Manufacturing Processes II
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Lecture No.22
Mounting of jobs and Cutting Tools in Machine Tools (Contd.)

Welcome again to our course Manufacturing Processes – II. We are running Module – 4:

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General Purpose Machine Tools and now is the fifth lecture under Module-4: Mounting of jobs that is workpiece or blanks and cutting tools in machine tools which are very important because the perfection or quality of manufacturing by machining is affected by properness or appropriateness of mounting of the tool and job. There are two parts part A and part B we have already completed part A. Now today I can cover part B.

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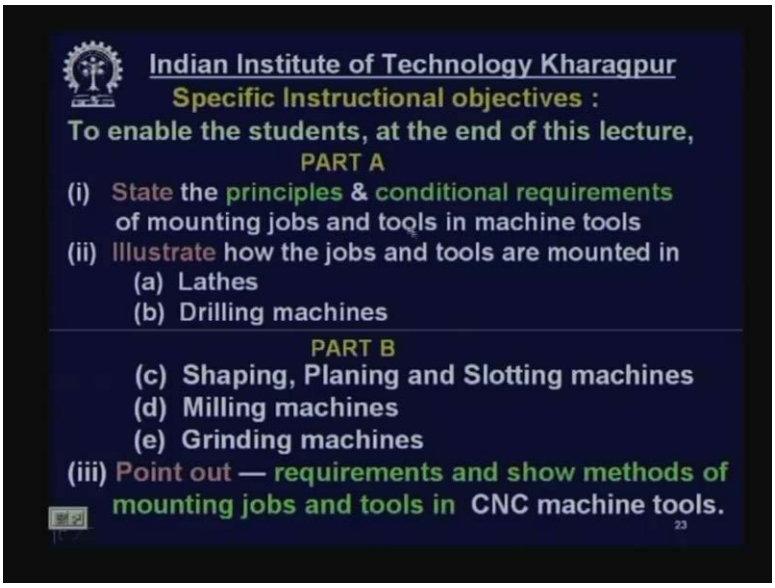

The overall Specific Instructional Objectives: the total content of the lecture part A and part B I remind you that State the principles and conditional requirements of mounting jobs and tools in machine tools. What should the principle and what should the requirements we fulfilled while mounting job and tool that has to be taken care of (ii) Illustrate in detail how the jobs and cutting tools are really mounted in different types of machine tools, conventional machine tools, general purpose like lathes, drilling machines, shaping planing and slotting machines, milling machine grinding machines and then point out requirements and show methods of mounting of jobs and tools in CNC machine tools because CNC machine tools is a special category of machine tool which are very precision flexibly automatic and these are the machine tools of future and present. So, special care should be taken about mounting tool and job of CNC machine tools. Now up to drilling machine we have completed in the part A. So today we shall start from the mounting of job and tool in shaping machine, planing machine, slotting machines and then milling machine, grinding machine and so on.

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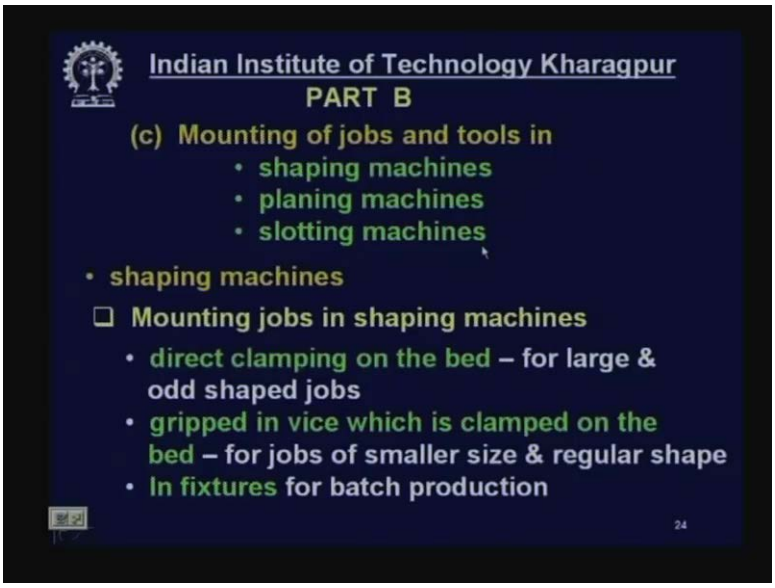

So this part B starts; Mounting of jobs and tools in the reciprocating machine tools may be shaping machines, planing machines, slotting machines, I remind you once again that these three machine tools are not very productive machine tools. They are cannot work at high speed or ate of production as well as the quality of product are also not that good except in planing machine which is really more productive compared to shaping and slotting but as such these three machines are not very productive. Shaping machine, slotting machines are used for piece production required for maintenance repair and so on even then there are certain methods of mounting job and tool in this machine tools.

Let us start from shaping machines. Mounting of jobs the method of mounting of jobs or work piece in shaping machines. There are three basic methods. This is a very this not a very machine so the mounting of tool and job are very simple. First direct clamping on the bed: So the work piece which is heavy may be odd shape will be directly mounted on the lathe bed which is horizontal okay with the help of clamps, T bolts, shoes or supports and then V blocks and so on. They are directly clamped, but if the jobs are small in size or irregular or regular size and shape then they can be easily mounted in the vice ordinary vice or swiving vice or universal vice which I described in my previous lecture and then the vice will clamped strongly on the lathe on the drilling machine bed. So second one as I said gripped in vice which is clamped on the bed. These are applicable for jobs of smaller size and regular geometrical shape. Another case for batch production, sometime the jobs are repeatedly you know loaded, unloaded, same job same size and shape of job is repeatedly loaded on the machine for machining. In that case, a special fixture will be better and more economically justified.

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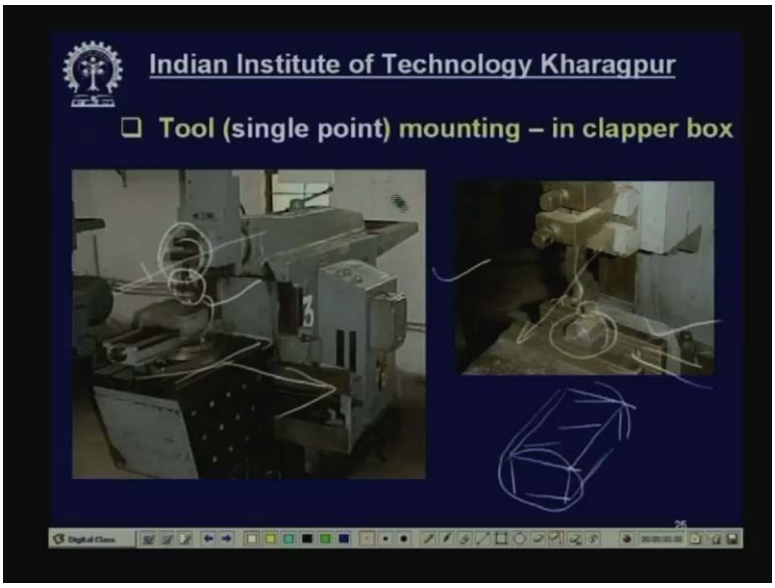

Say start from say tool mounting in clapper box. Now you have seen I have told you that how the jobs are mounted in shaping machine. Now this is a shaping machine all right. This is the shaping machine and were this is the cutting tool which is mounted in the clapper box and this is the work piece. Now see in this diagram enlarged view. This is the cutting tool and this is the work piece. This work piece suppose it is a cylindrical piece okay and you have to make a surface flat like this. This surface has to made flat and then you you may have to make a square shape like this so bounded by 4 parallel surfaces flat surfaces. Now you know the method the tool will reciprocate the job will move slowly in this direction or in that direction. So job here is a mounted in the vice. This vice is fitted on the the vice is fitted here this vice on the bed that this the shaping machine bed and that slides along the guide and the tool mounted on the clapper box which reciprocates along this. Now the tools those are used in shaping machine including even in a planing machine just single point. Single point means it has got only one cutting edge okay one cutting point not one cutting edge but one cutting point.

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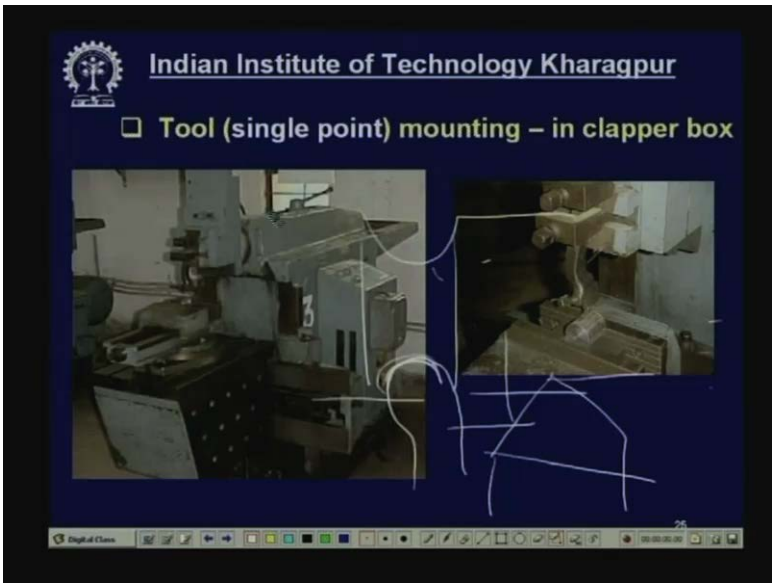

Say this is one cutting point for shaping tool. This has got single point tool and this can make flat surface like this or like turning and then sometime the tool can be with a now with a radius okay for producing form is called form tools. This can be produced in flat surface or like that okay. Now these tools those are used in shaping machines are single point single point and this tool as I told already is mounted in the clapper box this is the tool.

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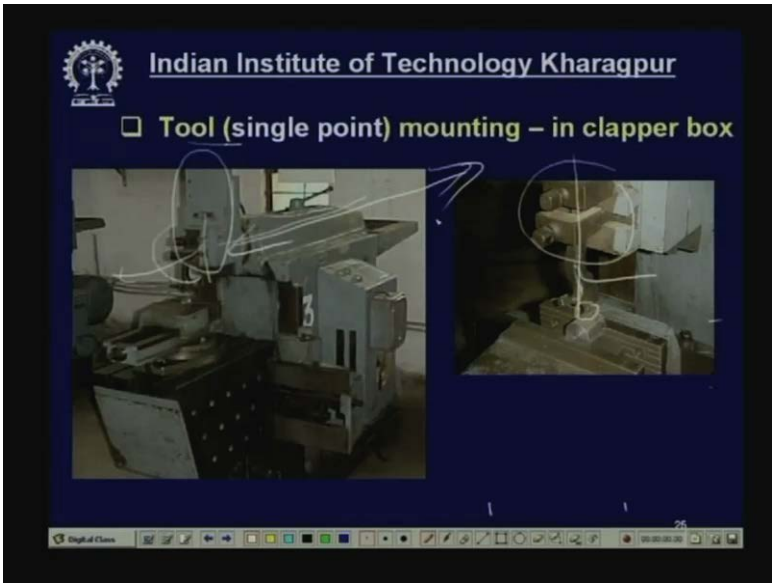

This is a small tool mounted in the tool holder this is the tool holder tool holder is mounted into the clapper box. This is the clapper box which can which will remain in position during the

forward stroke. In the return stroke, this will be lifted to avoid rubbing and this is mounted on the shaping head that is mounted on the cram and this ram reciprocates imparting cutting velocity. So this is how shaping machine work a tool and job are mounted.

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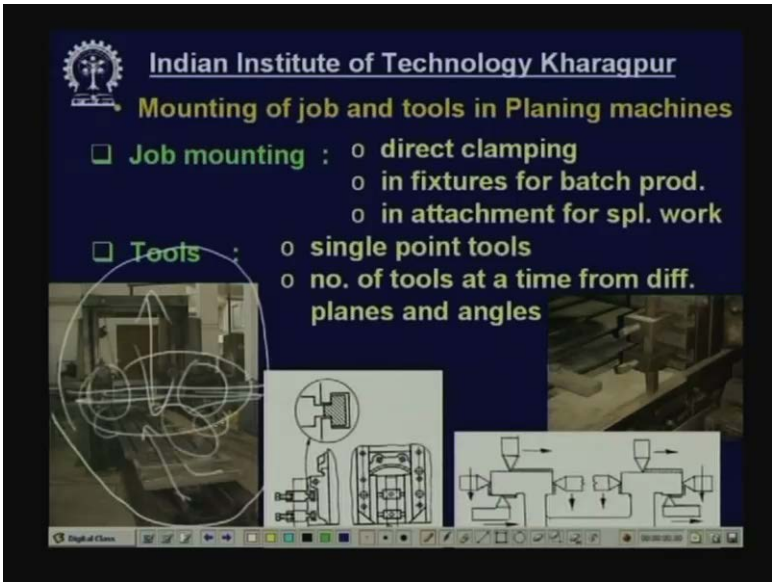

Now mounting of job and tools in planing machines: You remember that planing machines are much larger in size okay much more rigid and rugged compared to shaping machines and planing machines are used for large work piece and large and heavy work pieces were heavy depth of cut are given. So this is one this is one you see this is a planing machine. This is the table, this reciprocates unlike shaping machine and this is the job mounted on this table. This is the cutting tool and they are may be number of cuttings there for tool holders or tools heads mounted on a rail and these heads can move radially and the entire rail can the entire rail can move up and down. So the cutting tools can move laterally as well as vertically and here number of cutting tools can be mounted unlike in shaping machine only one cutting tool is mounted. Now job mounting in planing machine. How? Direct clamping by direct clamping: As you see here, this is the plate like work piece which is clamped. Now this is the plate like work piece which is clamped here on the table and this is the cutting tool which is mounted to the clapper box and that is fitted in to the head tool head one tool head and this is another tool head.

So this is how the cutting tool this is the tool shank or tool holder this one and this is the clapper box and this is the T slots in which the T bolts are fitted and this is the front view of the cutting tool holder. Now in fixture for batch production. If we want same thing to be produced repeatedly, then one fixture can be the used were the job can be easily loaded supported and clamped. Now most of the tools in attachment for special work. Now sometimes a special work is done: what is let us say for example a special work.

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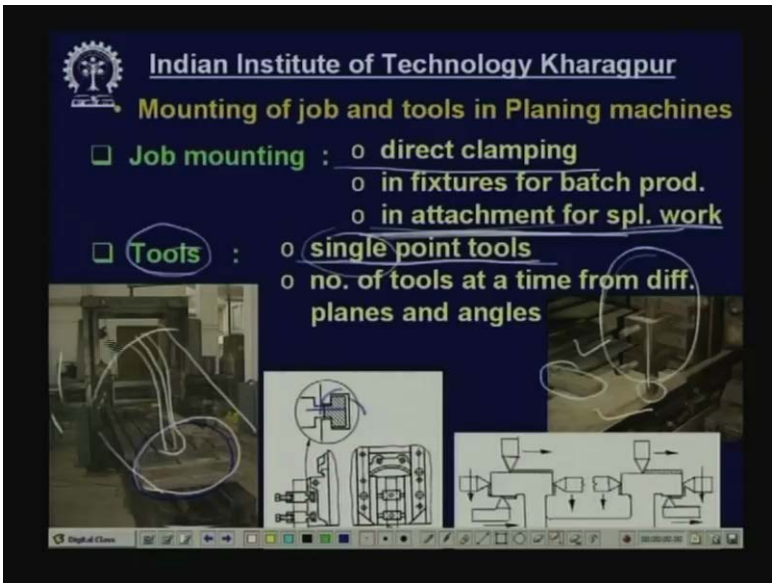

Say there is a rod large rod okay large rod here and in this rod a helical groove has to be cut helical groove has to be cut like this. Now this can be done by using a special attachment this was shown in my previous lectures that how such helical slot can be cut in a large job in a planing machine. For that the mounting will be done on an attachment may be centers and special attachments. Next comes the cutting tools, mounting of the cutting tools. Again you remember that in planing machine all the tools are single point tools may be straight form tool or cutting to simply surfacing tool single point tool. Now unlike shaping machine as I told you shaping machine. Only one tool can be mounted at a time, only one tool can be mounted at a time see this one. But in case of planing machines, number of tools on the rail, on this rail on this rail number of tool heads can be mounted okay and now this here you can see this is one example.

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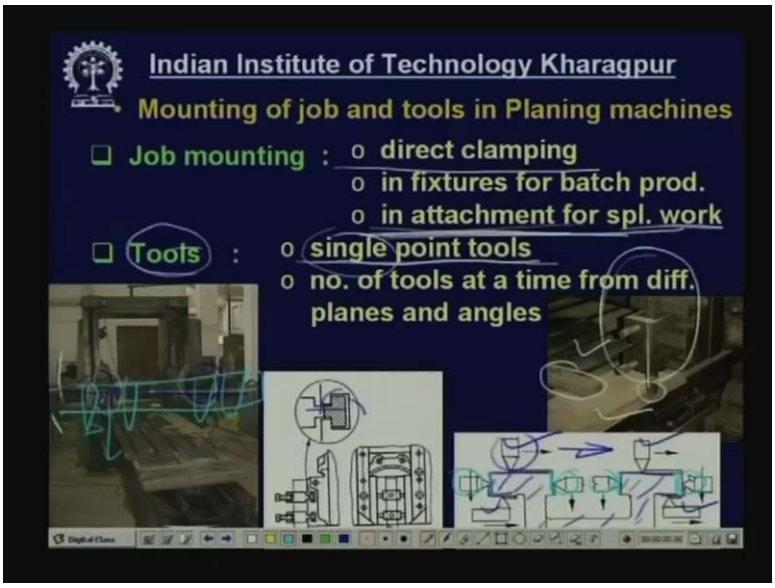

This is one work piece say lathe bed or a machine tool bed a planing machine bed okay this one. After casting this surfaces horizontal surface, this horizontal surface, this horizontal surface are to be perfectly machined and parallel and the vertical surfaces shown over here these are also to be machined. Now here you can see that this tool these 2 and these 2 at the bottom. All the 4 tools can move simultaneously in this direction. They will produce all the 4 surfaces simultaneously simultaneously. because the tools will be this tools will be mounted on the tool heads which will be mounted on the rail and then for the vertical surfaces say the vertical surfaces here four all the vertical surfaces will be produced simultaneously by these 4 tools and all the four tools will be mounted in a 4different clapper box and 4 different tool heads and all the tool heads will move they will be mounted here. Suppose the rail will this rail as a whole will be made to move downward and all the tools will work simultaneously. So this is how the tools are mounted in planing machines.

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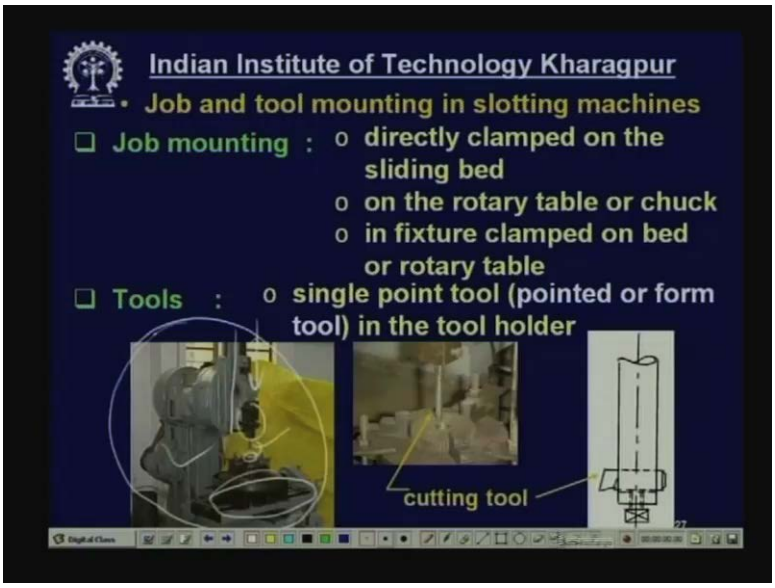

Now come to job and tools mounting in slotting machines. I remind you slotting machine is also a very resilient compliant, low productive, non automatic machine tool behaves just like a vertical shaper. The cutting tool reciprocates but it reciprocates vertically up and down okay and the job remains stationary on the table which may move either linearly or rotate slowly. Now this is the slotting machine. You remember that, this is the slotting machine. This is the slotting machine. This is the cutting tool holder, this is the cutting tool mounted in the tool head mounted in the ramp which moves up and down and the work piece is mounted on this table and this is the body of the machine. Now how the jobs are mounted and tools are mounted. Job mounting directly clamped on the sliding bed.

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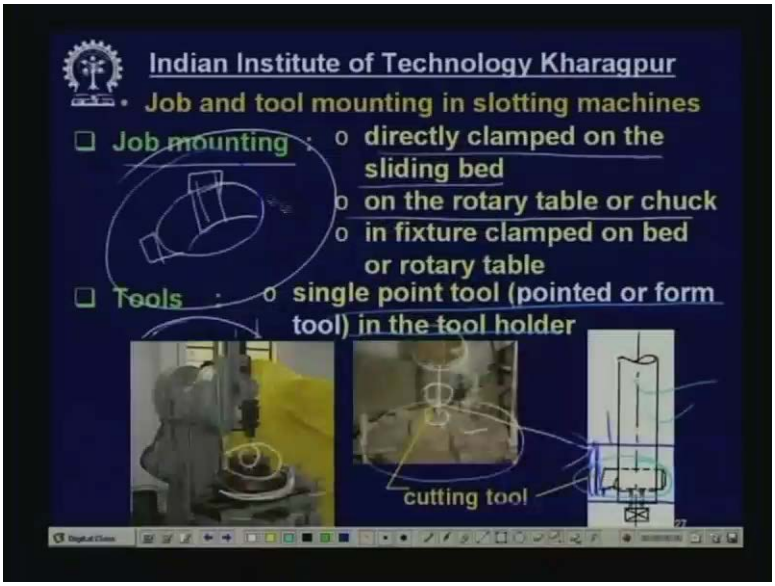

Now this bed this is the bed this bed can slide either in this direction or in this direction cross feed longitudinal feed cross feed. So if you put a job, then you can make cutting by this tool at different positions this is the one way. Second method the job can be mounted on the rotary table on the rotary table or chuck. Now this is a rotary table okay this is mounted on the bed. On the rotary table, a chuck is mounted. This is, you can see this is the chuck. This shows the chuck mounted on a rotary table. This rotary table can be manually or automatically slowly intermittently rotated and now this is the work piece say gear blank or a gear is mounted here and within the gear, within this gear there is a hole. So this is a hole, one T slot has to be cut like this or a T slot has to be cut like this here a groove, actually this is nothing but a groove. So the groove has to be cut by a cutting tool this is a cutting tool this is a tool holder mounted in to the tool head. Now this is another view. This is the tool holder, this is the tool holder this rod like, it can be bar like and this is the cutting tool.

This cutting tool cuts during the vertical stroke during the vertical down stroke say this is the work this is the workpiece this is the workpiece and there is a hole already and then a slot has to be cut. So when this moves downward, this cutting tool removes material like this and produces this slot here this slot. So now, in case of batch production a fixture can be clamped on the rotary bed were the small jobs repeated for repeated production or batch production will be easily and quickly located and supported and clamped and withdrawn and so on. Now the cutting tools again the cutting tools only single point cutting tools are used that can be ordinary or that can be form tool but these are all single point tools okay these are all single point tools. Now the single point tools are mounted in tool holder. This is the tool holder and this is the cutting tool. Now let us go to next.

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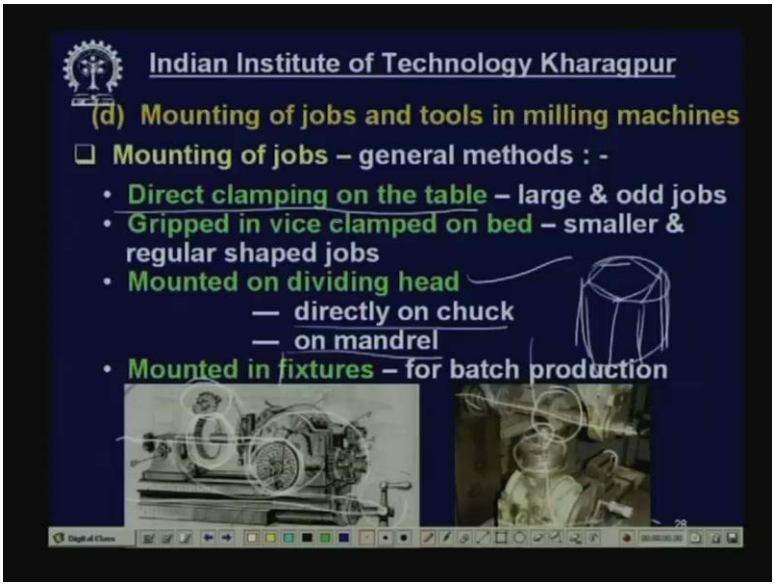

Mounting of job and tools in milling machines: Now milling machines are very versatile though general purpose but very very versatile machine tool and large number of and type of cutting tools of different type, different size, different shape, different geometry and sometime different

material are used for making various kinds of basically flat surface but formed surface can also be done and work like slitting slotting parting surfacing can be done. So here the method of mounting of the job and tool are very wide unlike shaping, planing and slotting. Now let us see one by one.

Mounting of jobs in milling machine, say general method. There will be always certain special methods. We are not discussing the special methods. We are discussing the general methods. Now first you see the direct clamping on the table. The machine the milling machine has got a large table. On the table, the job can be mounted directly especially when the job is little large in size, little odd shape and only one or two pieces have to be made then this is better to clamped on the machine by directly with the help of say clamps, then T bolts and supporting shoes and the similar other say V block or various things angle plates are required gripped in vice just like shaping machine and other the planing machines. If the job is smaller and a regular shape and to be produced a little large number then better you grip it in a vice the vice will remain fixed on the table and on the table in the vice you mount the job then mounted on diving head.

Now divided what is dividing head? You remember that this is one dividing head this is one dividing head it is not sorry this is the dividing head okay this is the dividing head what is the dividing head. This is the device where the input is operated manually or it can be coupled with this feed of automatic motion but some of this will be rotated slowly as a result on the output side at the face the chuck or the spindle will rotate slowly continuously or intermittently normally intermittently for indexing purpose all right. Now this is can be rotated at a definite angle at regular intervals and this axis spindle will also rotate accordingly. Now this head this face can be made horizontal axis or it can made vertical axis as you like. Now mounted on dividing head directly on chuck. Now here this is a dividing head. You put a chuck. This is the chuck, chuck is fitted at the face of the dividing head. The axis is kept vertical and this is the workpiece, a workpiece you can see that a workpiece, small work piece is mounted here. This is nothing but a rod is mounted and here the material has to be removed flat surface and then it has to be indexed and a hexagonal prism has to be made by this milling cutter all right.

So this is the milling cutter placed with the milling arbor, this cutting tool and this is the job which is mount into the vice as the chuck. Chuck is fitted into the indexing head with axis vertical. Now this can be used in another way also. As you can see here, in the dividing head the mandrel is mounted. On the mandrel, the job is mounted say gear to be cut a teeth of gear and this is the cutter. So when this job will move in this direction along with the table along with the table dividing etcetera, this milling cutter will rotate and produce this gap between the teeth of the gear. So one tooth gap is produced, then this will be indexed. After indexing, you cut another group, then we index again and so by indexing one after another the all the teeth of the profile will be made and this rotation indexing can be done manually or it can be coupled with this normally done manually with the help of say dividing head some whole plate and there are many other methods. This has been described in books.

This is on mandrel this is shown over here. Now sometime the job in milling machine is mounted in fixtures again I tell you that when there is a batch production or a small lot production of a small size piece repeatedly a number then taking the trouble of marking, fixing into the vice. Now these things or the plate better you design and develop a small fixture and put the job

easily, quickly into the fixture and you unload it. So the job can be done very quickly and repeatedly. So the fixture has to be used can be used in all machines for batch production.

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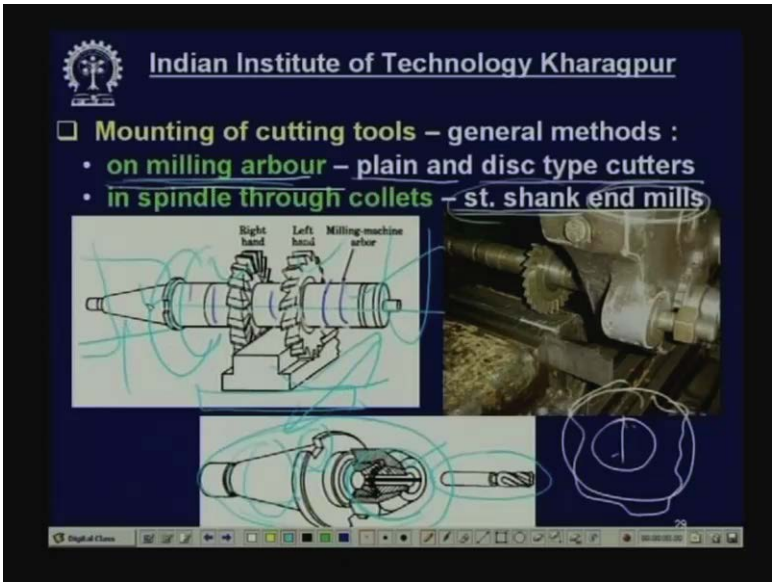

Next let us see mounting of cutting tools. So we have discussed about mounting of job. Now mounting of cutting tools in general purpose milling machines: Now what are the general methods on milling arbour? You know, the most common type of milling machine is knee type, horizontal arbor type, knee type milling machine and this is called arbor. This is the arbor okay and this is support and this is connected to a spindle in the ram and so on you remember and this rotate this mandrel rotates. On that cutting tool this is one cutting tool, this is another cutting tool and this is the workpiece which is mounted on the table all right along table. So the table moves in this direction and the job rotates along with mandrel. So you get this surface or slight surface is cut. Now come to the points on milling arbour. What are the categories? Here these cutters are mounted on cutters. What kind of cutters are mounted? Plain and disc type cutters which are hollow which have got certain hole or bore.

This is the bore. All these cutters will have a bore okay is a cutter with a bore and through that the mandrel will pass this mandrel. So on the mandrel, the job will be the cutter will be fitted like this and there will be collars. There will be a number of collars like this by which these tools will be positioned. Now in spindle through collets, now straight shank straight shank end mill cutters you know end mill cutters are really small size generally from say 1, 2 millimeter to up to say 30 millimeter. These may be straight shank or taper shank mostly straight shank like this. This is this is a cutter end mill cutter. This will be fitted into the collet this is a collet okay. So this is the outer surface which will be rotated. After fitting this one, the end will rotated and this will be tightly held in to the collet by rotating the cover and now the collet is mounted into a tool holder. This is called a rugged tool holder and it has got taper and this taper end shank will be a fitted into the spindle which has got a taper bore similar taper bore and this ends are used for locating or strong clamping and further this will be pulled end this side by a drover okay you know

drover. Now this example shown over here, this is the mandrel, this is the support and this is the milling cutter mounted on that on the arbor and this is the workpiece mounted on a vice and vice is fitted on to the table.

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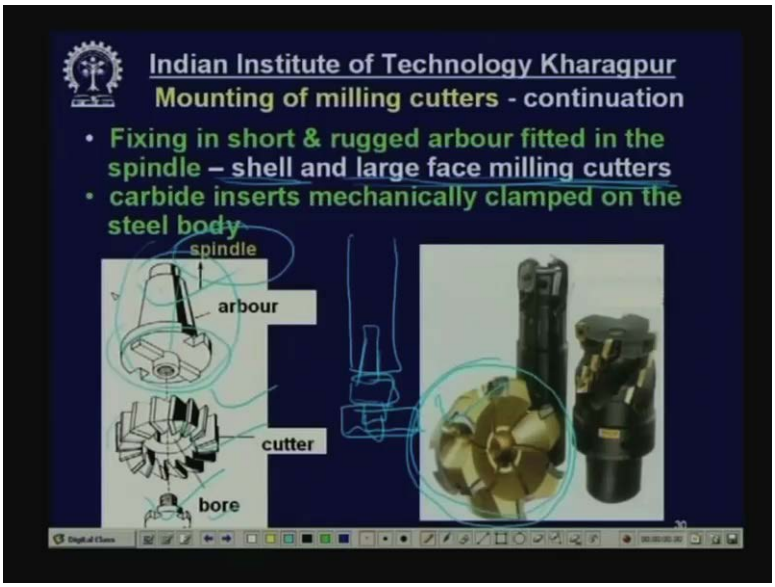

Other methods of mounting tools in milling machines, fixing in short and rugged arbour fitted in the spindle. Now these are spindle, suppose within the spindle this one, suppose this is a spindle. In this, this is a taper bore in to the taper bore, this arbour will be fitted into the arbour this cutting tool will be fitted this is a cutting tool and this will be clamped by a screw the screw. So how it is done? What kind of tool? Little bigger size shell milling cutters this is called shell milling cutter which is little bigger size may be say 40 millimeter to 100 millimeter even more and face milling cutters are very large and heavy. This can be you know from 80 millimeter up to 1000 millimeter. This is one example of face milling cutter, but this is very small with only 6 cutting edges okay but this can be as large as 1000 millimeter or one meter with around 60 cutting edges. Now this kind of cutting tools or shell mill cutters are mounted into the machine like this. So this will be fitted on the face of this rugged arbour then it will fixed by the screw and this will be fitted into the spindle. So this is how it is done. Next is now in milling machines now in milling cutters nowadays like other cutting tools, carbide inserts are used. Carbide inserts which are mechanically clamped on the steel body. Now this is one example

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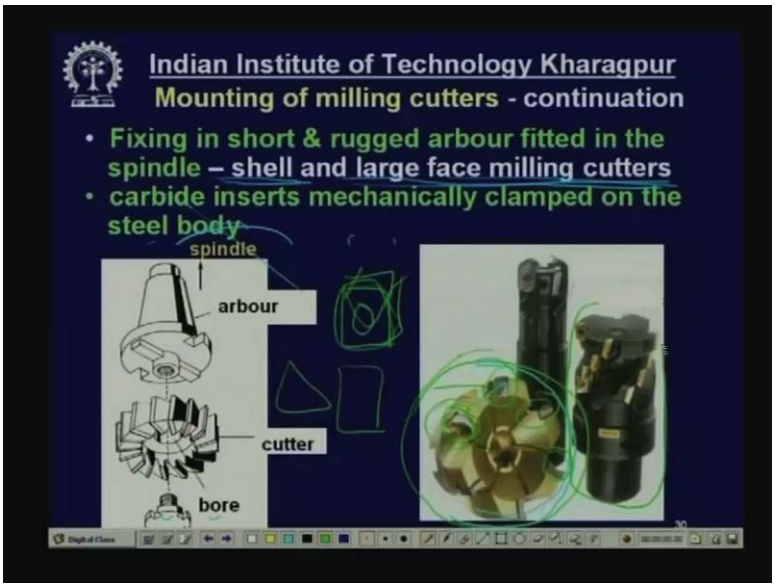

This is a face milling cutter as I told you face milling cutter and these are the inserts, milling inserts. These milling inserts can be square or can be rectangular or can be triangular. Normally in milling cutter, face milling cutter, this kind of cutting are used. This can be hollow or solid okay. These are very small size may be half inch square like that and this carbide inserts are mechanically clamped at different points when they are worn out, they are mechanically unclamped and new cutting inserts are placed in but they can be indexed time to time because it has got all the inserts have got 4 cutting edges after exhausting over 4 cutting edges they have to be replaced. Now this is one end mill cutter, large size end mill cutter. Here you can see with helical fluid, there are number of inserts are mounted in small size, end mill cutters the inserts are mounted here. Three or four inserts in end mill cutters even one say insert can be fitted. Now this we have talked about milling machine but mind that nothing is exhaustive in such a short term, we are describing mainly the general purpose machine tool and the general methods of mounting tool and job.

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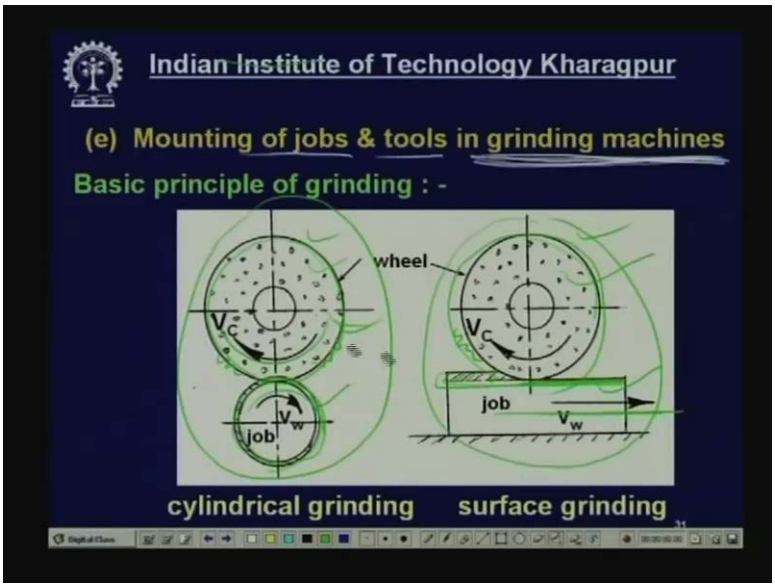

Now come to another important area of machining-grinding. Mounting of job and tools in grinding machine. Now remember grinding machines are special machines which are used for precision work for finishing purpose. So grinding process as such is a finishing process. How does it work and all the grinding cutting tools are wheels okay just disc like wheels like this and in this finishing process the tiny grids which function like small you know cutting edges they remove gradually the material from this surface of the job this is the one surface one job and say this is a job and this is the job and these are the wheels okay and then because of the interaction or relative movement between the tool and the job, the small grids abrasive grids which are projected like this projected like this.

They remove the material here from this side, from the periphery and then there are two categories. This is called cylindrical grinding and this is called surface grinding. Both of them are producing surface. This is producing cylindrical surface and this is producing flat finishing surface all right. But removing material by the fine tiny cutting edges in the form of grids which are dispersed or bonded in a material like vitrified bond or resin bond or rubber bond or may be as such metal bond okay and this wheel rotates the cutting tool which is always circular will rotate at high speed imparting the cutting velocity and the job will move slowly either rotation or translation. These are called feed motions so that, entire the surface comes into contact with the wheel. So this is the basic principle of grinding.

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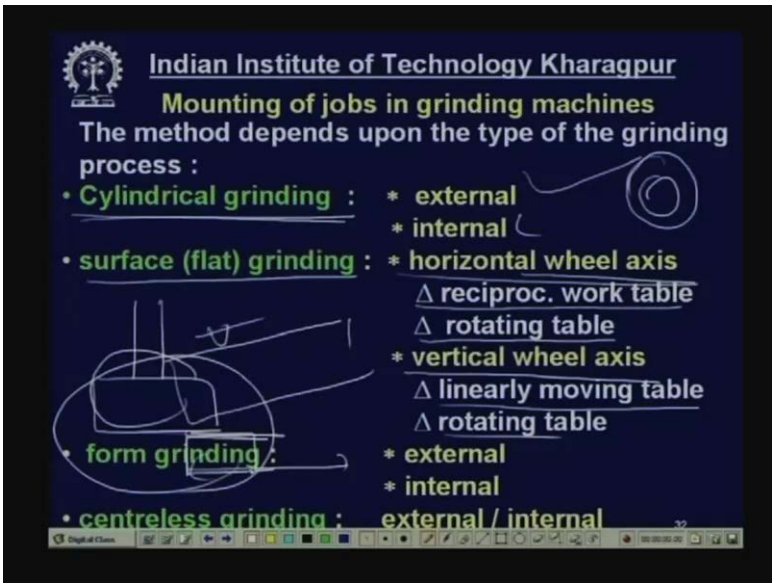

Now mounting of jobs in grinding machines; now as it is a precision machining used for high quality good dimensional accuracy and finish. So very very special care had to be taken all along in mounting the job and the cutting tool otherwise the quality will not be desirably well. Now the method of mounting the job and the tool largely depends upon what is the kind of the grinding process we are thinking of? Or what are the grinding machine tools we are considering? So first of all we must have thorough knowledge about what are the different grinding take system what are the different types of grinding machines and depending on that we have to decide and understand that how the tool and the job will be mounted in those different machine tools.

Now basically grinding machines and grinding process are categorized like this say cylindrical grinding. This produces cylindrical surfaces. Now cylindrical surfaces can be external like this or it can be internal like this internal surface. Surface grinding which produces flat surface area. Now this is the flat surface here. Now this flat surface can be produced in different machine tools in a different configuration. In one case, the grinding wheel axis remains horizontal. It remains horizontal. Wheel is mounted like this and the job is either reciprocated under the job under the tool or the job is mounted on the table which is rotated. Sometime the wheel axis is vertical and the wheel rotates. So this is the axis vertical shaft and this is the grinding wheel and you can put the job on the surface. So because of the rotation this surface will be machined. So vertical wheel axis but even then it is producing flat surface, linearly moving table when the table moves linearly or when the table rotates. Now similarly form grinding.

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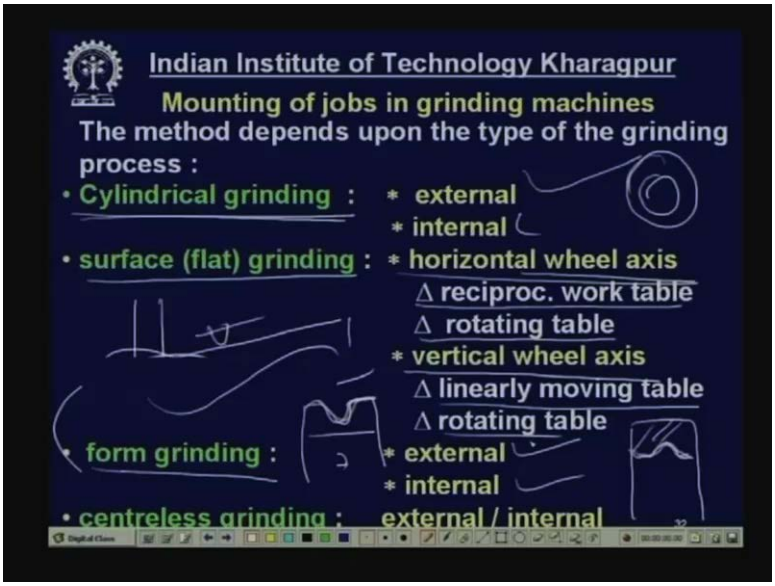

In form grinding, special form are produced 3 D or 2 D forms. This can be again external form, internal form. Say in a bearing, say this is the outer were this form has to be ground. This form is internal surface then if we want to produce say inner. So inner will have some surfaces like this. So this is external forming this is internal forming, this is external forming. Centre less grinding is another which is also external and internal this we describe later on and there is another which is called free form grinding which will be which you can learn also.

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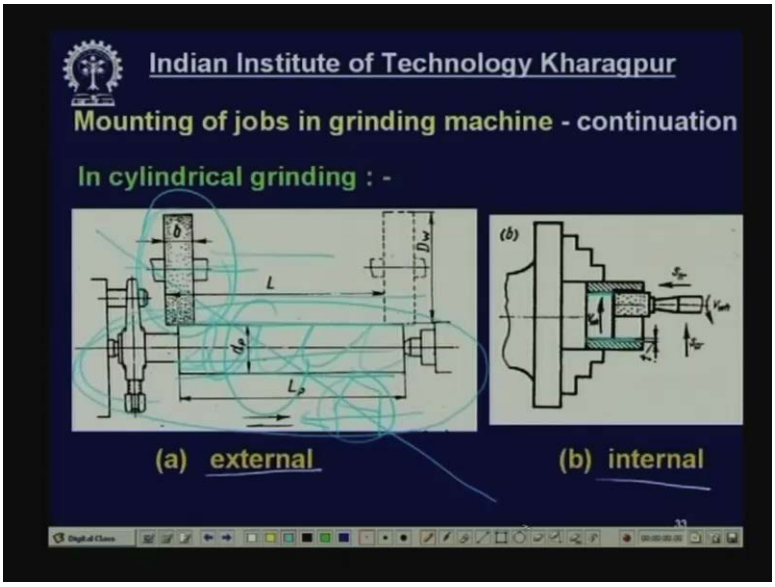

Now mounting of jobs in grinding machines and you have come across you have been aware of different types of grinding machines. So when we talk about mounting of job and tool we must keep in mind which kind of grinding process or machine tool we are considering. In cylindrical grinding so in cylindrical grinding machine which produces cylindrical surface. Again when it is a cylindrical it will be either external like this this is the external surface or internal. Now this is the external surface. External surface which have to be finished after turning or this can be internal the internal surface has to be finished. Now when we finish it the external cylindrical surface just like turning, when we do turning operation the tool is moved in this direction. Now this cutting tool is replaced by a grinding wheel which rotates about this axis and its wheel is made to move this is a mounted on a bed or this is not moved in this direction rather the bed on which the job is mounted that is moved in this direction. As a result this surface is complete. This comes in this direction and simultaneously this also rotates. So the entire surface is finished.

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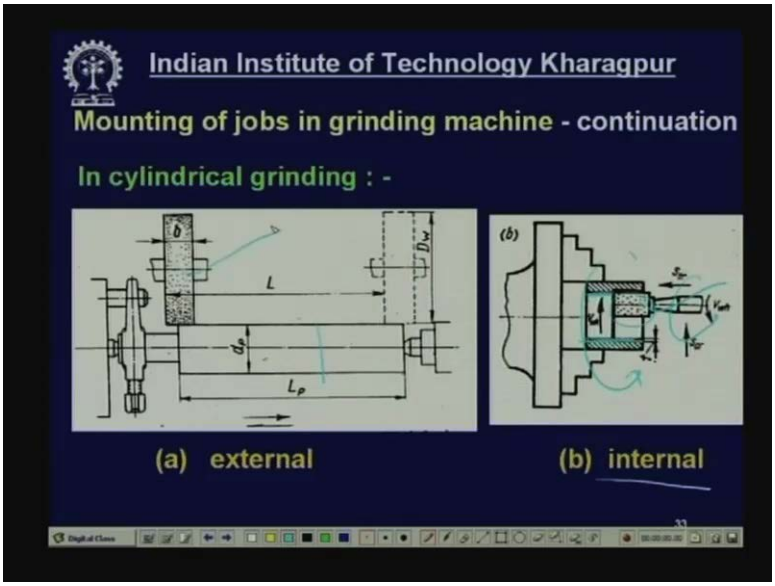

Now come to internal. This is a bush like where the hole has to be was made by casting or forging or extrusion or may be by pre machining but then finished to appropriate dimensional and surface finish by the grinding. So this is the grinding wheel which rotates at high speed and this is the job which also rotates. So job is also to rotate to get this finishing throughout the surface all right and here in internal grinding, the wheel is very small smaller than the whole but in external grinding whatever be the size of the job, the wheel is very large diameter is kept large to reduce chip load for grid. So this is cylindrical grinding.

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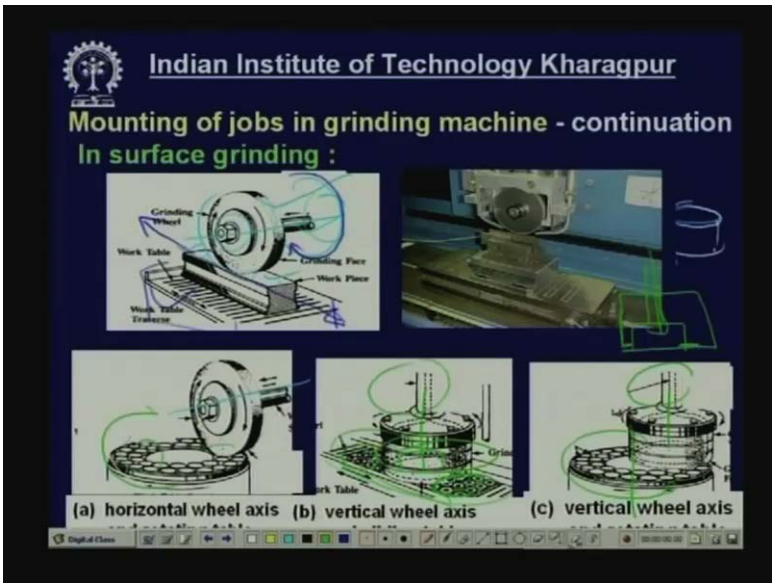

Mounting a job in surface grinding; now as I told you in surface grinding, we produce flat surfaces. This is the flat surface this surface is flat okay. Now this job this is a block where the surface this entire flat surface has to be finished. Now this is a grinding wheel which rotates about this axis. So this is the spindle. On the spindle this wheel is mounted and clamped. So it rotates at high speed, rotates at high speed and the job that is made to move in this direction gradually or it can reciprocate it which one to reciprocate along the surface. This job will be mounted on a magnetic vice, it is called magnetic vice. So when this will be energized put on all the magnetic action will be there and job will be held by magnetic force.

Here you can see one practical example. This is a German machine and this is the wheel say CBN wheel Cubic Boron Nitride mounted on the spindle mounted on the spindle and this is the workpiece which is mounted into the job holder that is mounted on the dynamometer which is mounted on to the magnetic chuck that is again mounted on the table which reciprocates. This is one method okay. Now here you can see that again when the wheel axis is horizontal rotate like this and you can produce lot of flat surfaces. See a small rod like pieces you have to make small rod like pieces.

So these blanks will be placed on this table here and this table will gradually rotate this gradually rotate and all the surfaces of all the jobs will be finished. So now in case of vertical axis, this is the vertical axis this also vertical axis. So this is the grinding wheel. Now this grinding wheel is slightly different. These grinding wheels are cup shaped are cup shaped. So this is the grinding surface okay and then this finishes. Suppose these are the bearings, faces of the bearings have to be finished. All these are mounted on the tray or directly onto the magnetic clutch sorry magnetic base bias and this will reciprocate slowly or move slowly and this will keep on rotating. So, all the jobs will be finished in batch. Here the the the this wheel is rotating and the jobs mounting on a table that is also rotating about another axis. So you get all the jobs finished. So these are the various methods of mounting jobs in grinding machines.

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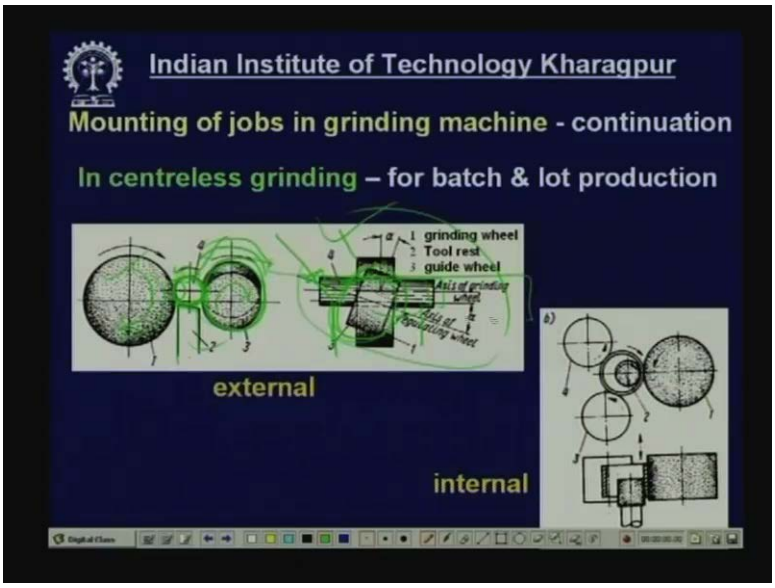

Centreless grinding: what is centerless grinding? Centerless grinding is a process where is a mass production method or lot product method where the job workpiece is not held in between the chuck or into the center. The job is just floating okay it is not held by centre this is not held in a chuck then how it is held? Suppose this is this is the rod job. Now this rod this rod is the workpiece and the cylindrical surface has to be finished by grinding. So this is the job which is more rest just put on a rest a plate okay. So it is resting now then there is a grinding wheel which rotates in this direction comes into contact and grinds and the job is rotated gradually by a guide wheel. It is the high friction made of hard rubber wheel which rotates about this axis. So when this rotates about this axis like this the job gradually or in this direction the job will rotate in this direction and all the surfaces throughout the surface grinding operation will be accomplished. So what is there? One rest on which the job will be simply dropped rod like job will be dropped.

The grinding wheel large grinding wheel will come into contact before that this will be guided by so the guide wheel and this wheel work together. So the guide wheel keep the job in position, make it rotate to bring all the surfaces towards the grinding wheel. Now this is the front view okay axial view. What is the side view? This is the rod which is mounted on a rest plate and this is the over one is there grinding wheel and this is the guide wheel. Why it is inclined? If you want the small rods are ground, then the width of the job is smaller then the width of the grinding wheel. So you simply drop it and the grinding wheel will be wider and this will finish. But if the rod is a long one, and this large rod and wheel is smaller, then the rod has to be fed axially in case of grinding say long rods may be 1 meter 2 meter long, then this rod this long rod has also to be fed continuously in this direction.

So throughout the length and periphery, this grinding is complete. For that, this guide wheel is kept little bit inclined. So when it rotates, the velocity vector will have an axial component and radial component. This tangential component makes the job rotate and its actual component makes the job move gradually along this axis. This is external cylindrical grinding. Now what about internal cylindrical grinding? This is a ring, this ring is the object. The inner the outer

surface the outer surface of this ring has to be finished all right or the inner surface has to be finished. So this is the guide wheel and this is the ring job. This is the guide and this is the grinding wheel in side and these are two guide rollers. Now these two rollers function as this stay or rest of the job which keep the ring in position and this is the guide wheel which makes this ring rotate and so this is making. Now in this case, this is the grinding wheel. This is the guide wheel which grinds the outer surface and this one this is the grinding wheel, this is the guide wheel and this makes finishes the inner surface of the job.

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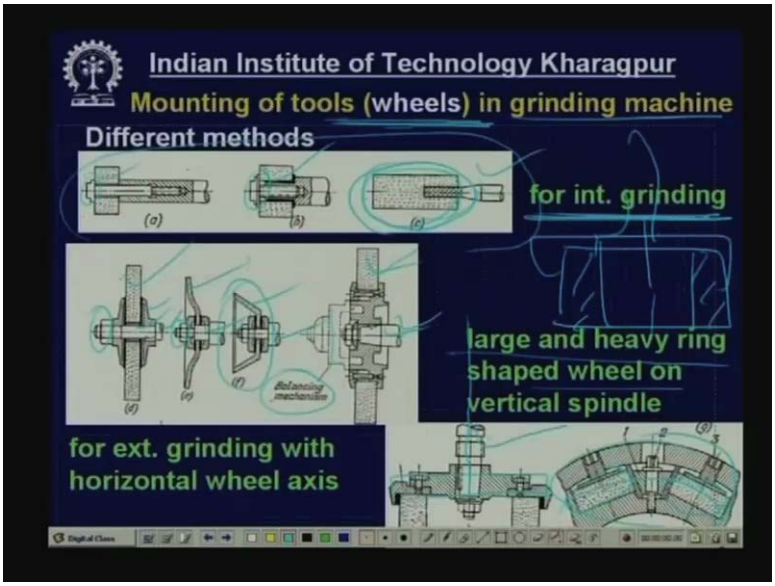

Now mounting of wheels; you have heard so for mounting of jobs in grinding machines, now mounting of wheels. Now wheels are nothing but the cutting tools in grinding machines. Only one type of only one cutting tool is mounted one that is called wheel and what is a wheel? Wheel is a disc like or a cup shaped and it will be definitely axis symmetrical or circular type which will be which will have a central hole and through that a spindle will pass and this will be fitted. So all the grinding wheels are circular, either disc shape or ring shape or cup shape as shown over here a rod like. Now the different methods of mounting the grinding wheels in spindle; These are the spindles of grinding machine. Now again you remember that the spindle of grinding machine rotates at very high speed may be 2000 to 6000 may be more up to 40000 RPM even more in high production machining. On the spindle this grinding machine has to be fitted these are the grinding wheels.

Now this is internal grinding process for internal grinding. As I told you that internal grinding process the size of the wheel diameter of the wheel should be smaller than the diameter of the bore to be finished. So usually the diameter of the wheel is very small in internal grinding. These are fitted on this spindle in this fashion like this. These are the various methods. These by clamping, this is also clamping and this is an embedding okay just by casting together for external grinding with horizontal wheel axis. This is the spindle these are the spindles all the spindles are horizontal axis and these are the wheels grinding wheels which are mounted. Here

you can see the disc type wheel which is this is the spindle on this side and here it is fitted by two plates and finally clamped by a nut these are the clamping nut. This is called cup shaped wheel this is another large disc shape which is mounted on this spindle by the system and here is an extra plate for balancing purpose. Now large and heavy ring shaped wheel; so this is one, this is the axis of the spindle and this is the spindle and this is the wheel holder and this is the wheel. So this wheel looks like a ring like this. This is the wheel and this will be cup and this will be fitted into this spindle shown and this is called segmented so large that grinding segments are fitted into the throughout the periphery at the face.

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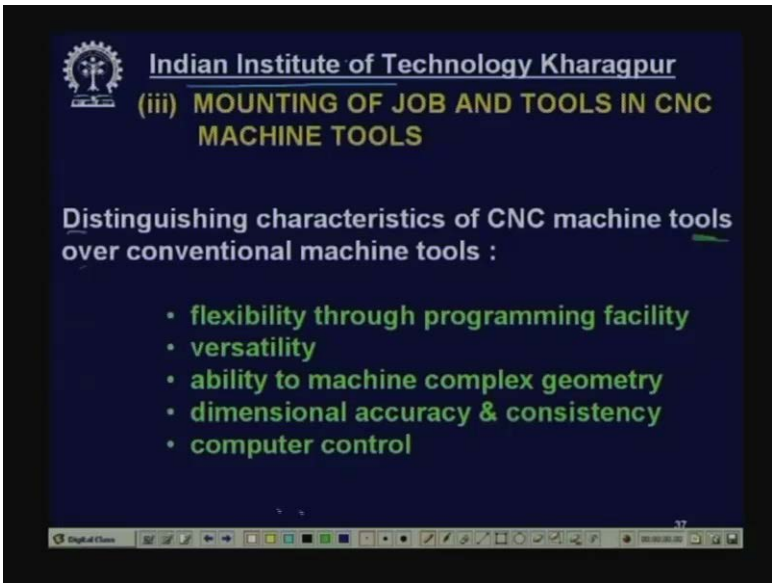

Now mounting of job and tools in CNC machine tools: Now CNC machine tools again these are computer numerical control; They are high procession machine tool quite sophisticated very sophisticated flexibly automatic and they are used for precision job. So again I tell you that special care should be taken regarding the appropriateness or mounting of the tool and job. Before I go into the mounting methods, we should study what are the distinguished characteristics, distinguished characteristics of CNC machine tools which should be remembered for mounting of the job and tool for all purposes. Now the first characteristics of CNC machines is that, when it is a CNC machine computer numerically controlled CNC lathe, CNC milling machine CNC grinding machine CNC or the higher versions of machining centre and so on.

Flexibility through programming facility; now what is flexibility? Now automation is of two types. You remember fixed automation and flexible automation fixed automation which is mechanically accomplished and if the job changes lot of things of the automatic system or devices have to be replaced redesigned remanufactured and reset were is a huge amount of effort time and money involved when you change the product from one job to another but now a days we are going towards batch production where the job lot size is very small and the product has to be changed very frequently. So the automatic system should be very flexible to coup up with the rapid change in the product. So this flexibility in the automation is essential and this is assisted

by what is called software or programming. You simply change the program and a new tool set will be ready and a sequence or process planning will be ready and new job will be done.

Versatility; These machines are just like 2 in 1, 3 in 1 like that different types of machining work can be accomplished say machining centre where milling, drilling, boring, taping, counter sinking all these various operations are done. So these machines are very versatile. Now ability to machine ability to machine complex geometry yes by appropriate programming intelligent programming, you can get very complex shape or complex geometry machine, dimensional accuracy is very high and that is maintained consistently and there is computer control. So many things are controlled by computer scanning, then editing, then running and do looping. These are all possible by then larger library or storing large number of program simultaneously and quick correction change over from one system to another can be done with the help of this computer. So this entry of computer since 1970 like that made a great break in the history of machining or machine tools. Now distinguishing characteristics of CNC machine tools I see this has been over.

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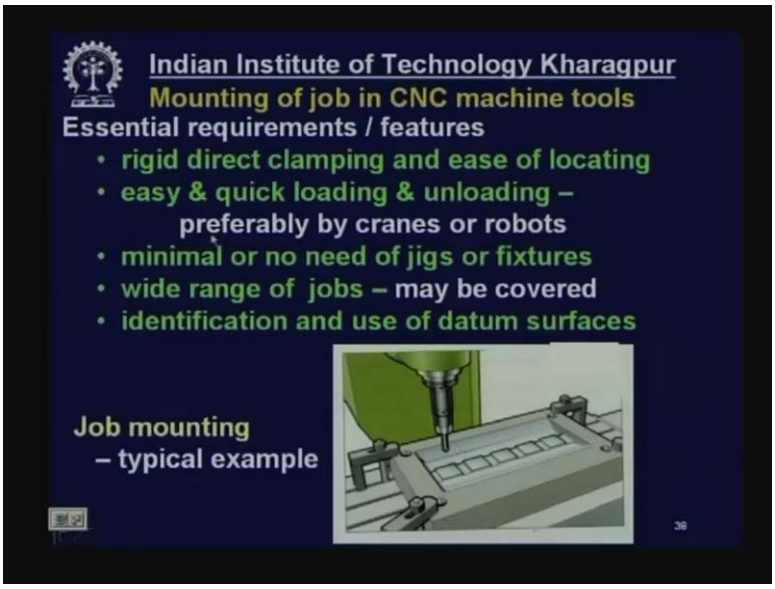

Next now come to mounting of job in CNC machine tools. What are the methods. Now before we go into the process we reconsider the essential requirements or features for mounting of job in CNC machine tools. First is rigid direct clamping and ease of locating so, the clamping of the job large job has to be done very rigidly and directly clamped on the table because only one or two pieces are normally made. Fixtures, jigs fixtures are not used so directly and rigidly mounted or clamped on the table and ease of locating. The locating here in machining system, the cutting tool is made to touch at any point and that becomes the reference. So locating and all these things are not that difficult. Wherever you mount the job or clamp the job the tool automatically will decide the locating easy and quick loading and unloading yes.

The job should be loaded and unloaded from the machine and to the machine should be done very quickly and comfortably preferably by cranes because these are very heavy and should not

be damaged by cranes or robots minimal or no need of jigs and fixtures I told you that, this is used for mainly piece production or job order production. So there is no need of jig fixtures wide range of jobs. Wide range of job means in size in shape, in weight, in material will be covered because this is so flexible in all respects. So wide range of work material can be covered identification and use of datum surfaces. Yes in machining by CNC machine tools, when you mount the job and the tool this reference planes or reference edges either some reference surfaces reference surface or a reference hole or a reference surface or any or age have to be decided okay. Now job mounting: This shows an example a typical example of job mounting, this is a work, this is a cutting tool mounted into the drilling milling machine spindle and this is an end mill cutter and the work piece is fitted on the table with the help of T bolt. This is T bolt and this is clamp and this is shoe okay. This is how these are mounted.

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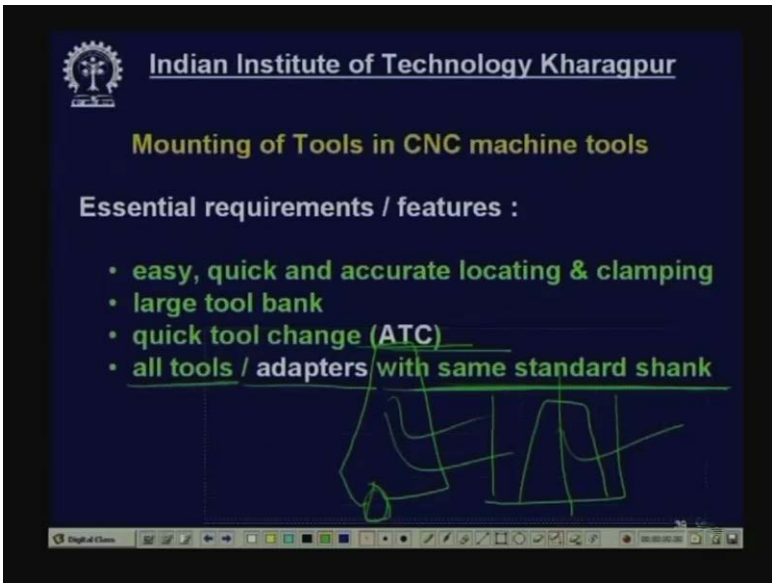

Then what about mounting of tools in CNC machine tools: Similarly some requirements are to be fulfilled and care should be taken. Easy, quick and accurate locating and clamping. Now this is inner end. In this kind of machine tool and this has to be kept in mind. These are provided by the manufacturers. Large tool bank because this machine tools are so versatile that large number of cutting tool should be preserved okay as and when required. The appropriate tool has to be selected and replaced. So, large tool bank from where tool will be pulled and put in quick tool change. Suppose one drilling is going on and then the deal has to be replaced by next is one boring tool, then by a reeler. So the tool has to be changed very quickly. The tool will be sent back to the tool bank and a new tool has to be brought back in to the from the tool bank and fitted in to the spindle.

So the fitting into this spindle and brining back to the storage and bank or magazine have to be done very quickly and if necessary in some sophisticated machines ah automatic tool changes are used automatic tool change called ATC. Now all tools or adapters should have or all posses same standard tool shank because the cutting tools may be small, may be big, may be drill or may be

milling cutter. But, all the tools have to be fitted one by one into the bore of the spindle all right. So the cutting tool may be different but the tools the tool holder should of same size so that this can fit into this. So it is stated that all tools or the adapters are with same standard tool shank.

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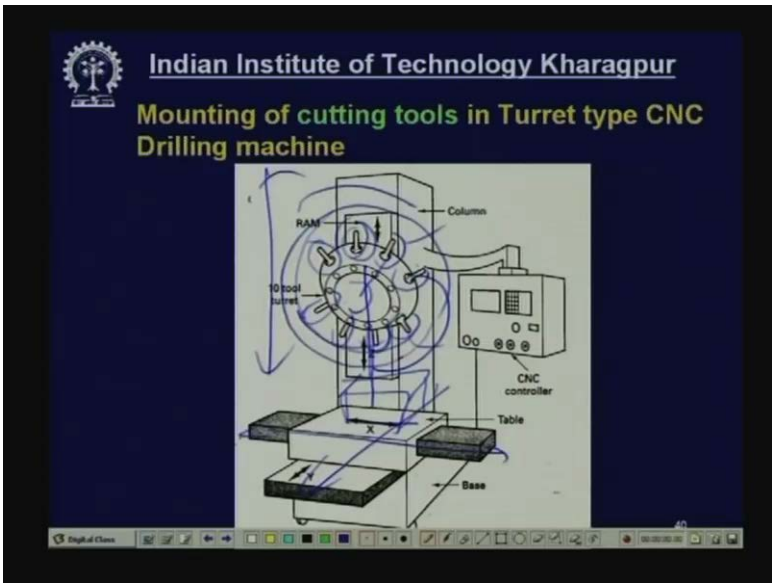

Say for example here, mounting of cutting tools in turret type CNC drilling machine. CNC drilling machine. Now this is a drilling machine. This is a turret. This is called turret which can rotate about this axis and these are the cutting tool. There are 10 cutting tools, not necessary all of them are drills. If they are drills they are of different size, different types. Some of them may be boring tool, some of them may be tap, some of them may be a different cutter all right. Now the job will be mounted on this table okay on the table by clamping or somehow this table can move in this direction or in y direction and the entire head turret can move up and down direction and this can rotate also. So the cutting tools are fitted like this. So the tool bank and according to the process plan, this will rotate and appropriate tool will come into action. Do this then will go back and will rotate another tool will come in and this way it will be done and this cutting tools are fitted into the turret. In to this turret, there are hole taper holes or straight holes and all the tools irrespective of the type and size must have the same shank. So that any tool can be fitted into any slot or any home place.

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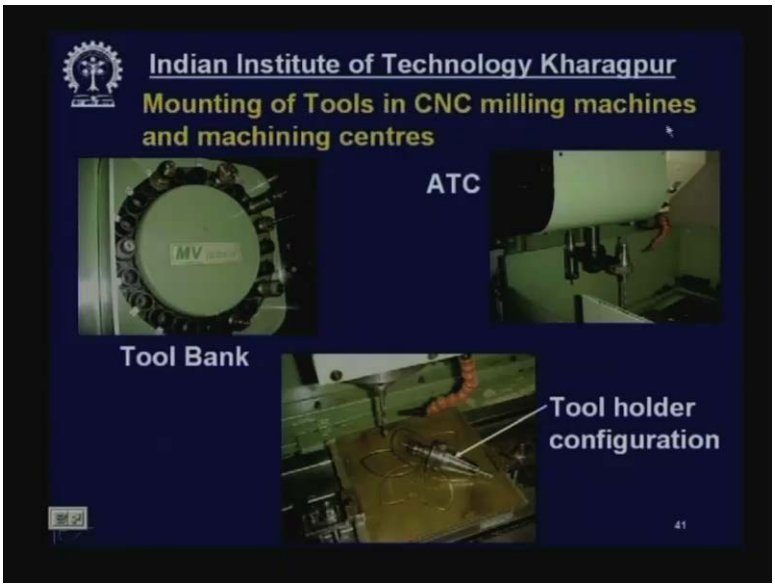

Mounting of tools in CNC milling machines and machining centre: Now CNC milling machine which is basically milling machine may be horizontal axis or vertical axis. So small milling machines are vertical axis and large milling machines are horizontal axis normally and if this can be CNC that is Computer Numerical Control Computer Numerical Control. Now here you can see that this is the now machining centre. I told you what is a machining centre? Machining centre is a higher version of milling machine, CNC milling machine where only milling milling operation is done but in machining center milling, drilling, boring, counter boring, counter sinking various type of work can be done in machining center. So for such versatile and various types of machining work large number of tools from say 20 to 200 cutting tools can be stored into a magazine or what is called tool bank. This is a drum okay on which these are the tool positions and in tool positions there is a tool cutting tools and these cutting tools are all different but the tool holder or shank are same that has to be same.

Now this is the spindle. Suppose this is one cutting tool is fitted into this spindle. This is a milling head, this is the milling spindle. This is the cutter fitted in to this is the cutter fitted into the tool shank okay. Now this is the cutting tool not cutting tool this is the cutting tool actually fitted into the tool holder and this tool holder configuration is standard for all the tools. The cutting tools may be different, may be drill, may be big size, may be small size, may be boring tool or countersink tool but all of them will be fitted in to the shank or this arbor which must be of same size shape. So that any tool any one can be fitted at any location of this drum. This is one very important aspect of machines CNC machines or machining centre. There is a tool automatic tool change here. Now here you can see one example. This is one automatic tool changer. Here is a lever okay. There is a lever just like a hand and there are two hands okay the two hands on two sides. This one like this, so this is one end here and one end there. So what happens? Say this is the hand this hand got there are two grips one grip here one grip here.

So this has got one tool is held here one tool is here. Suppose this is the axis of rotation of this hand so this hand rotates. So this one will grip the tool from the machine and this will grip a tool

from the bank from this one and then this will pull this tool out from the spindle and take this tool out from this one and then this will rotate 180 degree and this tool comes here and the used up tool comes back here and now this will be fitted into the spindle and this tool bank. So this is the tool hand. This is called ATC or automatic tool changer. This is the hand and this is the tool. These are two tools which should be interchanged from bank to the spindle. This is how it is done and all these things is called machining center and a cutting tool can vary from say 20 to 200 and the job mounting, tool mounting, every thing should be very carefully done. These are automatic. Do you know this automatic tool changer enables change of the tool here one to another may be theoretically half second practically may be maximum 1 second. So within 1 second the tool is getting changed. Unlike in conventional process it takes from 5 minutes to say half an hour. So this is the end of lecture today.

Thank you.