Living with complexity: Can we do better?

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A potted history of complexity

The history of the human mind can be written as a steady upgrading in our power to conceptualise the world, once we cracked the master technology---syntactic language. Yes, there were hiccups when our search for meaning led us down the paths of animism and magic. But the Greeks, talking and writing to each other, decided that the truth was something to be discovered. Indeed, it was they who discovered that there might be something called the truth! Fasting forward through the Dark Ages following the fall of Rome and arriving at the Renaissance we find Europeans learning how to systematically discover tentative truths by observation and experiment (Induction was never the Greeks' strong point). We call their recipes the scientific method. And it has served us well. By the early 20th century farm mechanisation was releasing the Western world's agricultural workforce from centuries of grinding, backbreaking labour. Electricity could suck the darkness out of night. And so on.

But, despite its successes, the mechanistic materialism with which Galileo, Descartes and Newton launched modern science took a simplified 'clockwork' view of Nature, one which had no place for the indeterminacies of natural selection, quantum mechanics etc. Physical relationships were reduced to motions which correlated in time and space. This Cartesian apparatus, as AN Whitehead called it, was blind to and blind-sided by complexity. How to study lumps of the physical, biological or social world where everything that happens depends on everything else that happens? What to do when nothing stays still long enough to make reliable repeated observations from which lawful generalisations can be abstracted? Heraclitus the Greek said it 2600 years ago, "You can't stand in the same river twice."

Twentieth century science pushed on through these background rumblings. Good scientists continued to "carve Nature at the joints" (thanks Plato), finding chunks where strong simple relationships overrode complexity. Some disciplines, notably economics and population genetics, resorted to equilibrium thinking---assume that the things you are interested in will keep changing smoothly towards a state where forces for change die away. The researcher's challenge is to identify one or more such states. In the real world something always comes along to upset this traverse, but meantime we gain rich insights. How powerful is the idea that in a perfect market the rate at which goods are supplied will, under the force of price, grope its way towards a balance with the rate at which goods are bought.

By mid-century people were scratching the complexity itch with systems thinking. In this narrative, the world could be parsed into *systems*, these being collections of parts which interacted much more amongst themselves than with the environment. With patience the way each link behaved could be quantified and the trajectory of the system over time simulated, on paper or in one of those new-fangled computers. The rewards were further powerful insights into how systems can be nudged and steered. But the frustrations accumulated. Many links were wilfully unstable and modellers could not cope with "system shifts," the appetency of complex systems to jump unpredictably from one pattern of behaviour to another.

Then came a rush of ideas for explaining and describing change-over-time in complex systems, including system shifts. Ilya Prigogine, Nobel Laureate, explained such "self-reorganising" behaviour as being like a camel flopping unpredictably to the left or the right as the last straw was added. More scientifically, the world, indeed the universe, is crammed with dissipative (energy degrading) systems which scoop in high quality energy (eg sunlight) and stuff at one end, so to speak, cycle these around various complicated pathways for a while and then excrete waste heat and rubbish at the other end. You, dear reader, are a dissipative system.

Within certain limits, systems adjust to changes in the stocks and flows of energy in their environment and still persist. But, if the amount of energy reaching a system exceeds some threshold, the system is forcibly broken up into simpler, smaller bits; post-war Europe for example. Conversely, if material or energy supplies from the outside world dry up, as in a volcanic winter, the system "dies." These possible fates may be avoided should the system act as if to resist (eg store energy) or replace (eg migration) the threatening environment.

In between those deadly limits, a social or bio-physical system may grow as if to take advantage of energy flows that are not being used, eg wind farms. Or it may, without changing its structure, change the rate at which it processes energy (eg food rationing). This is called homeostasis, and it too has its limits, eg our ability to control body temperature. When a system is forced past its homeostatic limits, it sometimes has one last trick in its survival kit. And that is to spontaneously self-reorganise into a new structure capable of processing a modified pattern of energy flows. The chrysalis becomes a butterfly.

In all these cases the system is *evolving*, that is, it is changing piece-wise over time. Evolution is a universal process, not just a biological process.

Dissipation is the way in which the universe complies with the second law of thermodynamics, namely that, over the universe as a whole, energy quality keeps falling. When not reorganising themselves, most dissipative systems are behaving *chaotically* meaning that while they keep cycling stuff around and around in much the same way, it is never quite the same. Not what most of us mean by chaotic!

A world of complex evolving systems

In recent decades, this basic model of an active universe full of dissipative systems, each embedded in a changing environment and ticking over chaotically till prodded into jump-shifting, has been applied to an ever-widening suite of physical, chemical, biological, psychological and social systems; from galaxies to nation states. The particularities and elaborations differ but the central idea of regarding what one is studying as a complex evolving system has generally proved workable and plausible. This common central idea has encouraged cross-fertilisation.

In biology for example, our understanding of the evolution of species has moved beyond Darwinism and neo-Darwinism. Its not that Darwinism---heritable variation followed by natural selection---is wrong, just incomplete. Tracing out a plausible history for a species nowadays requires consideration of various forms of coevolution (circular causation) including adaptation and pre-adaptation to changing environments, how species change their own environments and symbiotic relations with other species.

Consider next an example from cultural evolution, our main interest in this essay. Joseph Tainter, one of the few archaeologists to have made a comparative study of collapsed societies, concluded that each time a society brings in measures to solve a problem it makes the society more complex (you can never do just one thing) and the next problem even harder to solve. Eventually, at some point the costs of additional reorganisation exceed the benefits. Tainter's insight is that reactive problem solving is often successful in the short term but, in the long term, it is a recipe for "gridlock" and may well increase that society's vulnerability to collapse. Another insight which comes directly from applying complexity thinking to cultural evolution is that uncontrollable runaway change is always a possibility.

At very least, such insights help us understand past cultural evolution a little better. Maybe the Roman Empire got too complex to manage and maybe Eurasia suffered self-amplifying warfare in the Bronze Age. But the science of complex evolving systems is still adolescent and, as yet, has little to offer the future-gazer. Look at the uncertainties surrounding the prediction of climate change despite great efforts in that direction. Even worse, what we do know of complex evolving systems suggests that future-gazers have every right to be pessimistic.

How to frighten the complexity problem

Despite the prediction deficit, there is still reason to believe that the insights which are dribbling in from the science of complex evolving systems can help with this pervasive complexity problem. Pardon? The world is a complex place in which societies are constantly under threat of disruption, destruction, regression and stasis (lack of "progress"). In that contrary world, societies face a suite of interdependent ever-changing problems which they do not know how to tackle with confidence. This be the complexity problem.

The first thing complexity thinking can offer societies wanting to guide their own cultural evolution is an updated world view. Rather than seeing Australian (say) society in ideological, reductionist (eg, growth solves all problems) or fundamentalist terms, why not see it as a complex evolving system? Naming something is the starting point for thinking productively about it. The suggestion being made here is that we should extract as much as possible from studying Australian society as a self-reorganising system which keeps experimenting with its technology mix (and that includes social as well as material technologies), changing the way it does things when and if change promises to solve a problem or capitalise on an opportunity. Attempting to change the Constitution is a good example.

The over-arching lesson that comes from seeing societies as irrepressibly, complexly and unpredictably evolving is *Be prepared*, this being a punchier version of the more academic injunction to *Embrace proactive adaptation.*

Many guidelines for implementing a strategy of proactive adaptation suggest themselves. Here are a few.

Guideline: Draw on history and other disciplines to identify principles of cultural evolution which need to be recognised by policy makers.

Example: Some societies, we call them resilient, tend to resist shocks.

Policy response: Use periods between crises (good times) to accumulate capital, redundancy, slack etc for countering shocks when they arrive.

Example: Many new technologies have unforeseen side effects ('biteback') which soon demand that they be modified or withdrawn.

Policy response: Attempt to foresee bitebacks in advance and have response mechanisms ready. It is common enough for bitebacks to be foreseen (asbestos, global warming) but uncommon for early remedial action to be taken.

Example: Social technologies (eg institutional arrangements) for dealing with new material technologies tend to lag.

Policy response: While markets foster material technologies, special generation and selection mechanisms may need to be set up for social technologies. Australia once had a Commission for the Future which could have done just this if it had been better funded and managed.

Scenario construction and *adaptive management* are other examples from a stable of tools for helping to make what-to-do decisions about managing unpredictable technology mixes. *Scenarios* are plausible alternative stories (not formal models) about what the future might be like, depending on what one does now and the whims of the environment. The challenge is to choose what to do today in such a way that the future is acceptable enough whichever story turns out to be true. Scenario construction is a popular way of developing strategies for managing highly uncertain but significant processes like pandemics, industry policy, energy supplies…

Adaptive management is a "suck it and see" philosophy where one deliberately pokes the system in various ways to get a preliminary idea of how it tends to respond to manipulation. For example, indigenous health policy would benefit from randomised trials of different approaches. One of the under-recognised virtues of the Australian federal system is that the different approaches of the States to common problems mimic a set of "treatments" in a large–scale experiment. Education systems are a good example.

But is it progress?

At one level there is nothing new in what is being said above. Big-thinking historians like Arnold Toynbee and WH McNeill have been willing to generalise about why societies do and don't survive and thrive. Folk wisdom is full of maxims which translate readily to whole societies (A stitch in time…). Management tools can be developed without asking why the world is unpredictable. There is no shortage of good advice.

Nor is there any suggestion that complexity thinking can, at this stage, dramatically improve society's prospects for long term quality survival. There may be very powerful insights on the way but honest researchers make no promises. An example of a recent win is the idea that when social networks reach a critical point, just a handful of extra random connections transforms the society from being highly modular to being highly connected.

But there is this damned heffalump in the room. As in the Great Depression there is a pervasive feeling that we live in a time of great change, maybe even permanent collapse of our society. Increasing complexity plus rapid social change is making reform ever more difficult. There is little feeling that our political institutions have the capacity to guide this change towards achieving high quality of life for most people.

The time is ripe for a sea change in how ordinary educated people view the world---and it may just happen. And if such does happen, the political system will follow. That change could be a frightened retreat to a nasty populism or an iron bar fundamentalism. The suggestion here is that there is another candidate, one being created piecemeal by serious thinkers in a dozen disciplines. I am tempted to call it Preparationism. Its starting point is that the fundamental responsibility of any society is to be prepared. It asks what are we truly prepared for? What are we unprepared for? What should we be preparing for? And, what currently allocated resources should be reallocated to those preparations? Perhaps the sustainability movement is a bell-wether for proactive adaptation? I don't know. What I do remain convinced of is that we can lift our game even if there are no magic bullets for shooting the heffalump.