Complex Adaptive Systems: Riding the Wave of Weak Signals

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The world of Tides

Organizations are complex systems. What is more, they are complex adaptive systems (CAS), meaning that they adapt and learn, both as a whole entity and as a collection of individuals. Like all other (complex) adaptive systems there are early signs evident of the direction in which they are adapting, and these can be picked up and monitored if you know how to identify them. This is hugely powerful in terms of predicting how both the organisation and its environment are changing and acting both strategically and operationally to steer the adaptive behaviour in a positive direction.

It is also relevant to look at organisations as complex adaptive systems (CAS) because understanding the pertinent characteristics can assist us to recognise what is going on across the organisation and why it behaves as it does. Thus, being able to pick up the weak signals of adaption informs us on how to create, shape and lead such entities.

In this paper we shall explore the concept of adaptation as it pertains to the organisation as a system, and discuss a number of CAS properties which are particularly relevant to understanding how to identify and read weak signals – those first hints of change (internal and external) that adaptive organisations are able to identify from the noisy environment, watch, and then act upon when the time is right.

Of particular interest are properties such as self-organisation, emergence, interdependence and inertia as these properties largely influence how the system, in this case an organisation, evolves and is shaped by the identification, understanding and action taken in response to weak signals. We shall also touch on concepts such as thinking of the organisation as a mix of order and chaos (*chaordic*) (a concept used by Dee Hock to describe such organisations as VISA), as well as the properties of virtual stability and interconnection as these relate to how leaders can subtlety and successfully nudge and steer an organisation.

Steerage and change

Change is by nature full of weak signals. The ability to register and read this information, and to understand how they herald and shape change, enables leaders to influence, tend and steer the organisation in an adaptive direction. Adaption is critical to remaining a healthy and viable organisation as, like other CAS, it creates a capacity for learning, responding actively to events, picking up relevant patterns from the noisy environment and adjusting behaviour. Without learning, a complex system will still respond but it may be in a negative, maladaptive direction.

First, we shall explore adaption itself - how organisations as CAS adapt, and why systems need to do

this, before looking at specific aspects of identifying weak signals in order to identify where the system is going and thus steer it in the desired direction.

Watching the Ocean – Adaptation

Learning and adaptive behaviour in human CAS

One of the differentiating factors of a CAS is that it *learns* (as opposed to non-adaptive complex systems which still self-organize but in non-adaptive ways[i]). Whilst it may be novel to think of an organization learning, this is a key part of a successful organisation's ability to dynamically act in changing circumstances, a capacity linked to resilience and being nimble in a changing market.

CAHS

If we add in the element of humans to our discussion, as they are the primary element of organizations, we can term organizations as complex adaptive human systems (CAHS). Human systems are differentiated by *choice* and *intentionality*[ii], two uniquely human attributes which can change the rules of interaction in a complex human system[iii] and *create new order through innovation and adoption of new ideas, objects and methods*[iv]. This has many implications for the ways in which organisations as human systems adapt. People need to maintain an *internal locus of control* over what they do and think - if someone feels they have no choice in a situation there are negative consequences both to themselves (in the form of such things as stress, physical illness, disengagement, short term thinking and stifling of creativity), and for the organization as a system (evidenced by outcomes such as lack of cooperation, white-anting, power-mongering, cultural toxicity, non-cooperation and in turn, minimal innovation).

Thus response to stimuli and forces that act on a system can have positive or negative consequences – the organization, and the people within it including its leaders, can respond in an adaptive way that increases resilience and the capacity for learning and survival, or in a way that pushes behaviour to becomes increasingly maladaptive, recursive and rigid.

Intentionality and interaction

Intentionality is another aspect of adaptation in human systems. There is now an emphasis on organisations as human systems that are *intelligent corporate beings possessing an orgmind and a collective intelligence of their own*[v], (a lovely description for the culture of a company). Successful leaders know that fostering a shared understanding of the intention and purpose of the organisation is critical to ensuring successful evolution[vi] as well as a healthy learning culture - so much so that managing organisations as *human thinking systems*, with their non-linear characteristics, is becoming a major focus of study regarding the creation of a shared vision and concept of why the organization exists.

Interaction is key in complex adaptive systems as learning emerges through interaction, which is enabled by loose networked structures that allow information to be shared, exchanged and created so that learning can emerge. This occurs in all forms of CAS, from a bacterium learning to become resistant, to

a human collective. In CAHS terms information is described as *flowing horizontally along relationships*[vii], a thing we all recognize as people in organisations – in practical terms we talk to the people that are useful or enjoyable to listen to in order to get a job done or explore a concept. This point is particularly relevant to the registering and feeding-in of weak signals to the system, for the reasons we shall explore below.

It also governs the capacity for the organization to behave as what is now being called an intelligent complex adaptive system (iCAS). Liang (2007) and others considers that "all human systems, embedded with sophisticated knowledge structures, the information processing and learning capabilities of their (people), and the right connectivity of the system, are *intelligent* complex adaptive systems (iCAS)".[viii] This is an especially effective model when dealing with knowledge-intensive environments which require fast and continuous learning as the concept of the iCAS encompasses "fast learning, adaptation, quality connectivity, innovation, competition, smarter survival and co-evolution with the environment.."

Self-organisation

'Self-organisation' is required for adaptability – it is a key aspect of the new emerging from the old. It is the normal state of *multi-component* systems such as a crowd, social system or organisation[ix] - all complex systems self-organise, we just don't recognize that this is the case at times. A good example of this is putting strict rules and structures into place, hoping to control the way an organization (or person) operates, to ensure a particular outcome. Instead such decision makers rarely get what they intended because the system adapts to such restrictions by self-organising around them in unexpected ways (emergence) through feedback, co-evolution and interdependence.

Emergence

> *"Emergence can lead systems and leaders can foster emergence."* (Lichtenstein & Plowman)[x]

When a process is emergent the outcome is not able to be predicted at the start even though it is able to be traced back once the process is complete, whereas in a linear process there is more ability to plan and articulate the end result accurately. This is primarily because with linear processes or problems the required information is available in the shape of known knowns (simple) and known unknowns (complicated - we know what we don't know and can gain the information). However a complex problem or process contains unknown unknowns which will impact the progress in unpredictable ways. Like all complex adaptive systems, organisations are only stable for periods of time before part or all of it begins to evolve and change (disequilibrium in systems terms)[xi], adapting via self-organisation, stabilizing new feedback loops through connectivity and interdependence and propagating the effects of actions, decisions and behaviours throughout the organization[xii].

'Emergence' is also seen as a new set of properties displayed by the collective system as a whole, but *not apparent from the behaviour of the constituent individuals of the system*[xiii]. And in organizational terms this is about generation of knowledge, innovative ideas and novelty through learning, and the

new patterns created by interaction of individuals which creates emergence and even transformation[xiv] at the macro-organisational level[xv]. Thus, organizational members on all levels interact, exchange information, and often act without coordination from a central decider (self- organization) resulting in unintended changes at higher levels within and beyond the central organization[xvi].

When dealing with an emergent situation, process or system it is especially important to be vigilant for weak signals as these arise when stability lessens, or new forces begin to act on the organization. Being able to scan accurately yet widely is an attribute all adaptive organizations share.

Co-evolution and interdependence

A critical aspect of the organisation as a CAS is the interactive nature and feedback loops that shape it, from within the organisation as a system, with other organisations that share the same ecosystem, and with the (social, cultural, technical, economic, geographic) ecosystem within which they exist. Positive (rewarded) feedback loops are strengthened, and in organisational terms we see constantly that we get what we reward, we just might not know that we are rewarding!

Thus, it is critical to recognize that any emergent behaviour is being rewarded somehow, and an understanding of the dynamics of interdependence is critically important to being able to accurately read underlying cause and effect as many dependencies are not obvious in complex systems. Interdependence works two ways and describes the mutual reliance which exists due to a reciprocal relationship between interdependent entities whether they are objects, individuals or groups, which makes them dependent on each other.

This reciprocity means that the two interacting systems co-evolve, and we can see this in organisational terms as the ecosystem impacts the organisation and vice versa. This is just as relevant at the big picture level - globalization's complexity and interdependence has resulted in what Seijts et al (2010) call "small world" effects that shorten degrees of separation and create the capability for local events to have global effects. This "intertwining of organizations' value chains, corporate governance, and financial flows results in exposure to shocks at the periphery that can move to the centre of an organization in rapid succession"[xvii].

Further, as the business environment becomes more complex (complexifies) it brings with it the unpredictability, instability, non-linearity and speed of complex interrelationships and thus poses huge risk management challenges if leaders cannot successfully cope with it[xviii]. The capacity to scan and read weak signals is again of paramount importance here, especially as many outcomes and connections are not obvious and easy to observe and analyse in a linear fashion as complex systems are by nature non-linear.

Non-linear interconnections

In linear systems cause leads to effect in a way that can be planned and traced, and even though the path from one to another may be complicated, the known unknowns can be defined and built into a forward plan. In complex systems as discussed earlier, the path to the outcome cannot be predefined

as it emerges along the way, only becoming clear when tracing back the journey. Gupta and Anish describe organisations evocatively as "webs of non-linear feedback loops that connect to other people and other organisations by webs of non-linear feedback loops"[xix]. This is a great metaphor for explaining why it is so difficult to trace how a process or idea grows, travels and changes over time.

Another thing which is useful to apply to organisations in dynamic environments is that cause and effect are proportional to each other in linear systems or processes, whereas in non-linear cases they are not, making it less easy to predict the impact of activities, and the reactions which occur at both the individual and the organizational level. The explanation in systems terms for this is a little technical, but we are all familiar with examples in organizational change or political unrest where a large action has caused very little impact, and also where a small action has had an impact way out of proportion, often called the butterfly effect.

The technical reason is linked to our previous discussion on the stability of organisations: at any given time, some parts of an organisation are stable and other parts are changing – for example, there may be a restructure of a section, an IT system change or new operational equipment. This is called *multiple states of equilibrium*[xx] and any time this is the situation there are always multiple solutions – one reason why strategy is more difficult and long-term plans will always be wrong! However, in linear systems there is one stable state (equilibrium), and this is why linear processes can be optimized, and why complex processes and systems, such as organizations and economies, cannot – something many theorists, consultants and leaders fail to understand, with negative consequences.

Thus, organisations are by nature paradoxical, travelling between drivers for stability and control, and the opposite ones of decentralization and adaption. This is accentuated by organisations being a human system, as people require fluctuating levels of security and stability, and excitement and innovation. Leading such a dynamic system has been likened to being a conductor of an orchestra who knows the whole music score and thus coordinates each instrument accordingly, or Meadows' lovely description of "*dancing with the system'*. It is a critical skill because if the organization is too driven towards stability it will fail as it cannot adjust and change as required, but if it is pulled into chaos it disintegrates, so a successful CAS lies at the border of stability and instability – the edge of chaos[xxi].

Leaders who are complex thinkers are better equipped to manage such systems as they are more comfortable both acknowledging and dealing with the ambiguity that results from an emergent process which means that they cannot *control* a process or outcome, but instead can eloquently *steer* it, through nudging – in systems terms, 'adaptive buffering'[xxii] (I derive my term *emergent logic* leader from this concept[xxiii]). This leads to a range of possible responses (dealt with by concepts such as path dependence and bi stability), and choosing which to support or watch is vitally informed by the ability to scan, identify and understand weak signals, and becomes a key enabler for leading a CAS.

Developing such *radar* which allows for identification of nuanced information is further informed by understanding not only those forces that push organisations as systems to adapt and change, but also those forces that have the opposite effect of slowing down adaptation too much, including inertia and

virtual stability, both of which drive to minimise scanning for weak signals and maximise resistance to new and disconfirming information.

Virtual Stability

'Virtual stability' is one of the principles of complex systems and is a useful concept to understand when leading organisations, and when understanding the value of accurately detecting weak signals. Defined as "a system's ability to gain in flexibility and maneuverability by using self-monitoring in order to maintain itself in a state that would normally be unstable"[xxiv], understanding this subtlety allows the leader to steer and nudge progress, gently and continually keeping it on the right track. Virtual stability is about maintaining a consistent direction through self-monitoring and small (virtual) corrective actions, and though this uses effort the advantage for the system is an increase in flexibility or maneuverability.

Virtually stable states are common in nature, and can be argued as the norm in human systems / society as "human beings consciously monitor their behavior, and can keep different courses of action in mind without making an immediate commitment to any of them - a prime example of the capacity to maintain virtually stable states"[xxv]. Other examples are engaging in a conversation, riding a bicycle and global finance.

Interestingly it is possible for systems to be *too* flexible, creating potential for people or the organization to lose their way if direction is not clear enough and boundaries not sufficiently tight. Weak signals are important here as well, acting like early warning signs, but we have to measure the right things in order to pick them up or these signals will be missed. Measuring the right things aligns to the importance of allowing a CAS to self-monitor (a concept closely related to W. Ross Ashby's law of requisite variety[xxvi]) as often it is the fixed rules or goals of decision-makers that block or stop weak signals from being identified, fed in or acted upon.

To maintain stability there is a balancing act between expending too much or too little energy in correcting the small ongoing alterations in the system. Too high a level of monitoring leads to monopolization of attention on the wrong things[xxvii], buffering, skewing and a loss of room to innovate, risk take and other behaviours conducive to learning and wisdom[xxviii]. Too low a level of monitoring and the system loses its virtual stability as there is no longer adequate synchronization with external fluctuations, with destabilizing effects[xxix].

Voorhees contends that the basic lesson of virtual stability is that "life is not about stability, it is about *managing instability* (so as to produce the illusion of stability)"[xxx]. Managing instability is indeed a good job description for successful adaptive leaders who understand and interact with emergence, and a critical part of this is ensuring that weak signals are identified, collected and acted upon. A typical situation in which this is not adequately done is when the organization is in a state of inertia.

Inertia

Inertia can take many forms. Even in fairly benign or positive organisations, initial success (one of Meadow's archetypal traps[xxxi]) can cause non-adaptive people and organizations to stick to programs that repeat earlier success, especially if early success is sudden. This entrenches inertia by locking people into old ways instead of taking risks and trying new ideas. This also increases inertia by reducing perceptual sensitivity to weak signals (also known as perking information or new initial conditions)[xxxii]; thus weakening the links between organisations and their environments. Old ideologies and world views are reinforced instead of reinforcing the risk-taking that allows people to feel comfortable with the idea that tomorrow is going to be different from today.[xxxiii]

In more rigid, hierarchical and often political organisations, organizational myths and belief systems[xxxiv] are rewarded, as are over-rigid processes, vested interests and political coalitions[xxxv]. A change of plan or strategy is evidence of inadequacy or incompetence and can be met with shifting organizational power structures and biasing resource distribution. Individual members and groups may vigorously resist changes that threaten profit or prestige (creating a recursive environment instead of an adaptive one), and management discretion is either limited or not acted upon.

The lack of flexibility in such rigid organizations causes them to break, and the journey can consistently be mapped as either maintaining old ideas and practices (old thinking and doing) until it is too late, or becoming 'schizophrenic' through action not matching ethos by either *old thinking new doing* or *old doing, new thinking.* Many of us have experienced such inconsistency of the mission statement not representing the real drivers and rewards in the organization, or the values on the wall being quite different to those of the culture, and those closest to the coalface of the organization are often the ones who see this most clearly and are most affected by it, especially in times of formal organizational change. (Interestingly this is also the richest area for picking up weak signals as they are interacting right at the boundary of the organizational system).
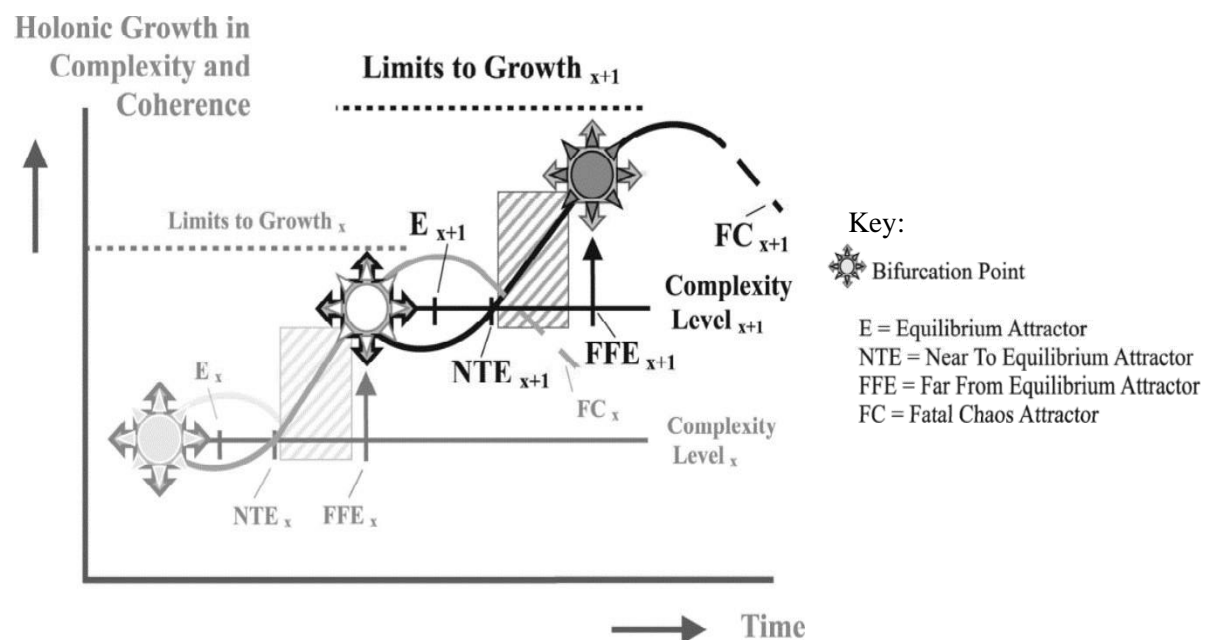
One of the best illustrations of several the concepts above is Van Eijnatten's[xxxvi] *chaordic* model of complex systems dynamics and change, and exploring it brings us to the next topic of where weak signals come from and why they are weak to begin with.

Chaordic systems and weak signals

In systems terms, complex systems have *discontinuous patterns* of growth (or decline), and they change states, *becoming more complex and coherent* as they mature[xxxvii]. In practical terms, this is akin to the way societal change can suddenly emerge, such as the massive and sudden adoption of the internet around 1995[xxxviii]. A useful model to understand the relevance of such terms to organisations is the

chaordic system. The term chaord was introduced by Dee Hock (founder of Visa Card International) as an amalgamation of chaos and order[xxxix] that best suited the way in which he found organizations to act[xl].

Chaordic systems are similar to the economic concept of the organisational life cycle, but richer and more informative. A chaordic system develops and grows into maturity, and in this period it is in a state of relative stability, growing in a linear, incremental way (see the rectangular shapes in Figure 4 below). When it approaches its growth limits a chaordic system starts to become more unstable – in systems terms this is bifurcation (the act of dividing into two parts or branches), and this illustrates how the organisation changes in a non-linear way (transformative change), and the reason it is very susceptible to external variations[xli]. It then hits its limit to growth and either dies or transforms (by leaping to the next level of complexity) to start a new cycle.
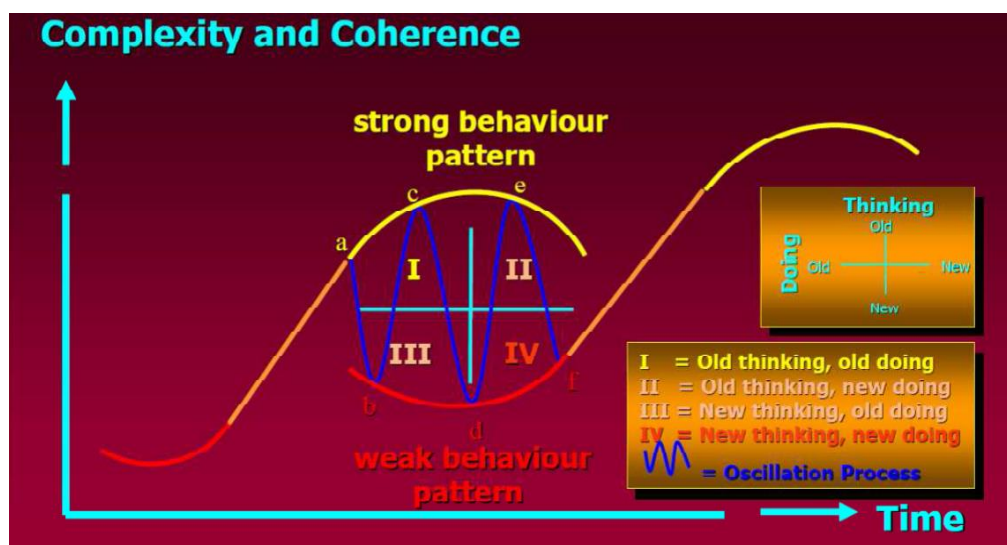

The discontinuous growth of a chaordic system[xlii]

Identifying the currents

Weak signals

One of the most important aspects of this cycle is its sensitivity to initial conditions, which allows the new and novel ways in which a system may adapt to be identified[xliii]. In chaordic terms these are referred to as 'weak signals', and change is full of them. An adaptive system, as noted above, allows for these to be picked up and acted upon in order to change old thinking, old doing into new thinking, new doing. In chaordic terms, this is represented by the "*cross in the chaos*"[xliv]. The strong signals of 'old doing and old thinking' are dominant and getting from there to the state of 'new doing and new thinking' in order to successfully transform is the essence of adaptive change.

Rarely there may be a 'qualitative leap' from the old state to the new with quick change, but the common process has to move people from old ideas, loyalties and practices to adopting new ones, and the journey of change will by necessity be via a path of temporarily maladaptive, unstable patterns that are a messy mixture of 'old doing / new thinking' or 'new thinking / old doing' (described above as schizophrenic). To steer people through this, the leader must continually scan for the weak signals that help to steer such a dynamic process. Picking up these weak signals allows the leader to minimize confusion, establish alignment along the way, and ensure that the right path is taken.

The edge of chaos / eye or cross in the chaos. (van Eijnatten, 2008)

It is interesting to note that organizational adaptation has been found to be more successful when the weak behaviour pattern path is taken, and new thinking is prioritized over new doing. This is consistent with the basic human drivers of minimizing *cognitive dissonance* (the discomfort we feel when we think or believe one thing and do another), and maximizing *internal locus of control*, as described in the discussion on intentionality and choice in human systems. Once people have overcome the natural resistance to change (as this involves breaking the pattern of a habit or concept and remaking it, an effortful process), it allows people to create new order through innovation and adoption of new ideas.

This shift into building new mental models also explains the exponential pattern of organizational change adoption, as once people have committed to the *why*, they move remarkably quickly to change *what* they do and how they do it.

From the diagram above we can see why the picking up of weak signals is critical to adaptive change as this is what causes the change in direction in the face of the current practice. It is a challenging route to take in these early stages as the weak signals are lost in the noisy environment, and overwhelmed by the strong signals of habit and accepted practice which are rewarded, and we begin to see the critical role that trust plays in such a choice, whether it is the trust an individual has to feel in order to flag 'disconfirming information' in the face of strong practice, or the leader who steps into taking people in a direction that cannot be clearly articulated in terms of what the outcome will look like. However, the results are learning at all levels of the organization, and adaption to a higher level of complexity and capacity.

Why are the signals initially weak?

Current practice rewards stability, containing strong connections and feedback loops including process and infrastructure that reinforces current methods, even in the face of mounting evidence that change is necessary. The weak signals, made up of what Aaltonen and Sanders[xlv] calls *perking information*, have not been strengthened or reinforced in any way, either in individual thought or action, or in the organisation as a whole.

Perking information is made up of the small ripples which are taking shape just below the surface in emerging conditions and changes but are not yet visible. They are especially difficult to see in emergent rather than planned change, as they are a consequence of *local* interaction between people at a local level and are not as easily identifiable or monitored as in planned change[xlvi] yet they are the norm in a CAS. As local interaction is based on local principles, rules and beliefs rather than a plan imposed by a CEO or a director, this reinforces the need for the leader to have created a shared mental model of purpose, goals and values to align and guide rather than attempt to control local action.

The signals are also weak because at an individual or whole of organisation level more effort is commonly put in to maintain present practice than to act on evidence and shift, and this can be explained in CS terms. Complex systems have a natural resistance to absorbing and applying information and forces that show a need to alter the present path as it requires the system to make more effort than it puts into maintaining the status quo. This can be a biological CAS trying to maintain homeostasis, the equilibrium of technical CAS, or the entrenched patterns of behaviour in human systems. The feedback loops that reward behaviour already in the system are well established and on automatic pilot, so any shift requires energy to pattern break, taking apart the current ways of thinking and doing, and building new ways in their place.

Consequently, organisations are naturally resistant to change, and in entrenched cultures not only are the feedback loops that shape it strong and well established, but feedback that would nudge it off the

well- worn path is not registered. At best this is because scanning for weak signals and disconfirming information is not done, but it can also be the case that the information is found but dismissed, or even actively skewed or rejected.

The lack of flexibility this creates can cause such organisations to fail dramatically once the force to change reaches critical mass and the system tips into chaos. However, adaptive individuals and organisations understand this phenomenon and *actively seek* disconfirming evidence to test their environment, their assumptions pertaining to it and the emerging path of response.

Finding the signals

> *"The real world, which models simulate after all, evolves by surprising. It feeds some slight variation through an incompletely known environment laced with non-linear relations and amplifies results unexpectedly. Planning has traditionally sought to avoid surprises by controlling events and suppressing variations". (Artigiani, 2005)*

Weak signals and perking information can be found at different levels of the organization, and when combined they give a rich picture of emerging conditions in which the organization exists. There are both formal and informal methods that can assist in weak signals being scanned for, monitored and acted upon, but critical to all is a culture of trust and respect that empowers people to scan, and makes it safe to feed-in what they find.

Along with formal infrastructure such as rich, flexible *pull out* information data bases, trust will ensure the ability and the will to put relevant information into the system from wherever it has been identified, no matter what its nature, or the (hierarchical) level of the sender or receiver. The perking information available to those at strategic level will be different from that at the service desk, but both denote opportunities to detect weak signals of change, adaptation or other shifts in the landscape that exist at the 'edges' or boundaries of the system where there is the most exposure to external dynamics, and the largest capacity to pick this information up.

Riding the wave

Boundary riders

In highly adaptive organisations, value is placed on using *radar* to identify subtle alterations in the landscape, and disconfirming information is actively sought, rewarded and acted upon. Yet for most organisations this can be challenging as typically such people are at the coalface of service provision, and those at the front line of the organization rarely have strong voice mechanisms to be able to feed information into the system. Normally they are not heard by decision makers, and in hierarchical structures they are rarely rewarded for speaking and are even actively discouraged, thereby greatly limiting one of the most valuable identification points of weak signal data.

A number of elements seen in adaptive organisations overcome these barriers, including people in these outrider roles having access to robust, simple communication pathways through which to feed weak signals into the organization; a culture of trust which allows them to feed in negative information without disadvantage, and visible evidence that such information is not only acknowledged but considered and acted upon.

Fostering radar and strategic intuition

Creating the capacity to ride the wave of weak signals is inextricably tied to improving strategic capability in various ways and at all levels of the organization (sometimes termed complexifying[xlvii]). At all levels such capacity can be increased by giving permission and encouragement to people to hone their radar through enhancing their ability to question present practice, exercise independent judgement wherever appropriate at all levels, share responsibility, and apply learning[xlviii]. This means giving permission to act, enhancing connectivity and allowing *guided self-organisation[xlix]*, which has the added benefit of freeing up leaders and executives to better execute their roles.

At the level of the organisation's strategy group, shared mental models, experiential knowledge and exposure to complex decision making are critical to building an adaptive capacity. However, even though a person's previous experience and level of control create and strengthen their internal mental models, these are rarely actively shared in order to ensure true alignment in terms of what good practice and successful outcomes look like. Where there is a good understanding of the organisation and its environment, shared mental models are also built through multiple efficient communication channels within and between strategy groups for exchange of information and learning[l].

An example of shared mental models, learning and innovation

Such shared mental models feature in Artigiani's [li] study of battle success as an underlying reason for the most successful commanders being those which did not apply rigid, formal top-down command structures (exemplified by the Royal Navy's 'permanent fighting instructions'). Artigiani notes that "shared goals and clear duty constrain how people act but not what they do"; meaning that the specific actions taken to achieve an agreed goal can be very flexible, but the shared goal and values that inform

those specific actions will remain clear and will bound and shape the actions[lii]. Thus, the hundreds of hours spent together creating not only trust but shared mental maps of alternative actions, allowed local commanders to read the immediate environment and respond by changing their structure faster than the environment. Critically, the leader showed the same trust in allowing his commanders to make such decisions in real time in a dynamic environment.

Strategic intuition

Artigiani's study also shows us what becomes more important in building strategic capacity: the ability to pick up and act on weak signals. This means that rather than strategists creating formal plans which will by nature be inaccurate (and will potentially result in criticism), instead effort should be devoted to building systems that read the environment, detect threats and quickly respond with local initiatives. It shifts the emphasis away from reliance on quantitative, analytical tools, most of which are not suited to picking up the qualitative data that make up much perking information. It also lowers the fear of failure related to being 'right' which pressures planners to use formal, often linear methods which match future forces to specific, quantified threats (with zero tolerance for deviations).

Instead they are able to operate more like the successful commanders known as *stochasts*[liii] - people who embrace change consciously, back multiple options, don't rely only on deterministic variables, and see error-making as vital as it leads to the 'accidents' of new technologies and innovative discoveries through experimentation. (This can also be seen in the *stochastic approach to disequilibrium macroeconomics*)
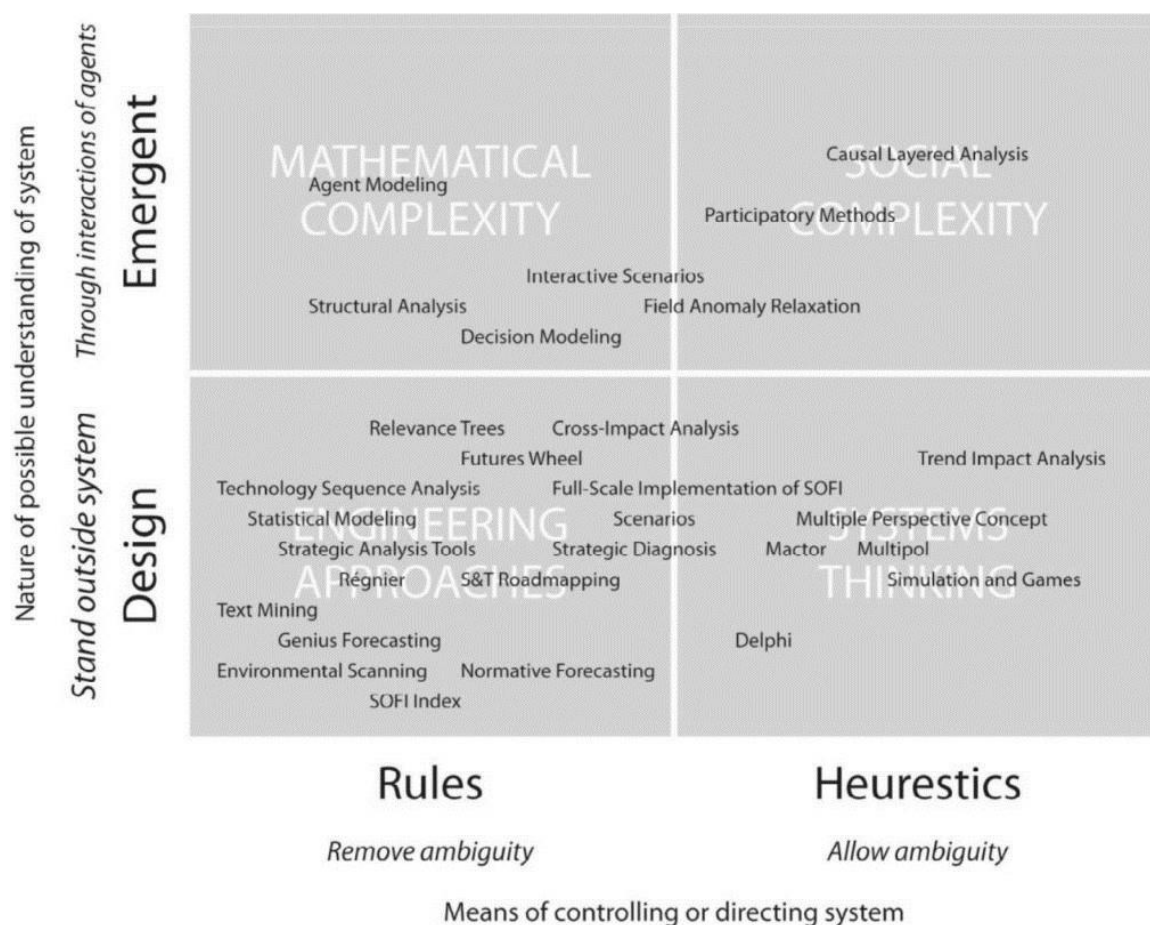
Use of formal tools for identifying weak signals

"All models are wrong, but some are useful" (Box)

Reinforcing the need for qualitative information to be seen as valid in planning, we know that the environment in which strategy building takes place is unpredictable and uncontrollable[liv], and shaped by both predictable forces and irregular cycles of discontinuous trends. This means that although analytical controls and planning methods are necessary for short-term operational plans, long-term planning and development methods need to be more spontaneous and non-deterministic as it allows new strategic directions to emerge, partly as weak signals are identified, observed and fed in. In practice this can be seen in adaptive organisations where a shared set of values is a stronger guide than a formal mission statement for shaping the capacity for guided self-organisation and the use of 'radar' at all levels of the organization.

It also means that strategic planning is replaced with strategic adaption[lv], and this is where weak signals come to the fore. New foresight and strategy methods better use the CAS's characteristic of *sensitivity to new initial conditions* to provide opportunities for influencing the future of the organization by trying to identify these points of influence. As discussed above, perking is a term to describe such new and initial conditions, changes and developments to which the system may be sensitive, and which makes up the weak signals.

The increasing acceptance of the strategic environment as irregular and spontaneous, and thus not suited to ontologically linear foresight methods, has not been matched by changes to such methods and models. A study by Aaltonen[lvi] into futures methodology since the 1940's shows only two relatively new methods – SOFI (2001) and causal layered analysis (1999). He categorized the methods into qualitative, quantitative, normative or exploratory and plotted them on the dimensions of *possible understanding of the system*, and *control or direction of the system*. The result shows that few methods are designed to maintain ambiguity and identify a future direction in a non-orderly environment. Only the social complexity methods have initial phases which are different from the final phases, thus allowing for emergence during the process.

The re-analysis of futures research methodology. (From Aaltonen & Sanders, 2006, p. 31)

Aaltonen then plotted a number of new methods (in capitals on the figure below) which aim at understanding the complexities, interdependencies, connections and patterns of interaction and relationships between order and disorder from which self-organising change occurs. Such change can be tremendous when a new building block is discovered (e.g. LAN-based networks, increasingly powerful microchips, the internet, JAVA programming language[lvii]).

Can confuse simulation with foresight　　　　*Finish with these methods*

Algorithm　　　　New Practice

Emergent

QUANTUM POLITICS

MATHEMATICAL COMPLEXITY

Agent Modeling

Causal Layered Analysis

Participatory Methods　DIALOGUE PROCESSING

SOCIAL COMPLEXITY

Interactive Scenarios

Structural Analysis　Field Anomaly Relaxation　FUTURESCAPE

AI　CHAOS FRACTALS　Decision Modeling　ACTION RESEARCH

CELLULAR AUTOMATA　JOINT-IMPACT ANALYSIS

ADAPTIVE NETWORKS

Relevance Trees　Cross-Impact Analysis　MEGATRENDS

Futures Wheel　MULTIDISCIPLINARY ANALYSIS　Trend Impact Analysis

Design

Technology Sequence Analysis　Full-Scale Implementation of SOFI

Statistical Modeling　Scenarios　Multiple Perspective Concept

ENGINEERING APPROACHES

Strategic Analysis Tools　Strategic Diagnosis　Mactor　Multipol　WEAK SIGNALS

Régnier　S&T Roadmapping　Simulation and Games

SYSTEMS THINKING

Text Mining　CHANGE ANALYSIS

Genius Forecasting　Delphi

Environmental Scanning　Normative Forecasting

SOFI Index

Rules　　　　Heurestics

Old Practice　　　　Test

Provide current info, use when stable conditions

Futures research methodology with complex systems concept – tools map.
(Adapted from Aaltonen & Sanders, 2006, p.33)

Aaltonen's study may be summarized as follows. Firstly, tools involved in foresight and strategic analysis need to foster non-linear thinking as strategists are dealing with the perking information which can assist in identifying weak signals and the small events which will cause turbulence[lviii]. Secondly, formal planning methods should assist in scanning across whole organisations, sectors and industries in order to discover emerging conditions and innovative opportunities. Finally, as long-term predictions will be wrong, the most useful thing is to prepare systems that can discover threats and generate solutions to them spontaneously.

Informal ways to watch the water.

Geared to preserving an open future, the ethics of complexity suggest that we need not legislate for perfection and eternity but only for fair play and participation. If we are free to correct mistakes we can live with limited knowledge. (Artigiani, 2005)

Mitleton-Kelly (2008) defined two key roles of a leader as identifying challenges correctly so that problems do not become intractable and creating an enabling environment able to co-evolve with its broader social ecosystem. A large part of creating such an enabling environment is to encourage and support informal ways to 'watch the water'. At all levels in the organization, ensure the capability for reflective processes and the active seeking-out of disconfirming information in order to minimize inertia and register weak signals from multiple sources. Management theorists now describe this as nurturing a higher collective intelligence, increasing individual and group cognitive complexity[lix] and growing non-linear systems intelligence[lx] through more widely distributed responsibility.

This also requires informal connection systems that allow information flow along relationships through social and informal ways to get together, share and listen. Allowing such systems also lets leaders gain exposure to both concerns that staff are not ready to formalize, and to the weak signals of new ideas. It encourages constructive criticism and disconfirmation to flow upwards, and also enables nudging, tending and the gentle reinforcement of shared purpose to flow down in a supportive environment, in a way not possible in formal communication processes.

Formal systems assist such dynamics by ensuring robust real time information systems that allow information to be pulled out where and when needed, in ways people will find useful; and ways to feed information into both tacit and explicit information databases, to be used where and when required. This is enabled by people having the agency to interact with such real-time data, and to be involved in decision-making and action at a level appropriate to their role.

The main ways in which a leader builds such capability, both personally and across the organization, have been a consistent thread throughout this chapter. They include accurate scanning of the horizon whilst being aware of their own blind spots; actively seeking disconfirming information; and understanding that once they make it safe to challenge old ways, transformation is possible as people can let go of habits and dissipation of outdated thinking and doing can occur.

Such leaders are comfortable with the ambiguity that transition creates, and instead of emphasizing control and action, they are skilled at listening to the weak signals and recognizing 'perking' information. Where formal, structured ways are used to seek critical feedback, trust is maintained through quiet consideration, logical inquiry and the obvious valuing of honest input.

People have good radar for recognizing a leader driven by ethical judgement exercised though decisions and actions governed by a long-term perspective. Such leaders empower people through fostering shared intention and consistent goals and values, which enables flexibility and resilience in unknown situations. They do this by using their sense-making capability[lxi] to isolate and communicate what is

important. They also support new ways of trying things before committing to a single path and provide impetus and resources for change from the top in order to allow change to emerge. The identification of multiple weak signals is critical here, as is the use of investigation processes which drive toward understanding instead of closure.

The end result will allow people to be in a better position to observe the surface patterns and early warning signs of weak signals through "*greater observatory and responsive capability due to an increase in group cognitive complexity*"[lxii]. Internally, there will be greater communication, connectivity and collective learning, all of which lead to greater resilience, facilitated by a leader who nurtures the capability for people at all levels to use their judgement, develop the analytic capability to discern relevant information, and act either independently or as a group to optimize the collective intelligence of the system[lxiii].

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References and End Notes

[i] (Gupta & Anish, 2011); (Liang, 2010); (Meadows, 2008); (Wheatley, 2006); (Seijts, Crossan, & Bilou, 2010); (Prigogine, 1996); (Marion, 1999); (Sterman, 2000); (Osborn, Hunt, & Jauch, 2002); (Schneider & Somers, 2006); (Uhl-Bien, Marion, & McKelvey, 2007).

[ii] (Mitleton-Kelly, 2003a)

[iii] (Waldrop, 1992)

[iv] (Mitleton-Kelly, 2003a)

[v] (Liang, 2007); (Kira & van Eijnatten, 2008); (Hämäläinen & Saarinen, 2007)

[vi] Kerr, 2013

[vii] (Wheatley, 2006); (Schneider & Somers, 2006); (Helbing & Lämmer, 2008); (Seijts, Crossan, & Bilou, 2010)

[viii] (Liang, 2007, p. 113).

[ix] (Schelling, 2006),

[x] (Lichtenstein & Plowman, 2009, p. 628)

[xi] (Mitleton-Kelly, 2006); (van Eijnatten, 2004a); (Lichtenstein & Plowman, 2009); (Fiksel, 2003)

[xii] (Lichtenstein & Plowman, 2009); (Mitleton-Kelly, 2003a); (McKelvey, 2004).

[xiii] (Gupta & Anish, 2011)

[xiv] In an organizational context, a process of profound and radical change that orients an organization in a new direction and takes it to an entirely different level of effectiveness. Unlike 'turnaround' (which implies incremental progress on the same plane) transformation implies a basic change of character and little or no resemblance with the past configuration or structure" (BusinessDictionary.com, 2011

[xv] (Mitleton-Kelly, 2003a); (Gupta & Anish, 2011); (Lichtenstein & Plowman, 2009); (Uhl-Bien & Marion, 2009).

[xvi] (Lichtenstein & Plowman, 2009); (Gupta & Anish, 2011).

[xvii] (Seijts, Crossan, & Bilou, 2010, p. 3)

[xviii] complexity (Seijts, Crossan, & Bilou, 2010)

[xix] (Gupta & Anish, 2011, pp. 3-4).

[xx] (Helbing & Lämmer, 2008); (van Eijnatten, 2004a), (Fiksel, 2003).

[xxi] (Gupta & Anish, 2011); (Kira & van Eijnatten, 2008); (Mathews, White, & Long, 1999); (Prigogine, 1996); (Morrison, 1991); (Kauffmann, 2000); (Dooley & Van de Ven, 1999); (Marion, 1999).

[xxii] (Kauffmann, 1993)

[xxiii] Kerr, 2013

[xxiv] (Voorhees, 2008, p. 133)

[xxv] (Voorhees, 2008, pp. 133-134)

[xxvi] Ashby's law of requisite variety says that the variety of control possibilities must match the variety of the external disturbances if the outcome is to be uniquely controlled. Thus, the degree of flexibility

required is no greater than what is sufficient to deal with the spectrum of ordinary environmental fluctuations, with a cut-off for very low probability events. (Voorhees, 2008

[xxvii] (Voorhees, 2008)

[xxviii] (Meadows, 2008)

[xxix] (Voorhees, 2008); (Mitleton-Kelly, 2003a)

[xxx] (Voorhees, 2008, p. 137)

[xxxi] (Meadows, 2008)

[xxxii] (Yasai-Ardekani, 1986); (Aaltonen & Sanders, 2006)

[xxxiii] Kerr,2013, (Kira & van Eijnatten, 2008).

[xxxiv] , (Metcalfe, 1979); (Mitroff & Kilmann, 1976); (Starbuck, 1982),

[xxxv] coallitions (Morrison & Hong, 2006); (Pettigrew, 1973); (Watson, 1969).

[xxxvi] Van Eijnatten(2004

[xxxvii] (van Eijnatten, 2004a); (Fiksel, 2003); (Holling & Gunderson, 2002); (Kira & van Eijnatten, 2008); (Helbing & Lämmer, 2008); (Mitleton-Kelly, 2003a). Ball (2004)

[xxxviii] (Ball, 2004).

[xxxix] (Hock D. W., 1995), (1999)

[xl] An amalgamation of the terms chaos and order signifying the fact that the two seemingly disparate properties of experience are so thoroughly interpenetrated that neither can exist without the other. The complex, dynamical, non-linear, co-creative, far-from-equilibrium system we know of as the organisation is chaordic in its essence, that is both chaotic and orderly at the same time – an entity in which nothing ever happens quite the same twice, yet enough happens in a tidy enough way to preclude complete anarchy (Fitzgerald & van Eijnatten, 2002, p. 414)

[xli] (Sensitive Dependence on Initial Conditions (SDIC) (van Eijnatten, 2004a); (Aaltonen & Sanders, 2006); (Aaltonen, 2007a)

[xlii] . (van Eijnatten, 2004a, p. 432)

[xliii] (van Eijnatten, 2004a); (Aaltonen, 2007a); (Lorenz, 1993)

[xliv] (van Eijnatten, 2004a, p.436

[xlv] (Aaltonen & Sanders, 2006)

[xlvi] (Bamford & Daniel, 2005),

[xlvii] Ashmos, D., Duchon, D., McDaniel, R., & Huonker, J. (2002, march). What a Mess! Participation as a Simple Managerial Rule to 'Complexify' Organizations. Management Studies, 39(2), 189-206.

[xlviii] (Heifetz, Grashow, & Linsky, 2009).

[xlix] Kerr, 2013

[l] (Malan, Erwee, & Rose, 2009)

[li] Artigiani (2005)

[lii] Kerr, 2013

[liii] Allen (1992)

[liv] (Helbing & Lämmer, 2008); (Mitleton-Kelly, 2003a); (Gunderson & Holling, 2002)

[lv] (Fiksel, 2003)

[lvi] (Altonen 2007)

[lvii] (Holland, 1995); (Bogner & Barr, 2000)

[lviii] (Aaltonen & Sanders, 2006)

[lix] (Kira and van Eijnatten,2008)

[lx] Hämäläinen and Saarinen (2007)

[lxi] (Weick, 2001)

[lxii] (Kira & van Eijnatten,2008)

[lxiii] (Hämäläinen & Saarinen, 2007); (Liang, 2010); (Uhl-Bien & Marion, 2009); (Kira & van Eijnatten, 2008).