Science and Technology of Weft and Warp Knitting
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Lecture - 32
Knitting Designs Possibilities

Welcome participants to lecture number 2 in this week. In this particular lecture I am going to cover some of the complicated knitting designs which you can make on advanced knitting machines. In last lecture I given you some important advancements in terms of machine functioning which is much-much better than the functions that you can observe from V bed machine. Some advancements were like racking where you can shift the bed with respect to the other bed.

The possibility of transferring the loop from 1 bed to other bed. The possibility of individually controlling the needle movement at any location on either of the bed. So if you have the possibility of these type of control on a particular machines you can create any type of design. Some of these designs you might have seen when you are going to use any knitted garments like sweaters or t-shirts. You might have seen these loops in your daily life. But trust me these loops are the preparation of these types of designs are not simple on the machines.

So I am going to show you some of these designs which you might have seen in the daily life. And how we actually create these loops. What are the principle and what are the science involved? What are the needle movement during these type of loop formations? I am going to cover in this particular lecture. Some of fabric designs especially tuck designs like cardigan, half cardigan, full cardigan, float designs like Milano, rib, rib ribble.

I have introduced you in week number 5, but now we are going to move some of the advance knitting designs and we are also going to look at the simulations. What is exactly happening in the needle movement on the machines during making these designs? So I am going to show you some of those fabric samples which I am going to cover in next 2 lectures starting from now. So let's see some of those fabric structures.

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And I will tell you what type of designs actually I am going to cover. So you might have seen these type of architecture on a knit fabrics and all of these architectures are created by the loops and needles is performing certain functions to create these type of structures. So if you closely look at some these loops. So you can see it here the columns are actually bending. So if you see here the columns are actually bending. These are called cable design.

If you see here if you see this point here you can see there are holes has been created in the fabric structure. This is called pointelle design. If you see this cable and from here you are actually shifting the cable in any direction. This is actually in general term, this is called aran design. **(Refer Slide Time: 04:09)**

And if you see this fabric this is just like a terry towel which have been created on the machines. This is very fluffy fabric and loops are on the surface. So that's why it has the terry appearance. This is again terry fabric again created using advanced knitting. So you can see how these loops are actually on the surface. If you see another fabric, if you carefully see the colours are actually moving not in the horizontal direction but with certain angle.

So this is also can be created. So when you have the possibility of partial knitting. So this is called partial knitting. So on the same course not the same color has been used 2 colours are used on the same course.

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The other fabric which is also possible is the jacquard fabrics. So here you can see the colours are different. So on the same course please remember these are not printed fabrics. We created by 2 different colours of the yarn. So you can see this here, this is a pink colour yarn and then the other one is a yellow color yarn, then pink colour yarn, then yellow colour yarn. So that is also possible. So any colours, any position you can get.

So this is basically a jacquard fabric. So how actually we make all this on the machine that will be covered in this particular lecture. So I have written our department name so this is textile technology IIT, Delhi. So how we actually create and what are the principle on the machine, how

the needle actually perform the function to create these type of designs that we are going to cover in next 2 lectures.

So let's start with the basic one. Some of these designs you might have seen and but my point here is to let you understand how actually the needle is doing the function on the machine.

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So let's see that we can see like how we can create any type of design on the machine. So you can see holes are there different patterns are there.

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You can see these patterns all are created by manipulation of loops in the fabric structure. Some of these designs are very complicated. And I am going to show you some selected designs and their principle. How the needles actually moves on the bed for making these type of designs?

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You can create, you can go, you can imagine the imagination is unlimited. The only important thing here is if you understand how the loops are moving on the bed that will really help you in design.

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So let's move with the first one, rib design. So I have already introduced you rib where in the same course you have technical front and back loops.

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So on the machines, we can create rib design very simply. This can be created on a manual V bed machine also. So if you see single jersey fabrics where the loops are created on 1 bed and double jersey fabrics where the loops are created on both the bed. So if you see the fabric appearance here you can see there are holes because its a single jersey fabrics not that dense. But if you see the double jersey fabrics it is very denses because you have multiple loops on the front and back side.

So if you want to see the animations here 1 bed is operated, here both the beds are operated okay. So this is how you create single jersey fabric and rib structure on the machine.

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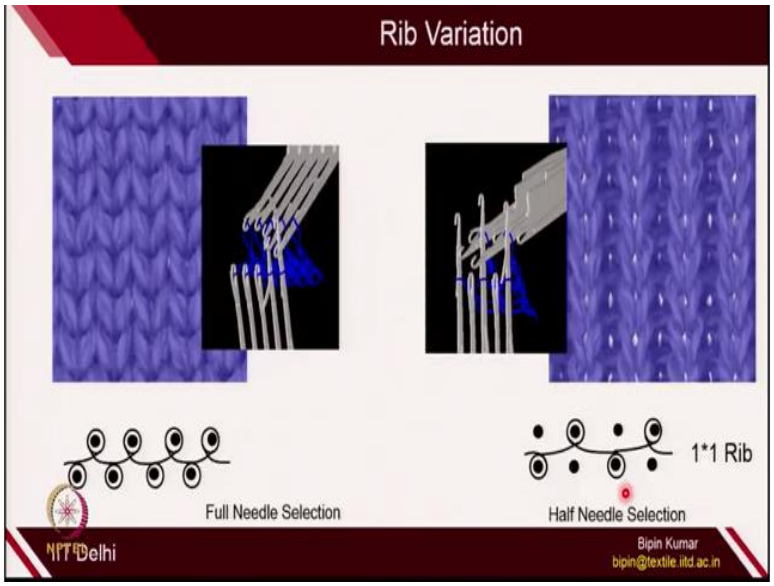

Now let's move to the complicated rib structures. So here full needles, so all the needles are making loops on both the beds. So front bed and back bed, so all needles are operating okay. So this is called full rib or full needle selection rib. The other rib is 1 cross 1 rib as the name suggest 1 cross 1, it means on each of the bed only 1 needle is active other needle is not active. So for example, if you see the animation so on each of the bed only alternating needles are operating rest needles are just sitting ideal. So they are not the part of loop formation.

So this is called 1 cross 1 rib. Here half of the needle from both the beds has been selected. And if you can see compare the fabric structure, this structure and this structured you can easily see because here more loops are there so the fabric looks more denser. Here you can see the holes are there, small holes are there. Because fabric is little bit porous. So naturally when you see the permeability of the fabrics, this fabric will be much more permeable compared to this full needles selection fabric.

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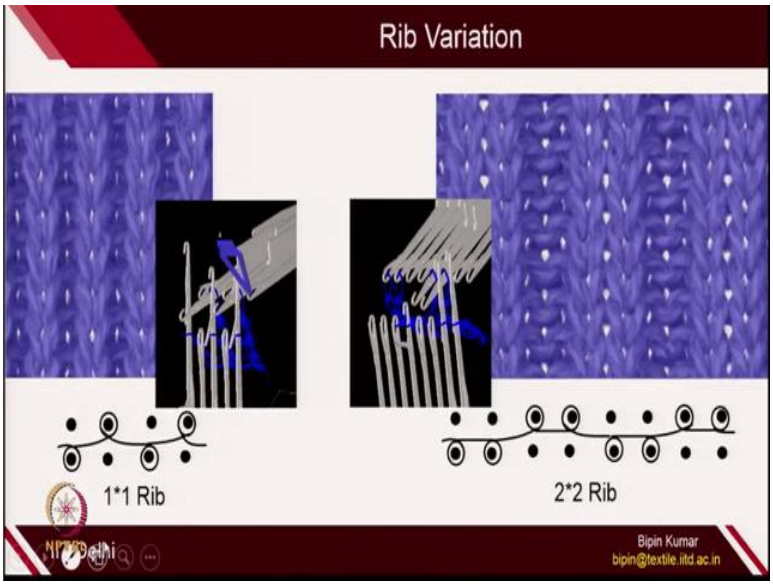

You can also go from 1 cross 1 rib to 2 cross 2 rib. So here in 1 cross 1 rib as the name suggested 1 alternating needles on both the beds are not operating. In 2 cross 2 rib in both the beds 2 needles are operating 2 are sitting ideal, 2 are operating 2 are sitting ideal. So similarly on the back bed these 2 needles are not operating, these 2 needles are operating, these 2 needles are not operating, these 2 needles are operating.

So this is 2 cross 2 rib on the machine also you can see this 2 needles, this 2 needles, and this 2 needles are operating the other 2 needles, this 2 and this 2 are not participating. And similarly on the back bed also same nature is there. So this is how 1 cross 1 rib and 2 cross 2 rib are being created. So if you see the porosity of the fabric, so in 1 cross 1 rib you can see the holes are smaller compared to 2 cross 2 rib, the reason because here a small portion of single jersey fabric you have created.

So these 2 loops they are together because of that the holes has becoming bigger so okay. So you can see if you see this fabric and if you measure air permeability definitely this fabric will give you more air permeability.

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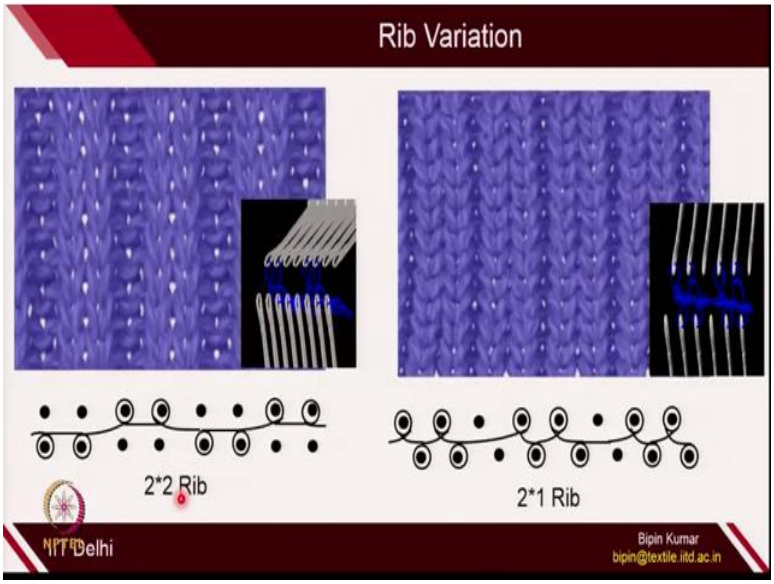

If you go for from 2 cross 2 rib to 2 cross 1 rib. So in 2 cross 1 rib you need to be very careful here. So 2 cross 1 rib it actually indicates on both the beds you are making 2 loops 1 needle are not acting. So if you see the front bed 2 are acting 1 are resting, again 2 are acting 1 are resting, again 2 are acting 1 are resting. Similarly on the back bed 2 are acting 1 are resting, 2 are acting 1 are resting, 2 are acting 1 are resting.

So if you see the animations here 2 cross 2. In 2 cross 2, 2 are acting 2 are resting. So which is there on both the beds. In 2 cross 1 rib 2 are acting 1 are resting so you can see here. So 2 are acting 1 are resting, 2 are acting 1 are resting. So this 1 is resting, this 2 is acting, this 1 is resting, this 2 is acting. Similarly on this side also on the back bed this 2 are acting this 1 is resting, this 2 are acting this 1 is resting.

So this is called 2 cross 1 rib. So from the surface it will look like 2 cross 2 but ideally speaking this is 2 cross 1 rib. In terms of technical language, we call this fabric as a 2 cross 1 rib. And because here you can see this segment is little bit more denser because 4 loops has been coming together. So that's why the porosity of the fabric got reduced. So here again 4 loops together, but here the 4 loops are distributed in much wider reason.

So that's why the pore size is bigger. But here the 4 loops are together in a much smaller reason. So because of that the porosity is lower. Again if you go from 2 cross 1 rib to this particular

structure here, do not call this as a rib because on the front bed all needles are acting. But on the back bed alternating needles are acting. So this is a not 2 cross 1 please do not get confused with this. So this 2 cross 1 means like 2 needle are acting 1 are resting on both the beds.

That's why it is named 2 cross 1, 2 is acting 1 is resting. But for this architecture where 2 are knitting on the front bed 1 is knitting on the back bed, 2 are knitting on the front bed 1 is knitting on the back bed. So this is actually there is no nomenclature for these type of fabric. It is a rib fabric. But we cannot say this as 2 cross 1. So if you see here all needles are acting on the front bed but on the back bed only alternating needles are acting.

So you can see here if you see the 4 loops together these are distributed in much wider region. But if you see 4 loops here they are distributed in much narrower regions. So this fabric is much-much denser compared to this fabric. So which is visible in the photographs also. So the permeability of this fabric will be more okay.

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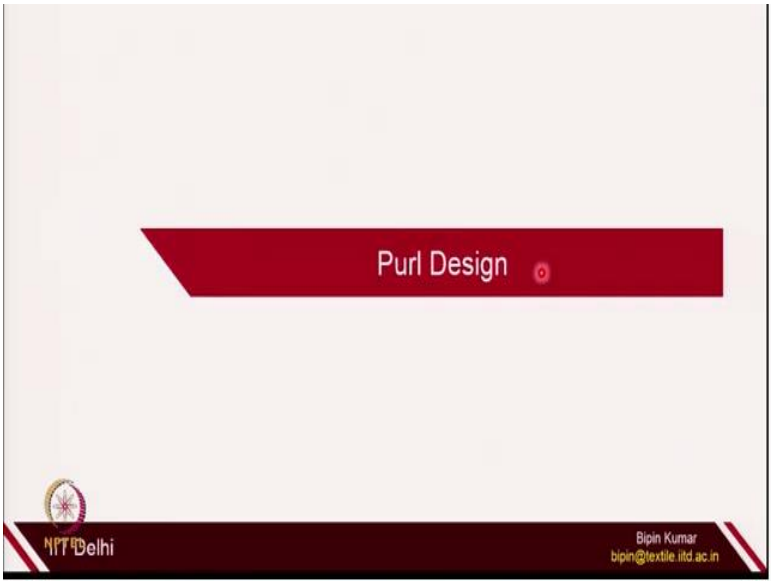

Now let's move to the purl designs. So in purl designs I already introduced this in week number 4. So in purl designs what we do is like we create technical front and back loops in the same column. So in rib designs you are creating technical front and back in the same course. In purl designs you are creating technical front and back loops in the same column or wale directions.

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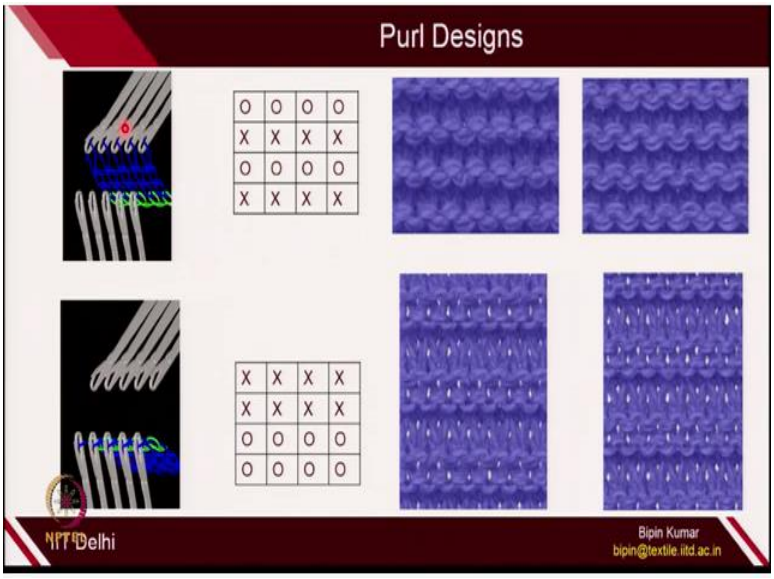

So in purl designs so the simplest purl design is 1 cross 1 purl design so 1 technical front loops. Then the next course technical back loops, then front loops, then back loops. So in the same column front, back, front, back. So if you look at the front side and back side only heads and sinkers will be visible. So the architecture will be same on both the sides. In rib designs both side your technical front is visible but in purls only technical back is visible in 1 cross 1 purl.

So if you see the animation here so first this course has been created on the front bed. Then by loop transfer it is transferred to the back bed and then back bed is making 1 course so this course. Then back bed is transferring loop to the front bed and now the front bed is going to create this particular course. So if you follow the animation. Again front bed is transferring to the back bed. And now back bed is going to create back loops.

So this is how 1 cross 1 purl is created and they look same on both the sides. Now let's look at this particular fabric. So here 2 technical back and then 2 technical front in courses so and the fabric looks like this. So there is this 2 is technical back and then 2 front, then 2 back, then 2 front, then 2 back and this will look similar on the opposite side. So if you want to see the animation so first it get transferred to the back bed.

Now the back bed is making 1 loop 1 course. So first course is done. Now the back bed is making second course. So this second course is done. Now back bed is transferring the front

loops and now the front bed is making course. Then in the fourth 1 again front bed is making course. So this is how purl design has been created on the same machine. So if you have the possibility of transfer of the loops on the V bed machine, you can actually create purl design.

So there are some designated machines which makes purl fabrics but in V bed if the possibility of transfer is there you can also create purl design.

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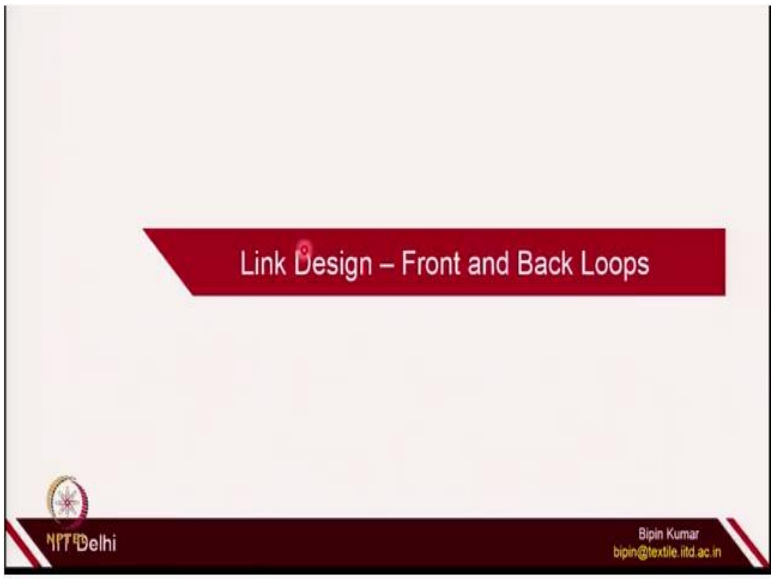

Link design, so apart from rib and purl design there is a possibility of link design. So anywhere anytime you can create front and back loops. So some of these I can show it here.

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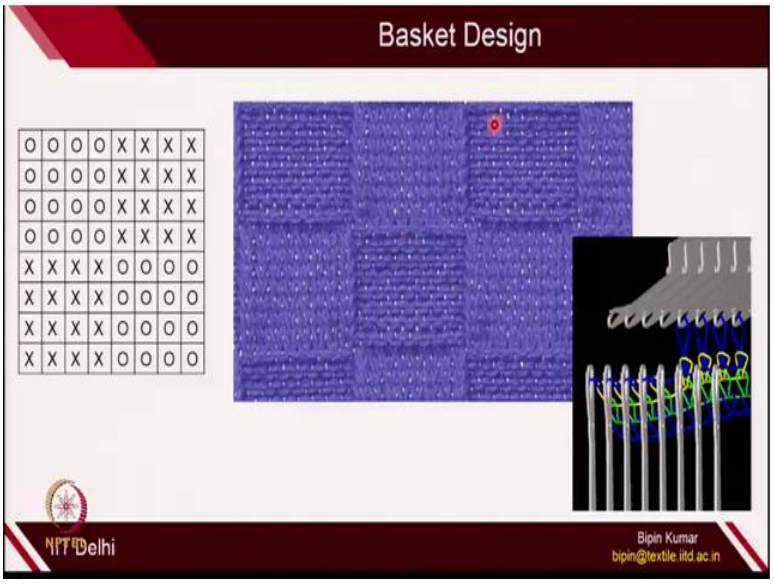

So the most important or popular one is the basket designs where there is a 1 segment of technical front loops and the other segment of technical back loops. Then front loops and back loops. So here the cross notation box notation you can see all technical front loops and then technical back loops then technical back loops and this is technical front loops. So this is also possible.

Any needles can be selected at any position and to create these type of designs we need both the beds. And here you can see 5 needles of the front bed is making front loops, 5 needles on the back bed is making back loops and rest 5 on both the beds are resting. So in this way you can create basket design okay. So basket design can also be created on manual V bed machines because that flexibility is always there. So this is more simple basket design.

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The other complicated designs are also possible. For example, here linking front and back loops you can see you can get any architectures aesthetically it looks very good. So if you want to give some pattern on the fabric surface you can play with the front and back loops. So I have 1 small fabric sample also with me. I can show you how linking front and back loops can give you a different appearance on the fabrics.

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So let's look at these fabric. So this is the architecture you can get if you are getting technical front and back loops. So I am going to enlarge this. So if you see this portion this is technical front side, then this is technical back side, then this is technical front side. If you go right, this is technical front side, this is technical back side. With this you can easily observe the pattern and once you relax the fabric it will give you 3 dimensional appearance. So it will just fold.

So if you remember the curling behavior curling will be very important to give a certain kind of dimensional change in the fabric and the whole fabric will look like this. Once you open up the fabric will show it technical front and back. And once you relax because of curling behavior the pattern will look like this. So you need to understand the science of bending of loops also to understand this behavior.

So linking of the loops is not only important from design point of view but also to create 3D loops on the fabric surface. So this is also possible if you create front and back loops. So you need to understand both the aspects. Now let's move to the next part tuck design.

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So tuck I have already introduced you. It is always accompany with the held loop.

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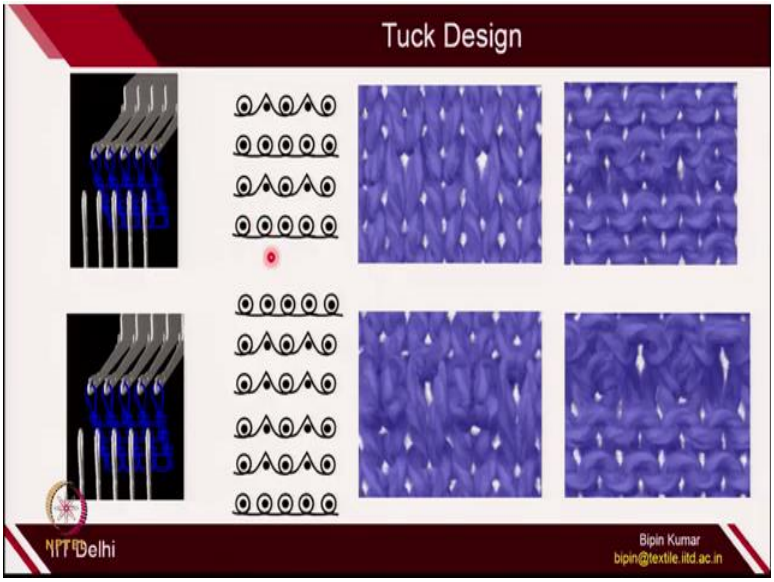

In tuck design on the machine you can put the tuck at any location. So here if you see the first course is making loop, the second course alternating needles are making tuck, third course all are making loops, fourth course alternating needles are making tuck. So in 1 of the column, the tuck is there because of that the fabric will if you see this particular column this loop is bigger and this loop is bigger.

So this is nothing but the tuck back side. And you can see here this is actually the tuck and this is also tuck. So if you want to see the animation on the back bed are only used front bed is not

doing anything. So the first course is being formed. In the second course, alternating needles are making tuck so which can be seen. The third course all are making loops. In fourth course, again alternating needles are making tuck. You can play any designs on this.

The other beauty of tuck design is when you make consecutive tuck in the same column on the fabric it will come like a bead. So some kind of purl design will come. Because tuck multiple heads are there on the same needle. So once all the loops will be released a bunch of yarn will be coming on the surface. And because of that that surface will be looking some kind of pearl is coming out from the surface.

So for example, if you see this particular design of the fabric first course is all knitting loops are being formed. In second course, alternating needles are making tuck, third course also tuck, fourth course also alternating needle tuck, fifth course also alternating needle tuck. So 4 tuck 1, 2, 3 and 4, 4 tuck are being formed consecutively on the same needles. So because of that 4 times yarn diameter is coming on the same needle and that will be released in the sixth course.

And because of that a kind of purl which you can see it here these are the bunch of the yarn its very difficult to observe what exactly happening on the surface. But if you create this type of fabric you just try and go and touch at that area a lot of loops will be there in the form of tuck and because of that it looks like a pearl. So if you look the fabric from far distance, it will look like some pearl is coming out.

Its like a beads of a necklace which will be appearing on the fabric surface. And if you want to see the animation how it works? So you can see the first needle and the fourth needle is making tuck. So again this is the second tuck, then fourth again tuck, then fifth again tuck and then all the needles will be released. So you can see here there are lot of yarns will be accumulated. Some head portion of the loops will be accumulate over there.

Because of that you can see the bunch of loops coming at this portion and because of that it looks like a pearl coming out from the surface. Naturally when you make tuck consecutive tuck on the same needles there is a chances that the needles might break. So there is always certain

limitations on the machine maximum 3 to 4 tucks you can operate. But if you are moving more than 4 or 5 there is a high chances that needle will break.

The head will break because head will not able to control 5 tuck at the same time. So you need to be very careful. Although from the design point of view on the surface it will looks like some 3D projection is coming out. So the fabric surface will not be levelled it will be having very rough patches on the fabric. So this is actually tuck design.

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So in tuck not only the purl will come out but if you carefully understand all of these designs are actually created by tuck. So you need to understand how you are creating tuck whether you are creating tuck on the front side or back side that will decide what will appearance will come on the fabric. So some of these designs are extremely complicated. Here you can see only the front side of the fabric is there. So on the backside tuck will be visible.

So some of these designs will be very difficult to analyze. But you can imagine most of these patterns on the fabric surface is created by using tuck either on the front side or on the back side of the needle bed.

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Now let's move to the float design. I have already introduced you the float. Float is also accompanied by the held loop. Here the yarn is not being catched by the needle and after 2 course the needle releases the held loop.

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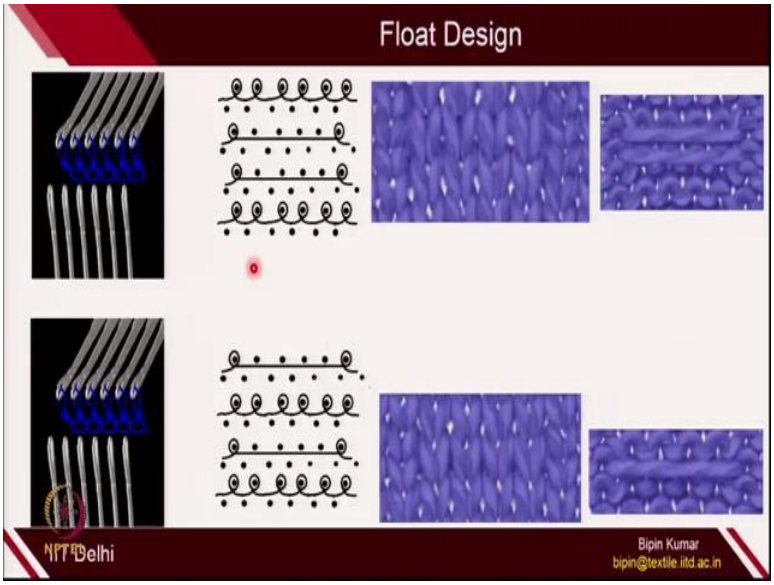

So in float design here the simplest float design I am showing you here. So this is the 4 courses I am going to create on this machine. So first course back bed is knitting. Second course 4 consecutive tuck is being formed. Third course again 4 consecutive tuck is being formed and fourth course all are knitting. So because of that the fabric will look like this. So here you can see these loops are much bigger compared to the first and sixth column.

So compared to this column and this column in between the loops will be much bigger which is shown here. And on the back side the float will be visible. If you see here this is the floating yarn which will be visible on the back side of the fabric. Let's see the animation here what exactly is happening? So here the first needle and the sixth needle is actually making loop and 4 needles are making tuck sorry float simultaneously.

So here you can see. So first course all are knitting. Second course only 2 are knitting 4 are resting. In third course again 2 are knitting 4 are resting. In fourth course, all are knitting. So this is how you create this fabric structure and the appearance will look like this. Now let's move to the this one. Here alternating the same pattern but here alternating courses is repeating. So here first course is loops, second course is float, third course is loop, fourth course is float.

So because of that the fabric will look like this. And on the backside you can easily see here there are 2 courses which is making float simultaneously. Here only 1 courses is making float. So if you want to see on the machine, the first course all are knitting so this course, second course only 2 are knitting, 4 are resting, third course all are knitting and fourth course again 2 are knitting 4 are resting. So this is how these 2 fabrics are different. So these are simple float designs.

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In float also if you understand the floating pattern of the needle, you can come up with very unique designs. So some of these designs are very-very complicated but most of these designs are actually being created by making float either on the front side or back side of the needle. Here you are actually looking the float on the back side. So these are the back side portion of the loops.

Here again on the back side, the other side if you somewhere see here you have much bigger loops. So this is in this the float is being formed on the back side of the fabric. Again these patterns are also very complicated but it is again depends entirely on the imagination of the designer, how what design he actually wants to create on the fabric surface with the help of knitting function.

With this I am stopping this particular lecture. Here I have already introduced you tuck design, rib design, purl design, and float designs. All of these terms were known to you in last 5 weeks. In the next lecture I am going to give you indication of more complicated designs where cable, pointelle, pile fabric, jacquard fabric will be introduced. So you stay tuned. Thank you very much for the listening.