Textile Product Design and Development
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Lecture - 07
Product Architecture

We are going to discuss the product architecture. What is product architecture?

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Product architecture is related to the arrangement of functional elements of the product. Any product must possess certain functional characteristics. So, how are those functional characteristics in the form of a physical entity arranged? What could be the guideline for the arrangement? Product architecture gives an idea about these questions. Functional elements are physical entities like parts, components and sub-assemblies, and they all depend on the product's design.

Various products may have different physical entities. The entity could be different parts of the product. The architecture emerges during the concept development stage through sketches, function diagrams or early prototype development. The architecture of any product is essential because the product's usability and functionality depend upon its overall architecture.

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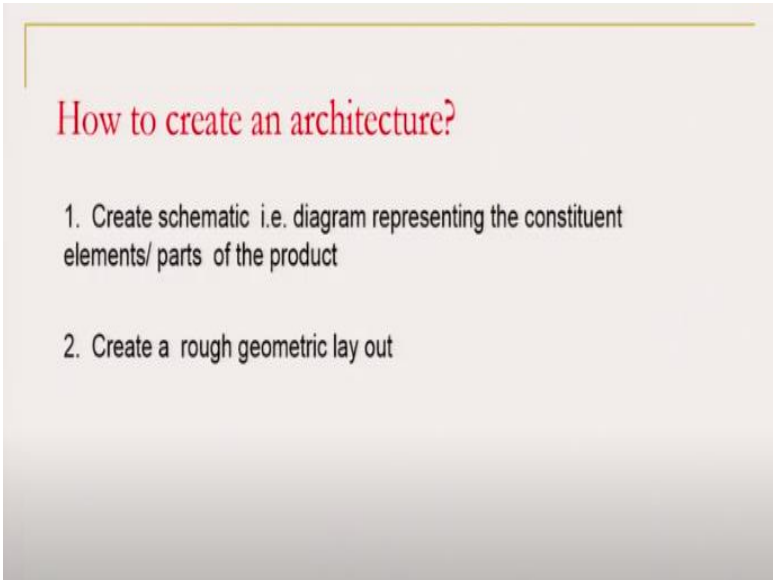

How to create an architecture? What is the first step? First create a schematic, i.e., a diagram that represents the constituent elements or parts of the product. So, the ability to use diagrammatic representation is very important in creating an architecture. The diagrams could be drawn using a computer with the help of graphics software, or it could also be drawn by hand as well.

Once we draw different product elements, a rough geometrical layout is created, depicting how the different parts could be joined to make a complete product. So, we can arrange drawings of the different elements to visualize the product. In this way, the product architecture can be built.

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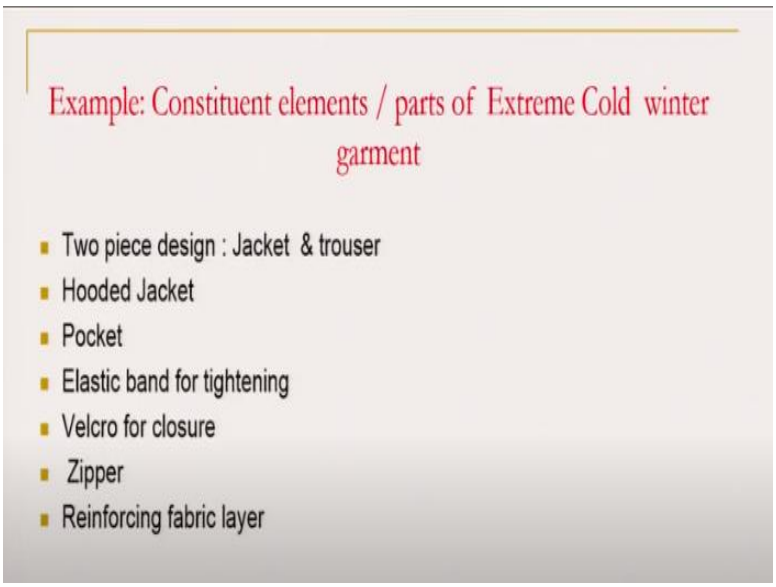

Let us look at an example of constituent elements or the parts of extreme cold winter garments. First, we must list the various constituent elements required in developing the extreme cold winter garment. As shown in the slide, the list indicates that it could be a two-piece design, i.e., the jacket and trouser must cover the upper and lower part of the body, respectively. So, the jacket and trouser are the two constituents of extreme winter garments. Next the jacket should be hooded to cover the head. The other requirement is pockets to keep utility items. The location and number of pockets are decided based on the requirement.

The other elements needed could be an elastic band for tightening the jacket, velcro for closure to avoid the penetration of wind, and zippers also required. The reinforcing fabric layer may also be needed. As stated, the list of constituent elements may vary for different products. Hence, the list is prepared first, and we can make sketches for some of the additional items if required.

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Let us take another example of a layered waterproof jacket. The key component is that it must be waterproof and breathable fabric as it is used by divers underwater. What do we need in this application? The requirement is waterproof breathable fabric. The fabric is not only waterproof but also breathable. The garment is made of different pieces, so a fully sealed seam is required. The seam must be completely sealed to resist the penetration of water. The other components required are waterproof zippers, a bonded hood brim, adjustable cuffs, side zips for ventilation, and a draw-cord with cord locks

at the hem. The cord lock is necessary to tighten the jacket. These are the key components required for developing a waterproof jacket; making a list is the first step.

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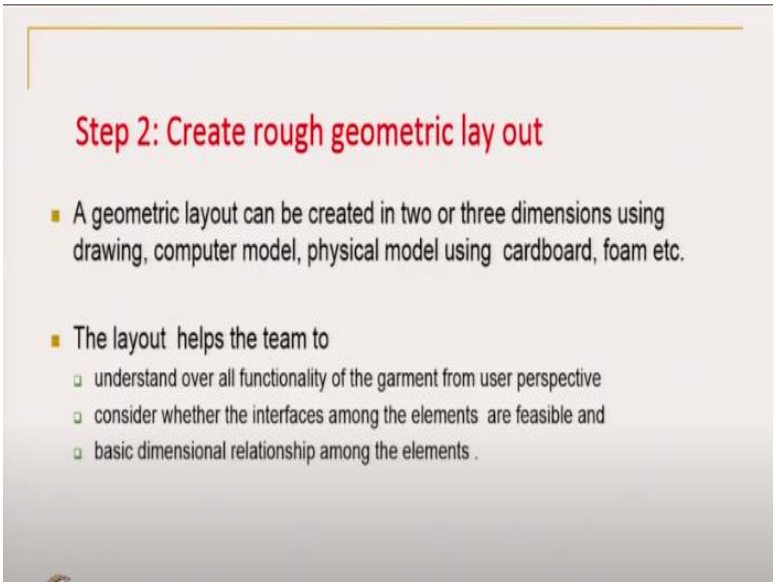

Next, we create a rough geometric layout. We can also make sketches of the parts. A geometric layout can be made in two- or three-dimensional form using drawing, a computer model, or a physical model using cardboard, foam, etc., so a developed model can communicate the idea easily to the other person. How? By creating a physical model through cardboard or foam, or a 2D or 3D model through computer graphics, we can convey the design idea to anyone. So, the idea can be communicated easily to the other person if we can develop a model. The layout helps the team understand the garment's overall functionality from the user's perspective.

Once the model is developed and demonstrated, one can look at it from various angles for the utility from the user's perspective. The model must be developed from the point of view of the utility of the garment. Next is to consider whether the interfaces work properly if the different components are put together. The other thing is a basic dimensional relationship among the elements. For example, we would not prefer larger buttons in a shirt, though different button sizes were available. This helps to understand whether the proportion is correct or not. In this way, the prototype development starts.

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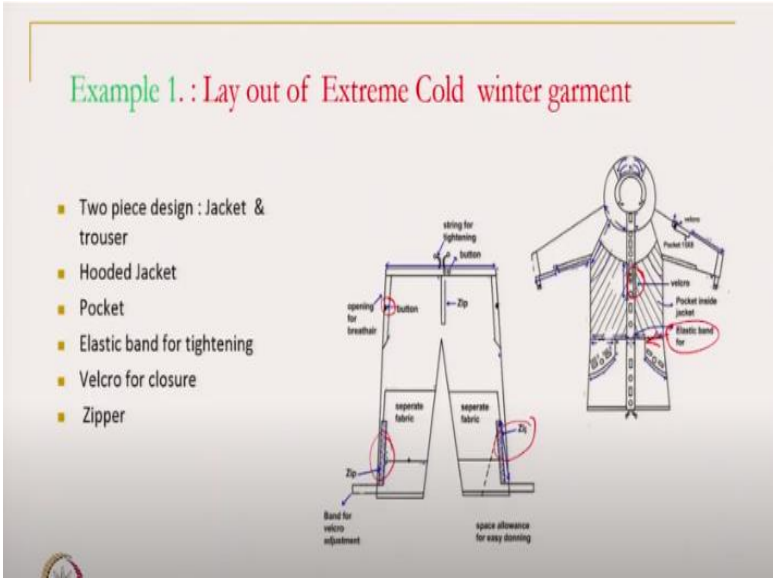

The layout of an extreme cold winter garment is presented on the slide. The items are listed on the left-hand side and sketches on the right-hand side. This sketch conveys the location or placement of the button and zip. The overall design should be understandable to all the team members so that the layout of different components must be mentioned. The design person must have an idea of the reason behind all the components involved in product development. For example, the location of the velcro or elastic band and the reason for placing it in the respective places must be explained. A sketch helps convey the location of different components in the garment, and in this way, the design layout is conceived.

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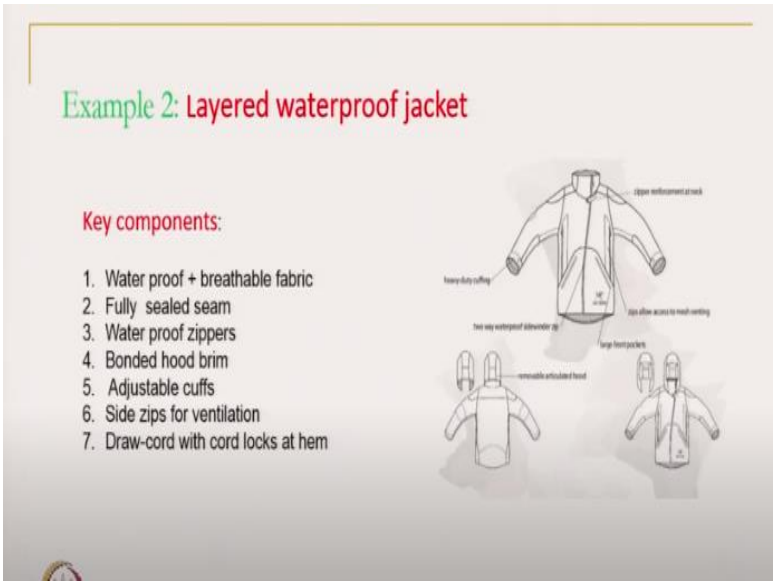

Another example of a waterproof jacket is also presented on the slide. As stated, the idea of design layout is to convey our thoughts to others, team members, or anyone else.

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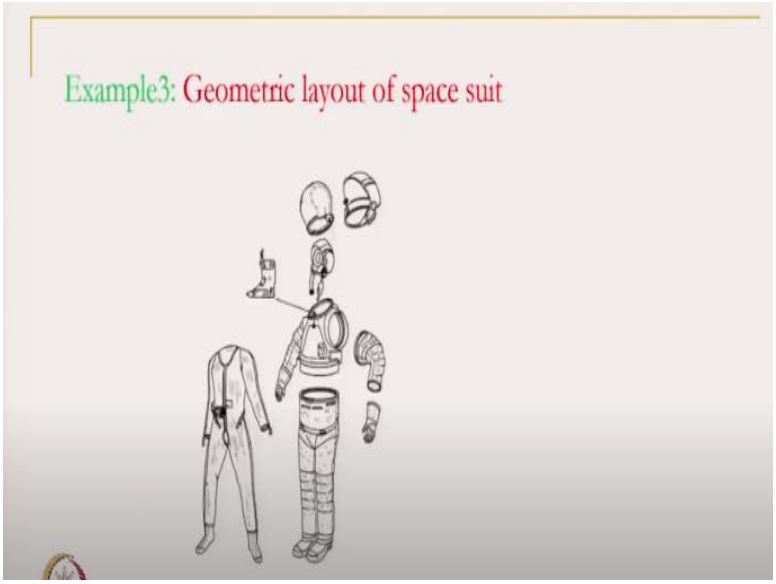

The geometric layout of a space suit is presented on the slide.

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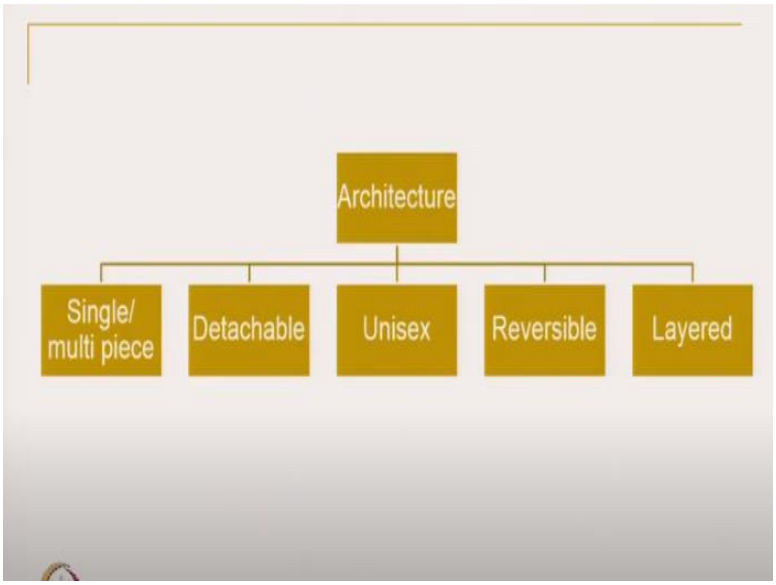

What are the different types of architectural products practised for the design of textile products? The classification of five different architectures is presented on the slide. Those are single or multi-piece products, detachable, unisex, reversible, and layered architecture. Each architecture will be discussed in the subsequent sections.

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An example of a single-piece design is on the slide's right-hand side, which is a uniform. The single-piece design indicates a pair of trouser with a shirt designed in a single piece without any seams. The most important advantage of the single-piece design is that it eliminates agent penetration through any openings because it is closed from all sides. So, the possibility of any external agent penetrating can be minimized. It also allows quick donning and doffing. Another advantage is simplified seaming and sewing when joining fabric pieces during garment fabrication.

The disadvantage is there is no provision to open the jacket or pants to quickly release heat stress or body chill, i.e., the entire garment must be removed, which is not feasible at every time. Heat stress can develop quickly because of the unavailability of any openings, which is the main disadvantage from the design perspective. As it is designed to restrict the penetration of external agents, it may be an impermeable fabric.

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Another alternative design is a two-piece design with a pair of trousers and a jacket to overcome the deficiency in the single-piece design. The two-piece design is shown on the right-side bottom of the slide. The advantage of the two-piece design is that it allows quick donning and doffing for quick heat release or body chill. Additionally, it enables the exchange of defective jackets and pants, i.e., if one is not functional, it can be replaced, but the other part is functional. So, the jacket and pant are independent of each other. However, an additional closure system needs to seal the opening between jackets and pants.

The other advantage of the two-piece design is that the restrictions imposed by the garment are much less because of its architecture. Specifically, the restriction imposed on the movement of limbs is reduced to a greater extent. The disadvantage is that it needs a closure system to seal the opening between jackets and pants. Hence, it requires more seam sealing and sewing. Knowing the benefits, a one- or two-piece design could be chosen for the requirement.

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The detachable architecture can also be included in the functional garment. Examples are collars, shorts, bibs and reflecting jackets. For the collar, keep the shirt the same; various colours of the collar can be chosen. Bibs or reflecting jackets can be worn over the uniform and in regular dress in the required applications; they can be easily removed as well if necessary. The detachable design is the trouser part, as shown on the slide. In this design, a special type of seam is made near the knee part from which the lower part can be detached easily.

The bottom part of the trousers can be removed and left with shorts. Similarly, jacket sleeves can also be removed to keep a sleeveless jacket. The benefit is that if the full-sleeve jacket becomes warm in some situations, the sleeves can be removed to reduce heat stress. In a similar way, the lower part of the trousers can be removed to use as shorts to reduce heat stress. The various parts can be detached from this architecture based on the requirement.

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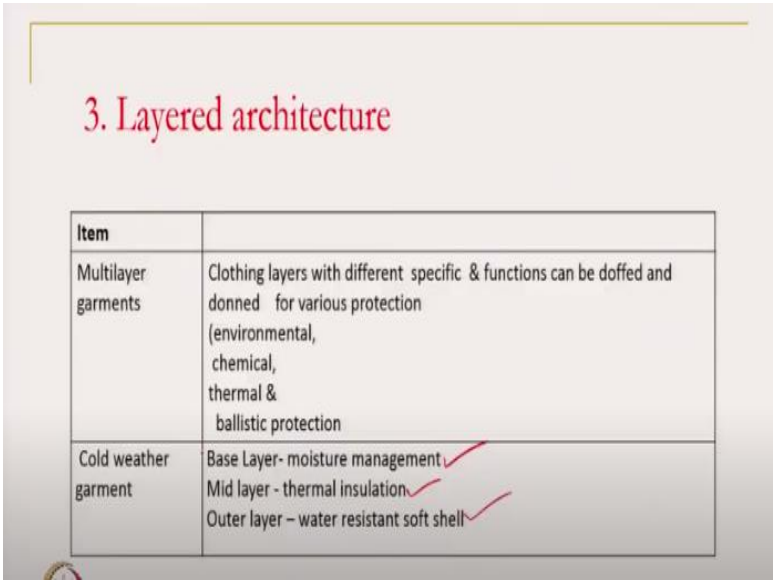

The next architecture is layered architecture. It is commonly seen nowadays in multilayer garments. Clothing layers with different specific requirements and functions can be doffed and donned for various protection, such as environmental protection, chemical, thermal, and ballistic productions. It is a multilayer garment, and layers can be removed depending on the environmental need. The whole garment is designed in such a way that the layers can be removed layer by layer for various needs.

An example of multilayered architecture is a cold-weather garment. There are three layers in a cold-weather garment with three different functions. The base layer is for moisture management, which handles the human sweat in vapour and liquid form and transports it to the next fabric layers. The middle layer is designed to provide thermal insulation, which entraps the heat released from the human body, and the outer layer is a water and wind-resistant soft shell.

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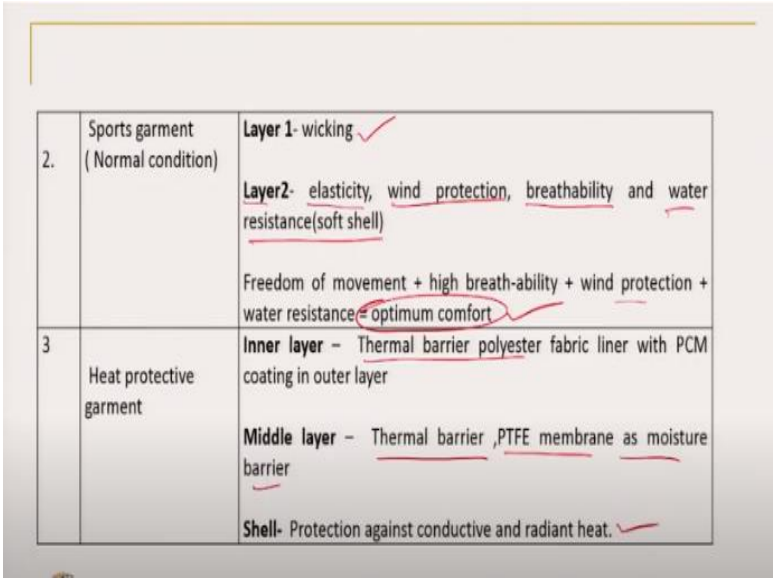

The other example of layer architecture is sports garments. In highly active sports, athletes can generate a lot of liquid sweat. The sweat must be taken by the fabric layer close to the skin. Hence, wicking is an essential property of the layer close to the skin. The next layer should have elasticity, breathability, wind protection and water protection. Elasticity allows the limb to move while playing, running, bending and twisting.

Breathability is also essential to release the moisture vapour from the human body to the environment. Wind protection is essential when sports are played at lower temperatures. The layer must be water-resistant to prevent the penetration of raindrops. Adding all these requirements gives the optimum comfort because comfort is a function of freedom of movement, breathability, protection from wind and resistance to raindrops.

A heat-protective garment is also made as a layered structure to fulfil different functional requirements. The inner layer acts as a thermal barrier, which could be made of polyester fabric. The middle layer is also known as the thermal barrier. PTFE membrane is used in a middle layer as a moisture barrier. Finally, the outer shell gives protection against conductive and radiative heat. A layered structure is created, and each layer has a distinctive function that affects the performance of the garment.

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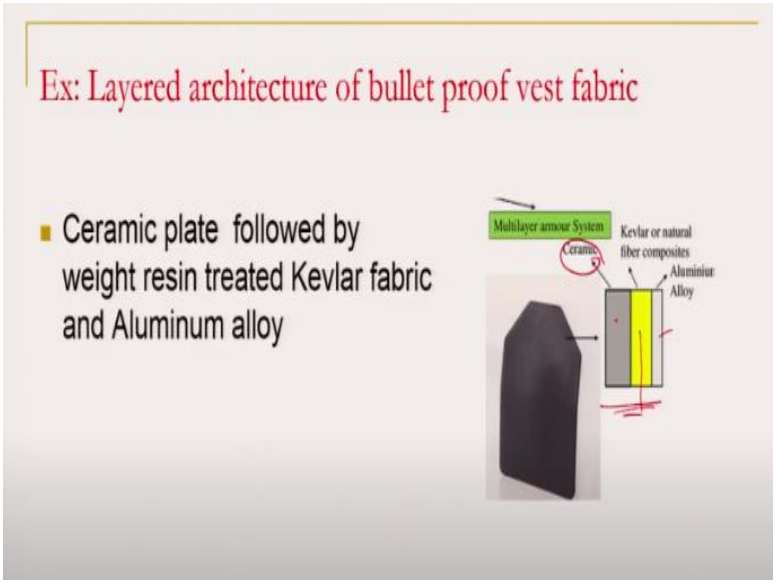

Another interesting example of layered architecture is a bulletproof vest. The multilayer component of the bulletproof vest is presented on the slide. The first layer is composed of ceramic material, followed by a kevlar or natural fibre composite as the next layer and an aluminium alloy as a subsequent layer. The three combinations of materials protect the person from bullet penetration. There are various other examples and products that utilize the multilayer architecture to accomplish the demands of the applications. Before applying the multilayer architecture, the functionality or performance requirement of the product must be considered.

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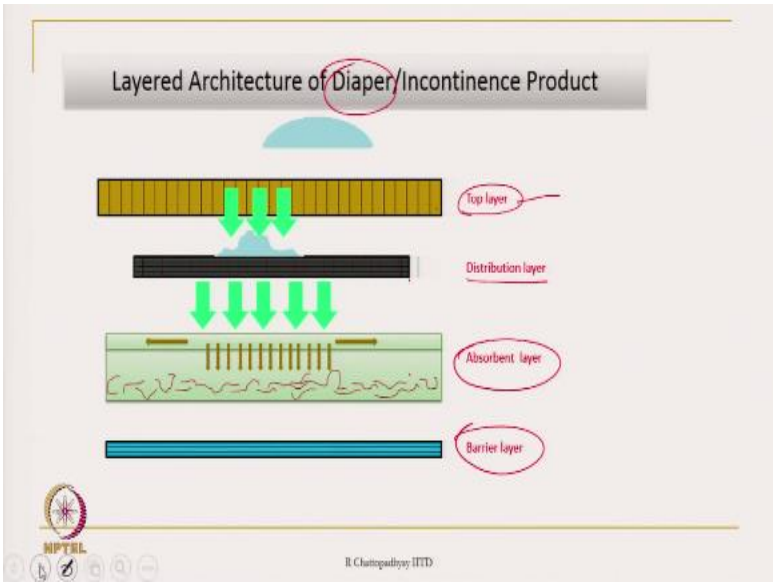

An example presented on the slide is the schematic representation of the layered architecture of diapers or incontinence products. If we observe the diapers used for babies and incontinence pads used for aged people, it is essentially a multilayer architecture. Each layer holds a crucial role in the overall performance of the product. The top layer, called the acquisition layer, collects the liquid secreted by babies or aged people. The second layer is the distribution layer, which distributes the liquid over a large surface area.

The third layer is the absorbent core, which absorbs and retains the liquid. The fourth layer is the barrier layer, which is also impermeable. The impermeable layer is the outer layer of the incontinence product or the diaper so that the liquid cannot move out from the product. Products like Diaper also have a layered architecture, which is also a necessity for a baby's hygiene.

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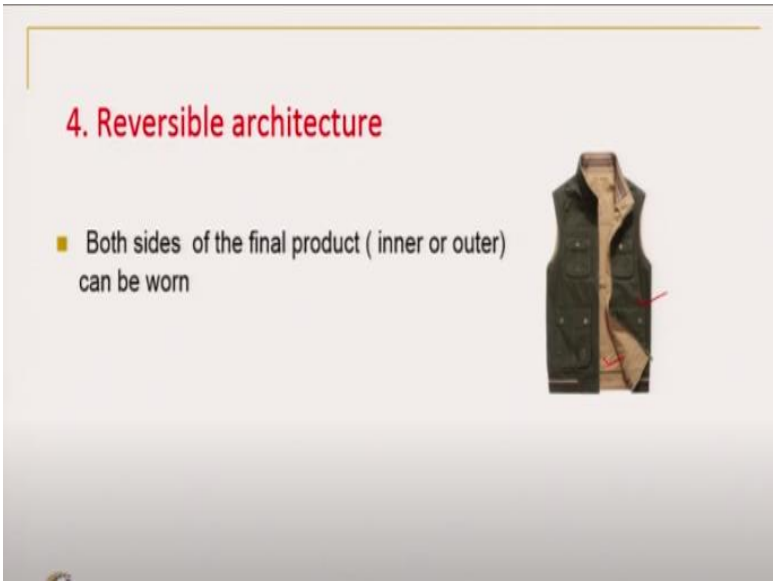

The next type of architecture is a reversible architecture. Many people use garments that are reversible, i.e., the user can use both the inner and outer sides of the garment. For example, a person can wear the same jacket in two different colours. So, one day, he/she can use one colour; the other day, a different colour will be used by the other side. So, it generally gives a feel of using two jackets, but one is used.

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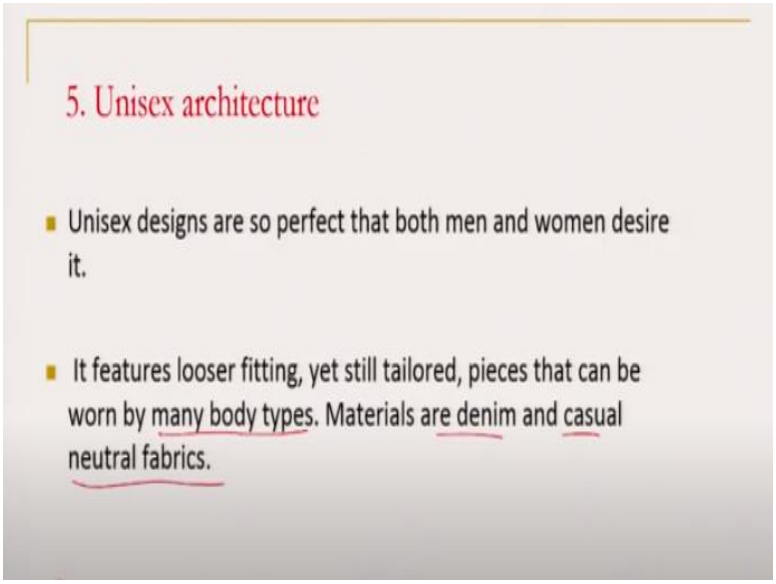

The next type of architecture is unisex architecture. The unisex architectural products are designed for both men and women, so both are interested in using them. An example of a unisex design is T-shirts, which both males and females can wear. It features looser fitting yet tailored pieces that many body types can wear. Materials are denim and casual neutral fabrics. Generally, these products are loose-fitting products and pieces that can be worn by various body types. Unisex architectures are not only used for both males and females but also cover various sizes of the body. So, these products must be stretchable.

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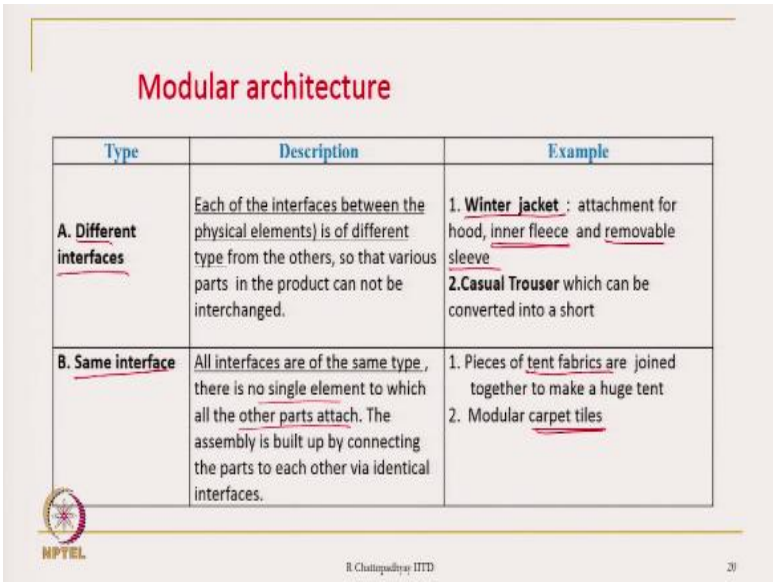

Besides all the above architectures, modular architecture could also be used. We are very familiar with the modular kitchen. We know about modular sofa sets. So modular is a concept that has come and is also being used. Modularity is an essential aspect of design activity. The types of modular architecture have different interfaces and the same interface. In the different interface types, each interface between the physical elements differs from the others so that various parts of the products cannot be interchanged. An example is a winter jacket with a detachable hood that can be joined with the neck part. A zipper, forming another interface, joins the neck and hood parts.

Similarly, there is another interface at the sleeve. So, the interface at the sleeve could be removable. At the interface, there could be an extra fleece attachment. Another example could be casual trousers, which can be converted into shorts. The interfaces are such that only one item can be attached to one interface because this interface is meant for that item only. Only the sleeve can be attached to the interface of the hood; only the sleeve can be attached to the interface of the sleeve. So, such kinds of designs are examples of modular architecture.

The other classification of modular architecture is of the same interface. The assembly is built up by connecting the parts using identical interfaces, i.e., any pieces can be attached to the interface. Examples are modular carpet tiles and tent fabrics. Let us say we need 30 × 100 meters of tent; we cannot make such a big fabric at the loom stage because of the width limitations of looms. So, the smaller pieces of fabric are joined together in the tent, and all the interfaces are similar in nature. So, there could be any pieces of a certain size that can be joined.

In modular carpet tiles, small carpets are combined to cover a vast area. A huge area needs to be carpeted, like the airport. So, the smaller sizes of carpets are joined together. The interfaces are similar in nature combined.

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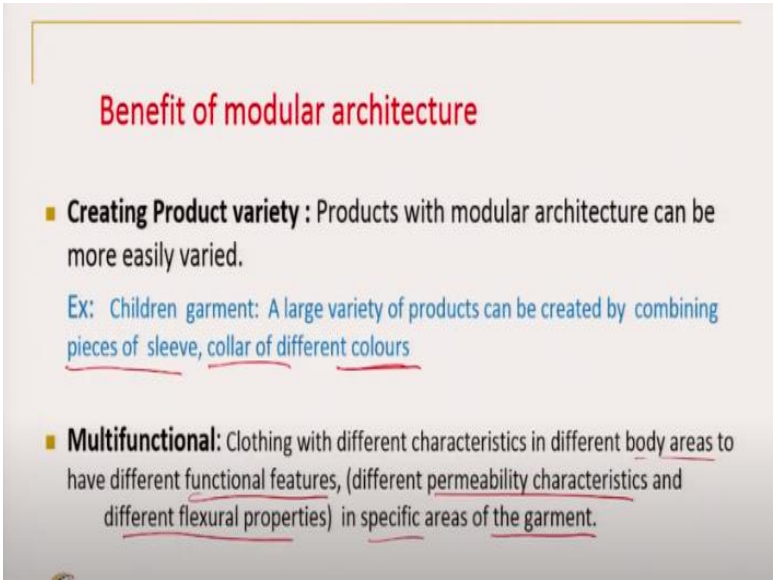

The benefit of modular architecture is that it can create a variety of products. Products with modular architecture can be more easily varied. As discussed, we may have pieces of the same size but different colours for the carpet and join them together to make a beautiful pattern on the final carpet. In children's garments, a large variety of products can be created by combining pieces of the sleeves and collars of different colours.

Only colour varied in the above discussed cases, and the rest of the components are the same. So, in the market, we have a large variety of products that can create aesthetic appeal for the customers. There is also the possibility of multifunctional clothing with varying characteristics in different body areas to have distinct functional features. We can design a modular architecture in which specific areas of the garment may have different permeability characteristics and flexural properties.

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Component standardization refers to the use of the same component in multiple products. A part used for one widely applicable functional element can be standardized and used in several parts. For example, the sizes of the buttons, zippers, and strings used for making garments can be standardized. It can also happen when several manufacturers use the same components from the same supplier. Component standardization is important because multiple manufacturers can use the same component made by one manufacturer.

If the buttons, zippers and strings are standardized, the supplier produces standard material and sends it to manufacturers. So, standardization is possible if we go for a specific type of architecture and design. An example is the lining fabric used in coats, blazers, etc., and as it is used widely, manufacturers can use standardized specifications. This lecture discussed the few architectures of textile products. It explains how to arrange the different functional elements of a product. There are many textile products that are highly standardized already, and therefore, there is not much scope to do something new, but possibilities still exist.

However, when it comes to technical textile products, there is a need to look at this because we do not have standardized, well-established designs. So, there it is very important. Some product's designs are standardized, and their geometrical layout and various components are already fixed. If there is a new technology which gives the fabric different properties or new fibre from which a fabric can be made that gives

different properties, then there is a chance that there is a scope to improve the design for those highly established products which are being used by many people. Okay, with this, let us close today’s session. Thank you.