# 5. As through a glass darkly: a complex systems approach to futures

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It is the year 1663 and in London, Charles II grants royal approval to a learned society which came into being three years earlier following a lecture by Christopher Wren. In 1665 one of the founders of the Society, Robert Hooke, published *Micrographia: or Some Physiological Descriptions of Minute Bodies made by Magnifying Glasses with Observations and Inquiries thereupon*, one of the classics of what was known as *experimental philosophy* which in turn owed its origins to Francis Bacon and Aristotle. The Royal Society, as it is now known, would go on to publish Newton's *Principia Mathematica*. However, the subsequent dispute with Leibniz over *the Calculus* demonstrated that whatever their lofty goals, scientists are not immune to politics. The Society approved Babbage's Difference Engine but didn't admit its first female fellow until 1947 despite the importance of Ada Lovelace, née Byron to Babbage's work. She was the first to see the wider implications of computing and wrote the first computer program. Her interest in mathematics and logic was encouraged by her mother with the intention of preventing her from falling into her father's perceived insanity. Significantly she described her work as *Poetical science* and described herself as an *Analyst & Metaphysician* (Tool 1998).

Our modern view of science was formed in the 17th century with the Enlightenment, a period in human history whose birth is variously attributed to texts such as *Principia Mathematica* and Descartes' *Discourse on the Method of Rightly Conducting One's Reason and of Seeking Truth in the Sciences*. Midgley (2001) has suggested that the Cartesian separation of the body from the soul was motivated in part by the desire to create a space for practitioners of science that would not be subject to the fates of Bruno and Galileo. Whatever the motivation, it brought into play a false dualism that prevails in the current day. In addition, a driving belief in natural law, liberty and constitutional government all characterise the period as does a belief in reductionism as a method. That in turn gave rise to a belief in the ability to predict through an understanding of underlying causes; Comte and others at the foundation of sociology saw themselves as applying Newtonian principles to social systems. Hope and optimism about progress were also shared by an international community of scholars. Even during the Napoleonic Wars members of the Royal Society in London and the Académie des Sciences in Paris both corresponded and even arranged meetings under safe conduct passes (De Beer 1952). Both groups were in their early stage of formation, not yet institutionalised and such behaviour came naturally to people driven more by curiosity than power.

Other significant events were shaping and forming society in Europe. In 1666 the Great Fire destroyed the medieval City of London and beyond. There had been three major fires before in 982, 1087 and 1212. The last of these saw the highest death toll and regulations were introduced to ban the use of thatch and other flammable materials, but these were largely ignored. Firefighting techniques at the time involved water and controlled demolition, often drastic through the use of gunpowder. There was little thought to the system as a whole, or to anticipatory thinking and planning; no one realised the significance of the fire reaching the waterfront and setting alight the water wheels that supplied the piped water system. The high Roman Walls built after AD 60 to protect the citizens now acted as a major constraint on escape and firefighting as the various city gates acted as bottlenecks, their unintended consequence was disastrous.

Despite this, the fire was not a surprise, although the timing may well have been. It was foretold in Mother Shipton's prophesies published in 1641 and an astrologer, William Lilly, who saw the future in dreams, issued a warning in 1651. The Great Plague of London (1665 to 1666) was a compounding factor and given that 666 is the number of the beast there were a cluster of end-of-the-world predictions for that year. On a less magical basis, the aforementioned King Charles II wrote to the Lord Mayor of London in 1665 warning of the dangers of narrow streets and overhanging wooden buildings. Even after the Great Fire, we have further major events in Southwark in 1676, Whitehall in 1698 and Tooley Street in 1861. All of these disasters arose as a result of a combination of events triggered by an accident of some sort. Only the Blitz of London in 1940–41 and Boudica's raising of the Roman City in AD 60 arose from malicious intent. That said, rumours of foreign undercover agents using fireballs resulted in a wave of street violence during the Great Fire which made matters worse. The assumption of intent is all too common in human systems, aside from having someone to blame, it also has the attraction of crude linear timelines and oversimplification. Fundamental attribution error (Ross 1977) identifies the way we attribute intent to others while excusing our own actions as a result of accidents: simplistic reasons and a readily identifiable group to blame for the consequences of our own neglect or inaction will always be attractive.

This very human catalogue of disasters, unintended consequences, accidents, scapegoating and failure to take cognisance of other than proximate threats, combined with countless other aspects of the rich tapestry of human experience, continues into the current day. We may be better at firefighting (literally and metaphorically) and writing building regulations, but the hope that with rational and reductionist science we could overcome the multiple and fractal realities of human evolution (please note the avoidance of the term human nature) has proved to be false. COVID (or something like it) was foreseen, preparations were made but only implemented in part if at all. Political corruption and the creation of false myths and conspiracy theories hindered attempts to manage the situation. And COVID is nothing to the plagues which are still to hit and the existential threat of the Climate Emergency. In that respect established financial interests are repeating the same errors of denial as did the tobacco industry. There is a revolving door in which companies employ former staff of their regulators and this pathway to higher earnings is known and understood. Worse, populism with its ability to exploit fear and uncertainty remains a growing threat. The influence of Manichæism remains, especially in North America with the demonisation of the 'other'. Breaking apart and dividing people in the interests of power, but not that of the planet, is the very opposite of the collaboration of those British and French scientists in the 17th century. But it very much reflects the partisan promotion of Newton over Leibniz by the Royal Society. The hope and visions of Enlightenment thinking from the 17th century through the Weimar Republic and into the current day have too frequently clashed with political reality. With climate change the myth, and it was always a myth, of steady progress towards greater levels of civilisation is finally shattered. Indeed, it could be argued that this myth of linear progress towards a culturally specific definition of 'civilisation' did as much harm as it did good through slavery and colonialism. The various empires of the world have always sought to *civilise* others. A concept delightfully satirised in Eric Linklater's novel *Private Angelo*.

The reality of the human condition is that we, in the main, only pay attention to the proximate future. That has consequences for both the theory and practice of Future Studies. The significant long-term changes required to deal with climate change involve a level of sacrifice that is not possible in a modern democracy, without a major change in the dispositional attitudes of voters. That will not be possible until the day-to-day reality of their lives involves small sacrifices which have short-term impact (Snowden 2019). It is not enough to simply point to a scenario or a series of scenarios which accurately predict future disasters. A major theme of this chapter is the need to manage the energy gradients of the current states in order to allow a different future to emerge. To achieve change, advocacy has to be hard-baked into evidence: any foresight approach is only as good as its ability to persuade people to act differently.

We need new ways to better understand the evolutionary potential of the 'thick present' (Poli 2011). This chapter aims to be a starting point in the development of both theory and practice in this area. It develops and uses material from a joint publication in 2021 between the author's Cynefin Centre and the Future Systems Directorate of the European Union, *Managing complexity (and chaos) in times of crisis* (Snowden & Rancati 2021). Hereinafter referred to as the EUFG.

## 5.1 THEORETICAL FRAMING

*Naturalising sense-making* is one of five acknowledged schools of sense-making (Urquhart et al. 2020) and asks the question: How do we make sense of the world so we can act in it? With that phrase comes a concept of sufficiency: given the level of our knowledge what decisions can we make? The school is distinguished by its acknowledgement of the naturalising approach to epistemology (Kornblith 1994); taking natural science as an enabling constraint in understanding social systems (Snowden 2010). This approach to sense-making is trans-disciplinary in nature drawing on both the humanities and the natural sciences. This section summarises four key pillars that underpin the approach.

### 5.1.1 We Only See What We Expect to See

A good way to illustrate the application of naturalistic principles is to examine the results of an experiment (Drew, Vo & Wolfe 2013):

> 24 radiologists were asked to perform a familiar lung nodule detection task.
> A picture of a gorilla, 48 times larger than the average nodule, was inserted in the last case.
> 83% of radiologists did not see the gorilla.
> Eye-tracking showed that the majority of those who missed the gorilla looked directly at it.

Known as *in-attentional blindness* the phenomena can be summarised as *we do not see what we do not expect to see.* The reasons for this lie in energy efficiency. We can't afford to scan all available data before we make a decision so we privilege the association of a limited scan of available data with first-fit pattern matching to individual and collective memories and imagination. In species terms this has an evolutionary advantage, if you are being pursued by a predator it makes perfect sense. It is not a bias in the sense of something that is wrong.

Indeed, Klein (2022) and others have argued that cognitive biases are essentially cognitive heuristics. Most of the time we will not see gorillas in X-rays so why waste energy looking for them? The theme of energy optimisation, or minimisation is key to much work in neuroscience (Parr, Pezzulo & Friston 2022). More recently, Clark (2023) has extended his early work on distributed, or extended, cognition to outline the way in which the brain is constantly hallucinating possibilities building on multiple sources, testing those micro-hallucinations against reality and only responding consciously if it detects anomalies. If you are walking down the street, you only pay attention if you stumble. There is a clear implication here – that we will draw on later – that creating anomalies is critical to sense-making both at an individual and a collective level.

Naturalising sense-making as a discipline takes this kind of scientific knowledge and uses it as an enabling constraint. To return to the experiment quoted above, if 83 per cent will not see the gorilla, then simply trying to improve the information flows and training of decision-makers is not the best way to make sure the gorilla does get spotted. Instead, we need to find ways, while performing situational assessment, to make decision-makers aware of the multiple patterns of differing interpretations. We do this through the use of diverse scanning networks, and in particular, aim to bring anomalies to decision-makers' immediate attention, the 17 per cent who do see the gorilla. We need to pay attention to outliers. To achieve this we need to ensure that scanning maximises diversity as much as for expertise (Syed 2019). We will come to this when we look at tools and methods later. This, and other aspects of modern theories of consciousness constitute the first pillar of naturalising sense-making.

### 5.1.2 Abduction

Humans are very good at abductive logic, and less good at inductive (where machine learning can be more effective). Sometimes known as the logic of hunches, the American pragmatists saw abduction as hypothesis generation, Bateson (2021) sees it as idea generation through the use of metaphor. Within naturalising sense-making it is the use of *abstraction* to allow novel connections to be made between apparently unconnected things. Abduction is key to the process of exaptation described in the next section. Abstraction, including art, is one of the ways that novel insights and intuition arise. Abstraction distances our understanding from material reality so that we can see or perceive connections and possibilities in unexpected ways. The downside is that it makes us more vulnerable to conspiracy theories. It also, to make a key distinction with machine learning, allows humans to break from the path dependency of training datasets.

The *Problem of Abduction* lies in distinguishing the validity of one intuitive insight from another, of sorting coherent insights from incoherent ones. Abduction makes humans both imaginative and excellent at problem-solving through what the EUFG (Snowden & Rancati 2021) calls the *radical repurposing* of existing capability for novel use. But we generate a lot of such insights and we get very attached to them, even in the face of negative evidence. Determining the validity of which insights are coherent is key to decision-making under conditions of uncertainty. The history of terrorism is littered with examples of someone spotting weak signals early but failing to gain attention. A common question used in post-event analysis is: Why didn't we join up the dots? With the benefits of hindsight, a causal chain seems self-evident and we assume that with better processes, training etc., it could have been seen in advance. But this is not the case, if we have four dots then there are six linkages that can form between the dots and linkages and 64 possible patterns. If we go up to ten dots then the number of possible patterns exceeds three trillion (Boisot 2004). How many dots are there in a human system? So how many possible patterns? We are dealing with the proverbial needle in a haystack, and the needle is made of straw. There are simply too many dots/signals for us to pay attention to all of them, so it becomes a matter of luck that someone will *see* the signal, then more luck that someone in power will pay *attention* to what has been seen and even more critically *act* on it. In a complex world, hindsight does not allow for better foresight, if anything it makes it worse.

So the problem of abduction is to determine which intuitions we should pay attention to, and also how we generate those insights at scale, and from multiple perspectives in the moment. Machine learning may help but it is inductive in nature, or at least constrained by induction. We need an objective way of determining coherent from incoherent insights. That means finding the 17 per cent who have seen a gorilla before they talk to the 83 per cent who have not and also gaining the attention of decision-makers for whom taking the insight seriously may involve considerable risk if it proves to be false. Time is also a significant factor and the ability to see things from multiple perspectives in real time is one of the key methods outlined later. This is our second pillar.

### 5.1.3 Complex Adaptive Systems

Our third pillar and the main scientific base of this chapter together with the EUFG is complex adaptive systems theory (CAS). The origins of this science lie in the three-body problem. Its development through the work of Prigogine in dissipative structures, Kauffman in biology, Arthur in economics and many others is beyond the scope of this chapter. While there is general alignment on the nature of a complex adaptive systems in the literature there is no single agreed definition. When we get to the use of 'complex' as a word in ordinary language we have even greater ambiguity. Historically *complex* has been used as a synonym for *complicated* but a variety of authors have increasingly made them antonyms and the difference is best understood in terms of their origins. The Latin root of complicated lies the idea of something that is folded, and by implication can be unfolded while remaining largely unchanged. Complex, on the the other hand, has a Greek origin in the idea of entanglement and any attempt to untangle it will create something different and the entanglement will never happen quite the same way twice, although there will be discernible patterns. Juarrero (2002) defined a complex system as being 'like bramble bushes in a thicket' and that evocative image will provide more than adequate definition for the purposes of this chapter.

In that context, it is important to realise that in a CAS there is no material linear causality (Juarrero 1999) but the system as a whole is *modulated*. To understand this, think of a ring of electro-magnets which can change in polarity and strength. Some you control, some are controlled by actors you are aware of and some are simply changing. In the space between are multiple iron objects of varying density and shape, some connected with elastic bands, some with chains, and some unconnected. If I change one magnet then I can predict the result, similarly if I change two. But when three change simultaneously it is no longer possible. To add to the complexity some of the iron objects will become weak magnetic fields. The magnets *modulate* system behaviour and as as a result a pattern *emerges.* The self-assembling wires experiments (Stanford Complexity Group 2015) illustrate this well. You may be able to make accurate statements about patterns and that has utility, but simulation is not prediction and patterns are not precision.

In addition to modulation, we need to introduce another term which will be unfamiliar to many readers, namely, that of an *actant*. This is used as an alternative to the use of *agents* common in CAS work (Axelrod & Cohen 2001) or the simple use of *actors*. In literary theory, an actant can mean a person but it can also mean any object which plays an active role in any narrative. So all actors are actants, but not all actants are actors. Material objects have always had a degree of agency in human systems (Malafouris 2016) and in a modern world of mobile devices technology has never been more important, as are institutions, common beliefs and universal practices, including rituals, all of which can be actants. A road design or map may also scaffold the system and thus be an actant. The term gives us more flexibility in both theory and practice. Actant is also used in Actor-Network Theory (Latour 2005) and there are elements in common, but our use is in Assemblage theory within the context of New Materialism (see next section) which has significant differences.

This magnet metaphor has important issues in terms of practice. If I focus on trying to predict future states I am doomed to fail but if I can observe the current state and if I control enough of the magnets then, by real-time action I can influence and possibly even control what patterns emerge. The need for real-time human sensor networks to achieve this in human systems is laid out in the EUFG and their function is to act as diverse monitoring systems for weak signal detection and emerging patterns.

Emergence is one of the most critical aspects of CAS and is frequently one of the most commonly misunderstood, and abused; too often used as an excuse for doing nothing. The emergent properties of a system cannot be attributed to the properties of the parts or the interactions which produced it and any perceived coherence will be retrospective in nature. There are three necessary but not sufficient conditions for emergence to occur:

1. There must be a significant number of actants.
2. The actants are characterised by rich, highly local interactions to which they adapt.
3. No actor is aware of the system as a whole.

Such systems do not necessarily have boundaries and the non-linear nature of the interactions can produce significant and unexpected effects from very small changes in the initial starting conditions. They also have path dependency and their evolutionary past is co-responsible for current behaviour, but this is not deterministic in nature. Critically, emergence is irreducible and irreversible so early detection of any change is key, hence the need for near real-time sensor networks. In seeking to manage a CAS all we can do is create or influence actants and their interactions and rapidly deploy energy to emergent patterns we consider beneficial while withdrawing it from those that could be harmful. Futures work will then include the creation of those networks and methods that will focus on understanding the current and possible future nature of actants and their interactions.

If we are monitoring for emergence, then we also have to know where we can direct the evolution of patterns and which are more plausible than others. Here we come to another key concept, on which we will depend later in this chapter: Stuart Kauffman's (2000) notion of the *adjacent possible.* In evolutionary biology, it argues that there are a range of possibilities available, which are *adjacent* to the present. At any given point in time, a system may re-orientate itself to possibilities that are adjacent to current reality, but not those which are distant from it. Not all such adjacencies are obvious. We will also use Gould and Vrba's

(2016) concept of *exaptation* in which a trait that was selected according to one function under conditions of stress *exapts*, rather than *adapts* for a completely different context. It initially changes function but not form, but with the new function, subsequent changes in the form will arise through adaption: dinosaurs' feathers which were selected for sexual display and/or warmth then exapt for flight; the cerebellum which evolved for fine-grained muscle control for feeding exapts to handle grammar in human language. Critically, in human innovation exaptive insights require someone to pay attention to things they are not expecting to see. In the 1940s a self-taught (which may be significant) engineer named Percy Spence realised the significance of a chocolate bar melting in his pocket, which resulted in the repurposing of the magneto of a radar machine to create the first microwave oven. Viagra, aspirin and many other drugs are examples of repurposing. The proximity of exaptive change will not be obvious at the time, hence the use of high abstraction metadata to map existing knowledge, outlined in the EUFG to manage serendipitous encounters with novel possibilities.

While many will be familiar with the use of complexity science to model the flocking behaviour of birds, termite nest building, the collapse of civilisations and many other projects, human systems have additional layers of complexity. To recognise this, Snowden (2000) and colleagues created the term *anthro-complexity* to distinguish the study of complexity in human systems from *computational complexity* with its focus on modelling. It argues that complexity in human systems differs from that elsewhere in nature by virtue of:

1. Intelligence: Humans have the capacity to reflect on their world and to work with abstractions, we can shape our world physically and spiritually.
2. Identity: Humans constantly shift between identities based on context, something that is not the case for insects and reptiles (putting the higher apes and octopodes aside for the moment). Those identities can exist within and between individuals and are not always bounded by time or space which makes the parameters for modelling and the necessary reduction involved problematic.
3. Intention: Humans, although definitely also subject to influences that do not arise from conscious intent, can also act intentionally, even against their own interests. Humans are the only species to demonstrate altruism and/or a willingness to sacrifice, outside of a kinship group, or to an abstraction.

To understand this we will need to draw on anthropology, cognitive science and a body of work in the humanities. That will include the critical role of narrative in entangling human perception and decision-making at scale.

### 5.1.4 Assemblage Theory and Narrative

This fourth pillar merges a body of work on the role of narrative in sense-making. Browning and Boudès (2005) compare Weick's work with the author's own Cynefin framework and to that we can add Dervin (1998), Boje (2014) and many others. Authors in the field are not without substantive differences (Oliver & Snowden 2005). In the context of futures we focus on distributed ethnographic approaches to social inquiry (Snowden 2010; Mark & Snowden 2017). There are clear links to the concept of an assemblage in Deleuzo-Guattarian ontology. An assemblage is an ensemble of heterogeneous elements which compose a territory. Assemblage is a slightly problematic term in English as it doesn't mean an assembly of parts.

It 'translates to *agencement*; meaning to arrange, to play out or to piece together', it is 'not a unified whole, but more a heterogeneous co-existence' (Panagiotou & Snowden 2024).

Patterns of similar micro-narratives form through conversation into patterns of sense-making which act rather like attractors in determining what is paid attention to or believed. In this chapter we are using the concept within the wider context of New Materialism (DeLanda 2016). There are three key characteristics of New Materialism (Fox & Alldred 2015):

1. It sees humans and all other entities as relational 'having no ontological status or integrity other than that produced through their relationship to other similarly contingent and ephemeral bodies, things and ideas. Assemblages of relationships develop in unpredictable ways around actions and events' and critically have an existence independent of human bodies.
2. It takes Spinoza's notion of affect 'meaning simply the capacity to affect or be affected. In an assemblage, there is no "subject" and no "object", and no single element possesses agency. Rather an *affect* is a "becoming" that represents a change of stage or capacities of an entity'.
3. Assemblages are also seen as 'territories', so 'affective flows within assemblages render them constantly in flux, with territorialising flows stabilising an assemblage, while others destabilise or de-territorialise it, sometimes leading to dis-assembly and "lines of flight" by constituent elements. These territorialisations and de-territorialisations are the means by which lives, societies and histories unfold.'

To put things a little more simply, we can look at what happens with tropes (avoiding the meme word is key here as that is based on the wrong metaphor) that emerge in society. I tell a story, you tell a story, we like each others' stories. That continues, and with social media is amplified a hundred-fold. We end up in a type of attractor well where there is an evolving, fractal state where proximity results in capture. This attractor now exists independently of the original storytellers and modulates what is or is not acceptable behaviour, it exerts downward causality. We can see this phenomenon in the tribalism that arises around populist politicians, where the energy of the attractor is maintained by key trigger phrases: 'Get Brexit done', 'Make America Great Again' and so on. The assemblage creates a reality or territory from which escape is difficult. And there is a degree of immunity not only to argument, but to encounters with real experience and other, more coherent tropes. The briefest look at climate denial narratives will demonstrate this. Assemblages also provide national and religious identity not to mention the loyalty patterns associated with sports clubs. Affective flows can comprise elements from many levels, from the grand narratives of strategy to the anecdotal accounts of human experience at the school gate or in the pub after work. They are a network of multiple connections that are not arborescent but are deeply entangled and rhizomatic in nature (Deleuze & Guattari 1980). The fact that they are not arborescent will be significant when we look at the use of Constructor theory (Deutsch & Marletto 2014) as one way to understand the affordance structures in which futures work takes place.

Assemblages territorialise the substrate within which planning, forecasting and sense-making in general take place. As such they are key to understanding the nature of foresight and futures. They don't just impact on common perception but also on those engaged in futures work in both academe and government. They are not something we can be trained out of, they are a part of reality. The radiologists who didn't see the gorilla were highly trained individuals after all.

The EUFG contains examples of using distributed ethnography to map assemblages in policy making and we will build on that shortly. It is worth reflecting that New Materialism 'supplies a conception of agency not tied to human action, shifting the focus for social enquiry from an approach predicated upon humans and their bodies, examining instead how relational networks or assemblages of animate and inanimate affect and are affected' (Fox & Alldred 2015, p. 401). This represents an ontological turn in futures work.

## 5.2 SHIFTING TO PRACTICE

The historical development of this approach is significant. The original work, focusing on narrative and complexity theory in the context of knowledge management and decision support, was in its early stages of development within IBM Global Services when it came to the attention of the US government's DARPA program. An initial piece of work focused on how to get people from different political backgrounds to take a non-partisan approach to situational assessment. That project was successfully concluded in a workshop in Arlington, Virginia, the day before 9/11. It then morphed into the Genoa II program for which the author was joint research lead with SRI from Merlo Park in California. The overall focus was on weak signal detection in the context of counter-terrorism (Lazaroff & Snowden 2006) with SRI focusing on scenario planning while the IBM team was responsible for:

1. Developing systems to capture and interpret street narratives to get an early indication of a switch from tacit to explicit support of terrorism.
2. Finding better ways to get decision-makers to pay attention to weak signals.
3. Solving the problem of abduction, how to create an effective approach to decision support.

That work continued when the author left IBM and acted as co-designer of the Singapore government's Risk Assessment and Horizon Scanning system, focusing on complex decision-making and alternatives to scenario planning for foresight under conditions of uncertainty. That work then extended into the not-for-profit and commercial sectors in addition to government and defence. When COVID hit the EUFG was produced as a cooperative project and this chapter builds on the work in that guide.

The journey has been a complex one with the constant interaction of theory and practice, working at both a micro and a macro scale.

### 5.2.1 The Basic Question

So how do we address futures work in a world where the future is inherently unknowable and there are major issues with the human capacity to even understand the here and now? To quote Seneca the Younger:

> The greatest loss of time is delay and expectation, which depend upon the future. We let go of the present, which we have in our power, and look forward to that which depends upon chance, and so relinquish a certainty for an uncertainty.

We live in an entangled world of complexity which means we live in a world of unknowable unknowns, although we can perceive patterns, albeit that in the words of St Paul *We see as* *through a glass, darkly* (1 Corinthians 13:12). In a complex adaptive system there is no linear material causality (Juarrero 1999) so, a priori, making predictions is problematic. Forecasting and backcasting both assume a degree of predictable relationship between cause and effect; so in the field of anthro-complexity, we focus on 'side casting' (Snowden 2012), casting around in the present to discover opportunities. That leads to mapping the affordances of the current state. The more accurately we can understand where we are, the more we can manage the evolutionary potential of the present.

That means a focus on what can actually be managed and/or influenced. The key first stage in that work is to understand the *affordances* provided by the current situation and, given the way bias is bound to creep we need to de-territorialise the dominant patterns of interpretation. In general, humans will always assess the current situation based on how they have already decided to act. We also need, if at all possible, to reduce or remove conflict at this stage of the process. Conflict is inevitable in terms of macro-level actions so we need to avoid and hint of the desired outcome at this stage. This need resulted in a new framework to map the affordances of the system or systems in which we are operating.

The name for this framework and linked methods is *Estuarine Mapping*. The metaphor of an estuary is important as unlike a delta, in an estuary, the water flows both ways. If you have a low-powered boat you can only cross at the turn of the tide. There are granite cliffs you may only need to check every decade or so and sandbanks may shift every day. There is a fluctuating balance between salt and fresh water. Overall, it is a rich metaphor for the reality of any situation. This contrasts with the arborescent assumptions of Constructal Law (Bejan & Zane 2012). The estuarine metaphor is powerful as it also has a recursive element in that the landscape created by the flow of water may also modulate the landscape itself through, for example, the creation of a river hazard. The multiple complex interactions may see the rise and fall of various different habitats over time.

In creating an estuarine map we are in effect mapping the affordances of a system and that will also involve two other distinct but connected activities, namely:

1. Understanding the fractal assemblages of the environment in which we are operating through the use of narrative topologies, a form derived from Kaufmann's work on fitness landscapes.
2. We need to resolve the problem of abduction in active decision-making. That will involve gaining multiple perspectives in both the present and potential future states and, critically, identifying outliers.

While we will describe the process as a once-off workshop, it is designed for real-time use, in effect combining grand strategy and tactics into a single framework.

### 5.2.2 Estuarine Mapping

The origins of this method lie in two primary sources, Juarrero's (1999, 2023) work on constraints and Constructor theory (Deutsch & Marletto 2014) whose origins lie in physics and in particular quantum mechanics.

Firstly, we will look at constraints. In a system without constraints all events are equiprobable, the introduction of constants creates a gradient which triggers evolutionary change. While from a scientific perspective constraints are neither positive nor negative, in common language, they are generally perceived as things that need to be removed in order to enable efficient flow. Any method needs to recognise the reality of common use of language, and also keep things simple and memorable if it is to gain traction. Over the years several typologies of constraints have been developed and continue in use, but the method settled on is a simple distinction between constraints that *contain* and those which *connect*. Containment increases predictability thanks to known boundaries while the connection may well result in fluid, boundary-free systems. In general, containment creates order and predictability, connectivity (rich interactions between actants) is more characteristic of a CAS.

Secondly, Constructor theory, which is well summed up by this quote from one of its creators, (Marletto 2021) also introduces two keywords, namely, *counterfactual* and *constructor*:

> A counterfactual is a statement about which transformations are possible and which are impossible in a physical system. A transformation is possible when you have a 'constructor' that can perform a task and then retain the capacity to perform it again.

Constructor theory provides a framework built on transformations rather than components and thus matches well with CAS theory. The application of this theory to social systems (Turner, Snowden & Thurlow 2022) is relatively new.

The essence of a constructor is that it enables a transformation in a replicable way. In Estuarine Mapping we identify three types of constructors, those that transform by *passage* (for example, a ritual or a process), those that transform by *contagion* (influence, imitation etc.) and those that transform by *presence*, such as a catalyst. In a further modification to the original theory, we hold that a constructor can change in the act of construction, if slowly, but with continuity of identity over time. Some other typologies and examples can also be used.

In effect, the constraints and the constructors are modulating the system we wish to manage, both in the present state and in its evolutionary possibilities. *Manage* is used here in the sense of its original Italian, namely, the ability to manage horses rather than its evolution into household management (Kurtz & Snowden 2007).

To understand the affordances of the current system we go through the following stages to create the grid shown in Figure 5.1.

1. We start by brainstorming what constructors and constraints are present, or which might emerge. This normally uses the simple typologies described above but more sophisticated metaphors can be used or created with the participants. For example, contrasting resilient with robust constraints. We also add actors into the process and present the three as a typology in the form of a triangle to facilitate discovery.
2. All three types are then positioned on the grid shown which maps the energy cost of change against time to change. Our overall goal here is to understand what can change either under our control or

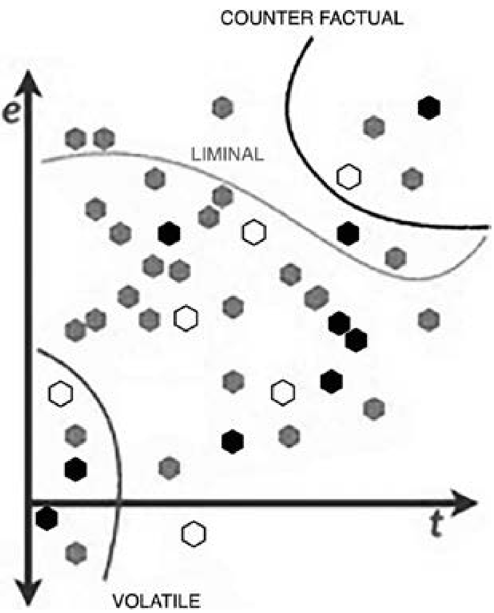


*Figure 5.1* *Estuarine map*

not and in consequence be able to better understand risk and resource allocation. Energy is used here to indicate any resource material or otherwise: money, focus, attention etc.
3. Once positioned the group create the counterfactual line where everything north-east of the line represents such a high energy cost and/or time that realistically it will not, or cannot be changed.
4. In parallel, a liminal zone is established where change might happen or be achieved but only as a result of actions of those not under the direct influence of those building the grid.
5. The south-west area, designated by the vulnerable line, represents things that could, to use a colloquial phrase, *turn on a dime*, that is to say. sudden change is possible with little or no control.

It is important to note that the approach is designed to remove conflict. To achieve this the group are instructed that, if there is any disagreement on the nature of the constructors or constraints, or their placement on the grid, then they should keep breaking them down until there is no disagreement. This is often achieved by situating them into specific contexts until there is no disagreement. In anthro-complexity, this is known as the *lowest level of coherent granularity*. It is about achieving agreement not consensus or compromise. This whole process can now be done with software to create a first pass, gathering data from large populations and shifting to real-time presentation to demonstrate changes.

In parallel, the group identify *phenomena* which cannot be attributed to an actor or a constraint or a constructor. Actants comprise actors and combinations of constraints and constructors, which is why we also allow actors to be mapped onto the grid. Phenomena which cannot be attributed are a form of dark modulation (a reference to dark matter). Once these are listed, then a parallel activity is set up to research and investigate those in order to identify how they are modulating the system. The number and nature of phenomena which cannot be so attributed is a measure of risk going forward.

Once the map is created it provides a representation of the energy cost of change going forward and what has the lowest energy gradient is likely to win out. Identifying the counterfactual space reduces the energy cost of decision-making by removing that domain from the table. But the group will create monitoring processes to check that the state is not changing, For all other actors, constraints or constructors the group can determine if they can change the energy or time; the metaphor here is the compass rose, so we can attempt to shift things to the south, the north-west and so on. This may involve making change more difficult or easier. We then end up with a range of micro-projects designed to skew the affordances of the system in our favour. In effect, we are reducing the overall energy cost of situational assessment and foresight by small-scale focused interventions. This is not a passive process. If the initial map is created using software, then we can capture additional data about the nature of constraints and constructors and also look at the grid from different perspectives.

More extensively, we have the following action types:

Vectors:

- Compass rose (increasing or decreasing the energy cost or time to change), for example, *south-west* involves decreasing both.
- Destroy, we need to get rid of this.
- Stabilise the current state, and possibly monitor.

Signals:

- Monitors which apply to boundary conditions but also more generally where change would produce a different result.
- Trigger a change, we are happy with the energy cost and time to change and now we want to make something happen, not just change the affordance landscape; that would be compass rose.
- Conditional changes, often made by having two statements with a coloured thread joining the two. If something else happens, then the energy cost and/or time to change will reduce and we can take action.

Communication:

- Research, as it says, is that we need to look into this more deeply.
- Requests for permission to change in the liminal zone – this has proved valuable as it is not a request to change, but for permission to change if a case can be made.
- Increase or decrease the visibility of processes to a hidden observer to change the behaviour of people.

A distinct activity, significant enough to be a method in its own right, is to shift actants to the counterfactual domain. This is used to create a stable form of scaffolding around which a system can emerge and provide a degree of predictability.

We now have an agreed map of what can and cannot realistically change, or be changed in the current situation and we have a strong indication of what types of development are more or less probable in the future.

At the time of writing, an experiment is being planned to use the affordance map in a red teaming exercise on both foreign and military policy as an alternative to scenario planning and there are other developments in both the strategy and futures space as well as the field of personal development.

### 5.2.3 Assemblage Topographies

Assemblages are generally mapped separately from affordances due to the nature of the process and their importance. But they can also be mapped onto the above grid as they can be both constraints and constructors, possibly as placeholders or links. They are generally fractal in nature – a regional narrative will inherit from a national narrative and so on. In early work on the above-mentioned DARPA program, we identified that they can manifest as, to use the language of complexity science, attractors. In effect, things fall into attractor wells and then find it difficult to escape requiring the *ligne de fuite* or lines of flight/escape identified in Assemblage theory (Snowden 2020). The approach to affordance mapping described above was, in part, designed to de-territorialise the strategy domain to remove conflict and also to prevent describing the present to privilege a particular view of what should happen next.

In futures work, we need to work with assemblages in populations, also known as human terrain mapping. To break or exploit fundamental beliefs and attitudes we have to first map what exists, not create a vision of what we would like it to be. We then have to see what is stable and to what degree. We can then *micro-nudge* the system to a more favourable state. Assemblage mapping may be a parallel and continuous process which not only identifies the attractor patterns that exist but also discloses their nature, how they are changing and when the underlying conditions make destabilisation more likely. In this context, it is worth noting that the original motivation of our DARPA program was to identify when a civilian population shifts from passive to active support of terrorism. There the destabilisation tends to be sudden and unexpected, but with the benefit of hindsight, we can see the early signs that were building up to what is mostly a catastrophic failure. This is the problem of joining up the dots we identified earlier and the need for weak signal detection and resolving the problem of abduction is key to its amelioration.

The focus of the DARPA program (especially post-IBM) and Singapore government work was to map the fractal assemblages and then use some of the mathematics of attractors, allowing the creation of alerts in advance of catastrophic failure. We are not forecasting, we are finding new ways to pay timely attention.

The approach adopted in the original DARPA program, and subsequently developed in multiple applications in government, industry and the not-for-profit sector was to use micro-narratives and observations self-interpreted at the point of collection by their creators into a quantitative framework (Snowden 2012; Mark & Snowden. 2017). This approach also had an ethical aspect in that the power of interpretation of the reported experience is given to those who have the experience, not a computer algorithm or an expert. This directly addresses the wider question in social research of epistemic justice (Fricker 2007). It also allows the capture of data at scale with no significant incremental cost, and critically in real-time. Citizen and employee sensor networks, panels of students from different cultural backgrounds, can all be used to gain insight and meaning as to underlying patterns and beliefs. The EUFG provides examples of these in terms of citizen engagement, refugee issues and others and a recent publication (Guijt et al. 2022) provides multiple cases of the application in the Development sector.

There are various ways to represent the results and Figure 5.2 shows an affordance topographical map based on underlying attitudes. In the early days of development, three dimensions were used but that was less effective than two dimensions. In this representation the tighter the contour lines, the more difficult it will be to disrupt and vice versa. The maps also represent the essential ambiguity of a complex system, avoiding the dangers of categorisation common in matrix and similar models.

Critically the representations also allow for three things:

1. A cluster pattern adjacent to another represents a possible line of flight. The map allows decision-makers to select a pattern seen as more positive and ask: 'How would we create more observations/narratives such as these …' and then select the dominant pattern and ask '… and fewer like these'. $A^1$ and $A^2$ demonstrate these shifts in Figure 5.2.

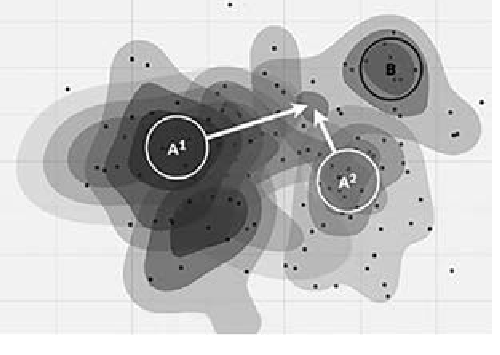


*Figure 5.2 Topographical map*

2. The maps can also be presented, from the same source data at multiple levels and with different selection criteria to show the topography from different perspectives. This also allows us to identify, for example, common areas of concern to conflicting

parties from which we can initiate small-scale interventions to change people's attitudes through empathetic contact (Snowden 2022).
3. The maps also allow us to identify outliners, and patterns of belief that we might otherwise ignore and which may provide threat or opportunity. Circle B in Figure 5.2 illustrates this.

As a technical note, a topography with only a Z axis is a type of fitness landscape, but the topographies can also be created using X, Y and Z axes to make their nature clearer to decision-makers.

The approach is not only about understanding the current state but also evaluating future possibilities at scale. Mass capture, via human sensor networks, of micro-scenarios of future possibilities, fears and hopes over different periods can be represented in the same way. The affordance landscape is also a new type of micro-scenario representation, avoiding reductionist approaches and/or limiting what can be imagined to those gathered in a workshop to do the imagining. By shifting to a metadata approach over multiple actors' attention is drawn to an anomaly before the material is read, or attention is paid to the individuals. That increases the plausibility of the anomaly and the likelihood of decision-makers both seeing and acting on what they see.

### 5.2.4 Solving the Problem of Abduction

As described earlier, many people will have intuitions some of which will manifest as strong convictions and then power wins out. With hindsight, we can always see what we should have paid attention to, but not so in advance and the issue of speaking truth unto power remains. In the DARPA program, one comment by a former US National Security Advisor was that analysts competed to have their advice accepted (and thus be invited back to the next meeting) not to give the right advice. So the need is for the decision-maker to go from an abstract representation of the decision space to the raw data without mediation. The original approach, developed in the Singapore IRAHS system, was based on the landscape approach also used for assemblage mapping. The original inspiration came while working with the Singapore army and seeing a three-dimensional map of Singapore while reading DeLanda; small coincidences and abductive connections.

There are variations of this but at its simplest, the decision-maker presents the data they have to a human sensor network who responds within a limited time slot, without consultation. This utilises the preconditions for what, in popular terms, is known as *the wisdom of the crowds* (Surowiecki 2004). Multiple agents make a guess or interpretation without consultation or awareness of what the other people have guessed. In this approach, the guesses are made by interpretation into geometric shapes using text and symbols from which we can draw the landscape maps (Snowden 2010). As in the case of affordance maps, these are represented as a landscape where the patterns indicate where there is consensus about a particular interpretation of what is going – n – and we can have multiple versions of these to represent the views of different groups or situations.

If the sensor networks are set up in advance, then they can be consulted in real-time, and the results of that consultation represented and presented again until there is agreement. This represents the waggle dance of bees and is an alternative to Delphi techniques and critically can take place in near real-time; this work is, at the time of writing, under development. Again participants can be invited to contribute scenarios about what will happen next, or over different horizons and the maps then identify which clusters of micro-scenarios have coherence. We can also retain and combine historical data to identify trends and assess the plausibility of weak signals from different sources over time.

## 5.3 CONCLUSIONS

This chapter started with a discussion of the foundations of modern science and the various disasters associated with the Great Fire of London. Mother Shipton could claim that she successfully operated as a super forecaster: her scenario came true. Despite awareness of the dangers humans failed to act. Science provided the *best of times* in progress and collaboration and the *worst of times* in political conflict between rivals. Scenarios about the future were created but not taken seriously. Unintended consequences made things worse and the population sought people to blame for an avoidable disaster.

The reality of human systems is messy but carries the danger of hindsight as identified earlier, we have too great a tendency to join up the dots. Human intuition is not separate from science, we increasingly understand how it works, and how that is different from machine learning. In reality, we have to find a way of navigating what is inherently uncertain to not only minimise risk but also to take opportunities as they arise. If we start journeys with a sense of direction we are open to novel possibilities on the pathway. If we are wedded to specific outcomes or forecasts, then those weak signals may well be missed.

The approach outlined in this chapter uses the concept of mapping affordances through the Estuarine Mapping process and then the attractors/assemblages which can measure attitudes and beliefs at country or organisational level. With Seneca, we focus on the certainties of the present but map it in such a way as to have an objective situation assessment before we move on to actions. That also allows us to manage the energy gradients so that desirable outcomes, or directions of travel, are the most likely. Coupled with that we need to have a real-time capacity to support decision-making as we move forward. To put it simply, we want to make the energy cost of virtue less than that of sin.

As stated, this represents an ontological turn in futures work. But the journey to use natural science as an enabling constraint, and thereby increase our confidence, is only just starting. To emphasise that point, let us return to Lovelace, she saw herself as both an analyst and metaphysician, she valued the poetry of her father as much as the science she was active in discovering. She exemplified the trans-disciplinary capability that this chapter has argued for.

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