Manufacturing Systems Technology

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Module – 06

Lecture – 31

Hello and welcome to the Manufacturing Systems Technology module 31, a quick recap of what we were doing in the last module.

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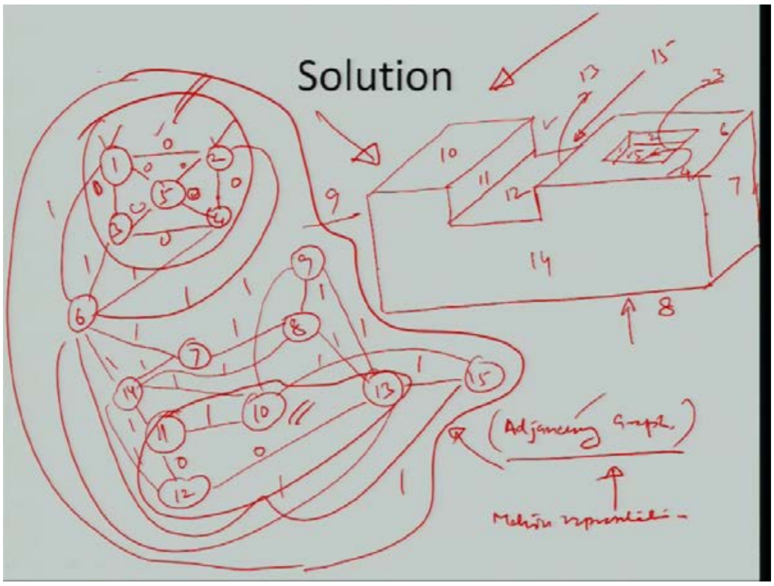

In the last section we were trying to actually kind of formulate the Attributed Adjacency Graph AAG. For this figure right here, as you can see here and for that we had drawn a graphical representation in this particular region. You can see, this whole was the graphical representation.

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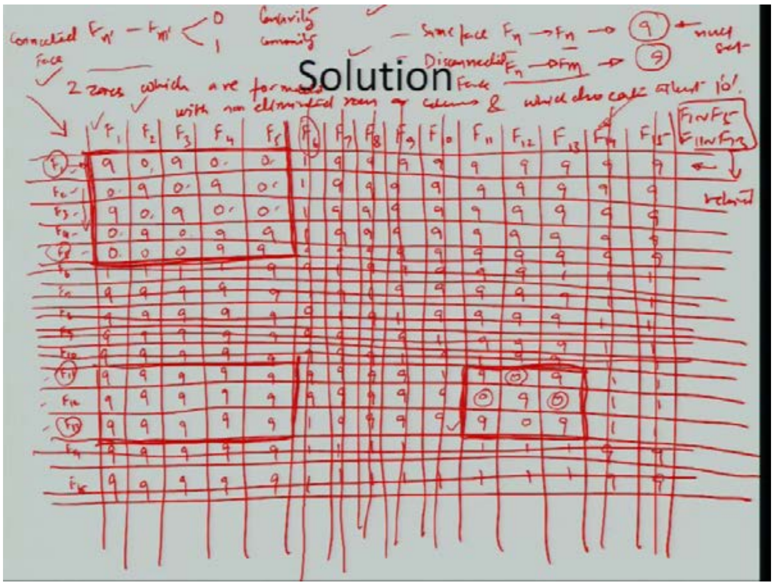

And, then we also tried to create a matrix which is more understandable for the computer, in which we actually processed by deleting all the rows and the columns which would contain the element 0, a non zero element. For example, any row which would contain 1 or 9 and not zero would be deleted and similarly, any row which would contain 1, 9 and not zero in the columnar manner also will be deleted.

So, this way we identified some three zones in the matrix if you may remember, which was talking about the different phases which should have some relationship, where there would be a feature. So, this was related to the feature identification problem, in which algorithmically the computer is able to judge where exactly the machining has to be carried out in the whole solid model, where a feature is actually in printed, so you are recognizing that.

So, that way what emerged is that, there were only the phrases F 1 to F 5 and F 11 to F 3, where there would be some utility or some means of having a feature. So, if we identify this back to the ((Refer Time: 01:47)) adjacency graph module, you can see that this 1 to 5 phases are actually in this particular zone and the other 11, 12, 13 three phases that they formulate something like this, you know in this particular zone. So, let us actually try to pin point these zones in a different manner together and see, how it happens.

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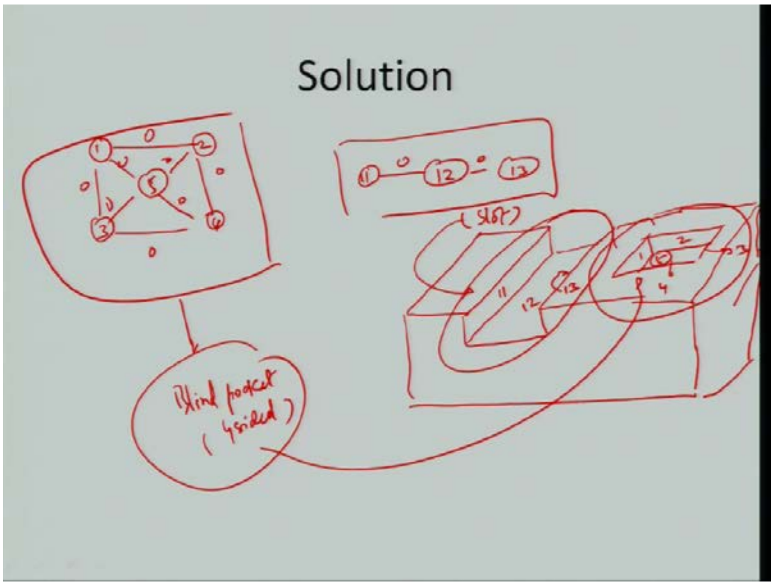

So, let us say the first is related to the phases 1 to 5 ((Refer Time: 02:19)), which were translated or which were written here as 1, 2, 3, 4 and 5 and all the relationships there in were 0 for the attributed arcs. So, let us actually draw that 1, 2, 3, 4 and there is a central phase and all the relationships here in correspond to 0. The other 11, 12, 13 would simply have a straight relationship here with 0’s on both ends, because both of them are sort of concave surfaces and what is emergent out of this whole matrix or what all these whole system, in that this particular architecture that you are seeing earlier, this was the architecture that you are earlier seeing earlier.

So, 11, 12 and 13 formulating this region and the phases 1, 2 and similarly a third phase right here 3, 2 and 5 formulating a region here are corresponding to probably, if you look at the data base done earlier are corresponding to probably a blind pocket, which is four sided and a slot between 11, 12 and 13. Let us just look back and remember what we had done earlier in terms of the feature identification, you know database.

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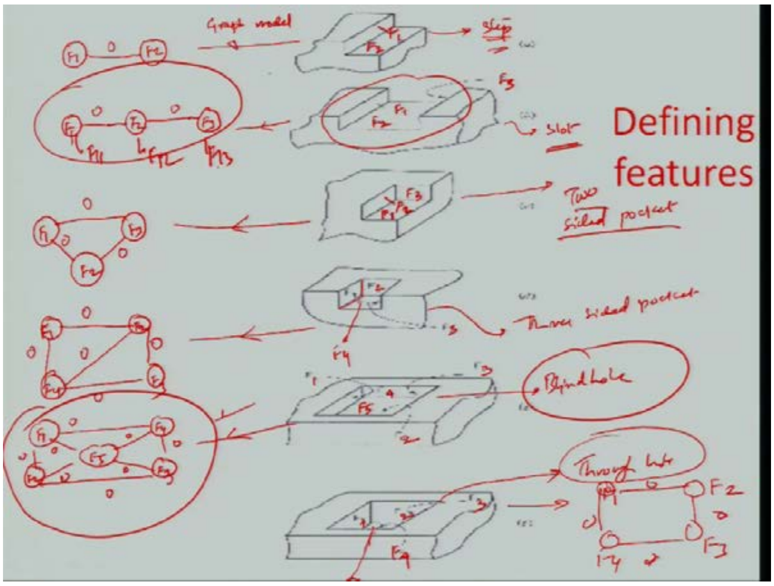

If you may look at this particular slide, you will find out that if there is a blind whole which is actually in a place or may be a blind pocket with four sides, it can be represented in this form, where there is a zero relationship between all the different phases in similar to what we had in our F 1 to F 5. And if there is a slot here for example, this is a slot, it is a completely linear relationship F 1 to F 2 and F 2 to F 3 all 0. So, this corresponds to our F 11, F 12, F 13 combination in our particular figuring question.

So, automatically there is a understanding generated in the computer that, there would be a slot over this region of the figure from this algorithm and there would be a blind pocket over this region of the figure from the algorithm. So, now, the most important problem has been solved that, if there is a feature in a solid module can I quickly able to sort of a certain, whether there is a feature presence in a certain zone of the particular solid module.

Now, question is you know there are many other ways of topologically mapping, but this happens to be the computationally more inexpensive and more rapid formulation of identification. For example, if I want to just make a simple topology difference, that wherever from a block, let us say you have cut out this piece. So, the block negative you can say of this whole piece from which this sample has been derived, if you compare topologically in terms of coordinate data; obviously, you will have differences in terms of the slot of the blind pocket in the final form from the block.

But, that again becomes a computationally exhaustive problem, because this may be a regular shape, but when the shapes are two complex, then this becomes a real problem to identify. So, it is a another way of, you know very less amount of logical efforts be able to drive out, that which are the features which need to be machine on a solid module. Once you have that in place, then the question is that how now the computer would instruct a particular machine to do this feature enabling on the surface of a block, which otherwise is the raw work piece material for the machining centre and for that, we need to go into a very, very different zone which is known as the computer numeric control of machining.

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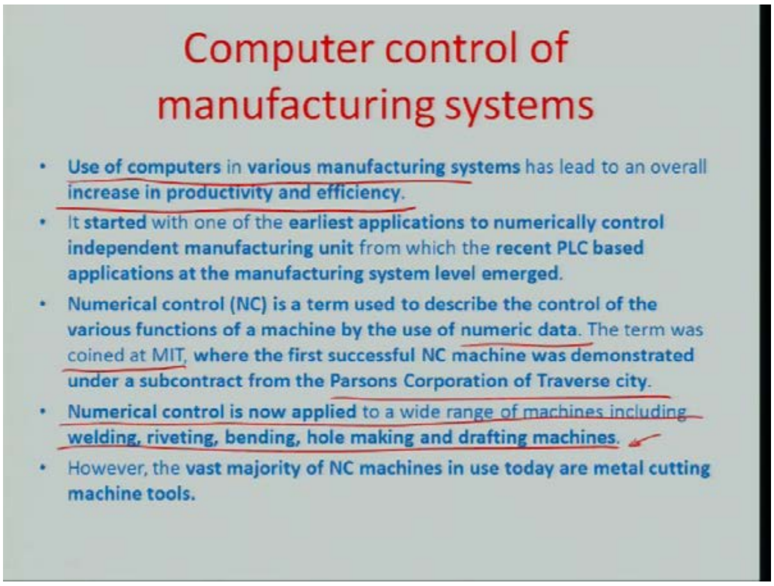

So, let us actually look at some of these computer controls of different manufacturing systems and how it has emerged over the years. So, if you look at this use of computers into various manufacturing systems, over all there has been definitely an advantage given to the manufacturing organizations in terms of increase in productivity and efficiency of all the processes of the manufacturing processes and the systems. So; obviously the use of computers has been a great benefit to the manufacturing systems.

So, the earliest form of application of such a computer integrated manufacturing system can date to back to almost the 19, you know the end of the 1950's and it was around 1956 that the term NC or numeric data based control of a machine was termed was coined and that was done at MIT, where the first successful machine, NC machine was demonstrated and this was under the subcontract from the Parsons Corporation of Traverse city at that particular time, it was a difference initiative.

So, this was one of the first demonstrations that how a set of numbers can be used to control by giving a pulsating signal to some stepper motors, which would otherwise be able to perform relative motion between the tool and the work piece. In any event, any kind of machining activity is about controlling that relative motion and if it is numerically controlled or numerically defined, it becomes an automated process, where you can identify your drawing or a structure or a sub structure in terms of coordinate data, which is now emanated under the various regimes, you studied earlier as CAD and CAPP.

And you can actually successfully now implement that in terms of machining certain zones and creating certain topologies in that particular zone and all of this is driven by complete numeric control. So, numeric control is now used or now applied to a wide range of machines and you can have numerically control machines, which can do welding, riveting, bending, hole making, drafting machines, so on and so forth. Lot of machines now exists with this capability of numerical control.

So, although if you look at really the history of how NC emerged and what is the maximum benefited area of numerical control, it has still by a large been the metal to metal machining.

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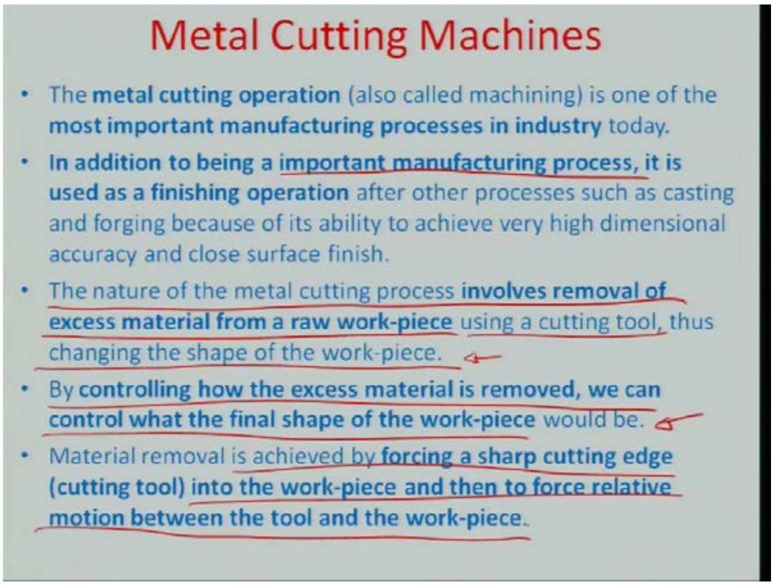

So, the metal cutting machine is by a large are the most widely used numerical control machines. So; obviously, if you look into metal cutting, it is really a very, very important manufacturing process. It is in fact, secondary manufacturing process, the primary being the once where the basic form of shape is given to material like for example, casting or forging, forming processes. So, machining actually comes a little bit later stage, because whenever you are wanting to take that basic shape and put it into an assembly, which otherwise formulates a part of a machine, which can give a power in power output, which can be assembled in power in power output system.

So, before going to that stage you need some kind of finishing or some kind of machining on the surface, so that it can have the requisite tolerance of the desired requirements for the relative motion, when it is in linkage or in a kind of a mechanism. So, metal cutting therefore, definitely is a stage which is evolved just after the primary manufacturing process stages and it is absolutely an important criteria for creating repeatability and creating ease of use of the components, which are primarily shaped by other processes to participate in assemblies of such items.

So, the nature of metal cutting process involves the removal of excess material from the raw work piece and typically, it is done by two things. One is the relative motion between the tool in the work piece, another is by ensuring that there is a certain continuous, you know motion with some kind of scribing action or something, at either a single point or at multiple points. So, that there is continuous metal removal by virtue of this scribing action.

So, you have the use of a cutting tool in such a process and you can change the shape of the work piece by moving the cutting tool in different parts around the work piece relatively. So, by controlling how the excess material is removed, we can control what the final shape of the work piece would be; obviously, you can have different machine parts or tool parts for creating all different shapes spheres, cylinders, so on and so forth and the material removal is achieved by forcing a shape cutting edge into the work piece, that is scribing and then to force relative motion between the tool and the work piece, automatically ensures that the material in the cutting zone goes to the ultimate yield strength and it starts to fail and this failure comes out as so called a continuous metal chip, which you can see to be the mainly the responsible factor for creating an impression of a certain shape governed by the path of the tool with respect to the work piece so on and so forth. So, that is how metal cutting happens.

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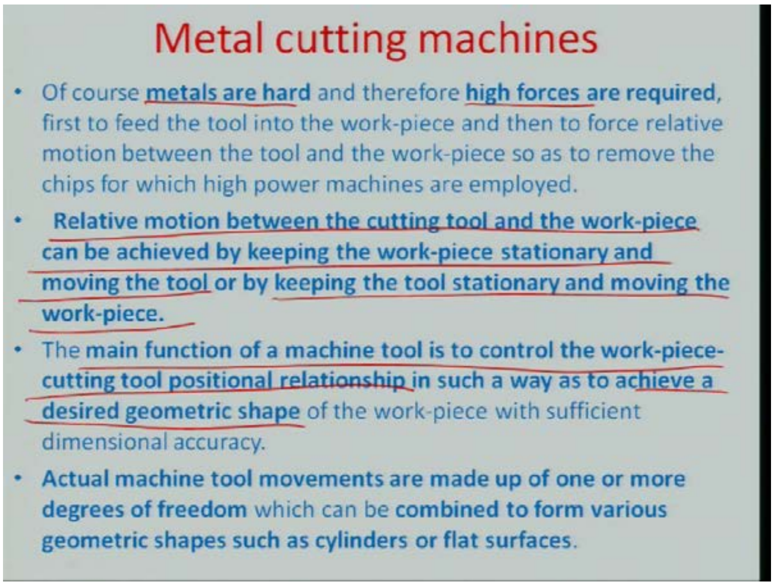

Obviously, because the metals are quite hard, the requirement therefore, of these tooling's are of high forces and high torques sometimes and this would ensure that, even if the metal is hard, relatively higher amount of force. So, that it goes to it is ultimate yield strength is achieved at the cutting tool surface or at the surface which is interacting of the cutting tool with respect to the work piece, which creates this situation you know where continuous emanation or removal of material starts to happen in terms of chip etcetera.

So, the relative motion between the cutting tool and the work piece can be achieved by keeping the work piece stationary and moving the tool or either by the visa versa that the tool stationary and moving the work piece. So, both ways you have one or the other form of machining. For example, if the cutting tool is one which is stationary and the work piece is moving, you can have something like a turning process where; obviously, you will have to give you a feed motion as well as, you know an axial as well as a radial feed, but once it has engaged to the surface, then for the time being you have to really rotate the work piece and unison. So, that there is a rotational symmetry which is generated and you can cut a cylinder or something like that.

Similarly, if you have a work piece stationary and move the tool, the situation that you can find in common place uses milling for example, where the tool is a rotating cutter and the work piece is again having a feed, but although at certain point of time, when the engagement of the pointed you know portion of the tool happens with the tool, it is considered to be a fixed work piece system. So, the main function of a machine tool is to control the work piece cutting tool positional relationships, so that you can achieve a desired geometric shape and; obviously, when you talking about such shapes and how to acquire such shapes, the question of geometry always starts evolving and by geometry you mean, mostly the numbers in terms of coordinate representations which you have studied all the way up till now in all the your CAD modules earlier.

So, that the geometry has to somehow in terms of a data be executed on to a controller, which then can intelligently order what has to be done in terms of the relative tool and work piece movement.

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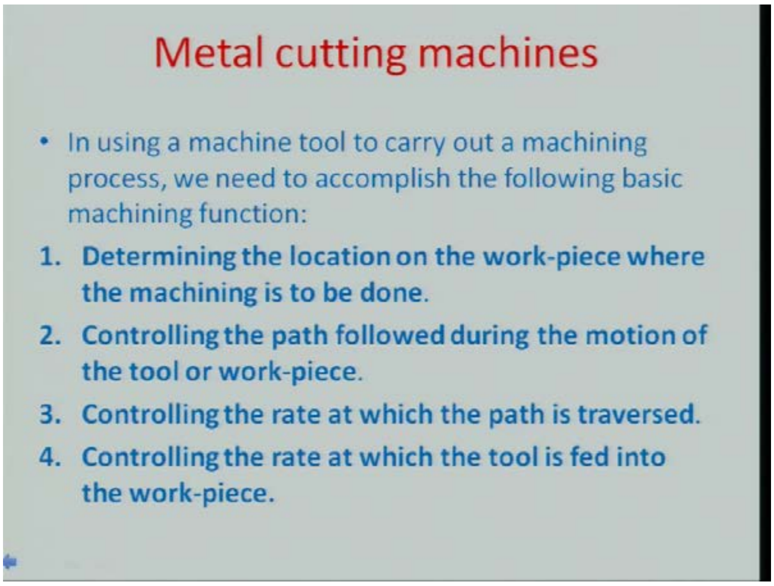

So, in using a machine tool to carry out a machining process, we need to accomplish therefore, the following basic functions. So, for example, you know you have to determine the location on the work piece where the machining needs to get started. You should also start controlling the path followed during the motion of the tool or the work piece. Then, you can control the rate at which this path is traversed and; obviously, the rate at which the tool is fed into the work piece. So, these in a nut shell would a combination of all these different parameters would ensure that metal to metal machining starts to happen.

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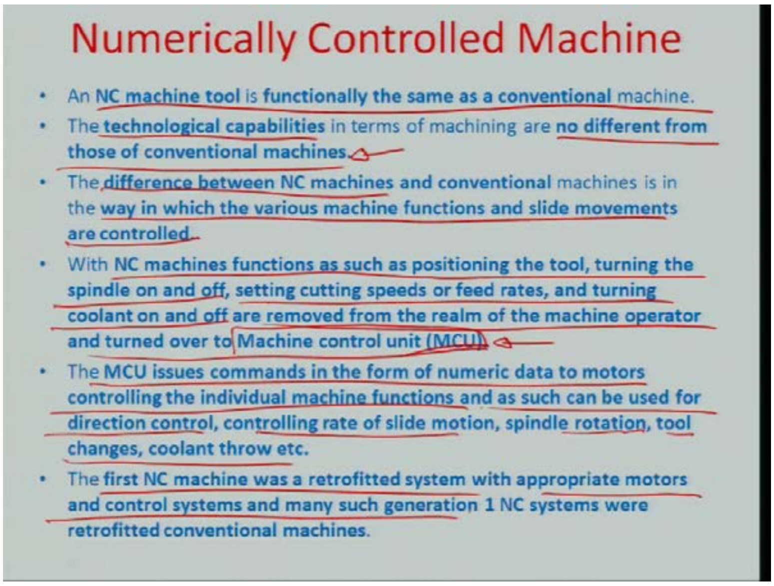

And; obviously, when you talk about numerical control, the numerical control has to be in terms of some voltage signals or pulses, which should be emanated on certain lead screws which are again mounted with feeding systems like motors, etcetera, where this relative motion now can be defined in terms of some numeric signals or voltage pulses rhyming with numeric signals and that is what you exactly mean by numerical control.

So, if you look at really a NC machine then, it is functionally the same as any conventional machine. Although the, you know if you look at really the technological capabilities apart from that controller and apart from that automated control, the technological capabilities are really not very different from a conventional lathe or milling machine which otherwise exist in any manual situation.

The only difference which this NC machine would therefore, have is in the way in which the various machine functions and slide movements are controlled and the NC machines functions such as positioning the tool, turning the spindle on and off, settings speeds or feed rates or turning coolant on and off are removed from the realm of the machine operator now and turned over to something called Machine Control Unit MCU, which is actually the controller for that particular machine.

So, the MCU now commands in forms of the numeric data to different motors controlling the individual machine functions and as such, it can be used for direction control, rate of slide motion, spindle rotation, tool changes, coolant throw all these different operations and it just comes in terms of yes no signal or a sort of an operation and then; obviously, you will have to develop an interface with that controller of a human system, so that at your ease you can now command the controller to do the job, which otherwise the direct manual operator was doing in a conventional machine.

So, the first NC machine was; obviously, a retrofitted system and which is appropriate motors and control systems and this was known as also the generation 1 NC system, which was developed at, might be the history was already been discussed earlier in this class. So, essentially the first NC machine started with a retrofitted conventional machine. So, you can think of it as no difference in the technological capability.

So, we are actually to the end of today's lecture, this module and the next module we will start learning a little more about, how the motions the relative motions of the tool work piece gets accumulated in the NC system and how that can be further be controlled by developing a suitable language of, where there is a manual to machine interface and simultaneously a machine to, a controller to machine interface which has been which ultimately get developed in this whole process.

Thank you.