From the Kitchen

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Complexity. It is all around us and within us. So it seems to us, at least. As humans, we see the universe and life as complex systems and processes and would like to understand them. In doing so, we pull things apart to a level we think we understand and then put all the simple parts together and wonder why the conglomerate does not function quite as the complex system did to start with.

If we can't physically deconstruct something, we attempt to do so with mathematical models. And we attempt to understand the unfathomable through applying what we have learned from those things we do understand (or think we understand). This is why in each age the explanations of phenomena and systems reflect the paradigms of the age. In the age of steam engines, many things, including living organisms, were explained in mechanical terms; today there is a likelihood that things will be explained in terms of computation and information[1]. For instance, some people describe the processes going on in a living cell as the exchange of information; for instance, the movement of an electron between a free radical and an antioxidant is equated to the movement of information.

Such paradigm models are usually no better than describing one thing in terms of another. However, they can lead to a breakthrough in thinking about processes and structures. One example of this is the concept of memes – that thoughts and ideas can propagate and evolve in a way similar to living organisms[2].

While similes can be useful, they can be very limiting when used to explain complex systems; they can even be mistaken for the reality of the complex system and we can become stuck in believing that the simile is the reality. Similes are often used when talking about the structure and workings of the human brain. Using comparisons with computers (hardware and software) may give some insights, but these fall far short of describing what happens in the brain. Such thinking does, however, flow the other way – results of research into the organisation and workings of the brain are informing developments in computer science.

The difficulty we have in dealing with complexity is also evident in the way much of medical research is carried out. Typically, researchers use single entities to test their effects on health and disease. They then attempt to make meaningful extrapolations to the effects of combined entities. They also carry out research on the effects of single entities on healthy and diseased cells in test tubes and petri dishes and draw conclusions from this about the effects of such entities within a living body. In doing this, they forget or ignore that in a living body there are complexities that cannot be mimicked in a laboratory. One of these is the body's attempt to incorporate or expel any substance in such a way that it will do minimal damage. There are myriad mechanisms by which a living body will attempt to maintain homoeostasis (dynamic equilibrium) or to return to such a state if disturbed. The effect of, say, a single nutrient on a bunch of cancer cells in laboratory glassware (*in vitro* research) may do little to inform us of how that nutrient, in the presence of hundreds of other biochemical entities, will affect the same cancer cells in the body.

We can reduce a complex system to its parts but, confronted with the parts, we can seldom reconstruct the complex system without sufficient 'other' information. More than forty years ago, I witnessed someone demonstrating this. A friend's father opened the gearbox of a small motorbike and the machine spilled its guts, propelled by a powerful spring, onto the driveway. What gave him the edge was his experience as a watchmaker and a list of the gear ratios of the bike. He was also able to see where components had been rubbing up against each other. The reassembled gearbox worked. He said at the time that, with all his knowledge, he would not have succeeded if he had not had the wear marks to see how the parts had interacted.

It is the interactions in complex systems that are so numerous, so hard to understand or even to know. We interfere in these complexities at our peril. And yet, sometimes the complexity and the propensity for such systems to ‘attempt’ to return to a state of dynamic equilibrium, can work in our favour. One example is of the doctors who are able to stimulate alternative biochemical pathways in children with Down’s syndrome, so that the effects of the extra chromosome they carry can be minimised.

Somehow the complex system that is my body is able to ‘automatically’ respond in useful ways to the complex systems that make up my environment. I can but wonder at it all.

1. e.g. Ray Kurzweil – some of his ideas can be seen at http://www.kurzweilai.net
2. see for instance www.wikipedia.org/wiki/Meme