Textile Product Design and Development

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Lecture - 05
Concept Generation

So, we are now going to discuss concept generation.

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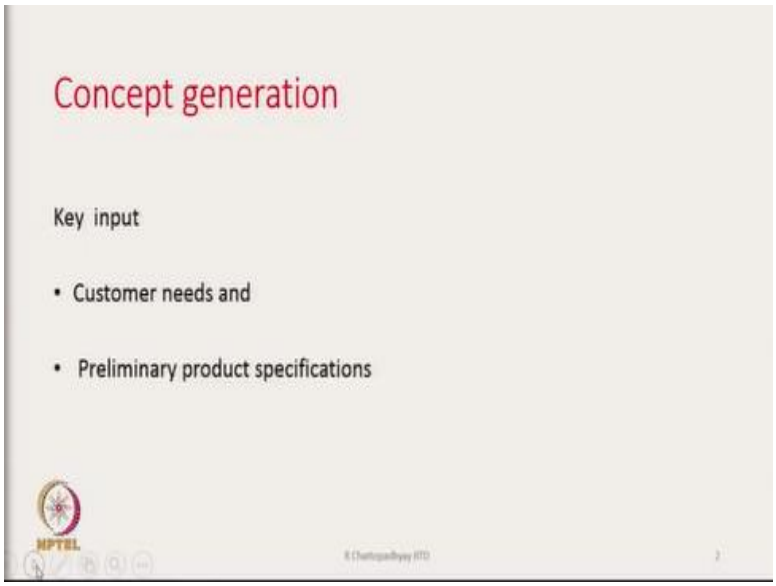

The two key inputs for generating a new concept are customer needs and preliminary product specification, i.e., a broad specification of the product is required, as well as the needs of the customers. Unless these two inputs are with us, we cannot give a concept for improving an existing product or some innovative product that is very unconventional or a completely new type of solution.

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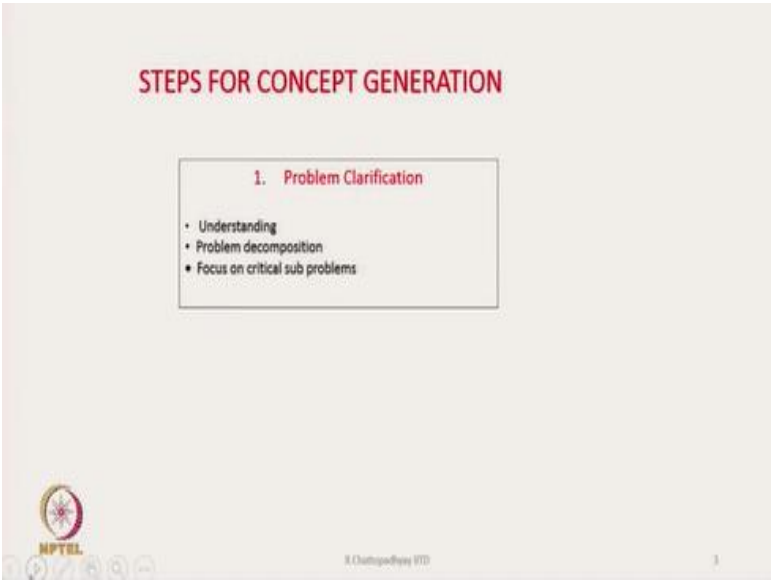

There are various steps involved in the concept generation process. The very first step is problem clarification, and within the problem clarification, we must have a very good understanding of the problem. A very clear-cut understanding is required, unlike a fuzzy understanding, which does not help. We should be very clear about what we want to design or what design improvement is required. The next part is problem decomposition, i.e., decomposing a bigger problem into smaller ones, followed by a focus on critical sub-problems.

So, first of all, understanding the problem for which we are looking for a design solution is essential. Then, if the problem is big in nature, we have to decompose the problem and find out what the sub-problems are within it and then only we can think of focusing on those critical subproblems which are most important for the overall performance of the product or an improvement, any aspects of the performance of the product.

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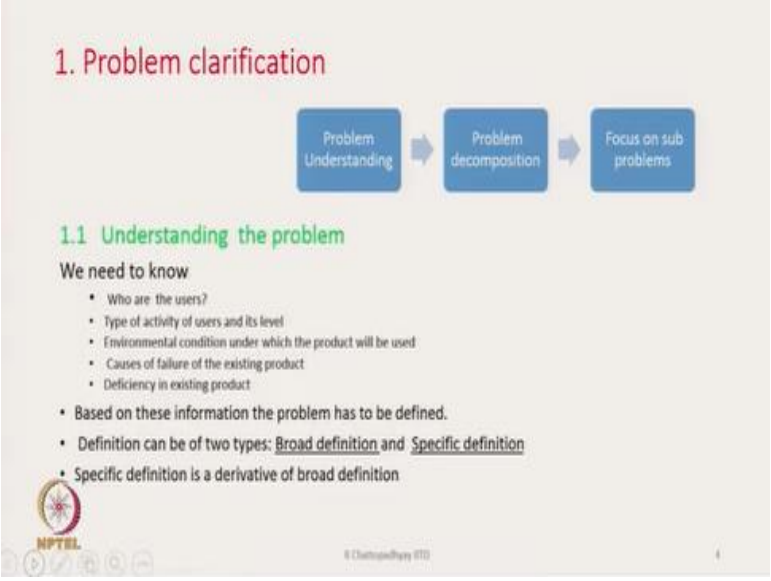

The problem clarification means a clear-cut understanding. These steps involved in problem clarification are also depicted at the top of the slide. So, understanding the problem is very important. What do we need to know by this understanding? The first one is who the users are. For any product we develop, there must always be some users. So, we have to know who those users are, i.e., Are the users working in a mine? or are the users are firefighters? or the users are working in a factory? So, what type of work are the users going to do, i.e., what type of activity are they going to do? So, what sort of activities are involved? i.e., the mapping of the working environment is important. Are they male or female? Are they working at the level operator? or what the age profile of those users could be? Are they young people, or are they middle-aged or old people?

So, we need to know all these aspects about the users. The next step must be to understand the type of activity of users. So, what sort of activities they are involved in must be known. As stated earlier, the environmental condition, i.e., the working conditions under which the product is going to be used. So, what is the nature of the working environment that we also need to know, i.e., whether they are working in an environment where there is too much humidity or a dusty environment? or is it an environment where a lot of heat is there? or too cold a temperature could be there. So, the working environmental conditions like temperature, humidity, weather, and wind speed must be known. Is it an environment that is outside in the field, in the mountains, or near the sea? So, we also have to clearly note all these aspects.

Then, what are the deficiencies in the existing product? We should also make a list of any existing product; it may be a product made by company ‘A’, company ‘B’, or company ‘C’; we try to analyse and note down the deficiencies and shortcomings in these products. For that, we have to do some research; either we do in-house research or we have to take customer feedback, which is why it is important the customer needs we need to know. So, customers can also spell out some of the deficiencies in the product that they are using. So, all of these are very important, and we need to have complete information about these aspects.

Based on the collected information, the problem must be defined. There must be a written documentary about what exactly we want to improve in the existing design that should be clearly spelled out so that there is a later stage and there is no confusion in the mind. When the problem is defined, we can have a broad definition and also some specific definitions. So, a general definition is about the problem and under that general or broad definition. We can have some specific definitions that spell out exactly what needs to be improved and what needs to be redesigned, and that is why the definition is split into two parts: a broad one and some specific definitions. So, in a way, the specific definition can also be said to be derivative of a basically broad definition.

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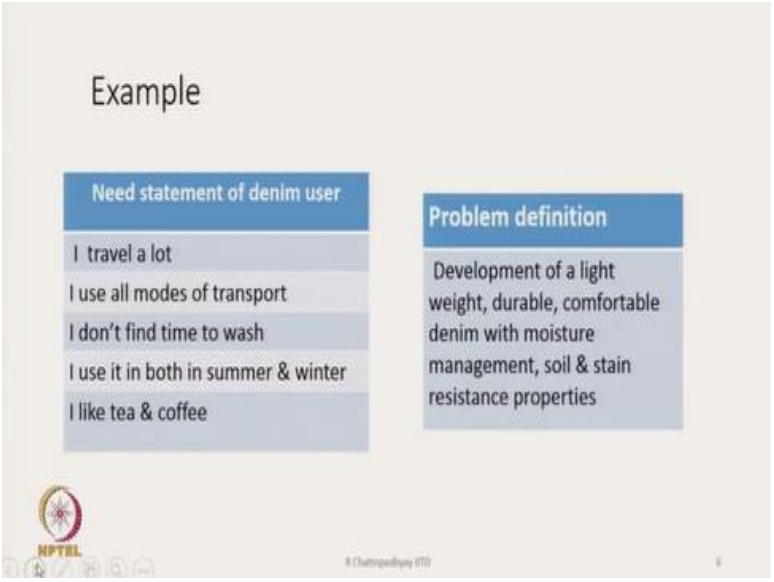

An example of the needs of the denim user is given. The need statement of a denim user is: ‘I travel a lot’, ‘I use all modes of transport’, ‘I don’t find time to wash’; as he travels a lot and moves from one city to another city very frequently, ‘I use it in both summer and winter’ and ‘I like tea and coffee a lot’; because he travels and he loves to drink tea and coffee. He meets his clients, so most of the time, tea and coffee are offered. He is burned up or may be compelled to take it because he is serving some clients or customers. So, these are the need statements of a person who is a denim user.

From this need statement, we can write down the definition of the problem. So, what do we write? If we translate the need statement into a problem definition, then we can write ‘Development of a lightweight, durable, comfortable denim with moisture management, soil and stain resistance properties’. So, we can easily associate the definition with the need statements made by the denim user because he has been using denim for a long time. So, it is better to have a lightweight denim that feels comfortable, not heavy. Because of his extensive use of denim, the durability of the denim fabric is also very important. As a customer, there are certain expectations about the life of any product. It must be a comfortable one. So, being lightweight makes denim comfortable.

We can also think of how to make it more comfortable. So, may be with moisture management property is one aspect which can be looked into. Soil and stain resistance because he loves tea and coffee that can be spilt over on the pants or trousers. Therefore, it is better to have his soil and stain resistance. At the same time, because he does not find time to wash, stain resistance and soil resistant properties are desirable in such kind of product. So, in this manner, from the need statement, one can define the problem, and then we can classify the general problem definition into sub-problems also.

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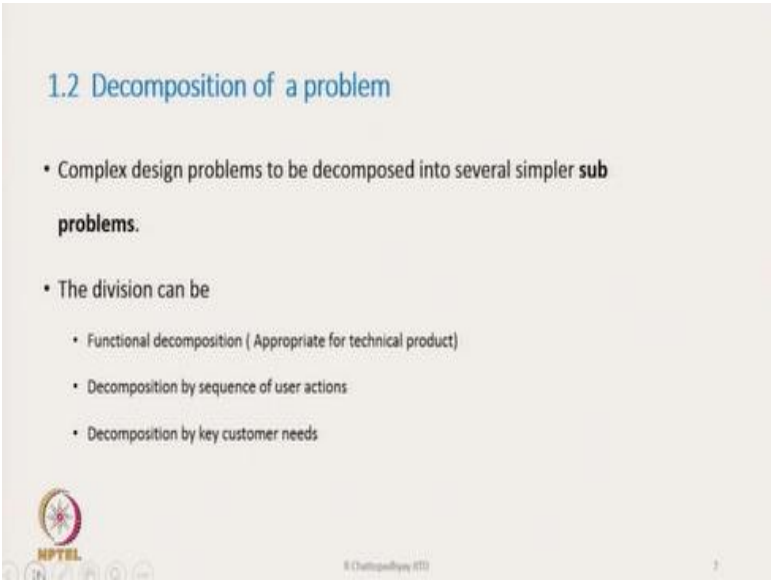

Decomposition of a problem: Some of the problems are so complex in nature that the problems are so big. So, we need to go for the decomposition of the problem. So, complex design problems are to be decomposed into several simpler subproblems. How do we divide it, and on what basis? One is functional decompositions which is very important for technical products. Function-wise, we can decompose the general problem into a number of subproblems. The next is decomposition by sequence of user action, and the last is decomposition by key customer needs. So, we decompose a big task into multiple small tasks.

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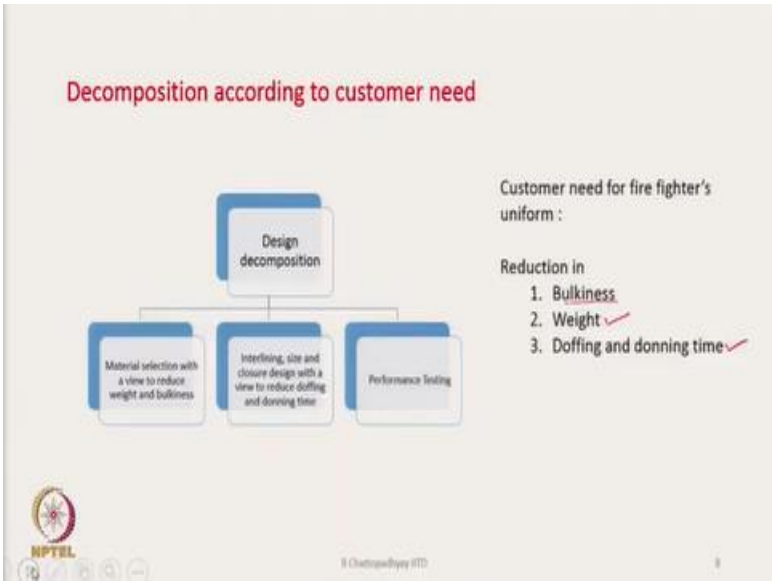

Decomposition according to customer need: For example, a customer's need for a firefighter's uniform is discussed in this slide. So, after conducting a survey of the existing uniforms that are used by the firefighters, it is concluded that the firefighters are looking for a reduction in the bulkiness of the uniform because that may be a hindrance to their activities. So, bulkiness needs to be reduced to produce the trim-type garment or uniform. Next is the reduction in weight, i.e., the uniform is probably too heavy for the users. The third requirement is a reduction in doffing and donning time, which is important for firefighters. They are looking for a uniform where doffing and donning time can be reduced so that they can quickly put on the uniform and then rush for the rescue operation wherever there is a fire.

The decomposition of this design problem could be a material selection with a view to reducing weight and bulkiness because weight and bulkiness reduction is one need. So, how do we reduce the bulkiness and the weight? The proper selection of raw materials, which could be fibre, filament, yarn, or fabric, could be one aspect. The other is interlining size and closer designs with a view to reducing doffing and donning time. So, doffing and donning time also could be in terms of interlining which is being used; interlining should be such that there is little friction so that one can put it on very fast and remove it very fast.

Size is also very significant; if it is too tight, pushing the limbs through the uniform will be difficult, and it will take more time. So, this is one thing. The other aspect could be performance testing because once the product is ready with improved design, the next job could be how we can test the performance of this particular product. So, this is how we can decompose a design problem into different sub-design problems.

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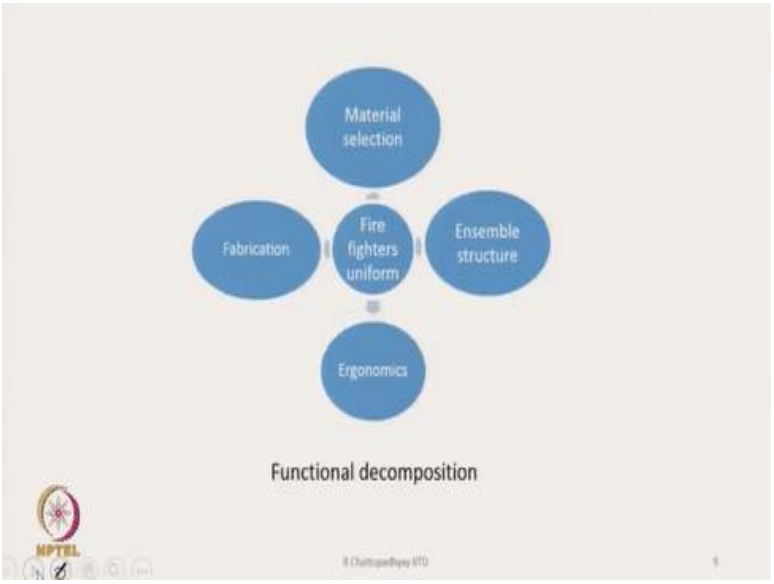

Another aspect of the functional decomposition of a firefighter's uniform is discussed in this slide. The functional decompositions are the material selection, ensemble structure, fabrication, and ergonomics of the design. So, the overall structure of the ensemble is so that the person is protected from extreme radiation heat or maybe from flames. The ergonomics of the design could be an important aspect so that the person should not feel too hot or uncomfortable, i.e., fit, size, and closures; these are all related to ergonomics. How much physiological load acts on the person and how much freedom the person has while trying to work when he is putting on the uniform is also an ergonomic aspect. The other aspect is fabrication. The fabricating procedure includes the thread to be used, the type of sewing machines to be used, the type of seam to be used, and the method of joining different layers; all these are part of fabrication.

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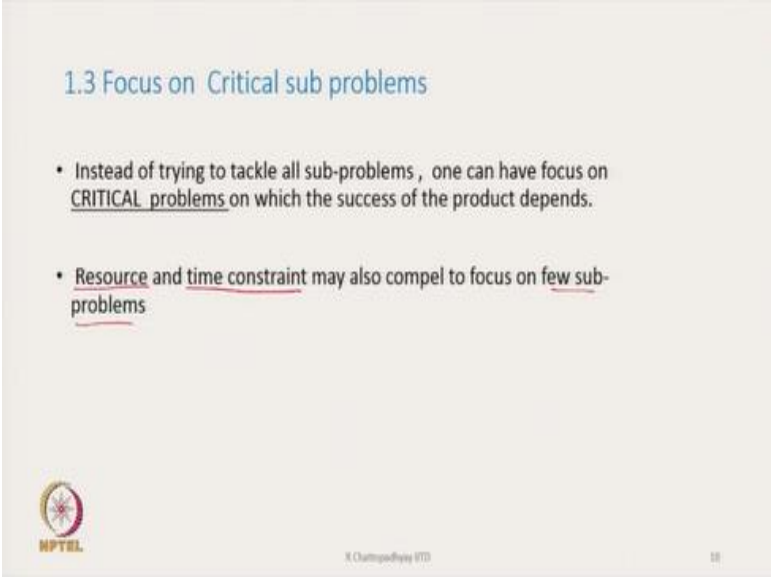

Focus on critical sub-problems; if too many subproblems exist, we should only focus on those critical sub-problems. What are critical problems? The problems on which the product's success depends are critical sub-problems, i.e., anything that influences the major performance characteristics of the product. For example, the most important criterion for a firefighter suit requires protection from heat. So, anything related to protection from heat will be a critical issue for firefighter clothing. So, the problem has to be given more importance than other minor problems. The other considerations are resource and time constraints, which may also compel us to focus on a few sub-problems.

So, based on the customer needs, if we find out there are too many sub-problems to be solved, then instead of tackling all the sub-problems, we try to tackle maybe half of them, which are most critical in nature. Why are we doing it? Because there may be constraints on time and resources. Therefore, we must bring down the major problems into critical sub-problems.

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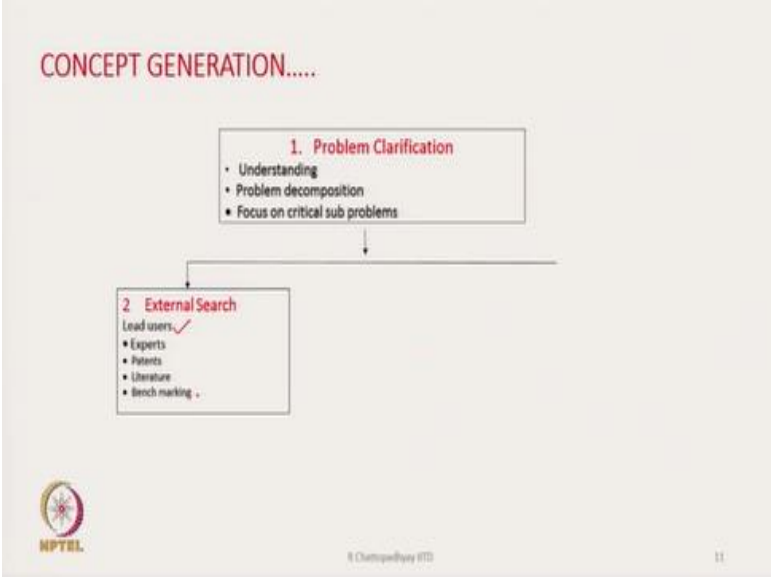

The next step in concept generation is searching for solutions. One is an external search, and the other is an internal one. So, in an external search, we must approach the following people or aspects: One is that we can go to the lead users and talk to them. We can consult experts in that field and go through the patent information. We can find the relevant literature by consulting different journals, magazines, and reports and benchmarking information.

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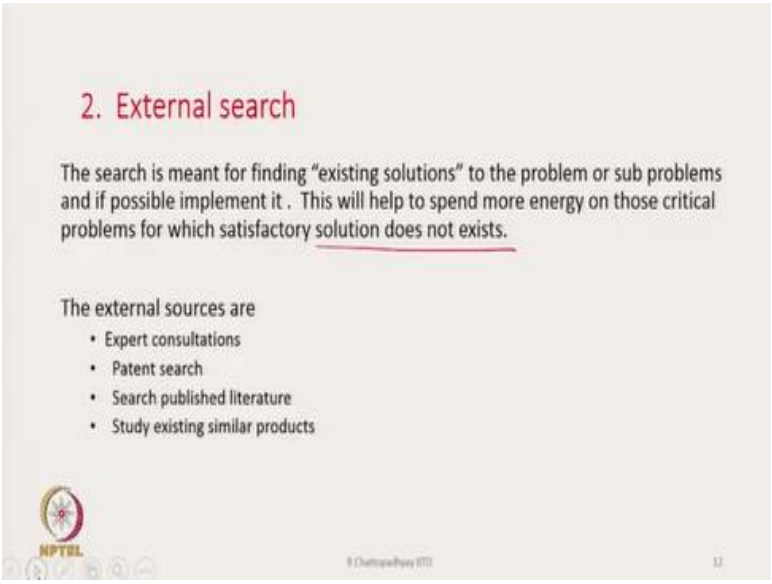

External search means searching for any existing solutions. So, if the solution already exists, we try implementing them first, which helps to spend more energy on those critical problems that do

not have solutions. The other external source is the consultation of experts, patents, literature, or information from different journals to solve the existing problems. We may also study the competitor's product with respect to that particular problem and study their solutions. The reason is if a solution already exists, then we implement it. If the solution does not exist for a problem, we can concentrate more time and energy on those issues. So, these are the various sources of information gathered from external searches.

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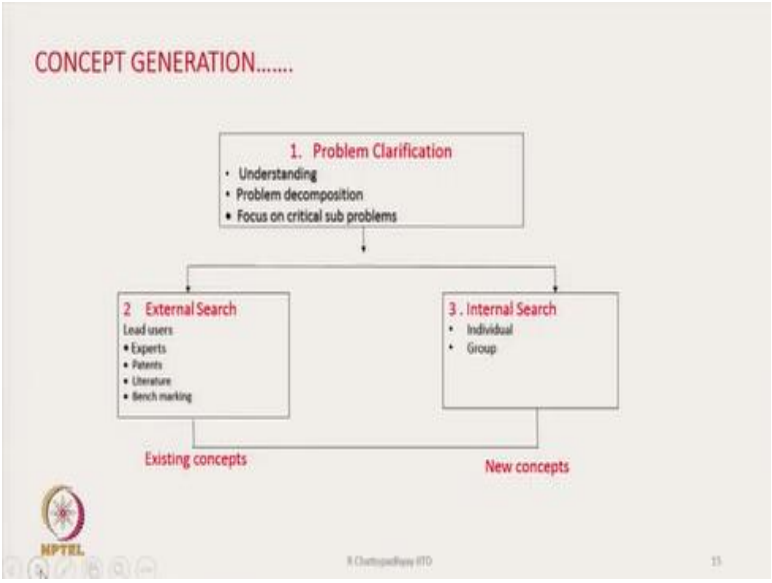

An internal search is carried out within the organization to find the solutions. We try to consult the people who work in the organization, in the production area, marketing, or design team. if we have some members, we ask each member to propose certain solutions.

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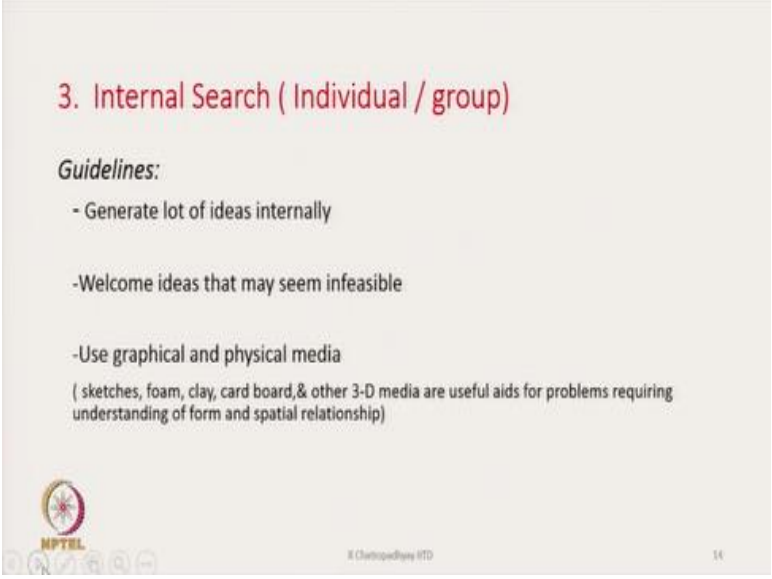

The internal search involves the people in the same organization to generate ideas. So, in the design team, many people work together in the development area, and we request that each one of them come up with an idea. So, each participant in this design exercise is involved in finding the solution to the design problem. We encourage people to develop a lot of ideas, and there is no hierarchy; everybody in the design team will be asked to develop an idea, and all ideas will be welcome, even if it seems infeasible. Therefore, idea generation ultimately aims to encourage people to generate ideas, and we should always not bother with whether the idea is feasible to start with or not.

Use graphical and physical media: to translate the idea, people can write in text form or use graphics. One can also make a physical model, like sketches, foam, clay, cardboard, or any other 3D media, computer graphics, or software, where we can have a 3D design. The graphics can be used to communicate with the other team members; in this way, we should try to develop the solution ideas within the organizations. The important point is that many ideas can also be generated internally. Some people may not be on the design team or outside the design team, but they can also give some very interesting input.

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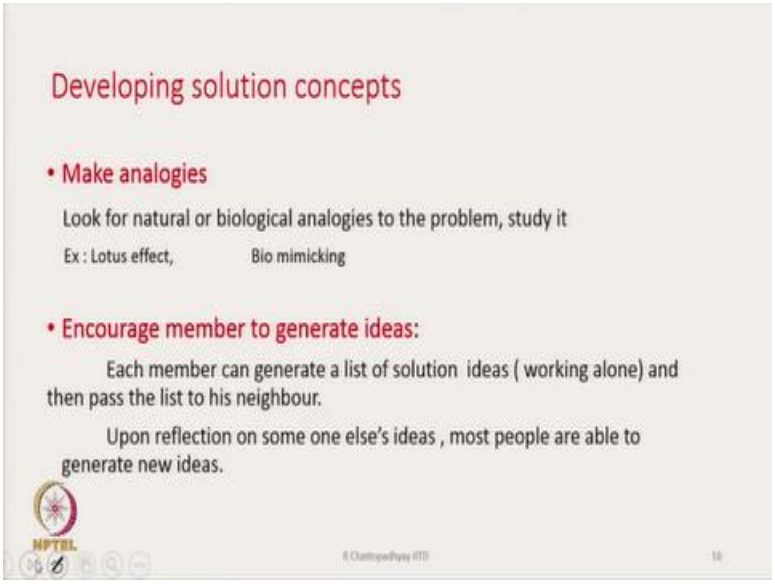

Develop solution concepts: While trying to develop solution concepts, we can use natural or biological analogies to solve the problem. When no idea comes to mind, then we may depend upon nature. So, we try to find out whether a similar analogy exists in nature or not. If there is some analogy, we try to study it, get information, and further analyse it to generate ideas. One of them is the lotus effect, where there is no dirt on them. Whenever water falls on it, it will easily roll down as it is a highly hydrophobic surface. So, as the water rolls down, it will take out the dust along with it.

We can go for bio mimicking, i.e., whatever solution nature has given to certain problems, we study it and try to mimic it in our design or give solutions to a design problem. It is very common to study nature to find solutions in many fields. In textiles also, there are many examples. The other thing is to encourage members to generate ideas. Each member can generate a list of solutions or ideas by working alone, which means the person should not be influenced by his boss. Every individual can be given complete freedom to think about a solution, and the solution can be passed on to his neighbour or to his colleague. Similarly, the colleague can pass on his solution to the other person which means everybody gives a solution, and they themselves are scrutinizing the solution.

Because they share solutions with each other, and upon reflection on someone else's ideas, most people are able to generate new ideas. Sometimes, people may say they don't have any idea; there is nothing in my mind. But then, when someone proposes an idea in a group type of activity, one person in the group proposes a solution idea. As a result, the other members start thinking based on the ideas given by their colleagues. So, a person who was passive till now has also started giving solutions. So, when someone says something or gives some idea, something triggers the mind, and anyone can give some other argument, or sometimes one can also develop another idea. So, the triggering effect is there when someone starts with an idea.

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Velcro development: Velcro is a pure textile product with many applications. The invention story of Velcro is described in the slide. In the early 1940s, Georze de Mestal, a Swiss inventor, went for a walk in the forest with his dog. Upon returning home, he noticed that the dog's coat and trousers were covered in cockleburs. His inventor's curiosity led him to study the burs under a microscope, where he discovered the hooked ends of the bristles that stick out from the seeds. So, he found that the hooked end of the bristles, which is the basis for a zip, later developed into two-sided fasteners. So, because it is hook type, it was getting entangled to the fur of the dog or the pants. In our pants, there are also a lot of projecting fibres called hairy surfaces.

So, it was attached, and the mechanism of attachment was bristles had a hooked end. So, what did he do? Because immediately from here, he got the idea. So, one side has a stiff hook like the burs, and the other side has loops; he developed two fabrics: one side of the fabric had stiff hooks like burs, and the other one has loops. So, when the hooks and loops are brought closer to each other, there is an entanglement once they mesh. The hooks get entangled with the loops present on the other surface, as shown in the diagram, and as a result, they stick to each other. So, the idea came from the nature. Velcro is a very interesting example. Similarly, there are many more examples.

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Another interesting example of the design is hiking socks. Jim Throneburg, the chairman of Thorlo Incorporation, was suffering from being overweight and having trouble with the exercise routine. He recognized that the problem was caused by his feet which hurt from walking and jogging. So, he wanted to find a solution. So, he and the design engineer developed a new kind of extra cushiony socks that had padding placed to absorb shock and prevent friction. So, whenever we work, the heel part comes into contact, and there is always an impact at the heel portion.

If we want to reduce the intensity of the impact, we can have padding at the heel portion. The sock became very useful, and he called it hiking socks. The hiking socks have become very popular as they are comfortable and breathable, have added protection against blistering and abrasion, have a

firm fit, and have reinforced heels. So, in this way, when a need arises, a person starts thinking, and after thinking, he tries to find the solution, which leads to developing a new product.

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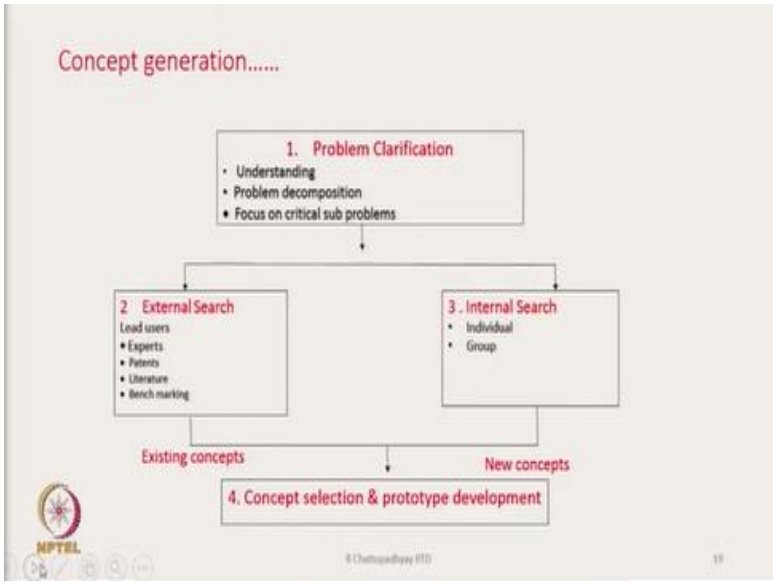

The last step is concept selection.

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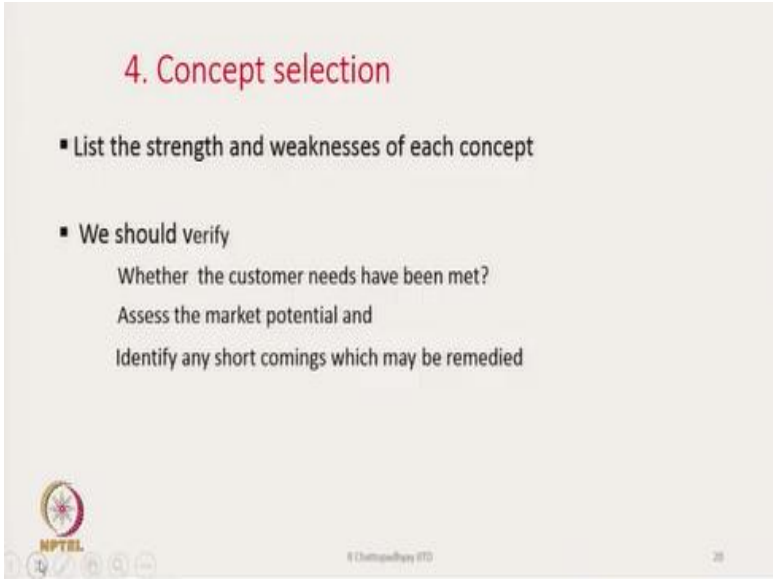

So, we should select concepts from the developed concepts, solution procedures, or solution concepts. So, what to do? List the strengths and weaknesses of each concept. So, if there are a couple of concepts generated by different people, then people should sit together and try to list the

strengths and weaknesses of each concept. We should verify whether the customer needs have been met or not. So, each concept is there, so we ask these questions and seek answers.

Have the customer needs been met? The second point is what is the market potential of the concept. The market potential is very important because any concept must succeed in the market. So, we may need some people from the marketing team to assess this aspect. Identify any shortcomings in the existing concepts that may need to be remedied or could lead to a better solution.

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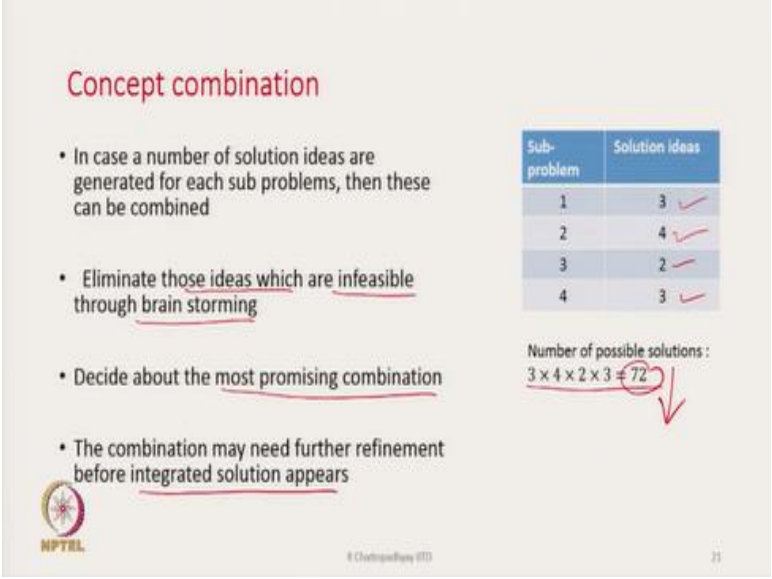

The next discussion is about the combination of concepts. Suppose for sub-problem one, there are three solution ideas; for sub-problem two, we find four ideas; for sub-problem three, there are two ideas; for sub-problem four, there are three ideas. So, there are 72 possible solutions that are not really feasible. So, we can combine the concepts or ideas generated by different people to reduce the possibility of combining them. Eliminate the ideas that may not be practicable. Therefore, we first eliminate infeasible ideas through a brainstorming session. Through brainstorming, we can reduce the sub-problem ideas.

We can trim down the number of solution ideas. Some of the solution ideas may be infeasible because of technology constraints, material availability, or any other reason. So, we may choose 3 or 4 promising combinations. The combination may need further refinement before an integrated

solution appears. It is also possible that even after the combination, the compatibility of the solution ideas for different sub-problems, and then maybe we can further define it before we find an integrated solution. So, once we reach a few solution ideas, we go for prototype development.

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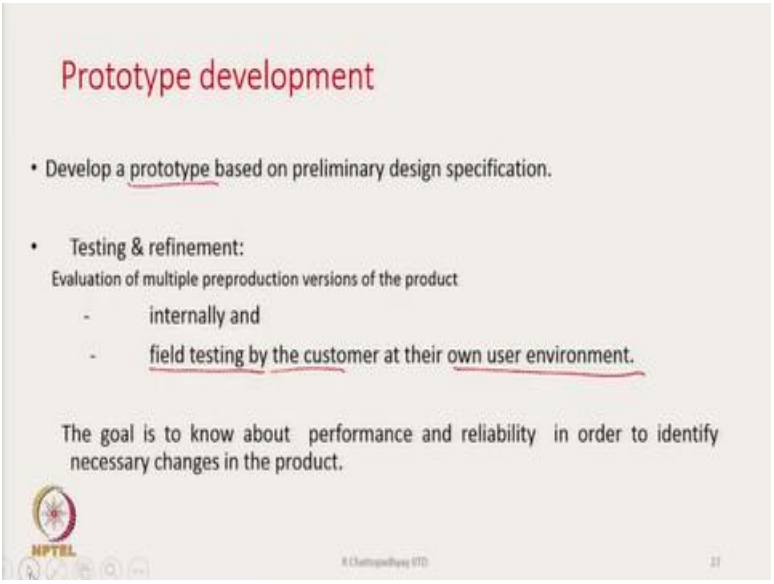

We develop a prototype based on the preliminary design specifications. We have to finally meet the specifications so that, based on the specification, we have to develop a prototype. Once the prototype is developed, we go for testing and refinement, i.e., test it in-house in our own laboratory, or if some test facility does not exist, we may seek outside help. So, evaluation has to be done, and then if there is a requirement for refining either the specification or the design, suitable modifications could be done. Finally, we go for actual field testing by the customer in their own user environment after making prototypes with refinement. So, once we succeed at the laboratory level, then we approach customers to use it. Testing in the own user environment is called field testing.

The goal is to understand the performance and reliability to identify necessary changes in the product, which means we have still not frozen the design idea or the specifications. So, after the field trial, if we find there is a need for further refinement due to the failure of the prototype, or if it does not perform to the expected level, we may need to redesign. So, redesign means either idea refinement, material changes, specification modification, fabrication procedure, or whatever it is.

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Once the field-testing data is available to us, we modify the design aspects if required in the material or fabrication process. So, we get different performance parameters through various prototypes and finalize the product specifications. So, target specifications set earlier are revisited after a concept has been selected and tested. The team must set specific values reflecting the constraint inherent in the product concept.

Limitations identified through technical modelling and trade-offs between cost and performance which also very important. If there is some constraint in the product concept, the team sets the specific values of achievable performance with the product with respect to the corresponding cost. After the development plan, the team develops a detailed development schedule and identifies the resources required to complete the project. After that, the development plan, complete plan of manufacturing, selling, etc., begins.

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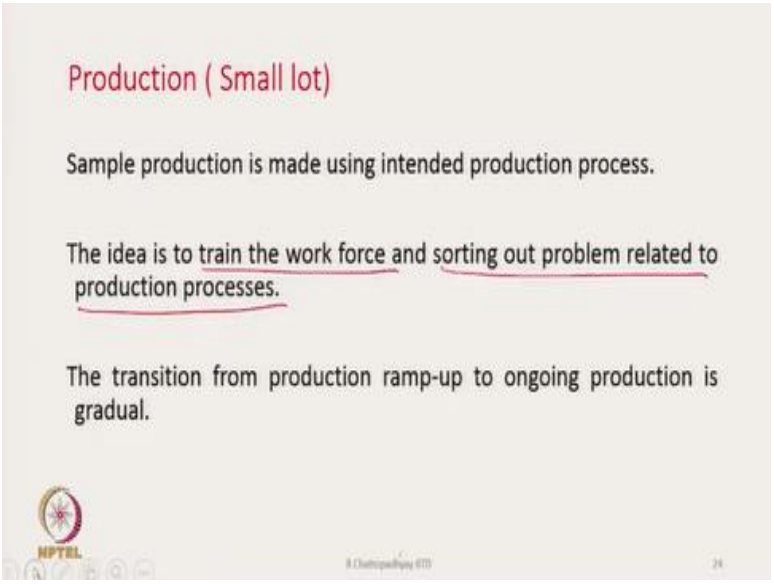

Production of a small lot: A small lot is produced initially. The sample production is made using the intended production process. Why do we produce a small lot to start with? Because the idea is to train the workforce and sort out problems related to the production process. The other consideration is production-related problems or process-related problems that may arise during a raw material change. Therefore, we need to finetune the process again; for this reason, we initially go for a small lot of production. The transition from production ramp-up to ongoing production is gradual. After sorting out the process and product-related problems, the workforce training; the large-scale production can be started. With this, we close this particular session. Thank you.