Introduction to Biomimicry
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Lecture - 14
From Problem-to-solution – Using the Biomimicry Design Spiral

This session is a follow-up of the approach that you learned, right? In the approach what did you learn? You learned to go from problem to solution. Now it is not enough if we simply tell you to go from problem to solution. We should also demonstrate that problem-to-solution actually works, right? This is why we have for you, a student project.

A student who took up the challenge, and you will see how she has gone from problem to solution using a very disciplined process, using the spiral that you learned in the first week, right? So, I am going to show you the live example of a student who went from problem to solution. Let me introduce her to you.

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Her name is Mugdha. Mugdha is from the department of biotechnology at IIT Madras. Mugdha could not be in Madras to make this presentation. And she very graciously told me to make this on her behalf. So let us see what Mugdha has done. The only request is when I am talking about Mugdha's project, try and find out if you can follow the process along with her.

Because when Mugdha started her work, we had about 13 weeks of the course. She started her work around the third week. And by the 12th week, she has come out with a brilliant solution. The only request is not to judge the solution itself because that is not the point of showing you this project. The point of showing you this project is to help you go through the process step by step in a disciplined manner.

So now because the approach is problem-to-solution, what is therefore natural? The first thing you have to do is to choose a goal.

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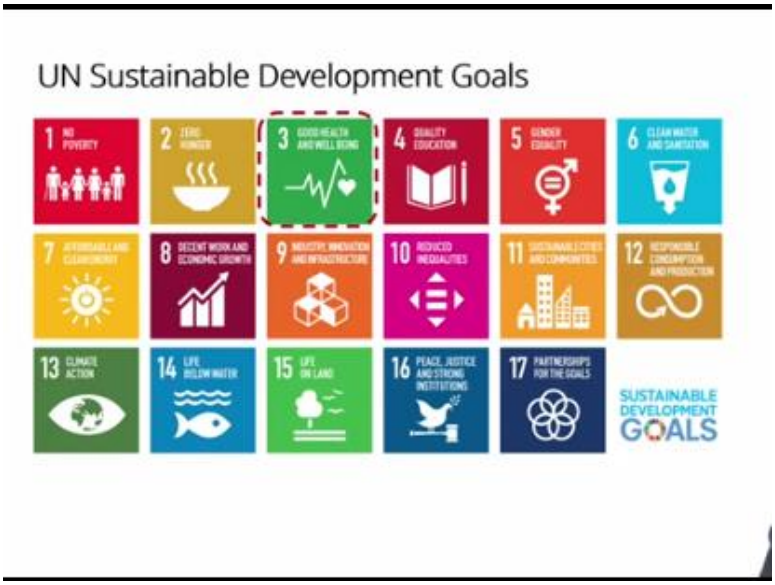

Among the 17 goals, she has chosen goal number 3- good health and well-being. Now, what is the logic in choosing the goal? Because I do not know how many times I have repeated this to you ad nauseam, but it does not matter. Creativity cannot happen without a problem to solve. And the United Nations Sustainable Development Goals are a gift of problems, readymade problems.

Otherwise, can you imagine the amount of trouble you will have in looking for a problem. Here you are saved the trouble. And she is saying I want to talk about good health and well-being. Why? Because she is emotionally attached to it.

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The emotional attachment to good health and well-being is important. That is what we learned, right? It is always good to find out what among the 17 goals am I emotionally attached to. And then in that what is the next step? She has to look for information on the goal. And this is available on the UN SDG website. She looks at the targets that she selected.

She also looks at the indicators. I am not going to get into all this because I am hoping that you will read this at leisure. You will read this in detail. But I am only explaining the process to you, right? So, Mugdha has chosen good health and well-being, these are the targets, these are the indicators.

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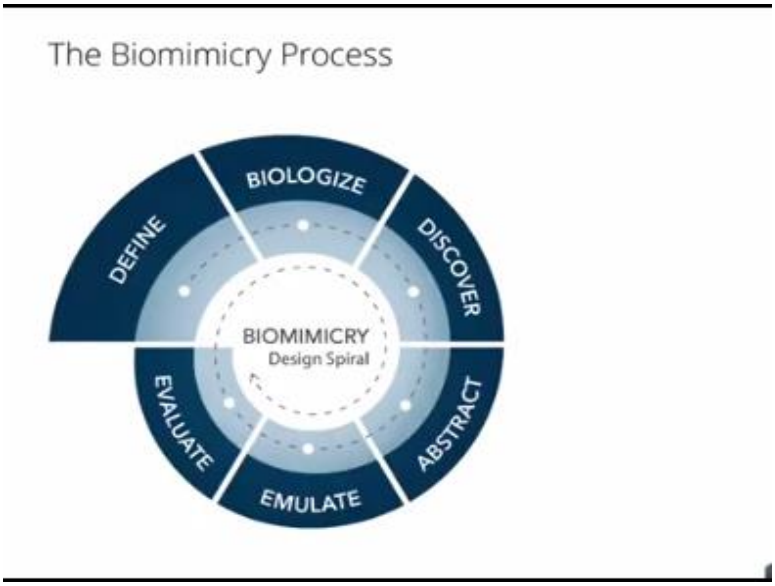

And she goes through the process. What does the process say? It says define, biologize, discover, abstract, emulate, and evaluate. These are the steps she must go through. Let us find out what she does.

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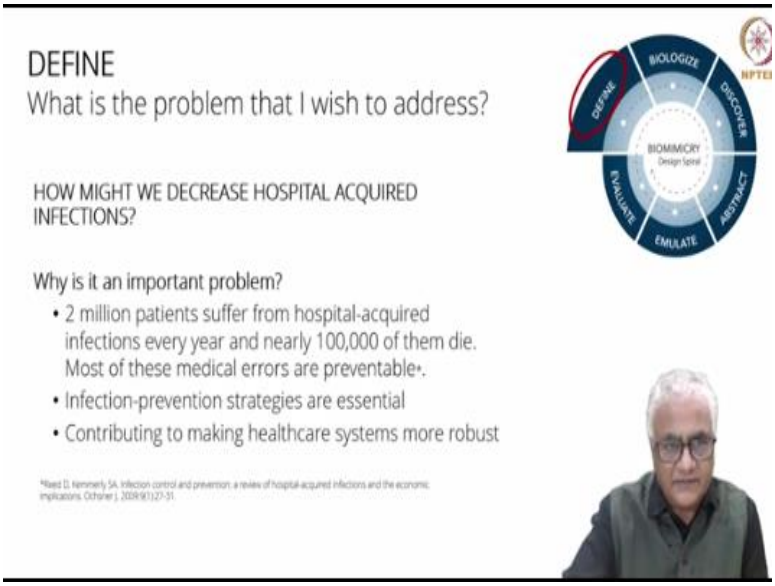

She does define. So, what is she doing? She is defining the problem in good health and well-being which is a large umbrella, in that she is picking up a problem. So, she is asking what is the problem I wish to address. And she has very brilliantly come upon a problem statement, which is how might we decrease hospital-acquired infections. Now, remember, you cannot solve the entire good health and well-being problem.

What you look for is a small problem hiding in that big problem. The small problem that she wants to solve is how might we decrease hospital-acquired infections. And then she has told us why it is important. It is important because you know lots and lots of people die and suffer from hospital-acquired infections which is something that is affecting her and she wants to solve it.

You would also notice at the bottom she has picked up some information from a very reliable source, which is a good practice, pick up as much information on the problem as possible before you try to solve it. So the ‘define’ that she wants to do is how might we decrease hospital-acquired infections, that is the ‘define’.

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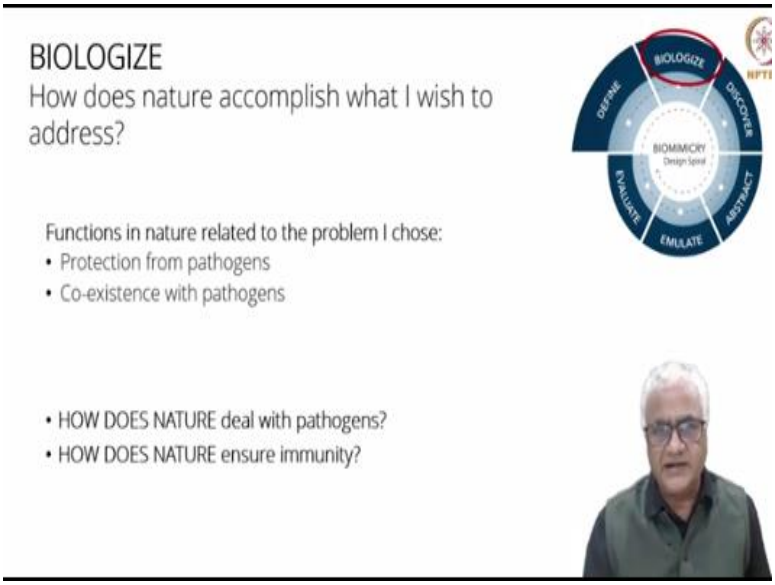

Now comes the, you know I always get excited when I talk about 'biologize' because it takes you to a completely different level, right? You talk about a completely different perspective. Now normally, when I say how might we prevent hospital-acquired infections, what will you do? You will either look for research or infections or you will find out how other people have solved it and everything because you are trying to go towards a solution.

Here you are learning that you have to ask, how does nature accomplish what I want to address? How does nature do what I want to do? And therefore then of course, the technical aspect of defining a problem, what are the functions in nature related to the problem. The function is protection from pathogens and coexistence with pathogens because that relates to hospital-acquired infections that is what.

So, therefore, what you really do is say, what are the functions that nature wants to accomplish? Are those functions similar to the function that I want to accomplish? There is a similarity in protection from pathogens and coexisting with pathogens, right? So, once you have identified that function, you actually define, you biologize the problem by saying how does nature deal with pathogens?

How does nature ensure immunity? Now how does nature do something is the biggest differentiator in the way biomimicry addresses problems.

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And then after having biologized what does she do? She does what is ‘discover’. Discover, you already have learnt in week 1, is to look for organisms that accomplish the same function, that perform the same function. In this case, she has looked at two organisms, the cicada and the burying beetle. Now you may ask where does she get these organisms from?

We will tell you about that. There is a beautiful website called asknature.org. Asknature.org will explain to you how to use asknature.org. There you can find all the organisms that accomplish the function that Mugdha wants to accomplish in her problem statement. So, she has chosen cicada and she has also looked at the function of a cicada which is very similar to protecting from bacterial colonization.

That means there is a connection between the cicada and the problem that she wants to solve.

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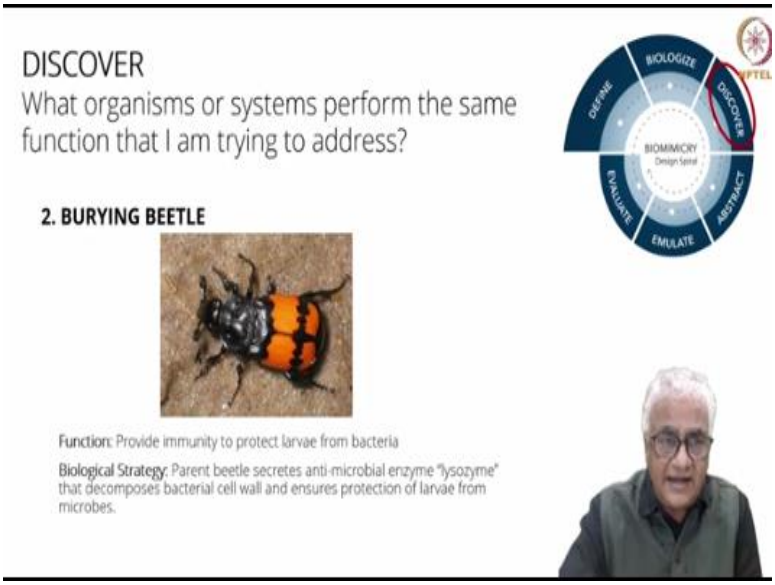

And there is a connection between the burying beetle and the problem that she wants to solve. The burying beetle, the function is to provide immunity to protect larvae from bacteria. That is what the beetle wants to accomplish. So, these are the two organisms that she wants to work with. And then now define is over, biology is over, discover is over.

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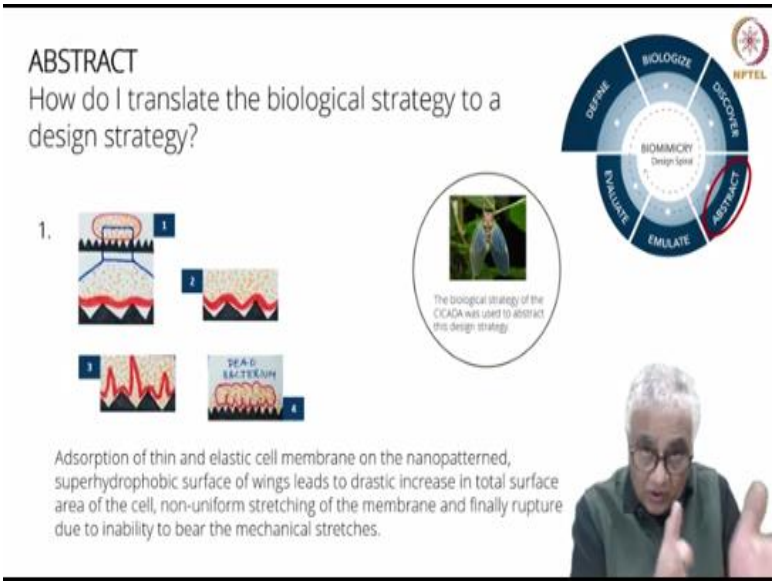

And then she goes to ‘abstract’. ‘Abstract’ is, I know that these organisms have a particular strategy, but that strategy is very lot of jargon and a lot of biology in that strategy. How do I make it simple? So therefore, how do I translate the biological strategy of the beetle to a design strategy, which means how do I make it easily understandable?

How do I remove all the jargon and make it a very simple diagrammatic representation of that strategy? So, you can see that she has drawn a diagram. And so therefore, this is how the cicada, this is the biological strategy of the cicada and then we have translated it into a design strategy. So, therefore, you will notice then the description of the strategy is very simple.

Absorption of thin and elastic cell membrane on the nanopattern, superhydrophobic surface, and all that. So, therefore, what she is doing is she is abstracting the biological strategy into a design strategy. So therefore define, biologize, discover, abstract.

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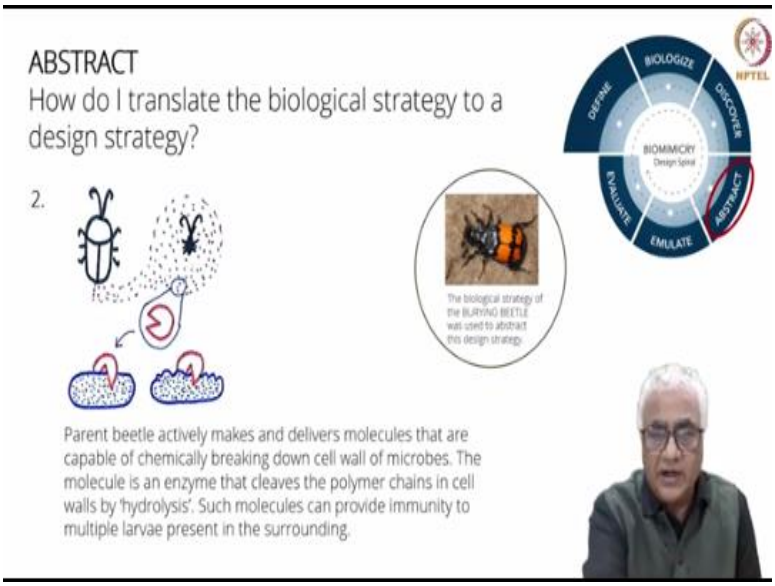

Then she goes on to abstracting the biological strategy into a design strategy of the burying beetle, same thing, right? Look at the language. It is so much easier now, right? Parent beetle actively makes and delivers molecules. So much easier to understand. But it would not have been so easier when you read the original.

And that is where the skill comes in of being able to abstract something very technical into something very simple. And then therefore define, biologize, discover, abstract. The next one is, of course, emulate.

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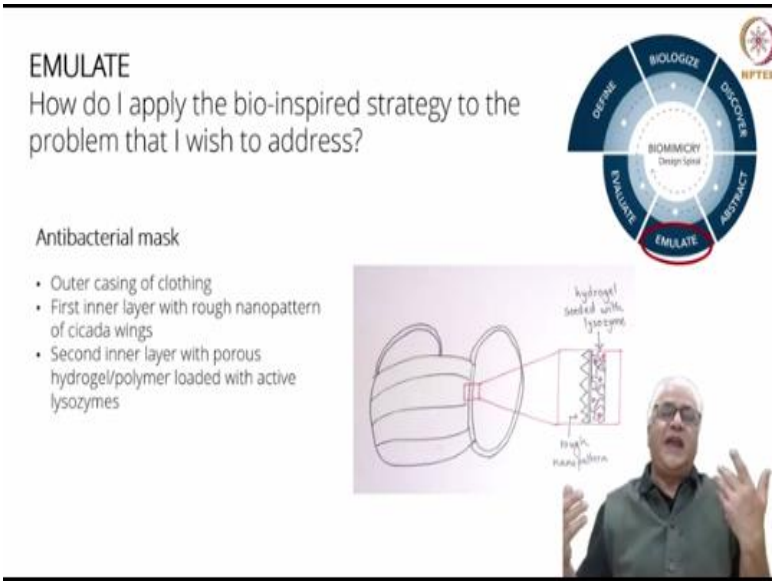

Emulate is where your individuality comes in, right? You suddenly go from the, I will not be able to explain to you the exact process of what happens between abstract and emulate. But emulate is where you use your imagination. And suddenly Mugdha has started to think about a mask, right? She says that the mask idea has a direct connection to the strategies of the cicada and the burying beetle.

And she says this is what I want to say. So, emulate is the ideation. Emulate is where you bring out your ideas. And therefore, the question that she asked is, how do I apply the bio-inspired strategy to the problem I wish to address? The problem is to reduce hospital-acquired infections. And therefore she says, if I have such a mask, it can reduce hospital-acquired infections.

So, what is special about the mask? She is using the strategy of the cicada and the burying beetle, and she is making a mask. And this is the description of the mask. So, it is an anti-bacterial mask. The outer casing of clothing. First inner layer with rough nanopattern of cicada wings. Again, a strategy adopted from cicada. Second inner layer with porous hydrogen polymer loaded with active lysozymes. This is from the burying beetle strategy.

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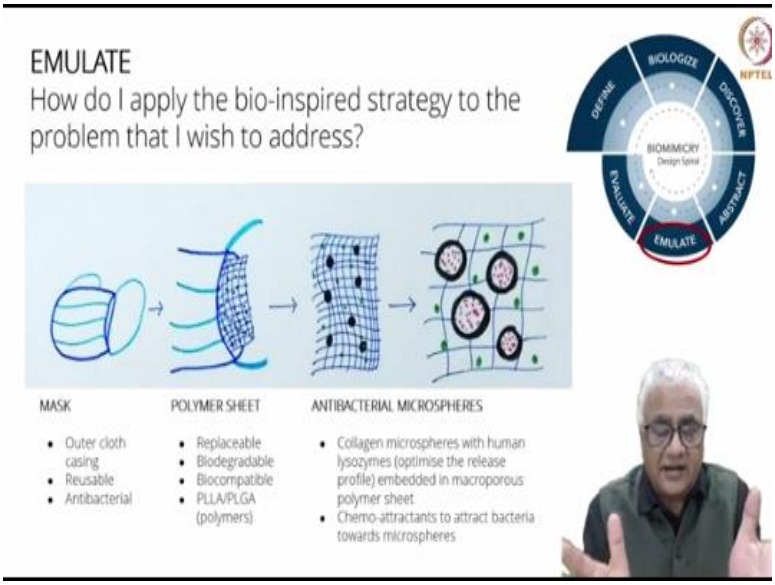

And she actually has drawn a very nice picture of the mask, right? And this is her strategy that just goes back to define. During define, Mugdha had a problem to solve. At emulate she has the solution, simply because she went through the steps in a very inspired, in very disciplined manner. And then, of course, I will come back to this. But just make a note of what is there in the mask.

It says outer cloth casing, reusable. Think about reusable, why should she say that it is an antibacterial? So, what she has got now is an idea for a mask using the biological strategy of the cicada and the burying beetle, because the problem she wants to solve is to reduce hospital-acquired infections.

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And finally, she evaluates a solution. She asks two important questions. How will I follow nature's design principle? Remember, you learned it in week 1? How will I follow nature's design principles for my solution design? So, therefore, remember I said you have to think about reusable nature. You remember nature, what do we learn in nature? Nature reuses.

Nature does not waste energy. Nature recycles everything, right? And therefore, she is very conscious that she must follow the design principles in her design. And she is also asking the question, what are the next steps to implement or deploy in her solution?

And she wants to make a prototype and make a small, at a small scale and find out if it works, do the testing and all that and then maybe produce it at large scale file an IP and all that. Therefore, what has Mugdha done? Mugdha has gone through the process in a disciplined way. She started with a problem. And she has ended up with a solution that fits in with nature's design principles.

She has also used inspiration from the natural world. She has found two organisms in the natural world that are solving the problem that she wants to solve. Is that not magical? And she is inspired by those two organisms. And she is looking at the strategy that those organisms employ to come back with a solution that she has picked up from nature.

And finally, she is actually following the design principles of nature. Is this not completely inspiring? Now every one of you listening to this, why we wanted to show you Mugdha's work and we will show you many other students' work is because we want you to be inspired. And we want you to in a way emulate Mugdha, right? Because you have the problem in front of you.

You have the 17 goals. All the goals are important, critical goals. Every one of you aspires to be something big, go back to the Ramanujan story. You are all endowed with so much intelligence. All we are asking is to use the potential that you have. And there is not even too much difficult work, right? It is just a question of falling in love with the problem, and wanting to solve that problem come what may.

As far as the solution is concerned, looking to nature for a solution, which is why biomimicry. Having the belief that nature has solved the problem that you want to solve. And then going to nature and finding out from nature, what are those organisms that have solved the problem you want to solve? Picking up the strategies of those organisms, and using those strategies to come back with an idea for your problem.

And evaluating your idea against nature's principles by which you do not harm nature anymore. Can you ask for an easier way to solve a problem? So, we are hoping that Mugdha's work and all the other students' work that will follow is going to inspire you to find solutions. Of course, you can ask what we do with these solutions.

Several things you can do. You can like what she is saying build the prototype. You can also maybe do some more research on this. You can collaborate with a company to make what you want to make. You can also file an IP if you want to. You can also give your idea to a group of entrepreneurs who can take the idea further. And there are several possibilities.

What is magical is that it is possible for every one of us when we put our mind to it, when we follow a process to go from problem to solution. So I am hoping that you are all running to the UN SDGs and looking for the problem that you want to solve.