Science and Technology of Weft and Warp Knitting
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Lecture - 37
Warp Knitting Technology- Loop Formation

Welcome participants to Lecture number 3 in week 8. Today the topic is Warp Knitting Technology Loop Formation. So in the last class I have given you the introduction about warp knitting structures and their application potentials and some basic principles. Today we are going to see the machine elements through which we can make the loops in a warp knitted structures.

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Let's do a quick recap of what we covered in the last lecture. We have seen how loops are connected in warp knitted structures. I already demonstrated you that the yarn in a warp knitted structures follows the length direction that's why it is called warp knitting and each loop is connected with different courses in the structures. So this is how this structure is different from a normal weft knitted structures.

The structure is not that extensible, but the structure is highly porous compared to weft knitted structure. We have seen it can be used in many technical applications like in medical it can be used for mesh fabric, for hernia, shoes knitting, for mosquito net fabrics for cushioning applications and also in garmenting. There are many lists of applications of warp

knitted structures you may follow other literatures to see the application potential of warp knitting.

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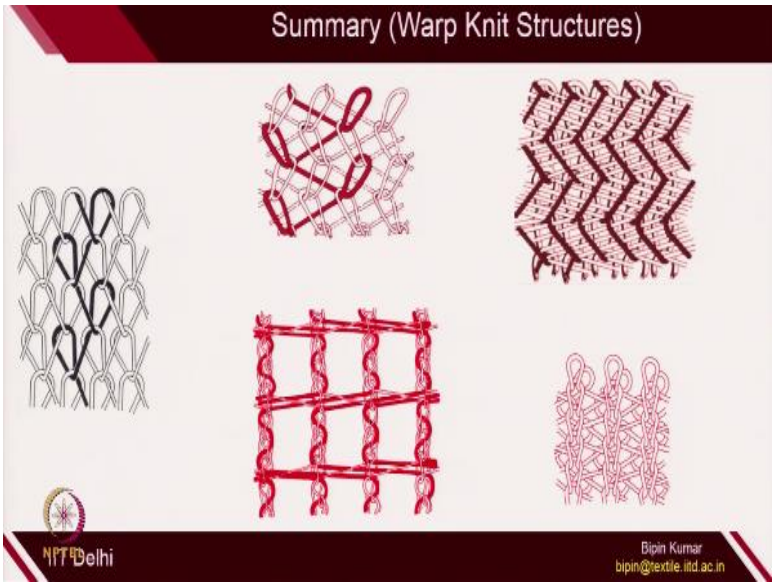

We also given more emphasis on how you can create different structures in warp knitting. The structural possibilities is unlimited and the designs are highly complicated. Some of the designs I will be covering in subsequent lectures, but similar to weft knitting warp knitting also gives you a lot of flexibility in fabric designing and analysis. So let's move to the loop production step in warp knitting.

Because this is the foundation if you understand the loop formation of any one of the structures that can be replicate for designing other complicated structures as well. So in this lecture, I will be focusing on the loop formation of a very simple structure like this, this is the simplest one compared to other structure which is shown in the slides. So if you understand the loop formation in one structures others you can visualize and replicate.

So loop formation in a warp knit structures. So before I move just a quick recap on the yarn movement in the fabric of warp knit.

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This is the actual machines on which you are creating warp knit fabric, but unfortunately you would not be able to analyze anything out of it. So this is you can see the fabric is being roll down in a roller and this is where the loops are being created. So at this moment it is really difficult for you to understand, but slowly, slowly I will unfold each of these machine elements and each steps of creation of warp knit structures.

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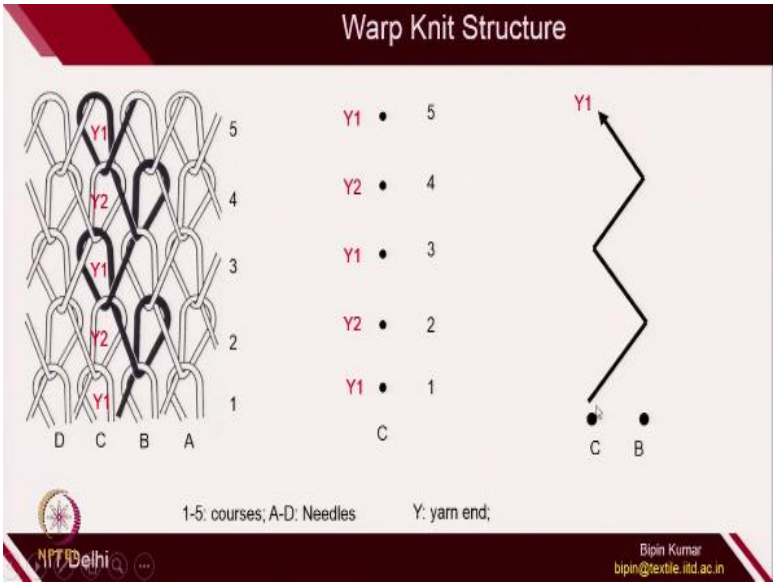

Before I move on I just want to recollect the yarn path which is being followed in a warp knit structure. So in a warp knit structures we have seen like for the same needle in every alternating course it is catching different yarns. So for example if you see this needle number C in first course it is catching Y1 yarn in second course it is catching Y2 yarn, third course it is catching Y1 yarn.

And these yarns are provided by guide to this needle and these guides actually take the yarn from one needle to other needle. So if you follow the path of one yarn for example if you follow the path of black yarn you can easily see that in alternating courses it is shifting the position of needle. So this in the second course it is this black yarn is with needle B in third course it is with needle C and this is repeating.

So the guide is actually taking the yarn from one needle to other needle in subsequent courses and this is how you create the structure.

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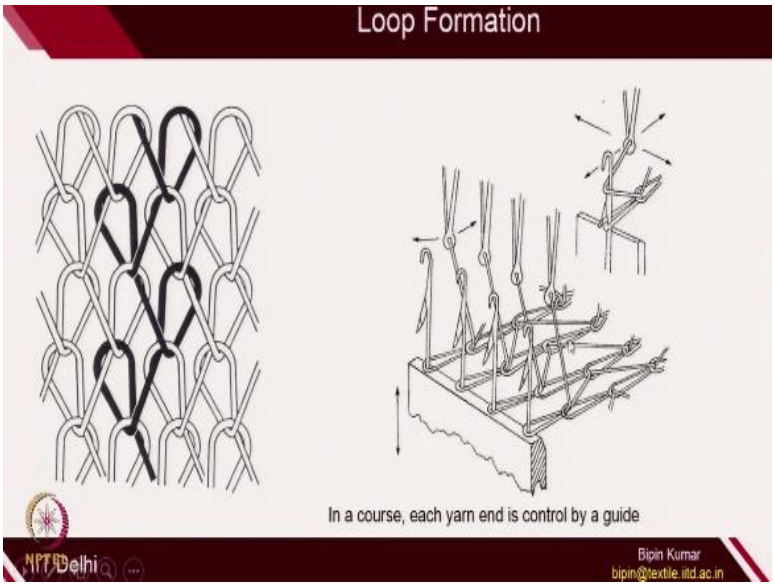

And for providing yarn to each needle we have individual guides and these guides actually keep changing the location in every alternating courses. This is how you define a design a very simple warp knit structures. So the bottom line is the role of guide is extremely important because the movement of guide in subsequent courses will decide you how the loops in the structure will look like and what type of fabric designs you actually want to create.

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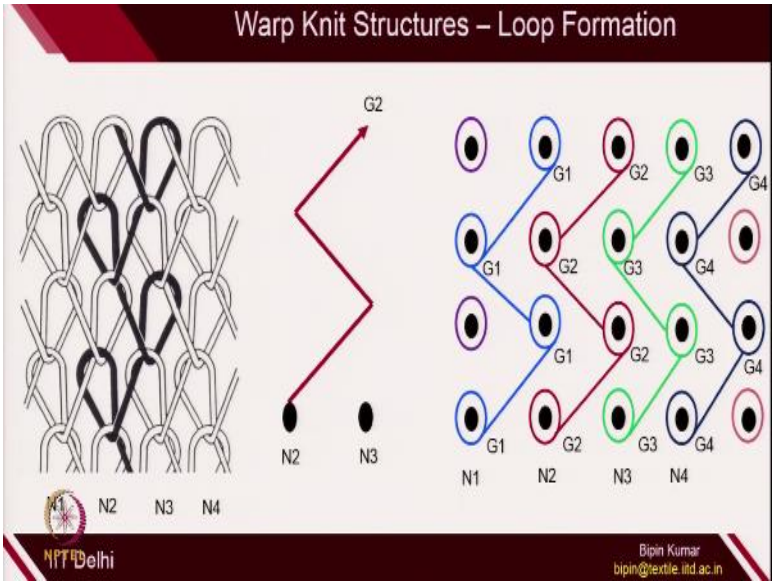

So again I showed you how the role of guides and needles are important in loop formation. For example, here in the first course needle N2 is making loop using the yarn from G2. In second course the G1 guide is providing loop to needle N2, in third course again G2 guide is providing yarns to needle N2 and similarly you are repeating the same thing. Why I am repeating this slides.

Because once this thing is clear to you the next few slides will be very easy for you to understand. So the bottom line is if we follow the path of guide or the yarn you can easily see in every alternating courses it is changing the location. So in the first course it is with needle N2 in second course it is with needle and N3, third course it is with needle N2 and fourth N3. So this is how the guides shift locations.

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So this is the fabric production in a slow motion I hope you can you can see it moves from left to right and then right to left. So left to right and then right to left so this is how it is doing. So left to right and right to left okay so it is shifting laterally left side and then right side. So this is how the guides are actually changing the direction of yarn in every subsequent courses.

I am now going to split each of these movements for your understanding, but before we move on let's see what exactly is there in the knitting zone which part is important and dominating in this knitting zone.

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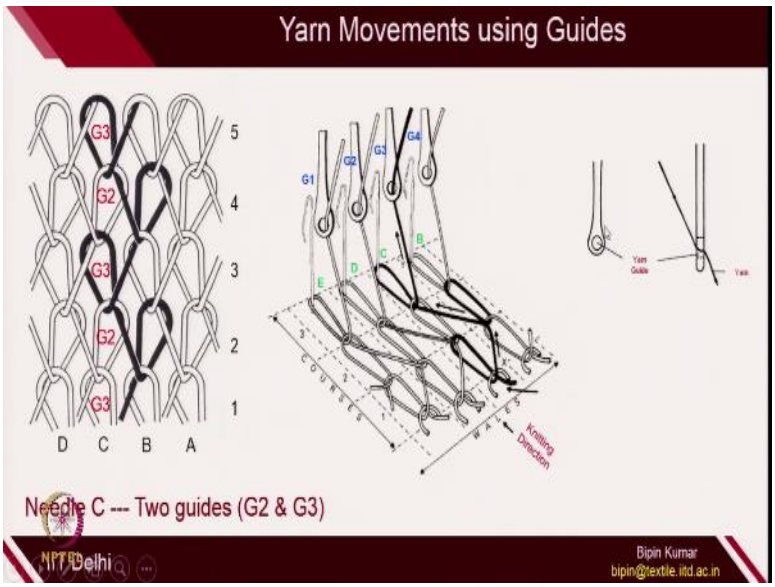

So it is the guide actually which provides yarn to a particular needle. So if you see this schematic. In the first course if you follow the path of this black yarn this black yarn is interlaced with G3 so the guide number G3 and the white one is guide number G2. So in course number 1 if you see this is course number 1 so this loop is created by guide number G3.

In course number 2 this loop is created by guide number G2 again in course number 3 G3. So you can see how the guide bar is shifting position in every alternating course. So for each needle two guides are coming and interacting during the fabric production and this is the guide through which you can pass the yarn and this guide can be shifting position during course formation.

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This is the normal machine the courtesy to the Karl Mayer which the machine from warp knitting technologies the most popular manufacturer around the world is called Karl Mayer and this is the some of the videos which you can see. So here the warp beams.

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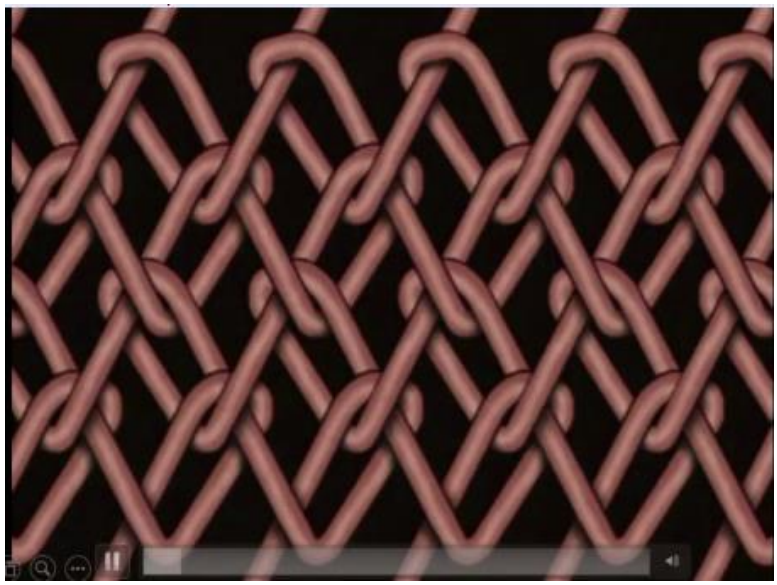

This is the structure which I already described. So if you follow the path of one yarn you can actually see how the yarn path is moving. So this is how it is moving so they are connected with different courses.

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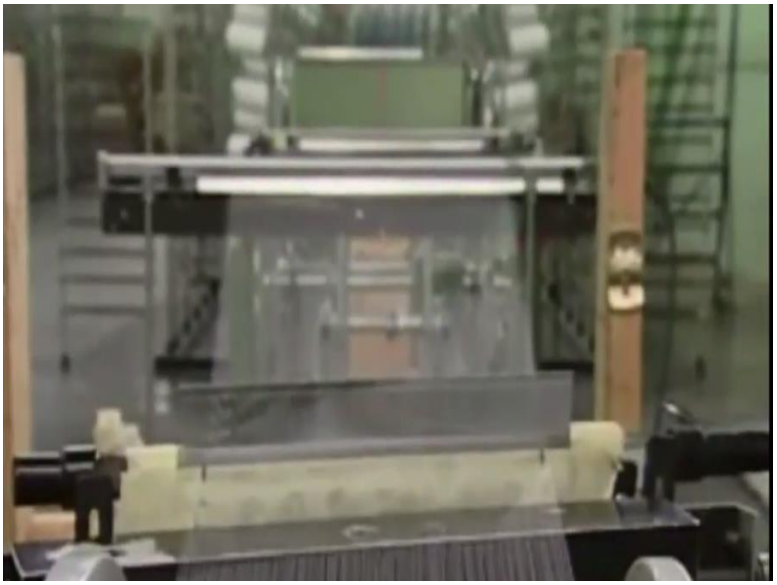

And this structure is created by multiple yarn ends. So these yarns ends are prepared on the creel or the beam you can see each yarns are going out and these yarns are actually feeded to the needle in this zone. So you can see this is the yarn which is provided to the needle and this is the guide through which you have passed a yarn. So I am going to split every section of this machine.

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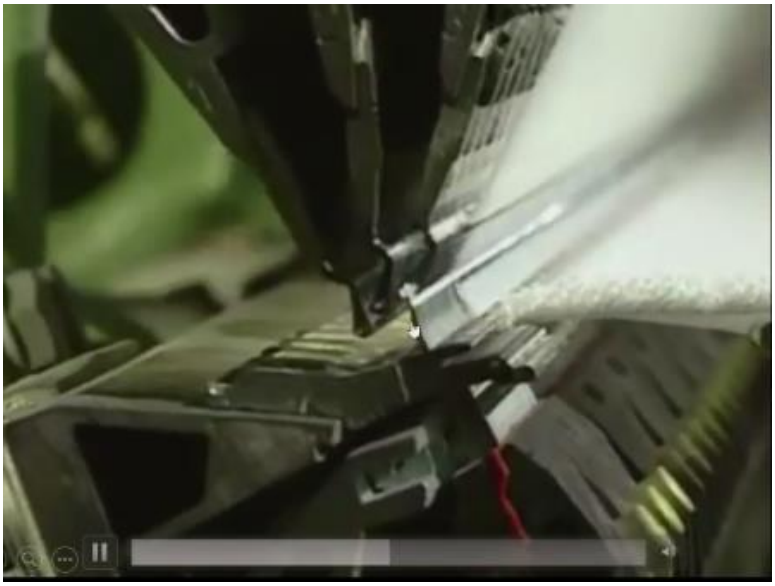

So you can see this is the guides and this is the needle which is coming up to catching the yarn from different guides and this is how you create the fabric. So this is the normal picture of the loom which is there in the factory and they make the fabric in one go.

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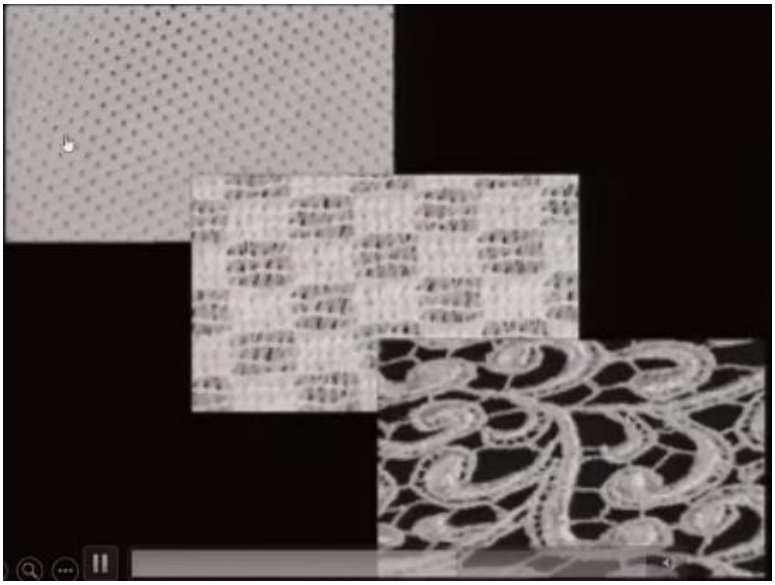

There are different types of fabrics that can be created smaller mesh bigger mesh and this is crochet from so you can see the mesh size is much, much smaller. So these are the types of fabrics that can be created on this type of machines. It again depends on how you are providing yarns and how the guide bars are moving. So the guide bar movement is very, very important in deciding the fabric structure.

So this is so even you can create lace pattern using warp knit structures. So how do we actually make this fabric? So I have demonstration on our machine which is there in our lab. So if the main knitting where the loop are being formed there are 3 basic elements which is needle, sinker, and guide.

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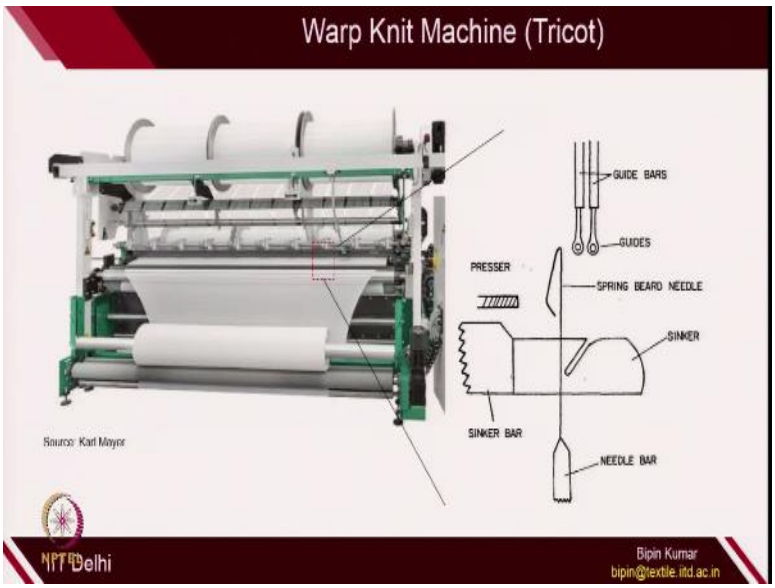

So this is the actual machines which is used in the factory and if you take out the knitting zone where you are actually creating the loops and pulling the fabric from one side. So you have 3 types of elements which you can find. First one is needle, second one is sinker and the third one is guides. So these 3 guide, needle and sinker they operate in a perfect synchronized manner to make the loops.

So first let's see this each element individually and then we will give you the step by step process of loop formations.

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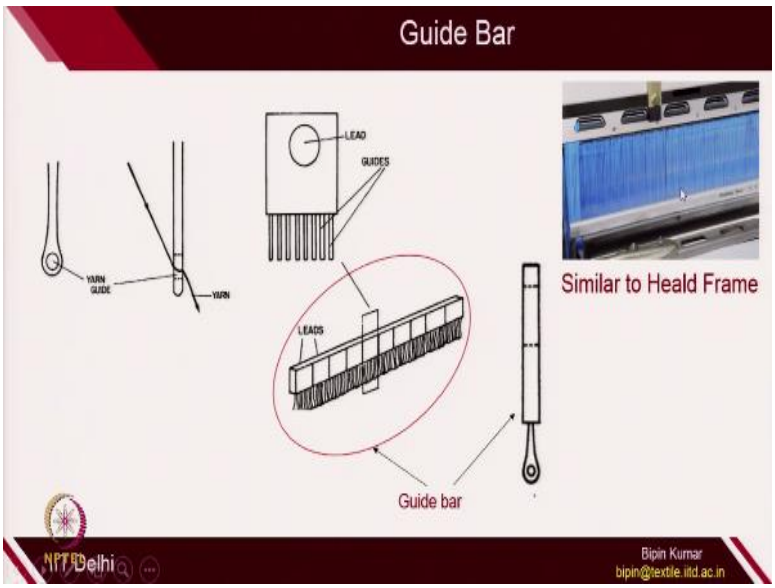

So the first one is guide bar. So guide is nothing, but it is similar to the heald frame. So each yarn will be controlled by one guide and if there are many guides you can place these guides on a bar so this is the bar and it has many guides. So one guide is shown here so it has 1000 guides so each guide can carry one yarn. So if it has 4000 guides it can carry 4000 yarns. It is similar to heald frame.

So if you look at from one side this is the hole through which you can pass the yarn and it is similar to heald frame in weaving machine. So in a heald frame if you if you recollect your weaving principles. So each warp yarns will be passed through the heald eye and the heald wire is actually placed on a frame. So this is the frame and on this frame there are multiple heald wires and through each wire you can pass each warp yarn.

So similar to heald frame here you have guide bar and if you give movement to this healed frame all the warp yarn which is associated with this particular heald frame will either go up

or down. The same thing you can be doing here with the help of guide bar. So if you move the guide bar left all the guides and all the warp yarns will be shifted left if we are moving the guide bar towards right all the warp yarns which is there on the guide bar will be shifted towards right.

And if you swing it, it will take the yarn to the front side of the needle. So this is how the guide bar is important.

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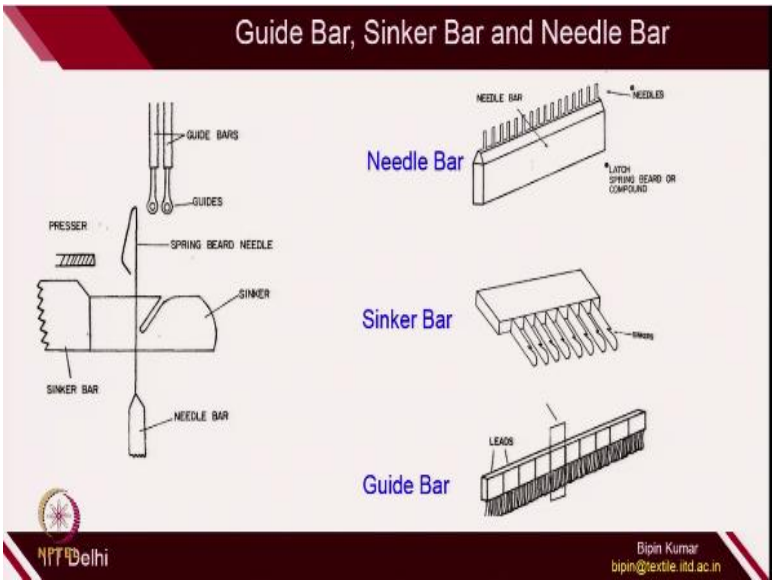

For the knitting to be performed these 3 elements needle, sinker, and guide are extremely important. So the first one is needle bar, second one is sinker bar third one is guide bar. In principle, if you recollect the needle placement on a weft knitting the movement of each needle was different this is not the case with the warp knitting. So in warp knitting all the needles, all the sinkers, all the guides will have same motion.

Same displacement at the same time. They are not free to so the each needle are not moving individually. They are rather fixed on a block and the whole block is moving. So all needles placed on that block will have exactly same movement so that's why the production of warp knitting is very, very fast because at the same time you can engage needle to catch yarn at the same time you can engage all the needles to release old loop.

So the production of a warp knitting technologies is much, much, much faster than compared to weft knitting technologies.

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So this is the 3 elements which is placed on the machines so guide bar, sinker bar, and needle bars. So this is one block of needles so this is the needle, this is the needle which is moving up and down. The other block is this is the guide and the third block is the sinker so which is you can see this is the sinker. So 3 blocks you can see it here so one is sinker this first one is needle sinker and this one is guide which is there on the top.

So this is guide this one is sinker and which is moving up and down this is needle. So let me show you these blocks before we move to the actual movement of loop formation.

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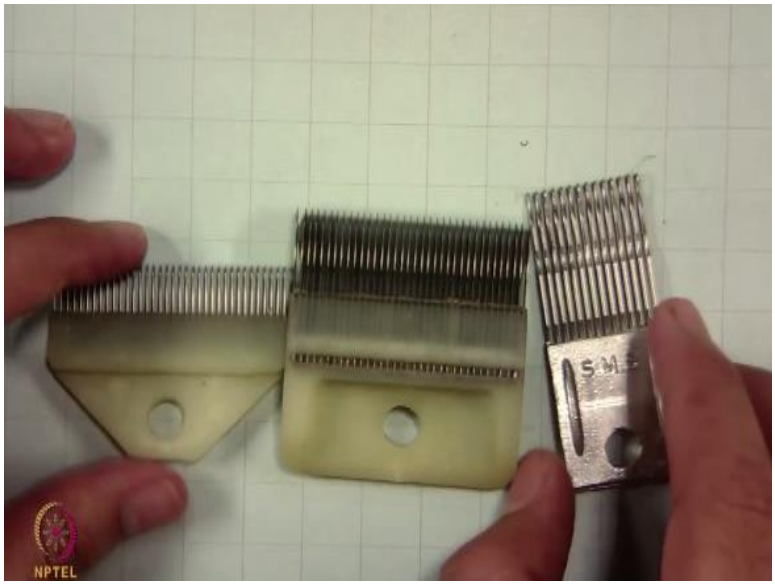

So I have the 3 blocks of needle, sinker, and guide block. So this is the sinker which so you can see there are many, many sinkers which is placed. So you can see there are many, many sinker so each sinker is fixed in this block okay. Similarly, you have the latch needle so this is

the latch needle okay. This is the latch needle and these latch needles are fixed permanently on this block okay and this is the guide.

So you can see here so this is the guide. So you can see each guide has a hole through which you can pass the yarn. So you can see there are multiple guides so again you can decide the gauge so the gauge of guide gauge of needle and the gauge of sinker will remain same. So this is the guide so you can see there are many guides which are placed and there are many sinkers which are placed this is the block of needle.

So the beauty of this is you can see if this block moves all needles which is on this block will have same movement. This is not the case with weft knitting. So in weft knitting each needle has separate movement. So the position of each needle during knit formation will be different, but here in case of warp knitting all needles will be having exactly same movement. Similarly, all guides so each guide you can see it if you from the left side if you see there is a holes through which you can pass the yarn.

So you can see it here so this is this is the guide so each guide can carry one yarn and each guide will provide yarn to each particular needles okay during loop formation and this is the sinker which again has very important role to play in loop formation. So these are the 3 blocks key blocks in one of the simplest warp knitting machines which helps in loop formation. So let's see how they are fixed.

So this 3 blocks of needle sinker are placed and they operate in synchronized way to make the fabric. So this is the fabric development. So during the fabric formation these guides shifts location from one needle to other needle.

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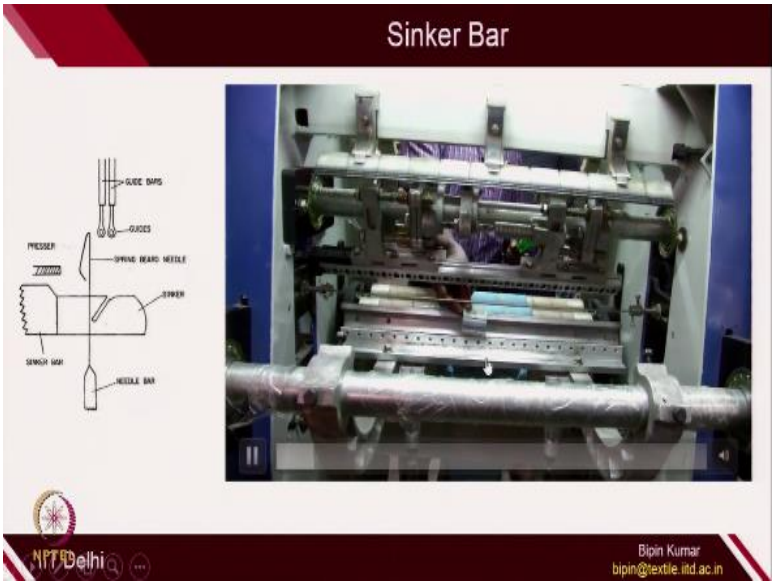

So let's see first fixing of sinker bar. So I am fixing the sinker block which I showed you so this is the sinker block so this is the sinker which I am keeping in my hand and I am fixing on the machine. So you can see it here so this is the sinker I can fix it there is a hole on the entire bar I can put that block in that hole and with the help of screw I can fix it on the machine. So the sinker is now fixed, sinker block is fixed.

So on one side you can look at what just one sinker is visible, but if you see the top view you have multiple sinkers which is placed on the same block.

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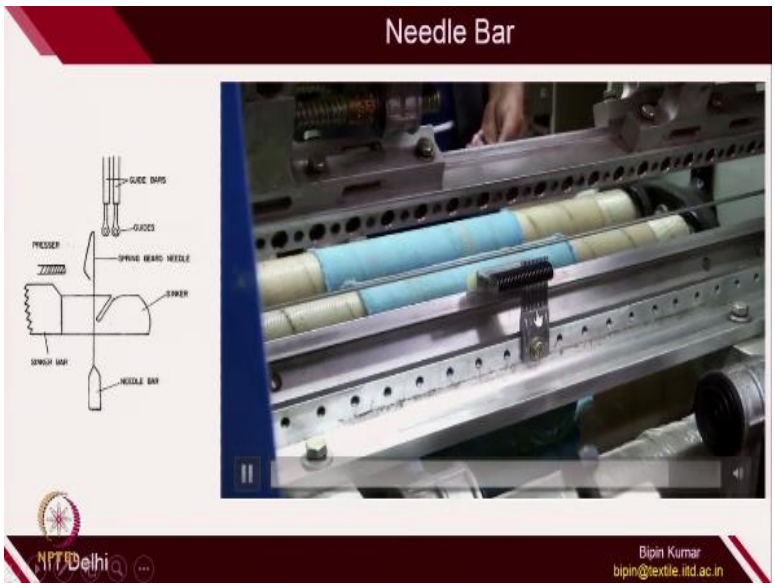

Now the needle bar I also showed you the needle bar. So I am fixing the needle bar on the machine so you can see this is the holes. So I have the needle block and this needle block I am fixing it on the machine. So you can see it here so I fix needle block.

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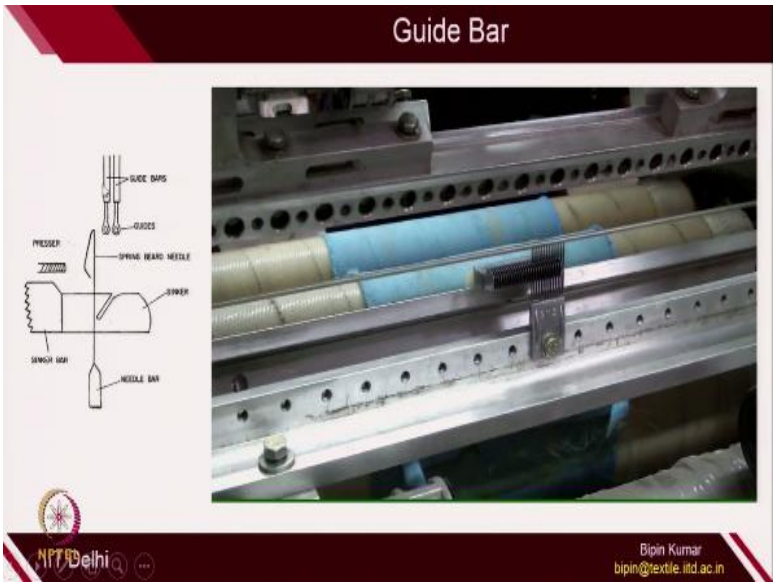

Now the next part is the guide bar so the guide bar this is the guide bar. So here there are 2 guide bars are formed, but I am fixing just one guide bar. So the guide block so I am fixing it so here you there is a holes you can see it here. So I am going to fix in one of the holes the guide. So this is the guide so in reality although you are looking one sinker one needle and one guide.

But there are multiple sinkers, multiple guides and multiple needles that are placed on the block, but from the side view you could be able to because the projection will remain same. So for a loop formation one sinker, one needle, and one guide will do the Knitting action. So how is that that I am going to explain in this lecture.

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So here you can see how multiple guides, multiple sinkers and needles are operating so you can see it here. So the guide bar is swinging so you can imagine this will be providing yarn and the needle is raising up and down to catch the yarn and the sinker again similar to the circular knitting I already described what is the role of sinker especially it is very important for making sinker loop, holding the fabric when the needle is rising.

So all those functions again the sinker is doing here so these 3 elements will be very, very important in loop formation and whatever you are looking it in a slow motion it is actually on the machine it is happening at very high speed which you can see it here. So in running condition it will be very, very difficult to even imagine what exactly is happening at the machine level.

So I am going to break down all of these movements for you to help you in loop formation okay. So the key idea is which you are looking at here so each guide will be shifting between 2 needles in every course. So I already showed you this so if you carefully observe the movement of this guides and these needles. So after every course development the guide will be shifting left or right depending on the fabric design and all this process is happening at a very fast speed, difficult to even imagine.

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So this is the actual condition where you can see this is happening each guide is carrying the yarn and the fabric is being formed. So you can see this is the yarn and the guides is there they are supplying yarns to the needles in alternating courses. This is the very dense fabric

which is being created the other fabric here you can also see the same thing, but the density is much bigger.

So again it again depends on the design what type of design and what type of motions you have given to guide bar for the fabric development. So the guide bar movement and needle and sinker movement are synchronized properly for fabric productions. In most of the warp knitting technologies you will find guide bar and needle as well as sinker all working simultaneously for loop formations.

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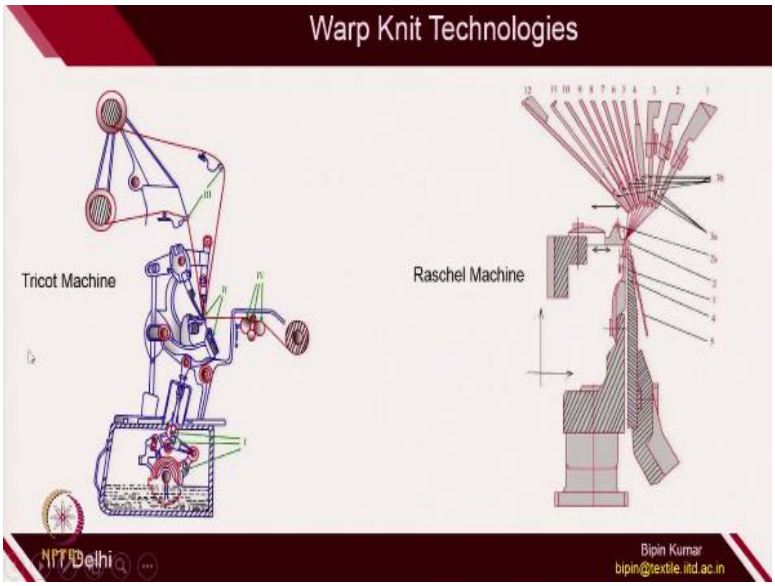

So in the market there will be 2 type of technologies which you will find out in warp knitting. First one is Tricot machine and the second one is Raschel machines. The name is just the name, but ideally speaking the principle of loop formation remains same there will be interaction of needle and guide in both the machines.

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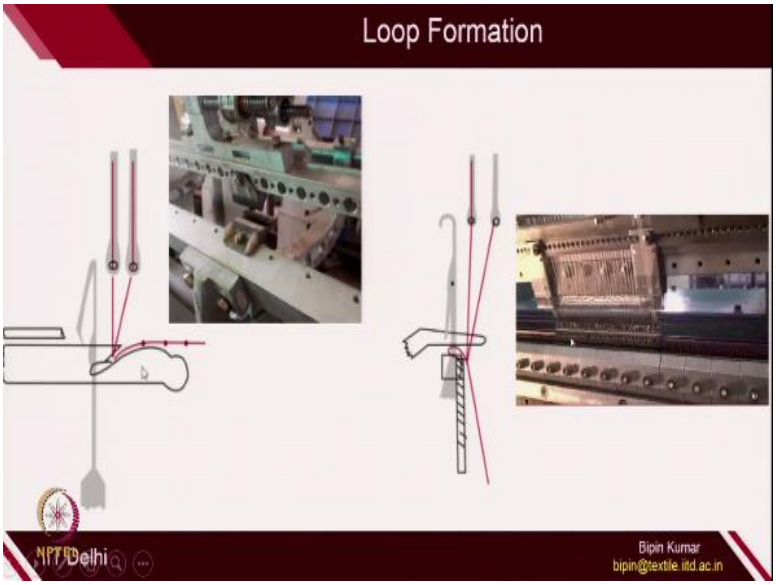

So here in tricot machine you have the sinker, needle and guides they will be working which I showed you and in Raschel machines sinker will have different shape. There will be a additional bed which will be helpful in fabric pooling. So this is the Raschel machine and this is the tricot machines. So let's understand the principle of first tricot machines what exactly is happening in every course in terms of movement of guide with respect to needle and sinker and then we will move to the Raschel machine.

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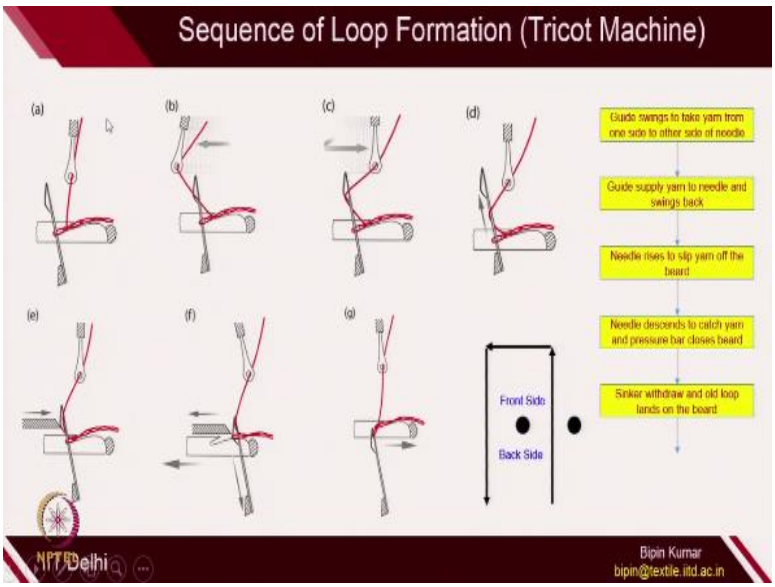

So sequence of loop formation on tricot machine. So as I mentioned for making a loop in a warp knit structure you need 3 elements one is needle, one guide to supply yarn and sinker to help in loop formation. So these 3 elements is a must. So before the formation of loop formation the guide is actually standing at the backside of the needle. So if this is the needle and if you are assuming the front side on the left side of this figure.

Then the guide is standing on the backside of the needle. So it is not facing the head of the needle. So this is the needle if you take the top view so this is the needle the guide is standing somewhere at the backside and the needle is there on the front sights. So I can show you the position actually you can imagine this is the needle so this is the front side because the latches there so you can see this is the latch and so this is the backside of the needle.

And in reality the guide bar will be standing like this on the backside and the guide bar actually swings from backside to front side. This is the front side of the needle and this is the back side of the needle and the guide bar is standing here which will be shifting from backside to front side okay so this is what is shown in the animation. So here you have the needle and here you have the guide.

So guide wire is actually before we starting the loop formation guide bar is at the backside of the needle. So this guide will be carrying one yarn because one needle will be taking one yarn for loop formation after that the guide is shifting from left side to right side. It means it is moving from backside of the needle to front side so this is the actual swinging. So here actually the guide is taking the yarn towards the front side of the needle okay.

And how this guide bar moves it moves through the space between 2 consecutive needles. If the guide bar is also fourteen so they are placed in such a way that the guide can swing in between the needles space. So this guide one guide is shifted in between the needle space and swing from backside to front side. So guide bar actually swings from backside to front side to take the yarn.

After that it actually swings back after providing the needle. So for providing the needle the guide bar not only has to swing back, but also it has to sift laterally towards right side. So from B to C this guide bar is doing 2 functions one it is shifting from right to left because it has to give yawn and then it is swinging back. So this process it is actually shifting laterally as well as it is doing swinging. So in this way it can provide the yarn to the needle.

So guide strings yarn from one to the needle and swings back. So 2 movements it is doing lateral movement and swinging movement. After once this is done the yarn is actually there on the beard part of the needle and then the needle shifts upwards so that the yarn moves to

the stem part. So this is the stem part so this is the needle bar is actually moving up to slide the needle from the beard okay.

After that actually the pressure bar is closing the beard and needle is going down. So in this way it is catching this yarn in the beard or head part of the needle okay. So in this 2 steps is happening one a pressure bar is coming to close the beard and also the needle is going down. So in this way needle descends to catch the yarn and pressure bars closes the beard. After that sinker starts towards left so that the old loop rises to above the beard part okay.

So you can see it here so the old loop is still in the belly of the sinker. So once the sinker moves back the old loop is now free and because of that it rises above the beard. So now the new yarn is still under the beard and the old yarn is above the beard and the beard is closed and pressure bar is now released in the next action the loop is released so the old loop is knocked over.

So this is the overall sequence obviously if you compare this with a warp knitting technology it remains same. First the old loop has to be cleared which is already there here then you have to provide new yarn and old loop has to be knocked out. So here in from B to D actually you are providing the yarn and from F to G you are actually knocking out the old loop so this is how you are doing this function.

In the next course, the needle will do the same function but the guide will be changed. So for example if guide G1 is here right now so in the next course some other guide will come for loop formation. So this is how you make loop in the tricot machine. Although the photo is given with the help of beard needle there are latch needle also available doing the same function not so difficult to understand.

You can also use compound needles for loop formations, but beard needle is mostly used in warp knitting machines so that's why I thought to describe in with the help of beard needle. You can imagine the role of guide needle and sinker is very key or prominent in the loop formations. And the sequence has to be followed.

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So you can see it here exactly those functions are happening here on the latch needle we are using latch needle here. So the guide is swinging so you can see the guide is swinging then it is providing the yarn it is shifting laterally it is so the guide is swinging you can see it here then it will provide the yarn and then swinging back and the sinker is also moving in the same fashion.

So if you compare those sequence with this video hopefully you would be able to understand, but on the running conditions it is very, very difficult because all guide is active, all needles are active, all sinkers are active so very difficult to visualize, but the same knitting action is happening here also on the machine.

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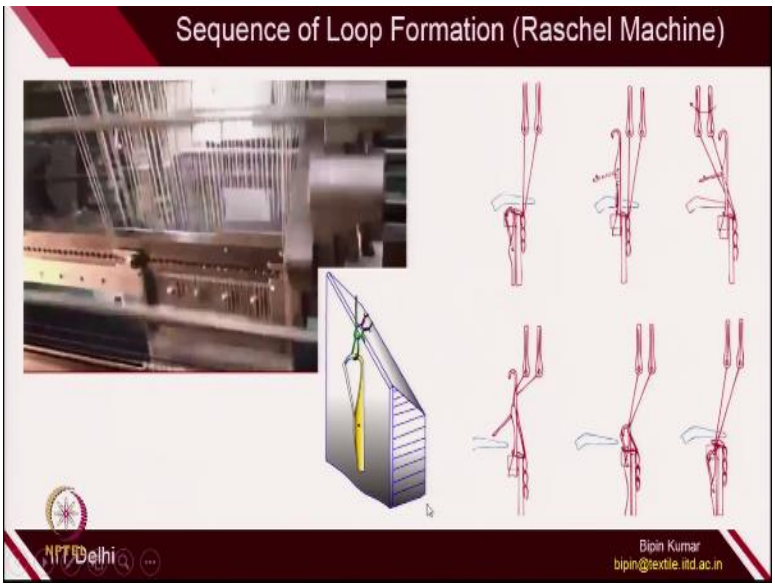

The other technology which is known as raschel machines. The sequence of loop formation remains same the only difference here is here the role of another bed is important. So right now in the tricot machine you have seen there was sinker which was helping in sinker loop formation, but here there is a additional needle bed just like in the case of V bed you have seen you just create the fabric.

And if you pull the fabric the automatically the fabric will be pulled from the other side of the bed. This is what is happening here also in raschel machines you do not need to have sinker for holding the fabric or making sinker loops. The bed itself will be able to create sinker loop and holding the fabric. So this is what is happening here. So here the needle is bottom position.

Then needle is rising then guide bar is providing the yarn here and old loop is knocked out at this position the old loop is knocked out then the guide bar swings and laterally moves to provide the yarn at this position and after that the bar actually moves back and since there is a dead weight which is pulling the fabric. Once the needle goes down the old loop is actually knocked out and it becomes the part of the fabric.

So this is the machines which is happening here so the role of sinker is not that prominent here in terms of pulling the fabric or catching the holding the fabric or making the sinker loop formation. The bed itself will be helpful in making the loop. So this is the raschel machine in subsequent lectures I will be focusing more on individual fabric development. Some of these technologies I will be explaining more in details.

Once I will explain you more complicated structures, but at this moment and this is more than sufficient. Similar to the weft knitting there are certain sequence here that has to be followed for fabric development and guide plays a very, very important role in fabric development and with this I am ending this lecture. In the next week, I will describe fabric notation and I will also categorize different types of fabrics.

If the fabric is created on a tricot machines what usually we call them if it is created on raschel machines what we usually we call them. What is the potential of these type of technologies and what type of different designs that can be that we can create and how we

can summarize those designs in simple terms? So the notations will be the top priority and the movement of guide bar is especially swinging, shogging under lap and overlap.

All those sort of things I am going to explain in the next class. So with this I am ending the introductory part of warp knitting. See you soon in the next week. Thank you very much.