

Introduction to Biomimicry
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Lecture – 22
Step 5 – Emulate Nature’s Strategies in Your Solution:
The Biomimicry Design Spiral

Now that you have done ‘abstract’, the next step is ‘emulate’. I know that emulate means to imitate and mimic and all that and I am not going to say it is the main part of this spiral because that would be silly to say that, it means the others are not important. But to emulate, we need to learn something else. So, what I am going to do is I am going to talk to you about this book and this book is about generating out-of-the-box ideas because ‘emulate’ and ideation go hand in hand.

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INTERSECTIONS



Adapted from THE MEDICI EFFECT by Frans Johansson



I am going to talk to you about this book called The Medici Effect by Frans Johansson and this book is about intersections. So, it is a lovely book, I am hoping that every one of you reads it. But I am just going to very quickly tell you what Johansson wants to say in the book.

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INTERSECTIONS

Peter Café Sport - Horta, Portugal



Images: <https://www.petercafesport.com/en/>

So, what is this? This is a picture of a restaurant in Horta, Portugal. It is called Peter Café Sport. Why am I showing you this picture? Because you must read Johansson on your own, it is very interesting. I would not be able to do justice to the stories that he tells. But there is one story he particularly tells of two fishermen because Portugal is at the edge of the ocean and after that, there is a vast expansion of the ocean up to the West Indies and the Bahamas and all that.

So, Portugal is a place where many people from different cultures, and different professions meet, especially fishermen. And Johansson says that a typical conversation between two fishermen would be how do you do the fishing? And this man may say, of course, we do the conventional way of fishing. We put a hook into the water and then get the fish. And he asks the other person, how do you do fishing?

And this person will say you know what, we do not really use a hook, but we use a sack or something like that and then when the fish is caught, when we pick up the fish and we find that we do not need that fish, we can take that fish and put it back into the sea, into the ocean because I do not hurt, the hook would not hurt because we do not need it anyway. Now, what are these two people talking about?

They are talking about their ways of fishing, but what happens at the end of the conversation? Each one learns from the other and each one comes to understand what the other does and new ways of fishing start to develop. So, Johansson uses the Peter Café example as a way

where different thoughts come in, different perspectives come in and a new perspective emerges. That is the principle of the book.

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INTERSECTIONS – Eastgate Centre, Harare (Zimbabwe)

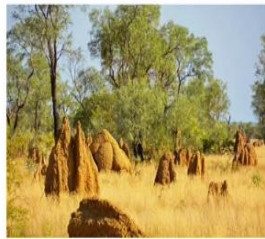


Image: <https://www.mickpearce.com>

- The Eastgate Centre, an office complex in Harare is designed based on how termites construct their nest.
- The building, designed by architect, Mick Pearce, has a system to ventilate, cool and heat it entirely through natural means.



So, now you must have already seen this several times. The principle again is from the termite mound, the idea for the Eastgate mall. So, therefore, what are we learning? We are learning that emulate is the ideation stage. There is no magic in emulate, at the same time, emulate is a very individual effort. And when two ideas come together, a third idea is formed.

So therefore, Mick Pearce thought about, how he thought about the Eastgate Mall, how he thought about the solutions to the Eastgate Mall from the termites we do not know, but the questionable point is he did establish a connection and that is what we are seeking in this emulate, establishing a connection between 'abstract' and 'emulate'.

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The Power of Intersections

- The Intersection is the perfect environment for:
 - Widely different ideas to come together
 - Lots of different ideas to come together
- The number of ideas/combinations increases beyond those in a single area when we:
 - Break down associative barriers
 - Step into the Intersection



So, the power of intersections now I am just going to give you the theory. Intersection is the perfect environment for widely different ideas to come together and lots of ideas come together and a lot of ideas intersect. When a lot of ideas intersect, new ideas spawn. There is this, I do not know how many of you have heard of something called Cirque du Soleil. Cirque du Soleil in French means circus of the sun.

And Cirque du Soleil is a very famous circus where the founder of Cirque du Soleil has actually mixed two concepts. He mixed circus and theatre. And when you mix the idea of the circus and the idea of theatre, you get a completely new idea of doing theatre with the principles of a circus, for instance therefore if you are doing a play on Romeo and Juliet, you may have Romeo and Juliet on a trapeze.

So therefore, suddenly we are saying a new idea or an idea that no one had thought about before comes into existence because two ideas intersect with each other and that is the principle of intersection. So therefore here, I am not going to read it, but the important thing is to look at the fourth line, the number of ideas and combinations increases beyond those in a single area when you step into the intersection, when you actually step into the intersection, new ideas emerge.

I do not know how many of you have looked at something called association of words and thinking that you may be faced with a problem of let us say making a new camera. You want an idea for a new camera and you are looking at an idea for a new camera, suddenly you think of water. And now there are two ideas, one is the idea of the camera and the idea of the

water. Now, what is the attribute of the water? Attribute of water is water is free flowing, water is transparent while camera is about taking pictures.

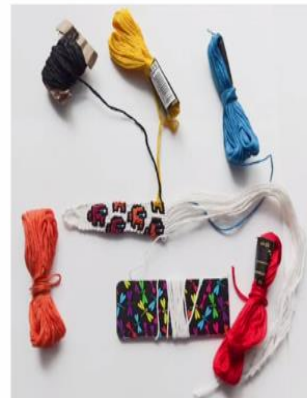
So suddenly in your mind you can say wait what if I join these two ideas, the idea of the camera and the idea of transparent water, the transparency of water and suddenly join these together and you get an idea for a transparent camera where you can actually see the workings of the camera. Again, another idea that I often think about is water can be easily swallowed and camera is about taking pictures.

What if these two ideas merge? I make a small camera that I can actually swallow and that is very prominent in the medical field. So, what are we learning? We are learning when you let your mind think about new associations, and all these associations come together to form a new idea. Now, this is good exercise for you. As for your emulate section because emulate is about ideation.

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Developing Intersections

- Can we create new solutions using new intersections?
- What could be new subjects that we could learn?
- What related, yet unusual, subjects can help us in our work?
- What questions should we store in our minds to precipitate serendipity?
- Can we, therefore, be deliberately creative?



So, the question is can we create new solutions using new intersections? Yes, we can. What could be the new subjects that you could learn? Now supposing you are working on engineering problem, building a bridge. Do you think that there could be a connection between building a bridge and cooking, there could be, you never know. Supposing you watch a gardener working and you have a problem to solve. You have a big problem to solve.

You say okay let me take some rest and then you watch a gardener working. Is there something from the gardening that you can pick up by way of idea and apply it to the

engineering problem you are solving? Of course, you can. You never know, right? You will never know because all you are doing is connecting several concepts. So, therefore, the question is what related, yet unusual, subjects can help us?

So do not let your mind be restricted only to one branch of science or one branch of engineering or one branch of something, there could be something from other fields that you can actually use in order to help you in your work. What are the questions that we can ask in our minds? And this is the word I love which is called can we be deliberately creative? Can you not please leave creativity to chance.

Can you actually say I know how to create new ideas, the word deliberate is purposeful. His heart is saying do not disturb me for the next 10 minutes, I am going to sit down and generate new ideas instead of saying ideas will come to me anyway. They are called top-of-the-head ideas. Those ideas that come to you anyway are called top-of-the-head ideas, but deliberately making ideas is using techniques like this, techniques like intersections where you pick up the problem that you have and you have several ideas.

You put all these concepts on a drawing board and try and mix two, three concepts and find out where it takes you. You are going to have exciting times when you are going to be doing emulate. So now, I hope intersections has given you enough excitement to go very confidently to emulate. You know that is one of the important attributes for creativity, for generating new ideas that you go with a lot of confidence.

And where does confidence come from? Confidence comes from essentially telling yourself that it is okay not to get great ideas in the beginning, no idea is great or small. There is nothing called a great idea or a very bad, no it is not there at all, I do not know why we keep on using adjectives for ideas. It is simply ideation. And your mind is trained to give you lots and lots of ideas. If you use things like intersections, it gives you even more ideas.

So right now, we are on emulate. Emulate is that portion of the spiral where you generate ideas for your solution. There is no particular method. Each idea is different. If the same person will make different ideas every day or over a period of two hours you get different ideas, so, therefore, look at it as a fun session, absolute fun session. Can you imagine a

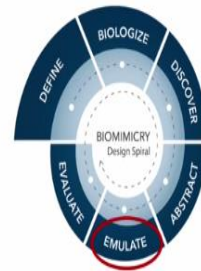
session where there is nothing called right or wrong, it is just simply fun. But there are some rules. So let us look at those rules.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Emulate = Imitate, Copy, Mimic
- EMULATE is the core of biomimicry
- You apply what you have learnt from nature in the first four steps to the problem that you are trying to address.
- The intent is to come up with a blueprint for your solution – not just imitate a strategy blindly.
- Explore ALL the design strategies you have abstracted from biological strategies AND brainstorm ideas and concepts that you can use in your solution.
- This is where you start ideating.



So, what is 'emulate'? 'Emulate' is how I apply the bio-inspired strategy, which means what? I already have got some strategies from the organisms and how I apply those strategies to the problem. So, you have two things in your mind. You have the strategy and you have the problem and you must find out what is the idea, and the solution you are getting for the problem. So, what is the meaning of emulate? This is just the basic stuff.

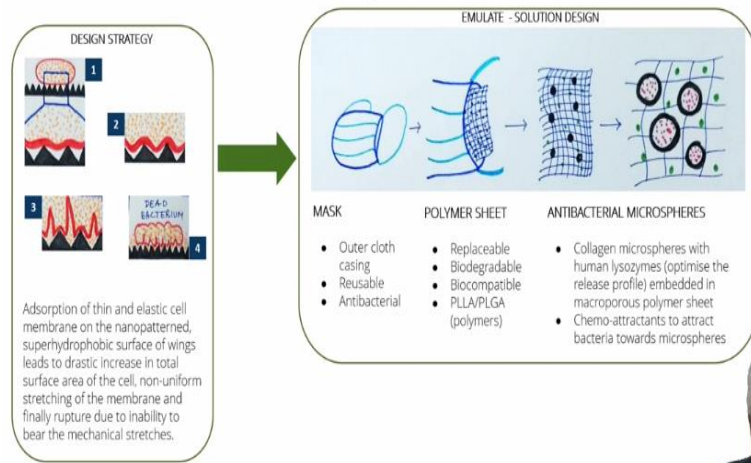
You know, it is always important to learn the basic stuff before you start to, because otherwise what happens is we do not remember the basics and we go off to something else. So, emulate means copy, mimic, imitate. It is not bio emulation, no it is biomimicry. So, 'emulate' is the core of biomimicry. You apply what you have learned from nature in the first four steps, your problem that you are trying to address.

So therefore, now it is very clear. You learned through. What did you learn? You learned define, biologize, discover, abstract, now you are doing emulate. So, it is a step-by-step process. The intent is to come up with a blueprint that is sort of an idea, not the perfect idea. So, you have to brainstorm here, you have to brainstorm ideas here, you have to brainstorm what you will use for your new solution and all that. So, you know what is emulate. What you are understanding from this slide is 'emulate', is about ideation. The emulate is where you start ideation.

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EMULATE - Example

DEFINE: HOW MIGHT WE DECREASE HOSPITAL-ACQUIRED INFECTIONS?



Now, this is the design strategy for Mugdha. So, this is what she said and that was the problem that she had. How might we decrease hospital-acquired infections, this is the design strategy of the organism that she chose. And this is the emulate, the mask idea that she has. Now, look at what you will do. I hope you are already ready for emulation. Now, what do you do to emulate? Just look at this slide.

This is the core of what I am trying to explain. You have the problem in front of you. How might we decrease hospital-acquired infections? You have the strategy. You do not have the solution design yet. Right now, what you are working with is the problem definition, the problem that you are trying to solve. How might we decrease hospital-acquired infection that is the problem.

You have figured out that there is something in the strategy that will help you, you figure it out that is why you did discover. With this problem, you went to AskNature.org and you did discover. You discovered this organism. And from this organism, you brought out the design strategy of this organism. This is the abstract portion. Now you want a new idea. So, what do you do?

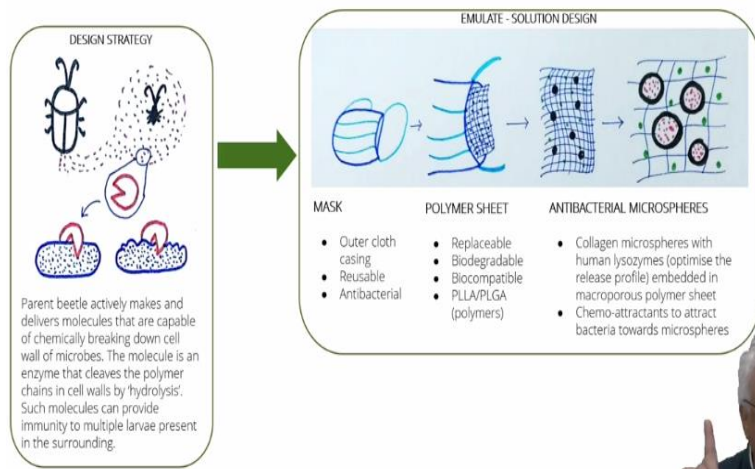
Look at the strategy, adsorption of thin and elastic cell membrane on the nanopatterned superhydro and all that. And finally rupture. Wait, maybe there is some meaning there, the word rupture what is it convert for you, breaking through, breaking away, and you say wait, let me keep rupture and find out how I can use that word rupture for hospital-acquired infections. Remember, I am only guessing this is what Mugdha did.

I am just guessing that she probably used one of these words over here and that gave us the idea, go back to the water example, go back to swallowing the camera example, swallow gave me the idea of swallowing a camera. So maybe rupture is what is giving me the idea for a mask. But keep it, you cannot really define exactly what it is. So, therefore, how might we decrease hospital-acquired infection? And she has got this mask idea.

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EMULATE - Example

DEFINE: HOW MIGHT WE DECREASE HOSPITAL ACQUIRED INFECTIONS?



Look at the next. Next strategy she employs. So, the parent beetle, the beetle what does it do? It actively makes and delivers molecules and all that. And the molecule is an enzyme and it can provide immunity. How might we decrease hospital-acquired infections, providing immunity that is probably what gave her the mask idea. What am I trying to tell you?

What I am trying to tell you is there is no definite method to go from abstract to emulate which is the idea. But you use the abstract, you use the problem definition in order to go from abstract to emulate. Just go ahead and try as many ideas as possible. Talk to your friends, talk to your teachers, talk to your professors, tell people what you are trying to do. And you never know which idea you will say this is what I want to work with.

For the next four or five slides, I am going to help you understand emulate in a deeper sort of way so that; you do not have to do it right away, whenever you are trying to do emulate you can come back to these slides because these are guiding slides for emulate. It is not possible for me to leave you only with this slide. It is important for me to get into the depth of emulate which is why I am going through the next few slides.

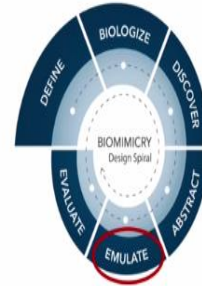
Let us look at 'emulate' in a deep way now. You know what is emulate? Emulate is generating ideas from abstract combining abstract and the problem definition. There is no right or wrong idea.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Brainstorm ideas and concepts from your design strategies.
- Explore patterns, connections and relationships between your design strategies (from ABSTRACT) and look for ideas and concepts that you can apply in your solution.
- Keep an open mind – do not try to fit your ideas into preconceived solutions/notions that you may have.
- Quantity not quality - generate as many ideas and concepts as you can; do not judge/reject while coming up with ideas.



Now brainstorm ideas and concepts. So, therefore brainstorm as many ideas as you want, brainstorm itself means getting several ideas. So, what are the patterns, connections, and relationships between your design strategies? Keep an open mind. Do not try to fit your ideas, do not start saying I want to make a mask and somehow make the mask fit into your plan that is not a good way at all. Keep an open mind, wait for the ideas to come to you. Quantity, not quality. So, generate as many ideas as possible.

You know some of the creative sessions that I have run people have generated 20, 30, 40 ideas. There is no limit to ideas. What happens is you do first time, for the first few minutes all of us do what is called top of the head ideas, everybody generates ideas, ideas for going on a picnic, everybody says different, different ideas and then we use different techniques and all that and then come to the end of the session we have about 40 ideas for a picnic. Ultimately, we use only about 2 or 3 ideas. So, quantity not quality.

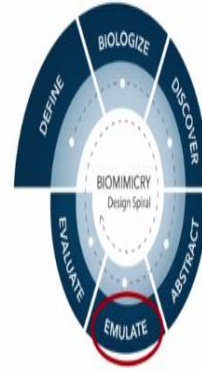
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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

Uncover patterns and relationships between your design strategies:

- Look for connections you see. (Mind maps)
- Visually organize all the organisms/living systems that you have identified - create cards or a chart or table with the following - function, context, strategy and look for connections.



Uncover patterns and relationships. You can make a mind map. You can put all the ideas on a piece of paper and look at the connections between one idea and the other. Just look up, try mind map as much as possible. Mind map is a very lovely tool. Visually organize all the organisms or living system you identify. So, suppose you have identified 7 organisms, put those organisms visually on a chart.

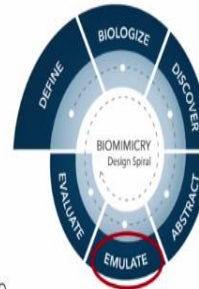
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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

To help look for connections and patterns:

- CONTEXT - How does context play a role?
- SCALE - Are the strategies operating at the same or different scales (nano, micro, macro, meso)?
- PATTERNS - Are there repeating shapes, forms, or textures?
- BEHAVIOURS/MECHANISMS - What behaviours or processes are occurring?
- RELATIONSHIPS - What relationships are at play?
- INFORMATION - Does information play a role? How does it flow?
- INTERCONNECTIONS - How do these strategies relate to the different systems they are part of?



So how do you look for connections and patterns? So, what is the context you say? What is the context of this organism? And what is the context of the problem that I want to solve? So, look at the context. So, therefore, then you ask for scale, are the strategies operating the same or different scales? So, is it a nanoscale? Is it operating at nanoscale, for instance the lotus leaf is about micro scales, very micro. The termite mound could be maybe macro.

And is there a scale that I have to look at that these organisms are operating in? Patterns: is there a repetition of the form structures? What is the behavior of these organisms? How are they behaving? Relationship: what is the relationship I should look for between two organisms? How much information do I have? Make use of as much information as possible. How much information do I have about the problem itself? How much information do I have about the organism?

Maybe it is not enough. Collect information, maybe you can collect more and more information from different sources. And how do they interrelate? Go back to intersections? If there are 4 organisms I have chosen, what are the interconnections between these organisms themselves? So, what we are really doing is think, think, and think as much as possible about the problem that you have, about the strategies of the organisms and keep an open mind and let your ideas flow.

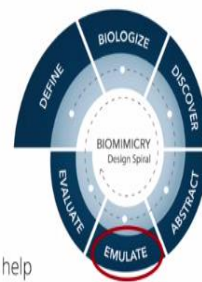
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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

Write down your "How might we...?" question from DEFINE:

- Consider your design strategies one-by-one and ask "How can this strategy help address my problem?"
- Capture all the ideas you get – in words or simple sketches.
 - Do not worry if your ideas are incomplete or in the form of questions.
 - Do not judge/reject your ideas at this stage.
 - Each idea may represent only a single component of a larger possible solution.



So, one of the ways you can do it because remember, one very important thing to remember in all this is that you will probably forget why you started this. You will have to remember why you are doing this. Why are we doing this? You are doing this because you have a defined statement, and because you want to solve a problem. Keep your 'define' statement prominently in front of you.

Do not, in inverted commas, lose sight of your defined statement because that is what you are going to solve. So, write down your how might we question and ask yourself, it is a beautiful line. Very easy, ask yourself how does the strategy that I am dealing help in solving this

problem? So, keep in mind that the purpose of all this is to solve that problem, so your define question is very important. Do not get carried away by your ideas.

Always try to bring your ideas back and say this strategy, this idea I have, how does it solve my problem? So, capture all the ideas you get. Do not worry if your ideas are not complete, just one scribble is okay. Do not judge your ideas. We have this habit, right? We are our worst judges in a way. The minute we have an idea, we say do not work, do not do that, please.

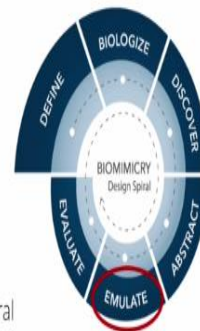
Many times, friends and relatives and other people say it would not work, that is okay, you are not bothered about that. In this case, you should not judge your ideas. When you come to evaluate, I will talk about judging your ideas. Right now, it is not your function to judge your ideas. And you can pick up small components from every idea and make all of them into one big idea.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Once you have examined all the design strategies, and have recorded several ideas – see if they can be grouped based on similarity, connections etc.
- Examine if any of the ideas seem to fit together. See if you can combine or mix some ideas to arrive at newer ideas. Capture additional ideas.



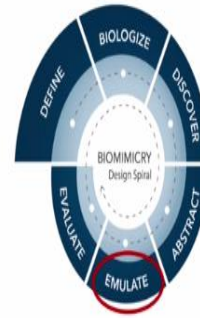
So, what are we learning? We are learning that emulate is about ideation. Once you have examined all the design strategies and have recorded several ideas, you can start grouping them and examine. You know, it is not necessary that you simply stop emulate. You can continue to capture additional ideas whenever you get, of course there must be a logical end to the ideas, but you can continue to generate the ideas. Ultimately come to a decision on which is the solution that you want.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Avoid focussing only on strategies that fit a solution that you already have in mind or that match a solution that already exists in a similar form.
- Focus on strategies that best match the context and function based on your “How might we...?” question.



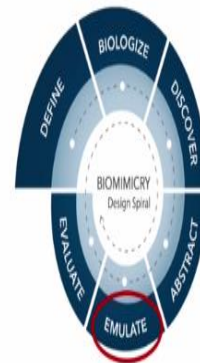
And finally, this is I think I already told you but I want to say it again, do not fit an existing solution to your idea that is a very lazy way of generating ideas. I already start with an idea, the minute I have looked at the United Nations Sustainable Development Goal, I have got an idea in my head. And that is the only idea I have, I am so excited because we are so much in love with our own ideas. I am so excited by that idea that everything I do define, biologize, discover, abstract everything is to serve that idea. Do not do that. And focus on the strategies, keep looking at the ‘how might we’ question.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Expect to iterate in the EMULATE and EVALUATE steps.
- Once you have done your ideation using all your design strategies, list out all your ideas and concepts, and do a quick assessment to see which seem the most promising. (i.e EVALUATE)



So, once you have done emulate, you have to go to evaluate of course. So therefore, once you have done emulate and then you have to do evaluate, there may be a need sometimes to iterate between emulate and evaluate. There may be a need to iterate between evaluate and

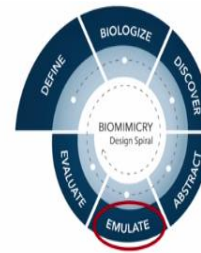
emulate, so, therefore, keep your emulate ideas. And once you go to evaluate, you may have to change some of your ‘emulate’ ideas.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Examine the promising ideas in the context of nature’s ‘design principles’ (i.e. Nature’s Unifying Patterns).
- How can you strengthen each idea using these principles?



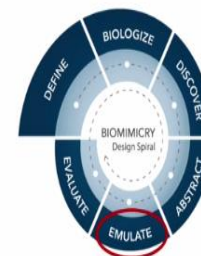
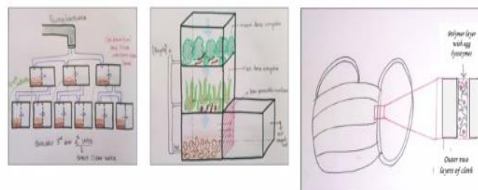
And just a marker for you, I will come back and explain it in a deeper way later on unifying patterns. But the unifying patterns can help you to strengthen your ideas, make your ideas stronger.

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EMULATE

How do I apply the bio-inspired strategy to the problem that I wish to address?

- Based on the ideas and concepts that you have come up with, articulate your solution(s). This can be a first cut.
- Use words and simple sketches.
- You can then refine the solution in subsequent stages.



So, all that I have told you up to now is about emulate. You do not have to learn all these at a stretch. The depth of emulate that we have told you up to now is simply to help you come back to emulate again and again and again. It is not something that you will learn overnight, it is not something that you will be able to master overnight, but it is important that we give

you all the information we have on emulate so that at some point of time you become a master of generating ideas.

For the moment remember very simply that emulate means ideating and you will have to remember the connection between the strategies and the problem. And that is a very simple way of doing emulate, strategies and problem. What is the connection I see between the strategies and the problem. So, this is just examples, some drawings of emulate from the students. So therefore, here you see some drawings.

Drawings are very powerful because drawings help you see the strategy in a clearer way and ultimately, when you get the idea, when you get to emulate idea, you can actually draw a quick drawing of that idea too. So, therefore, what you have learned is emulate. It simply asks the question: how do I apply the bio-inspired strategy to the problem that I want to solve?