Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Manufacturing Process Technology -Part-1

Module-33

by
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Hello, and welcome to this manufacturing process technology part 1, module 33.

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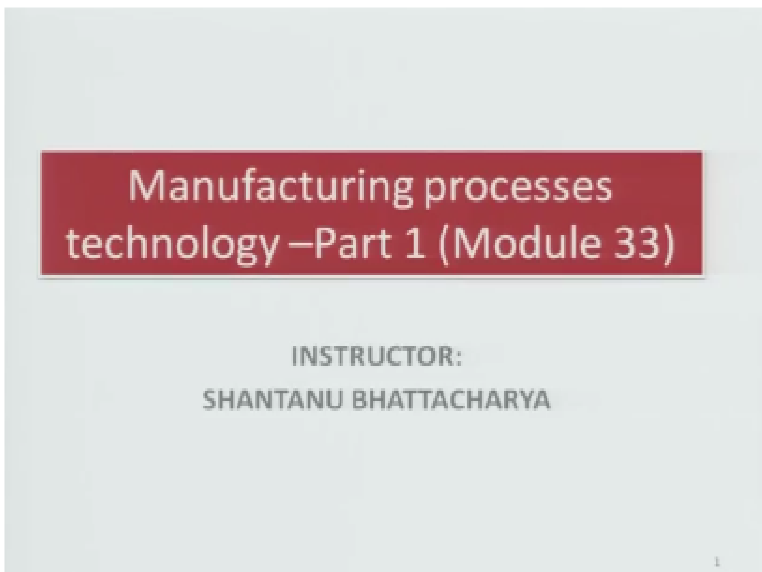

Today we will be talking about the conventional or metal to metal machining process as which are the major component of the industry, and the different generations of machining evolved, way back from the 17th century in fact were power was increasingly the used as the steam power or later on electrical power for developing of the machines. And machining in all different forms lathe, milling, shaping, planning, grinding or drilling is the other way of manifesting the force or the energy through a metal to metal contact.

And for doing that you have normally the capability of producing shapes which are regular, but then later on when CNC technology took up and it could really be from a CAD to the machining directly from a CAD to a machining interface directly there was an additional increase in the complexity of shapes which machining could actually do. But before that we would like to first investigate the machining which is more like related to conventional systems.

And were mostly the outcome of the machining would be symmetrical components. So having said that the most important part in machining in such kind of machining processes are how the tool moves with respect to the work piece.

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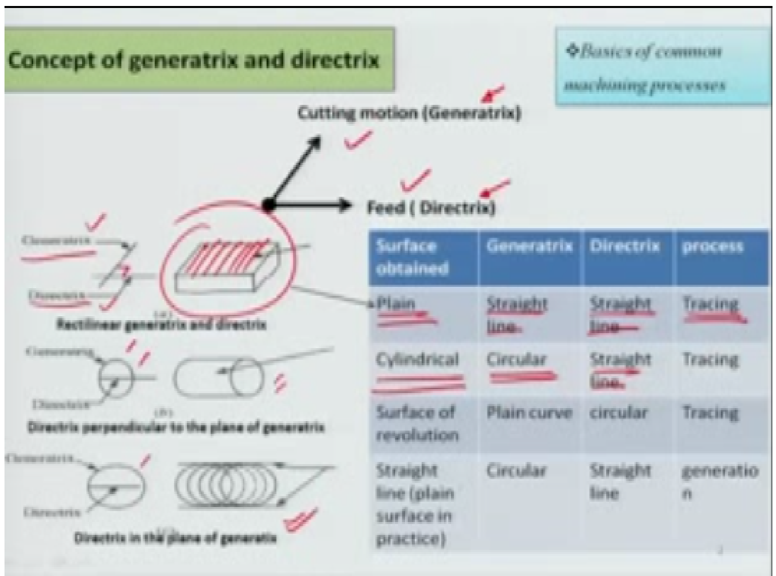

And this slide right here shows the concept of two important motions associated with the motion of the tool with respect to work piece, one is the feed motion which is actually also known by the term directrix and the cutting motion which is basically the generatrix. So as the name indicates the different geometries that are expected out of machining processes are formulated by a manipulation of generatrix and the directrix.

For example, let us say in case of a shaper machine or a plane machine there is a movement of the tool with respect to the work piece which is mostly on an XY plane. So this right here shows the rectilinear motion of the feed direction, and the cutting motion and they are perpendicular to each other making 90° angle, and therefore you can have a XY plane generated because of such directrix and generatrix, both straight lines perpendicular to each other okay.

So we can obtain a plane surface out of a straight line generatrix and a straight line directrix and the process can also be known as tracing. Similarly, in the case of a turning center you have normally the motion of work piece in a circular manner and we can say that the generatrix direction of the cutting motion that happens in a circular manner and the relative feed direction of the tool with respect to the work piece is against straight line.

So a straight line in a circle in generally will yield or which make an array which is like cylindrical in shape. So of course, the straight line in a direction is perpendicular to the direction of the cutting velocity. So that is very important particularly here, or in case there is a motion which is related to circular motion of the tool and the motion feed motion of the tool in the direction almost in the same plane as the cutting velocity or towards the direction of the cutting velocity.

In that case also you can generate a plane surface example of that is milling. So in a milling system we have the circular motion and the cutting motion is really along the circular the cutting velocity and that the way the chips get formulated is particularly in a face milling operation is how the tool engages in a circular manner at different points it is a multiple cutting tool, so that you can have the chip formations along that circle.

And then you basically moving it in a direction either perpendicular to the direction of the cutting velocity, and so you get a plane surface based on this two motions, so various complex geometries with different symmetries can be obtained with different cutting motions directions and feed directions and that is how you understand the basic engagement of the tool processes with respect to the work piece. So let us talk about now some of the processes.

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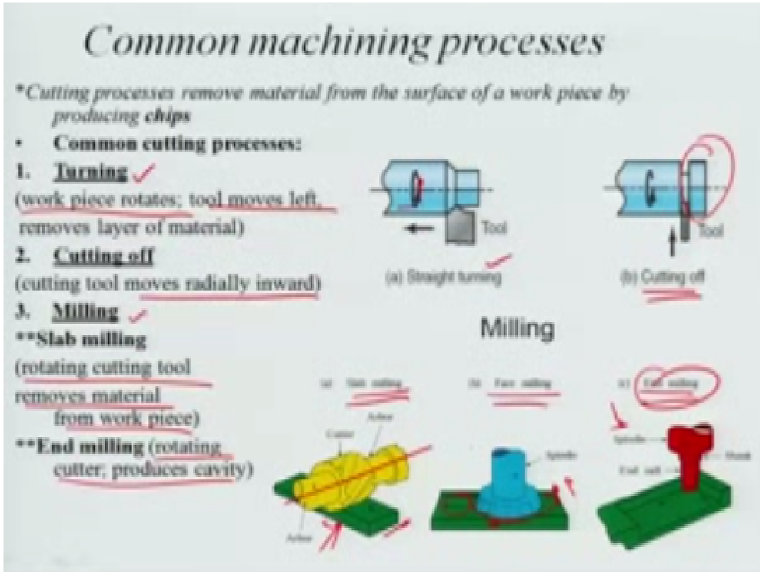

So we have the example of turning where the work piece rotates and the tool moves to the left directions you can see here that the tool is moving perpendicular to the direction of the cutting velocity which is actually tendency to the circular motion here, and this generates the cylindrical surface as we have earlier illustrated. So this is a case of straight turning there is a cutting off so basically this portion is now being saved off using a parting tool.

So this surface is completely eliminated from the cylindrical surface, so cutting tool moves radially inwards. you have again milling which is the other form of cutting and slab milling operations you have a rotating cutting tool and it removes the material from the work piece as shown here the milling tool is typically mounted to arbor which is an axis which provides rotation to the cutter.

And the work piece is moved actually perpendicular to the work piece is moved in both X and Y direction with respect to this particular cutting motion and such examples as known as slab milling. You can also have different other forms of milling like face milling example that I was providing were the cutting motion is also along the circular plane which is probably in the similar direction.

So the cutting velocity for example in this particular direction is similar to that of the feed motion or similar again to the direction of the feed motion of the tool in the Y direction. So in this particular examples you can have a plane or surface okay, then you have end milling operations where you can actually have a rotating cutter and it produces a cavity as you can see here at about here so these are different variants of milling process.

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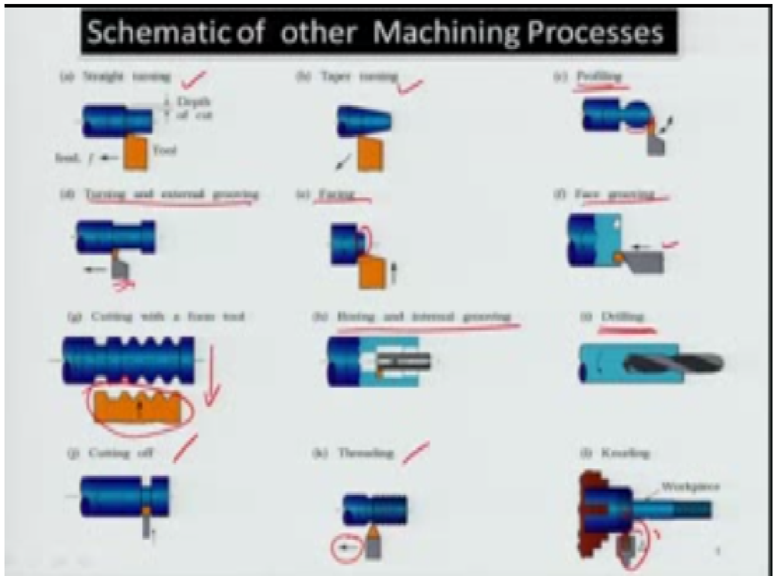

Some other common machining processes particularly for turning you can have a lot of different operations straight turning shown here, there is a tapper turning where the tool goes from in a tapered manner with respect to the rotating axis of the work piece, and it generates a profile identical to its motion, profiling where you have a certain shape XY shape which is typically the curve or the path that the tool follows with respect to the turning work piece.

So that you have a complex shape profiled on to the work piece, you have turning an external growing as can be indicated here, facing operations where one portions of the circular work piece is completely removed or shaped off, you have a face grooving operations were by a different orientation of the tool, the tool moving in a direction perpendicular to the circle of motion you can actually have a small groove as you can see in this particular example.

This shows that of a cutting with the form tool so you have exactly something in printed the negative of something in printed of which the tool is shaped up to, and so you can actually have a shape in printed directly by cutting it with a form tool you have boring and internal grooving as listed here which is typically done by a boring tool mounted one of this spindle axis of the, which is sort of co-axial to the work piece direction.

You can do in a similar manner by using a drilling tool to drill on side of the cylindrical work piece. you can do cutting off by having a tool which would be enabled to go in a direction perpendicular to the radial direction with respect to the work piece and produce a deep cut. You have threading tool were the thread moves the threading tools moves that a certain feed and it generates thread of defined pitch because of the motion of the tool direction parallel to the axis over which the work piece is rotating.

You have a knurling tool were you have a pattern impregnated on to the surface which is exactly negative of the pattern that the tool contains. So these are the different operations that you can actually use the turning system or lathe to obtain.

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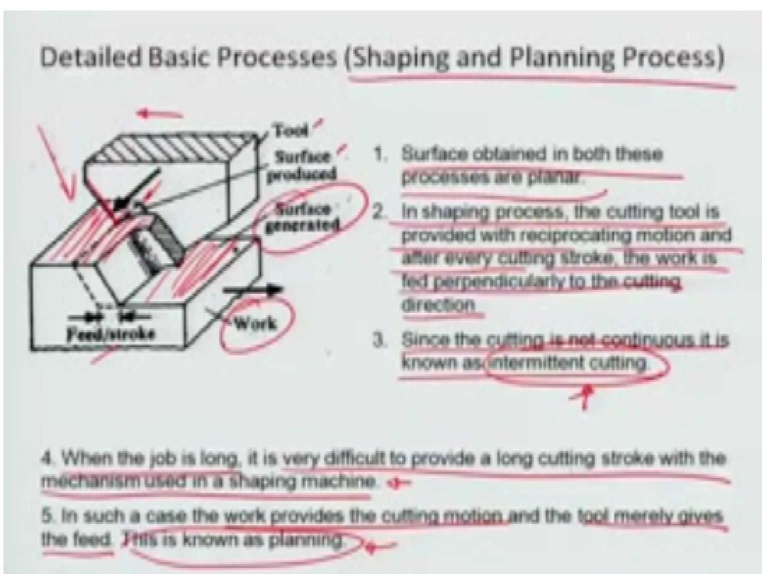

So if we talk about the basic processes of machining it is really about peeling off the material. So as I told you earlier that there is a metal tape which would be engaged with another metal which is the work piece in other case the metal tape is harder in comparison to the work piece, and it actually glows into the metal and starts to peel off the metal, that is how you do conventional machining, and that is how the chip formation takes place within the system.

So if I look at this figure right here it talks about a basic shaping or a planning process where the surface obtaining both these processes or planar nature this is the cut surface, the surface generated you can see in this portion of the figure and you can see how the peeling of the action is happening at the point of engagement of the cutting age of the tool which is actually this edge right here with respect to the work piece.

So you are having the portion of the work piece which was otherwise making this particular substrate or surface constituting this particular surface cut off, so you have the similar surface produced at the bottom here and there is a certain feed at which you can move the tool inside whereas moving it at a certain speed velocity perpendicular, and that is how you generate XY surface of the work corresponding to the different feed and stroke.

So you have a tool and a surface which is produce in shaping process the cutting tool is provided with reciprocating motion and every cutting stroke the work is fed perpendicular into the cutting direction. Since, the cutting is not continuous it is known as intermittent cutting process it is not similar to lathe machine where you have a continuous flow of chips coming out, when the job is long and it is very difficult to provide a long cutting stroke in mechanism used in a shaping machine.

Generally, in that kind of a case instead of moving the tool all over to the whole span of the job you basically move the work piece. So the work piece provides the cutting motion and the tool merely gives the feed and that operation then would be known as planning operations. So only difference is the terms of work piece size and what moves. So the primary cutting motion would be generated by the cutting stroke of the tool if it is smaller component and operation then there would be known as shaping.

And vice versa the work piece is the one which generating the cutting motion where the tool is only giving the feed and is a longer or a larger component, then that kind of motion is now known as the planning motion.

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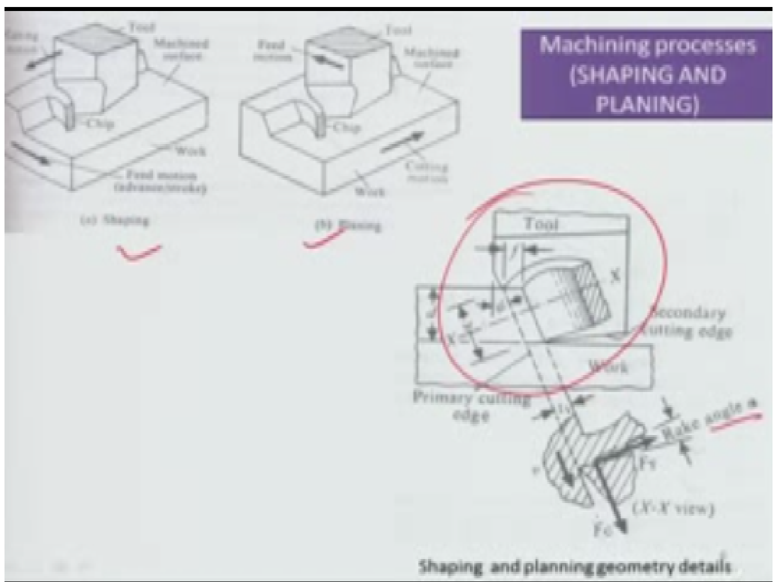

So effectively what you can see is peeling process which is going on here you have similar examples where the same shaping and planning happen in both the cases you have peeling off the work pieces which is happening you can actually do a mechanistic diagram here which I am going to illustrate later were how the chip etc., is generated, function of the angle different other forces like the cutting forces like the cutting force or the friction force which comes in there okay.

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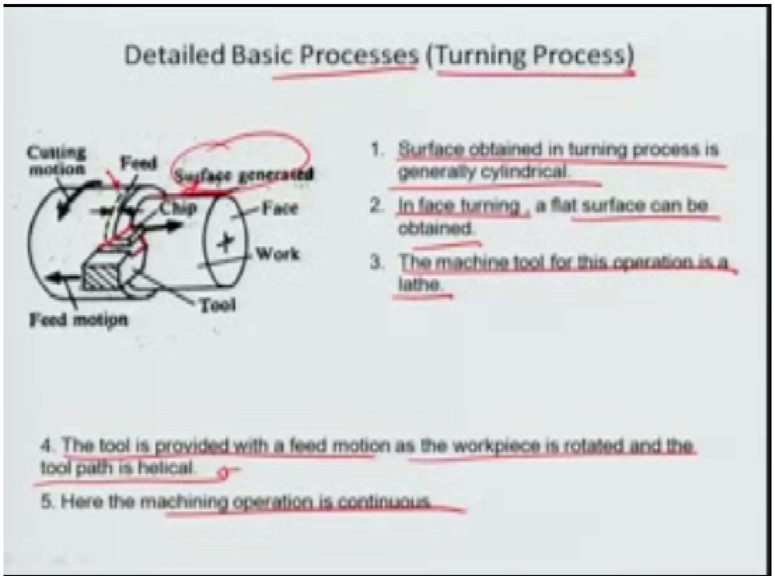

So similar kind of a processes of peeling can be illustrated even for the turning operations. So here also you can see a tool and you can see the level of engagement of the tool with respect to this tool surface or tool edge which then peels off the material, the surface material and basically tries to again remove the material by peeling action. It is a continuous process again because when the surface is rotating with respect to the edge there is a continuous removal of the chip material from the work piece surface.

So the surface obtain in turning process which is cylindrical in face turning a flat surface can be obtained the machine tool for the operations are lathe. And the tool is provided with the feed motion as the work piece is rotated, and the tool path is a helical path that it follows the removing of this material here you can see this is the surface which is generated, because of the cutting motion and this was the surface which was before which is being cut to generate the surface this new surface. So here the machining operations is a continuous machining operations.

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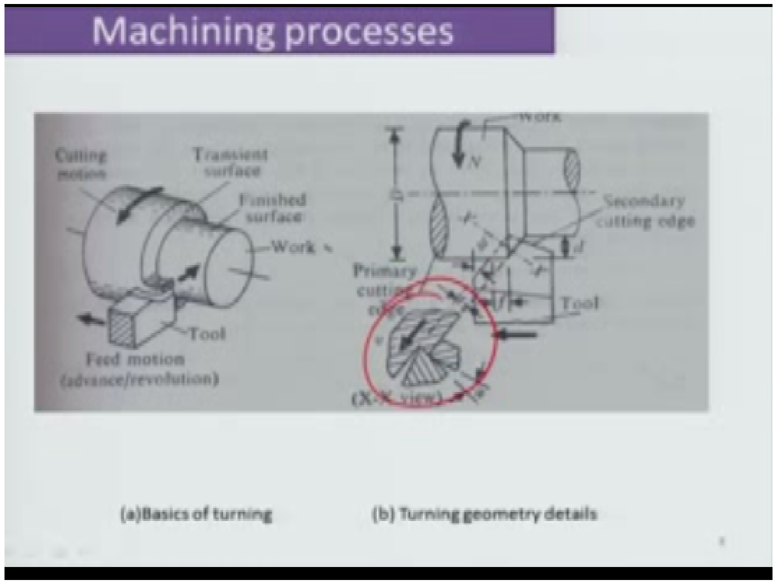

You can see how again the chipping actions happens here as the function of the different forces and the angle, and we are going to do all the analysis of how this chipping actions happens in a later on stage. But that is how the basic of turning process happens.

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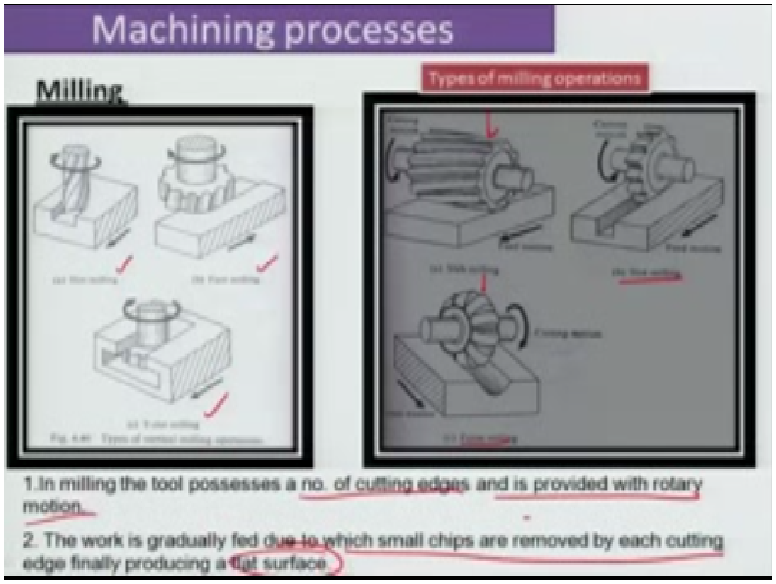

You have a similar kind of a strategy for a milling processes here for examples, you are seeing three different kinds of milling one is a slot milling, other is a face milling, and other is a T slot milling and I can see here that there are different other kind of millings for example, in slab milling case you can see that a milling tool is mounted on a arbor and there is a feed motion of a work piece similarly there is again another kind of a slot milling case here with the similar kind of a vertical mounting of the milling cutter.

Or a form milling that a certain form of a shape is impregnated on to a surface because of the form of the tool which is there. So the same operation of a rotating tool of a multipoint cutter which is utilized in various forms to obtain different kind of peeling operations as the milling systems. So in the milling the tool process the number of cutting edges that is provided with the rotary motions the work is gradually fed due to which small chips are removed by each cutting edge. And finally it produces the flat surface.

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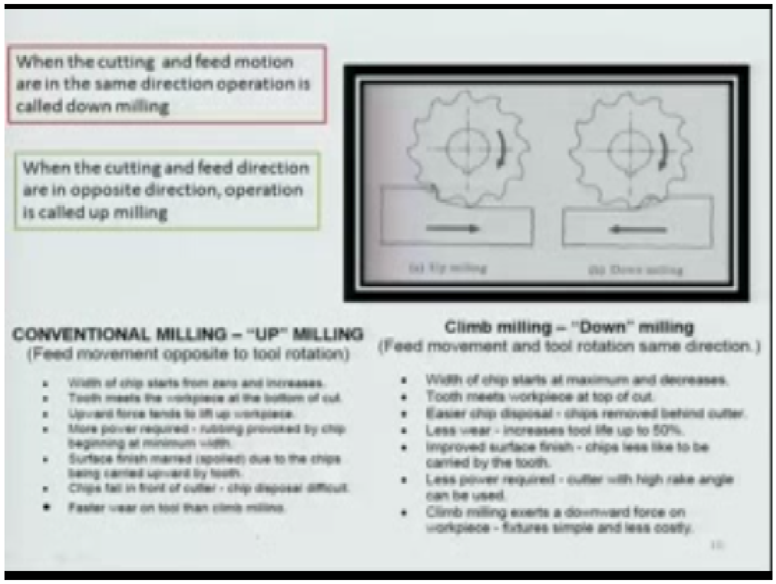

But then again if I look at the way this milling operations is performed.

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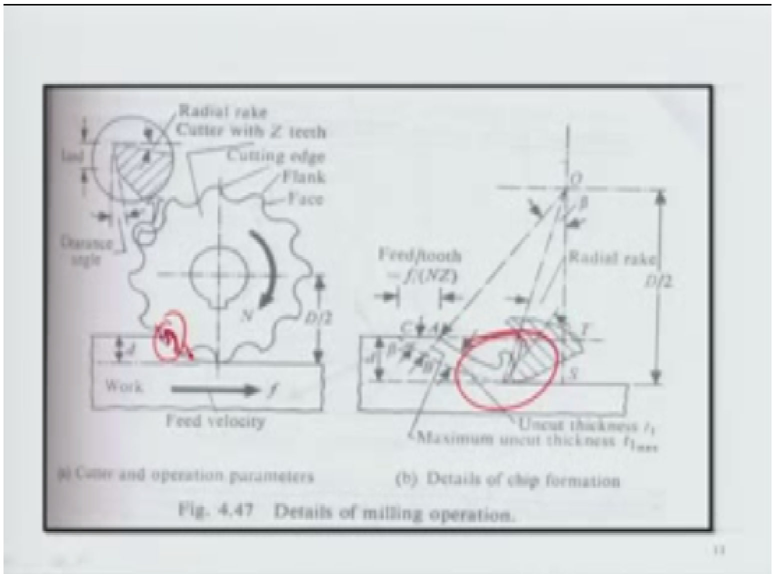

It is really about the way of the peeling process again which is happening somewhere again here. So if the engagement of the cutter happens at a portion somewhere here, there is a original surface which was actually this surface which is been cut off. Now into this new secondary surface and there is a milling cut the chip which is coming out because of the engagement of the cutter.

So effectively again it is the same it is the same peeling process. So all these figures and strategies it is kind of clear that irrespective of whatever be the name or the shape that is obtained in the machining process it is about relative motion of the tool with respect to the work piece in one way or the other end it is about also the engagement of a cutting edge which thereby peels of the materials so that you can have cut metal.

So having said that the basic premise is clear now we can do some mechanistic calculations in a manner so that we can understand this process of peeling or material. With this I would like to close this particular lecture, but in the next module we are going to start off from here do the various kinds of milling which are possible and then we slowly get into how the peeling process can be obtained magnetically and what are the different issues associated with the different force balances which would happen there, so with that I would like end this module, thank you.

<u>Acknowledgement</u>

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