NGI101x - Characteristics of complex systems II

Hello again.

In part 2 we are going to look at the characteristics of complex systems that we have come to understand through the theories of complexity. Let me remind you. What we looked at in the first video were the group at the top, connectivity, interdependence, feedback and emergence. We will built on those to look at the others, but let me first of all introduce you to some of the theories of complexity that have come from the natural sciences. Because they have all contributed to our deep understanding of complex systems. So that understanding has come from chemistry and physics, through evolutionary biology, autopoiesis, biology and cognition and chaos theory. And from economics based very much, to begin with, on the work of Brain Arthur. So what we will look at now is the contribution that these theories have made to help us develop and understand much further the four principles I discussed in the first video. So let's start with self organization.

In biology this is an example of self organization, birds flocking. They do not have a particular leader, they know where they are flying and so on. But what does that actually mean in a human context. And this is where I think we need to keep making that distinction of what is appropriate, what is relevant in a human context. Because we cannot always take something from the natural sciences and apply them directly to a human system. So, self organization in a human context, is first of all something which is spontaneous, is a coming together that has not been pre thought and it's not directed or designed by someone outside the group. That is very, very important.

Now let me give you an example. During the Arab Spring, there was a point when someone took a broom and went on to Tahrir square and started cleaning up the square, simply because the square needed cleaning. No one actually told that person, and of course when one person started others joined him. Now that was pure self-organization, it was spontaneous, there was a job that needed to be done, someone decided that they could do the job and it was not directed by anyone outside. And the group that eventually cleared the square were not directed. Now this is quite different from self-management. A self-organized group decides what needs to be done, how, and when. And it can be a great source of innovation. In self management we have something different. A senior manager would probably identify a particular group, would give them a particular objective, but then give them the freedom to address it in whichever way they want. Can you see the difference between the two? In the second one, the self-managed one, there is someone outside the group that actually directs the group what to do, not necessarily have to do it, but what to do. So it is not spontaneous and it is directed from outside. So let's keep that distinction in mind and go on to the next principle.

The next principle is called exploration of the space of possibilities. What that means is it is simply that the system explores new options, different ways of working and relating, because it has found a particular constraint that will not allow it to fulfill a particular objective the way that it may have been preplanned. So for example, your grandmother is dying, you love her dearly, you really want to be there with her, but your flight is cancelled. What are you going to do? You can of course do absolutely nothing, that is one option. But if you really want to see her, you will explore the space of possibilities and find a way of getting there to actually be with your grandmother. And that is what complex systems do, they are very good at finding new ways of doing things. Now let me explain something else. This is a fitness landscape, we borrowed this idea from biology. And what it shows is that the very successful species has climbed to the very top of the highest peak. Because it has got a very successful strategy. Now imagine that as a strategy of a very successful company. It has that one very successful strategy that has put it to the very top and nothing else. What happens when the entire landscape actually changes? Because that fitness landscape does not stand still, it is moving all the time. If you know what a children's bouncing castle looks like, that's the way to imagine it. As the children jump up and down the bouncing castle it changes all the time, and that is how to imagine a fitness landscape.

So if we cannot rely on one successful strategy, what is the answer? The answer is multiple micro-strategies. Let me explain why that is the case. We are encouraged to think of a single optimum strategy, but I would suggest that a single optimum strategy is neither possible, nor desirable in a changing or turbulent environment. Because it can only be optimal under one set of circumstances. When those circumstances chance it is no longer optimal. So what do you do? And as I said, the answer here is while that one strategy is successful, you need to explore different micro-strategies, and then do different experiments in order to see what works. So when your big strategy fails, you have already worked out, experimented with alternatives. And this is of course absolutely essential for innovation. So that is the principle of exploration of the space of possibilities, and that is something that complex systems do very well indeed.

The next principle is called co-evolution. Now, most of you will be familiar with the term evolution. But evolution happens within an ecosystem, with relation to other things. The principle I will explain to you is far more accurate than just evolution. In this case we have an example in biology and we look at bumblebees and the flowers that they pollinate. Now they have co-evolved so that both have become dependent on each other for survival. So this is the definition in biology. What does it mean in a social context. By the way it took us two years to actually understand what does co-evolution mean in a social ecosystem. And I will use the term ecosystem because I want to emphasize the fact that nothing evolves in isolation, it is part of a bigger picture.

Let me give you an example. I take a decision or action that affects you. It affects you to such an extend that you have to change your behaviour in response to my decision or action. Now that is simple adaptation, what you are doing is adapting to changes in your environment. That's only half the story. However, if you change your decision or action in due course comes back and affects me to such an extent that I also have to change my behaviour, that's co-evolution. So let's look at the definition. The definition is reciprocal influence which changes the behaviour of the interacting entities, and it is a very, very powerful dynamic. Because what it means is that we cannot just think about the impact of the environment on individuals, on organizations, on societies, because the moment they start changing their behaviour, that behaviour will go back and influence the initiator of the change. So this is co-evolution which happens within a social eco-system. And the final one I want to discuss with you, because I think it brings all of the characteristics together is far-from-equilibrium. The original work, which was done on dissipative structures by Ilya Prigogine and with his co-workers Nicolis and Stengers, it won Ilya Prigogine the Nobel Prize, because he reinterpreted the second law of thermodynamics. We're not going into the second law of thermodynamics, what we're actually going to look at is what does far-from-equilibrium mean in a human context. And let me give you another example.

As you may recognize there, you will see the two screens and again it is a global financial system when it tumbled down. So let me explain what happened there. When a system is pushed far-from-equilibrium it means that it can no longer carry on under its previous way of operating. You will see that the system is dynamically moving within a certain limit. But what happens is when there is a disturbance outside the system, that means it can no longer continue to function in its old way. This is called pushing the system far-from-equilibrium. In human terms it means that it has to change its norms, its organizational structure, its culture, etcetera etcetera.

But let us look at what this science actually tells us. There is a point in the second part of the diagram, and that is called a point of bifurcation. Bifurcation means splitting into two. But that is only a very great simplification of what actually happens. Because at that point, at that critical point, the system, the complex system, will explore its space of possibilities, will continually explore different options. Because if it doesn't find another way of operating it will die.

So what that simple bifurcation shows is it will either create new order, remember at the very beginning I said that the complex system has the capacity to create new order, and this is what I mean. It uses all its characteristics to create something new. It could be a new structure, a new way of relating, a new way of organizing, a new culture, but it needs to do something completely different in order to survive. And if it cannot create that new order then it will die. But what happens at that point is very, very exciting. And let me also point out that even though we talk about a point, it could be a process, it could take days, months years for that exploration to actually take place.

So what happens is when a system is pushed far-from-equilibrium the following characteristics come into play to create the new order. It will self-organize, it will explore possible solutions, it will co-evolve, new structures will emerge, there will be a sense of coherence, but also the precise behaviour can neither be predicted, nor controlled. Now this is a very disturbing conclusion. Especially when we're looking at complex systems. When we're looking at complex systems that we actually want to design. And one thing I want to make very clear is to give you a distinction between complicated systems and complex systems. Complicated systems we can design, we can predict their behaviour and we can control their behaviour. Now these are systems for example like producing a glass. We know exactly what we're producing, but we cannot do these things with a complex system. We may try to design it, but we cannot quite predict the outcome. So the behaviour is not predictable, nor is it controlled. And in our third video on the challenges of managing complex systems we will then look at what is it that we can actually do if we cannot design, predict and control a complex system.

Thank you.