Introduction to Biomimicry
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Lecture – 27
Systems Thinking - Introduction

You know, for the last one and a half sessions now you have been learning biomimicry. I am going to take you to a completely new topic. You will find out the connection between this topic and biomimicry later on. But I do not know whether you remember the first time I spoke to you, I said I started learning a subject called systems thinking, which led me to biomimicry.

Since that time, I have told myself that whenever I teach biomimicry, I will also talk about systems thinking. So, the topic that we are going to learn now is called systems thinking. What you see in front of you, systems thinking, thinking and system, etc. It is a huge subject, a huge**,** amazingly huge subject, but I am going to try and explain it to you in the simplest of terms, simplest of language, and simplest of concepts.

Because like I said there are very few topics in the world that transform you completely and this is one topic. I still remember when I was working with TCS, I do not know how many of you have heard of the legendary Mr. F C Kohli who is known as the father of software in India. He started TCS by the way, and he brought, you can imagine, today India is the biggest in the world for software and Mr. Kohli started that revolution.

I still remember I worked with him very closely, unfortunately, he is no more now. And I was one of the fortunate people to have actually interacted with Mr. F C Kohli. So, he told me, Shiva, I think this was in 1993-94, he said you must learn systems thinking, but I sort of ignored it at that time. And it is taken me almost 20 years or a little more than 20 years to actually listen to his advice.

You have this great opportunity now to start learning systems thinking in your life because what you are going to hear, and what you are going to learn is something not too many people even know. So let us start. I am going to show you a picture.

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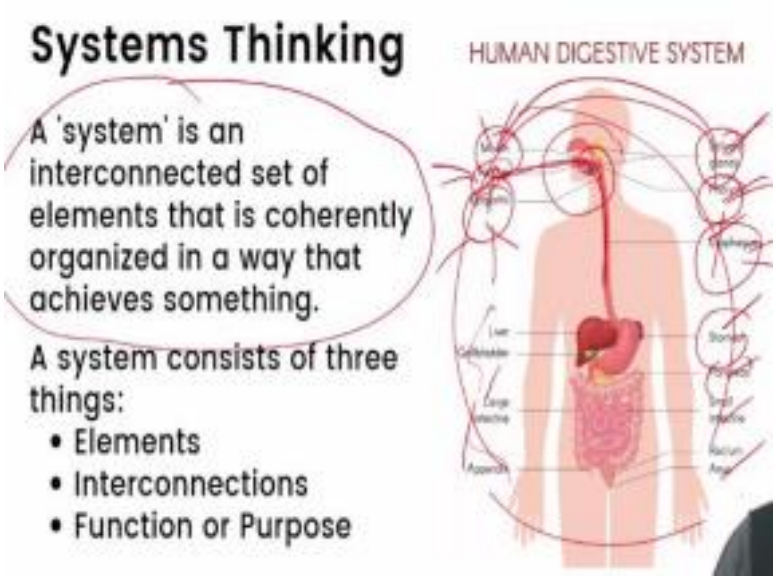

Look at that. What you are looking at is the human digestive system. So what are you looking at? You are looking at the mouth, tongue, and epiglottis, you are looking at the salivary glands, you are looking at the pharynx. You are looking at the oesophagus, stomach, pancreas, small intestine, etc, etc. Now, each of these is separate, each of these you can look at separately. But what happens? Look at the wording here.

A system is an interconnected set of elements that is coherently organized in a way that achieves something that is all it is. Can you believe that the entire topic is contained in one line? Let us look at this line once again. Let us look at this line. A system is an interconnected set of elements, so you need elements. What are the elements? These are the elements; the mouth is an element, the tongue is an element, the epiglottis is an element, and salivary glands and pharynx are elements.

What is that? An element is interconnected, each of them is connected to the other, and every one of them is connected, and organized in a way that achieves something. So, what does this whole thing achieve? Achieves the ability to swallow food and taste food. So, the digestive system has elements, elements, elements, elements, but they are all connected in such a way that all of them achieve a purpose. So, what are the three things?

Look, I need not even have told you the next three. What is the three things systems have? It has elements, interconnections, and it has a purpose. That is it. I am going to wait for two more minutes for you to look at that digestive system and ask what is a system. A system, elements, interconnections, purpose; elements, interconnections, purpose, and suddenly you say wait, Shiva, what are the other systems I know? So, I am going to give you 2 minutes to look at other

systems. Did you get any answer? The family is a system. Your college is a system. IIT Madras is a system. Elements, interconnections, purpose.

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Look at that. This is a classic slide to remember, a classic slide to remember systems thinking. Heap versus, what is the heap, a heap of stones. So, what I do is, I pick up, I have a heap of stones and I remove one heap, if I remove one heap what happens? Nothing happens, the whole heap remains the same just one stone less. But look at the next picture which is a house, right? If I remove one portion of the house, the whole portion crumbles.

So, go back to this slide now. Imagine removing the mouth, what happens? All digestive system; you cannot say no, I have only removed one element. So what? Out of all these things I only removed the mouth, but the whole digestive system fails the minute you remove the mouth. So, therefore what are we learning? The system is interdependent. Everything is dependent on everything. Look at that. Look at the interdependency now.

The mouth is dependent on the salivary glands. The tongue is dependent on the mouth. The esophagus is dependent on the liver. So, suddenly what happens? So, for instance**,** supposing I have kidney failure, can I say let me remove my kidney and keep it at home and go? No. The minute I have kidney failure, my whole body can die. And if you can start to become a systems thinker if you can start to look at the connections around you.

For instance, take IIT Madras. I asked you to reflect on IIT Madras. What are the elements of IIT Madras? Elements are the teachers in IIT Madras, the professors, the students, the canteen, the campus, the director, and the management, everybody is an element. Can you remove one of them? Can you say I do not want professors for tomorrow, what will happen? The whole

system will collapse. Parents, fees, resources, the government everybody are involved in creating one IIT Madras.

So that is what we are learning. From today you can look around you and say, identify the systems and say everything around me is a system which means a system essentially contains elements, interconnections, and interconnected elements have a purpose. You have started to become a systems thinker.

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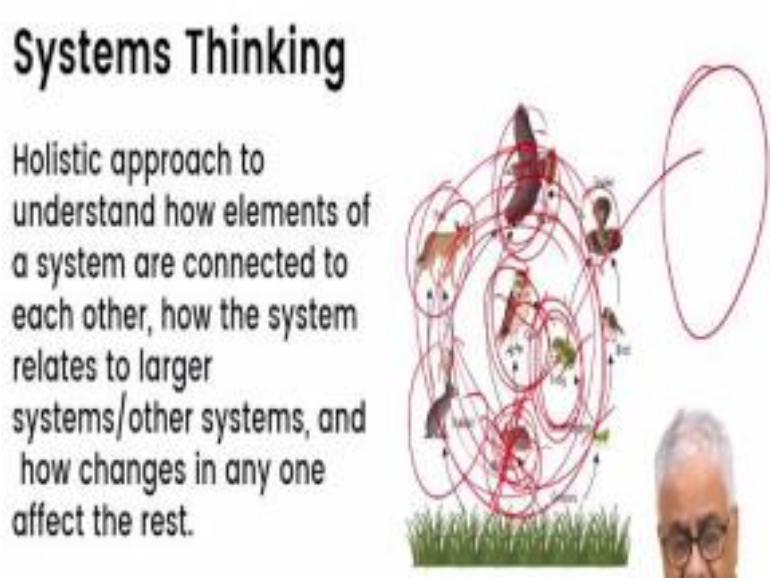

Now it is becoming easy. All I am going to do is reinforce this learning that is all. So look at this system. This is the owl. There is a frog. There is the owl. There is a frog, grasshopper, and mouse. Let us assume you do not like mice. You say I hate mice, I am going to kill all the mice in the world. So, what do you do? You kill the mice. What happens if you kill the mice? What happens? Anyone? What happens is the frogs will start to increase.

The owls will have no food at all. So once the mouse is dead, there will be full of frogs over here and all the owls will die. You never intended. You never intended to kill the owl, but you have killed the owl by killing the mouse. So suddenly we are learning. By the way snake also, I think snakes love mice. Many times. your mice can be gotten rid of by a snake. I am sure even birds, even the hawk everybody likes the mice, except me, I think.

So, therefore, this is what it is, everything is dependent on. We can probably call this a food chain in the jungle and everything is dependent on it. All these the hawk is an element, but

inside the hawk, there is a system, how it flies. Fox is an element, rabbit is an element, etc. See how interesting is becoming. Let us very quickly read this. What is systems thinking? Systems thinking is, I am just doing this because it is also important to remember the theory, the rules, and all that.

So, a holistic approach to understanding how elements of a system are connected to each other. We know that now very well. How the system relates to a larger system, therefore one small system, how does it relate to, how does this whole system relate to a different system? And how do changes in any one system affect the rest? So therefore, if I take off the mouse, something happens. You know what happened was, let us assume for instance my sister, they were a family.

My sister, her husband, the children all of them were family. So, they were one system, the family, each one depending on the other, interconnected to each other, and all that. But my sister passed away last year, very unfortunately, and because she passed away what happened, one element from the system got changed and the family members did not know how to cope with each other because they had lost one family member and this you will find it almost everything in your life.

One of the ways you understand life is to understand systems. Everybody will be wondering why is it that suddenly there is so much confusion in the house, suddenly, and then if you are a systems thinker, you will start to understand that the loss of my sister in that family has affected the entire family in some way. And over a period of time, they start to cope, to understand how to deal with that loss. So, for me, systems thinking is about understanding.

The more and more of a systems thinker you are, the more and more you start to understand things, understand why things happen because of the connections and the dependencies and the purpose, etc. So that is systems thinking. Have you started to understand? Now, you may probably draw the parallel between why I am doing systems thinking in a biomimicry class because biomimicry is about connections. Every organism is connected to the other, connected to a problem, etc. Let us go on.

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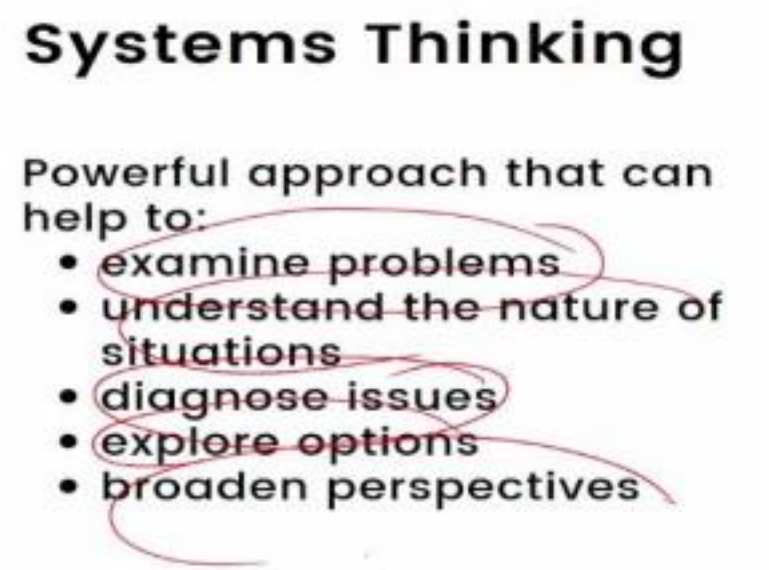

So, what do we do with systems thinking? Systems thinking you can examine why problems happen, and what are problems. You can understand the nature of a situation. You can diagnose issues. You can explore options and broaden your perspective. Your whole perspective changes. When I told you about my sister's when I told you that the family is suffering because my sister is not there, you start to understand why things happen.

And suddenly, you are able to understand, and diagnose the issue. So, if you are a counsellor to my sister's family, you will say you know what, this is how you can deal with it. You are having all these problems because of the loss of one lady there. And therefore, maybe one of you should take some of the responsibilities, others should take some of the responsibility, etc. and you start to diagnose and help people. Systems thinking can be a brilliant way to coach people, to help people.

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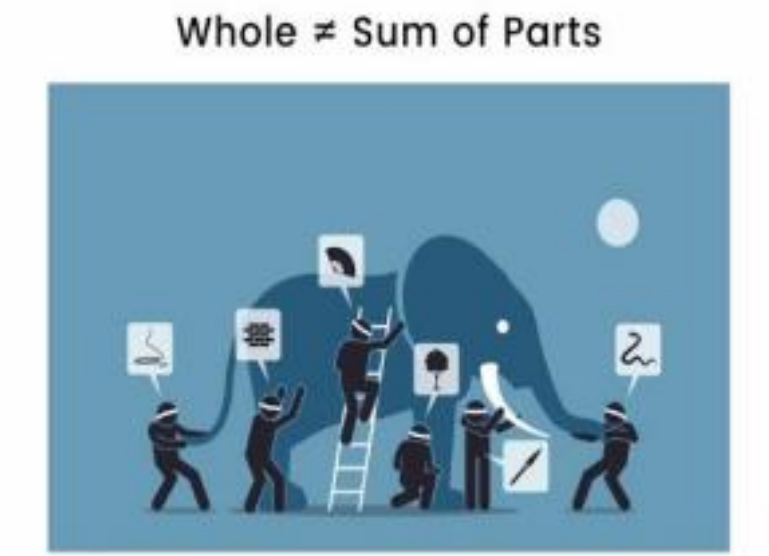

This is a classic example. There cannot be a better picture to understand systems than what is called, how many blind men, 6 blind men here, it will be 5 or 6. whatever. So, the story is that there are 6 six blind men, and all of them are blinded. And they are touching an elephant. So therefore, there is an elephant, but they do not know it is an elephant. They are all blindfolded. And one man touches the trunk of the elephant and he says it should be a snake because that is how it feels.

Another man touches the leg of the elephant and says it is a tree. One man touches the ear of the elephant and says it is a fan. One man touches the tusk of the elephant and says it is a sphere. And all these people what have they done? They have touched only one part of the elephant and they think it is something. And then you remove the blindfold and you remove the blindfold and what do they see? They see an elephant and the same thing happens to all of us. We think that our problems are the most important thing.

So if you are in IIT Madras, you will say the canteen, I am in charge of the canteen and whatever happens, this is what must happen in the canteen. And suddenly what happens because you are so adamant and because you want that canteen, whatever you want in the canteen to happen you forget that it may affect other things. Suppose you want to keep the canteen open on let us say throughout the night that is what you are saying.

Because you are not looking at IIT as a whole, you forget that it could be a security issue. So, security could be affected because it is open the entire night. So, before you make a decision system thinking helps you to look at the entire picture from the top and when you look at IIT Madras from the top, suppose you are able to take a helicopter, I will come back to this again and again and again this helicopter view.

You take a helicopter above IIT Madras and you look at IIT Madras from the top what do you see? You see the entire system, all the elements. You see the professors, you see the campus, you see the trees, you see the deer, you see the dogs, you see the houses, you see the canteen, you see the students and you see other systems interacting. You see the government system interacting, the family system interacting, the examination system interacting, the career system interacting, you see so many systems interacting and suddenly you say wow.

This is how I have to look at IIT Madras from now on. I have to look at the entire thing as one

system. Because most of us are wearing blindfolds. We only see, we only imagine what is in front of us, the minute you remove your blindfold. So, this elephant story is not just for those 6 blind men. It is a request for every one of us to remove our blindfolds and look at the entire system.

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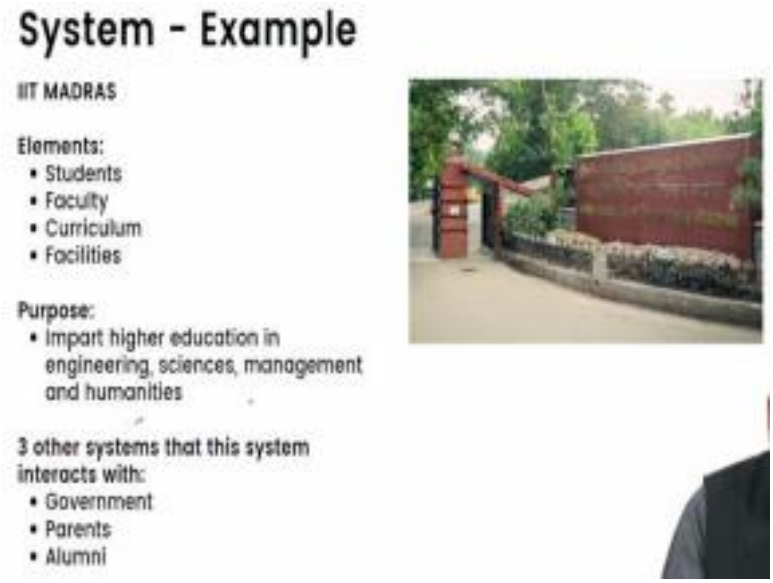

So, therefore I have been talking so much about IIT Madras, I might as well give you a slide on it. So, what are the elements? I am sure, see now what you should do is now start to add to this. So, I may have missed out something. So, the elements in IIT Madras are students, you can look at your own college, it does not have to be IIT Madras, almost every college in India, almost every college in the world have similar elements and connections and all that.

So student is an element, faculty is an element, the curriculum is an element, and facilities are elements. The purpose of IIT Madras is to impart higher education in engineering. The purpose can change. Purpose can be so for instance, there is an activity in IIT Madras called Sarang. Now for that the purpose could be to keep the students entertained, to bring out the talents of the students.

So a system can have several purposes, not just one purpose. And then you have what are the other systems it interacts with? It interacts with government, interacts with parents, interacts with alumni. So, what are you learning? You are learning that IIT Madras has elements, has connections and has a purpose.

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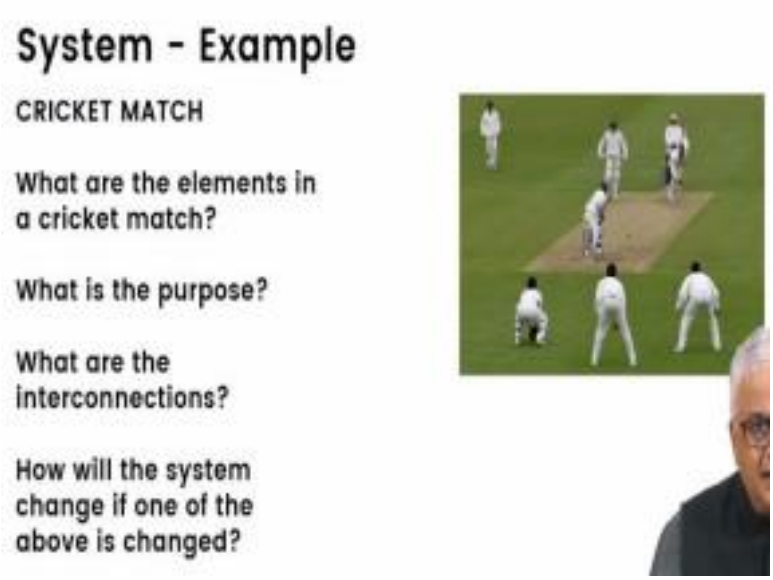

Now just examples. Look at the match, cricket match. What are the elements in a cricket match? I am going to give you about 2 minutes to answer this question. What are the elements in a cricket match? Yes, I am sure you have written it down. The player is an element, the ground is an element, the umpire is an element, the spectators are element, the ticket sales are elements. So, all of them are elements. What is the purpose of a cricket match?

Yes, it could be several things. You could learn from a cricket match. You could learn team building from a cricket match. It should be entertainment. It could be learning about competitiveness. It could be simply to have a great time with family. It could be a family picnic, for several purposes. What are the interconnections? Obviously, everything is connected. Remember during the pandemic, none of the football matches, the EPL football matches or any football match, or the world, even cricket they had no crowd.

Many players complained especially the home players complained that they could not win the match because there was no crowd. So, what are we learning that even the crowd is involved in a team winning. You remove the crowd. Some damage, some problems happen. And then you say how will, exactly that is the question how will the system change if one of the above is changed? If you do not have the crowd, the competitiveness decreases.

If you remove the umpire, you cannot have a match. But here again, is where the scope for innovation happens. You do not remove the entire umpire, but you remove a particular role of the umpire. What has been removed in the present cricket match? The role of the umpire to look at run out has been removed. So therefore, instead of the umpire, there is a camera that helps the umpire to find out it is run out or not.

So, using technology for fulfilling the role of something in a system is the scope for innovation. I am sure by now you are starting to understand systems thinking. Systems thinking let us quickly go back to the presentation. Systems thinking is very simple. A system is an interconnected set of elements that is coherently organized in a way that achieved something. A system consists of three things; elements, interconnections, and purpose.

Heap versus system. Systems thinking, a holistic approach to understand how elements of a system are connected to each other, how the system relates to a larger system and how changes any one affects the rest. Go back to my sister's example. What can it do? It can help us examine problems, understand the nature of situations, diagnose issues, and broaden perspective. You start to understand the new perspective. Of course, this is a famous story that all of you must remember.

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And look at that right now, interconnection. So, when you talk about interconnections, this is a Swiggy person or food delivery person. What are the connections? I am going to give you some time to look at the connections. Someone rings the bell; you open the door and there is food in front of your house. But if you are a systems thinker, you will look at all the things that happen behind the scenes, and all of them are connected.

You know many times we just simply open the tap and complain there is no water, but have you even thought about all the connections behind that opening the tap exercise? So, look at this. What are the connections behind food delivery? Yes, so food delivery the connection behind the scooter that he comes, so the connection between the automobile. The automobile runs on petrol, there is a connection to petrol or fuel?

And then there is this employer, the structure of the service provider. And then what does he do? He brings food. Therefore, the restaurant is a system. In the restaurant there is a chef, there is a cook, there is a waiter and that is the system. The restaurant gets its vegetables from the farmer, therefore the farmer is a system. And from the farmer the farmers depending on the rain, so the season is a system. Look at the number of systems. The rain is a system.

And imagine if you do not get food or I mean getting food outside your house actually depends on whether or not there was rainfall. If you can start to think like that, if you can start to look at the connections between elements, I tell you, you will become a great thinker. People will want you to think for them. People want your advice, people come after you. And that is what we are learning.

I hope what we have learned till now has piqued your interest in learning more and more of systems thinking. There are plenty of books that you can learn from. For me, the favorite has been The Fifth Discipline. And I think that is the book it is called The Fifth Discipline that is the book. I started getting interested in systems thinking with that book. And of course, now I am seeing a lot of connections in the natural world. I am able to see the connection. Essentially, we talked about elements and connections and interdependencies.

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Can you tell me that elements and connections and interdependencies do not exist in the natural world, you cannot. For instance, look everything is connected, there is nothing in the natural world, why are we saying the natural world, human world, this whole world everything is connected? We are as much connected to the natural world as the natural world is connected to us. There is no problem or solution that exists in a silo in the world.

Now today, why are we saying that we must do biomimicry, we must turn our eyes to biomimicry, we must look for nature solution, why? If they are two separate entities, the natural world and the human world, then how does it matter? We can keep destroying, how does it matter. That means we are doing something that is connected to the natural world which affects the natural world, to there is a connection.

And that is what becoming a system thinker will do for you, will help you understand that the more and more of nature that you destroy, the more and more of yourself that you destroy. And if you can see that connection, I think you will start to really transform yourself. And I am saying you, you, you because I think we must start with ourselves, the first thing I must do, I must do is understand the connection between me putting plastic or me using plastic and throwing plastic in the garden.

And looking at the connection of that plastic, the harm that the plastic will cause to the surroundings and all that, and tell myself that I am part of the problem. It is not as if the problem is different and I am different, I am as much part of the problem as anything else. And if I can see that connection, if I can start to look at systems thinking in that holistic way, then I am not going to be any more irresponsible because I know that I am as much part of the problem as anything else.

So, like we always say, the change has to start from us. In this context, there is this video how wolves change rivers. I am going to ask you to pause the video right now. Pause this video what I am talking to you right now, and look at this video, please that is exactly what I did before I started speaking to you. It is a video that will help you understand exactly how systems thinking works in the natural world.

How the introduction of wolves in Yellowstone Park has actually helped change the behavior of rivers, how the introduction of wolves in Yellowstone Park has decreased the number of deer and therefore because the deer want to move away from the into wolves into a different area, the vegetation in that area starts to grow. And because the vegetation starts to grow more and more animals, more and more birds, the trees become stronger.

And because there is so much vegetation, the reverse start to change the direction, change the behavior. I am sure if you had paused the video and if you had looked at it, then you will

understand what I am saying. So, this video is important for us to remember, so keep this video for yourself in the sense whenever you have to explain systems thinking to someone, explain how systems thinking works in the natural world, this video is going to really help you understand.

And it will also help you become more aware of what you can do for the environment. And how even a small change from you can have a big cause-and-effect relationship. You can cause a big change by simply making a small change in the way you do things and what you learn from the video. I have a question for you. I am 16 years old and I have just come back after doing very badly in an exam and I am absolutely upset, I am devastated.

I do not know what to do. The whole world seems to be against me. I did very well, I studied very well but I did not do my exams well. I do not see any future at all and I am really depressed. And I want you to help me. What will you do? Why are you saying that everyone gets into a situation you will give me advice? Yeah, all that is fine but what will you do? What is it that you will make me sit down in and give me a ride on? What will you do that?

What will you do? No, no guesses. I am sure many of you are guessing. And I would love to sort of discuss this topic that I am going to talk about at some point. I would love to sit down with all of you and thrash it out, but I want to introduce the topic to you. What you will do is to put me in a helicopter, of course, you will be in the helicopter too and you will take me 10,000 feet above and you will show me my life. You will show me my life over the next, I am now 16.

So, you will show me my life over the next let us say 70 years, which means 86. And you will show me and when I see my life what will I see. I will see what is called a big picture. And what is this big picture that you will show me? You will show me that Shiva your life is now at 16. Yes, I know you have done badly in your exam, but look at your life, when you are 20, you will probably have finished your graduation. Look at your life when you are 25, you would have entered a good Masters or Ph.D. or whatever.

Why academics, I would probably be doing something else, I will probably be in business. When I am 30, I will be in a job. When I am 40, I will probably have bought a house and make my parents live in that house. And therefore, you will take me through my entire life. And once

I see my life from that big picture, I start to understand. I will not do badly again an exam, I am not saying that, I will start to understand that doing badly in an exam is not the end all and be all of everything.

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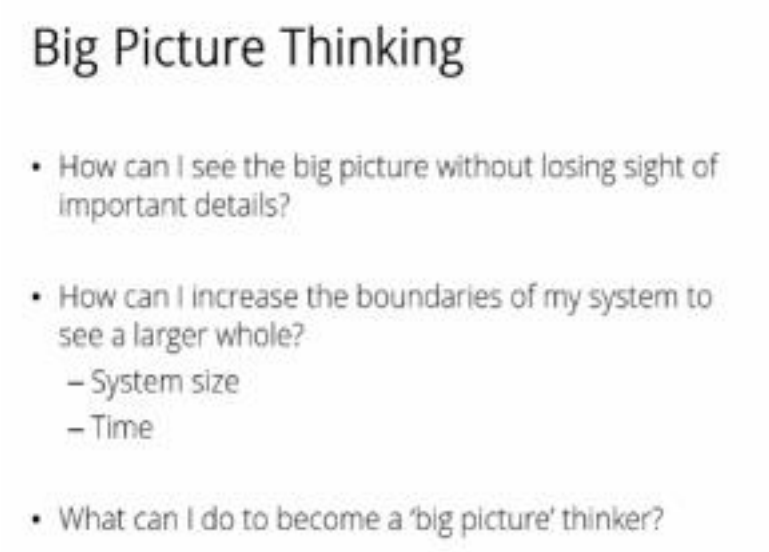

So, what you are learning to make me be is be a big-picture person and that is the topic for today, big picture thinking. So, the question that you are asking is how can I see the big icture without losing sight of important details? I know exam is important. I know that passing and doing well is important. At the same time, how can I also see the big picture? You know, once I started telling myself I am going to talk about the big picture, I started preparing lot of notes.

And I am going to be referring to my notes in the next 10-15 minutes, several times so that I do not miss out anything. Most of these notes are points of discussion that I want to have with you. But essentially, you have understood the big picture. The big picture is the ability to take yourself up in a helicopter, look at things from a different point of view, not look at the narrow picture that is the big picture.

At some point during this lecture, we must be able to connect the big picture thinking to biomimicry, please start asking yourself what is the relevance of big picture in biomimicry? The next point is how can I increase the boundaries of my system to see a larger whole. What does it mean? Does it mean that am I a person who is only looking at my family, that is all? Am I looking at my neighborhood? Am I looking at my community? Am I looking at my state?

Am I looking at my country? Am I looking at the earth? So how can I increase the boundaries or am I looking only for the next 2 years? Am I looking for the next 10 years, 15? How can I

increase my size? So, these are the two ways of taking in the big picture, two ways. Remember that great story. I am sure everyone of you knows, but it is always nice to repeat a great story. So, there is this person who goes and asks this mason what he is doing?

He is saying what I am just putting one brick after the other he says. So the same guy goes to the next mason he says what are you doing? And this guy says I am building a wall. And the same guy goes the third mason and says what are you doing? And he says I am building a church. Three people doing the same job, but each of them having a different picture in their heads and does not it happen to every one of us?

Whenever you know most of the time in our life, we always see the small picture. For instance, if I am a security guard, I will keep saying what is this, I am a security guard, these guys are going in coming around in cars. But if I am a big-picture person, I know how important my job is. And I think one of the things that all of us can learn from the big picture is to see how our roles in an organization fit in the organization.

Actually, it is a very good way to look at life because it helps you understand what is the role that you must play in the organization. And if you play that role well, automatically you can expect to be a leader and things like that. So, now what we are going to see very quickly is what can I do to become a big-picture thinker, which is why I have written some notes. So, one of the things is how do I see things that I cannot normally see?

How do I help myself see things that I cannot normally see, what does it mean? It means that there are certain things I cannot normally see, for instance, I cannot normally see things that will happen 5 or 10 years from now. So therefore, constantly having that helicopter whenever I am making an important decision, going into the helicopter, and taking myself up is one of the ways. So, what we cannot see is very far into the future that is one thing we cannot see.

So, the question is how do I make myself see what I cannot see? when I have a chat with all of you, you must be able to tell me more examples of what is it that you cannot see for which you need to be a big-picture person. The second is a small system can be interacting with other systems. How do I take myself and look at all the systems, for instance you know if you come to campus, if you come to let us say you are in the campus, you are in an engineering college campus.

There are a lot of systems over there. There is the canteen system, there is the academic system, there is the exam system, there is the alumni system, there is the hostel system, every one of them has their own elements, they are all there, small-small ones. Now, supposing one day the food taste is not very good let us say. And normally you will get angry and you will say what is this? The food is not tasty, etc.

But if you take yourself in a helicopter again and ask yourself what are the interactions and you will probably notice that particular day, there is a transport strike and because of the transport strike many of the employees who normally work in the canteen are not able to come to work, which is why the main cook has not come to work that day and that is why the food is not so tasty.

So instead of immediately coming to a conclusion saying that whole world is out against you and wants to give you bad food if you are a systems thinker if you are big picture person, you can take yourself up and you can look at all the systems that interact and find out which system needs correction. The next is how can I influence the picture. That is when you take yourself in the helicopter or when you are taking me in the helicopter and when you are showing me my life, look at this, it is very interesting.

When you are showing me my life, you say Shiva look at your life, 5 years from now, you have just got a job, 10 years from now you bought a car and a house, 15 years from now have a family, 30 years from now you have attained some sort of importance in your own world. Now in these stages that you are showing me, what is it that I can control and what is it that I cannot? I can control my expenses. I can control who I will be with.

I can control what is it that I want to do, do I want to buy a car house, etc. There are certain things I cannot control. Now those things that I can control, if I am a big-picture person, look at the opportunity. It is almost like scenario building, look at the opportunity, and you can start to adjust certain things in your life. You can say you know what 30 years I want a car, which means if 25, I am still not qualified, then I will not be able to get a car when I am 30.

So right now, my big picture is telling me at 25, I will only be a diploma holder or something like that I would not earn enough money. So can I actually learn a new language and of course be very proud diploma holder, at the same time also learn a new language French and with my

extra income in French, I look at the big picture I say 30 years old I need a car and how do I acquire a car, even though my job is not paying me very well.

And suddenly you are saying, wow, I can actually control the picture. I can actually control the things that will happen in my life. Now the question is how does the big picture connect to biomimicry? Any questions? So one of the things that we learned was that going up in the helicopter. Now, I am just going to make a blank statement here and saying that you cannot learn biomimicry if you are not a big-picture person.

You cannot learn biomimicry because if you are not a big-picture person. You agree or not? You have to agree, no? Because what does big picture do for you? It takes you up. It takes you up and makes you look at the whole world. You remember, there is great story I must share with you. There were these two astronauts going towards space. And while going you know very much out of the earth's orbit, one of the astronauts is looking around, the other fellow is asking what are you doing?

What are you looking for? He says I am looking for the earth. Where is this? Where is the earth? And the other person said look, look at that, that is there, that blue ball that is the earth. And this person is surprised. Because this particular blue ball has no lines, just a beautiful blue ball. Because he is used to seeing the world with lot of lines and territories and all that, he cannot recognize the blue ball from space as the earth.

So, what does it tell you? It tells you when you learn biomimicry when you learn the United Nations Sustainable Development Goals, you will learn to see that blue ball, you will learn to see that everything that you do you are doing for the earth. And once you are a big picture person from that point of view, if you say that this is my earth that it is not as if this particular land belongs to me, I can take myself up and see the entire earth.

And I can see that the actions that I am committing now can actually destroy some parts of the earth, then I have to do something not to do those actions. So, if I am a big-picture person, I will do two things. One, I will start to look at the earth as my earth. And two, I will start to look for means and methods to protect the earth and biomimicry is a definite way to do that. So, this is the link between biomimicry and the big picture.

And if what you are learning is making sense to you, you will start to understand that everything that they are doing it biomimicry, all the spiral, how to go from problem to solution, United Nations Sustainable Development Goals, the design principles of nature; all of that are starting to make sense. Because of the big picture in us, we are able to use biomimicry to protect that beautiful blue ball.

So, I am not going to speak any more about the big picture, but I am hoping that the big picture has made enough of an impact in you, for you to read more about this and for you to sit down and discuss and the most important thing is can you influence others into becoming big picture thinkers.