INDIAN INSTITUTE OF TECHNOLOGY DELHI

NPTEL

NATIONAL PROGRAMME ON
TECHNOLOGY ENHANCED LEARNING

VIDEO COURSE ON
ADVANCED TEXTILE PRINTING TECHNOLOGY

BY
PROF. KUSHAL SEN
DEPARTMENT OF TEXTILE TECHNOLOGY
IIT DELHI

LECTURE: 7
TRANSFER PRINTING

So we continue from where we stopped,
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and we'll take up a new topic and therefore let us just go a few steps back,
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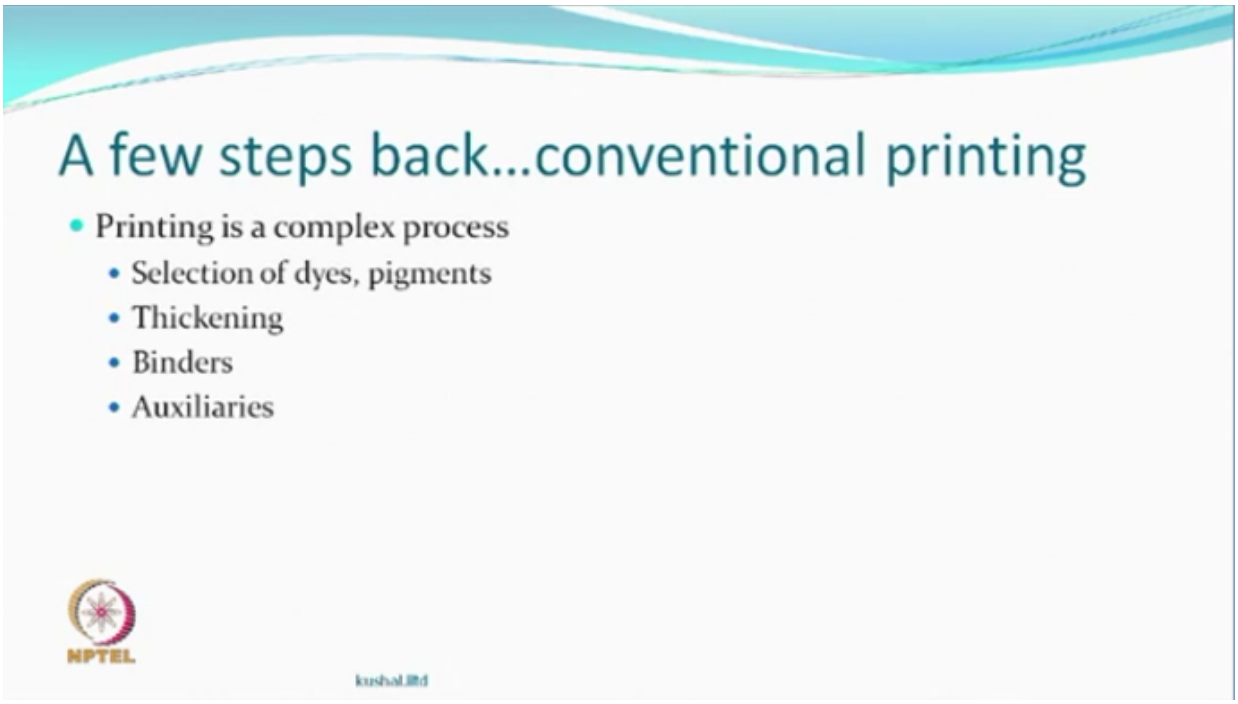

so we did realize that printing is a complex process, it involves selection of dyes based on the fibers or the pigments, then the thickening agents, various kind of thickening agents you had to do worry about the rheology, you had to make a stop thickening, you had to add various compounds there which should not affect the thickening or the ageing property or the time with which it can withstand all the things without changing the rheology, without significantly changing the reality, then your binders, binders obviously are for pigments, what is happened is different kind of binders have come up with low glass chance in temperature so that they handle of the fabric after pigment printing is not changed.

And various auxiliaries which may be assessed basis, conductance, and various other oxidizing reducing agents other than betting agent, they all have to be added in certain sequence and certain process, a certain composition, and therefore it's a complex process, this is what we understood.

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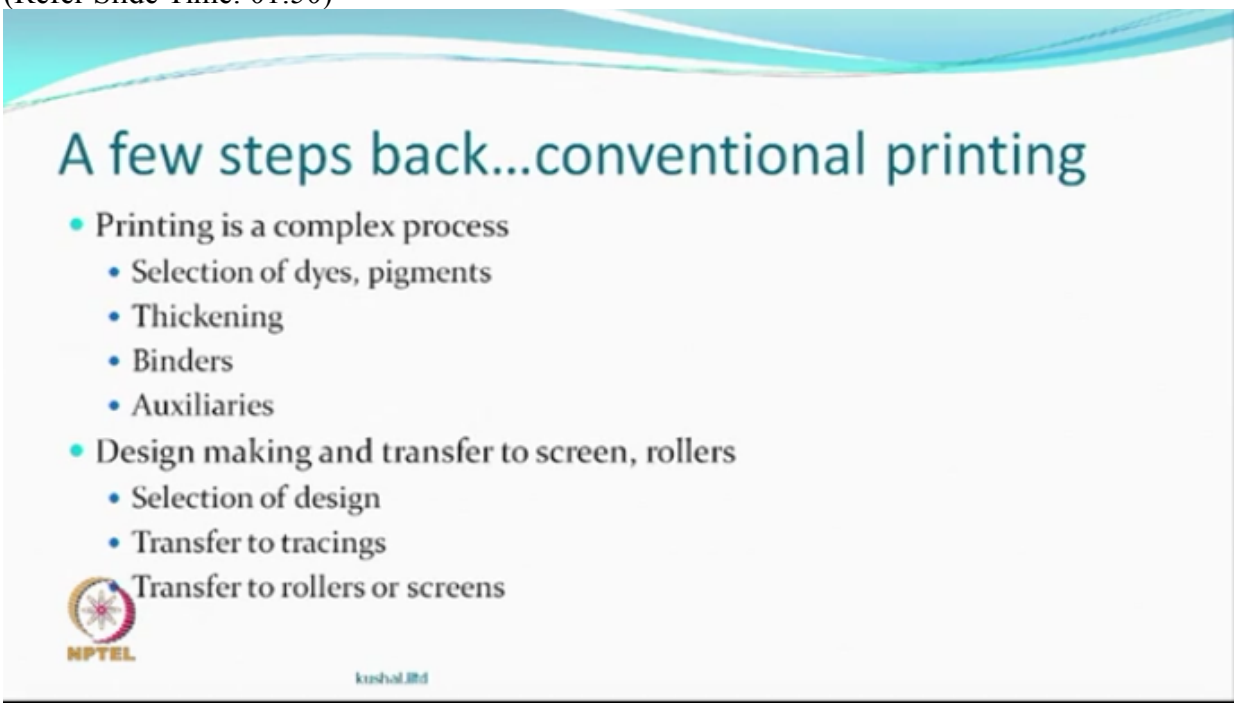

Then making of the design and transfer on to the screen and rollers means first selection of design which anyway depends on who is the client, then you transferred the design on tracings, from the tracings you transfer them on to the rollers those screen which finally have to be used, there is a complex process.

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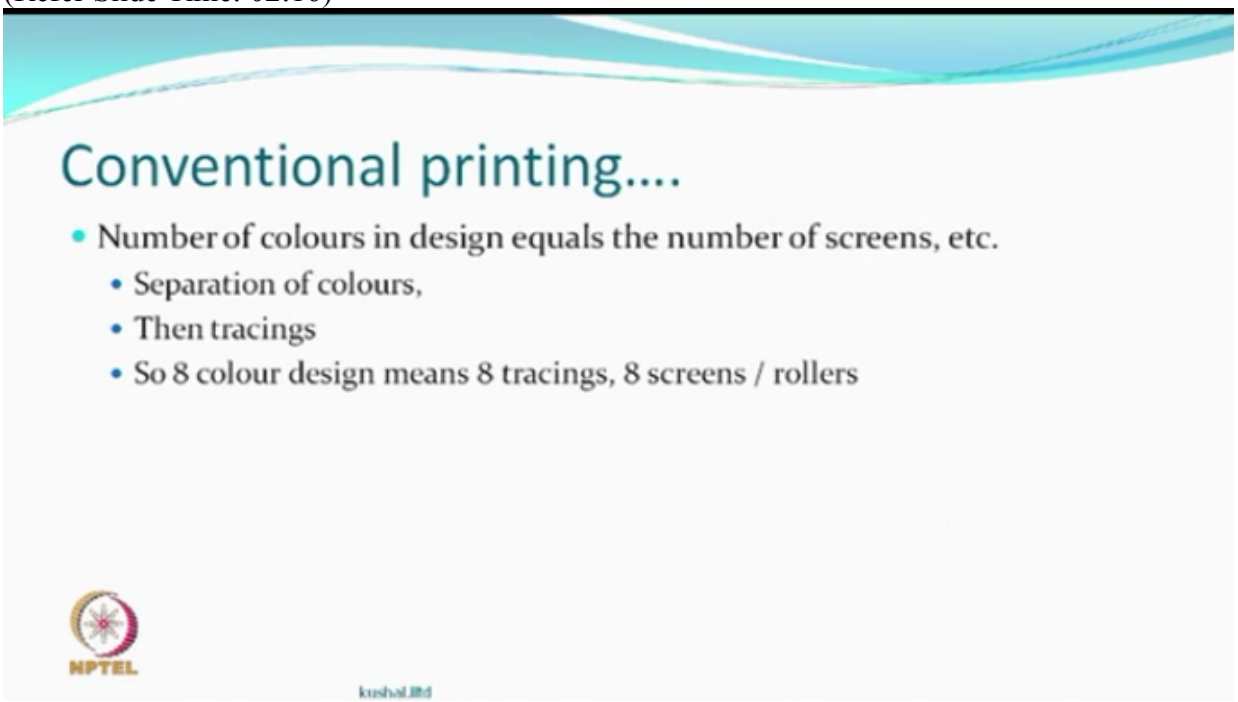

Coming to other points like a machine which is let's say flatbed or rotary screen or roller printing machine, so important thing is how many screens, how many rollers you are supposed to make, so depending on the design you first do the separation of colours, there is a green,

there is a yellow, there is a light green, there is a blue, there is a red, the design they have to separate them and accordingly make tracings for each colour, so if it is a 8 colour design so you means you will make 8 tracings based on the separation of colours and then you will make either 8 screens or 8 rollers, and so whole of this is a complex process, you are not supposed to make errors anywhere.

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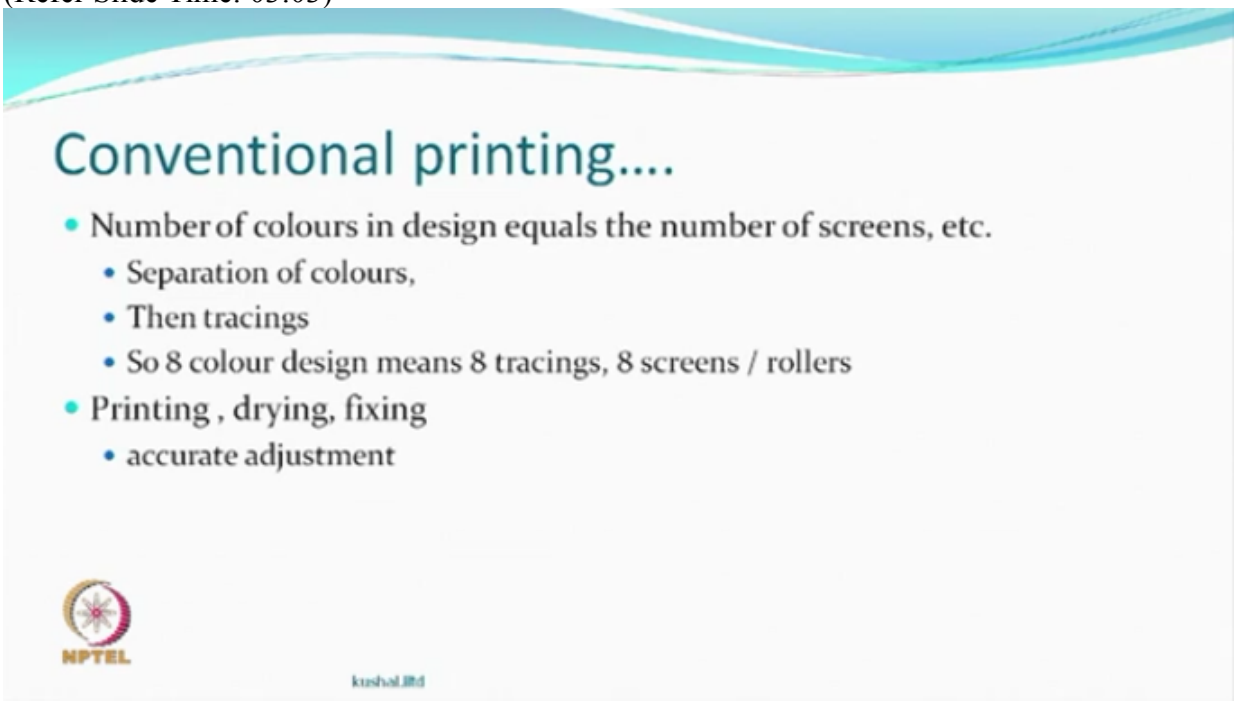

And then of course you do printing, accurate printing, if there are 8 colours and part of design then you better fixed them very accurately if the adjustments are little wrong here and there, you will get fault and that is what becomes an important part, so what it means is tomorrow somebody says that I wanted new design kindly printed or give me, show me a few designs which I may like to you know buy and use, so you have to go through all this process before you can show anything called a design, you can't show it on a you know just some imagination kind of a thing or let keep just draw, you have to show it after printing to someone who says well this is it, you like it or you don't like it, and based on the fiber or fabric chemistry you may get different shades, and that therefore has to be shown, so it's a long process, even getting approvals takes a long process.

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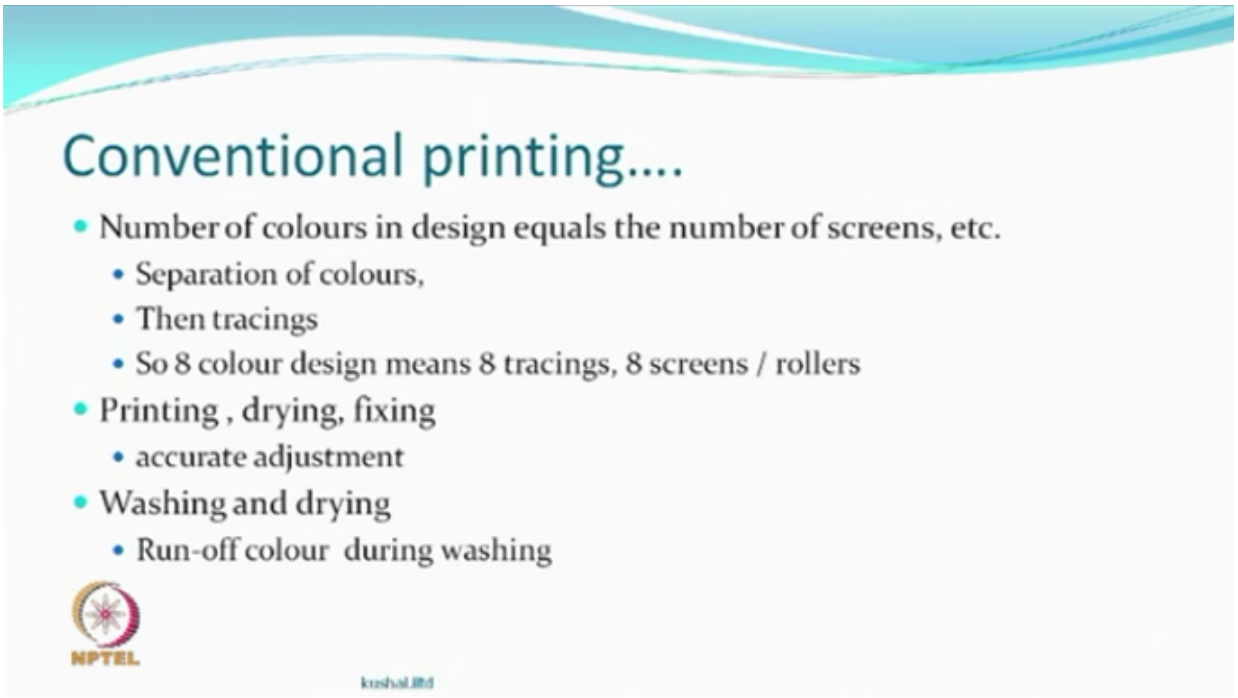

Then washing and drying of course has to be done, the run-off colour during this whole process has to be at a very careful on that, so that it doesn't go to the areas where you are not supposed to have that colour, and then of course drying that is if nothing else energy of course is there,

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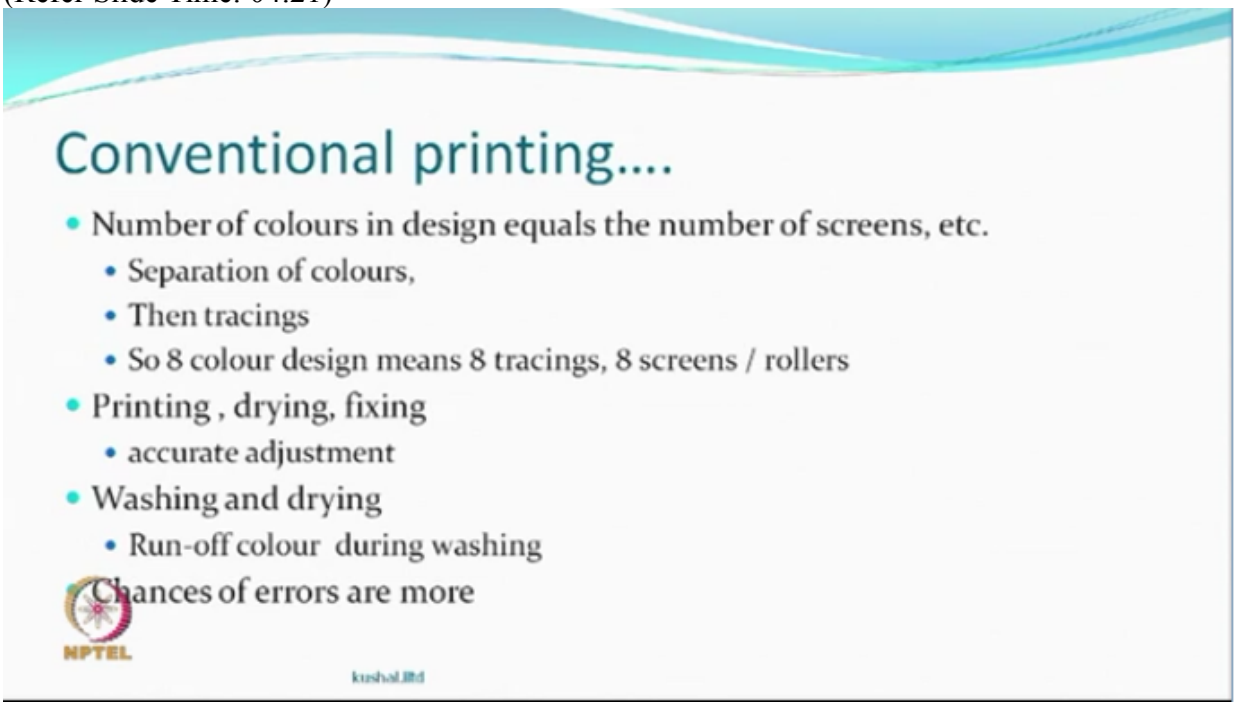

so there are chances of errors in almost every step that you make, because errors only get added, you know, there is nothing called subtraction of errors and therefore it becomes more and more complex in difficult process, and if you make errors the rejects will be high and that is

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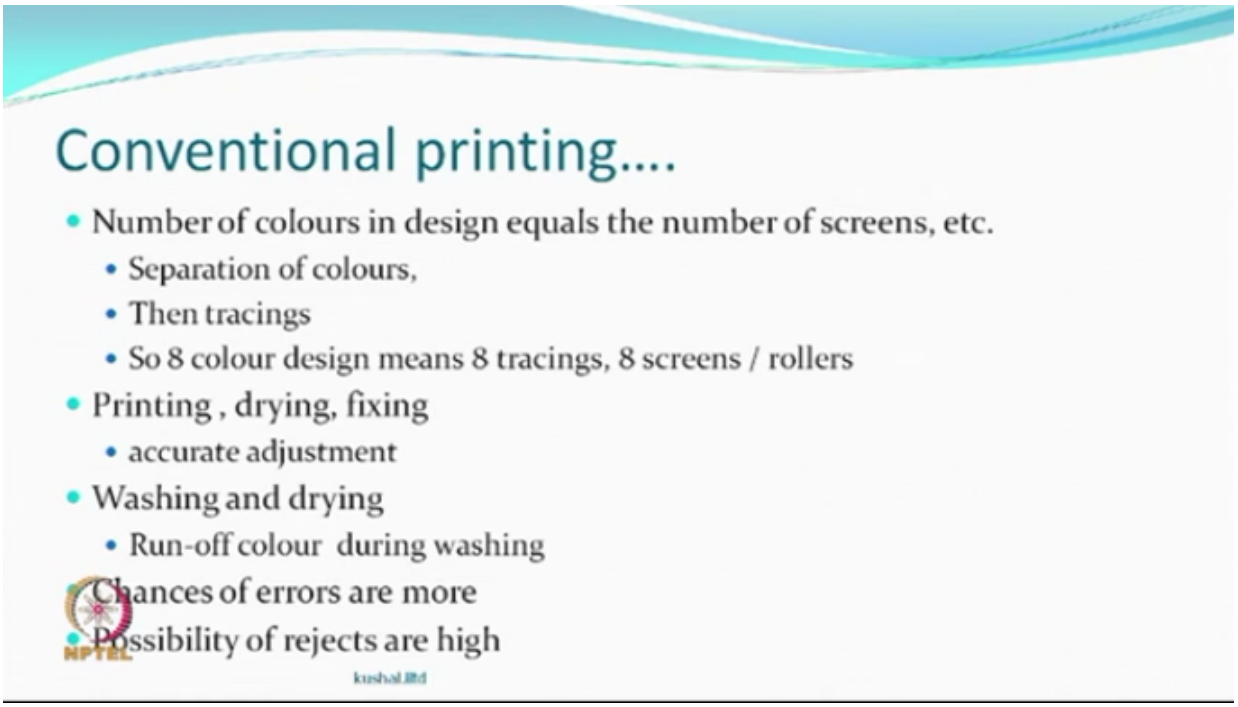

the conventional printing for you which has been invoked and being used every day, so this becomes an interesting part.

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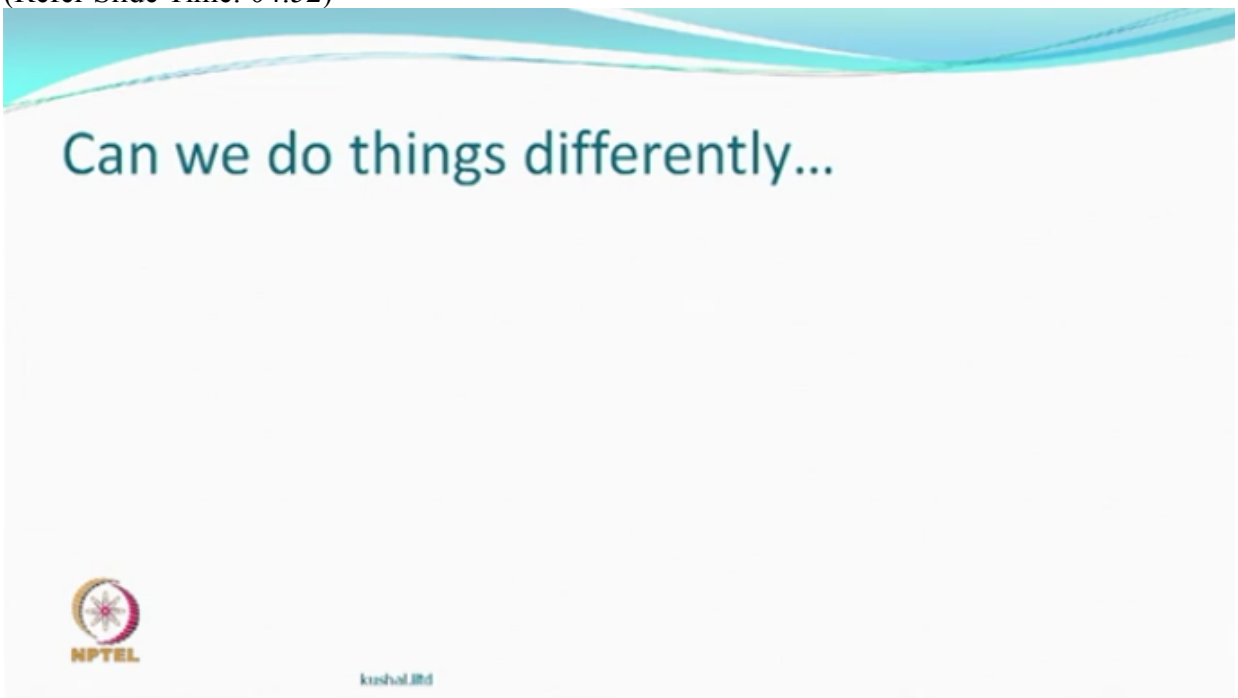

So now the question that comes is that can we do things differently, like you don't have rollers, you do not have screens, you don't have anything else and what can you do, so that particular conventional printing obviously involves large number of steps, people will be interested and can we avoid some steps and work around, then you may be interested in the design if somebody say well I want to show, see a few designs how quickly can you make a design and

show to the customer and get approvals, there are practical problems and there are less to do with your thought process, and how can one address the energy environment concern because every time you're printing, then you are drying, every time you are fixing of that your washing, after washing then you again drying and then you again, so wash dry that's part, then whatever goes into the waste water obviously has environment concern and you are supposed to work on that.

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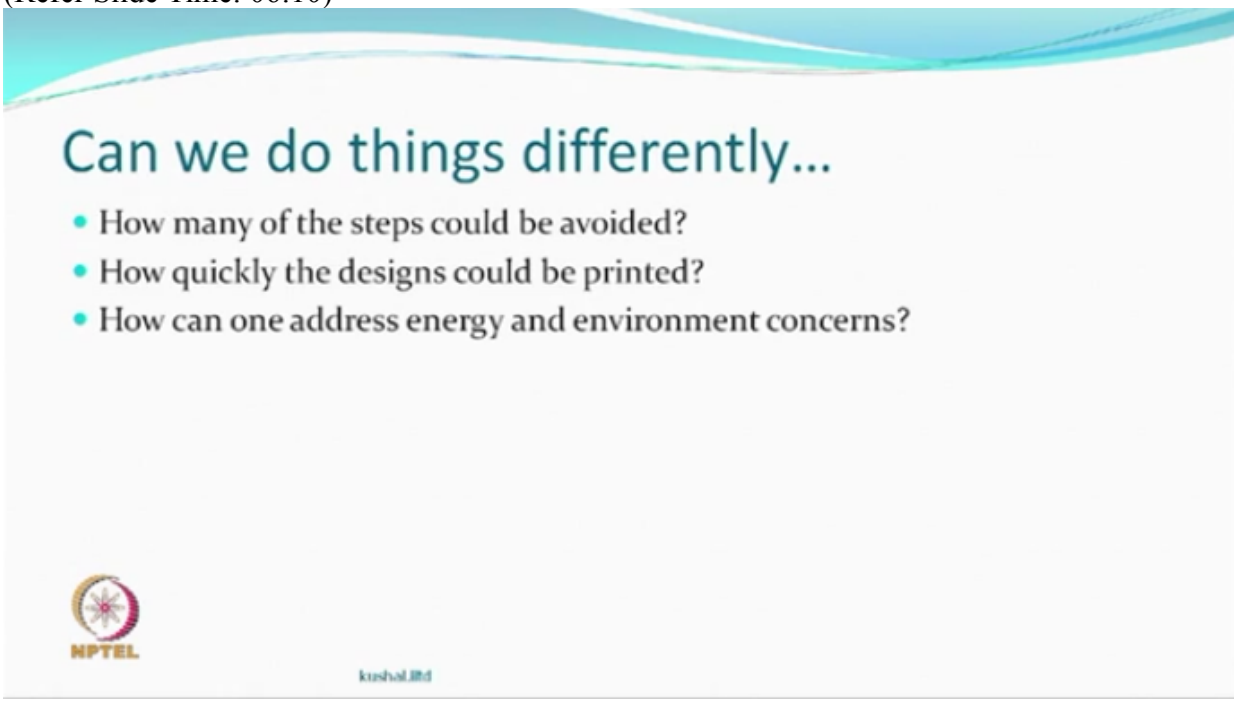

Everything therefore is does it cost something, so when you talk about environment so there are cost that you know incurred, so how does one do this process which can probably address some of these issues,

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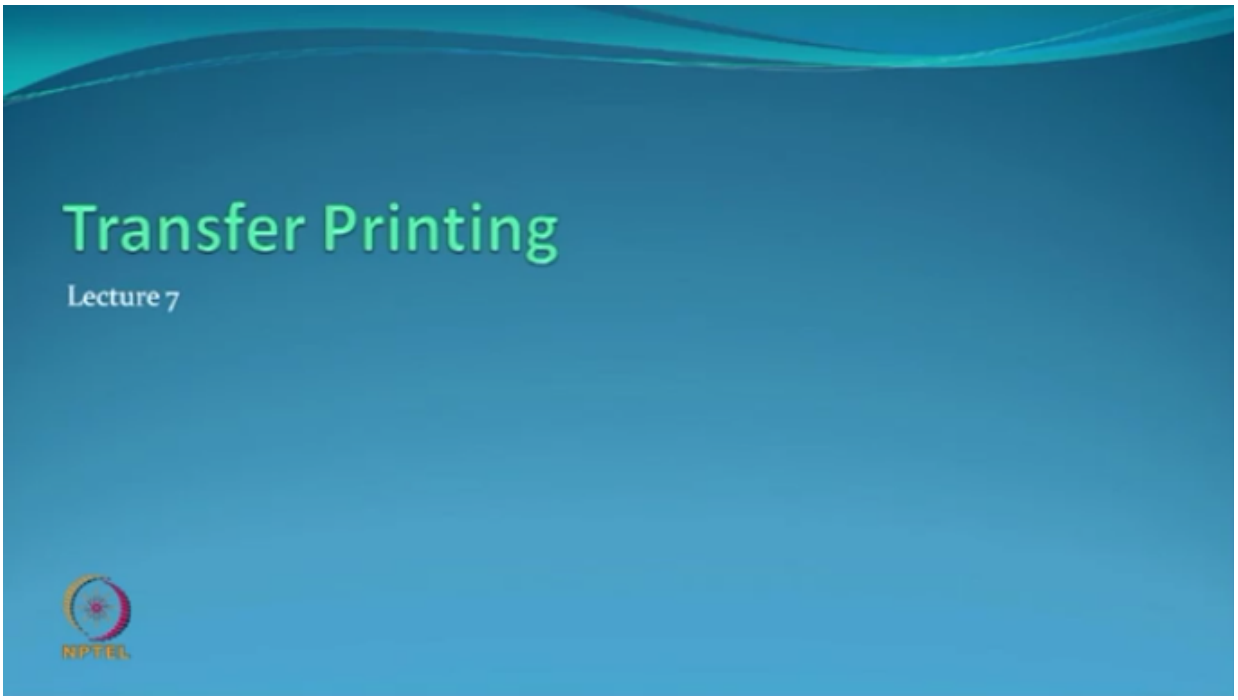

so this is the topic that we will start working, discussing, called the transfer printing, as the name suggest that the printing is done somewhere else, not directly on the fabric, till now all the printing that was been done by directly on the fabric, whatever happen happens and you could do.

Now you are talking about low, we can't probably, print somewhere else and then do the transfer,

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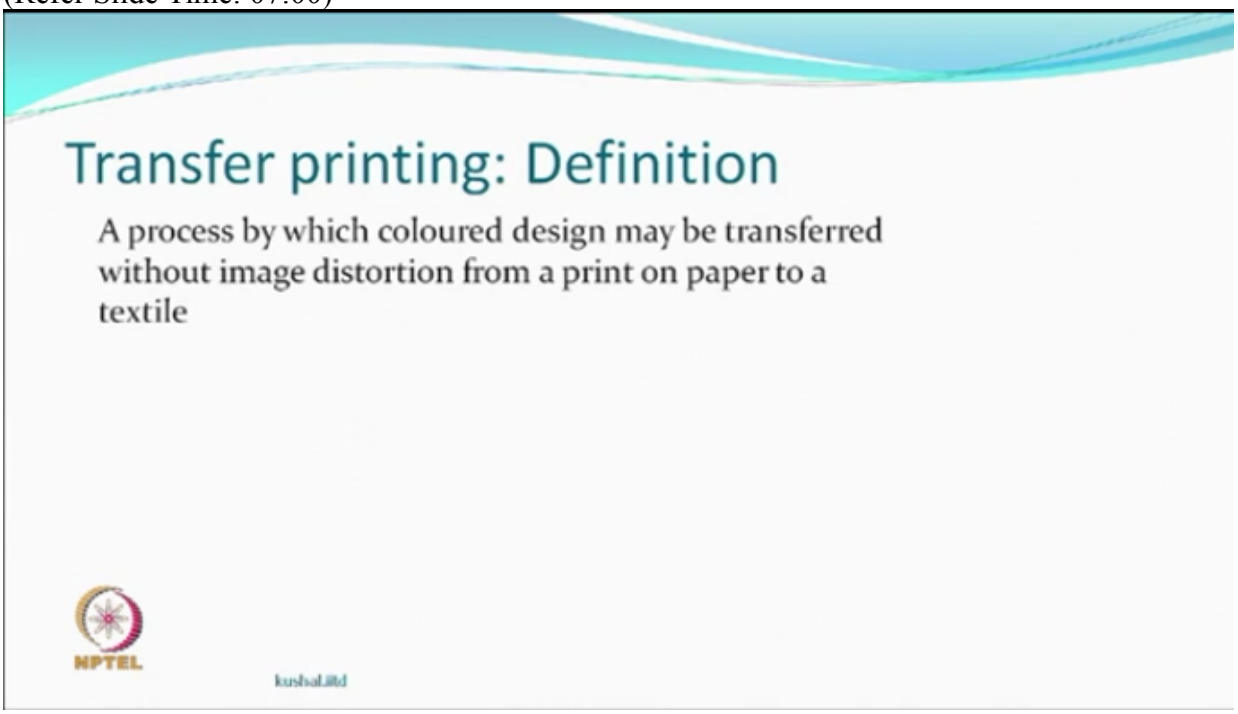

so theoretically speaking this is the process by which designs can be transferred without image distortion from a print on a paper to a textile, now paper could be a film also, but generally paper is what people may be using, so you first print the paper and then transfer from the paper to a fabric, now when say without distortion, now what it means is that the kind of errors that you were expecting that it has a 6 colours, 7 colours system, then you have very sharp lines somewhere else they are overlap, they may smudge one into the other, all those things will not happen because whatever is supposed to be on the paper if you like that, then you just transfer, we obviously hoping that the printing paper is relatively less costly, paper is supposed to be a very smooth surface compared to a textile which obviously has undeleting surfaces, hills and valleys all over, making sharp images there is a very tough thing, but on a paper you can make very nice sharp images and once that is done and if it is possible for you to transfer then it becomes a very interesting process, this actually attracted a lot of attention quite early 70's and 80's people were really thinking about it as to how things could be done.
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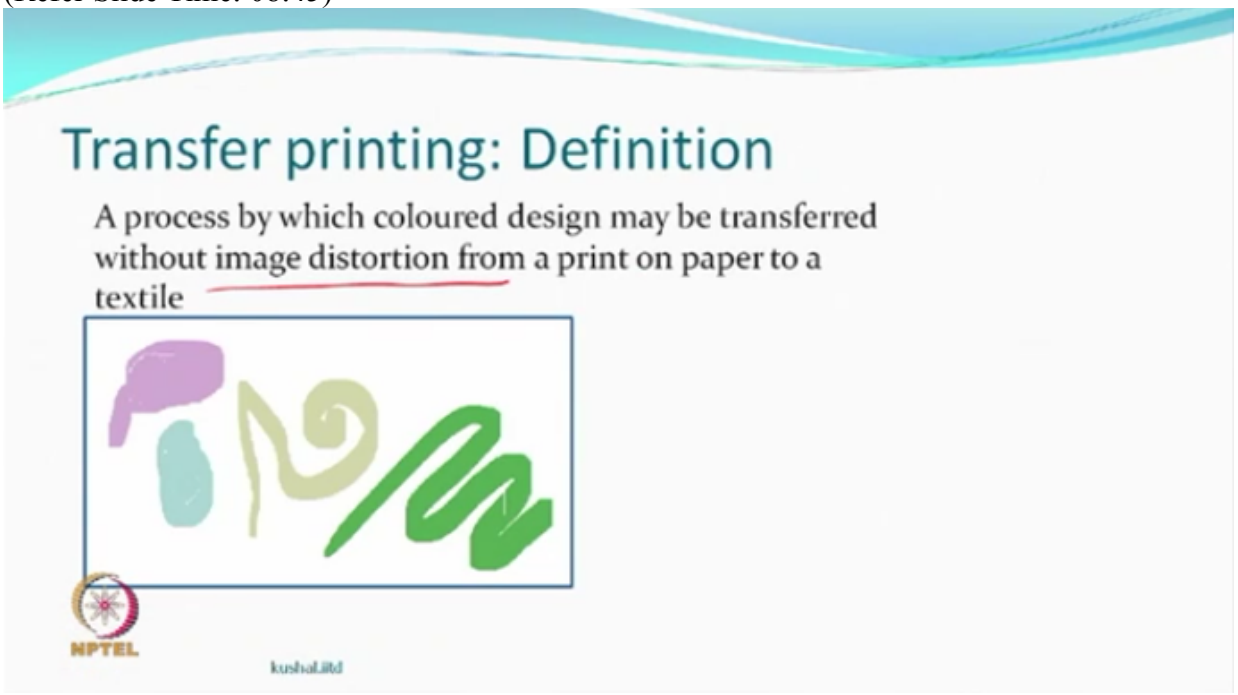

So whatever design, let us say this is design on the paper or whatever colours that you have and all you are expecting is that after the transfer exactly same thing will be on something called a fabric,
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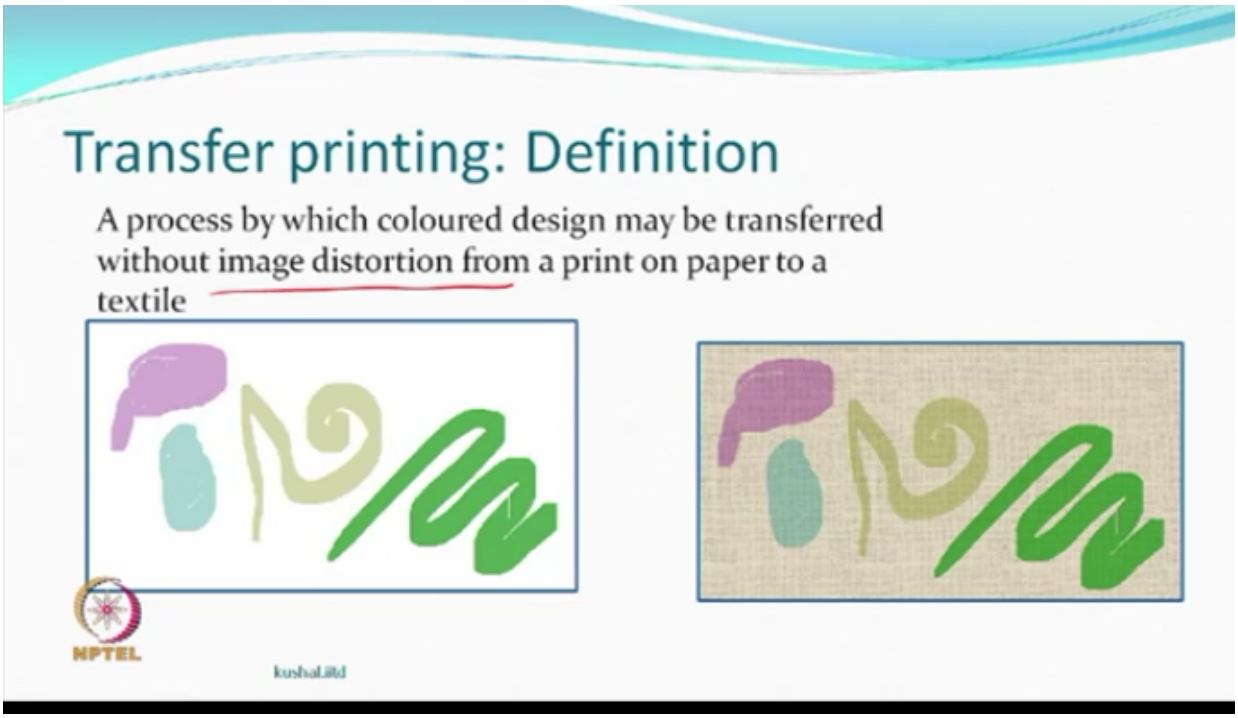

so you have this transfer and this is what we call as a paper to fabric, so you have a transfer printing on your hand.

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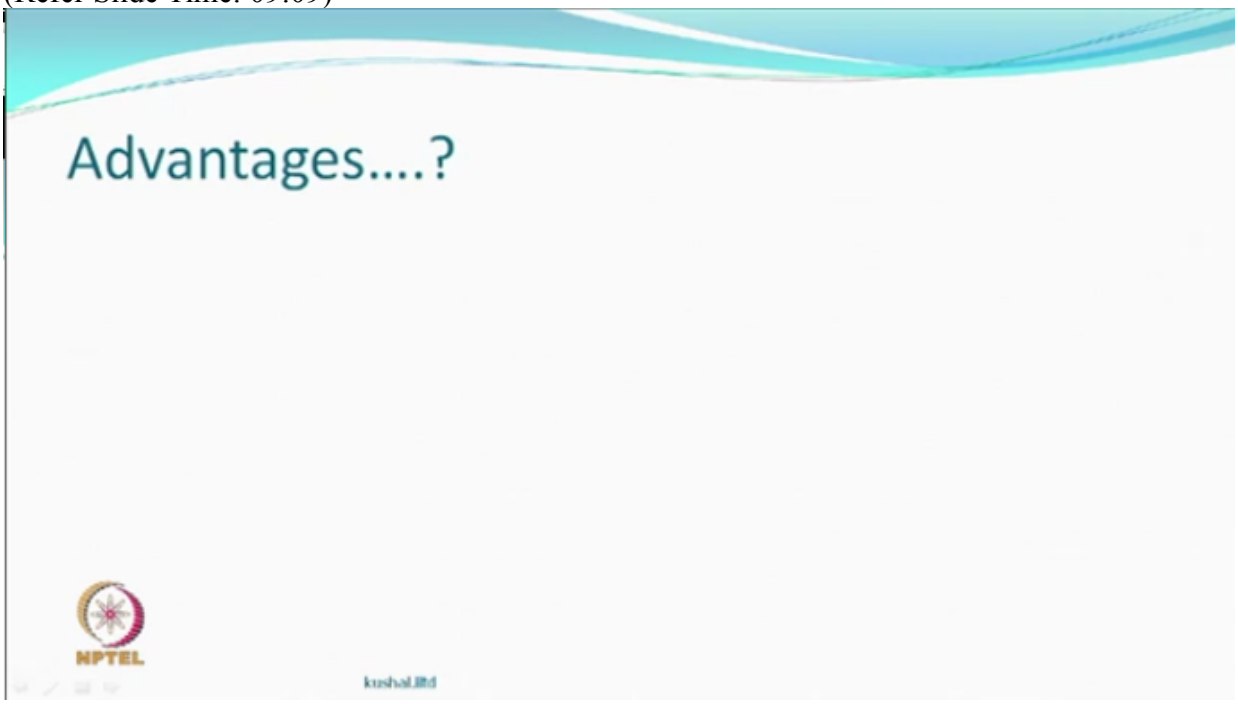

So some commonsense advantages that we can talk about, so designs maybe printed and stored on a cheap and non-bulky substrate, so bulk of a paper is very less, the thickness of a paper is very small, you can make a role and you keep it, and so storage could be cheap the whole thing,

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otherwise we had to do store all kinds of rollers, screens, and then bring them out whenever you have to, so that's one advantage one can say the commonsense advantage.

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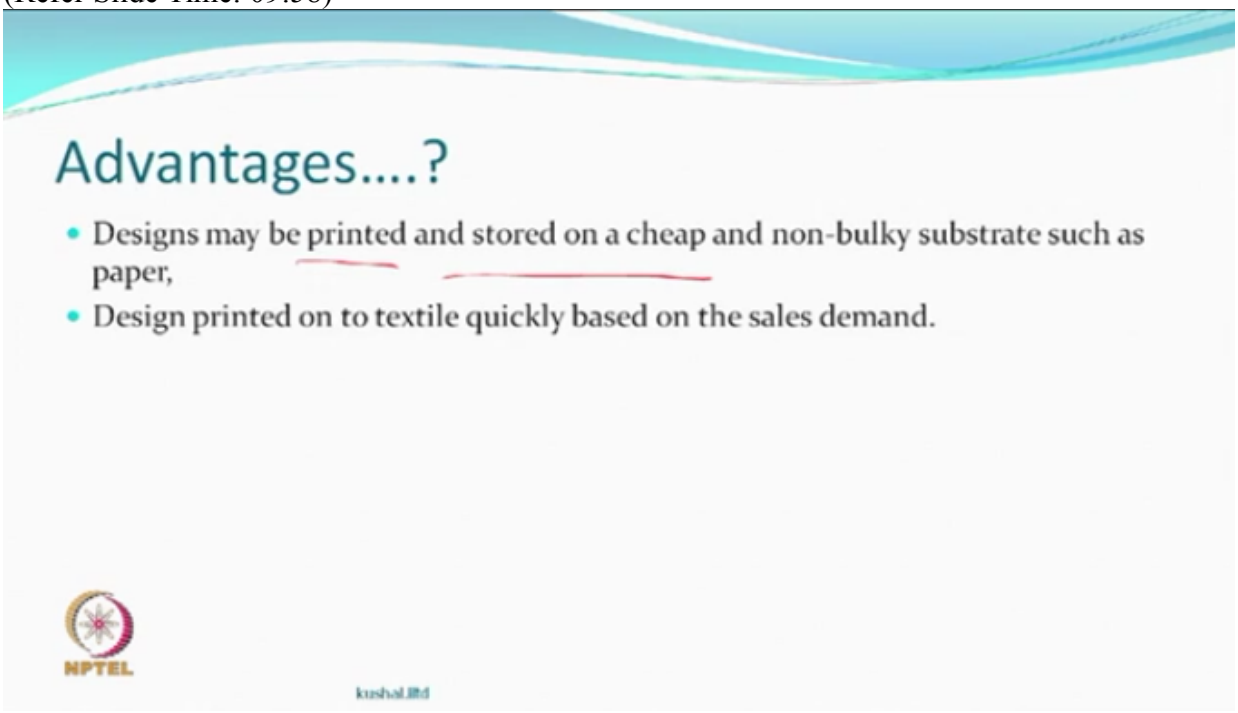

Design then can be printed on to textile based on the demand, if somebody says I want the same design 2018 or 2017 I got it in September month or September you show, bring out the same thing so you actually have a printed design which has to be just transferred, so if somebody says that while you had given me on this fabric which was let's say one up, one down kind of a fabric oven, now I want the same thing on mandated stuff, can you do that? So you say yes let's

try, so different kind of substrate to which this transfer is valid can be used and then you can see well this looks this good or this bad in the substrate and then you can take a call whether needed or not needed, so it's a quick stuff.

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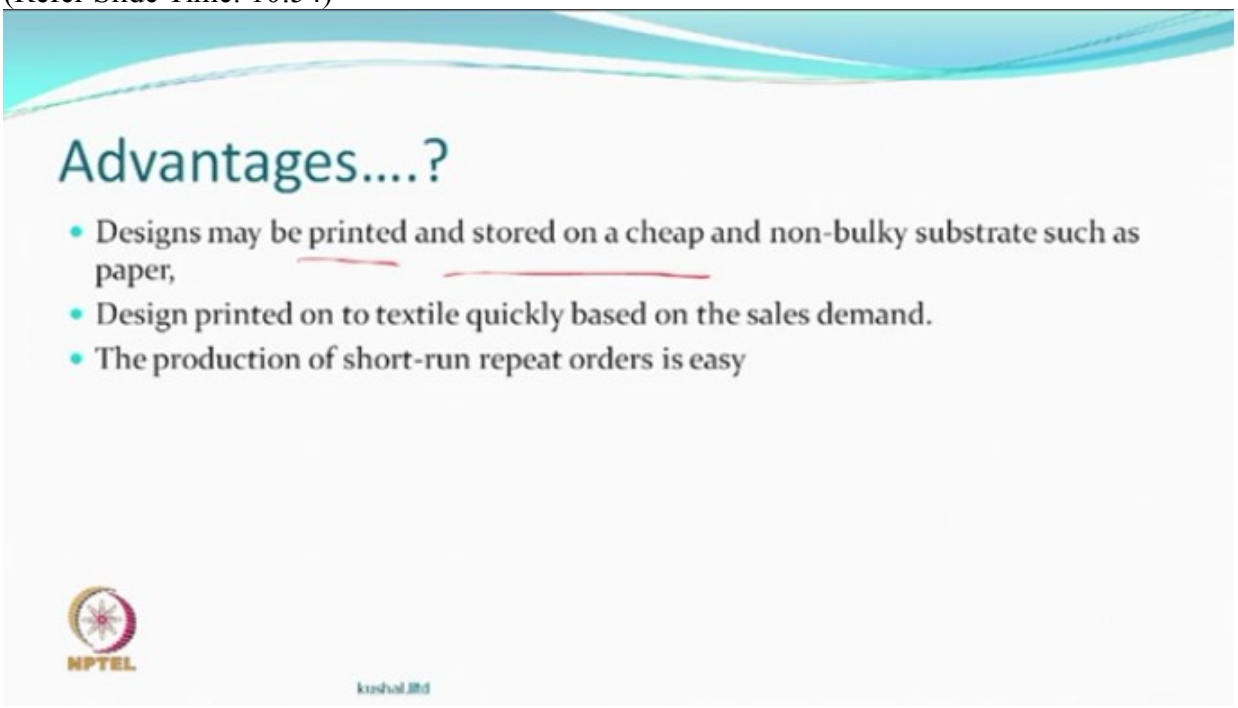

The production of short run repeat orders is easy, if somebody wants only 100 meters of printed design most of the male would say sorry we don't have energy time to do this, because the whole process is so long, in this case you may say well I don't mind maybe I'll give you 100 meters also if you are there, so that means short run repeat, but this month after 3 months another little bit for the same design say it's possible, and that is what becomes some attraction,

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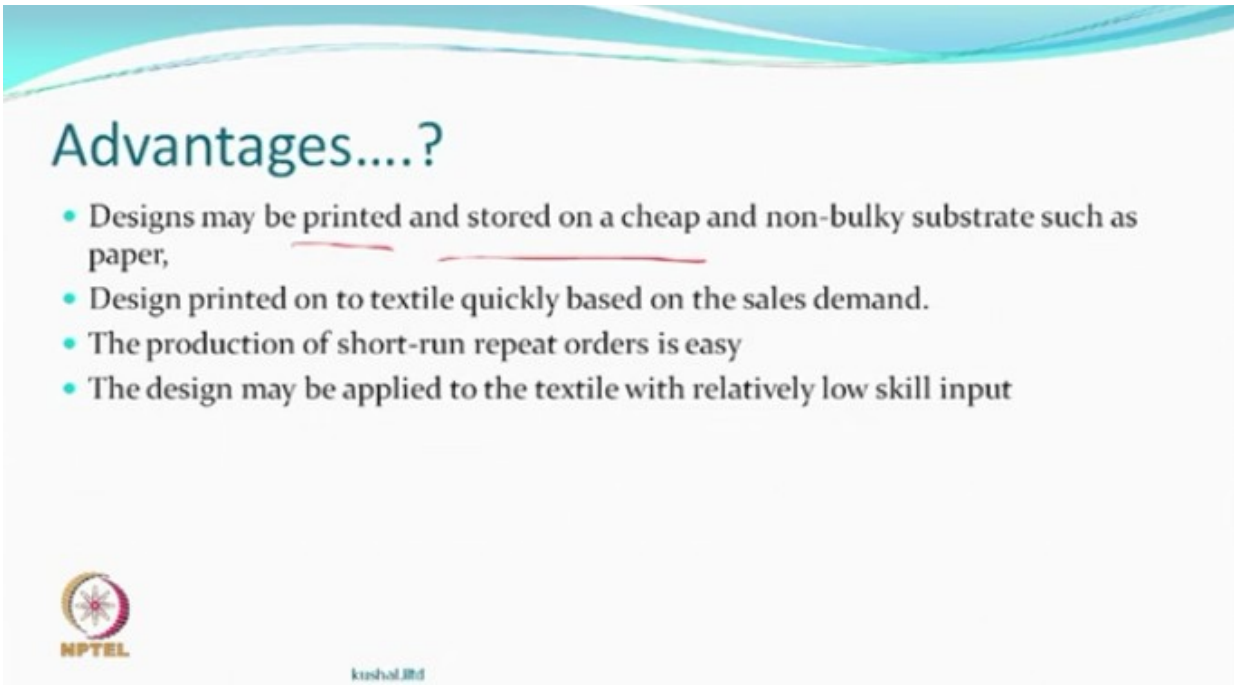

this is a very interesting thing that you can apply this design whether relatively low skill worker on a printing, not only the printing head, departments head, the people who work on the machine, the people who fixed the design, the people who transfer the design, all of them have to be highly skilled, in this case the skill part has been taken care somewhere else, the textile person only has to have a simple machine of transfer, and so skill level could be very low that means anybody can theoretically open an textile printing section, get the paper design paper from somewhere else who maybe a paper printing system and bring it in and start transferring, so low skill anything that require low skill mean the errors are very less, otherwise you require high skill people.

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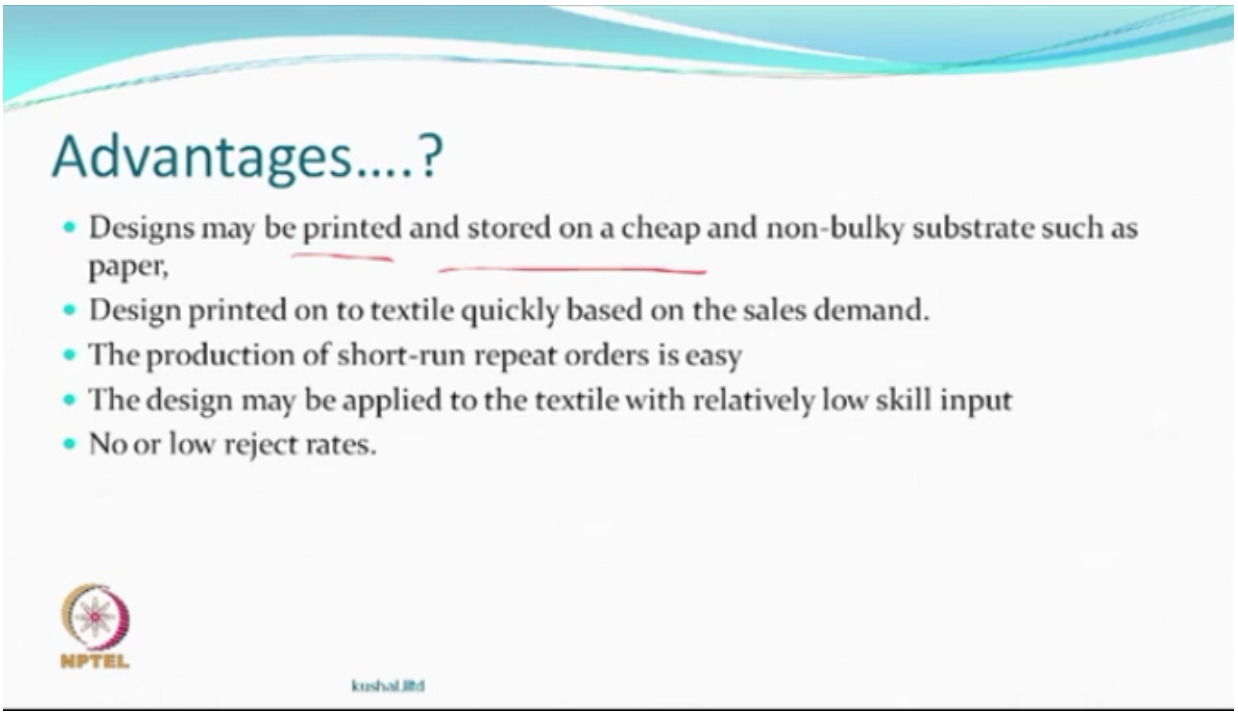

No reject rates or maybe low reject rates, no is the right word because if you have just little skill that you can actually have a fabric fed into the machine in an open width and the paper is always an open width, they go together, they don't slip, the temperature, so for that is the temperature of a transfer is required that you are able to make in control, then chances of rejects are almost 0, but yes you can always make a mistake not worry about wrinkle somewhere else or the fabric and the paper are slipping then obviously, but invariably this maybe not be the case.

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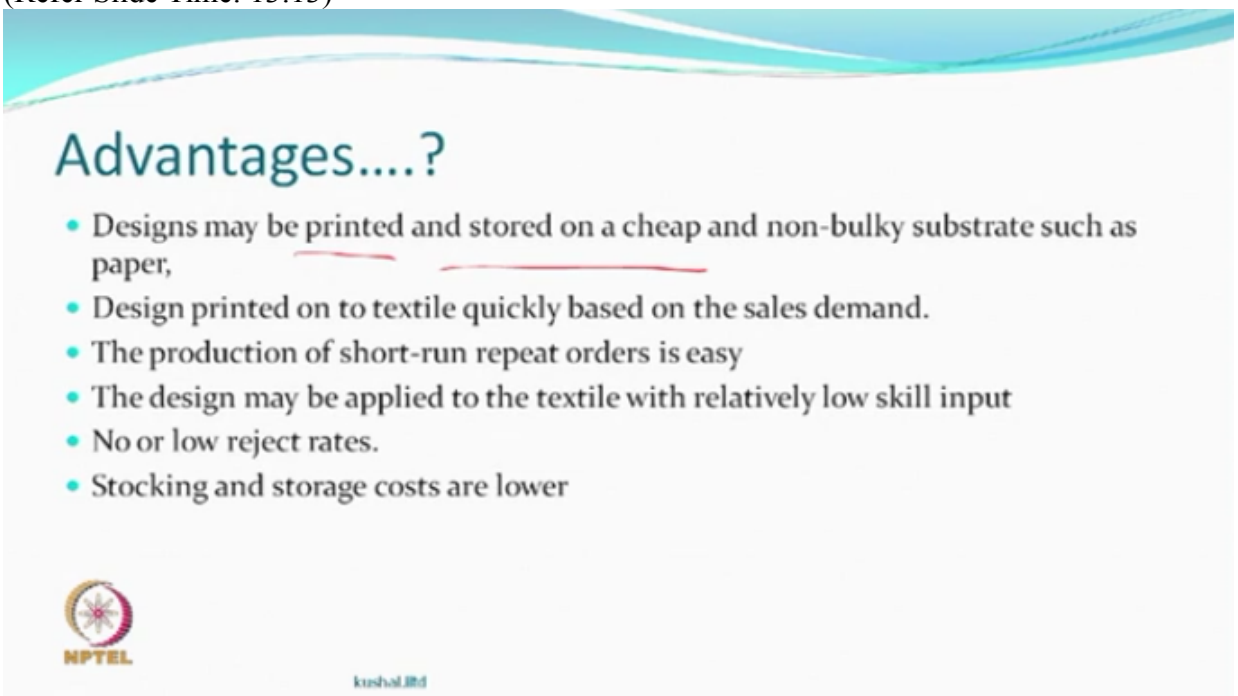

The stocking and storage costs are lower because space requirement is also low, only thing one has to be concerned is if it is a paper that it should not be a moist environments, the water should not be seeping all through, that's the only thing that you have to worry about in case that you can take care which you should, then the overall costs are going to be low,
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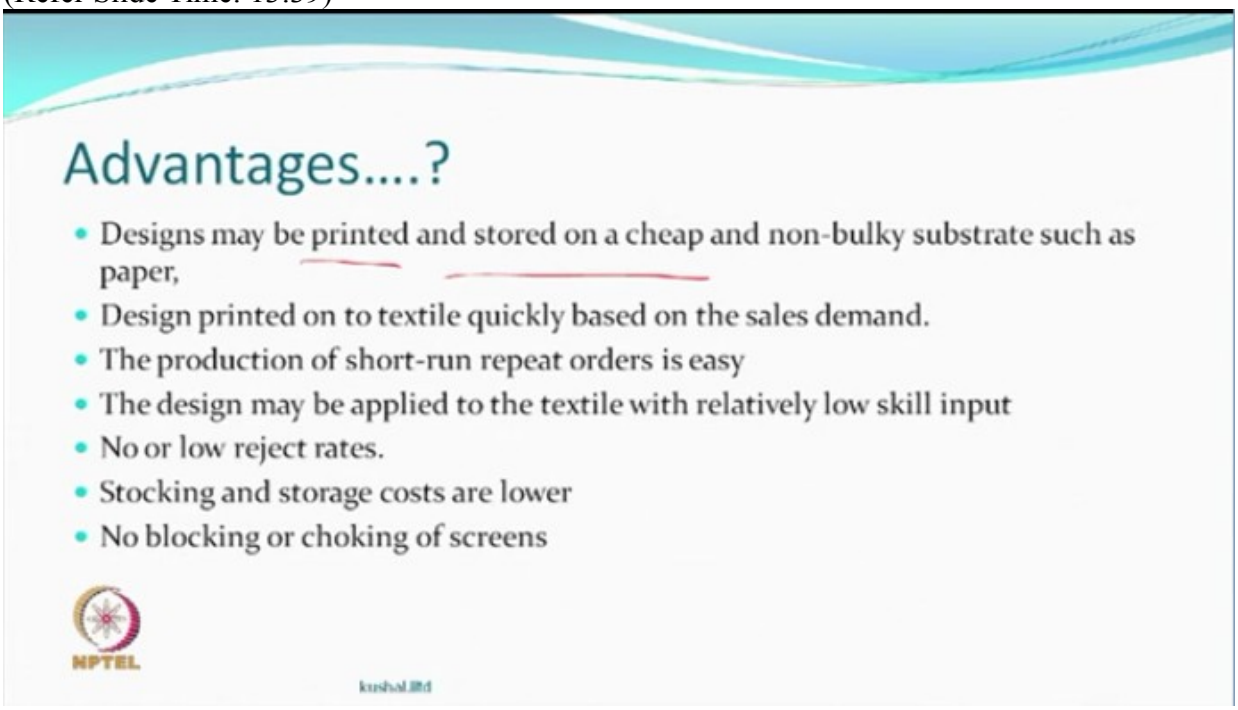

so invariably the screens after the print they have to be cleaned, so two things can happen, one somebody did clean, but some part of some design at some portion is blocked, of course you are supposed to clean or somewhere where actually there was a block it has come out, because of friction and other thing, so you have to keep repairing them correctly, so that kind of a problem will not be here because you just don't have to do anything.
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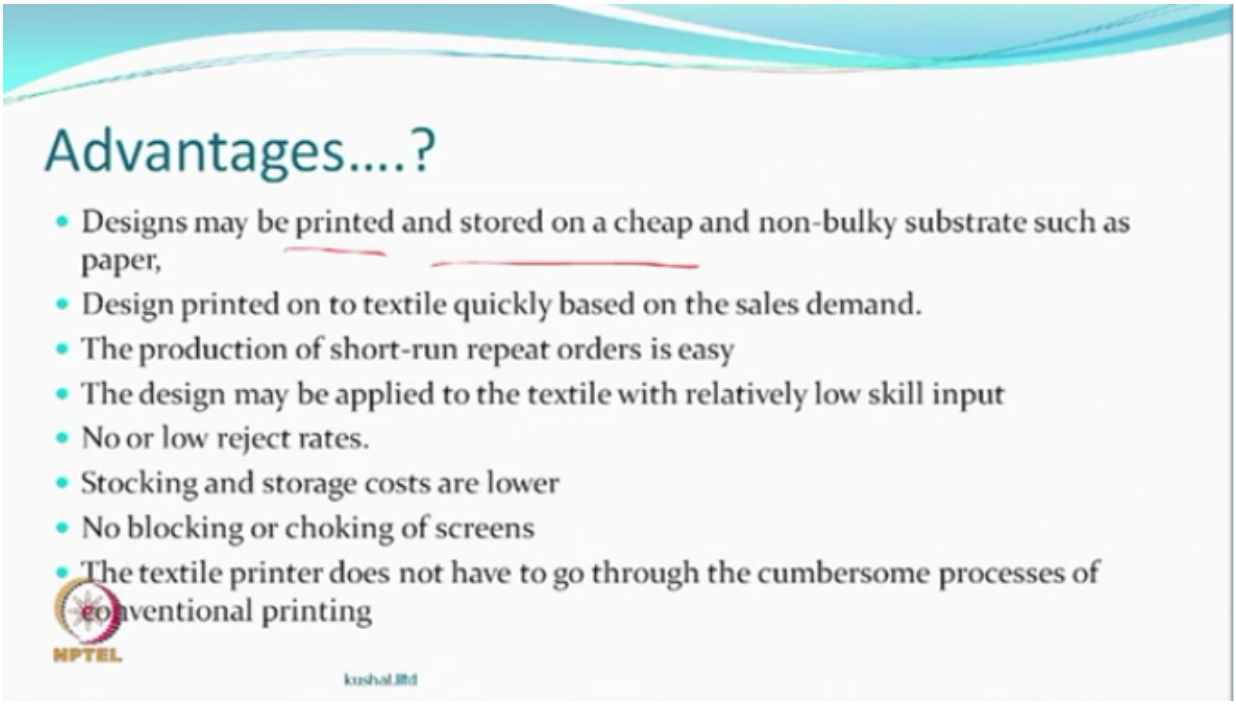

So the textile printer which does not have to go through the cumbersome processes of conventional printing, and suddenly you may say now the printing is not complex, you just have a paper, you just transfer and thank you very much and it's done.

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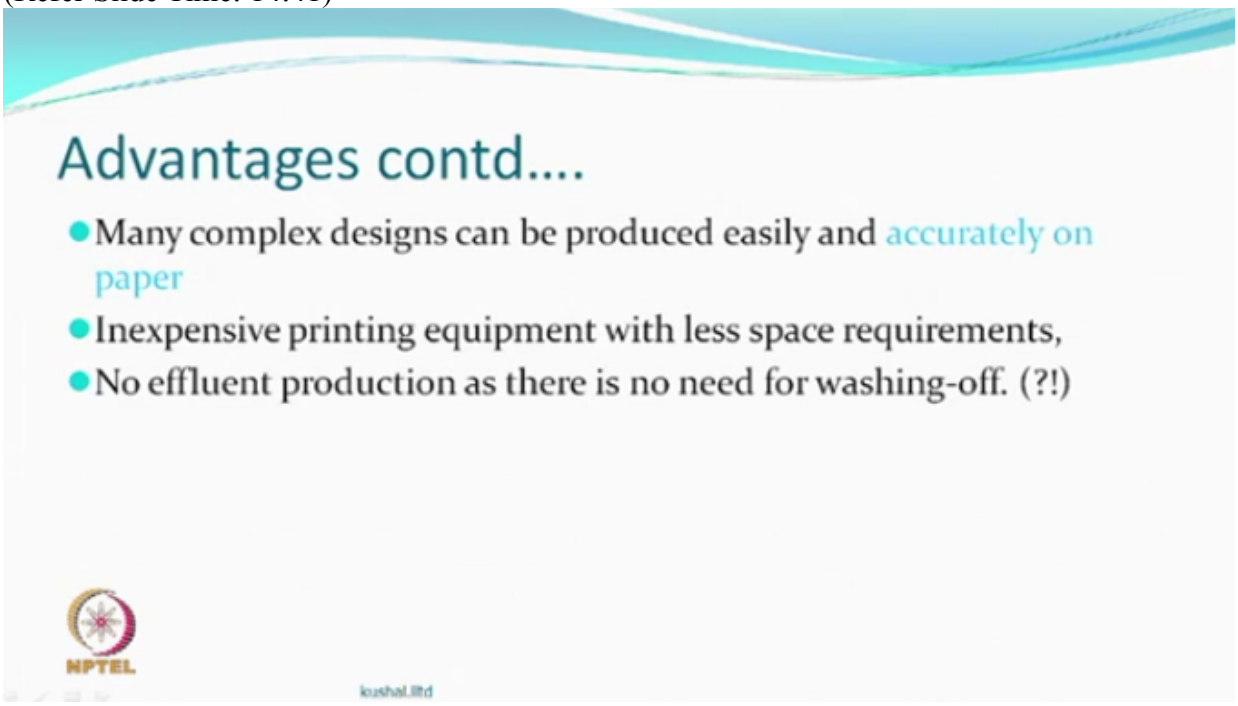

The accuracy of designs can be achieved on a paper which is a smooth surface, if it is simple designs of squares, then rectangles, then circles, that's easy and anybody can print lines and squares, whereas the complex design where they find lines of the one which are important to

you, then it is very accurate to print, it is very easy to accurately print on a paper, and so that one.

Printing machinery equipment, printing machinery and equipment are relatively inexpensive and would require less space, okay, and if everything is right you do not have to wash off, one of the case in point is the disperse dye and polyester, if it is already defused in you do not need to wash off, even in dyeing you have to do many other sequences with disperse dye, in SDHP as well, and so no affluent production, so you could actually will look in at environment cost, you are looking at you know washing expenses and there is the error due to washing colour flowing from one to another one, portion is not obviously there, so there seem to be umpteen number of reasons why one should actually be adopting this technology called the transfer printing.

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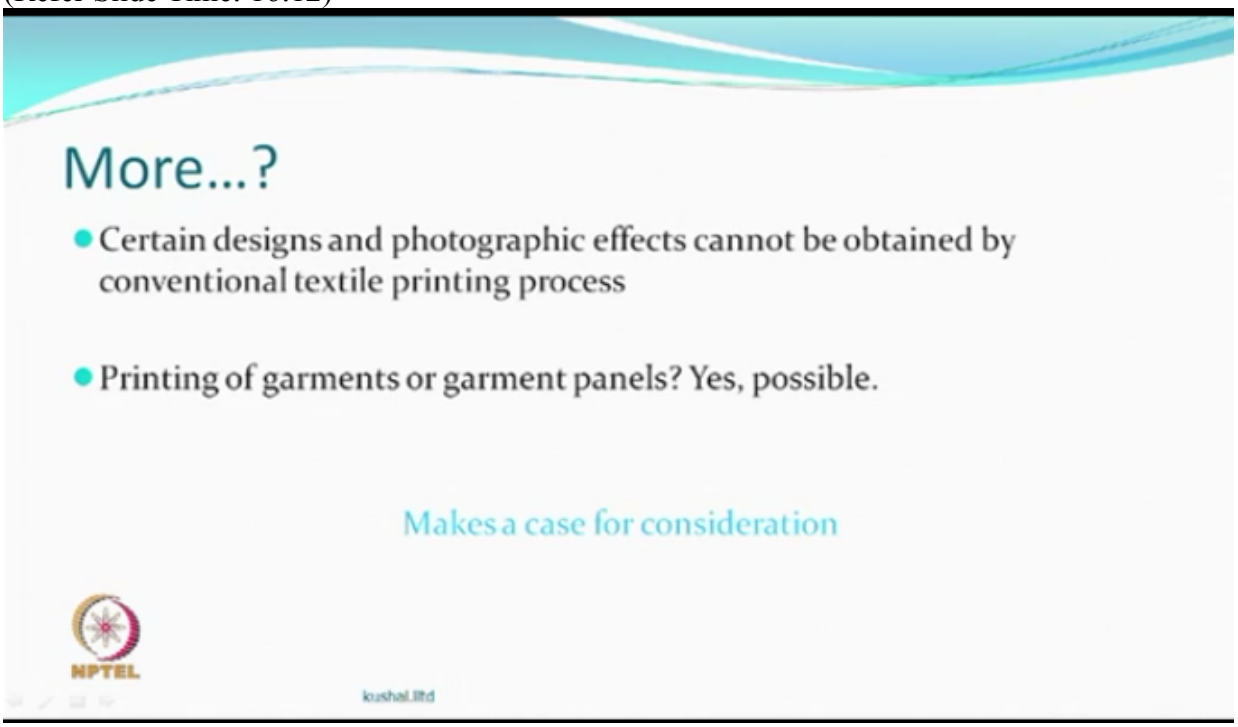

Certain designs and photographic effect cannot be obtained by convention printing process, this is very important actually, till the time you actually had a concept of transfer printing you were not even dreaming about it, what kind of a design that you are thinking of on a machine, let say a rotary screen printing machine, we said 8 colour, how many more? Let's say we can take 12 colours, so 12 different shades you can produce, but if you look at a human face starting from one end to the other the shades are continuously varying, and if you divide this into 12 shades when you were only looking at a posturized picture, posturized picture, it will never be natural, and therefore a large number of design only had such kind of designs which would not be photographic, which is nothing to do with the scenery, which is nothing to do with the faces, which is nothing to do with the real life colour and design, alright, so that could not have been done at all, cannot be done even today with a conventional printing process.

Then we were printing always fabrics, and then hoping somebody will use them to make garments, so today it is possible for you in this kind of a scenario that you can print any part of a garment, you want to print only the pocket, fine, you want to print only the colour is fine, or only one side of a sleeve is fine, but in a conventional way if you say well I will put the t-shirt through the screen printing and then a normal way or a roller screen, rotary screen it will be pretty difficult to handle, because the size and shapes are very different and so this becomes a real case for consideration, it's called the transfer printing.

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So a photographic image like this you can see, if it is on a piece of paper or a roll you can cut it out and just take it away and print it, look and see how many shades of things are there here, the simple picture which you actually see well its natural, it's okay, there is nothing great about it, but the greatness is the moment you start printing it, how many colours? So you said 12, try to divide in a 12 colour, you don't know what you are going to get, alright, in the conventional sense the way we understand the textile printing, alright, and here there is no problem, you just take it, take a t-shirt and then say well this is what I want,

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and so wherever you want to place it you can place your design, if it requires only thermal treatment you give the thermal treatment, and that's it, and you have a same kind of a effect on the textile.

Somebody may ask exactly look the same, it may not exactly look the same, because that was of plane surface versus its of, this surface has a texture, so based on the kind of texture that you have the effect will be different, but if you still look more natural and photographic, alright, so the key concept is transfer,

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that is you're not printing the textile but you are transferring the design and therefore whatever has to be done, has to be done before somebody else can do, and it so happened over the period of time while the printing or paper was going on and the printing of textile was going on, the paper printing technologies and systems got designed developed much better for various reasons and this is to utilize that knowledge for the textile purpose, so transfer printing, so this is where we look as a key concept, so is this a new method or style, what do you call that? We call it a new style or a new method of printing, so it's a method,

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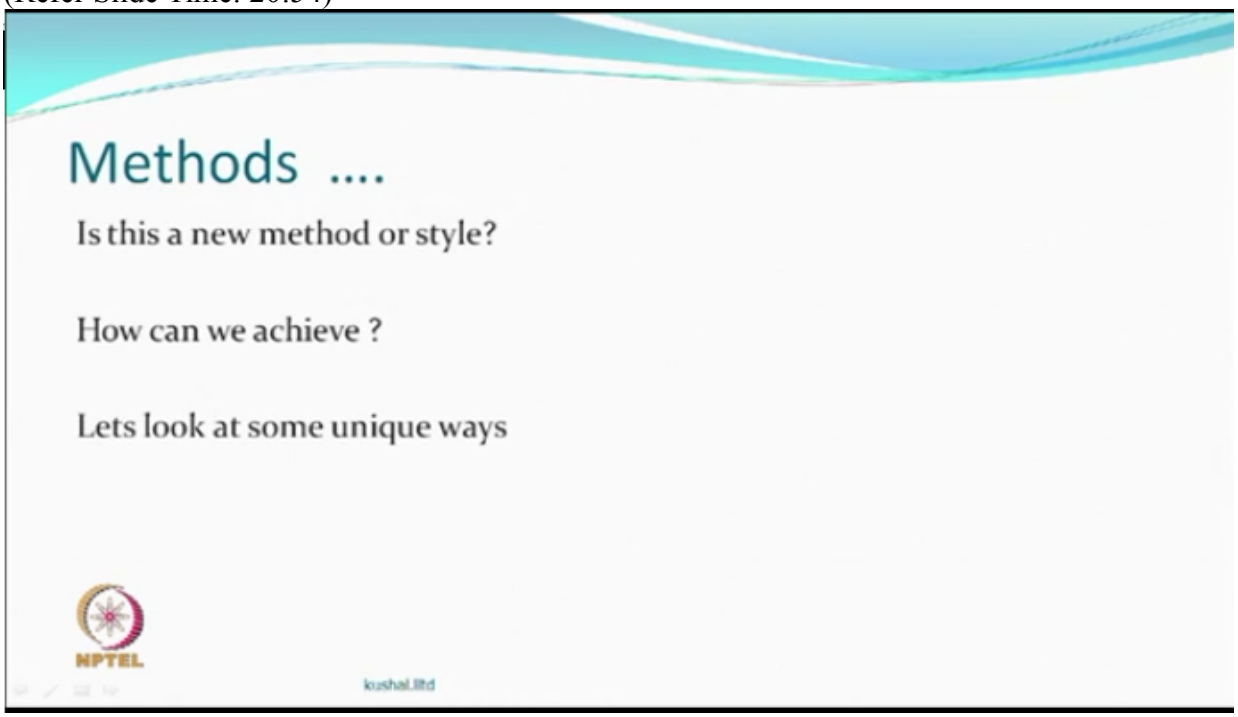

style is that the same design is being put it on a textile directly, so style remains the same and then you work around, because all that was needed to be done as already been done, you want to do discharge way because you wanted to have a certain effect after discharge, so that effect was that there is a colour here and there is a colour there, it's a small spot here and a big spot there, these were the differences that you are talking at, and I say exactly the same thing I can print on the paper and I transfer, so the whole method will remain the same style, but the method is you print somewhere else and paper printing would not like to have situations where you do resist printing and discharge printing, because that would require all kinds of chemicals and that would mean a damaged to the paper itself and therefore there's no question, so they were directly printing systems and from direct printing you print the direct style on to the thing with transfer.

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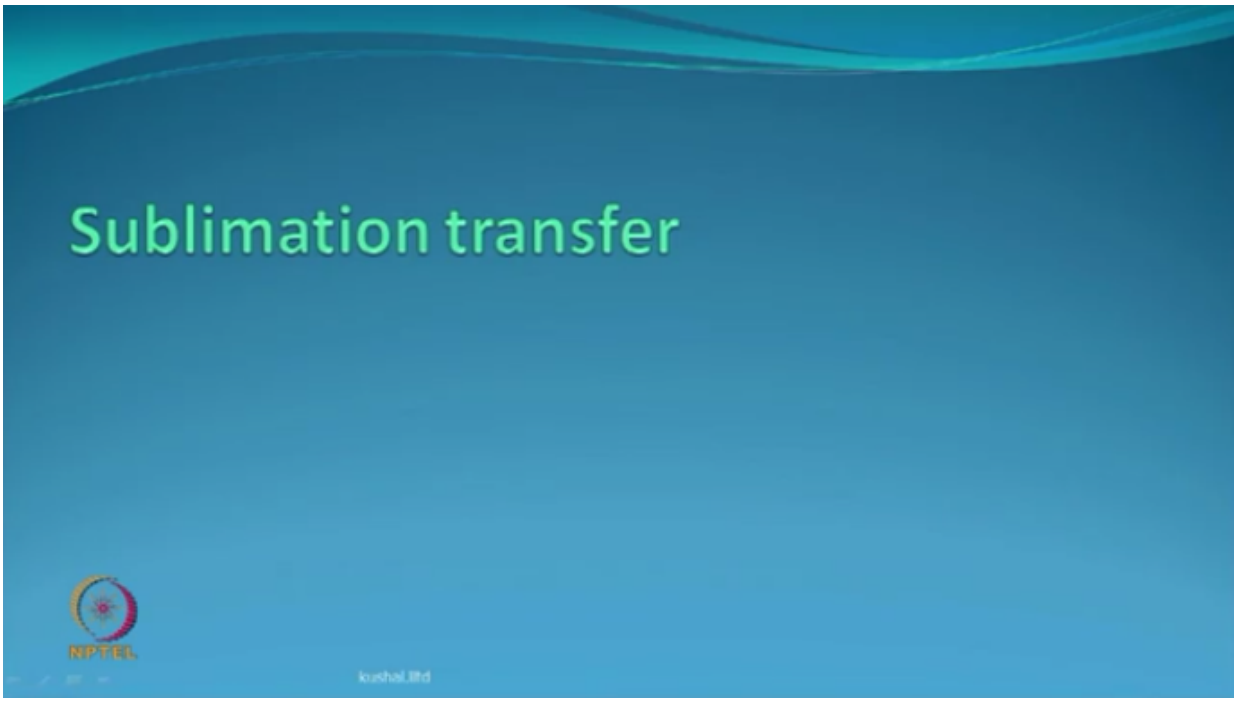

So how can we achieve, we'll just go through the beginning with some of the systems, and then later we will discuss in detail, so one of the most important development historically has been the advent of sublimation transfer, sublimation you understand is a material going from a solid state to a vapor state without melting, without getting into the liquid phase.

Advantage that also it gives is that the molecules when they sublime or the particles when they sublime they are actually in the molecular form, the vapor is not, the particles are not vaporizing, it is the particle after sublimation, the molecules are there in the air, so for any diffusion process we understood it is not the particle which goes inside, it is the molecule which must diffuse, sublimation immediately provides you that option, so this was one of the commercially successful this is,

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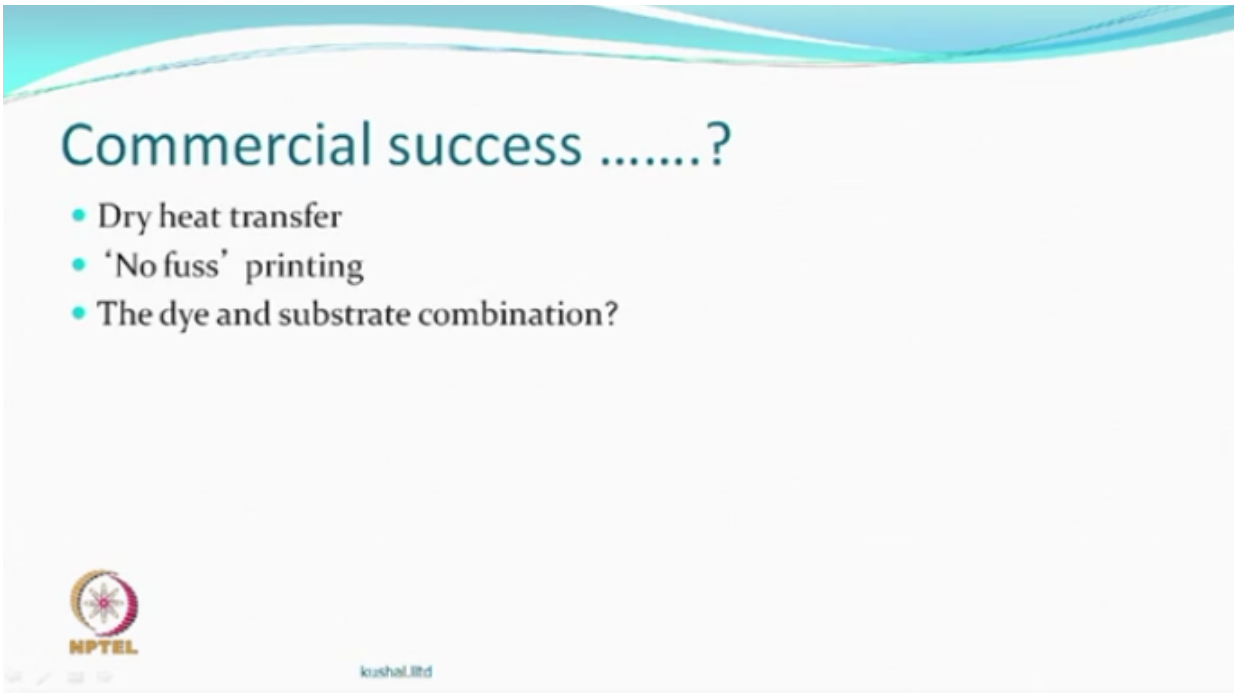

should I say commercially successful method, okay.

Sometimes is also refer to dry heat transfer, so because using dry heat to sublime, no first printing means basically nothing to be done, put the textile or a substrate, heated up it will just go in and happy, the dye in a substrate combination, that's an important part, every dye that you have seen and used cannot sublime, so every material as a substrate that you see may not like the dye that sublimes and so you have to have an right combination, now the right combination comes with the class of dye which we know as a disperse dye and synthetic fabrics like

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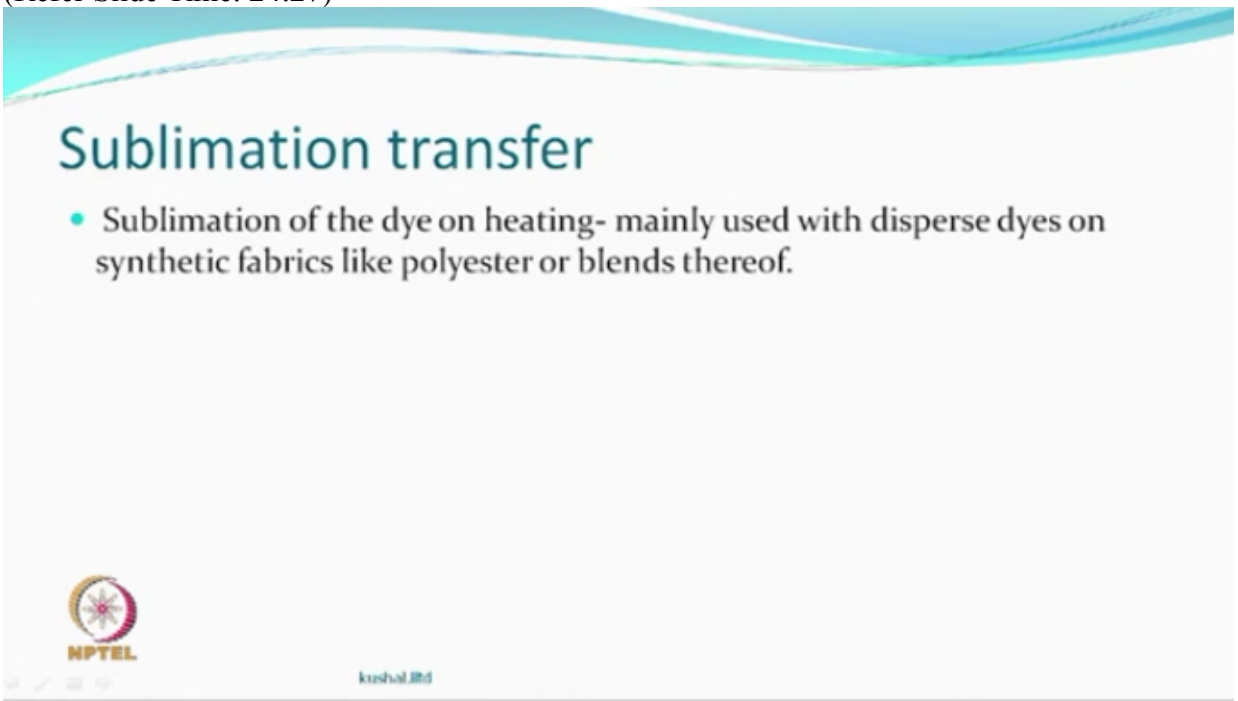

polyesters, this is almost like a made for each other kind of situation, when somebody design disperse dye they were not hoping this would be happening although during fixation you had the thermo sole fixation also and they understood this could be the mechanism also.

So as long as you are interested in using the disperse dye and a synthetic fabric like polyester because even today if you say all synthetic fabrics, acrylics don't, people don't dye, so you can dye acrylics with disperse dye they don't dye, you can dye nylon also with disperse dye but you don't dye, right, so it's the polyester which you dye with disperse dye so actually disperse dye and a polyester combination is the best combination that as far as the transfer printing is concerned which is sublimation transfer printing.
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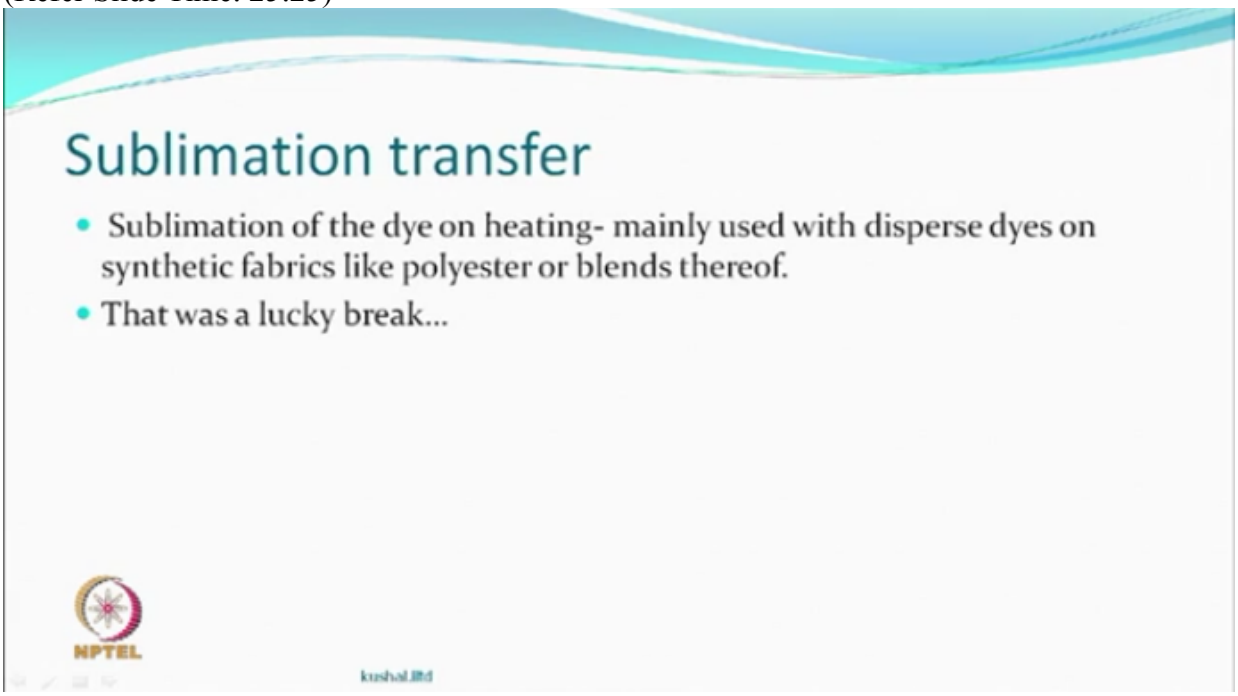

A lucky break we'll call it, and the disperse dyes sublime that is understood and polyester is open at a temperature where the sublimation takes place, what there for it means is that you have let's say 200 degree centigrade, 190 degree centigrade,
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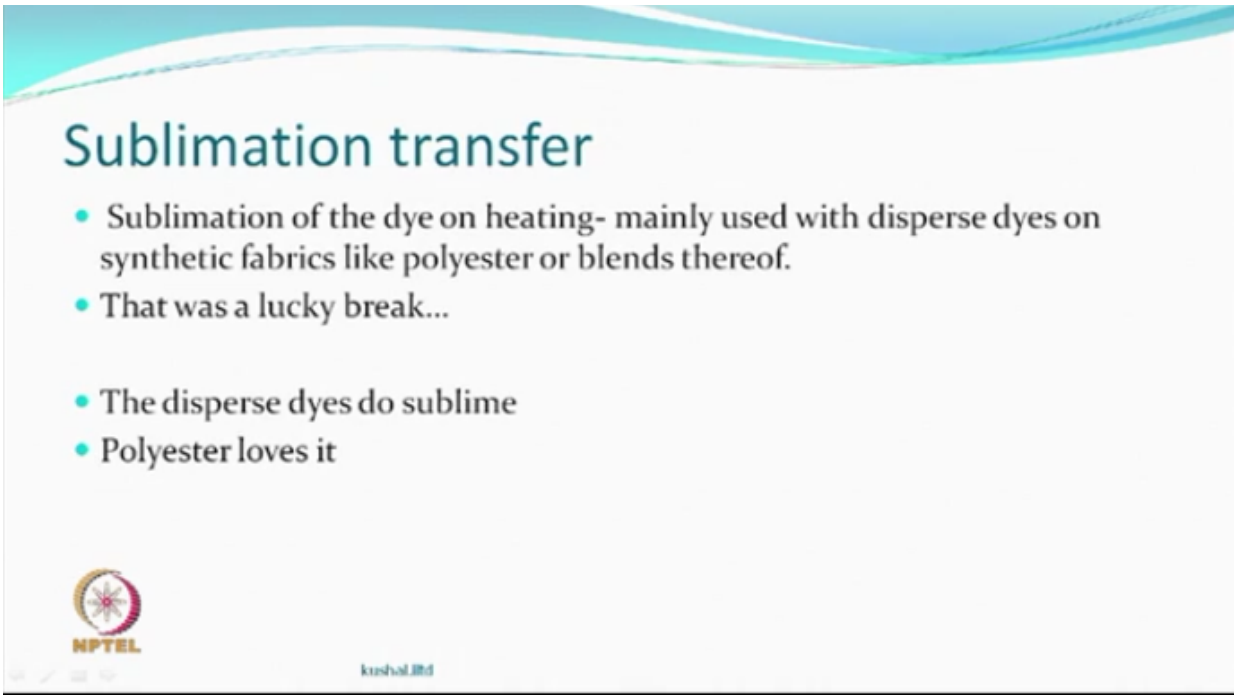

then the polyester segments mobility is very high, the pores are open, vibrations are good enough and the diffusion can take place, so if you do the same thing at any other temperature polyester may not be receptive like you have the normal dying has to be done at high temperature, high pressure, but here the sublimation itself is at high temperature and therefore they just fit into each other, and this therefore has been a commercially successful system.

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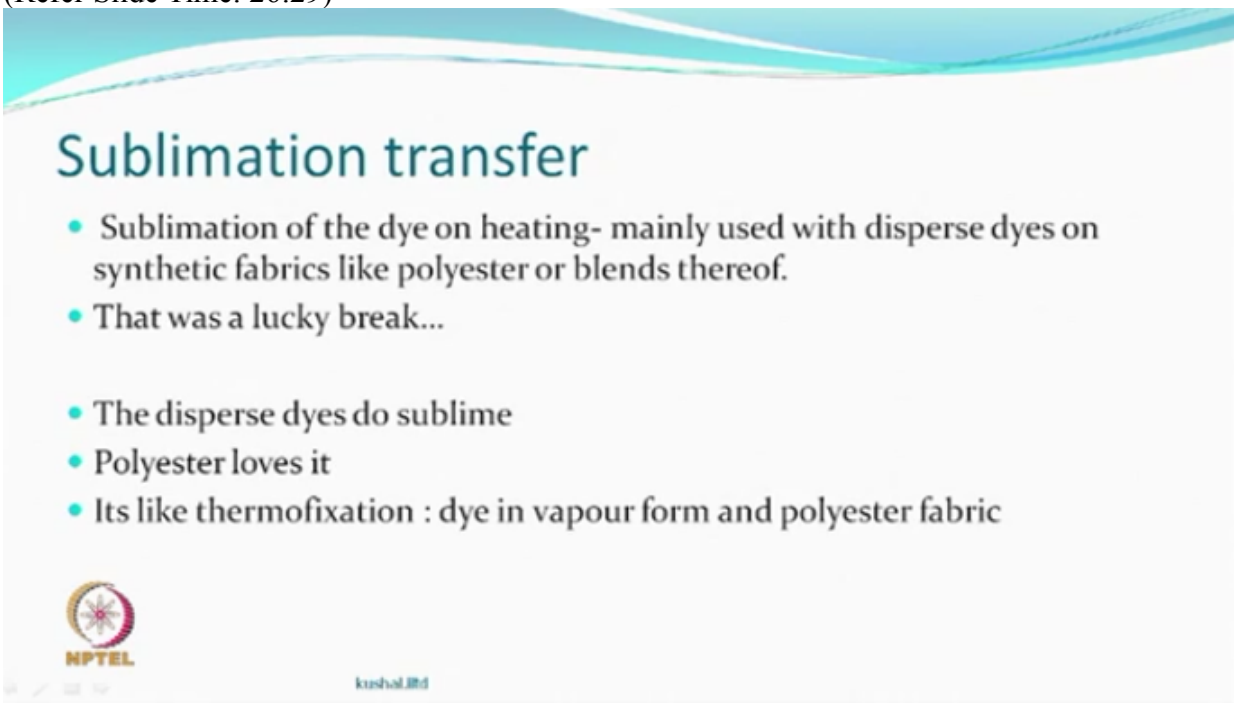

So I said dye is an vapor form which means molecular form and polyester fabric is really in a receptive form,

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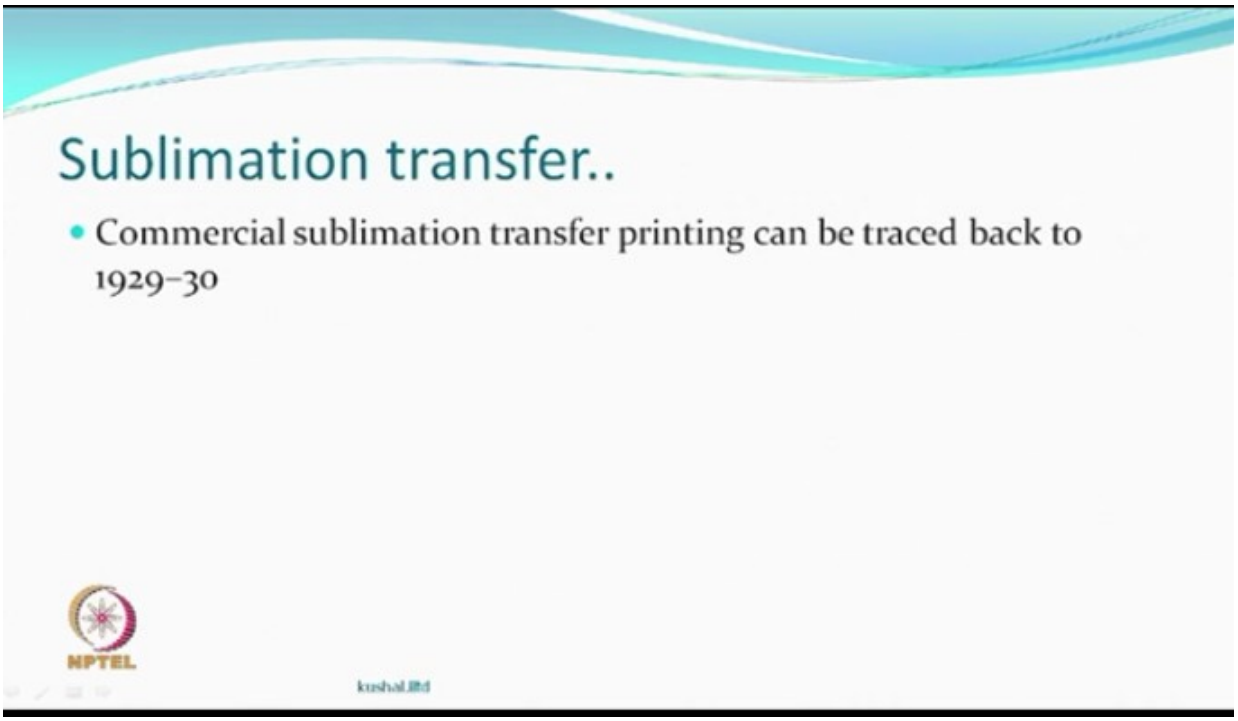

so this is not that this concept was understood after polyester was developed, so people had been thinking about things even as early as 1930's, that can something be done, but obviously it took time, so particularly when the cellulose acetate came into picture

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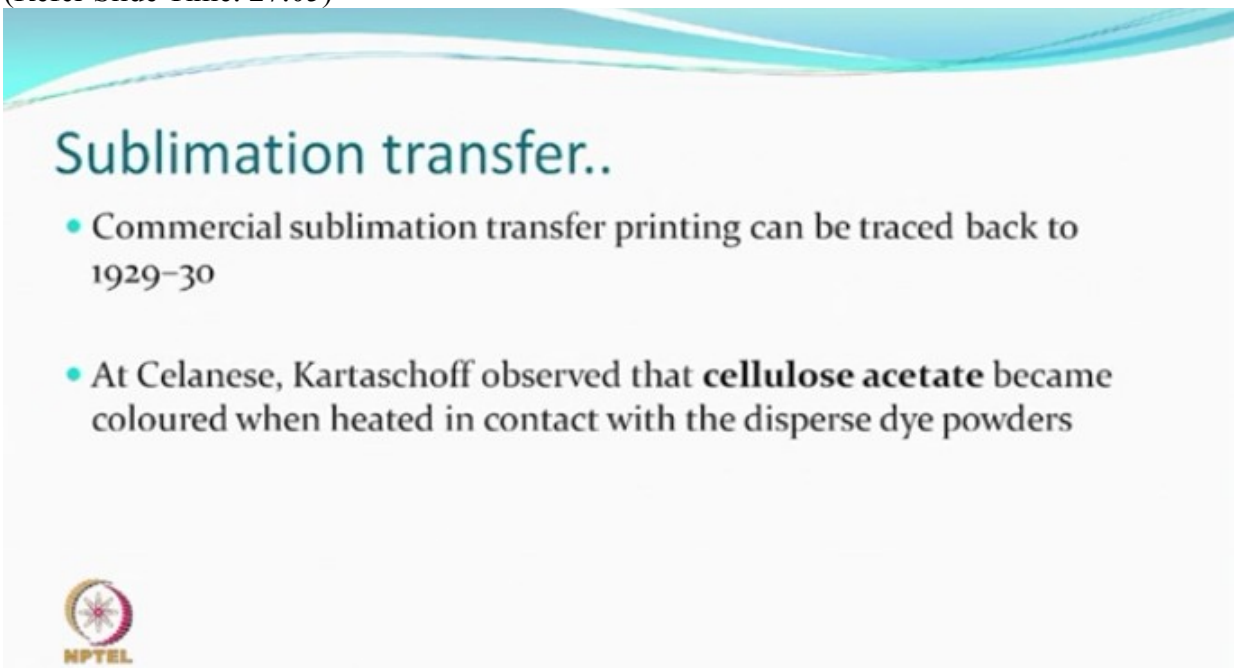

and then some experiments or accidental experiments could be seen that yes the diffusion can take place, then a commercialization thought came that is for the PET it took 20 years to come

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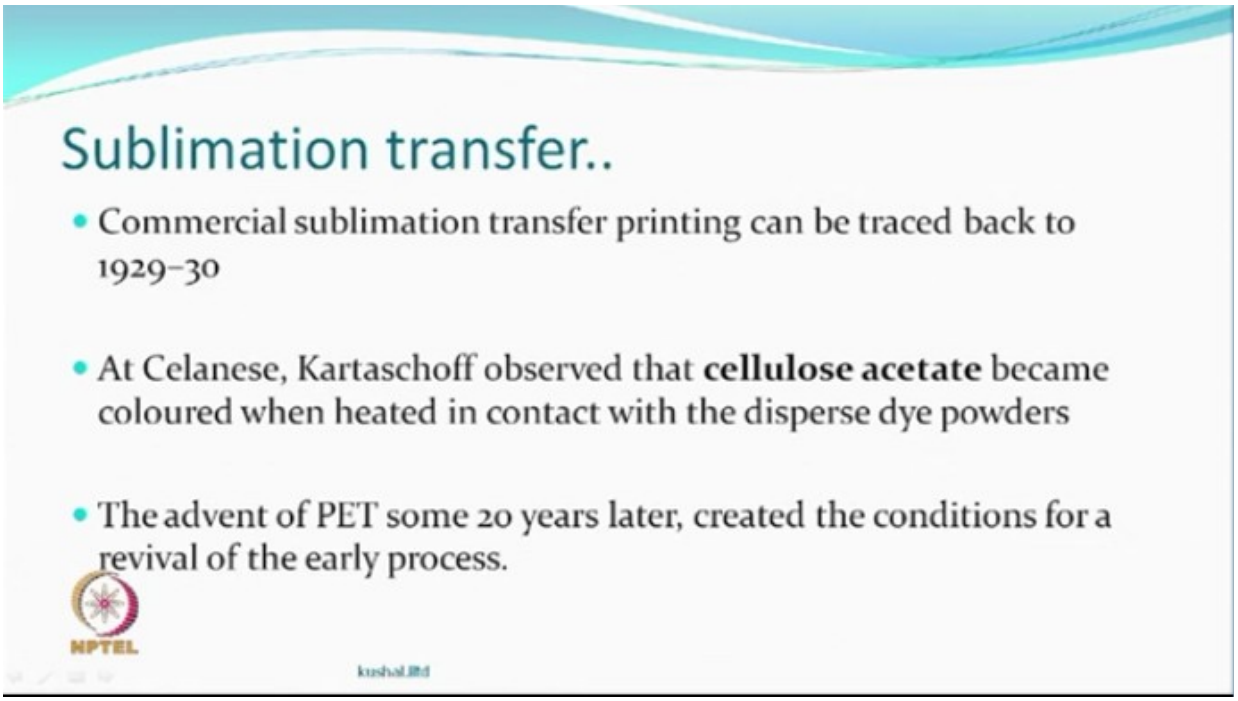

and this process also was tried, but we would say that actual commercialization and production would be even 10 years later, so when this process came people actually had been forecasting

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that you would be producing fabrics, printed fabrics as 1 to 2 billion meters by 1980's that is the kind of production, excitement was very high but it not happen, it did not happen because slowly and slowly that was found that even paper printing and storage is not something which is easy and uneconomical and what you do with that printed paper after printing that was one.

Excitement was such the people said that we could print anything because whatever you can print on a paper can be transferred, so one is the design, the other said well we can actually have an acrylic or a polyester jacket on which we would have printed a worsted photograph, you know photograph of worsted fabric like so you may say oh it's a woolen fabric of wearing, but actually it was polyester, so ideas flew all over, of all kinds but they did not really succeed in that way, the way you wanted it to succeed, in fact there was a good number of years, people were actually thinking about this technology is not going to go too far as for textile printing is concern, alright.

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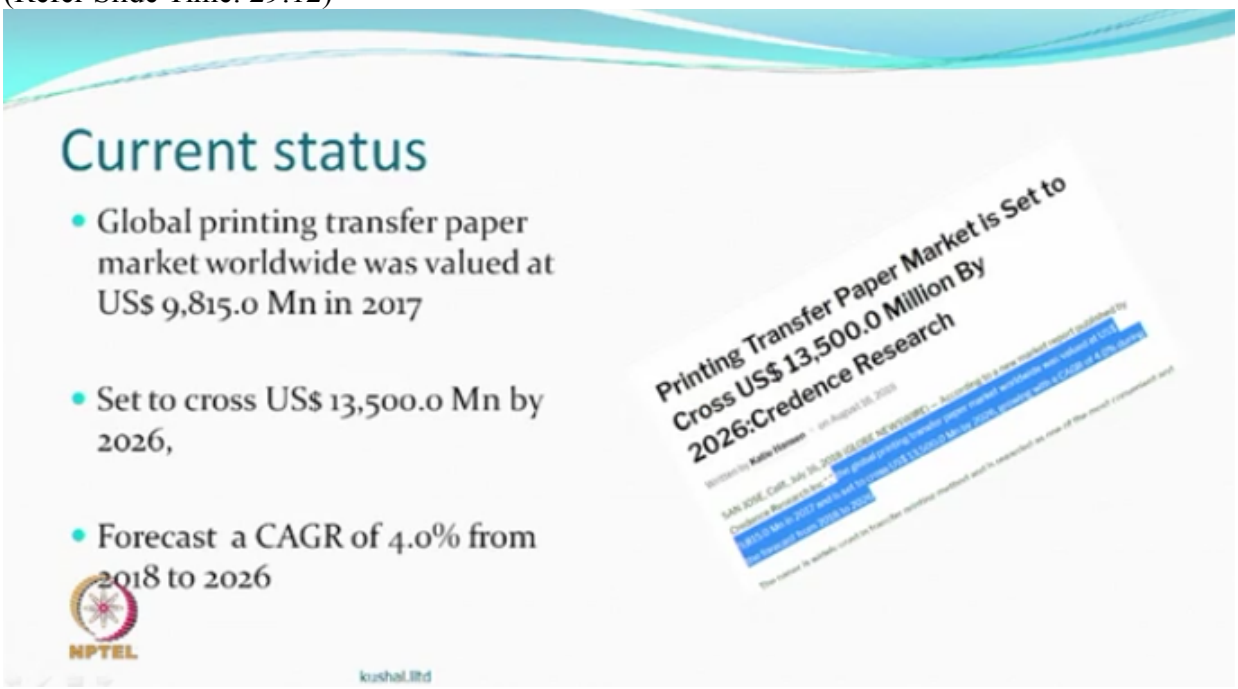

But currently it's a recent study which believes that the value closed to 2017 which is something like $9800 US million likely to go to $13,500 by 2026, hoping that annual growth rate would be about 4%, so that means some revival of interest has come in, for the same reasons which were given 40 years before that you are now getting into the same thing and in India also very near to us there are industries who are printing, transfer printing paper, once you print a transfer printing paper after that who wants to print on textile depends on what you have printed on a paper, it could be a t-shirt guy who wants to do it, it is the garment person who wants to do it or a person who wants to actually print the whole fabric anything, so this is still, the interest is still around and therefore now if it was a study better, it's good, theoretically if somebody wants to be entrepreneur today as a printing guy and wanted to use a normal conventional textile printing process, the total cost of a project is very high, this one only requires a simple transfer calendar, and you are done, that's the kind of thing you wanted to wash.

Print, pack, sell, and there you are, as long as you are in a sublimation transfer, you are looking for generally polyester, you can do nylon also and of course disperse dye, if you want something else then something else has to be done, so from the transfer point of view other methods also people wanted to try, for example any dye which does not sublime then does not

sublime, material that people wear is not polyester so how many people currently for example are wearing polyester, not much, and therefore even if technology is very nice and the people who want to use 100% polyester you can use blends, but the transfer is happen only the polyester part of it, not the other part, if any dye goes there because it will go vapors don't you know distinguish between whose in front, but fiber dos, fiber may not like it and if it doesn't like then it doesn't like.

So you wear different kinds of fabrics and garments, use them and so people were looking at is there any other method, you can work around, so one method which is termed as a wet transfer, so that was a dry transfer, so the fabric is dry, the sublimation thing and the particles are dry, the paper is dry, everything is dry, other than wet, and why do you need wet? Obviously you have a hydrophilic fibers, the diffusion they don't like disperse dye, and therefore if you want to do the transfer sublimation is not the answer, unless you say well don't worry, whatever we can do is good enough so that's it, so you want to do wet transfer therefore you got to have a system, where you are again printing the same manner, but during transfer there is enough moisture available for the dye to again get dissolve then diffuse, and you can also appreciate if it is a silk fabric and you are looking at acid dye which will be water soluble, then after diffused let's say you provide the moist thing, hot environment it gets diffused, you still have to fix, so there was a post treatment required, unlike dispersed polyester combination there is no post treatment required almost, you just do the transfer and pack.

Here you may have a situation where because you have a wet conditions, so what you do is maybe you can take the fabric and then moist it, and then let the paper come in contact, and then after doing this you have to separate them out, then you have to fix them, you may also find that let's say reactive dye everything has not reacted, that means even require washing, so you may require washing, you may require thing, but of course photographic designs can be transferred, alright, so but process different.

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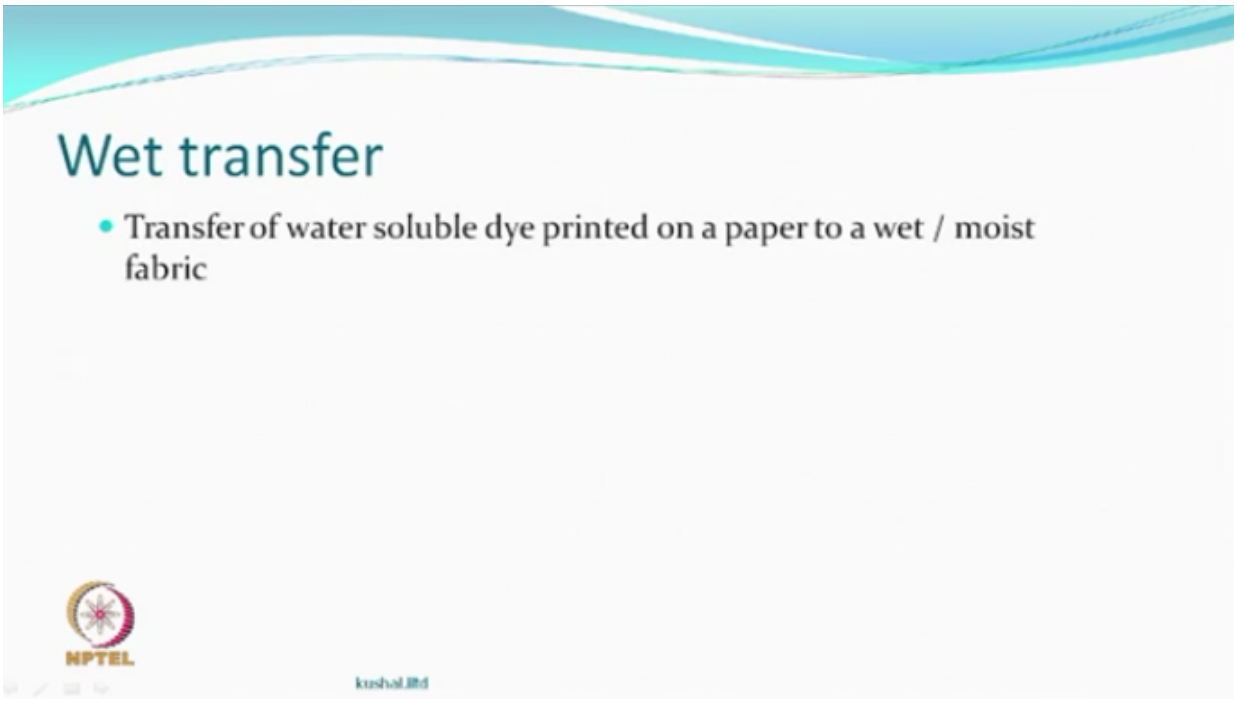

So water soluble dyes printed on a paper and transfer to a wet or a moist fabric, it can't be too much of wet, otherwise design may get smudged, paper may get torn, because paper obviously doesn't like the water too much, you see the polyester disperse case it so good, the paper also does not like disperse dye, and polyester likes, so when you have vapor they have a tendency only go to the polyester and not get retained by the paper, if this is normal paper in a wet transfer then what do you have? We have a situation where paper is also cellulosic, fabric also cellulosic, then under the conditions in which you are looking at it may like to get retained on the paper also, so although you can say well I have not added alkali, I'll add alkali later that means fixation step will be a different step, first is just wet diffusion and then fixation, so it can happen, you can work around, but then again as you said through the aqueous medium, so there will be some dissolution happening and has to be very controlled resolution, so that as when it is getting transferred is directly going to the place where you are supposed to go a colour and not anywhere else,

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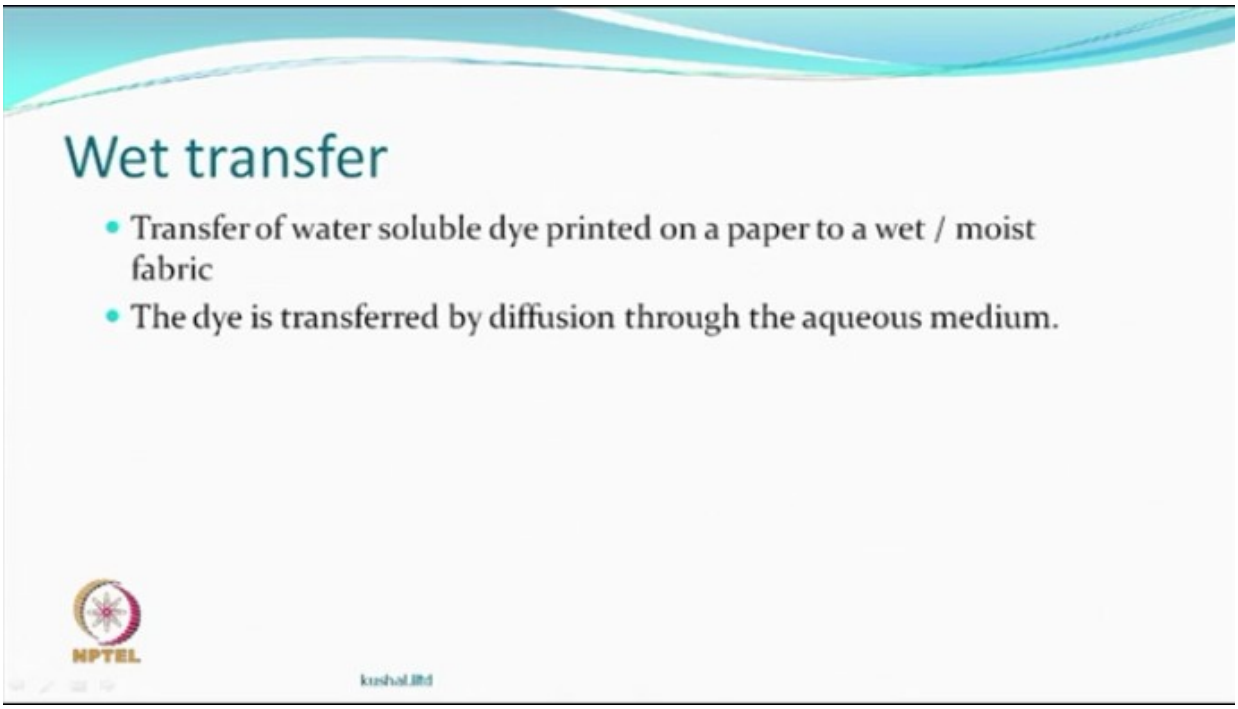

otherwise you will not obviously get the same effect of a photographic image, if you are just transferring a normal design, square, circles, Jackson so on and so forth that's fine, it is not going to have much, if you have a 5 or 6 colours not a problem at all which is going to be the major consumption whenever happen, there will be hardly you know anybody who would like to have photograph of a jungle always, everywhere on t-shirts and trousers and shirts, that's a fashion kind of environment, but the normal environment is simple design, so all simple designs can be printed relatively easy.

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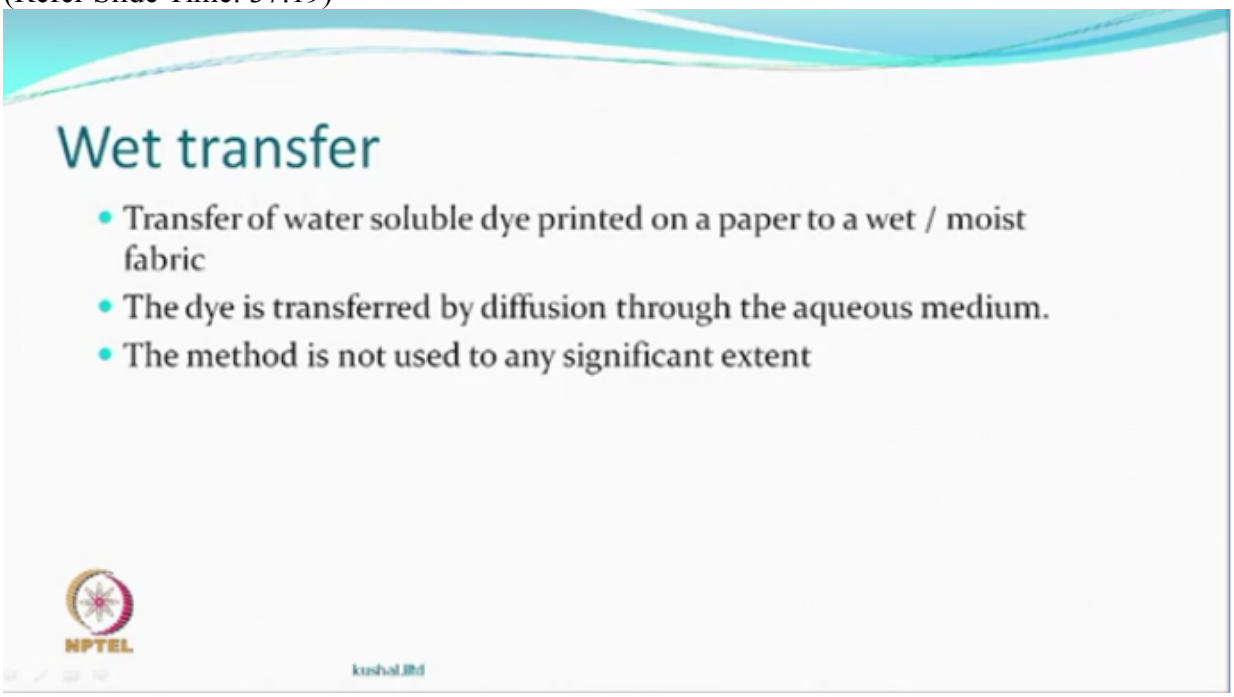

But for reasons that we just slightly understood the commercial success of this process is not easier to be seen, right, but promises are quite a lot, the understand is the difficult process and so difficulty is not in terms of selection of dyes and fabric, it's the technology part itself, and so you work around.
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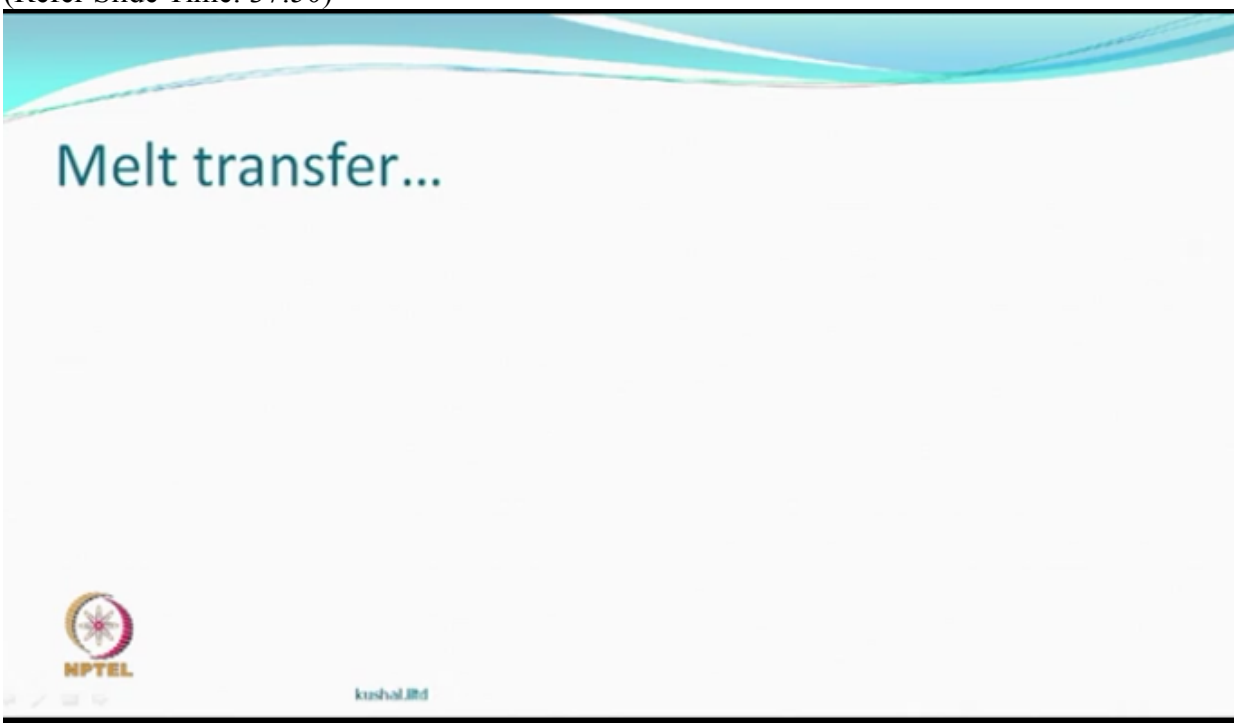

There is another way of transfer that you have something on a paper or a film which selectively according to design could be you know melted and then transferred, so you are looking at part of a film is going to be melting and then getting transferred, so it's a process, so why I'm trying to say is whether something becomes commercial or does not become commercial, as an engineer you think that somebody, whenever you talk about a concept everybody would like to say can this be done, can that be done, whether you do it or not separate story, but as an engineer you are going to be using this, so this is one of the thing that people thought well we can now transfer the whole thing called the design after melting, if it contains colour very good, right, so like a waxy ink,
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wax can melt, you can pour it, and that can go, so I do have to go to a temperature where this would happen, so this process which says melt and transfer design on to textile, so you are melting and transferring, so you are going to above room temperature, right.

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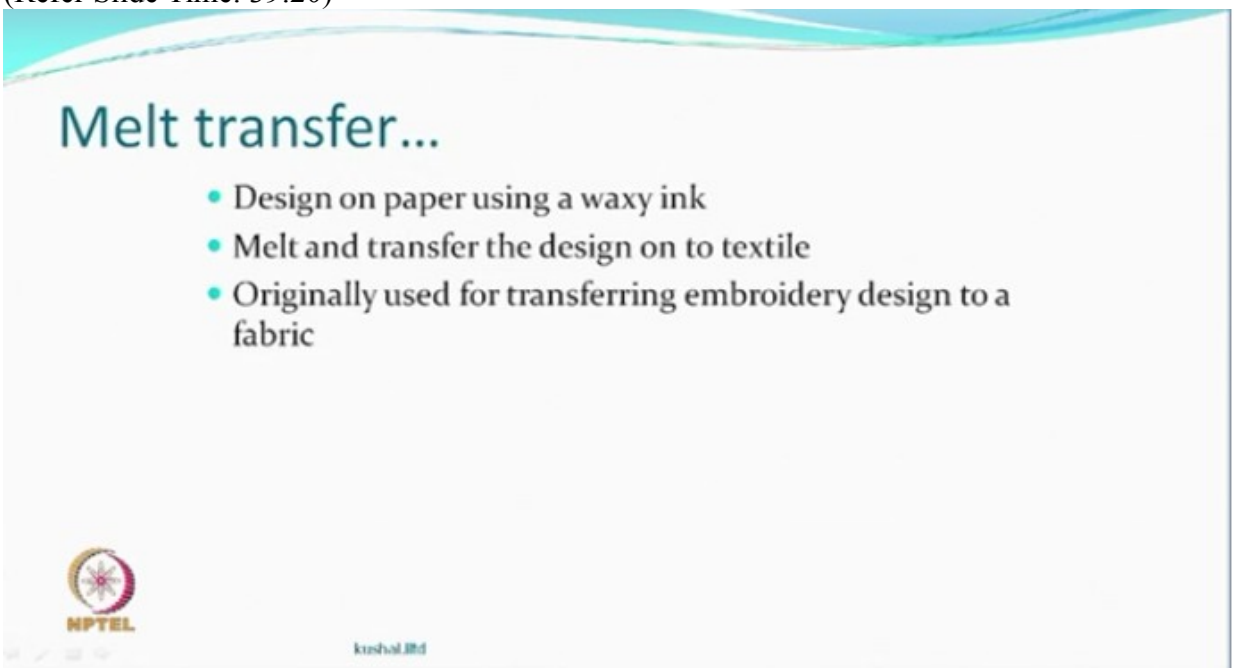

It was originally it was used for embroidering designs, so take a textile put this kind of a thing and then you get some colour or maybe no colour and then you put the embroidery around same thing, so design is evenly transfer is one, one of the uses, so people melt transferring systems, and that's it, so wherever you do certain things here also whatever is in the film that is going to melt and get transferred will get transferred irrespective of whether it likes the fiber, or it

doesn't like the fiber, you see in the first cases the disperse dye like the fiber, in the wet transfer you also wanted fiber and I'd like to each other, in this case you are saying it's just the Bolton material is going there and going to get stuck, it has got colour and design, so don't worry about it, whatever happens it will be there. Of course you will have to worry when you wash it, when you rub it, it's brace and resistance and all those kind of things that want to come into play, but if you are looking at fashion this is it, you can work around.

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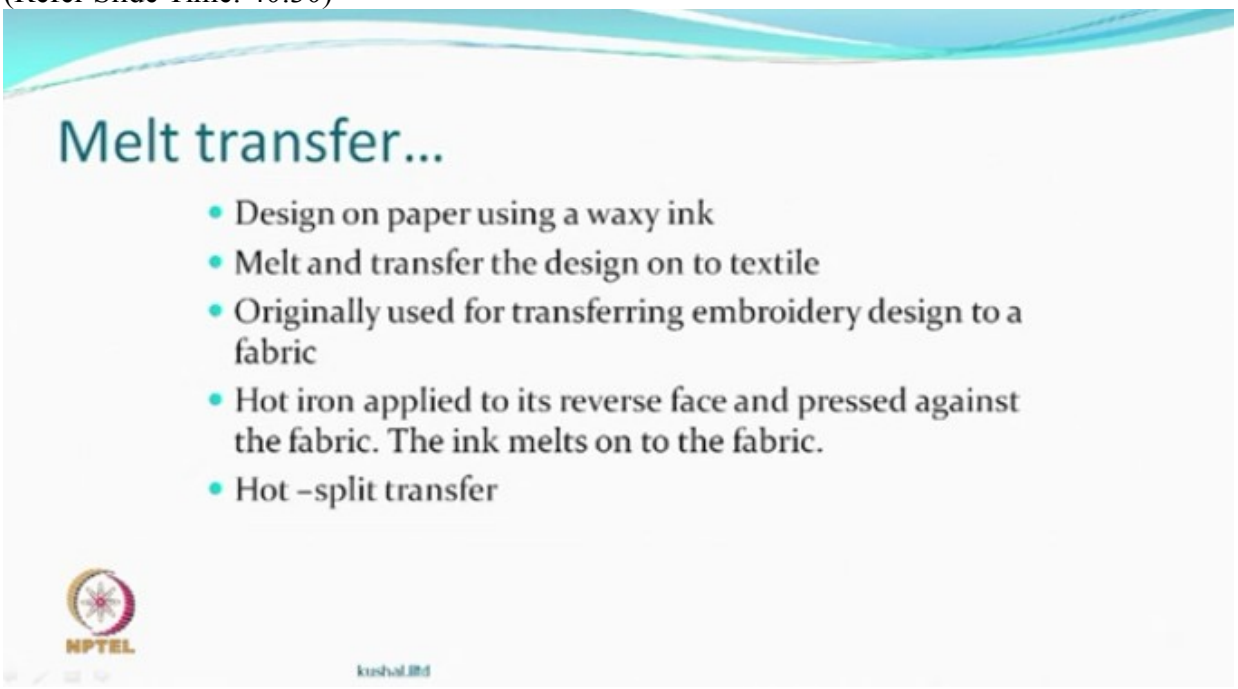

Sometimes called the hot split transfer also, so it's a split, you're splitting the material from that portion and getting into, because sometime maybe a film which is a same colour, but you are splitting into say, and design is coming of the same colour can come just like that, only a portions somewhere the material is gone out and gone on to the textile, can you see that, so you see blank on the thing.

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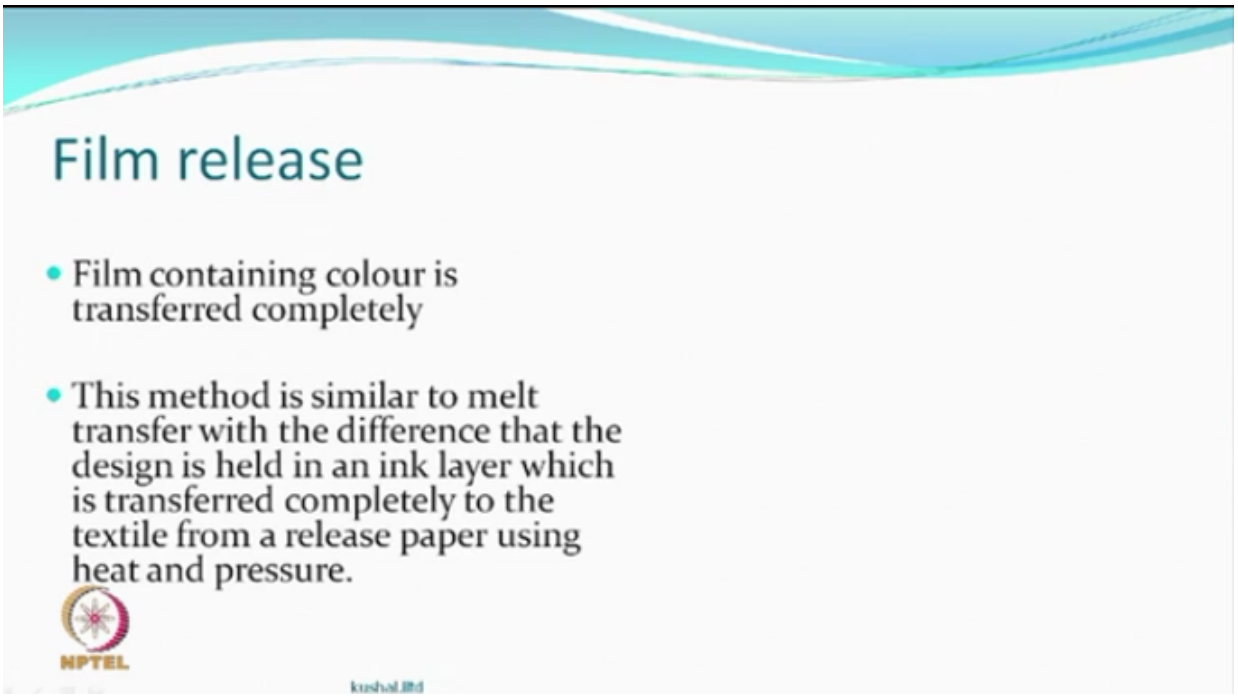

Other is similar, but is like a film getting released, so film containing the colour transferred completely, so if there is a film which is on the paper loosely held, but when you put it there it likes the paperless than the fabric and they just, when you press, compress, or do whatever it just gets transferred on to the substrate, the difference is that here is the completely the film gets released from a release paper by heat or pressure, okay, so nothing is there on the paper so there is a paper.

In the other case it could be actually a film which is a coloured film which gets melted and then gets transferred, okay, so that's little difference which is interesting difference, it has become popular for different reasons today,

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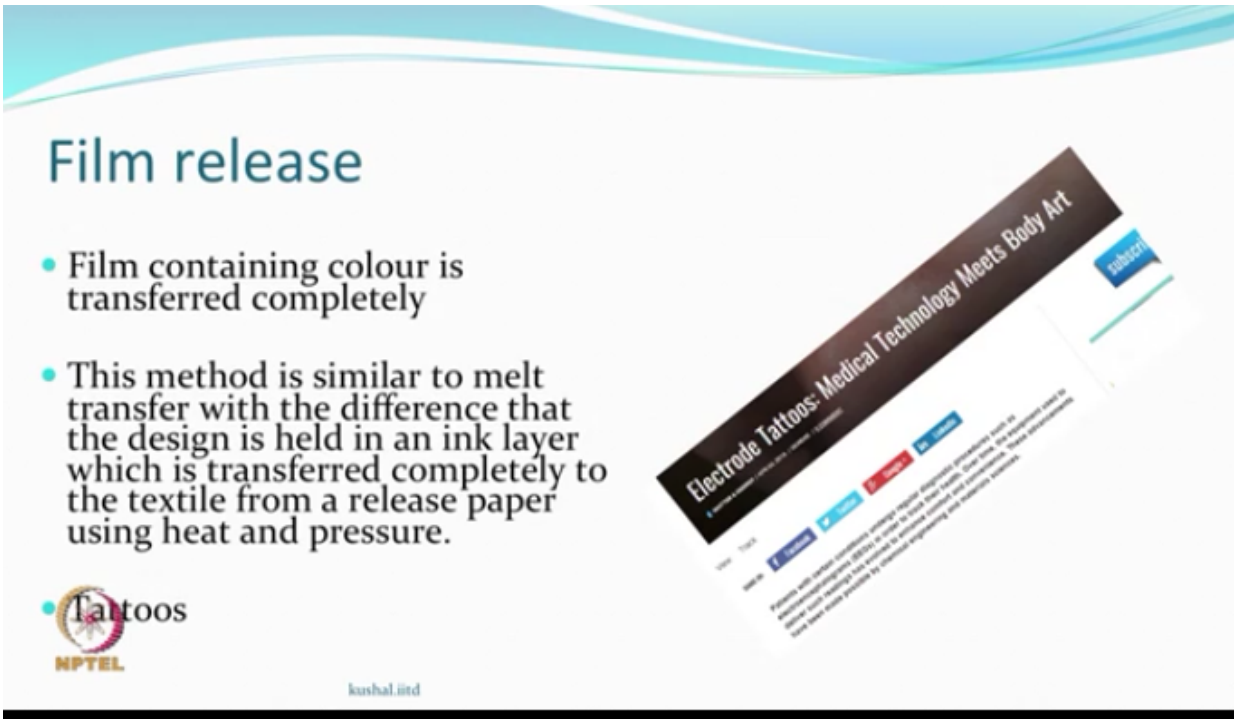

the so called temporary tattoos people want to use, it could be on your shelf, something similar could be on the fabric also, and so this itself is a market, but it's a transfer so design is somewhere on the release film, and the whole of the film which is on the release paper gets transferred to whatever surface that you give.

Tattoos obviously the whole system of design that you don't have to heat it, right, it's a room temperature transfer is have to apply certain pressure, and they move and you are not looking at permanency there, you cannot looking at permanency so you wash it off it goes very good, next time next design, and you are happy.

So one interesting thing which recently people saying well if this what happens I can make electrodes tattoos which could be an electrode here and not connected to some measuring device, and whatever happens, whatever you are doing it's on your skin, this is the tattoo which actually looks like a nitrous tattoo, but it's actually is an electrode, so when you want to do an ECG for that matter what you do [unsupported language 43:21], here you could do a simple thing for at least two days or one day, you will be getting monitored and you will feel well, that's a nice tattoo, nobody bothers about it, but this is not just a dream but people are actually thinking where this kind of thing also, conducting inks can be used to make a tattoo which is again means electrode, of course fashion but this is a fashion plus this is a fashion plus that you actually are getting a functional thing out of it also,
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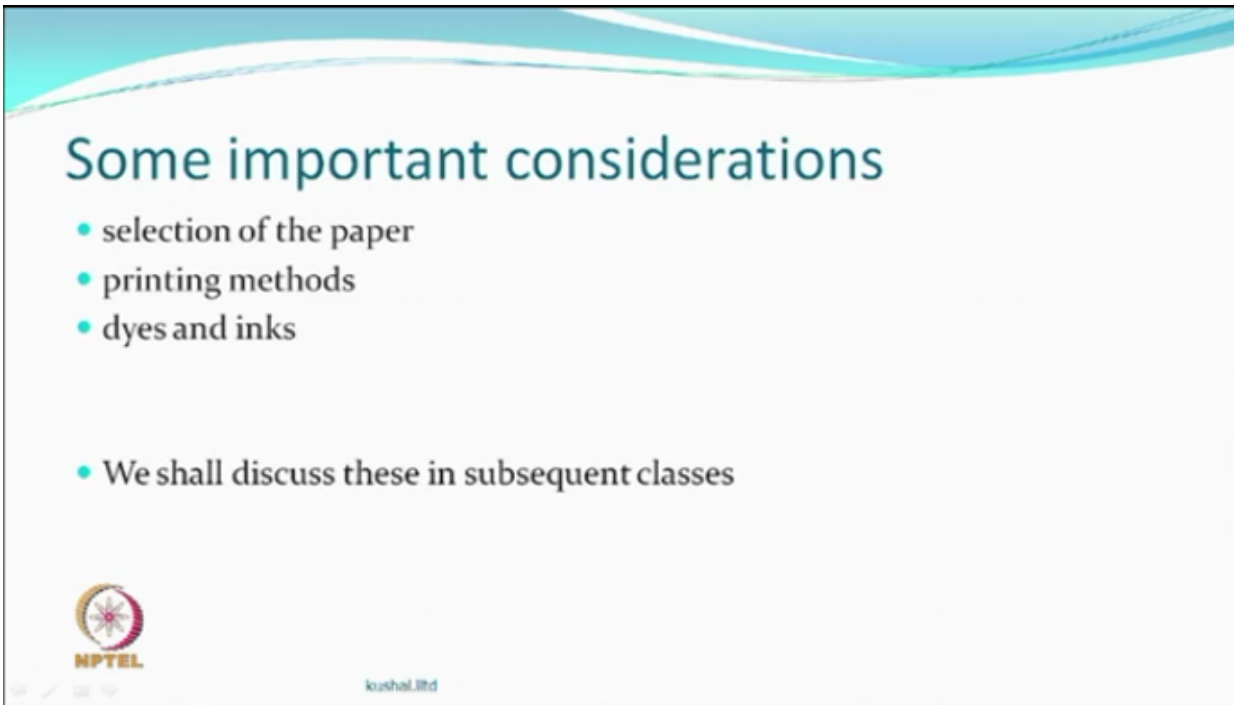

so we will stop here, as we move further we look into how people do the selection of a paper, how what kind of a printing methods are used for printing paper, what are the dyes and inks you know, the change that is happening is that whatever we call dyes and pigments in textiles paper industry always call everything as ink, so from dyes pigments so you are gone to the inks, the selection of inks etcetera, etcetera, this is what will be interesting , so let's say we'll look at it later. Thank you.

INDIAN INSTITUTE OF TECHNOLOGY DELHI

TECHNOVISION

For Further details/information contact:
Head
Education Technology Services Centre
Indian Institute of Technology
Hauz Khas, New Delhi-110016
Phone: 011-26591339, 6551, 6131
E-mail: npteliitd@gmail.com
Website: www.iitd.ac.in

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