Module 25 - Lecture 15

Inkjet Technologies: Machines

So we continue, journey, in the area of, Digital Textile Printing.

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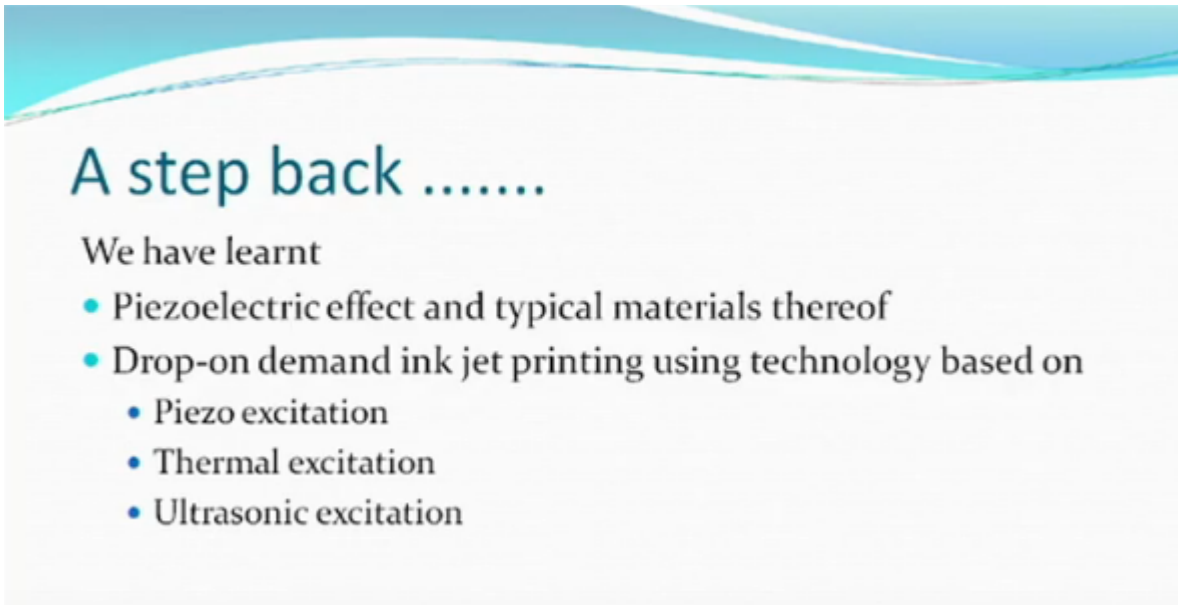

And what we have learnt till now is some of the printing technologies, use piezoelectric crystals. So, we know, what type of materials, do give piezoelectric effect and what the effect is and many drop on demand, in jet printing technology use, piezo excitation. Drop on demand technology also have, thermal excitation, which means, there is a bubble, which has to be, a bubble is created by heating and the heaters could be anywhere, on the top and the bottom, on the side, like in the piezo also it could be on the top or on the side, may share the walls, of the chamber, where the ink is there. And other type of excitations could also be there, which are, ultrasonic and so and so, forth. So, one was continuous yet, the other is drop on demand. These are two basic principles.

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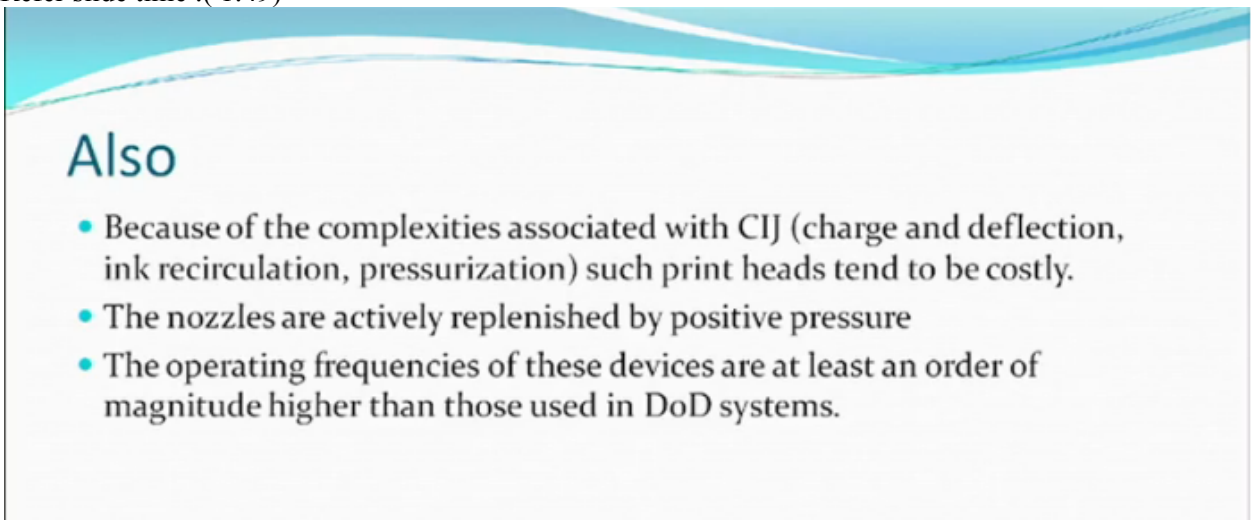

And also we learned, that because of the complexities, associated with continuous inkjet, charging, deflection, ink recirculation, pressurization, etcetera. Such print heads, could be costly. The nozzles are

actively replenished by positive pressures, and the operating frequency of these, that means the, continuous inkjet print heads, are generally, about an order higher than those use in the, drop on-demand systems.

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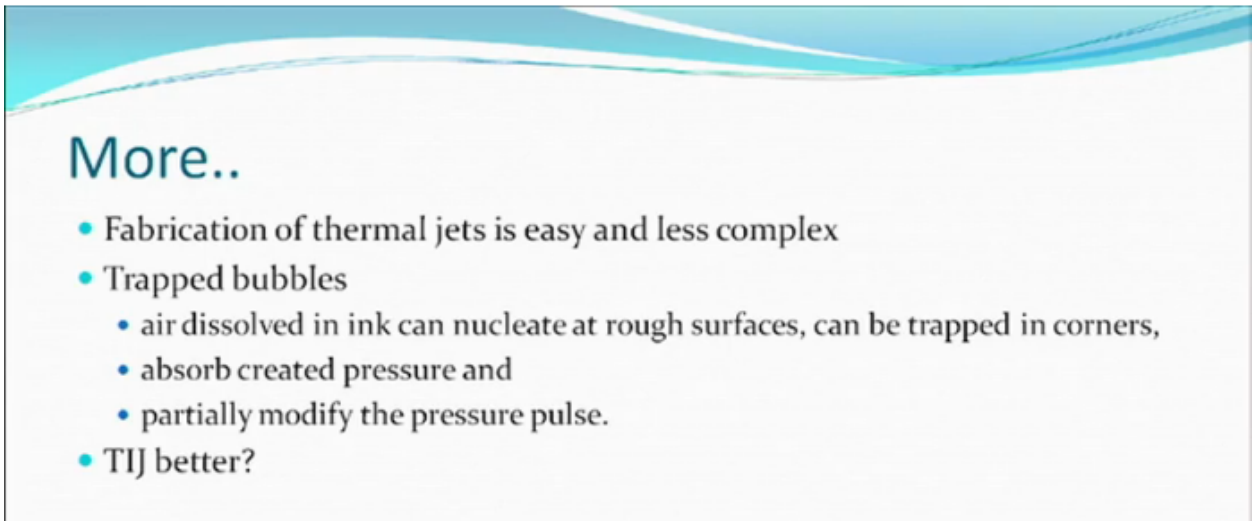

We also appreciate that the fabrication of thermal jets, that a thermal inkjet is relatively easy and less complex. In the thermal inkjet systems, you have trapped bubbles, which are air dissolved in the ink, this can also, nucleate from the surfaces, can be trapped in the corners and when the pressure is created by heating and generation of steam, that pressure partially can be absorbed by such, trapped bubbles. And can modify, the pressure pulse, which would mean that you may have, designed to have a certain amount of drop volume, where the volume may be different than, what you had planned. Which may not happen, when you are looking at, piezo based system because that is based on displacement? So, thermal inkjet although simple, may not be able to be used for pigment print, printing inks which these days include, the binder within the ink formulation. Which obviously gets polymerized, when you heat later, but it can happen during this, process of generating pulses?

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So, today we will talk about machines that mean, print heads and general assembly of machines. And see, what kinds of processes generally are available? What we are supposed to be doing.

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So, the most important part of the machine; should be considered as a print head. the whole system is very complex and in a very short space, short size, short volume, a lot of things have to be included and you expect, right kind offside of drop to be produced, at the right frequency, at a right time, so all that makes this whole process complex and in some way is not the domain, of a textile, chemical processing, person.

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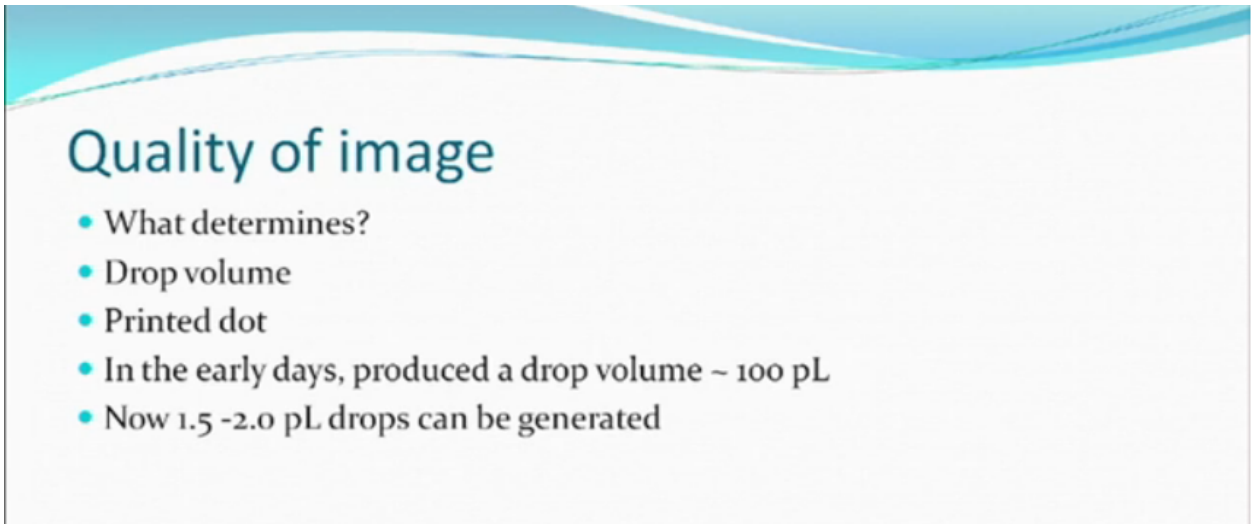

How we can comment on some of the things. So the quality of the image, that is going to be finally printed on a textile, would depend on, the volume of the drop generated. So, if you can generate a very small drop, you will get a dot, which maybe very small dots. So ultimately, what we're saying is there are many dots, which are going to be printed, indifferent colors, to give different shades and different tones. So large is the drop volume, large will be the printed dot and smaller is the drop volume ,smaller in the printed dot. it can also, determine the quality of the prints as well, in early days, we produce large volume, like hundred Pico letters, nowadays it is possible, to generate very very small volumes of drops that could be as less as 1.5 to 2 Pico meters, that means, you can become finer and finer. That control is available and so, quality of the image, can be improved. But, that would also make, that you will have to not only have a small drop size, than the total number of drops or the points or dots to be printed, will be also large. So number of nozzles, that you may have, they will also be large. And so, all of them have to be accommodated.

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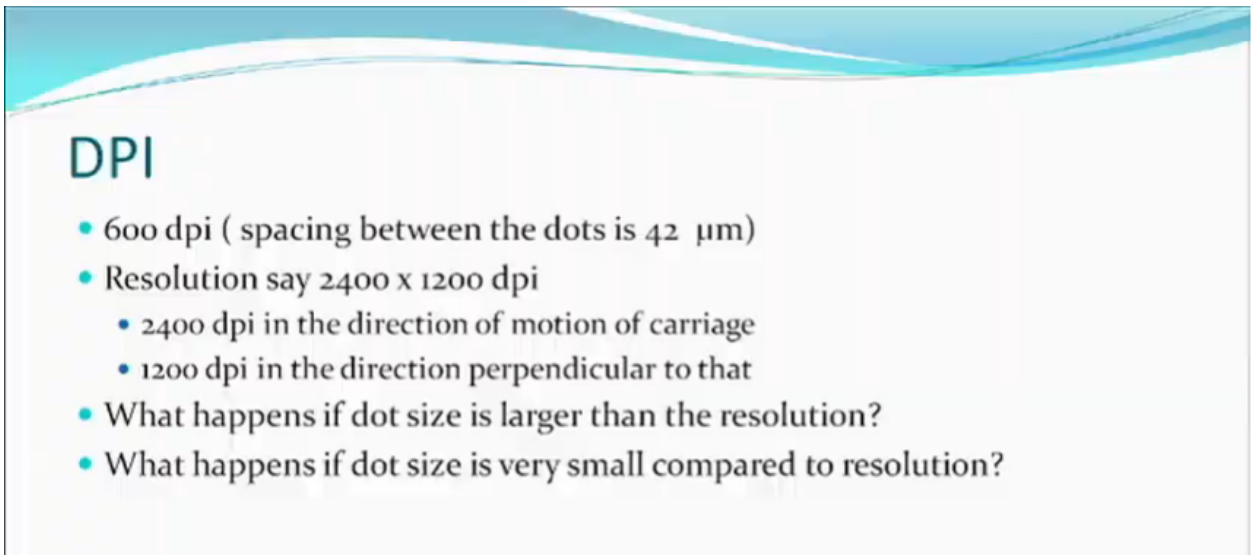

So, we express our resolution in dots per inch. Now, this inch has stayed with the printing industry. So, if you have let's say 600 dpi, that is a linear direction, then what it means is, that between two dots, in the same line ,you may have a gap of or let's say the center to center, gap may be, somewhere around the 42micrometer, centered Center I am saying is, because the drop size, may be large, then the gap between this circumference, will be less. But, this is how you can think of resolution sometimes also expressed, as the two directions, expressed let's say for example, 2400into 1200 dpi, what means is that, for a textile printing system, the in the direction of the motion of the carriage, carriage this is the fabric moving in this direction, the carriage is moving perpendicular to that. So in the direction of the carriage, you may behave 24 dpi and in the direction perpendicular to the carriage motion, which is the direction, when the fabric motion is there, this could be 1200, this is what it means. and so, this is how, people define the monitors also in terms of pixels, so here we have instead of pixels, we have dots, which as we said, smaller drops dots would probably be able to give sharper pictures. What happens if the dot size is larger than the resolution? larger than, you have a matrix in which you are putting dots, if the diameter of the dot is larger, then in the matrix that you've generated, then there was a problem, in the sense that, the colors may overlap at those boundaries and then you may get an effect, which may be different effect than what you had planned for, so one has to optimize in that sense, that you just cannot. Therefore the drop volume is going to be controlled. if you control resolutions very large, therefore the drop size cannot be the same, as for a600 by 600 or 600 by 400 dpi, resolution, drop size may be larger, than at 2400 by1200 dpi drop size and so, the volumes will have to be controlled in that. What happens if the drop size is very small, compared to the resolution, so what happens if the drop size is very, very small compared it is there, but very small. So, there is a matrix and in which let's say, on a center where small dots are there, so what you will see, is a different thing.

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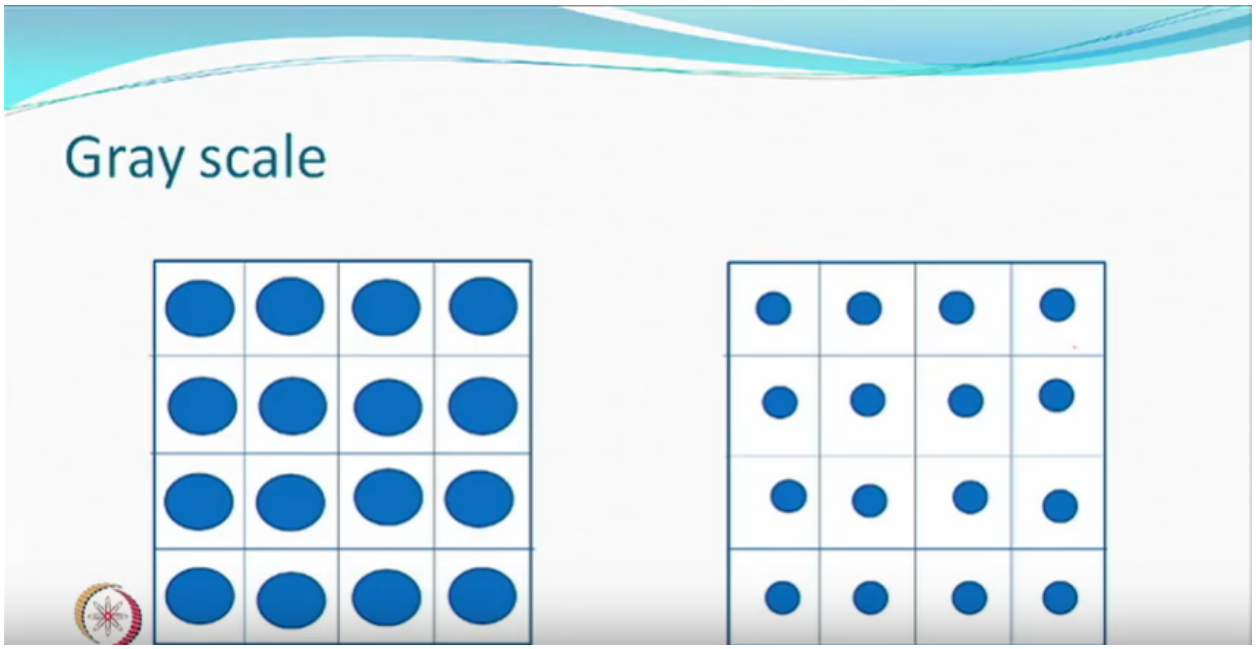

For example, the resolution is same here, in both directions. But, the drop size is different. So, what will be the effect? it will be as if you are producing, a lighter shade because, the background is also going to be visible, so more background is going to be visible, therefore resolution could be same, drop size can affect, the overall appearance of the design and the effect. So you have, variables therefore a print head today is able to print, large drops as well as small drops. So, it may be a strategy, which is a software based strategy, what do we do? When we generate shades? So, it's quite possible that you may say, well the resolution remains same in that particular area ,you may have smaller drops, same color, that's possible other way of creating a different grayscale is that you have a lighter color actually, that the concentration of the dye in the ink is less, that also is possible, it's still called the magenta. But, it may be lower concentration magenta. So, it can also do so, your strategy could be, either you change the drop size and then, worry about the and then get the appearance because the ground or you actually use a ink, which is the concentration is less. Therefore, when we thought of earlier therefore colors can produce everything, that's true. But, for technical reasons, for reasons of speed, for reasons of complexity, people may use, more than full colors, I'm not just talking about the white, they may use another color or a lighter version of the color, to change. So, there may be actually eight color printing systems also, which is different than the eight color, conventional printing machine, where they are the colors already prepared for the shade, which is their, hair the shades can keep on changing based on the understanding and the resolution of the software. So, but you may still have more than four colors.

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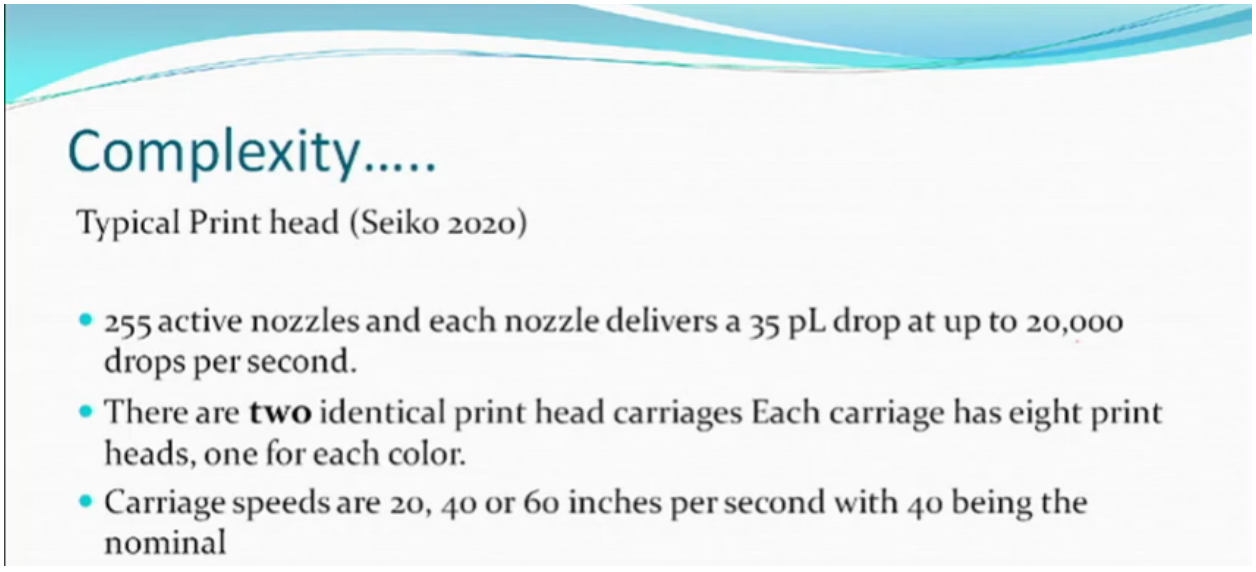

So, complexity in one of the typical examples, like this particular print head, which is made by Seiko called two zero two zero. for example, has something like 255 active nozzles, you know, nozzles may be more, let's say, the shared wall so you may, ensure that only one of the side one, starts the other one is not firing. So, all of them fire then, there could be something different, so you may have active and all this

any given point of time, you may have drop size, the every of 35 pickle eaters, the drops per second maybe up to 20,000, so you see this is a complex thing, what is the second time? And this, you are actually hoping all of these things could happen, there can be identical print head carriages. So, instead of one carriage you can have two carriages and each carriage, can have eight print head, one for each color, so if you're looking at eight color system. So you have, so many print heads available and then this carriage moves, so that means, you are covering more area, when you move. So, if somebody says, increase the speed of printing because this has to go like this and then come back, so in one go, you're covering a large area obviously it has been calibrated correctly, so that the area of the picture and the area on the fabric is matched, obviously the picture size is on a small monitor. But, it has been calibrated, so that finally the resolutions are matched, separated ink information is matched and so, firing takes place, as it moves. The carriage speeds could be very high, in inches they could be moving, 20, 40, 60. So as you, grow into the technology, the printing speeds will have to be increased because that means production. It's like a linear system moving, one way or sometimes when you move in one direction you print, then you come back and be other direction you print, so you can keep increasing your speed, so the time utilized in this whole business of motion of carriage.

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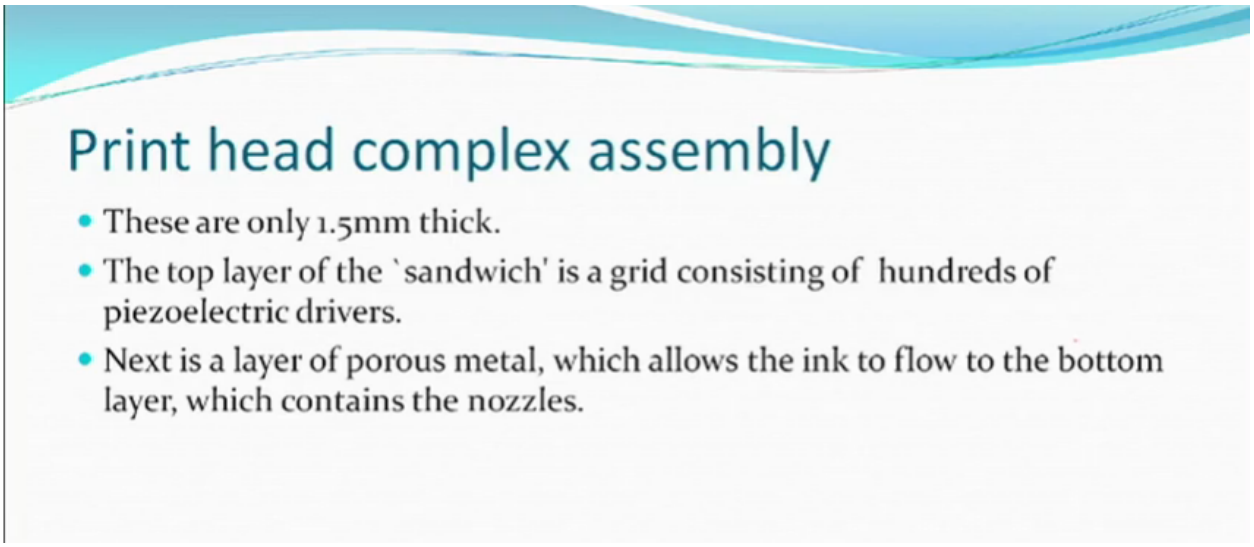

The assembly could be like a sandwich, but the total dimension may not be very high, at the point where it's being printed. Because, the main storage may be somewhere else, it is, it is being fed and then it is being jetted, as is required so it could be, hundreds of piezoelectric systems sitting on top of this and which are called the drivers, you know, like you have an LED lamp and the driver. So, you create completely, the circuitry and voltage controls and then you have, ensuring that there are porous systems, which are porous in the sense, that if you really look it from a naked eye, you may not be able to see, that there are so many holes there and then ink flows, from one layer to the other and finally, which is a nozzle plate but the bottom ,from which the ink is going to be jetted out. So, very small assembly but has got everything, the circuitry which controls, the firing and various sandwich systems.

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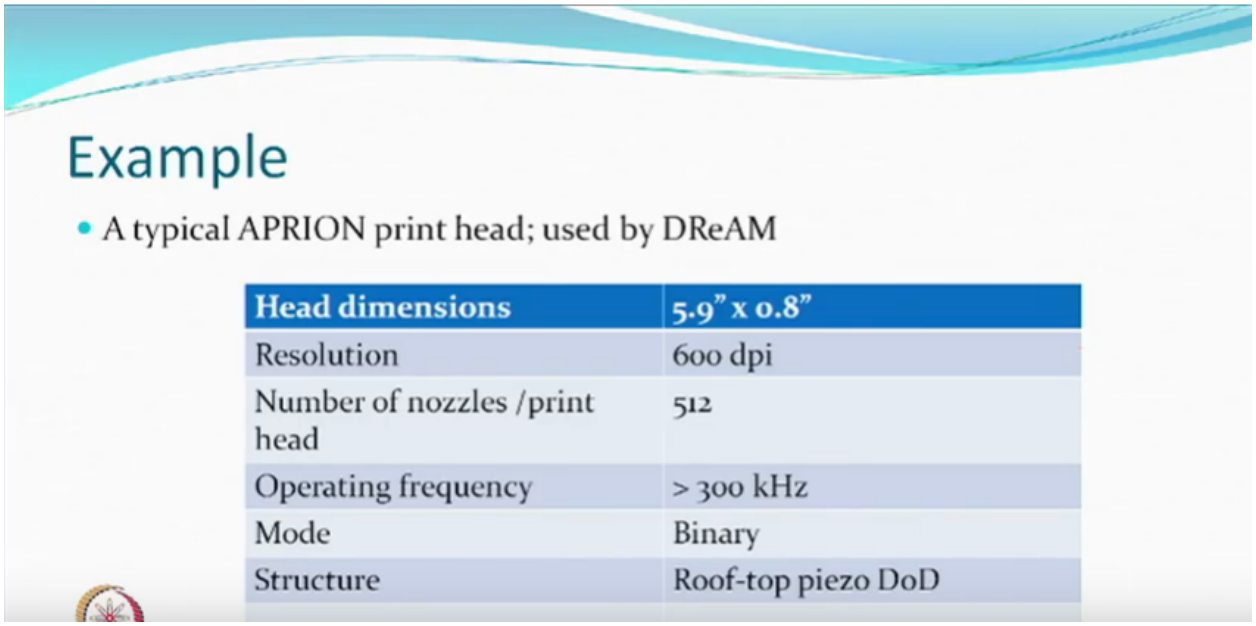

For example, there is a project which was called, 'The Dream Project'. Which means, that there is a company ,which makes the machine, there is a company which makes the print head and there is a company which makes inks? So, what was understood was, that you must collaborate and if you do not collaborate, then you design springhead, which may get damaged because of the conditions of ink ink may be Equus, it may have some chemicals, which may not be suitable to the adhesives, which have been used, for example, to create a print head. So, in this Ragini, for example is the company and uses, another typical print head, let's say Aprion. Now, this print head dimension is for the dementia concerned, the print head may be loud thickness is very small, but up to 600 dpi, it can print, number of nozzles could be 512, operating frequency is 300 kilohertz pretty high, mode is binary that means, either it is there or not there and it's a Roof-top, roof top piezo drop on demand type of a system. So, the possibility are here, so high frequency number of nozzles are very high, can produce six and dpi and has drop on demand the roof top piezo.

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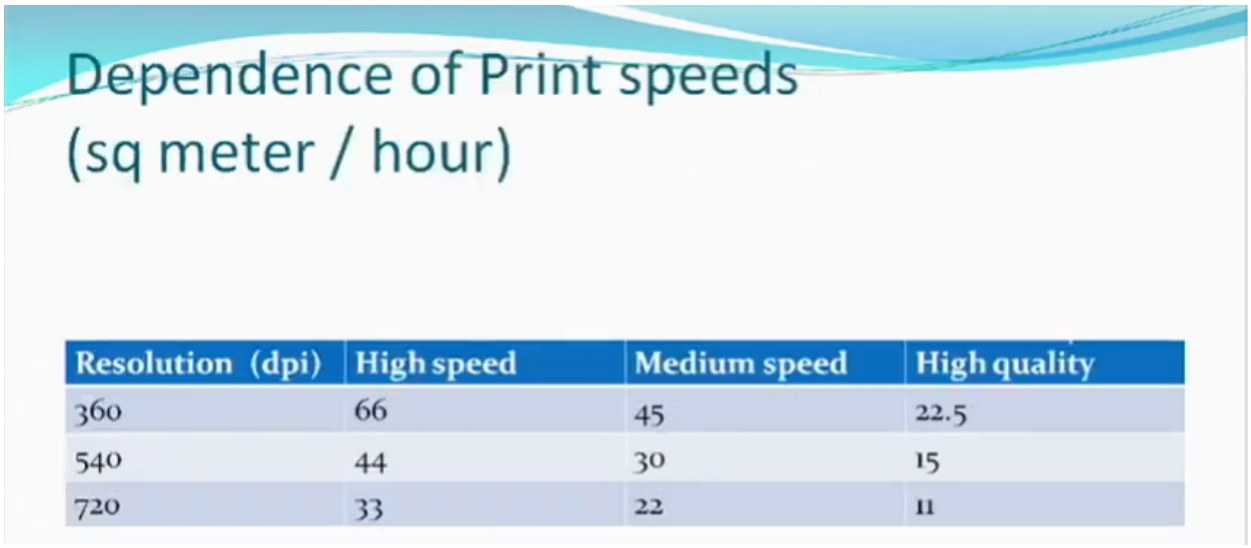

So somebody says that, how will the speed. Let's say, square meters being printed per hour. So, it is easy to understand, that if your resolution is high, the speeds will become slow, but if you want high quality, again you may reduce the speed. So, drop size, control, so how much area you can cover, would depend on how many drops are going to be put, so even for a high quality thing the speeds can reduce, if you go for high DPI, the speeds can reduce, the typical example, doesn't have to be followed as it is. So, both the things when you increase, the dpi the speed goes down, like this weed is going down or if you increase the quality, then the speed goes down or the same dpi.

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So, productivity of springhead, let's say, there is a print head productivity pH is the volume, of the drop volume, the frequency and the number of nozzles. So, if you produce more volume, so maybe you can cover more area, if you have high frequency putting the same on a volume, high frequency you can cover

more area, our if in the print head your more nozzles, they can cover more area. So, that's how a print heads productivity, should be defined, sometimes you can define it by productivity per nozzle in which case, you have only V and F, it's again the repetition of the previous thing, that the drop on demand the frequency, as we said whatever the frequency, 10 kilohertz for example, could be or more as we've seen before, but the for the same kind of quality, the frequencies to be used for the continuous, inkjet would be 10 times more. Generally if you have a hundred percent coverage, then the ink required approximately is 15 to 20 milli litters. So, you are not really looking at very large volumes, but you're spreading this, very effectively, you know, in case of conventional the amount of volume of the pace that we use is very very large. Because, there are so many things, which you don't want but, it will wash it later of, later on. In this case everything that you use is more or less being used, inks may be costlier. But, you don't use too much of ink, you use just the right kind of homing there's no wastage theoretically.

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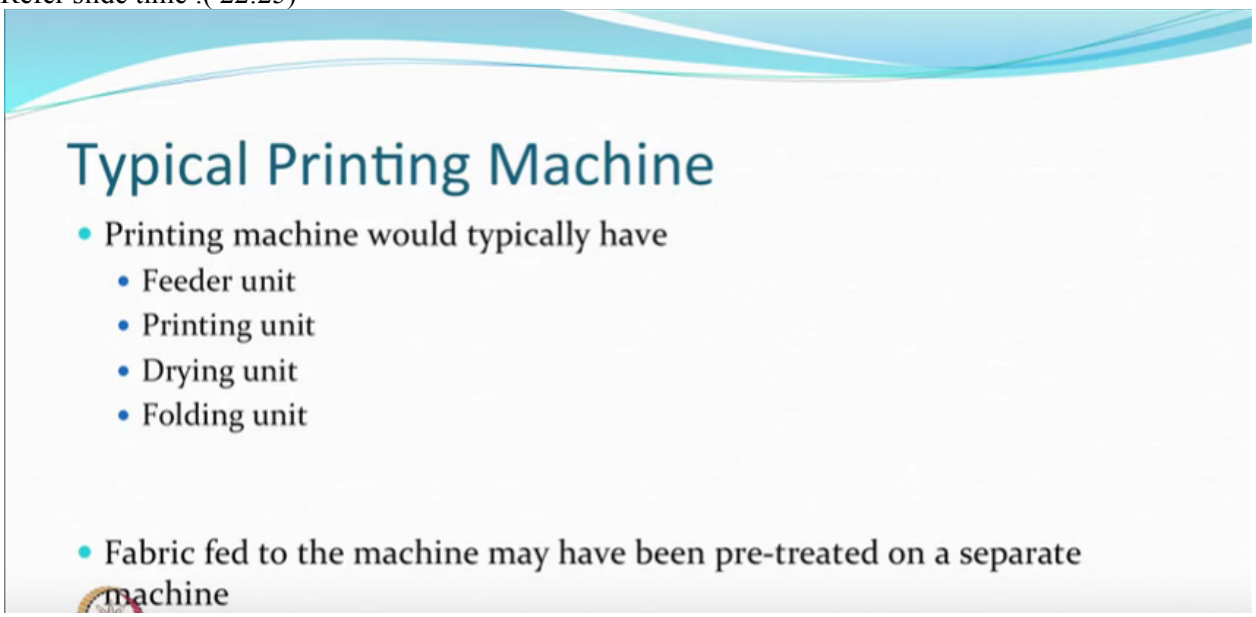

So, we look at the printing machine as a whole. a typical printing machine would have, a feeder unit, a printing unit, drying and folding. This is the digital printing part. But, you may have to, do the pretreatment to the fabric, which may be done on a separate machine, before you feed. So, the fabric let's say, a very lightweight fabric, knitted fabric, a pilot fabric or something which has got lot of, protruding here, may have to be first done given a pretreatment, so that the surface becomes smooth, dimensions are control, that it should not happen, you put a little bit of tension and the skewing takes place. And you're not able to do, this there can be difficulties in printing and your designs can go haywire. So, the machines may be for that different, but the printing machine would have a feeder unit ,which would mean that controlling tensions ,controlling the conveying, the fabric into the Machine correctly and then, after this you have actual printing taking place, where there are jets, the print heads, which are working and then of course you dry before you do anything else, can fold or do whatever.

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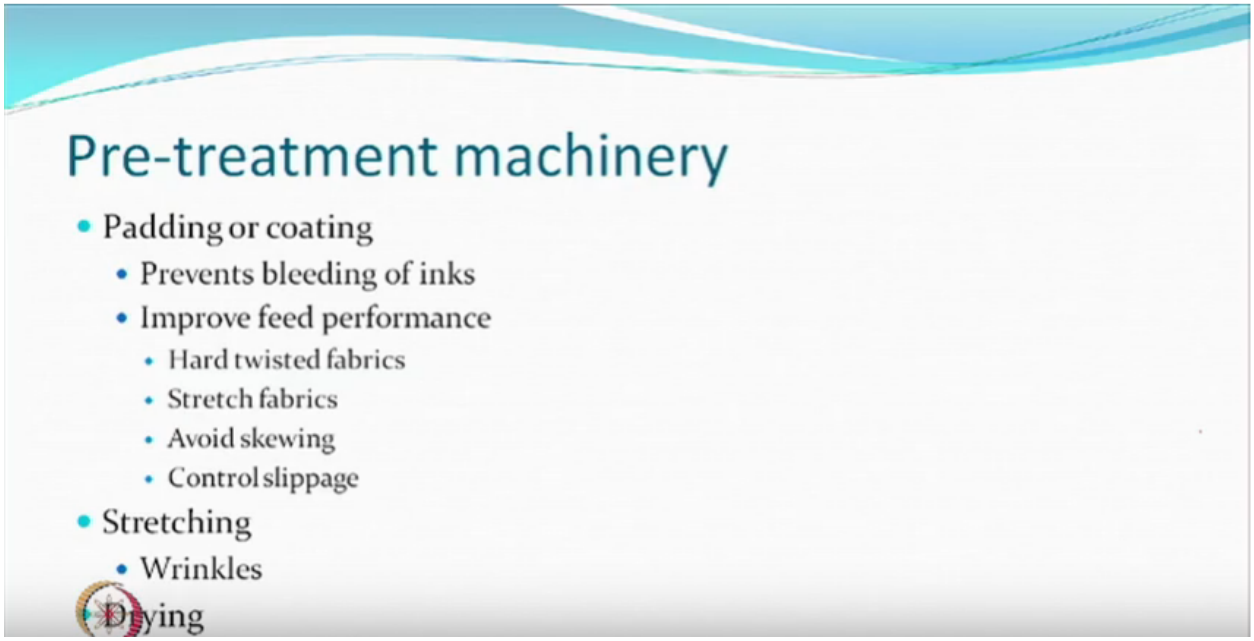

So, it could be a pretreatment could be padding and coating. if you, think only one surface is important you can take care, you can have a coating system, some type of a polymeric things, which gives little viscosity so that, it gets taken care of and surface becomes, pollute and the ink does not bleed, because there is viscosity is low, capillary actions etc. can take things from one area to another, which you would lock, look not like. So, it would like that too, this pretreatment can improve the feed performance, like you are feeding, the roll of a fabric, to the printing unit actual printing machine. So, let's say, hard twisted fabrics. What are the hard twisted fabrics? Within the fabric the twist is high, what type of examples of the fabrics, crepe. So, crepe Georgette's etcetera, so you can have hard twisted fabric, which obviously can extend their dimensions based on tension, so you may like to do some kind of a treatment to that, stretch fabric these days, you may get, material to be printed which has got, inbuilt stretch or knitted fabric for that matter and you want a world skewing and also sometimes, control slippage very very shiny slippery surfaces, can also have difficulty, so you may have to make sure the dimensions remain control so, the pretreatment be there, other than that of course for different inks you may have, other chemicals, which also maybe there as a pretreatment part. So, you do a bit of a stretching here, so that there are wrinkles, which are also removed and then you have treated them, so it becomes a stable structure. And this machinery may also be, having a drying system. So, you have a pretreatment machinery, which not only does padding or coating or stretching, but also dries so you cannot take a wet fabric and start printing. So, unlike what we were looking at the transfer printing system, which appeared a very very simple, take a paper, take polyester ,heat it up and finished. Here, some of the things would be required, which would, which increase the scope of this printing system, that you can use different colors, different types of chemistry of colors, for different fabrics.

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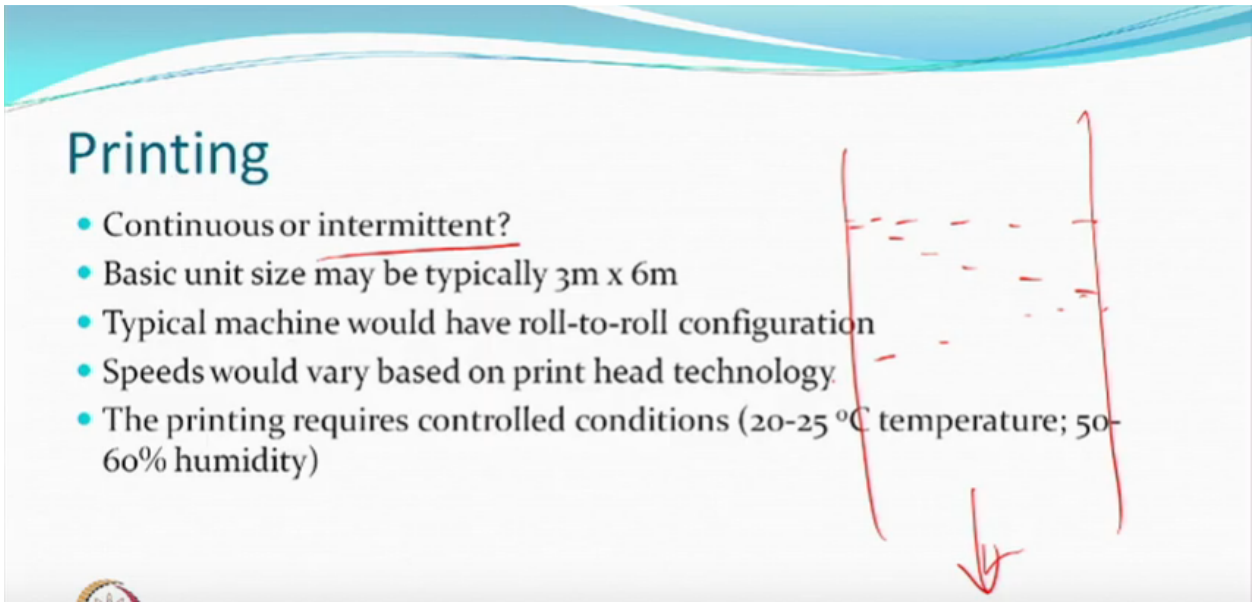

So coming to the printing part of it, if somebody asks, this question, is this inkjet printing. Continuous printing or intermittent printing system, we understand this, you've seen, rotary screen printing, roller screen printing, the called continuous. They have this type of a system is, it continuous or intermittent. it actually not continuous in that Strix is intermittent, that is when actual printing has to take place, when the carriage is moving from one head to the other, the fabric must remain stationary, so the design is there if it fabrics is continuously moving, the print head moves perpendicular ,so what you will see is, that the fabric is moving in this direction ,you intended the design be here, but the design, may actually be printed like this and coming back, it may print it like this. So, you may not, be able to do anything, this is justice, although if you see high-speed printing systems, it may appear that is going fast. But, if you look at clearly, clear fully, first one row once it is complete then it will move and if, half design is on one side and the other half is being put into the other side, then it will move after the whole, that linear area which is to printed, from one end of the one selvage to the other selvage, first it gets printed completely, then it moves.

The basic print unit, maybe three meter by six meter, three meter wide six meter, long which would have everything, inking stations ,all the print head, print heads, the carriage, the motion, everything else would be there. Typical machine may have, industrial versions for the textile printing, may have roll-to-roll configuration ,we start from a roll, finish on a roll. But, that's not it, you may have machines which are printing piece goods only, like a t-shirt or a small piece or something, so this will be conveyed and then you keep printing. But, a typical fabric printing machine, would have a roll on one side and the roll on the other side possible. So, speeds would obviously vary on the kind of print head that you use, but this is slightly different than the normal printing that we do, that here at least this machine, should be kept in relatively more controlled conditions. the pretreatment or the post treatment is not going to be in this area, because there you may be having, drying of a different kind, curing of a different kind, steaming you may require, washing you may require, that does not require conditions of control, conditions of temperatures of25 degrees or humidity control of 50, 60%. So, this zone will be different. So, even if you want to have a continuous system ,which most probably will not have, pretreatment done make a roll, bring the roll here in an environment which is those, print completely take it out and do whatever post-treatment have to do.

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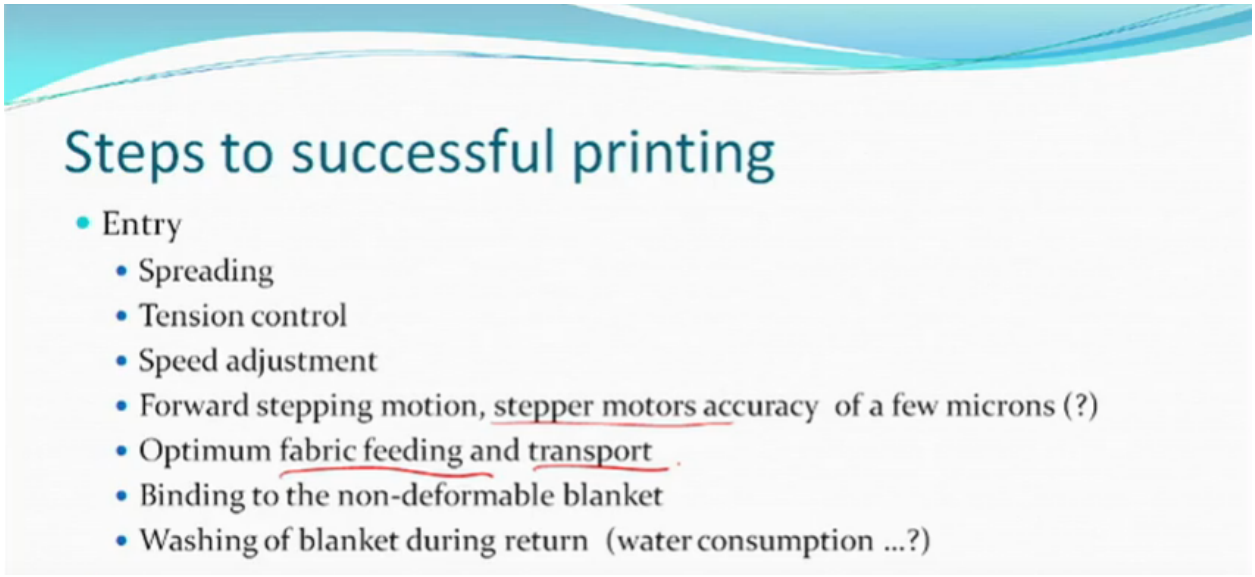

So within this so-called printing zone, you may have done a good job there, but it still would have its own spreading mechanisms, entry to the printing machine, it would have tension control system. So that, fabric actually is being fed, correctly adjustment of speed may have to be done, based on the print head systems and can where this is definitely controlled, so what do you do? As we said intermittent so you have a stepper motor system. So, motors will move, in steps, so that the fabric to be printed also, moves in steps, so this ensures that the feeding of the fabric and the transport is controlled. So this, entry part of a machine is an important component, which is precise. So here everything is precise, you're looking at stepper motor accuracy a few microns, you're not looking at millimeters. So, that would mean, that everything is controlled and therefore, the cost of the machine becomes high, it's not like a normal clear or belt based motion, which are use generally, then we're done and the other printing process also, so there is a blanket there could be a blanket, which is endless blanket and you will do some binding of this, after you have ensured that everything is coming correctly, then you bind so all of them move in the same. The blanket speed, the fabric feeding speed everything is same. And the blanket after printing obviously it's the endless blanket comes back, it has to be cleaned. so that again, you apply some gum, it again is pasted, so as the blanket moves, keeps on printing then fabric is removed the building can comeback, so think of that, when you are actually doing, cleaning, that means there is a water consumption, so it does look like a dry printing process, unlike what you see an inkjet, paper printing, everything looks dry. Because, paper itself is dimensionally quite stable, unlike the textile. So, all this is there, so you would be having in within the system, some water inlet, outlet, cleaning process covered so that nothing else, gets wet, so controls have to be there. So, digital inkjet printing for fabric is complex, from technology, but also from the desired requirement that we have.

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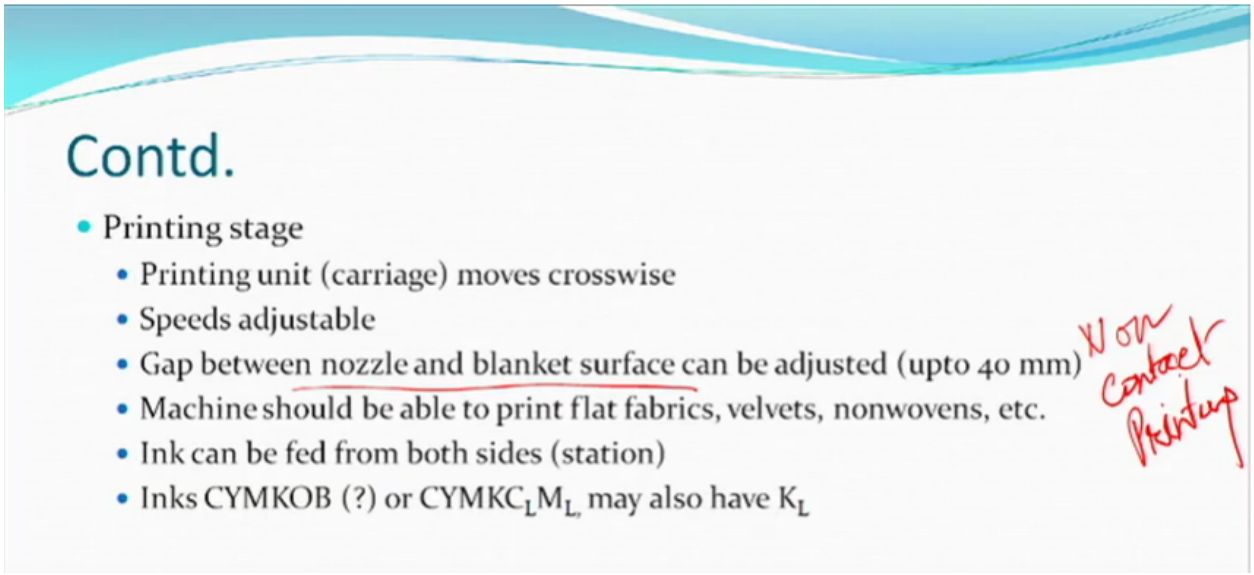

So in the print point, you have a carriage, which got as we said, many number of heads may be there, carriage may have one or two rows, adjustable speeds, the gap between the nozzle blanket and the surface, nozzle and the blanket surface. can be adjusted up to 40 millimeters, you know, that means thicker fabrics can also go, if there are thinner fabrics, you will obviously reduce the gap, so that the spread is not there. If you, if the gap is too much, then ink it is being fired for example, by continuous inject systems going in an angle, let me land somewhere else, but if fabric is thick, then obviously you take the nozzle plate up. But, still remember, this is non-contact printing. So, machines can print flat fabrics, well there are no no ones and so on, so forth. The ink obviously has to be replenished, as the ink has been done .so for the continuous system, so you can have ink feeding, as it goes to one side, to the other side, in can be fed from both sides, to the carriage system.
So interesting, so you can have six color systems, which is CYMK plus orange and blue? Or you can have a CYMK, c light, m light. Or you may also have, black light black that means towards grey, right. So, so you can have six, we could say eight also, you know two graves, two more colors or one right and this is how you can keep Ink. so eight color, being used now is considered as a common thing, more production also, Bo production ,you can actually there's a large area which requires light, things instead of using to control the drop size, you keep the drop size large and use the other one. But, it is not infinite, any color that you can it. They are all colors have been correctly, calibrated that the image is going to be there, like sine light and magenta light, will give you the right kind of pickup. But, because that area requires less, so you can have a larger, volume of the drop, but a lighter size will give you the same effect, as small drops, large number of small drops and then area. So, that is the production could also increase.

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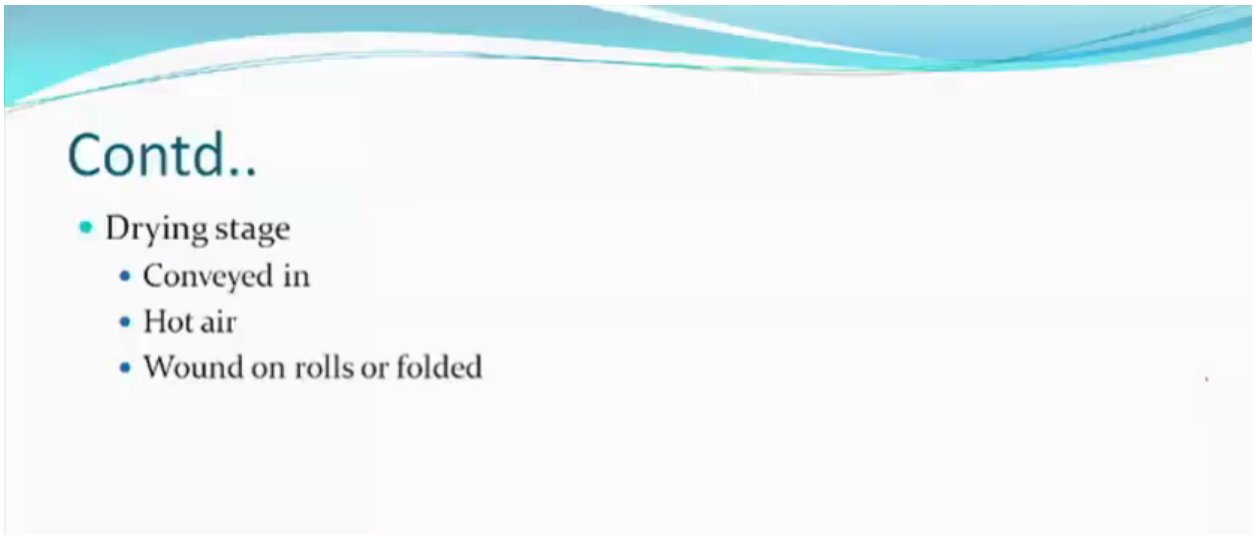

So, then you take this of out of the conveyor and then dry. Before, you take it for post printing operations. So, this has to be done, you can bind, on rolls or fold. The generally hot air is used to dry, just to dry. Because, most the inks may be, Equus Waste Systems. If it's a solvent base then it dries quickly, but if your fabrics are generally hydrophilic, you may want ecosystem, some penetration in the depth also may be a good idea.

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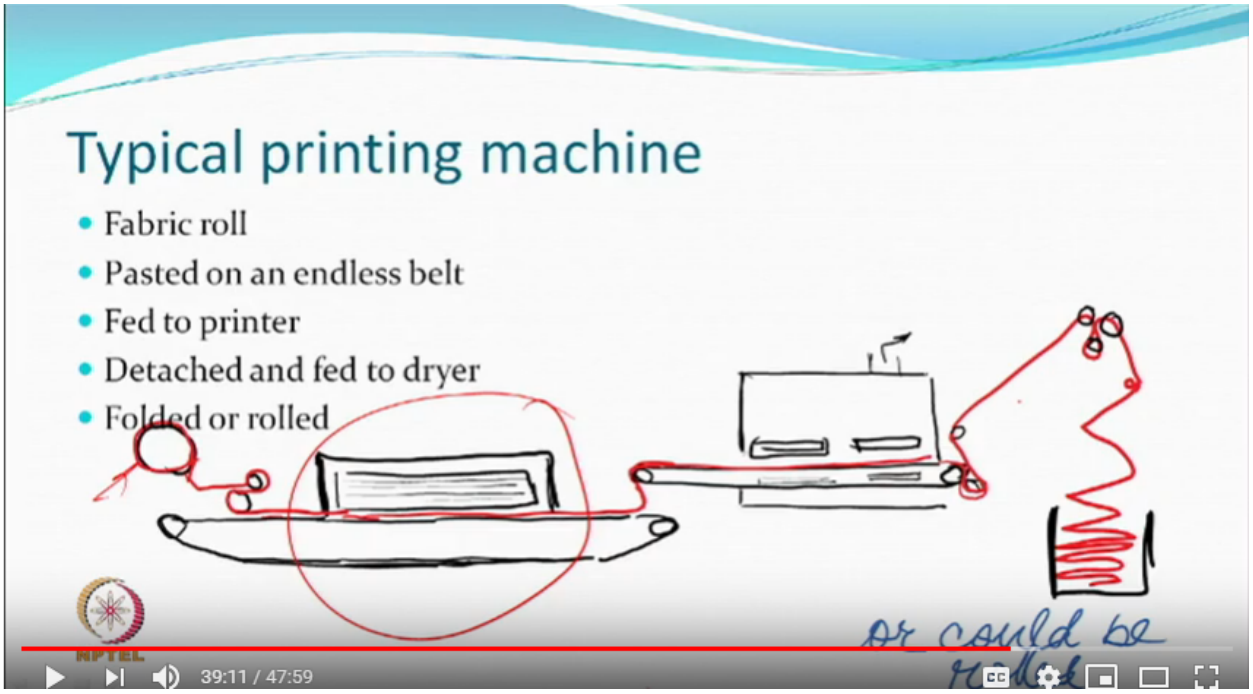

So a typical fabric machine, printing machine, may be looking similar to what we have seen somewhere, so you have a fabric roll, then you have an endless belt, where after some controlled, stretching and pushing, you apply, a fixit here, it moves in the print head, get sprinted and then, you take it on top, dry so

this is drier and then, you can fold or roll. Now, this part is definitely intermittent, which is the print part. But, here you can adjust the speed in a manner, that they would appear, that this is a continuous process, you have stop and you have an excess fabric, being there, so you adjust the speed in a way, it would appear as if this one is regular, everything is moving from irregular, so that adjustment can be done because you know, how much of the fabric, per unit time has been printed. So in this type of a typical machine, you have a carriages which are moving .right?

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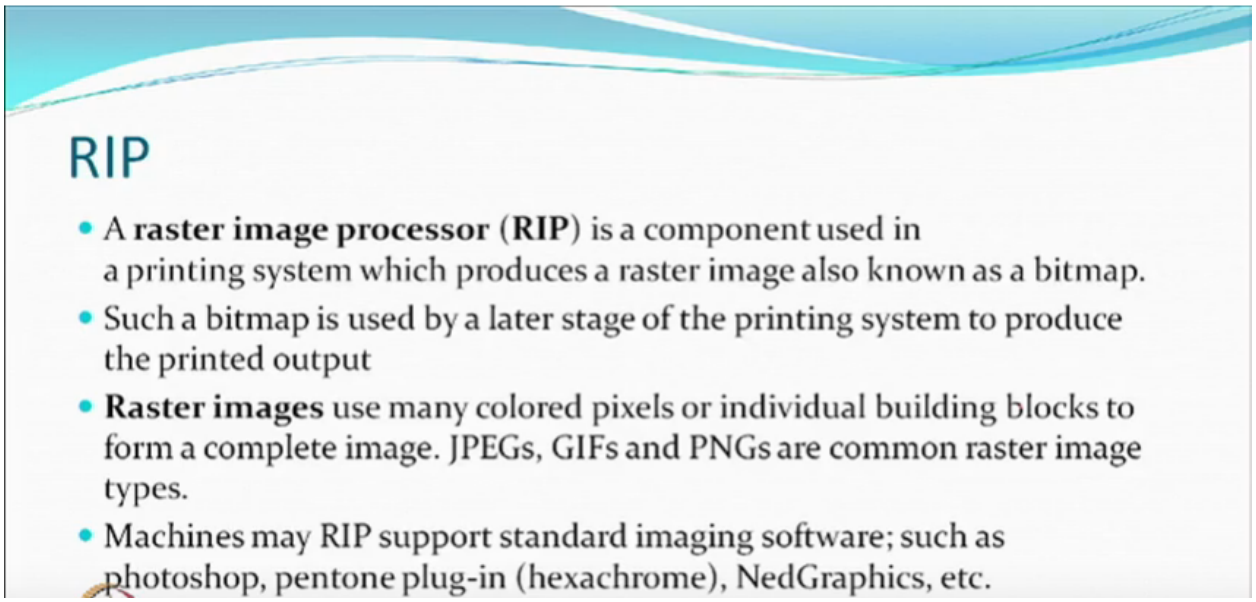

These days, so this carriage of course the image which contains, is something called a raster image you know, this matrix and the dots or pixels, in the image they call the 'Raster'. The other image formation format is called the 'Vector Image'. The vector image is basically, a mathematically, derived system. What it means is, that if you want a larger area or expand, the equation the mathematics will make sure that everything looks good, in a raster if you have a small resolution and you try to enlarge, we will see pixilated images. But, if you fix the resolution based on what you want, the life could be good. So, some of the things in the formats, which are JP, JPEGs, GIFs, PNGs are some of the formats, which are, which have the raster, most of the machines that you use, obviously have to understand, the information which is coming from somewhere else, the information may be there is some design station, who's making image, there is another station who is scanning or taking a photograph, that format must match, the format which the Machine understands. if you try to get any other things, so it may not work, so these days people use photo shop ,which creates these kinds of formats also, hexachrome systems, which are six color based paint on, there also they take, anything designed on graphic software, like net graphics and so, on so forth also we'll be creating, design and after that images which will have format like this, which is raster format and which will then, be understood by the machine, hardware, software, so that it goes correctly.

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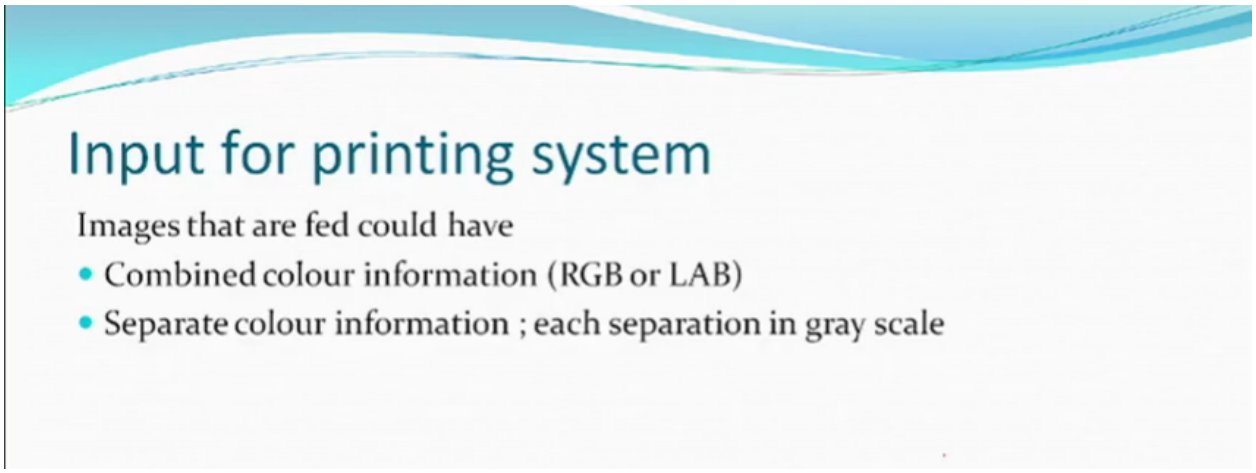

So, input for the printing, as I said, can come either as a combined color information, which means, information is coming as an RGB or the LAB, format or it can bring information already separated in grayscale. So, yellow and its complete grayscale based system that you have separated out, light yellow, red green yellow, light yellow, dark yellow, etcetera. through separation Sam so information comes in grayscale, off four yellows four magenta, four black and that is fed so this meant all machines, normally would be able to understand any of these things, just to make sure there's universal eyes, you know, otherwise people say, use only that software then becomes more problem. So, some of these common formats and common system information would be, fed into the information, by any mode, by wireless or wired mode, will come and we'll understand.

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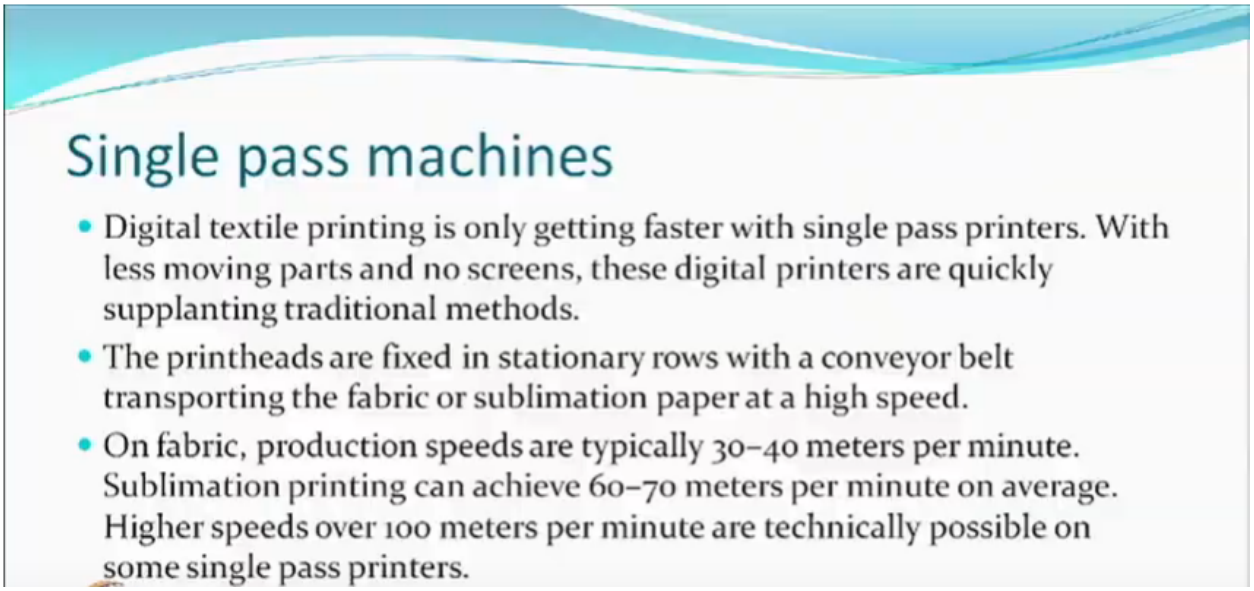

These days, people are now trying to promote machines, which are called, ‘Single Pass Machines’. So what it actually means typically is? that there is no carriage which is moving, at the moment what is the print head, I have got eight colors, all the carriage contained the eight color and all of them, move together, wherever it is required, they print its color and then keep moving in this, they are saying why move the carriage at all. let there be, like you have a rotary screen printing, eight color system, one color per screen, so why can't we have eight heads, covering the whole thing and wherever yellow is required, just giving yellow there and then next station, what's the cyan, next station puts the black and so on, so forth. So don't move, why because you are now looking at possibility of speeds, as high as 100 meters. Which is very high, very high, normally in the carriage system, these kinds of speeds are not, way so now you're looking at this.

So, print heads are fixed in stationary rows, the conveyor belt is transporting the fabric, which was anyway doing in the other case also or either to print fabric or sublimation paper, for the transfer printing purpose. So, same machines can be used for transfer printing, the same machines can be used for printing fabric directly. But, obviously inks are going to be different. And so, less moving parts in the digital printing. So, whatever digital inkjet printing, if you see at your home also, there the carriage is moving but carriage moves, for a4 size paper, for a3size paper, different then a 2 meter 2point, 2 meter wide fabric where large, amount of motion has to take place. And so this its cells take time, even if you do very fast. If you say well, now we do not have any situation, we are going to only keep the heads, fixed, good idea. So people are trying to promote, single pass machine. So one pass one color, the other pass other color.

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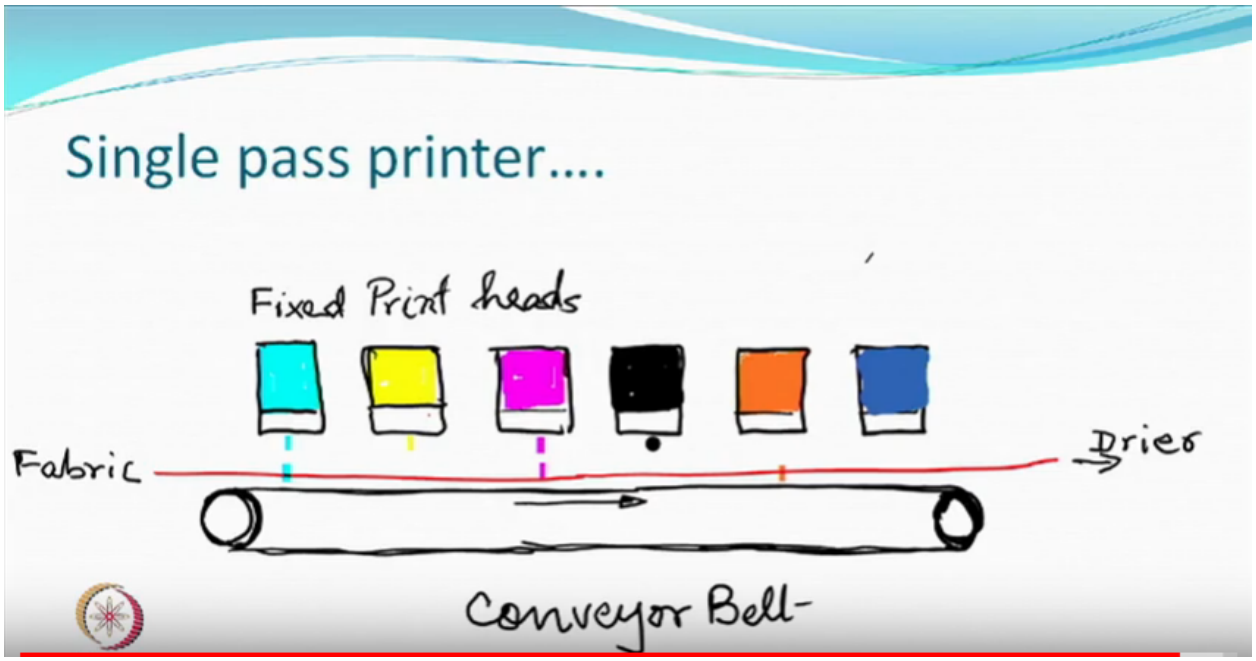

It may look like this, so different colors, at different points. Fabric moves on one direction, goes to the other direction, conveyor belt does whatever it does fixed print heads, 6color, 8 color, whatever 4 color,

you got what you want. So, this could be the type of machines, which you will steam more often for textile printing.

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And some examples are there, for example, a company at the bottom says the stock was one of the companies, which was printing, making printing machines anyway. So, they use a printer which is called Pyke, they use springhead which is made by Fuji films, the ink that I use reactive, Konica, Minolta, know these kinds of the photographic people. They are in textile business, right? So you have, a printer made by some machine, company, our name is called, ‘Messenger’. Konica Minolta print head and drop size can vary from C to six to thirty Pico letters, disperse reactive, another company at the top to, talk about the different company making print head, different company making your printer, different company marketing and says well, drop size very large, acid, disperse, pigment, reactive, sublimation, anything can be printed. Now, so single pass printing machines may, become more important.

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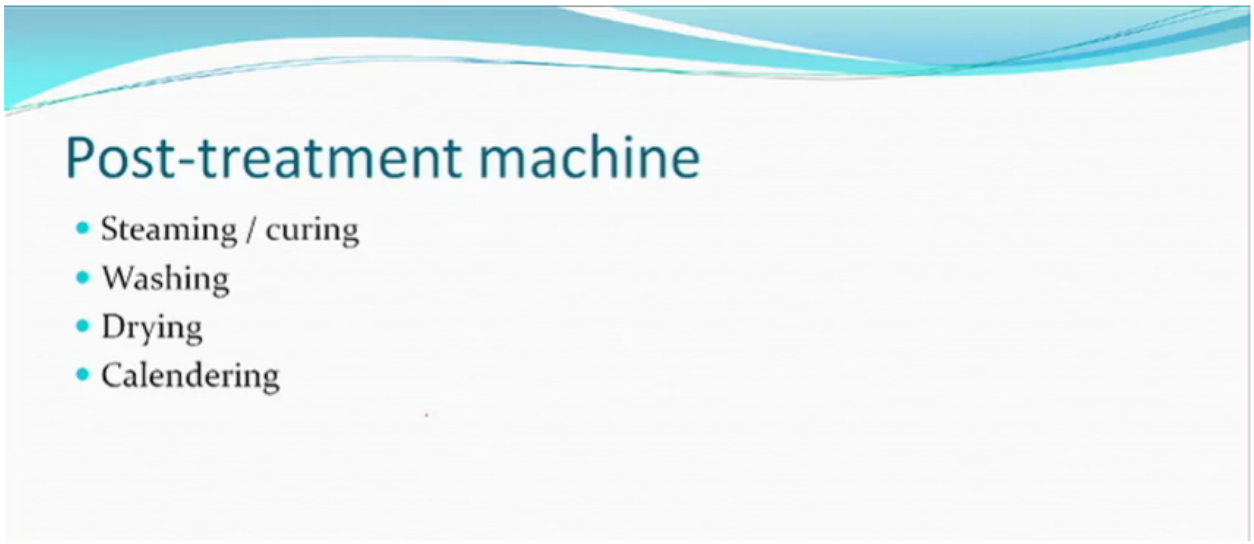

Post treatment, as we said, would have steaming, curing, washing, drying, calendering and then, based on what type of a color that you have. Steaming with etcetera, for reactive, acids curing for pigments, washing of course if required and drying, calendering, these are the simple treatment that you, anyway would like to do. So, we can stop here and next time we'll, talk about, Inks.