Editorial (19.3-4)

On the need for continuous learning

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Looking at this issue of *E:CO*, I am struck by the incredible diversity of topics and discussions proposed. In this current issue, for example, we have such topics as: Lifecycle Assessment of biofuels; How people's mental models can affect organizational outcomes; Citizen trust and distrust and how AI might mimic cognitive functions in humans; Dynamical organizations theory, considering openness, synthesis and emergence; Dealing with a drone ecosystem; The paradoxical "Hispanic Paradox"; Leadership and Steinbeck's 'non-teleological thinking', in embodying emergence in visioning; New poetic-scientific research instruments; Towards a plausible framework for cosmic evolution; Envisioning the future of work. This represents a remarkable spread of thought and of reflection.

This comes about because the underlying ideas arising from our deeper understanding of complexity and emergence are a really enormous step forward in our understanding of the universe, and also in the limits and possible transience of such knowledge.

When the ideas of self-organization and complexity first emerged, it was something of a surprise. The Nobel Prize in Chemistry had been given to Onsager in 1968, for extending thermodynamics from equilibrium situations to situations that were close to, but not at, equilibrium. Prigogine wanted to extend thermodynamics to situations further from equilibrium, which were subject to significant flows of energy and materials. In other words, move away from the science of systems that were isolated (no exchanges of external energy or matter) or closed (no exchanges of materials) to Open systems driven by material flows and temperature gradients. But, it proved difficult to establish clearly the behavior of a non-equilibrium open system. Eventually, faced with this seeming impossibility of predicting the precise trajectory into the future, the idea emerged that, if you couldn't show what MUST happen from the equations, then somehow the system had attained some freedom in its possible behaviors! Different possible spatial and temporal patterns could emerge and entirely unexpected regimes of organized behavior could arise spontaneously. He initially called this 'order through fluctuation', as the precise forms and organizations that emerged depended on which fluctuation – non-average behavior – happened to occur, at the moment of instability.

This meant that a system subject to flows of matter and energy could take different possible paths of organizational evolution as a result of the creative dialogue between the macro and micro levels of the system.

But, despite the incredible interest and research that these ideas have led to, many people, trained in the 'mechanical school of thought' still do not grasp the open, evolutionary nature of all this. When we hear the word 'system' we automatically see a set of 'variables' within a border that marks their contact with the 'environment'. But for Open Systems, which can exchange matter and energy with their environment, the physical separation of system and environment is not clear at all. An Open System is NOT necessarily in a box, with carefully controlled channels of flow in and out – as in the original chemical experiments and models. In our evolved and messy world, models and understanding comes from the decisions made as to which types of element interact strongly and may be the principle cause of the phenomena that we are examining. The 'system elements' and the elements that are considered as the 'environment' may be freely floating together. It is the person wishing to 'understand' what can happen that chooses which type of elements constitute 'system' variables and which define the 'environment' – which are variables and which are parameters? However, there is not necessarily ANY border. When looking at a problem in non-linear chemistry, it is fairly natural to think of a chemical reactor with controllable inputs. But in many physical and engineering domains, and in biology, ecology or in social interactions, the system and environmental variables may not be physically separated. Most 'systems' may need to be seen as subsystems of a larger world – depending on the problem considered and its timescale. Clearly, when trying to 'explain' what is going on somewhere, and what might happen, some factors may seem constant or slow moving, while others are changing more rapidly.

When a system is subject to flows of energy and materials (any living system for example) there can be 'reaction chains' that lead to self-organization – emergent spatial patterns or structures. These forms are both created by the reactions involved, and at the same time shape the reactions that are occurring. In the short term this can either lead to a stationary spatial structure, or to an oscillating pattern.

Prigogine called this idea 'order by fluctuation', meaning that the non-average local values of variables were 'testing' the stability of the patterns that were present, and could 'tip' them into new ones. Of course, this could not only be true of the 'system variables', but also of the variables that had not been considered as part of the system. Some new type of element can also 'test' the stability of the pre-existing patterns, and potentially grow. This constitutes an evolutionary mechanism, as some novel elements initially absent or rare may grow in the system and change it qualitatively. Also, elements with new folded structure may occur that offer some emergent functionality, which not only change the 'system variables' but also may change the environment. This means that the open system will change qualitatively over time, as new type of element, with new emergent behaviors will characterize the evolving open system.

This is how system dynamics of open systems is radically different from the ‘mechanical’ view that has been traditional. Indeed, much of system modelling has been about the need to predict behavior and study how to improve performance. But, once we examine a system operating in the real inhomogeneous and diverse world, we see that some systems will evolve qualitatively, while others may stagnate and disappear. New variables will emerge as important and new environmental factors may emerge as being vital. New morphologies will occur in elements of the system, with emergent functionalities and impacts. So systemic ‘learning’ occurs as a result of the co-evolution of sub-systems and their environments. This will defy precise prediction – and it is important to realize that Darwin did not use evolutionary theories to PREDICT what precisely would occur!

So, across a vast range of subjects of concern and importance, complexity offers us a new vision and understanding of how the universe operates, and how emergence is not a spectacular rarity, but in fact a basic mechanism of our creative universe. It has great importance of many areas of interest and also shows us the limits to the predictive mechanical model that was built by struggling competitors in the economic and commercial world we had developed. Instead, we have to embrace the creative, co-evolutionary processes and face up to the need to keep learning and evolving our understanding in a never-ending pursuit of emerging reality.