Science and Technology of Weft and Warp Knitting
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Module - 2
Lecture - 6
Flat Bed Machine - Needle/Cam Interaction

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Welcome participants. Now we are going to move in lecture 2 of weak 2. So, today the topic is chosen regarding flat bed knitting machine. And today we are going to have detailed observation on how needle and cam interact during loop formation. Let's have a quick revision of what we have done in the last lecture.

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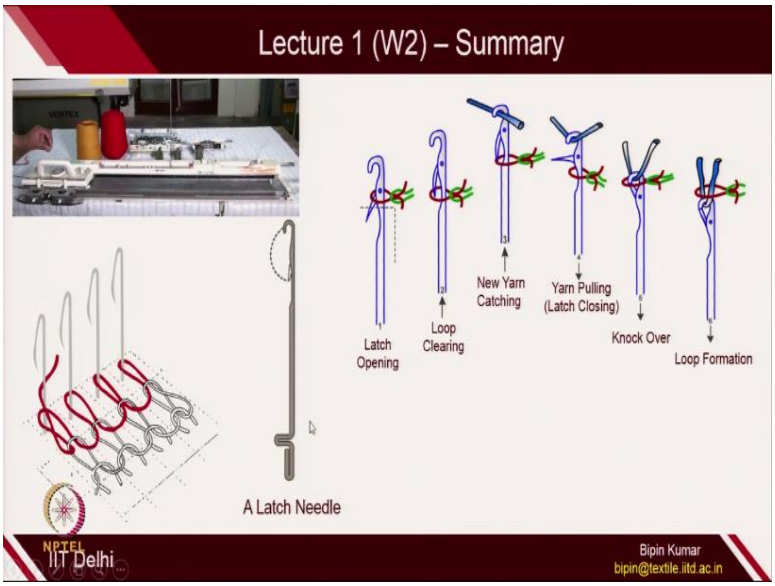

We introduced you a kind of machine, weft knitting machine, especially the flat bed knitting machine. We also talked about the functioning of latch needle, which is the heart of knitting, how this latch needle is fixed on this bed and each latch needle is making a particular loop in a column of the fabric. During this loop making formation, the latch needle has to go certain movements.

It started from latch opening to, because of the old loop. We also discussed about how the latch in the needle are self-operating. So, the old loop simply slide downs the latch to open it. Then the loop gets cleared. Once the loop get cleared, the head of the needle is free to catch the new yarn. You can see here, it is catching the new yarn. And then, it, the needle starts sliding down due to which it starts pulling up the new yarn.

Simultaneously, the old loop starts to slide up. Because of that, the latch starts to close. And finally, once the latch closed fully, the old loop is knocked out from the needle. And in this way, the new loop is getting formed and the old loop is get stuck with the new loop. So, we have a brief understanding of how each part of the needle helps in loop formations. So, the most fundamental part was the hook, latch and the butt. Now, let's move to the next section.

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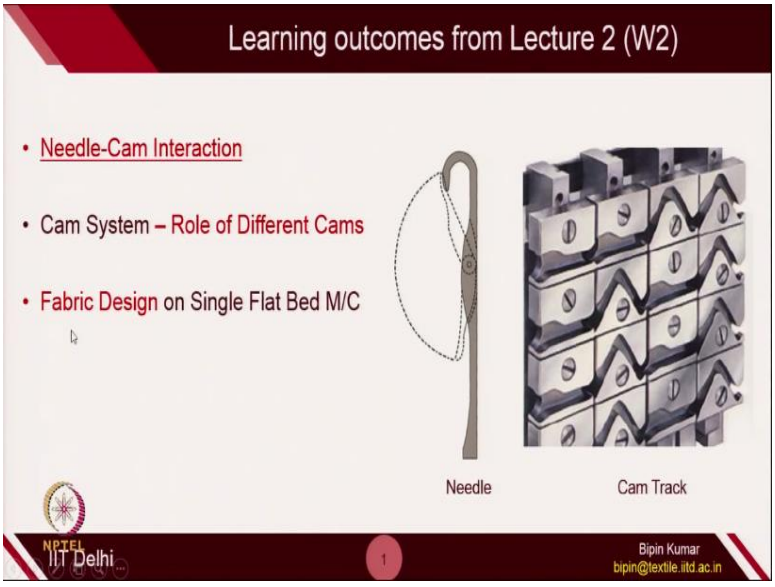

Today, what we are going to learn about is, the first thing which is of most important in almost all kind of knitting process is needle-cam interaction. This is the most fundamental thing. And we need to understand this in detail, because this is the basis for understanding all the structures which we are going to deal in next few weeks. I am also going to introduce to

you the cam system; how the different cams are arranged and how they help to interact with the needle and decides its movement.

So, you can see here is the track which is made by some of the cam. So, we are going to discuss this cam system or the cam track in detail. After that, we are also going to learn about how we can play with the machines to make different fabric designs. So, some design aspects we are also going to cover in this particular lecture.

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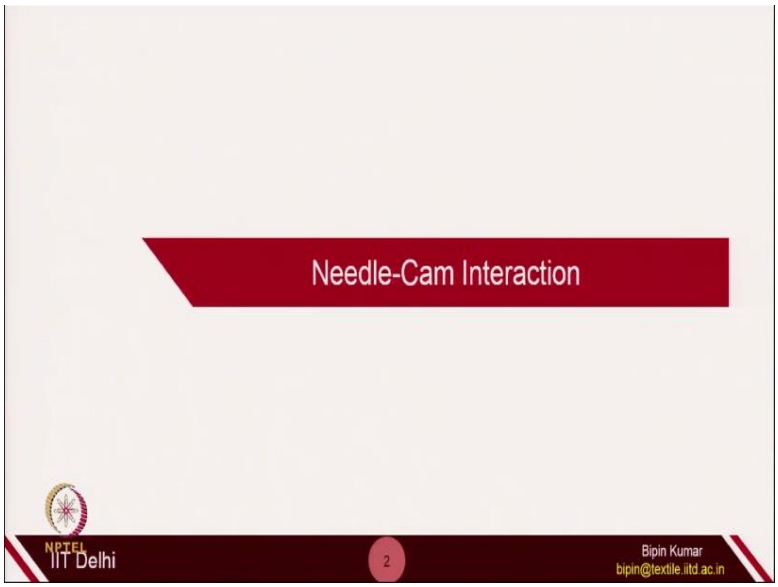

Now, let's move. So, straight away, we need to understand how needle and cam interacts during knitting. So, just a quick recap.

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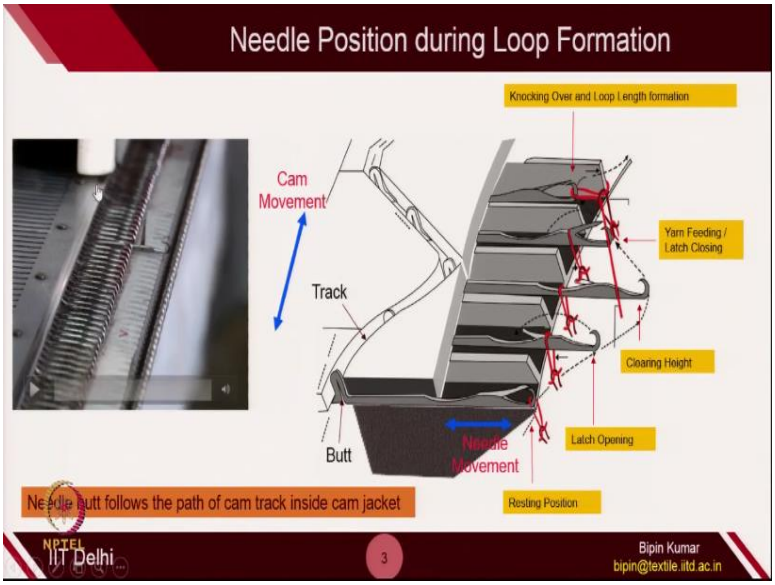

In the last week I showed you one of the video, **(Video Starts: 03:23)** where the needle was placed on the bed. This is the needle bed and I am showing you the movement of one particular needle. So, here is this cam which is interacting with this needle. And because of this, needle is doing some kind of reciprocative movement. So, you can see here, the needle just goes out from the bed and gone inside.

Simultaneously, once the cam jacket moves from the opposite direction, the same movement was repeated. So, this is happening because the butt of the needle is following a path. And this path is created by cam jacket. So, we are going to understand about this path. So, some fundamental thing. So, this butt is the responsible part which helps in the reciprocation of the needle.

And it is following a track **(Video Ends: 04:20)** inside the cam jacket. The cam, you have seen in this video also, the cam is moving from left to right and right to left on the machine. And because of that, the butt is forced to follow the track inside the cam jacket. And once the butt follows, the needle is forced to move a kind of reciprocative movement, which you can see it here.

So, during this process, the needle is undergoing certain specific position of loop formation. So, for example, when you take the snapshot at this particular moment, each needle is having different positioning during the loop formation. And we have discussed this in detail also. How, this is the first position which is the resting position. It is holding the loop. The second needle is doing the latch clearing because the butt is at the different location of the track.

You can see here, this one is the maximum height or the maximum forward movement which was happened to this particular needle. And this is the clearing position. And here you can see the butt is actually at the highest point of the track. After that it is going down. You can see here the downward movement. So, this particular needle is at this position where the butt is pulling the yarn.

And finally, at this position, you can see it is forming the loop as well as it is releasing the old loop. So, this kind of positioning of needle is well designed because of the track which is provided by the cam jacket. So, in this lecture, we are going to understand why this type of track is designed and what is its role. So, key take away from this particular point is, the

needle butt has to follow the path of the cam track inside the cam jacket. So, it is the track which we have to designed specifically to make sure the knitting is happening properly.

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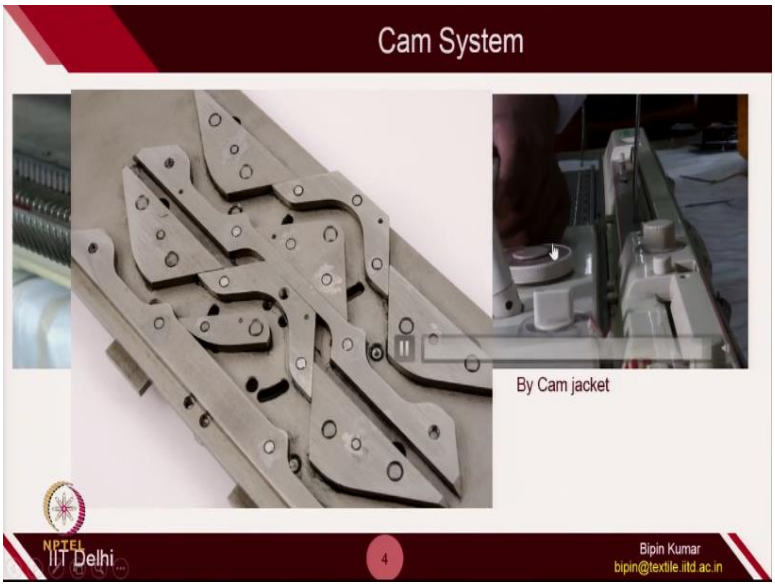

So again, let's have a quick look on the machine, because it is not just one needle we are operating, we are operating 1000 of needles or maybe sometimes 50, 60 needles depending on the fabric width. **(Video Starts: 06:33)** So, here you can see, I am just showing you how by hand also you can do this kind of reciprocative movement. And operating the butt; and because of this, the needle is moving, coming out and going inside in the bed in a certain slot.

The same thing is happening because of this cam jackets. So, this is the cam jacket. When you are taking the cam jacket from left to right of the machine, you can see the needle is doing the same movement as it is shown in the left video. Okay. So, here you can see, the needle is doing the same thing. So, this is happening because of some kind of track that needle butt has to follow.

So, we are going to understand these tracks which is created by cam system. Right now, we are going to discuss about this particular cam jacket of the single bed flat bed machine. **(Video Ends: 07:38)**

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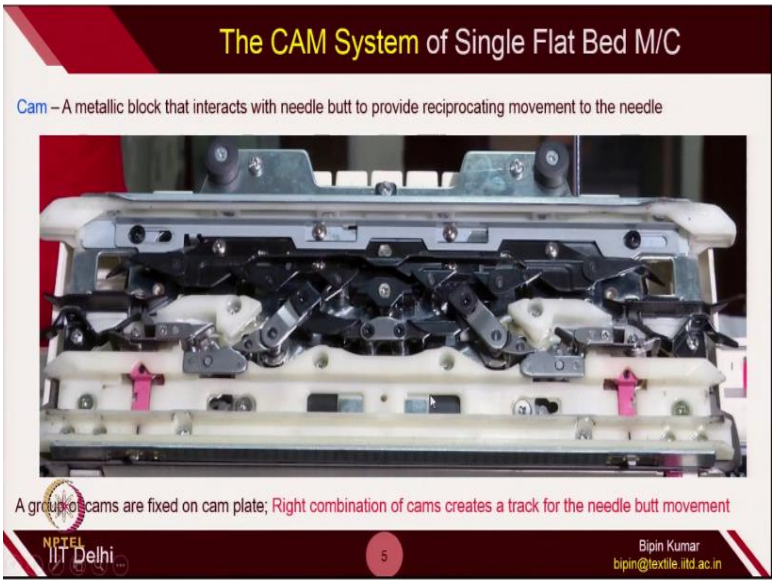

So, if you reverse the cam jacket, it will look like this. So, this is the back side view of the cam jacket. At this moment, it looks very complicated. You can easily see, it consists of lot of metallic raised blocks. And these blocks are placed in a specific order. And at this moment you would not be able to understand what was the track the needle was following. But let's have a look to this particular cam track in detail.

So, first of all, the cam is nothing but a kind of metallic block, you can say, which interacts with the needle butt. And once the needle butt interacts, it follows the path which is created by the series of cams which is there inside this block. A series, you can easily see, there are a lot of nut bolts are there screws are there. So, many metallic blocks are arranged. So, a group of cams are specifically placed on this platform. Okay.

This is called the, entire surface is called cam plate. And on this cam plate, a small small metallic blocks are placed. Right combination of these cams create a path for needle butt. And because of that, needle is doing a kind of reciprocative movement on the bed, while operating the knitting action.

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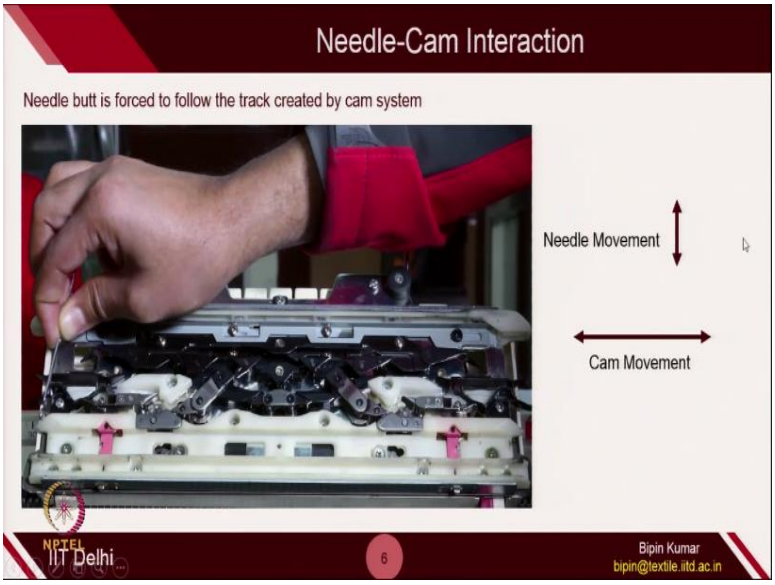

How it moves? So, here is a small video. You can see how the butt is interacting and following the path. **(Video Starts: 09:08)** Here you can see, the butt here. So, the butt is following this path. And now, you can see because of this cam, it is raising up. And then, it is again going down. And then, again you can see, because of this hindrance, it has to go down. And then it come backs to its original position.

If you carefully look at these, it looks like a symmetric placement of each of these cams. So, once you reverse the path of cam jacket, the butt has to follow the same kind of nature of movement. So, you can see here, it again raised, goes down, then again down and finally come back to its original position. **(Video Ends: 09:52)** And this process is repeating when you are traversing the cam jacket from left to right or right to left.

So, ideally, if you see the movement of needle and cam, so, the cam is moving on a horizontal plane of the needle bed from left to right or right to left, while needle is doing a kind of 90 degree motion, also it is doing the reciprocative movement with the respect of bed. And needle and cam are having 90 degree difference in the movement.

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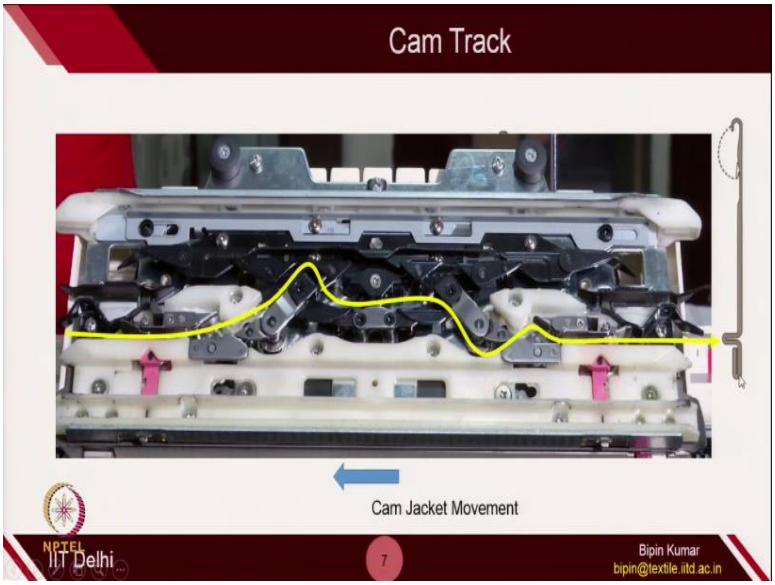

Let's see what exactly is happening here. So, here is the butt, the needle. So, once the cam approaches the butt of the needle, it get engaged with the metallic wall here. You can see, these are the metallic wall. And because of that, this butt starts following the path which is available to it. **(Video Starts: 10:46)** So, what exactly happens. So, here you can see the butt is going. And then, butt starts raising.

And then, it is going down and coming out from the other end. **(Video Ends: 10:57)** So, the actual path, if you carefully follow the path, you can easily see, the butt initially remains in the same line. Then it starts raising. So, raising means, it is actually coming out from the bed. And after that, it goes down. Again, goes down and then finally it raise to the same original locations. So, this is how the cam track and the series of cam helps the butt to do or to make the right kind of reciprocative movements.

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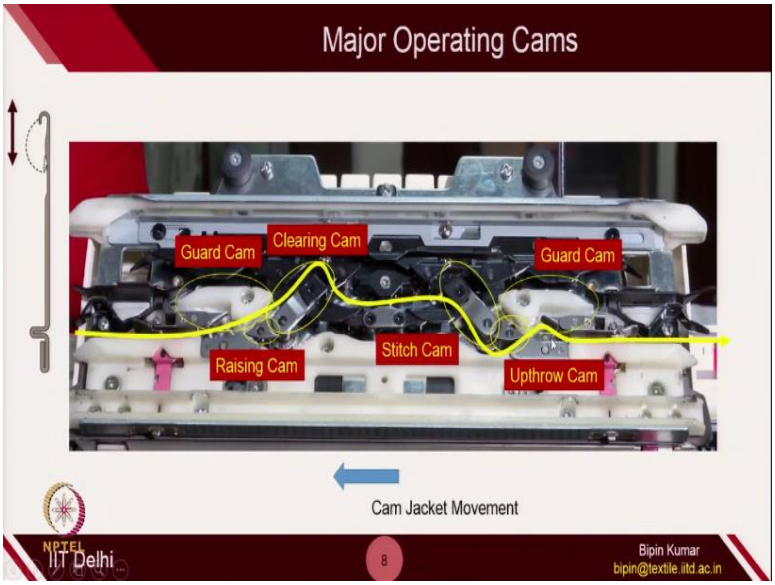

During this process, you have seen this butt was interacting with lot of metallic blocks. So, let's see the role of each metallic blocks. So, the first metallic block which it hits, the butt hits was the raising cam. And this raising cam, by name it suggested; you have also seen the path. The butt, the moment it hits this particular cam, it is forced to raise. So, that's why this is called raising cam.

And once this is done, then the second cam is also making this butt to raise further. It finally reaches to a maximum height or you can say the location of this particular needle is away from the bed, the maximum distance where it actually releases the old loop from the hook and the latch. So, this particular cam which is responsible for clearing the old loop is called clearing cam.

Once clearing cam is done, the feeder provides the yarn to the needle and needle starts going down. So, this is the downward movements. You can see here, the path is free and needles goes down. After that, it is striking this particular cam. So, this cam, again, since the moment the butt strikes here, it is forced to go further down. And during this process is actually, it is pulling the yarn as well as the old loop is closing the latch.

And during this entire downward movement, latch is closed, old loop is knocked down and new yarn is also pulled to make a new loop. So, this stitch cam, that's why it is known as stitch cam, because it is the main fundamental cam which helps in the stitching of the loops on the flat bed machine. After that, it strikes again and you can see here, it is again raising. So, this particular is the upthrow cam.

Upthrow cam is nothing but, it is helping this needle to go back to its original position. And after that, the path is clear and the needle, after performing this knitting actions, come backs and stay on the same position on the bed from where it started. Apart from these cams, you can see, so there are so many other cams. Some cams are the guard cam. By the name itself, it suggests that it is guarding the butt to follow this path.

So, guard cam actually helps to make the needle stay in the path, to not let the needle to go away from the designated path. So, that's why it is called guard cam. So, in totality, these, each of these metallic blocks has certain function and role to play during this knitting process. And this is the path, you can see. So, the raising cam, then clearing cam; so, you can see here, both this raising and clearing cam is forcing this needle to raise up or get away from the bed, so that it can clear the old loop.

After that, it has to go down, so that it can catch the new yarn, pull it, knock out, as well as release the old loop and make a new loop. Once the job is done, it has to go back to its original position. So, that's why, this is, again it is raining. And this upthrow cam is helping to do that. This is how it works.

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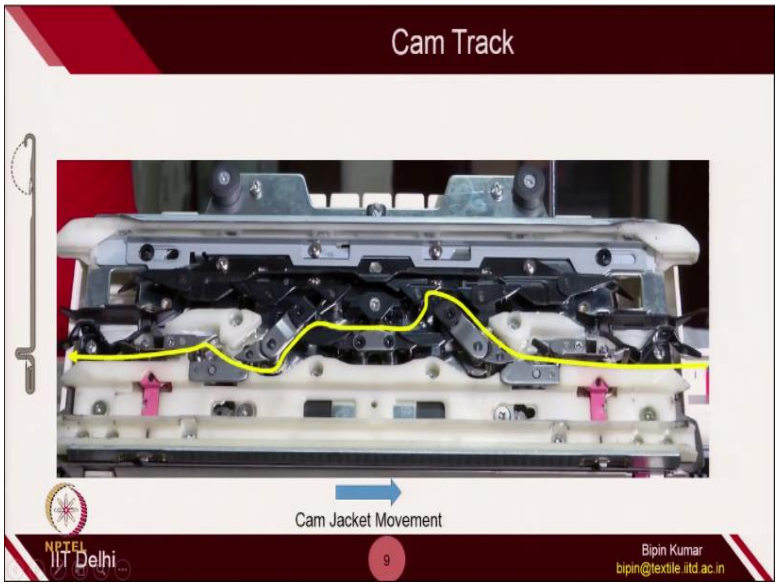

If you reverse the path, the same nature of movement is observed. **(Video Starts: 15:08)** So, you can see here, again the butt is going, then coming down, then down; and then finally it come to original position. **(Video Ends: 15:17)** This time, the cam jacket movement was from left to right. And with respect to cam jacket, the needle was moving towards left. While in the previous slides, the needle was moving towards right and the cam was moving from

right to left. This is the actual path when you reverse the movement of cam jacket. So, again it raises, goes down, then down. And then, finally come back to its original position.

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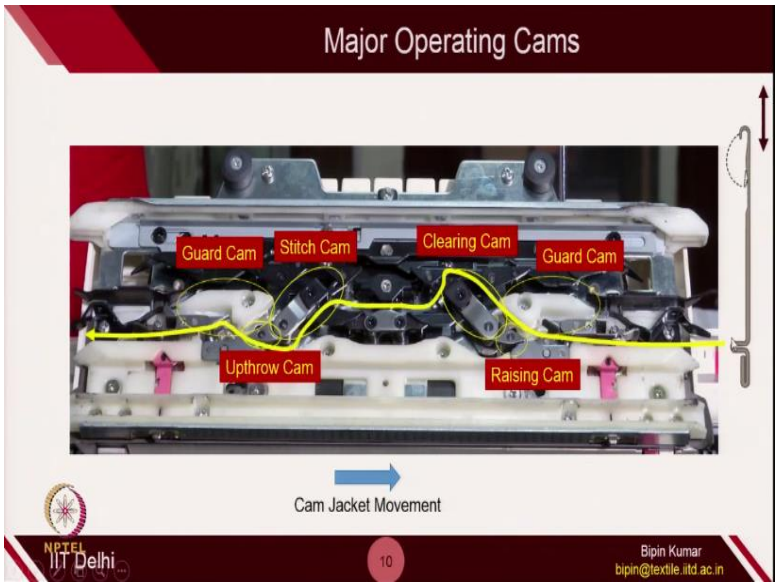

If you want to observe the kind of metallic block which helps in this movements, again we start from the raising cam, the same function it helps to raise the needle; now, because the path is like that. After that, clearing cam, this actually helps the needle to release the old loop from the latch. And also, it helps to make sure to catch the new yarn. Then stitch cam, then upthrow cam and finally the guard cam.

So, if you carefully observe, when the needle was coming from this side, this particular upthrow cam was acting like a raising cam. So, now the function is just reversed. And the stitch cam was acting as a clearing cam when the needle was coming from the, this side. So, because of the symmetric, the role of left metallic blocks are just reversed than the right metallic blocks. So, in totality, these are the 5 cams which is quite popular in most of the weft knitting machines. And they are always there to make sure the movement of the butt follow a certain path.

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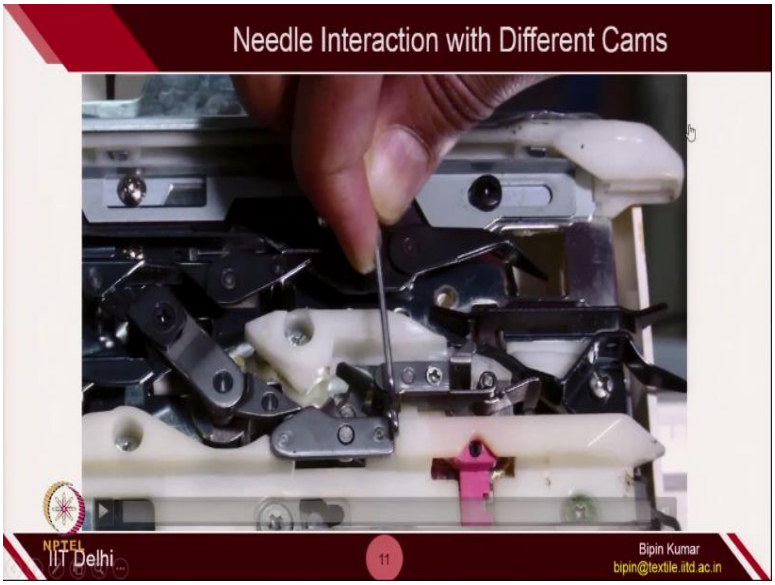

Again, there is small videos, if you want to zoom it, you can easily able to appreciate how this butt was interacting with each of these cams. Let's see again. **(Video Starts: 17:06)** So, you can see here, the butt is going and the path is clear. Now, the path is raising. So, this particular cam is the raising cam. Again, you can see this metallic block. It is making the butt to release, move up.

This is clearing cam. Then it goes down. During this process it is catching the yarn. Then again, you can see it is going down, then down. This is stitch cam. And finally, this is the upthrow cam which is forcing it to go up. And then, needle goes back to original position. Again, when you are reversing the path, again you can see this become the raising cam. Then, this is clearing cam.

Then this particular metallic block becomes stitch cam. And then, this one become upthrow cam. **(Video Ends: 18:00)** And finally, it goes back to its original position. So, this is how needle interacts with different cam during knitting process. And each of these cams, the timing and positioning is designed so carefully that it follows all the knitting action in a sequence.

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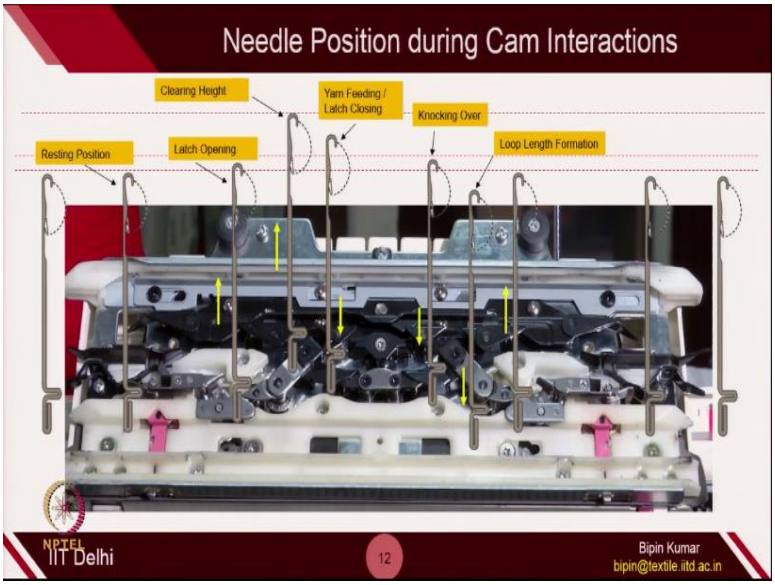

So, let's see what exactly is happening when the butt is position at different location inside the cam jacket. So, butt is entering, for sometime the needle remains in the same position, because the path is clear. And after that, it is hitting here the raising came. This is where you can say the latch starts open. So, because the needle is rising, since the needle is holding the old loop and it is rising; so, because of that, the old loops slides down on the latch and latch starts to open.

After that, you can see, the path is still remain upward. And because of that, the needle start raising even further due to which the latch become completely open. And finally, the old loop slides down away from the latch. So now, the old loop is free from hook as well as latch interactions. So, this old loops now slides on the stem part. So, you can see here also the lines are also drawn, to make you understand much the needle has moved away from the bed.

So, you can see here, this was the resting position. And finally, this was the clearing positions. You can see the difference. So, it has to move certain centimeter to make sure the old loop is completely cleared from the hook or latch. Once the old loop is clear, you can see the hook is now free. Now, new yarn is now provided to this particular hook. And once the new yarn is provided, the needle starts to descend.

So, you can see here, it is starting descend. And during this descending process, it is still holding this new yarn. And after that, for sometime, it remains on the same height. And after that, it is going to hit this particular metallic block. And because of this, it has to go down.

Once it hits this metallic block and starts doing the downward motion; since it is doing the downward motions, the old loop starts sliding on the top of the needle.

And due to which it makes sure to close the latch. Because now, at this moment, the old loop is underneath the latch. And once the old loop slides with respect to needle, its automatically closes the latch. And once the latch is closed completely and the old loop is near head, it actually released from the or knocked from the needle. And after that, you can see, still there is certain download movement is there.

This is where, the hook still is pulling the new yarn. And this is the point where it actually make the loop length, because it is still pulling the yarn during the download motion. Once the new yarn is pulled, come and sufficient length of loop is formed, now the job is done. But you can see here, the location of needle is still downward and it has to go back to its original position.

So, that's why it is, you can see the path here is raised. And this particular cam, the direction is upward. So, this is upthrow cam. So, again, it forces the needle butt to go back to its original position. So, here you can see, this was the original resting position; this was the original resting position; so, they are exactly at the same location or same height. Once the needle reaches to this position, it simply comes out from the other side.

This is how each of these cams are placed specifically to make sure needle does the right motion. Also, sufficient time is given or considered during the knitting process. So, the design of this cam system is highly scientific in the sense, so that knitting can be done very smoothly.

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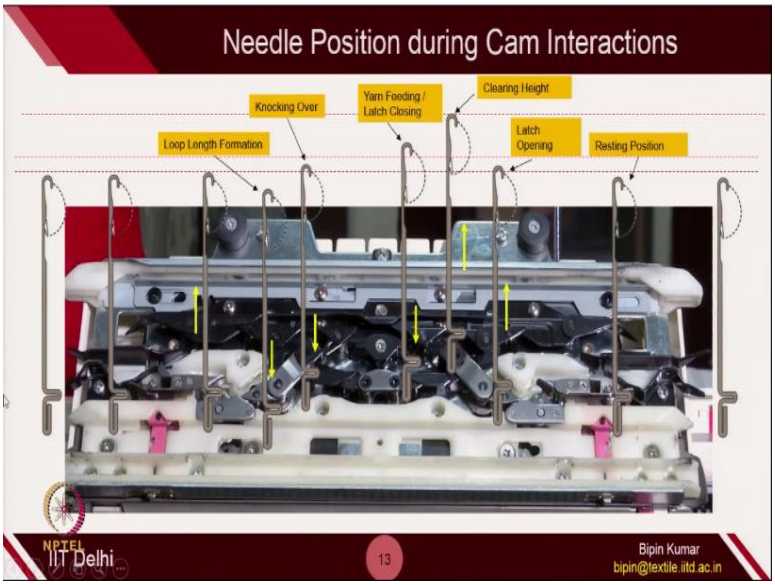

If you reverse this process, again the same thing is happening. It starts from the resting position, again it hits here, the latch starts opening, then it hits the clearing cam. And at this moment, the old loop comes out and it is raised to the maximum height. Now it is catching the new yarn. And since it is going downward movements, automatically the old loop starts closing the latch because it is underneath the latch.

After that, it hits the stitch cam. You can see here, its showing the downward movement. So, now the latch is closed completely. And because of that, the old loop is knocked out from the needle completely. And the new yarn is still locked in the latch and head. So, after that, it reaches further down. Because of that, it creates sufficient length of loop, because it is pulling the yarn.

So, once sufficient length of yarn is there, it helps to create the loop length. After that, the job is done. The upthrow cams helps this needles to go back to its resting position and rest once it comes out from the cam jacket.

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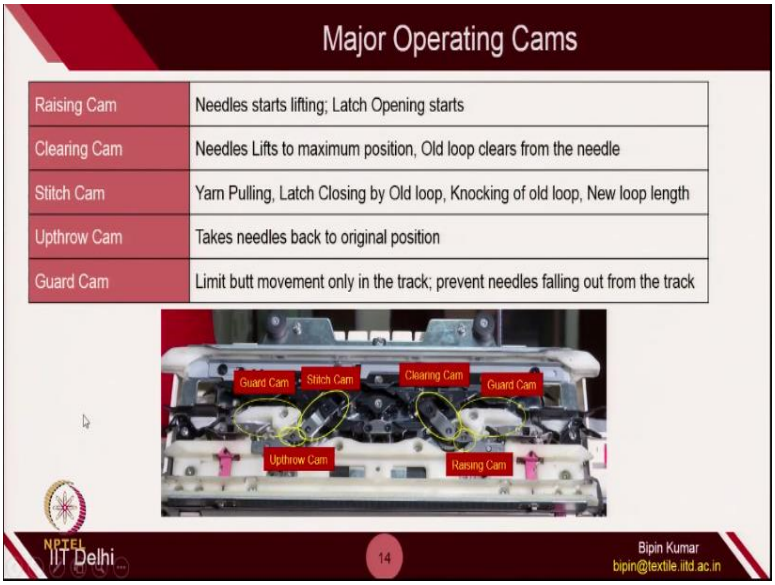

In totality, these 5 cams which we discussed just now: rising cam, clearing cam, stitch cam, upthrow cam and guard cam are the most fundamental metallic blocks which is almost there in most of the weft knitting machines. And now, you can also able to appreciate why these cams are so important. Raising cam is helping in lifting, latch opening. Clearing cam is helping to lift to maximum position, old loop is clear from the needle.

Stitch cam is helps in yarn pulling, latch closing, knocking, new loop. So, stitch cam is extremely important. You can see how many functions it is doing during the downward movements. Upthrow cam is also important because we have to make sure the needle remains ready, once we are changing the direction of cam jacket. And guard cam is also very important for the protection, because it limits the butt movements only in the track.

It also prevents needle not to fall out from the track. So, each of these metallic blocks are extremely important during knitting process. And in most of the knitting machines, especially in weft knitting machines, if you carefully observe the metallic blocks, you will be able to find out some of these cams. Right now, what we showed you was just one of the cam jacket of the first machines which we started in the week 1.

Obviously, once we move to the different machines, you will observe different types of cam profile, different types of metallic blocks. But the fundamental principle remain same. Some cams has to raise, some helps the needles to clear, some cams helps the needle in downward movement which is especially the stitch cam. So, role of these cams are always there. Now,

let's move to the important part for the designer point of view. How we can help, use these machines for fabric design.

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We have made some of these samples on the machines which I am going to show you. Let's first see some of these samples. And then, we will demonstrate you how you can play with the machine elements and make different designs of the fabrics. **(Video Starts: 25:45)** So, here you can see, the first thing which you can easily do on the knitting machine is changing the color pattern.

So, here you can see, here we are having orange color of yarn. And simultaneously, you can change the yarn, you can feed different color of yarn and you can come up with different types of stripes. Also, next thing what you can do is, you can easily see here, the loops are much much bigger, the fabric looks more porous. But here you can see, the loops become smaller and compact.

You can also play with the porosity of the fabric. And you can repeat this process. You can make whatever length of the fabric you want on this machine. Other thing what you can do is, you can also play with the width of the fabric. So, here you can see, you started with certain columns and then you are increasing the width of the fabric. So, you can see here, the width is increasing. Okay. You can go to any width.

And the moment you want to narrow down, you can select different amount of needles and you can still come up with smaller number of columns. So, this is some of the design

possibilities which are there on the machines. And this actually helps you to make the different designs of the fabrics. **(Video Ends: 27:23)** Let's see some of these designs and understand how this machine elements which we discussed helps in these designing. The first thing is, before we start;

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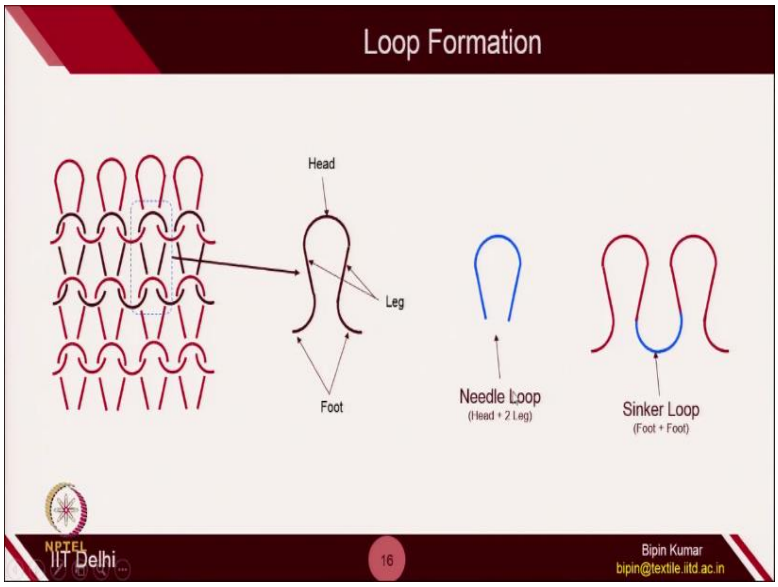

In the first week, I talked about some of the terminologies. While discussing the structure, I discussed about, that each loop is made up of head, 2 legs and 2 foots. And I also talked about how 2 legs and 1 head, this complete unit is called the needle loop. I hope you remember from the first week lecture. And the second thing which I talked about was when the 2 loop is connected by the foot, 2 consecutive foot; and these 2 consecutive foot is called the sinker loop.

So, in each of these fabrics, the needle loop and sinker loop are present. So, we define 2 terms for the fabric loops: needle loop and sinker loop. Needle loop consists of one head and 2 leg. While the sinker loop consists of 2 foots.

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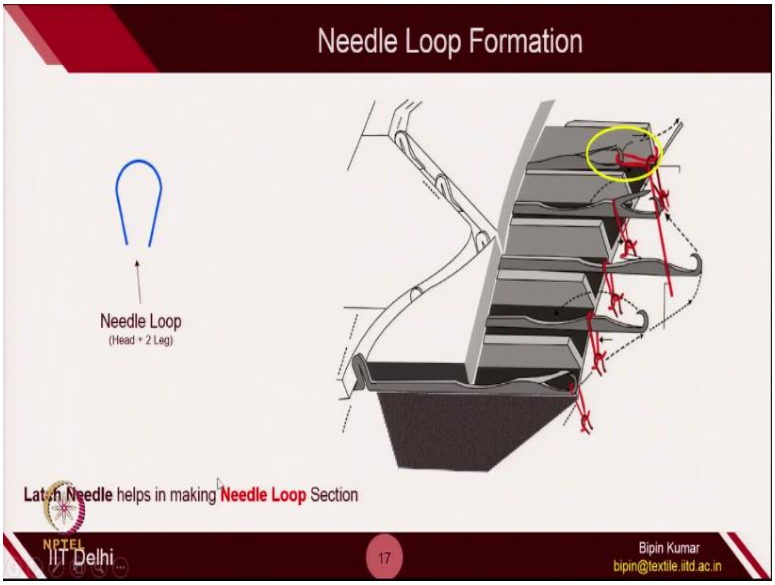

So, let's see how we make the needle loop; why we give this particular segment of loop as a needle loop. So, you can see here, in this machine, if you carefully observe, the needle actually, especially at this location, is making the head part and 2 leg part during the downward movements. So now, you would be able to appreciate why this is called needle loop. Because, the needle is actually pulling the yarn towards the bed and because of this, 2 legs and 1 head is created.

So, latch needle helps in making needle loop section. So, that's why, since the needle is completely responsible for making this part of the loop, so that's why this segment is called needle loop.

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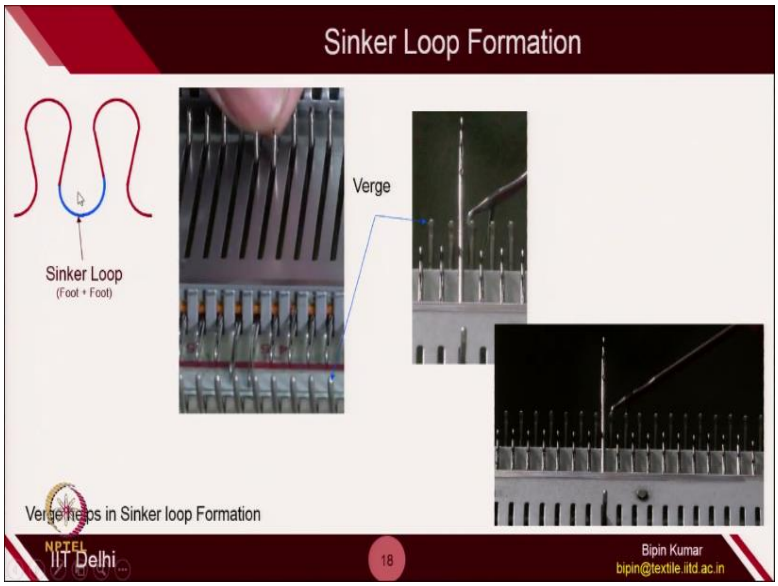

But if you see the sinker part, who is making this particular sinker part? So, here there is a another element on the machine. You might not have observed this. The other element on the machine was the verge. So, you can see here, once the needle was coming out from the bed, it is actually coming out in between a 2 verge. So, you can see here, this is the verge part and while pulling this verge actually provides support for, to this sinker loops.

So, without this verge, it would be difficult for the needle to pull the yarn inside the bed. So, this verge is important segment. Although the name is not coming directly from the verge loop, it is called sinker loop, because there is another element on different machines where other element on the machine which is called sinker which is responsible for making this sinker loop. So, that's why it is called sinker loop.

But at this moment, that sinker element is not there in this particular machine. But once we move to the next lecture, I will talk about sinker loop part. And this particular word sinker, this is a another machine elements which we need to understand very carefully. But at this moment, this machine is free from sinker loop. The verge is playing the role to make this sinker loop. Because, once the needle is catching the yarn going inside the bed, the verge is there to support.

And because of this support, the sinker part or this yarn segment get struck with the verge. And due to which, sinker loop is created. **(Video Starts: 31:00)** You can see here, in this video also you would be able to see what is exactly happening. So, you can see here, this needle is coming down and this 2 verge on left side and right side is there; and which helps to give support to the yarn segment. Okay.

This is the needle, this is the verge part. You can see here, this is the verge part. I am showing you by needle. **(Video Ends: 31:33)** This has to be there, otherwise the knitting would not be happening. Because, we cannot simply make the needle part, we also need the support system to support this segment of yarn during knitting process.

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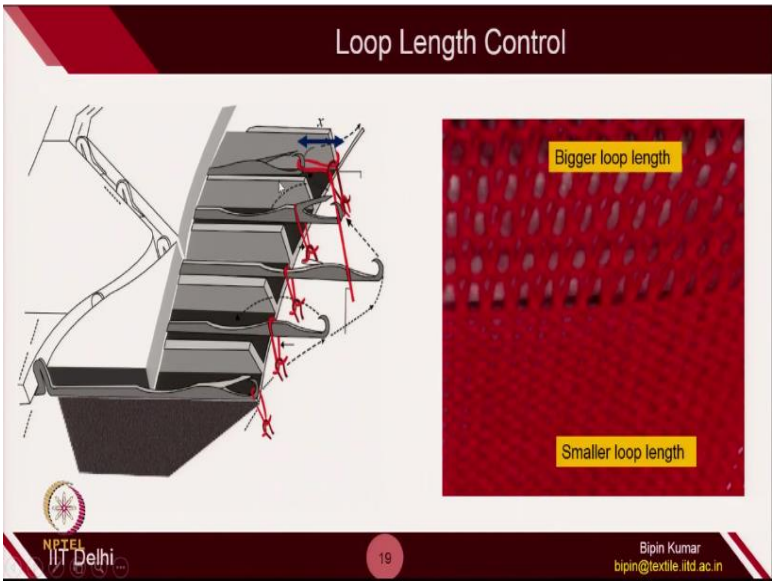

Loop length control: just now I showed you one of the fabric where you can easily observe, like some places, the loop density was bigger and at some places the loop density was smaller. Because of bigger loop length, you can observe this part of fabric is highly porous, this part of fabric is highly dense. And this is all happening because of how we are doing the knitting.

So, here if you see this particular segment, this particular needle, if it goes further inside, you can pull or you can take maximum length of yarn. And in this way, you can create bigger loops. But if you make sure the X remains smaller, you can create smaller loops. So, it depends, how much downward movement is happening to the needle, which decides the loop length on the machine.

So, there is a knob on the machines which you just rotate it and it will change the functioning of stitch cam. And ideally, this stitch cam actually change the distance to which this particular needle can descend and go up. So, this is what is happening during the loop length control.

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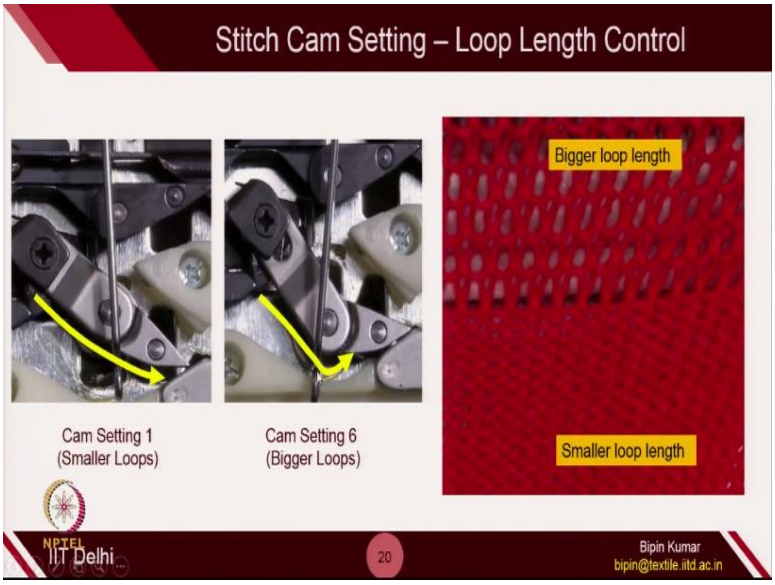

Here you can see, this is the stitch cam which I showed you. So, in cam setting 1, this stitch cam was slightly straight. So, the butt was somewhere here positioned. So, it simply goes like this and then raises up. But if you see in different cam setting positions; so, that butt is forced to go even more down. So, if it goes down, it takes more length of yarn and it creates bigger loops. And this is the smaller loop.

So, the cam setting 1 results to smaller loop length because of the positioning of stitch cam is different. But for creating bigger loop length, the positioning of stitch cam is different. So, you can see here, the butt is going more down. So, more down means, more X, more X means more yarn length. And more yarn length means bigger loops. So, this is how what is happening on the machines. You can see here, the direction also, it is showing completely, it is going little bit more down.

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Here you can see the **(Video Starts: 33:54)** small video, what is exactly happening. This is stitch cam. And now, the stitch cam setting is getting changed. You can see here it is, it is going down. And because of this, it forces this butt to go even more and downward position. So, because of that, the yarn length or yarn consumptions is more and loop length increases. So, playing with the loops is one of the fundamental key elements which is **(Video Ends: 34:27)** helpful, not only in design, but also in engineering.

You can play with the comfort of the fabrics by playing loop length, because you can change the porosity, you can, the lot of fabric properties can change. Stitch cam is the most important metallic block on the cam jacket which plays this function.

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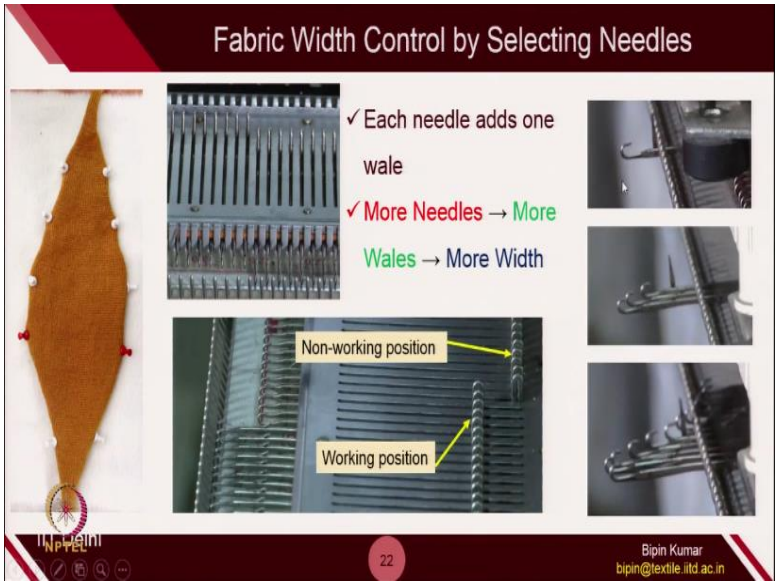

Another thing which I showed you just that how you can play with different needles and you can control the width of the fabric directly on the machines, which is not possible on the woven fabric productions. Because, in woven fabric, you have to actually cut the fabrics. But here, knitting gives you that flexibility. Because, you can start with, let's suppose 10 columns or 10 loops.

And then, you can increase the needles on both the sides. You can increase the width of the fabric. So, this is possible. So, in one of the lecture, I also do that there are 2 position of the butt. One was resting position, one was working positions. And each needles add 1 wale to the fabric. So, more needles if you select on the needle bed, you can create more wales. And more wales means more width of the fabric.

And selecting of the needles is highly flexible. So, while running one particular fabric on the machines, you can increase or decrease the needles that's operating or engaging with the cam jacket. I showed you 2 positions of the needle; so, non-working position and working positions. So, non-working positions remain idle, because this butt does not engaged with the cam jacket. But working position, this butt engage with the cam jacket.

So, during anytime you can push this butt downward and upward depending on what type of design you want to create. So, we can see here, simultaneous, we started with 1 needle, then 3 needle, 5 needles, everything is possible.

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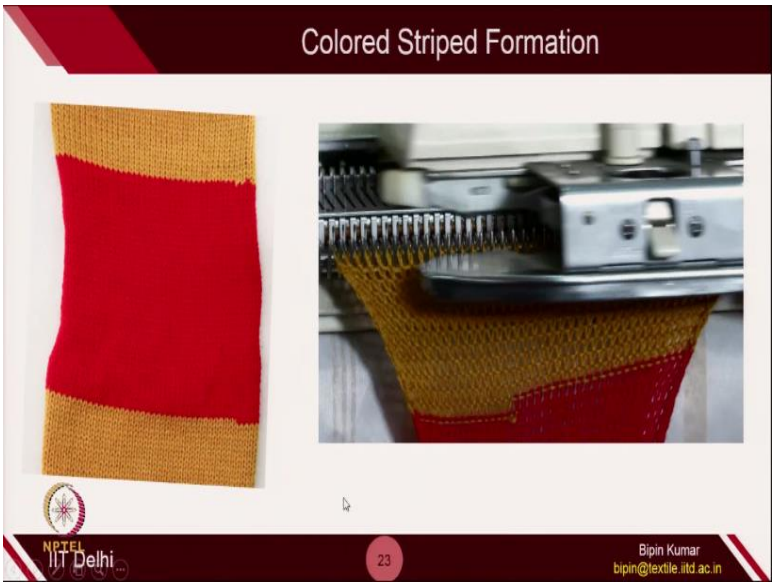

Other thing which you can do is like, anytime you can change the color of yarn by feeding different yarns. And you can create stripe design of the fabric. **(Video Starts: 36:30)** So, here is a small video you can see. So, currently it is consuming red color of yarn, now I started feeding yellow color of yarn. You can see here, automatically this yellow color become the part of the fabric system, which is also a unique flexibility that knitting gives, not the weaving.

Because in weaving, changing any warp thread, it means extremely difficult. So, clearly, knitting is **(Video Ends: 36:59)** much flexible compared to weaving process. And if you understand the technology well, the possibilities are enormous. Now, let's summarize what we learned in this particular lecture.

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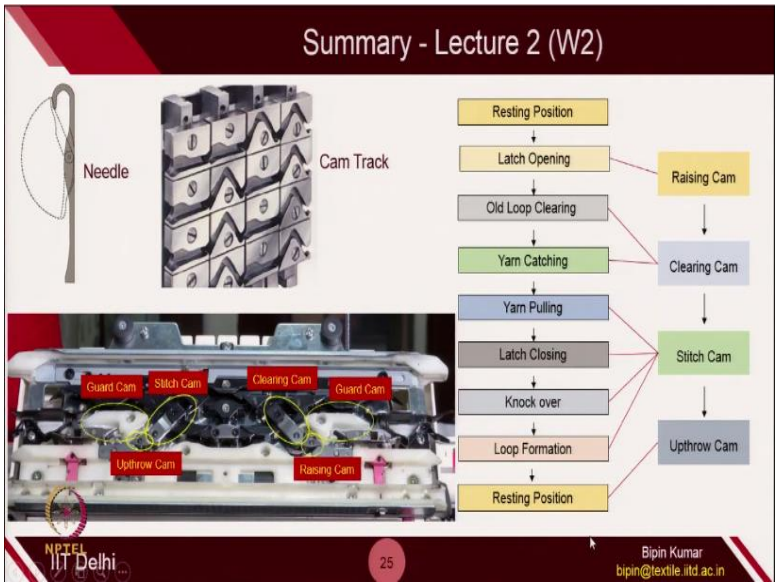

We talked about needle and cam interaction. So, the whole lecture was devoted only to cam and the track which was created by these metallic blocks. So, this is another cam. But we mainly focused on the single bed cam system. The main principle remains same. It always have certain section of metallic blocks and these blocks are called cams. Ideally, there are 5 to 6 cams operating during the knitting process.

One is stitch cam, clearing cam, guard cam, raising cam and upthrow cam. So, even if we change the cam jacket, some tracks will be created, some metallic blocks will help the needle to raise, some metallic blocks will help the needle to download motion. So, the fundamental principle will remain same even if we change the machine. So, next time, once we will be discussing the different machines, I am not going to go in the detail part.

So, I hope you would be able to understand these cam system well. These cam system are fundamentally extremely important to locate the butt positions, to do certain functions of knitting. So, this was loop formation process. We started from the resting position of the needle, then the latch of the needle opens up, then it, old loops get cleared, come out from the latch. After that, the head is free.

So, head of the needle is catching the yarn. Then it is pulling up, then latch is getting closed. Finally, the old loop is knocked over and the loop is getting formed. And again the needle goes back to resting position. So, the process is actually in a very synchronized way and the timings also extremely crucial during the knitting process. And similarly, the process is so synchronized.

The interaction or the positioning of raising, clearing, stitch cam and upthrow cam on the cam jacket is also synchronized in certain way. So, first it, the needle butt interacts raising cam to do this particular operation of knitting. Then it interacts with clearing cam to do this particular 2 operations of a loop formations. Then it interacts with stitch cam and you can see how important is the stitch cam, because it helps in yarn pulling, latch closing, knocking, loop formation.

And finally, upthrow cam which helps or make sure the needle remains in the same starting position which is the resting positions. So, with this, we are going to stop this needle cam interactions in this lecture. In next lecture, we are going to introduce you circular bed knitting. So, see you soon. Thank you.