Science of Clothing Comfort
Prof. Apurba Das
Department of Textile Technology
Indian Institute of Technology, Delhi

Lecture - 07
Psychology & Comfort (contd…)

Hello everyone. So, we will continue with Wear Trial Technique.

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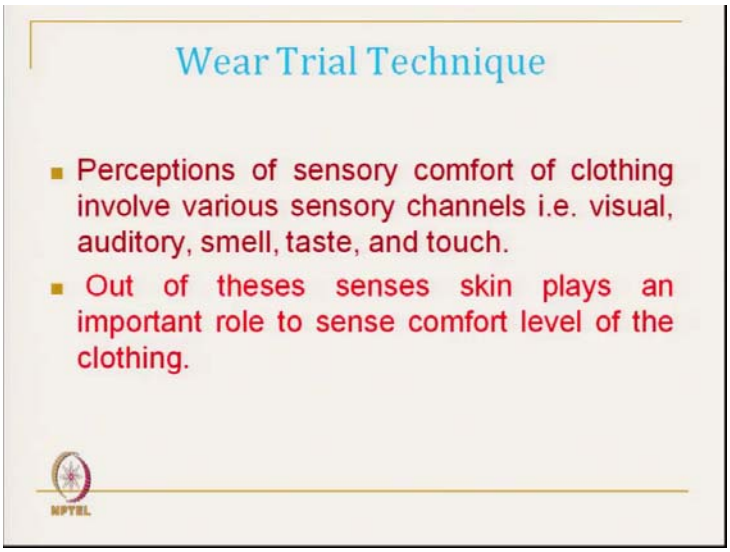

So, in last class we have discussed that Wear Trial Technique is extremely important in Clothing Comfort related research and where, the actual where situation is important to evaluate the comfort sensation.

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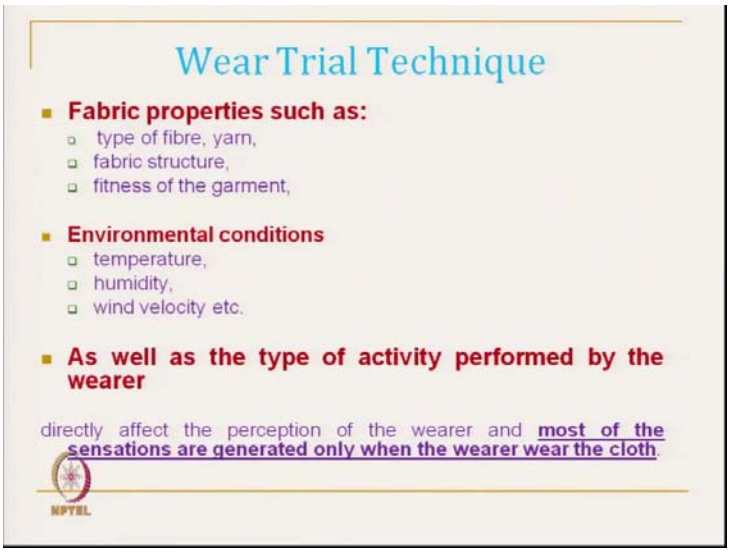

Also, we have mentioned that Wear Trial Technique basically depends on the fabric related properties that is type of fibre, type of yarn, type of fabric structure and type of garment like fit related characteristics; then, environmental related characteristics like temperature, humidity and wind velocity and also the activity level. So, this all these things, we can only get if we perform Wear Trial Technique. Individually measuring a particular value say thermal transmission and moisture transmission or whatever may be or handle related characteristics will not give us the overall sensation of clothing after wear.

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So, we have to get information from the respondent after wearing the cloth and at different level of activity and at different climatic condition.

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So, Necessity is that we have discussed, this is very important to get actual data from the respondent to generate reactions of wearer to any perceived discomfort sensation produced by different climatic condition, different activity level.

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So, there are different external stimuli for particular wear sensation, we can generate for a particular type of external stimuli and physical activity. The external stimuli is heat, moisture and wind velocity and mechanical stimuli is softness, scratchiness, prickliness. These are different types of harsh or may be rigid. This type of mechanical stimuli, we can get.

These stimulations are normally generated and it under specific wear condition or specific physiological state or specific environmental condition; like Sweating rate, Physical activities, Material used in clothing, Fitness of clothing, temperature, humidity and air velocity of the environment; all these things control, actually response from the wearer.

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So, the steps are first step is to generate the sensory attributes with wearer. First, wearer has to define, what type of sensory attributes we are looking at. Like for extreme cold climate clothing, we are trying to develop we may not require the whether it is a soft or hard or something. So, for a particular requirement, we have to define the sensory attributes. What are the sensory attributes we are looking at? We, suppose, extreme cold climate clothing; we are looking at whether gives warmth or not. So, according to the requirement, we have to define that is the first step.

Second step is that selection of a particular test condition, like if we want to develop a clothing for extreme cold climate, we will not definitely select temperature of environment of a normal room temperature. We have to select that particular, suppose our target is minus 40 degree Celsius. So, target should be that you have to test perform this wear trial at test condition at room temperature minus 40 degree Celsius.

Then, next is the psychological scale. Some different types of rating scale, we have to design particular ratings scale that we have discussed earlier. What type of sensory attributes, we want to evaluate and we have to design, we have to select a particular rating scale. Like this, whether do we want to evaluate stiffness, stickiness, non-absorbent, cold, damp, clammy, rough, scratchy; so, at different time interval. So, we have to actually design these tests at different time interval in a particular environmental condition; that questionnaire you have to give and we have to define total procedure.

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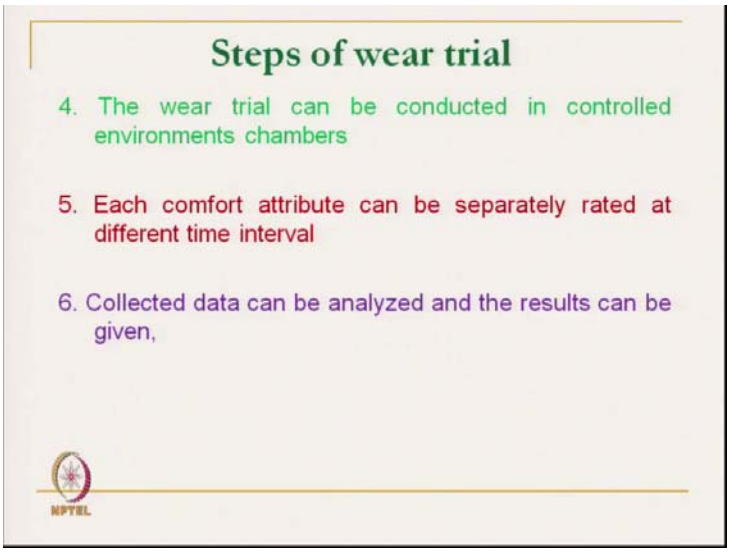

Next, is wear trial can be conducted in controlled environmental condition. So, in particular environmental condition, we have to generate and that condition we have to perform this test. Each comfort attribute can be separately rated at different time interval. This is very important; we cannot have overall comfort sensation perception at a particular time. It changes; it is not constant.

So, that during our design of the experiment, we have to take the response at the beginning, at after interval of the particular time and at the end of the experiment that we have to. A particular fabric, a particular clothing may be very comfortable at the beginning, but at the end that may fail. So, that is why we have to define the time, these are the steps of wear trial.

And then, next is that you have to collect the data. All the collected data then we have to analyse. So, with the statistical technique, we have to analyze. Then, we can tell we have performed the total wear trial technique. So, what are the steps? Let us see once again. First, we have to generate the attributes of the wearer. Which attributes we want to test?

Then select particular test condition. Test condition means we have to select total, not only the environmental condition, but we have to say we have to train the wearer; you have to respond at the beginning, after certain time. So, these are the steps and then, we will discuss couple of examples which is published one.

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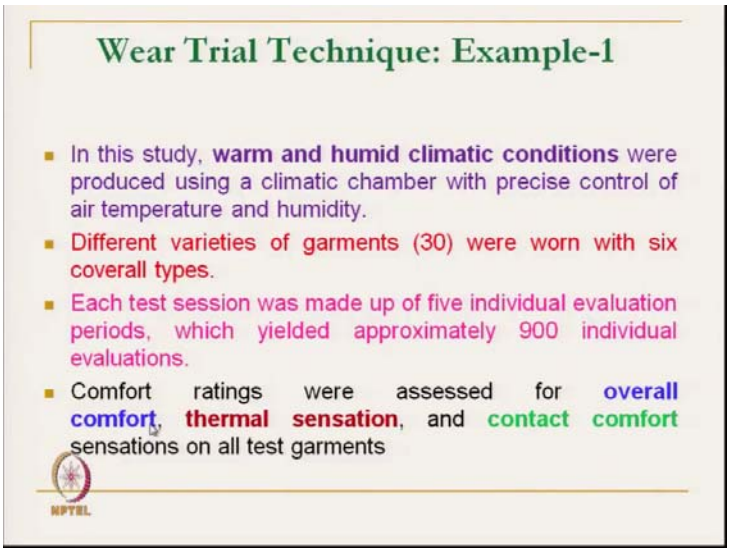

In this study, warm and humid climatic conditions were produced using climatic chamber with a precise control of air temperature and humidity. So, this garment which will be used for warm and humid. It is a work wear. Work wear type garment is developed and we have to test. So, that exact humidity and temperature of the climate, we have to generate. So, different varieties of garments; work wear garment has been taken, 30 different varieties of garments were taken with 6 coverall type. So, 6 different types of coveralls were used. So, here the variability is 30 multiplied by 6. So, 180 different types of combinations are generated.

Then, each test sessions were made of 5 individual evolution period. So, at different evaluation period; it 5 different evaluation, now data responses were taken. So that means, 180 different types of clothing combination and 5 different types of at different time interval, we have got the response. So, total data number of data will be multiplied by 5; it will be 900 different types of individual evaluations will be getting.

So, of this large number of data; so, why which one is constant here? Constant is the environment. For a particular environment, it is same. If we want to vary the environment, then the number of data will be huge. So, normally in wear trail, we do not want to we do not change the climatic condition because the particular garment is targeted for a particular environmental condition that is why it is not varied ok.

So, here 900 different data vary and comfort ratings were assessed; this type of ratings

scale, its overall comfort means, in 1, 2, 3, 4, 5, 6, say 10 or whatever scales are given. Another attribute was thermal sensation. One is overall comfort, another is the thermal sensation; 1, 2, 3, 4, 5, 6 scale and contact comfort that it is at different types of contact measurement tactile sensation. So, these 3 different types of attributes were sensation were taken.

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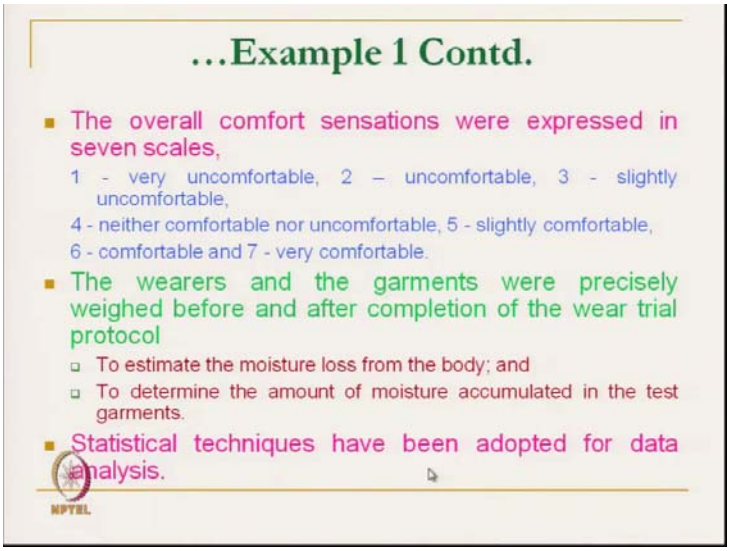

So, the overall comfort sensations were expressed in times of 7 different types of level. So, 1 - being the very uncomfortable; 2 - uncomfortable; 3 - is slightly uncomfortable; 4 – it is a neutral one; 5 - slightly comfortable, 6 - comfortable and 7 - is very comfortable. So, this is extremely important to train the wearer. Wearer, he does not know. So, he has to be actually trained; which one is very comfortable; which one is very uncomfortable. So, this data has to be there with him, then only he can rate that one.

The wearer and the garment were precisely weighed before and after the completion of the protocol. The total protocol here completes; then, before start of the Wear Trial Technique, the wearer has to be weighed. So, you take the weight of the wearer, then take the weight of the complete garment before and after. Why do we need that one? Because to estimate the moisture loss from the body. How much moisture is lost from the body?

That physiological activity, we would like to know because that will help in assessing the human physiological activity for a particular garment with that particular environmental

condition; if he starts giving the air, moisture loss may not be actually good. So, it correlates its moisture loss with the overall thermal comfort perception.

And also to determine the amount of moisture accumulated in the test garment. So, before test and after test, we have taken loss of moisture, loss of moisture by the body by the person may not be equal to the gain of by the garment. This loss, this difference is actual evaporation; we will get this data. This will give the overall; whether this garment will be suitable or not irrespective of the whether it is comfortable or not.

So, this is one scale, it is psychological scale; it is comfortable or not. In addition to that it is checked that whether this is a physiologically perfect or not? And it gives an idea about the type of moisture released by the garment. This is the experimental design and then, statistical technique has been adapted to analysis. So, we can get overall. So, just by simple designing of wear trial, we can get total behaviour of clothing.

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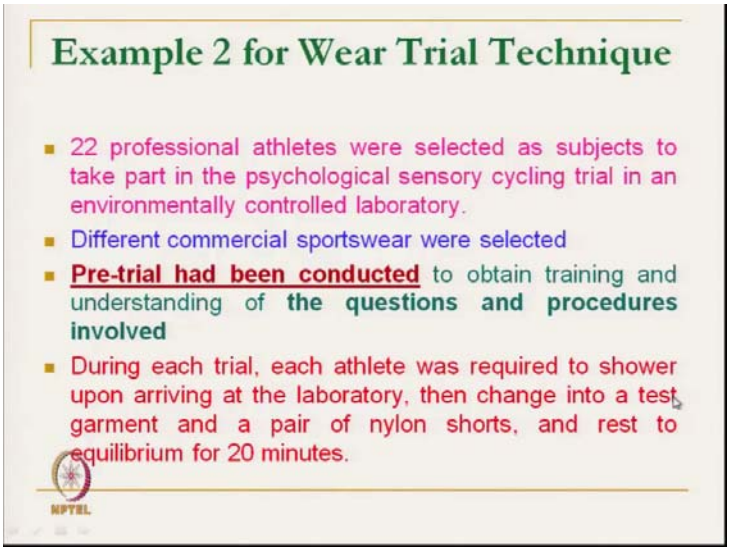

Next example, Wear Trial Technique is used in sportswear. A particular sportswear been developed. So, 22 professional athletes were selected. They have been selected as a subject taken who have taken part in the psychological sensory cycling trial in an environmental condition, controlled condition of the laboratory. So, that controlled condition is created in the laboratory to simulate the actual environmental condition when you will use the cycling; different commercial sports-wears were selected.

Now, different commercial sportswear were collected and which one will give you the best result, this study will tell. So, pre-trial have been conducted to obtain training and understanding of the questions and procedures involved. So, this is very important. These professional athletes, they may not know the actual condition, what do we want. So, we have to do several pre-trial at different level and then, we have to actually train them the about the procedure or about the question; how to actually respond.

So, during each trial, each athlete was required to shower. So, they have to actually to keep the condition uniform. Stringent requirement is there. They have to take bath upon arriving the laboratory. Then, change into a test garment. So, they will change to test garment and pair of Nylon shorts they will wear and then, rest with the equilibrium condition for 20 minutes. So, 20 minutes they will take rest. So, this protocol is actually fixed for all athletes.

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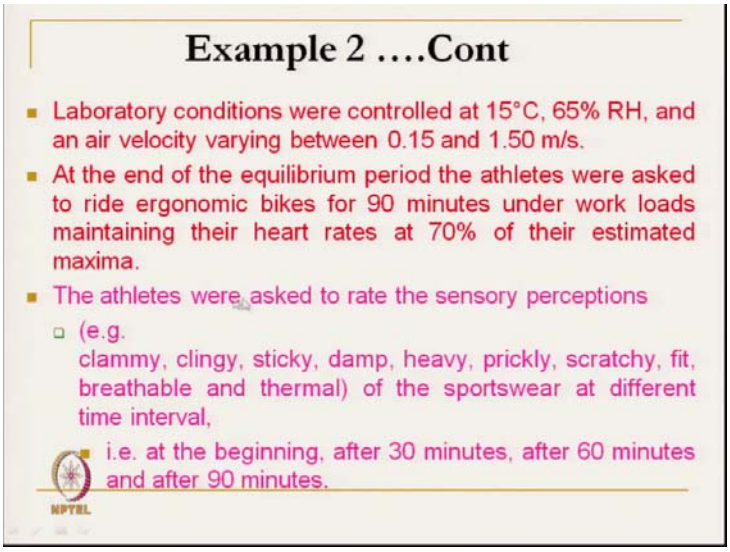

Now, the laboratory condition is fixed, where it is a 15 degree Celsius, 65 percent relativity and an air velocity of 0.15 to 1.5 meter per second. So, it is created. Then at the end of the equilibrium period that is 20 minutes, athletes were asked to ride the bicycle; the ergonomic bike for 90 minutes under the workload to maintain their heartbeat at 70 percent of the estimated maxima. So, speed for different athlete, speed will be different.

Now, speed cannot be subjective or different, so to keep the physiological condition constant. So, heart rate taken here. So, maximum heart rate is known for a particular

person its known. So, 70 percent of that heart rate is kept. So, if it is more than that, activity has to be reduced.

Then, athletes were asked to rate the sensory perception. So, what are the perception he is feeling; it is clammy, clingy, sticky, damp, and heavy. So, all these type if different types of sensory attributes were presented and asked he has he was asked to evaluate or rate this value; at different time interval here time intervals were taken at the beginning time interval, then after 30 minutes, after 60 minutes and after 90 minutes. So, at this different types of different time interval, he was asked to rate with all these perception sensitive perception.

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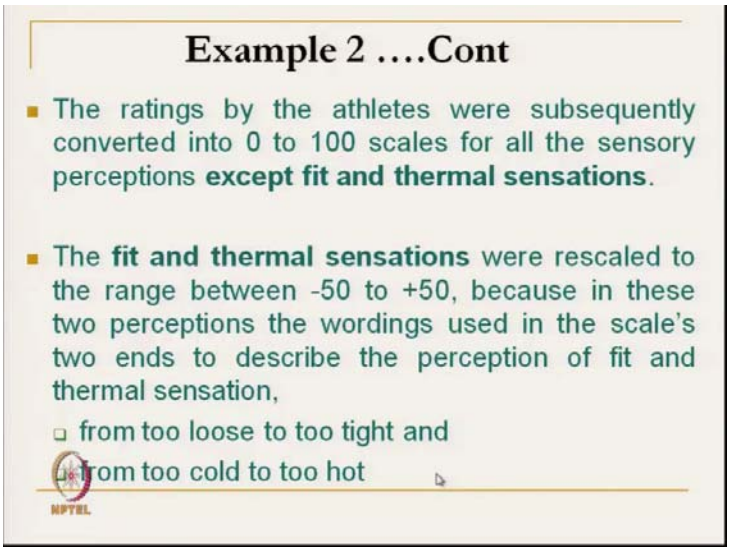

The rating is actually its 100 scale. So, it was subsequently converted to whatever rating is given, it is converted to 0 to 100 scale for all the sensory perception except fit and thermal sensation. So, fit and thermal sensation, what they have taken? It is a minus 50 to plus 50. So, it is extremely loose or extremely tight or extremely hot or extremely cold. So, rest other attributes, like this attribute, they have taken into 100 scale, but the fit and thermal sensation. So, from too loose, to too fit, too tight and from too cold to too hot. So, this way it has been rated and then they have done the statistical analysis and results were reported.

So, we can design our Wear Trial Technique for our own applications & own use. So, another Wear Trial Technique that we have performed, this is psychological response of

clothing by Wear Trial Technique under cold weather condition. So, here we have developed four different types of clothing jackets. This is done in our lab.

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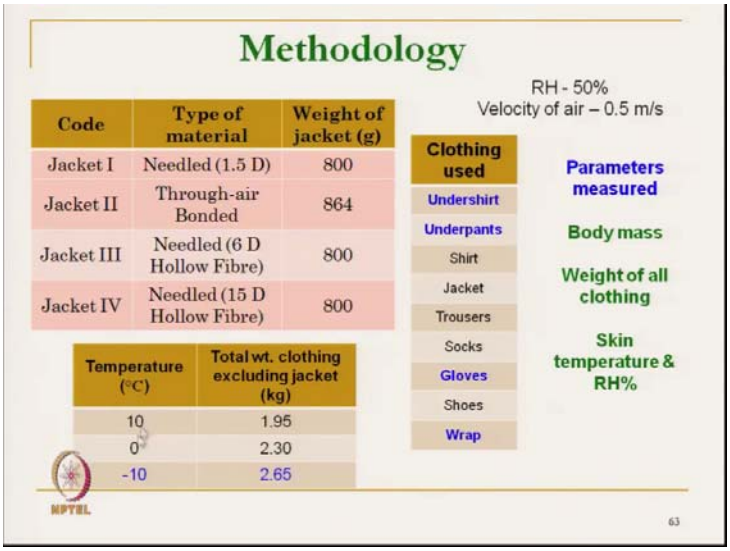

So, 4 different types of the jackets have been developed and so, the Jacket I, the difference is only that inner layer and outer layer there fixed; only difference is that the middle layer. So, middle layer is made of say 1.5 denier needled punched nonwoven fabric. Jacket weight, we have tried to keep around say 800 gram. And Jacket II, is through air bonded nonwoven this through air bonded nonwoven, actually we will see this gives very high thermal insulation.

But due to very high thickness, it fails. We will see that Jacket II, fails in giving warmth. So, why? Because it is due to its higher thickness, the moisture vapour transmission is not proper. So, that gives poor result; that means, which shows here the needle, felt or say hollow needle, felt fabric needled punched fabric with one 15 denier fabric, although it gives lower thermal insulation than the jacket than through air bonded fabric if when we tested objective testing when we tested by the thermal insulation, it gives Jacket II, gives the best result as per as thermal insulation is concerned.

But in Wear Trial Technique, this fails because other environmental and physiological condition comes into picture. So, that is the importance of the Wear Trial Technique. Here through Wear Trial Technique, we could say that this fabric jacket II is not suitable for extreme cold climate clothing. We have performed the test in 3 different

environmental temperature; 10 degree Celsius, 0 degree Celsius and minus 10 degree Celsius; 3 different temperature, we have performed.

And total clothing weight is for 10 degree Celsius, it is although the jacket weight is same almost; but total clothing weight is different as per the standard norms, we have used different. In addition to the jacket, we have used under shirt, under pant. So, different types of other accessories we have to use. The parameters what we have measured is the body mass, weight of all clothing before and after test and skin temperature relative at different parts of the body. So, we have designed as per the standard protocol, relative humidity and air velocity of the chamber were kept constant around 50 degree. 50 percent and 0.5 degree Celsius per second that is the relative humidity and temperature we have changed.

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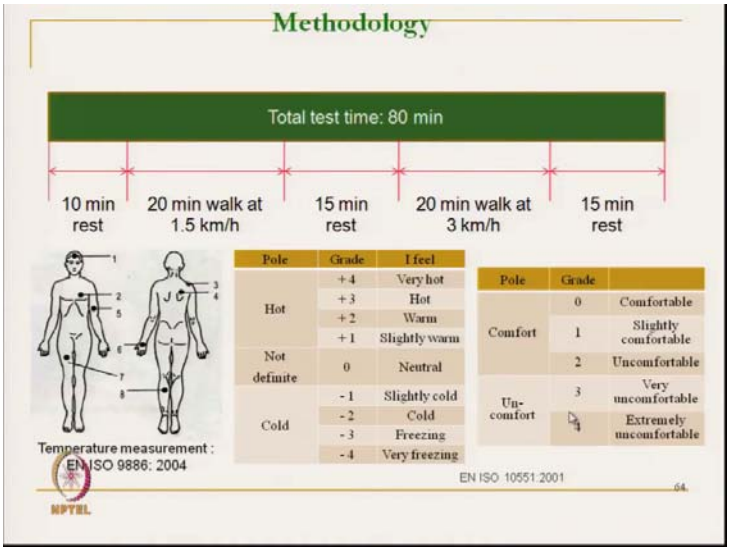

Pole	Grade	I feel
Hot	+4	Very hot
	+3	Hot
	+2	Warm
	+1	Slightly warm
Not definite	0	Neutral
Cold	-1	Slightly cold
	-2	Cold
	-3	Freezing
	-4	Very freezing

Pole	Grade	
Comfort	0	Comfortable
	1	Slightly comfortable
	2	Uncomfortable
Un-comfort	3	Very uncomfortable
	4	Extremely uncomfortable

And total test protocol is that total time was kept 80 minutes and initially 10 minutes they were rested inside the chamber, then 20 minute walk at 1.5 kilometre per hour speed. Then again, 15 minutes rest, then 20 minute walk at 3 kilometres per hour speed. Then, at last 15 minute rest; so, total it comes out to be 80 minutes test protocol and during that time along with other parameters, we have rated the garment in terms of comfort garment, comfort rating and in terms of the warmth rating.

In warmth rating, we have taken 9 point scale. It is hot; it is positive; it is from plus 4 to plus 1; plus 4 denotes the very hot; 3 hot; 2 warm and 1 slightly warm and 0 rating is

the neutral and similarly for cold, it slightly cold to very freezing. So, these are the cold related. Hot or cold related temperature or feeling comfort related fail, we have used 5 point scale. It is from starting from 0 which is trembling comfortable and 4 means extremely uncomfortable. We have used the standard ISO 10551: 2001 with this protocol, we have performed the test.

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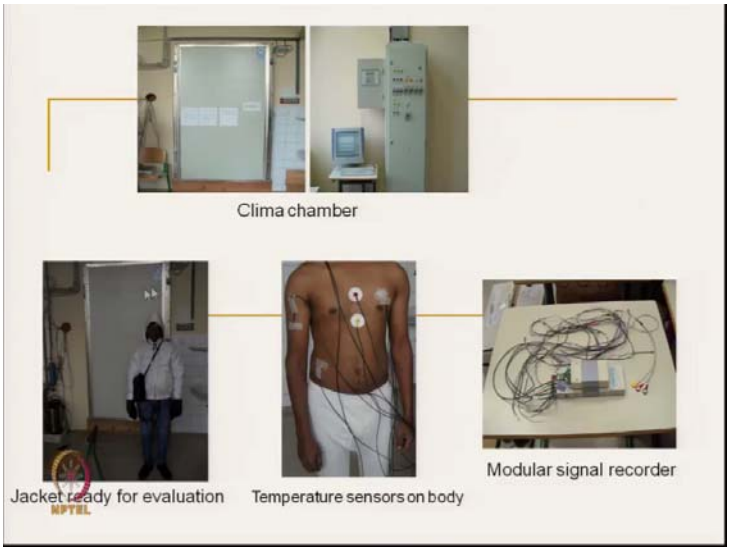

So, this is the climatic chamber and these are the sensors which sense the skin temperature and skin humidity at different parts of body and the after wearing cloth within this is after jacket and what we have observed?

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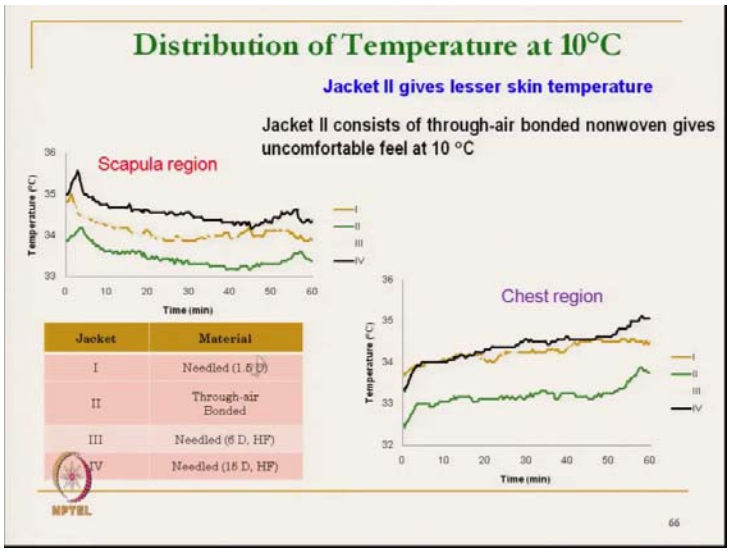

We have observed here, just see at 10 degree Celsius temperature, Jacket II consisting of through air bonded nonwoven gives uncomfortable feel because you just see temperature is for jacket II, it is little bit cooler because it gives little bit cold; skin temperature should be around 34 degree Celsius or 35 degree Celsius. So, 34 or 35, 36 degree, but it is little bit uncomfortably cold. So, why? So, this is needled I discussed.

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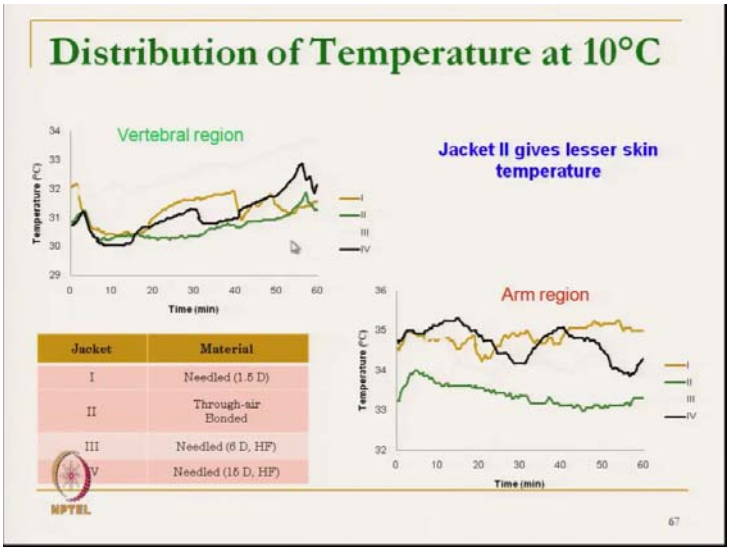

If we see the temperature at different say arm region, vertebral region earlier where chest region. So, at different zone, we have seen that this gives the lowest temperature.

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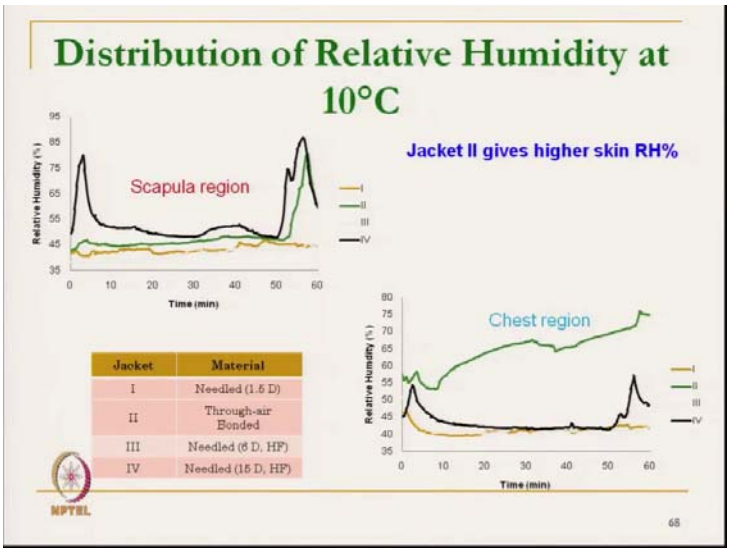

So, why? If we see the humidity, the humidity sensor shows that it gives the very high humidity; very high humidity at that or jacket II; that means, at 10 degree Celsius temperature, whatever your humidity sweat body is releasing particular jacket is not able to actually transmit because of its thickness.

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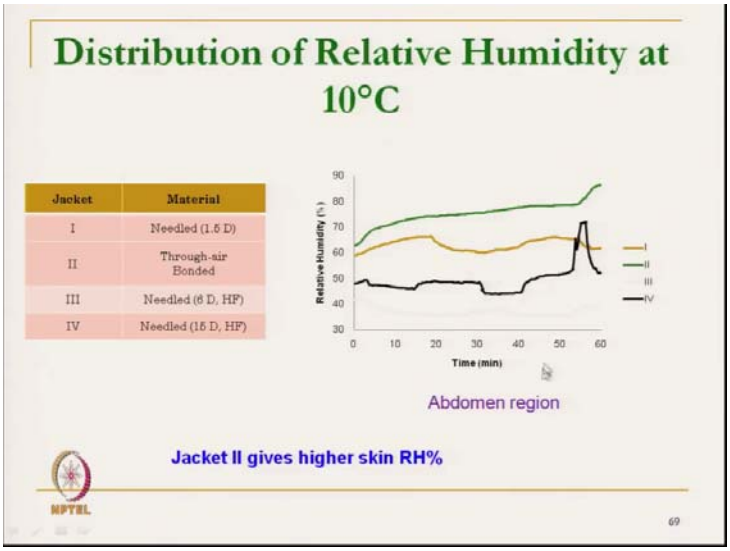

And see this is a different abdomen region, we can just see this high humidity high sweat rate.

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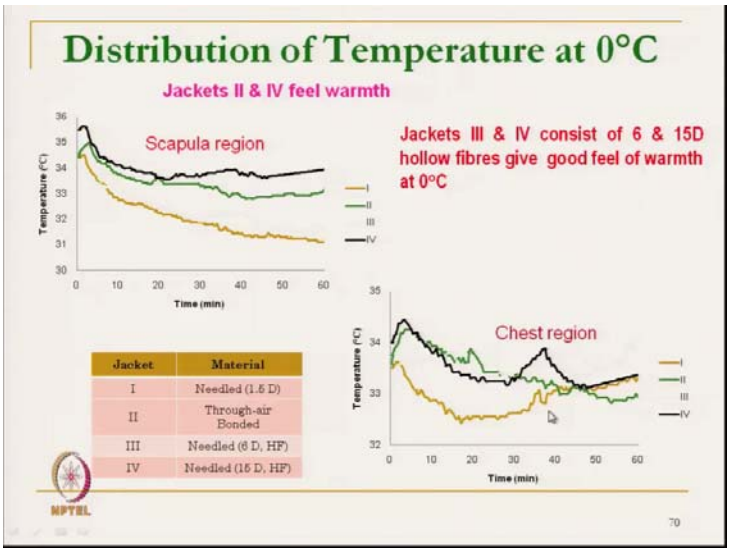

Now, coming to 10 degree, it is a 0 degree Celsius temperature the jacket III and IV consisting of a hollow fibre gives warmth; see temperature is little bit high. So, at 0 degree Celsius, it gives warm because of the presence of hollow fibre.

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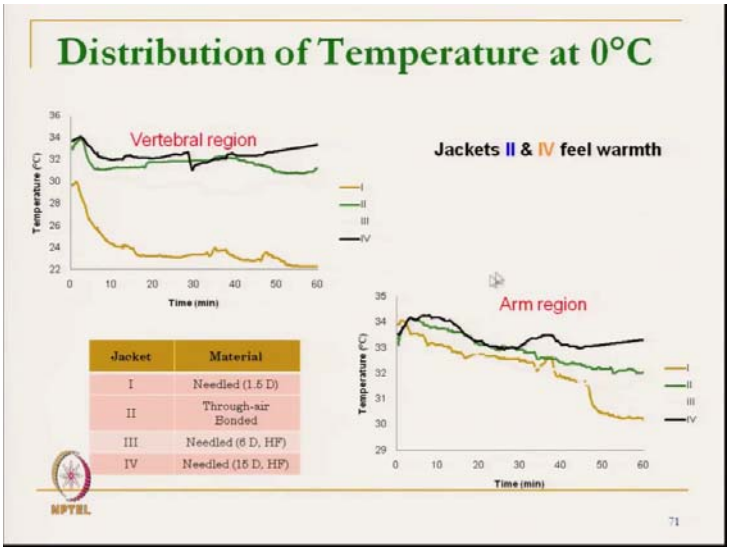

Even this is true for other region at different region you see.

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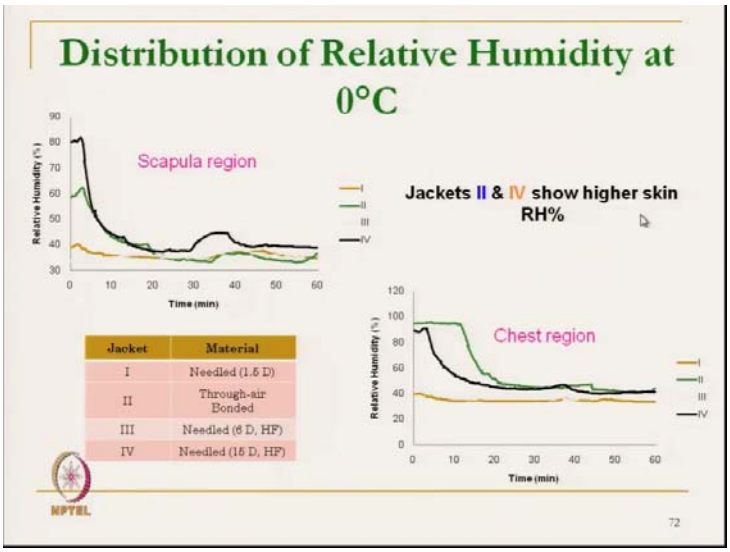

So, this fabric gives this trend, we have to see the overall trend. At different body part, it is not consistent. So, depending on the physiological condition, the sweating pattern is different, but we try to study the overall sensation. Now, just see that at 0 degree Celsius jacket II and jacket IV shows higher skin moisture; that means, it is not able to transmit the moisture

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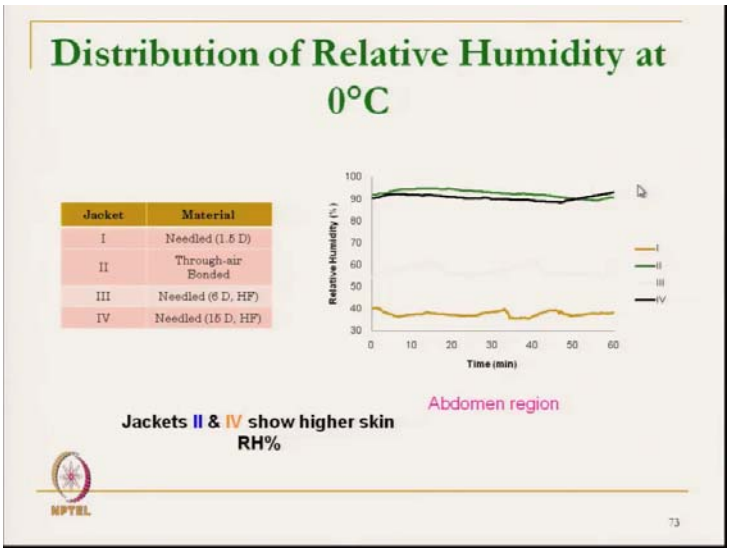

Edged Abdomen region, the relativity of the moisture above the skin is very high.

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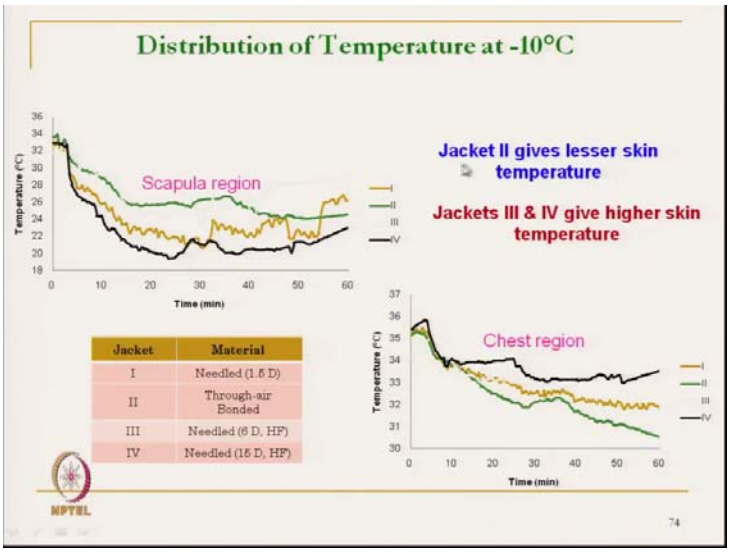

So, now coming to the subzero temperature. At subzero temperature, if we see carefully jacket II gives lesser skin temperature. Jacket in this scapula region is confusing, but if you see other chest region and it gives the lower skin temperature. So, chest chamber area is the area we will discuss in next session in neurophysiology that the cold sensation in chest is very sensitive; where, if we get the lower temperature, our sensation will be very high, cold sensation will be very high.

So, at jacket II, if you see, it is green one which gives the temperature from 35, it drops to say 31. So, with the time, with the activity, what does it show x axis? It is a time of activity. So, initially the temperature was at that minus 10 degree Celsius the temperature of the skin was 35, it is comfortable. But during activity as we start sweating during walking as per the protocol or this jacket fails to actually transmit moisture from body to skin to outside that is why it fails at as the temperature reduces because the humidity increases at that zone.

So, why you start feeling uncomfortable, cold, and uncomfortable as the skin temperature become around say 30, 31 degree Celsius. But the fabric with hollow fibre; so, 4 gives the better temperature, which is comfortable temperature.

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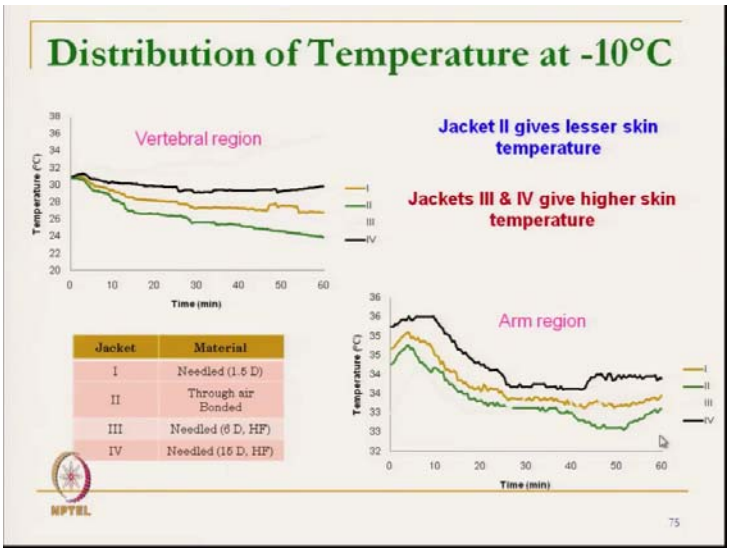

So, let us see other zone also. Other zone the temperature it gives the lower temperature it is around. So, this is giving a cooler effect at extreme cold. So, this actually fails at that temperature, even in the arm region. Another thing that we have not shown here, the psychological rating, the rating scale we have compared at different time, we have got very good correlation with temperature and humidity.

So, this temperature say at 50 or after 60 minutes time, this fabric whatever responses we have got from jacket II gives the uncomfortably cold sensation. So, actually we have got proper correlation.

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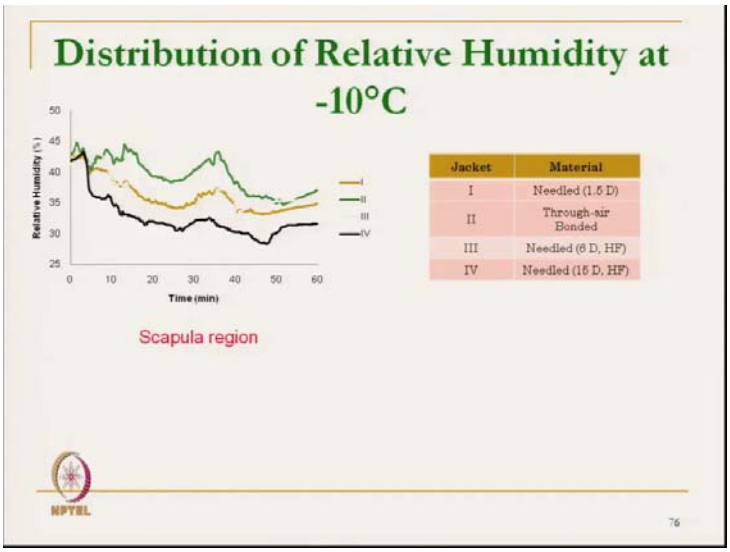

Like if we see the humidity, now humidity will give the proper picture. This is the temperature. Humidity we have taken in one Scapula zone only. If you see, it is a clear; the humidity of environment of the skin, humidity is very high, its almost we have seen that in the microclimate zone, the comfortable temperature should be around 32, 33, 34, but here if we see that temperature is around more than 40, 35, above 35, so actually it does not give the comfort. It is correlated with the psychological study.

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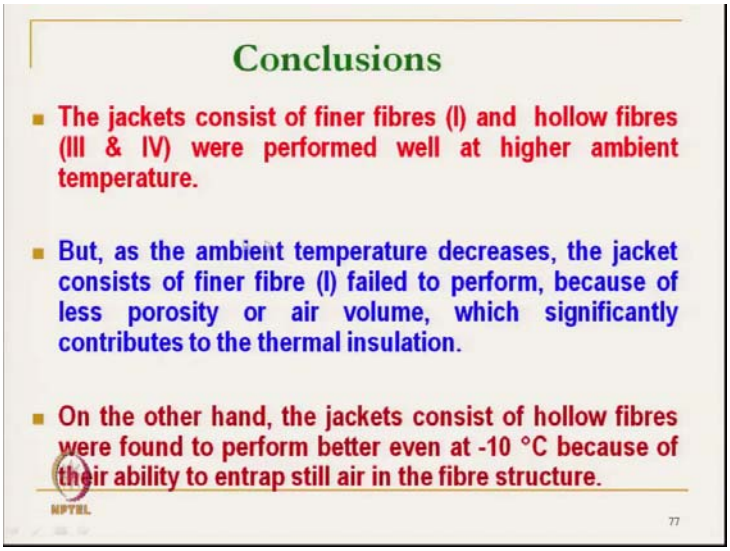

Now, see the conclusion. So, jackets consisting of finer fibre that is 1 and hollow fibre 3

and 4 were performed well at higher ambient temperature; but as the ambient temperature decreases the jacket consisting of finer fibre failed to perform because of less porosity and air volume which significantly contributes to the thermal insulation. Now, we will discuss the aesthetic comfort. So, aesthetic comfort is completely related to the psychological perception of human body.

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There is a complex interplay between clothing aesthetics and body attributes. So, it depends on the body attributes; how the clothing will look like. Human body imaging is the technique which can be adopted to study the clothing aesthetics because body imaging will give us the complete picture, 3 -dimensional body imaging will give us the complete picture of the shape of the body and basically the wearer through the clothing would always like to get aesthetic pleasure. And by emphasising some positive attributes of the body, positive features of the body and hiding some negative feature.

One simple example is the very well known example, like if we select our checks or stripes, we can actually get some aesthetically illusion effect of so the of human body. Suppose, a person who is actually short in height. If he wears a vertical stripe, it will automatically give a taller look. So, that way even by designing a fat person or a lean person can design their clothing. Accordingly, suppose, a lean person can design a clothing with a loose fit clothing.

So, it will give him some bulky nature. So, that similar person depending on a body

feature by designing the clothing, one can actually hide its some negative feature and give some aesthetic pleasure; aesthetic comfort. So, aesthetic comfort is actually totally psychological in nature. It is very difficult to measure at least objectively and due to its subjectivity, it is very difficult to measure.

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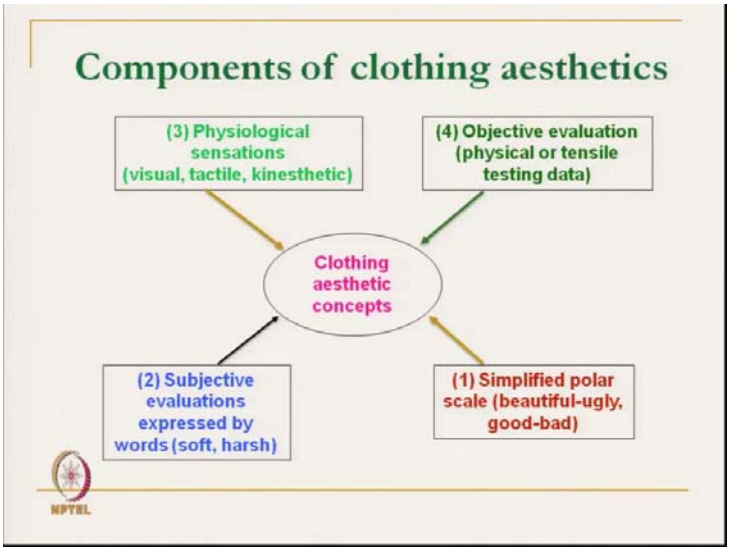

So, the clothing components of clothing aesthetics are basically there are 4 different components, we can measure the aesthetic. We have to ultimately measure the aesthetic first is simplified polar scale whether it is a beautiful or ugly, whether it is good or bad. It is aesthetic pleasure, aesthetic concept of clothing; it is good. So, some polar attributes we can give.

Then, by subjective measurement; it is soft or hard. So, this is expressed by word, by a subjective evaluations, we can measure the aesthetics like drape; it is a beautiful, but you can measure the drape by flexible or rigid like psychological sensation. It is visual, it is pleasing. So psychological sensation and fourth one is objective measurement. So, we have to see that, can we measure these psychological aesthetic aspects by objective measurement? This objective evaluation of the aesthetic is very important to quantify. So, we will stop here.

So, we will continue in the next class.

Thank you.