Textile Product Design and Development
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Lecture – 1
Textile Product Design and Development

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In this course, we will focus on the functional and ergonomic design aspects of textile products. General development process stages, which are followed in the product design and development, will be discussed. Next, we will learn about the design basics, the need analysis, need metric matrix development, the development of specifications, concept generation, product architecture, and the use of natural analogy.

Material selections, i.e., how to select fibre, whether fibre blend, yarns, fabrics, etc., will be discussed in this course. We will also discuss the application of existing mathematical models developed by many researchers and the use of those models. Performance property relationships and estimation of the design parameters for different types of textile products will also be discussed. Some practical examples or case studies on technical product development will be partly discussed in this course.

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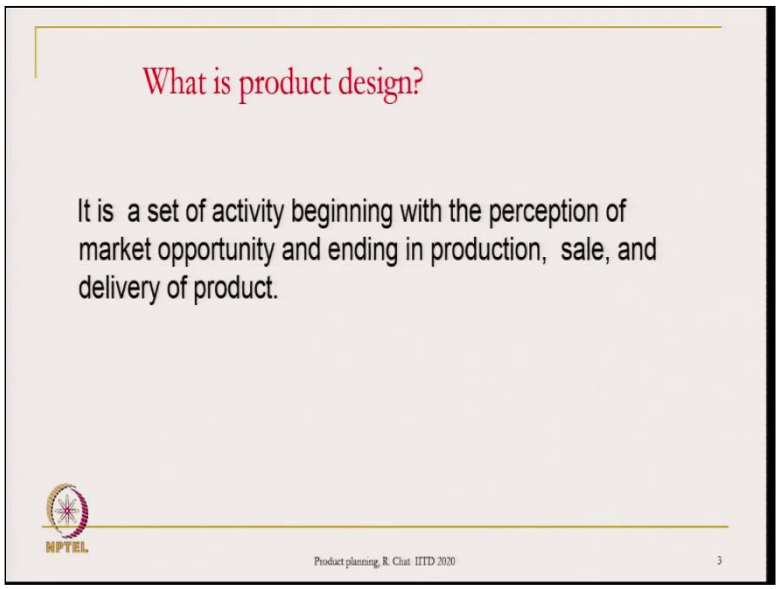

Now, what is product design? Design is a set of activities that begin with the perception of the market opportunity and end with the production, sale, and delivery of the product. So, design is not limited to only the design part; it starts with finding out the existing market opportunity. Without customers or buyers, there is no purpose in designing a product. This means that before starting any design process, it's crucial to identify a market opportunity. So, identifying market opportunities is an essential part of the design activity.

Mass-scale production, sale, and delivery are part of product design. We will not discuss how to sell or deliver the product. However, in an organization, all aspects, from finding market opportunities to delivery of the product, are considered during product development. Every aspect is considered before starting the design process.

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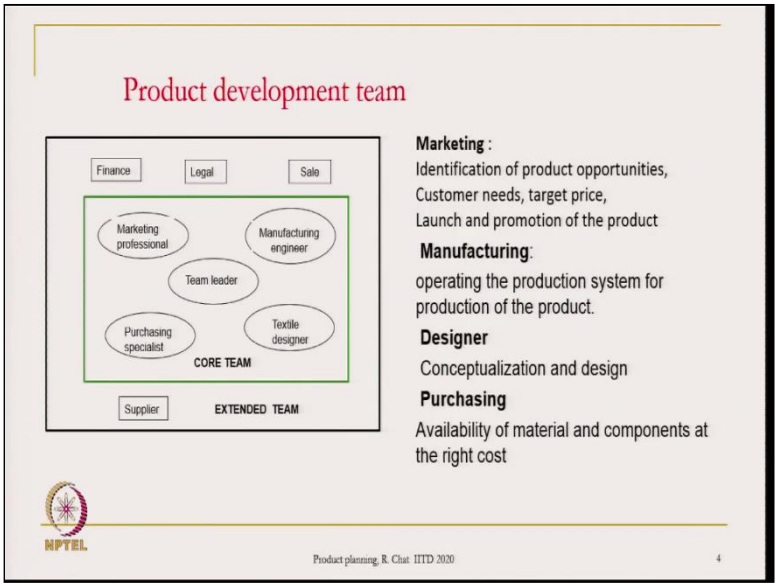

Next, we will understand the product development team. A product development team or product design team is a group of people with different backgrounds or expertise participating in product development or product design. It is represented on the left-hand side of the slide. The green rectangle represents the core team, and the extended team members are in between the green rectangle and the black rectangle. So, who are those people who will participate in the product development or product design? Marketing professionals. They can determine the existing market opportunities, understand customer needs, determine the right target price, and decide on the product launch timing and the promotion activities of the product.

All these are required for successful product design; hence, marketing professionals also become part of this team. Next are the manufacturing engineers or actual production people. They ensure that the product designed can be produced on a mass scale because they know the existing technology and machines in the manufacturing process. They also judge the design from the angle of mass-scale production.

Next comes the designer. The designer plays an important role in the product development team. Textile designers are involved in the production of textile-related products. There will be a purchasing specialist who is responsible for procuring the raw materials needed for the product design. To make a successful product, the availability of raw materials and various components is an important requirement. A design may fail if the materials are not

sourced at the right price or time. Hence, in large organizations, these people are the important participants in the design team.

One member of the team could be a team leader. In addition, members from the financial department are also needed because a lot of financial investments are involved in large-scale production. Finance professionals can suggest the availability of financial resources. A legal team or legal member is also important because they ensure that the design complies with legal and safety aspects. When introducing a new product in a country, understanding the laws of that country is essential.

So, the legal team member ensures that all safety and legal aspects are related to promoting or selling the product in a specific market. Salespeople have a direct link with the customers, and they can provide insights into whether a product will be sellable.
They understand what customers are looking for and can identify the product's unique selling positions or (USP) to make it more marketable.

Additionally, suppliers or vendors are important because they provide the necessary materials needed for designing or developing a product. They help ensure that the required components and raw materials are available for the designing new product. Suppliers should know the challenges in procuring or making them available to the industry where the design activity occurs. This understanding is why they should be a part of the development team. So, in an industrial setup, a lot of people are involved in the design process, each contributing to ensure the success of the product.

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One of the challenges in product design is the trade-off between cost and performance. a designer must consider how the product's performance impacts its cost. Generally, better performance often comes with higher costs. Improving the product's performance requires better quality raw materials, which increases raw materials cost. If faults have to be reduced, then a lot of inspection is required during production. It also requires more time and leads to increased costs. Hence, better performance leads to higher costs. This makes it essential to evaluate whether the product, given its cost, will still be marketable and sellable.

Therefore, the cost versus performance tradeoff is very important in product design. The other thing is dynamics, i.e., when technologies improve, competitors introduce new products into the market, and customer preferences change from season to season, year to year. So, decision-making in a changing environment becomes a difficult task for the designer. The designer has to consider all these aspects. Another major challenge is time pressure. Product development decisions have to be made quickly, especially in industries like textiles and fashion, where new designs are introduced every season; otherwise, competitors will introduce a new product. So, within a limited time frame, the design and production have to be finished, and the product should be available in the market.

There is always time pressure on certain types of products, particularly those with season-to-season variation and consumer-type products. The economics of product design requires a huge investment, depending on the type of product. Ideally, the product should

be both appealing and cost-effective to produce. Cost is a crucial factor in design considerations. It is also important because expensive items will be challenging to sell. The other essential thing is detailing. The design team or the designer must also work out all the intricate design details. Therefore, these are the various challenges in the product design process.

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Design is the process of constructing a product description that satisfies several criteria. First, it must meet functional specifications and aesthetic needs. Additionally, it must meet certain performance criteria within available resources and technology. Furthermore, the design should meet other criteria such as simplicity, testability, manufacturability and reusability.

These aspects are all part of the design process, which must satisfy the product's functional or performance specifications. Some products, particularly wearable textiles, also have aesthetic requirements. Most consumer products have an aesthetic part other than their functional purpose. Next, the performance criteria must be met with the available resources and technology of that particular organization. It is important to ensure these criteria are achievable within available resources and technology. Additionally, product design should be simple and easy to operate, especially for gadgets, and it should be easily testable.

Manufacturing is another criterion that must be satisfied in the design. The product should be easy to manufacture and should not have any complexity in manufacturing process and reusability. Reusability is important because of the impact of pollution. Recycling or reusability of the product has become a key factor in achieving sustainability.

Nowadays, sustainable design is becoming increasingly important. The design has to be sustainable, i.e., using natural materials and consuming less energy, water, and labour. Additionally, we have to consider whether the product can be recycled once it has reached the end of its life. So, these are all actually a part of the design. Hence, design is a process of constructing a product description that satisfies and means all these aspects.

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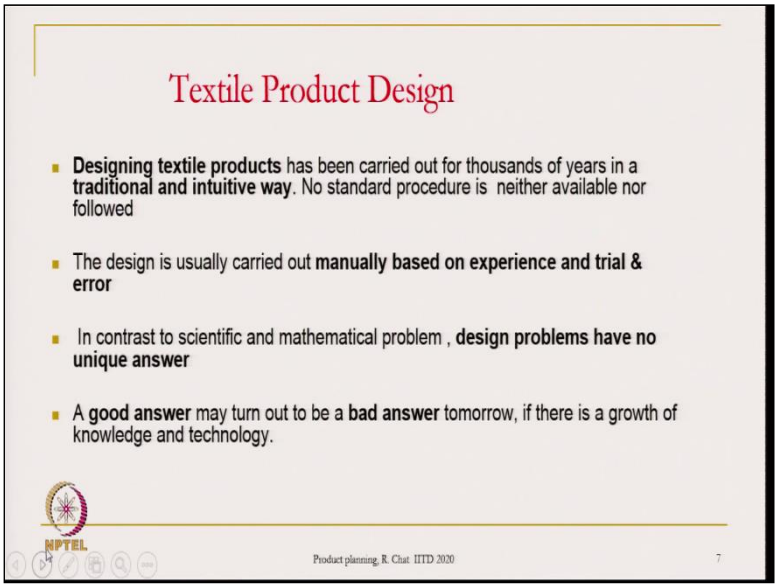

The above discussions are in general terms of product design and are not specific to textiles. These aspects and statements are true for any product regardless of textile or non-textile product. Now, textile or product design will be discussed. The design of textile products has been practiced for thousands of years. Since the beginning of civilization, textiles have been an integral part of human life, and clothes have been designed for several centuries or millennia. Similarly, certain technical textile products like ropes and cordages have also been designed for millennia. It is not a new beginning; these items have been designed by designers from ancient times, long, long ago.

However, the designs were traditional and based on intuition. People were able to design the products successfully using their intuitive understanding; there were no standard

procedures, science or technology available at that time. Despite this, people designed the products, used them and contributed to their survival. In those days, there were no product design courses, engineering programs, or scientific knowledge. Despite this, people were resourceful and intelligent. They managed to create various tools for their needs, build shelters, design clothing, and develop other essential utensils.

In those times, people used whatever materials and technology were available to them, which were all manual. Despite this, they managed to create and survive. The design was usually carried out manually, based on experience and trial-and-error methods. Even today, many textile products are designed manually, and they are all based on experience and trial and error methods. In contrast to scientific and mathematical problems, design problems have no unique answers. This is another important point to remember: when designing something that will satisfy certain requirements, different designers propose different solutions. Therefore, a design problem may have multiple solutions, and all the solutions will be correct in its own way.

This is why you see a wide variety of products in the surroundings. For example, there are different types of chair designs. Chairs can be made from plastic, wood, metal, or other materials. The availability of different materials allows designers to make use of it and create new designs. The variety in chair designs showcases different shapes, sizes, and structures. Despite these differences, the fundamental purpose of the chair is to provide a place to sit. All these designs fulfil this purpose. Hence, design problems can have multiple solutions, unlike mathematical problems, which have only a single unique answer.

Sometimes, it is considered that a good answer may become a bad answer if there is a growth in knowledge and technology. New materials, technologies, or innovations can emerge, making previous designs less effective. As a result, new products will be designed to incorporate these advancements. For instance, in the past, only ring-spun yarns were commonly used because ring-spinning systems were there. Then, rotor-spinning technology emerged, introducing a new type of yarn to the market known as rotor-spun yarns. Subsequently, air-jet spinning technology was developed, leading to the use of air jets and vortex-spun yarns.

As technology changes, new types of yarns are being produced. For example, we have filament yarns, bulk yarns, carded yarns, and combed yarns and today, compact spun yarns are also available. These innovations lead to the development of new products or the enhancement of existing products using the latest materials. New fibres are continuously entering the market. In the past, the apparel sector primarily relied on natural fibres such as cotton, wool, silk, and linen. These were the main fibres available. With the development of science and understanding of chemistry, people started developing rayon fibres. This was followed by polyester, nylon, and many other synthetic fibres.

As the new fibres emerged, people wanted to use them in the existing products. That leads to a new design, improved product performance, and improved acceptability in the market. So, the design that is considered good today might become less relevant tomorrow because of these ongoing advancements and changes. Similarly, the evolution of design can be observed in the development of mobile phones. Initially, mobile phones were not available, but once introduced, their designs continually evolved. Over time, designs kept on changing in terms of the performance of the phone, and they also kept on improving, leading to the smartphones with various features we use today.

A design that was considered good ten years ago may no longer be effective or relevant today. Today, the design has to be different because knowledge and technology might have improved. Therefore, the product designer must consider these aspects so that he can always offer something new to the customers.

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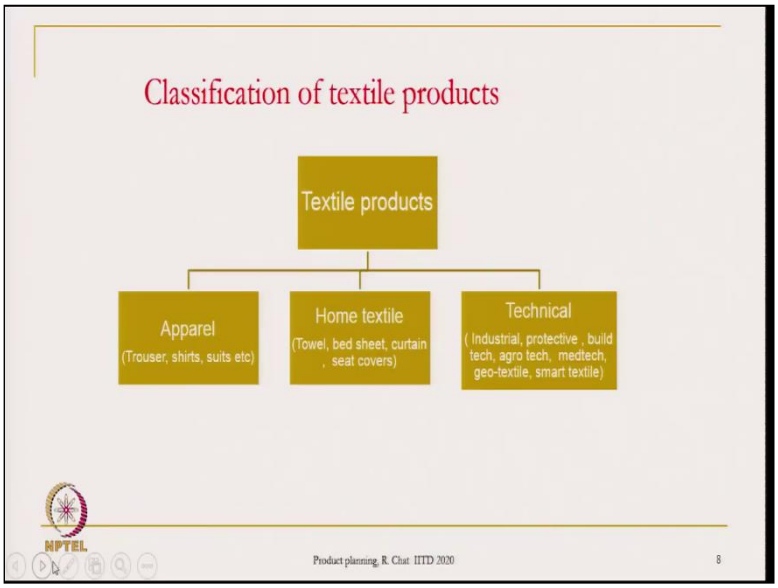

The classification of textile products is shown in this slide. Textile products can be classified into three main groups: apparel products, home textile products, and technical products. Apparel products such as trousers, shirts, suits, etc., have existed for a long time and are used daily. Home textile products like towels, bedsheets, curtains, seat covers, and carpets can also be included. There are numerous home textile products that can be classified under the home textile category. The third category is technical textile products, which are increasingly important today. This category includes a variety of applications such as industrial textiles, protective textiles, build tech, aggrotech, medical textiles, geotextiles, smart textiles, and more.

The use of textiles to develop technical products is a relatively recent development. While apparel and home textile products have been around for centuries, their contribution to technical applications was very limited. Earlier, textiles were primarily used for items like ropes and cords, which were essential for tying logs or constructing shelters. Textiles have been used for a long time in various ways. For example, ropes and cords have been essential for many purposes. Additionally, textiles were used to filter and strain water. Textiles have been used for a long time as a wicking material for lighting. For example, oil lamps used wicks made from textiles to provide light. These were some of the primary uses of textiles in the past.

Earlier, the use of textiles in technical applications was limited. But today, we are trying to develop more and more technical textile products. And now, the applications of fibrous products in technical areas are increasing day by day. The development of high-performance fibres is also increasing the scope of the use of textiles in technical areas. Therefore, the design of technical textiles is increasingly important today.

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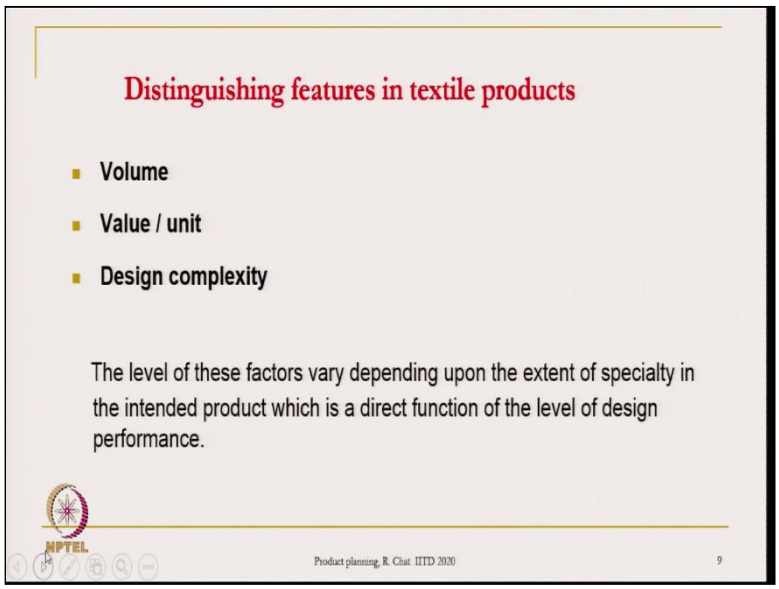

Now, we discuss the distinguishing features of textile products. The three important distinguishing features of the textile products are volume, value per unit and design complexity. The level of these factors varies depending upon the extent of speciality in the intended product, which is a direct function of the level of design performance.

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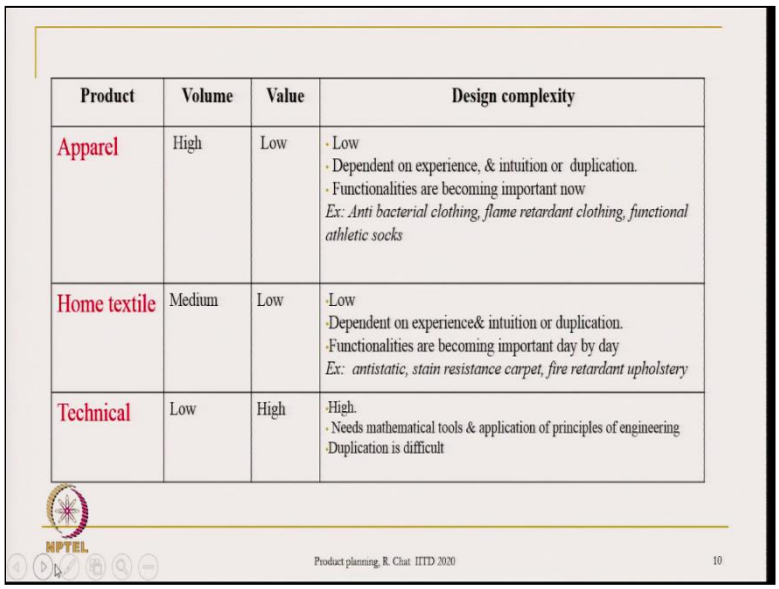

To clarify these aspects with examples, let's consider apparel products. When categorizing products, it is helpful to evaluate them based on volume, value, and design complexity. Apparel products are high in volume-wise. So, the majority of the textile is going into making apparel products. That is why the volume of production is extremely high. Most of the fibres produced, whether synthetic or natural, are primarily used for making apparel.

Consequently, the volume of apparel production is very high. In terms of value, apparel tends to be low-cost, and design complexity is relatively simple. Apparel designs are often based on experience, intuition, or duplication, making them easier to design and reproduce.

Functionality aspects are becoming important in design. Today, we are introducing features like anti-bacterial clothing, flame-retardant garments, and functional athletic socks. The development of the finishing techniques allows the addition of new functionalities to the apparel products. These are the things which are new now. Design complexity-wise, this is very easy to design and was made much earlier by our predecessors when the design was only based on experience and intuitions. The next category of products is home textile products. Home textile products, in terms of volume, production is medium. So, volume-wise, medium and value-wise, they are relatively low and not very expensive.

In terms of design complexity, home textile products are not very complex. Designing items like towels, bed sheets, pillow covers, carpets, or seat covers is not very complex. They are relatively easy to design and depend on experience, intuitions, or duplications. But functionalities are becoming increasingly important here. In home textile products, we are adding new features such as antistatic properties, such as when we want to produce antistatic carpets. There is a growing demand for antistatic carpets in the electronic industry and domestic use due to less static charge generation. When synthetic carpets are used, these properties are becoming increasingly important.

Another functionality introduced in carpets is stain resistance. Additionally, fire retardant properties are becoming important for upholstery and curtains. Fire retardant upholstery is especially crucial in environments like railways, hospitals, schools, and domestic use. These things are now being considered in the design aspect of home textiles. The other part of the product is the technical textiles. The production volume is relatively low compared to apparel and home textiles. However, the value of these products is very high. So, they are expensive compared to apparel and home textiles.

The design complexity is also very complex. It requires mathematical tools and various engineering principles to make very efficient technical textile products. In technical

textiles, duplication is difficult, and they are not easy to replicate. We can observe differences in volume, value, and design complexity from the three types of products.

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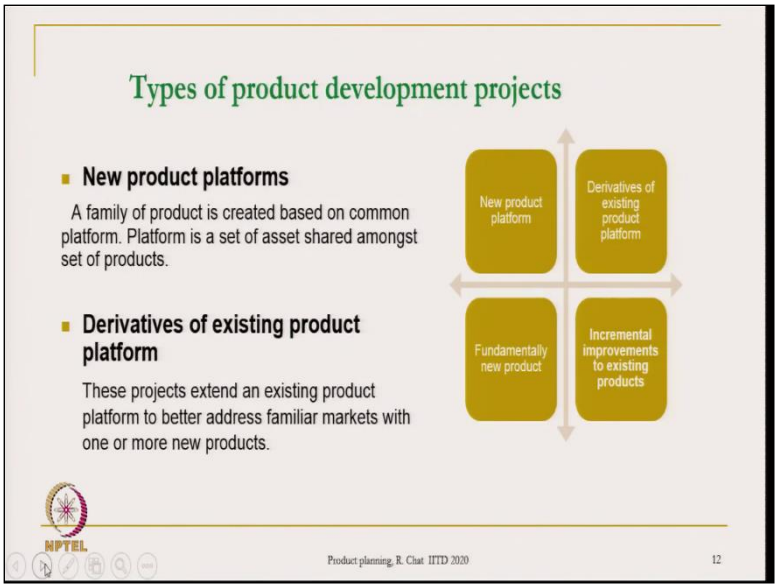

Now, we discuss the types of product development projects. On the right-hand side, we outline four types of product development projects: new product platform, derivative of the existing product platform, incremental improvement to existing products, and fundamentally new products. What is the new product platform? It means a family of products is created based on a common platform. The platform is a set of assets shared amongst a set of products, which means you choose a platform where multiple products can be made here.

That is a completely new product platform, where the same platform can be used to develop multiple products. Derivatives of existing product platforms mean these projects that build upon existing product platforms to better address familiar markets with one or more new existing products, slightly modified and get into a new market. A good example of using existing product platforms is the design and production of masks. When there was a global demand for masks, manufacturers who already had stitching machines and used various fabrics for other products saw this as an opportunity. They adapted their existing capabilities to meet the new demand, using their equipment and materials to produce masks.

For example, garment manufacturers who typically produce items like ladies' tops or bottoms or those who specialize in home textiles like bed sheets were able to use this as the opportunity to switch to producing technical products such as masks. This is an example of derivatives of existing product platforms. That is, making use of the existing facilities and satisfying the new market is what the derivatives of the existing products platform.

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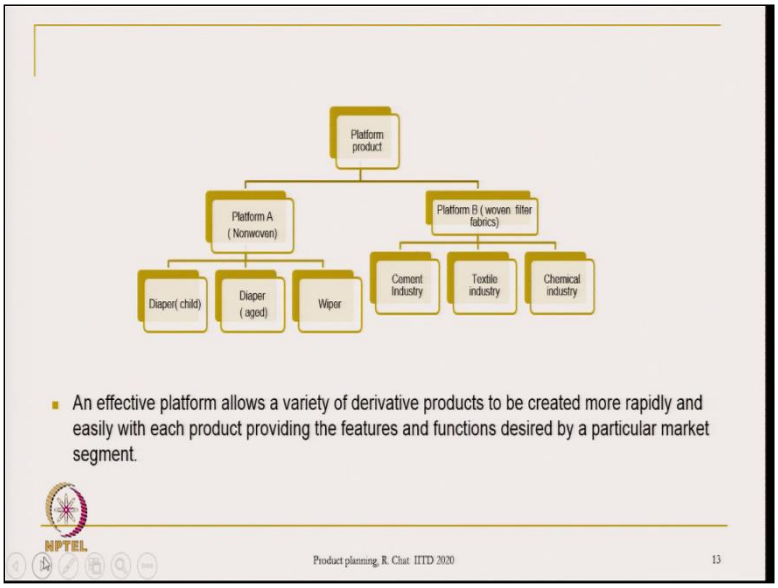

Another example is a non-woven product platform. If we have a platform based on non-woven materials, we can utilize it to create a variety of products. For example, non-woven fabrics can be used to manufacture items such as diapers for infants or cleaning wipes. So, if a non-woven product platform is available, various products can be made from non-woven materials. Another example is the open-filter fabrics platform. If we have a filter fabric manufacturing unit, we ultimately make some open filter fabrics that can be used for cement, textile, chemical, and other industries. The same platform is used to serve different types of industries. So, these are the creation of derivative products.

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The other type of product development project could be incremental improvements to the existing products. Every organization produces some products. For example, a spinning mill specializes in producing yarn, and yarn is the product. Similarly, fabric is the product of the weaving unit. For the garment manufacturing unit, the final garment is the product. Every industry creates products which serve as raw materials for other industries. But whatever it produces becomes its primary product. Incremental improvement refers to the improvement in terms of its functions or performance in the existing products. The aim is to add or modify some features in the existing products.

To keep the product lines current and competitive, improvement in design can be made in a socks manufacturing unit by having anti-microbial socks. If there is a growing demand for anti-microbial socks, consider purchasing antimicrobial yarn to produce these socks or applying an antimicrobial treatment to the socks before packaging them. Then, it could be a slight improvement in the existing design. It could be similar to an anti-static carpet or frame retardant mosquito net. The person who manufactures mosquito nets can add a feature that they are also flame retardant. So this type of development activity is called incremental improvement to existing products.

Another type of product development process could be fundamentally new product design. It is a radically different product involving risk, and the market is also unfamiliar because it did not exist earlier and is a completely new product. Mobile phones and computers are typical examples because they were not available earlier. When the mobile phone was first

conceived, the market for it was entirely unknown. They weren't sure who would buy such a device or whether it would even have a market at all. So, there is a lot of risk involved. The market is also unknown, and the design aspect of such a product is highly scientific. This product can be developed only when new knowledge is generated.

When such products appear in the market, they become known as fundamentally new products. There are a few examples in textiles, like the development of an artificial artery using textiles, which is a fundamentally new product. So, we can say the entire product development can be categorized into these four different categories.

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Existing products are already available in the market. So, why should we put money, employer, designer, and pay him and think of designing something new? So, what are the reasons for new product design? The market pull is one of the reasons, i.e., the market is actively looking for something new or improved product, and the identification of customer needs from fashion, legislation, or seasonal factors. As fashion changes, there will be demand for new products. Therefore, if an organization is there, it can feel the pulse of the people. They are trying to understand that fashion is going to change. People are going to buy something new, something that looks different, and that could be an opportunity for designing a new or a different product.

Legislation can significantly influence new product design. For example, if a government passes a regulation requiring all curtains used in hospitals to be flame-retardant, there will

be an increased demand for flame-retardant curtains. So, all the existing curtains that are not flame-retardant will be removed and replaced by new ones. Similarly, if regulations are made mandatory that all seat covers in trains must be flame retardant, there will also be an increased demand for these products. This process, driven by legislative changes, is known as market pull, which demands the design and development of new products.

Another reason for the design of new products is technology push. This occurs when new technical potentials or research findings create opportunities for innovative products. For instance, when compact spinning technology was introduced and commercially successful, it led to the development of compact-spun yarns for use in shirting fabrics. Technology-push products appeared in the market because of the change in the production technology of yarn making. The other thing is situation opportunity, which is exploiting new manufacturing methods. For example, if a new method for fabric production or finishing becomes available, it can lead to the development of new textiles or improvements in existing products.

The other is the direct request. Big organizations such as Defence or Big Buying Houses, Marks and Spencer, Ford, Gap, Nike, etc., may request specific features or products. Based on the request, designers think of designing something new. With this, we will conclude this lecture.