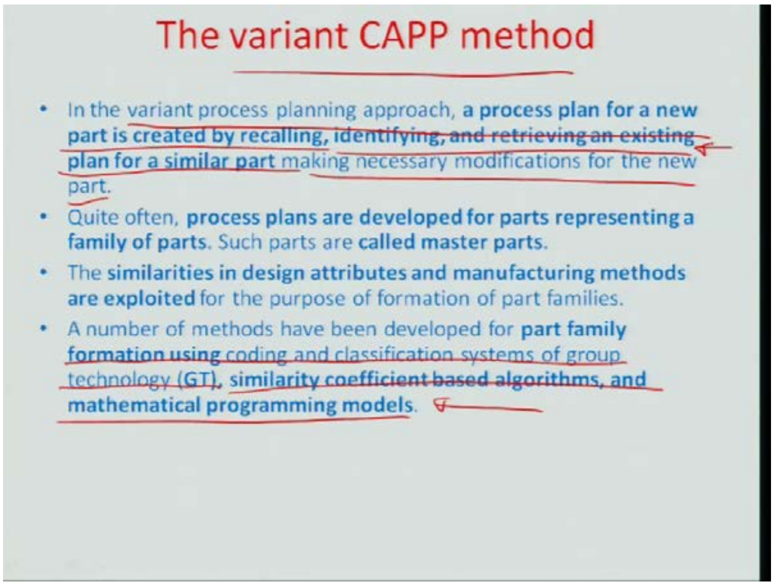

So, having said that let us look at the approaches in question. So, the first approach is I told as the variant CAPP method. So, in this process planning approach, a process plan for a new part is created by recalling identifying and retrieving and existing plan from a similar part making necessary modifications to the new part. So, supposing you are do make some kind of a soft and the soft design on drawing has been at some point of times suggested and recorded in the CAPP system.

So, you have to do some changes do the already existing CAPP process which is there by sort of creating in new part requirement on the bases of identifying and retrieving an older part geometry or a older CAPP plan which is already there for a similar part. So, this is some kind of a variant approach from the existing designer every stage. So, quite often the process plans are developed for parts representing a family of parts and you know there are other approaches like group technology, etcetera where the parts are grouped into different sections or sub sections.

And similarities in design attributes and manufacturing methods are exploited for the purpose of formation of the part families particularly by the CAPP system. Obviously, supposing we are considering the family of bolts or the family of nuts and we have made a layout were all these families are grouped as individual family, one family two something like that for a computer system to choose from now a locally identified group of bolts to create have another bolt would be a easier process rather than looking at the whole jumbled list of parts and trying to figure out which bolt is to be considered.

So, basically there is some kind of optimization in terms of processing speed which is covered in that particular case. So, the process plans are developed again and similarities in design attributes and manufacturing methods are also exploited sometimes technology can be basic functionality of the part it can also be on the basis of the kind of production process similarity which are there. So, there are criteria's for doing the various grouping.

So, in that case you know we can again further sub classify into a part which is having a certain functionality and is being done by a certain manufacturing process. So, number of methods have been developed for part family formulation using coding and classification systems of GT. And similarity coefficient based algorithms and mathematical programming models have also been develop to adders this variant CAPP method process or variant CAPP process.

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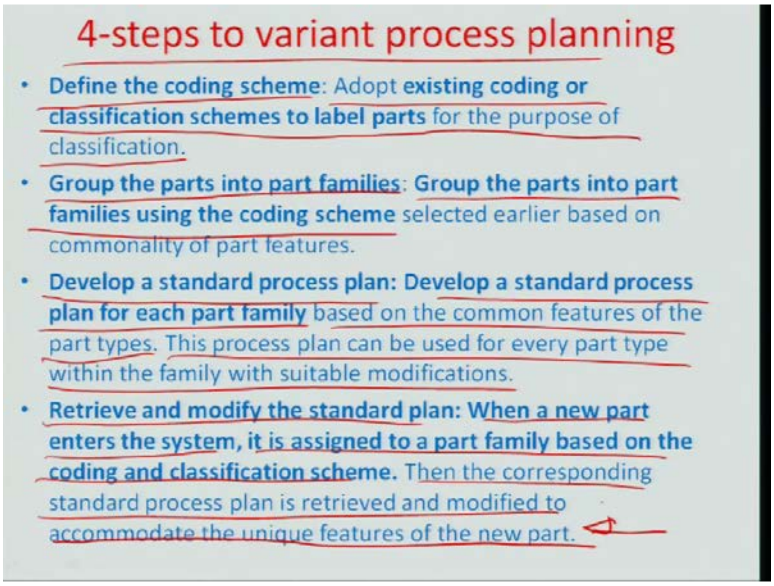

So if you look at the various steps for the process planning in the variant approach, you define the coding scheme. And so where you adopt and existing coding or classification scheme to label parts for the purpose of classification, group the parts into families, group the parts into part families using coding scheme selected earlier based on commonality of the part features, develop a standard process plan for each part family based on common features of the part types, the process plan can be use for every part type within the family, with suitable modifications.

Then finally, retrieve and modify the standard plan when a new part enters the system it is assigned to a part family first based on the coding and classification scheme then the corresponding standard process plan is retrieved and modified to accommodate the unique feature of the new part. So, these are the various process steps which are needed for understanding the variant process planning approach.

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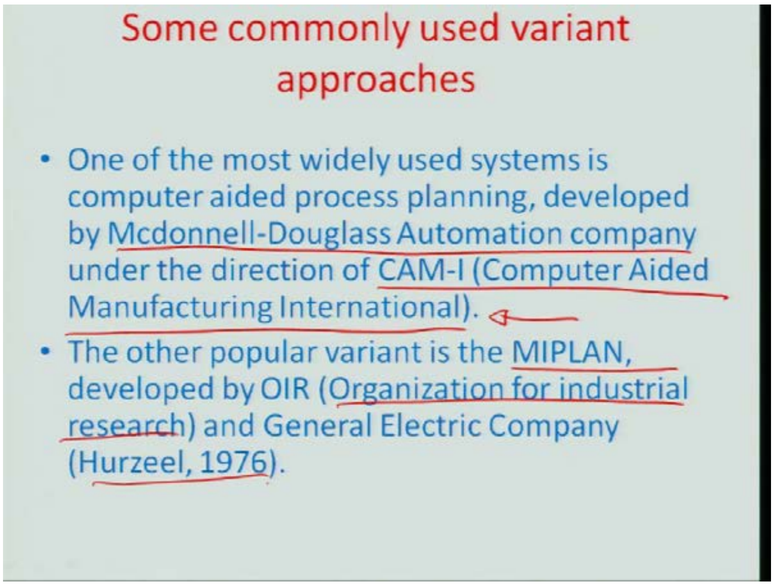

So, some of the commonly used variant approaches across the world or one of them is than been develop by this McDonnell Douglass automation company and this is under the direction of CAM-I which is you know set of standard computer aided manufacturing international organization. And the other popular is a MIPLAN which has been developed by the organization for industrial research and general electric company in 1976. So, these are some of the commonly used variant approaches. So, I am going stop here to go to the next topic, which is the generative approach which will cover in the subsequent module.

Thank you.