Chance and necessity; diversity and belief

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Abstract

In this paper we explore resilience from the perspective of complex systems thinking, building, in particular on the work of Prigogine (1984) and Allen (1997) and revisit a study of the population dynamics of Darwin's finches (Allen 1976, 1985). We consider different approaches to resilience and demonstrate the importance of diversity. We explore how the creation of intentions and beliefs affect resilience for human organisations, particularly in times of fast and radical change.

Key words: resilience, self-organisation, radical change, adaptation, diversity, complexity, evolution, sustainability, belief, worldview

1. Introduction

Our intention, in this paper is to explore resilience and what creates conditions for resilience through the lens of complex systems thinking. We build on the work of Prigogine and the development of that work by Allen, who worked for twenty years with Prigogine and has subsequently focused on the application and development of these ideas to social and ecological systems. We will first, in section 1, describe what we mean by a complex systems view, and, in section 2, relate this view to resilience. We take an ecological example (Darwin's finches on the Galapagos Islands) and show, in section 3, how this elucidates different types of resilience. In section 4, we consider what this ecological example has to offer as a perspective for organisational strategies, exploring similarities and differences. Section 5 provides a summary and conclusions.

1.1 A brief definition of complex systems theory

Systems theories in general bring to our attention the interconnected, systemic nature of our world; more than that, these theories bring into focus the synergistic nature of those interconnections and interactions and the potential for patterns to form. Some systems theories, however, still do regard the world as complicated, without doubt - but deterministic nevertheless; we assert that what complexity theory adds to systems thinking is the notion that the future is unknowable in principle; it places attention on change and emergence of new forms and patterns and sees current forms as temporary dynamically-stable outcomes of synergistic interactions. This view accords with that of Marshall (2004) when she says, *' 'parts' and 'systems'…. are patterns, shifting qualities, not things.'*

Marshall (2004) summarises what it means to explore the world as if it were systemic:

- Hold in mind ideas of connectedness, systemic properties and dynamics, persistence of patterns and resilience
- Respect emergence and unfolding process
- Believe that often 'parts' cannot change unless there is some kind of shift in systemic pattern, but/and that sometimes 'parts' can change and influence change in the wider 'system'

Prigogine (1978) was interested in how dynamically-stable patterns came to emerge. His initial interest was in certain chemical and hydrodynamic systems not in equilibrium. He showed that the emergence of structure (later called self-organisation) came from the inter-relationship of the *function* of the underlying process together with *fluctuations* (Prigogine 1978:781, Allen 1997: 15). By function, he was referring to the underlying internal dynamics; in an ecology, for example, this would define what drove the structure of interactions; for example, who can eat whom, what food intakes are needed, how long it takes for mature fish to grow and so on. He also underlined the potential for bifurcations that is for situations where the underlying system dynamics have more than one possible solution available in moving forwards. He explained that the existence of bifurcations introduces 'history' into science (Prigogine 1978:781).

By fluctuations, Prigogine refers to the propensity - within any ecology or set of interconnected elements of any kind - for variation, both spatially and temporally and with respect to any kind of classification. So, if we consider a pond, then the density of pondweed, the temperature of the water, the size, age and type of fish, the size of the ripples on the water – such factors will not be uniform over the pond or with time. Equally, if we consider human systems, although we can classify people according to age or race or social grouping or education, clearly these classifications do not capture all that we are; each of us, and everything else is unique. It is the existence of this fine-graining - what Allen (1997:7) termed microdiversity - that is fundamental to the potential for self-organisation, self-regulation, the potential for emergence of radically new qualities and forms - and for the fact that the future '*is under perpetual construction'* (Prigogine 1997:1). Prigogine explained that at a point of bifurcation, fluctuations '*play an essential role'* (1978:781) and affect the direction the system subsequently follows. As we will discuss later, this central principle, '*order through fluctuation'* (Prigogine 1978, Jantsch 1980), for which Prigogine received the Nobel Prize, makes us aware of the vital role of *chance*.

It is important to note, that, as suggests Marshall (2004), Prigogine did not 'reify' the structures that could emerge within thermodynamic systems not in equilibrium – that is he did not express them as fixed and permanent 'things'; he saw these self-organised structures as dynamically stable but subject to change, chance, and evolution. Wadsworth (2008: 28) captures this quality in articulating:

'The simultaneous nature of form and process – as both stabilising, organising and containing and dynamic; as moving and in energetic balance'.

1.2 State space, self-regulation and self-organisation

In order to discuss resilience from the perspective of complexity, we will first define and contrast notions of self-regulation and self-organisation; in order to do this we will introduce the concept of state space.

1.2.1 State space

State space is a well-defined and well-established tool used in mathematics and physics. It is defined as the collection of all possible states in which a system can exist – the totality of the degrees of freedom or variety, defined by Beer (1984:5) as '*the number of distinguishable elements in a system or by extension the number of distinguishable systemic states'*. A piece of music, for example, can be defined by writing down each note, together with the time intervals between them; equally the music can

be described by the combination of frequencies it contains, as displayed on a spectrum analyser. In this example, the frequency spectrum is the state space for the music.

More generally, complex systems will need a number of state variables to describe them and the state space will have multiple dimensions. State space can be considered as the totality of states available to a system and between which it can, under certain conditions, move. It could be applied to represent all the possible strategies an organisation could inhabit, for example, where the state variables in this case would be things such as technology, organisation structure, product and supply chain. What seems to happen in many cases is that the behaviour over time of a complex system settles in one region of state space – that is, a particular type of strategy, at least for a time, may become stable, successful and sustaining. This region is called an *attractor basin* and the process of settling there is called self-organisation. When the system has settled into that region it will tend to remain there if environmental conditions are pretty stable; it self-regulates through small adjustments and maintains its stability or equilibrium in a dynamic fashion.

In general state space will contain a number of attractor basins; that is, there are several distinct combinations of characteristics that are options; in our strategy example, there will be more than one group of available and stable strategic options that can potentially exist in the market place. For example, it may be possible to succeed with one or several 'cheap', multi-purpose product and it may also be possible to succeed with one or more expensive, specialised products. There may also be regions of turbulence, where any possible structures do not self-reinforce and patterns of connectivity are constantly shifting and changing. The constant shifts in power and forming and breaking of structures and alliances in unstable political regimes is an example of such turbulent behaviour.

It is also important to emphasise that structure of state space is also subject to change, as the environment itself changes; new qualities can emerge, strategies that were once available may no longer succeed, new entrants and invaders may shift dynamics and so on.

1.2.2 Self regulation

If a system is in a condition of dynamic stability, it will be robust against relatively small shifts in the environment or small changes from within and will be able to *self regulate* (Ashby 1956). In effect the system is stable, for a time, with respect to its own fluctuations.

As we will justify later, the conditions for self regulation to be effective are when the elements of the system are free to shift and change both internally (ie within an element) and in relation to each other (ie between elements); where there is diversity (ie propensity for fluctuations and variations) and rich interconnectivity. If the system is too rigid, too regimented, too standardised, such adaptability becomes problematic. With respect to state space, we are describing a situation whereby the system adapts to stay within the same attractor basin.

The mechanisms for such self regulation result from shifting balances between positive feedback loops and negative feedback loops in the interactions between elements within a system. Take for example the human body. Most of the time, this is an excellent example of a self-regulating complex system (Briggs and Peat 2000). The state parameters, such as temperature or weight remain steady, despite the person eating, or moving from place to place. In that way the negative feedback loops are keeping the body is dynamic equilibrium. However, if the changes are too great, if the person gets a serious illness or is subjected to extreme temperatures, this dynamic equilibrium will break down; certain positive feedback loops will dominate and take the system out of control - with potentially serious outcome!

1.2.3 Self organisation

Self organisation describes the situation where new emergent structures and properties may arise without being imposed from above or from without; it is a distributed response of a system (ie it cannot be expressed as a function of one part or element but only as a function of parts in concert). Prigogine (1978: 781) calls it '*long-range order through which the system acts as a whole'*. Fontana and Ballati (1999) additionally comment that self organisation does not come from '*any tendency of inidividual agents to prefer or seek order*'. It is the process of forming new, dynamically stable coalitions and combinations of routines and ways of operating in response to some external or internal change. In this process, there evolves a new balance between emergent and sustaining synergistic loops of interacting processes connecting certain aspects of the system. This leads to the establishment of new macroscopic qualities and structures; at the same time, other possibilities do not self-reinforce and thus will die away. The timing and order of these processes will also influence the solution; if certain possibilities are triggered earlier, it may preclude other possibilities getting established.

When a system has self-organised and stabilised, the tendency to self-regulate will work to keep the form of the structure stable in a dynamic fashion (ie through minor readjustments, such as we make when riding a bike). However, if the environment changes or the internal variations have made the system less coherent and stable, it may shift into a new form, in effect into a new attractor basin in state space; in that instance, the process of self-organisation, ie the finding of new stable forms, will come to the fore.

1.3 The crucial importance of fluctuations

If we ignore for a moment the possibility of fluctuations, then, as a thought experiment, we would be considering a situation that, however complicated to understand, is deterministic. In this case, future behaviour is defined by and unfolds from earlier behaviour. There may potentially be a number of available regions of operation, but once the initial conditions are set, then, without fluctuations, the region of operation is also set; there is no way for learning and adaptation to take place.

However, in reality there **are** fluctuations in most situations of interest; these fluctuations lead to small, local perturbations which will constantly probe the stability of a given state. If an organisation or ecology has achieved a degree of stability (ie self-organised), then it can cope with small variations and changes and indeed uses these to self-regulate. And it is important to note that it is these same fluctuations that create the propensity for radical change; the fluctuations are also the mechanism that allows the system to move from one attractor basin to another. We will return to this point later.

The emphasis then is on seeing the world as 'under perpetual construction', as becoming rather than being. The focus is on what can be understood about change and how it happens, rather than an emphasis on how things can be described at a particular moment in time. Stability is seen as unusual and evolution and change as the norm. As Jantsch (1980:6) states:

'*The notion of system is no longer tied to a specific spatial or spatio-temporal structure nor to a changing structure of particular components nor to sets of internal relations. Rather, a system now appears as a set of coherent, evolving, interactive processes which* ***temporarily*** *manifest in globally stable structures.'*

This combination of coherent behaviour and yet random variation gives this tension between 'chance and necessity'. Chance fluctuations give the system its unique history and yet the movements take

place in the context of coherent dynamics which are stable, at least for a time. As Allen (1997:16) explains:

'[this] begins to throw light on the basic difference thought to exist between 'science' and 'history'. In the former, explanation was believed to be traceable to the working of eternal, natural laws, while the latter provided explanation on the basis of 'events'. In this perspective of self-organising systems we see that both aspects are present and that such systems are not described adequately by either laws (their internal dynamics) or events (fluctuations) but by their interplay.'

This 'story' of coherent unfolding of our lives and yet the possibility for change or luck, good or bad, can perhaps seem familiar. As time goes on, our personal and collective history narrows choices and creates a strong probability that we will respond to situations in predictable ways and make predictable decisions; in other words the 'function' or dynamics of the relations that constitute our local 'world' become well-established. And yet there is still the possibility that either something will happen that was unexpected, or that we will make uncharacteristic choices – thus introducing the tension between 'function' and 'fluctuation', to use Prigogine's (1978) words. So, it is perhaps true to say that we do not experience our lives as random, nor do we experience them as entirely determined, but as a complex interplay which can lead to the emergence of completely new patterns and radical renewal. These patterns, however fixed they can seem, are, however, temporary and are held in place by self-reinforcing processes that, through their dynamic, rather than static nature, always offer the possibility (and threat) that all can change.

2. Resilience

2.1 Resilience and staying the same

From the perspective of complex systems theory, then, how do we understand resilience? Resilience is defined by Brand and Jax (2007) as a:

'measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables. The magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour' and 'the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity'.

Resilience of this type can be described as maintenance of the status quo through self-regulation. If we consider how to describe this using the language of state space, we would say that the system is able to maintain its position within one attractor basin in state space by making minor adjustments. The structure of relationships and the patterning sustains. As Allen (1997:17) similarly says, resilience is usually taken to refer:

'.. to the ability of the system to stay within its basin of attraction and resist being kicked over into another basin and another pattern of behaviour'.

What are the conditions necessary for enhancing such resilience? Carpenter et al (2001:776) report that there is a relationship between the maintenance of biodiversity and resilience in ecological systems. Holling (1973:18) emphasises not only the relationship with diversity but also the importance of the number of links between species. Allen (2001) takes this further and suggests that the degrees of freedom must be greater than those required for the system to maintain functionality if the environ-

ment were stable. Allen (2001) called this the "law of excess diversity" (as opposed to the law of requisite variety (Ashby 1956)); the law of excess diversity means that the long-term survival of a system requires more internal diversity than appears requisite at any time.

If a system is too finely tuned to existing conditions it will almost by definition be less able to cope in a dynamic fashion with change. Its rigidity renders it unable to shift position and make subtle adjustments. Equally, it is interesting to ask if there can be too much connectedness and diversity in a system; that is perhaps forgetting that what we are considering is the *underling* diversity in the system and the *potential* for connecting. The self-organising process enables the system to find self-reinforcing patterns of relationships and thus select self-sustaining patterns. Self-organising is a simplifying or ordering process that occurs from within; it is the *potential* for connecting and the allowing of diversity and redundancy that must not be compromised. As Allen (1997:17) goes on to say:

'*The capacity to adapt and respond to external and internal variation, although requiring some 'instability' can be the origin of the system's resilience. This is an example of the complexity of some of these issues in which adaptability may allow stasis in a broader sense, and rigidity may lead to collapse'*.

Holling (1973:19), similarly, states that persistence, or resilience may be enhanced by the presence of fluctuations.

2.2 Resilience and radical change

The type of resilience we have discussed so far is focused on the extent to which the status quo can be maintained, in a dynamic fashion, as circumstances fluctuate or change slowly. Another angle to consider when exploring resilience relates to radical change. If circumstances change radically, radical reordering of structures and relationships and ensuing qualities - as occurs in self-organisation - might be required. The conditions necessary for the system to have the potential to do this effectively, as we have already argued, are the same as for self-regulation – ie maintaining connectivity, diversity and degrees of freedom. In this case, however, the system in effect moves to a new attractor basin in state space and the qualities it now displays can be radically different from before; this is an irreversible change.

This may seem at first glance confusing. How can it make sense to say that the same conditions that maintain the status quo can lead to effective adaptation into a new form? The issue is to do with the underlying dynamics of the environment. If the environment is stable or fluctuating, then interconnectivity and diversity will help to maintain the system in its current state. If the environment shifts radically, then state space itself will be co-evolving and the shapes and existence of attractor basins will themselves be changing. What was a stable configuration may no longer be available and the internal diversity of the system will help it to evolve into and co-create new stable forms.

Holling (1973:10) says:

'these examples point to one of more distinct domains of attraction in which the important point is not so much how stable they are within the domain, but how likely it is for the system to move from one domain to another and so persist in a changed configuration.' He goes on to say (1973:19) that '*increased variability could move the system from one domain to another'*.

Of course such a self-organisation is only considered beneficial and hence resilient if the new order is considered positive against some criteria; extinction of one species, for example, is a radical response to change and may be positive for the ecology as a whole, but not from the point of view of the spe-

cies rendered extinct. So we introduce the need for criteria for assessing from what perspective we regard a change as positive and hence a form of resilience - or negatively, and hence not a resilient response.

This brings us on to another question - which is whether resilience is necessarily what we want. Flooding the financial markets with cash from reserves may help to ward of a credit crisis – but at the cost of what? Maybe a crisis is what is needed to force a radical restructuring of the markets? Resilience, if translated as staying in the same place, or upholding the status quo, can clearly mitigate against change.

So, in agreement with Holling (1973) we would like to extend the definition of resilience to mean the ability to persist and absorb change and disturbance in a way which **either** maintains the current form **or** leads to re-structuring and reconfiguration through adaptation – where the reconfiguration is judged as positive against some explicit criteria.

3 An example; Darwin's finches

3.1 A description of the original research

We would now like to reflect on these ideas about resilience by revisiting some work undertaken by Allen (1976, 1985) focusing on Darwin's finches.

Figure 1 The Galapagos Islands

Fourteen different species of finches occupy different sized islands in the Galapagos. Some islands hold large populations but have limited species diversity; others have greater species diversity (Lack 1947); the question is why.

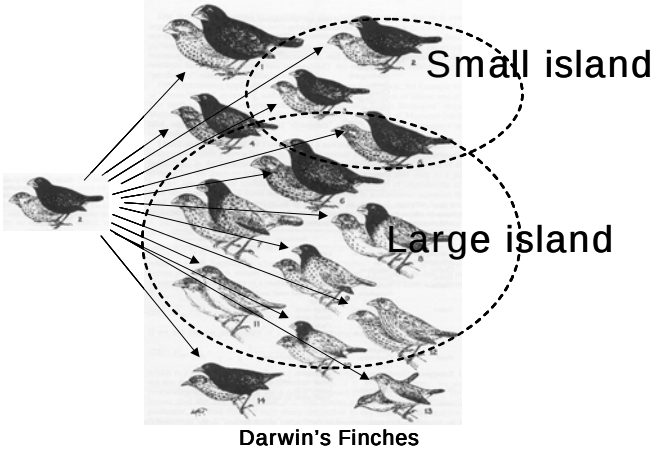

Figure 2 Darwin's Finches

Allen (1985) describes three types of fluctuations; fluctuations to the density of the finches, ie to the numbers per unit area; fluctuations in the environmental conditions ie areas may get hotter or wetter sometimes and provide varying amounts and differing types of food; fluctuations in the morphology of the finches – ie within one type of finch there can be variations in the size or strength of beak, for example.

Allen used the invadability criterion developed in his 1976 paper to explore the degree of morphological variation that could lead to resilience when there is competition between species. If a given species were too varied, its characteristics would overlap with other species and they would be vulnerable to extinction – ie they would have competition for particular resources taken in particular environmental conditions. Equally, if the morphological variation were too narrow, the survival of the species would be vulnerable to fluctuations in type of food available or weather conditions. Allen expressed this dynamic balance, to which species existing alongside each other would move towards, as 'niche width', 'ws' in the diagram below. He showed that niche width, ws, would be narrow when food was plentiful and its supply was stable ie the different species would become highly specialised.

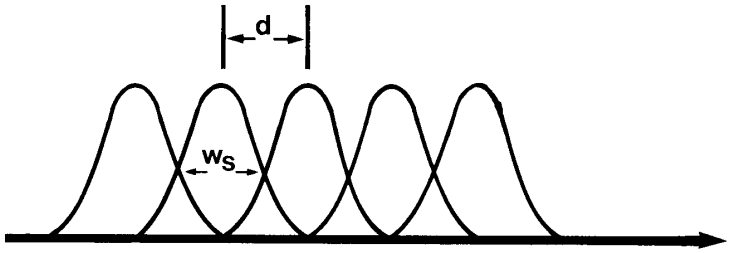

Figure 3 Niche width

Previously, Robert May (1973) had calculated that the species separation ('d' in the diagram above), ie the degree of genetic variability between species, would depend on the degree of resource fluctuations. So, together, these two calculations allow prediction of the evolved diversity, ie the number of species the situation settles to over time.

What May's calculation showed was that, if there were a high level of resource fluctuation, it was likely that there would be fewer distinct types of finch; so there was an inverse relationship between the degree of resource fluctuation and the degree of morphological diversity (ie distinct types of finch with quite different qualities). Joining this together with Allen's exploration of niche width allows construction of the following relationship (Allen 1976):

morphological diversity is proportional to the volume of resources and inversely proportional to the degree of environmental (ie resource) fluctuation.

Allen found that Lack's (1947) data for Darwin's finches, as explored by Bowman (1961) accorded with this relationship. Indeed the data showed that the more precise prediction concerning the total 'morphological diversity' – which is more general than the number of species because it can take into account intra-species diversity between males and females – was in agreement (Allen 1985).

3.2 Implications for resilience and evolution

How does this relationship between morphological diversity, resource volume and resource fluctuation relate to considerations of resilience? Well, if we consider the differing ways the finch populations evolved to meet differing circumstances on different islands we can see that on large, rich islands we shall expect a high degree of specialisation and maybe in addition strong variation between male and female, as the morphological diversity made possible by the resource is great. On small, poorer islands, only species with fairly general characteristics emerge, with wide niches; as niches are wide, only a few distinct species can co-exist. These demonstrate two differing forms of resilient; one is to generalise (ie to be able to eat a range of foods under a range of conditions) and the other is to specialise and find sharply-defined niches; which one is effective depends on the nature of the environment.

To translate this into the language of state space: on the poor island, the finches evolved to be in one broad attractor basin and, whilst there were morphological fluctuations, these did not lead to morphological distinctions. In contrast, on large rich islands, morphological fluctuations lead to the shifting of the population into two or more attractor narrower basins – and these distinct species co-exist stably due to the unique specialisation of each.

Allen's work suggests that microdiversity – ie variation between individuals of one species - is a prerequisite for evolution; any fluctuations in the characteristics of individual birds, ie this microdiversity, are selected upon by the prevailing environment; over time, stability - in the numbers of birds, numbers of species and degree of morphological fluctuations within a species - evolves to a dynamic balance. So one factor that leads to resilience is this microdiversity; from this the populations were able to evolve into stable structures of species.

4. How are these ideas relevant to organisations in a changing world?

We will first consider, in 4.1, to what extent ecological systems can be compared with organisations and to what extent notions of generalisation and specialisation are relevant. We will compare the work on finches with discussion of the 'population ecology' perspective described by Hannan and Freeman (1977).

An exhaustive comparison of the characteristics of ecological systems and organisations is beyond the scope of this paper. We will, however, consider three themes; the first is the impact of timescale. In looking at situations such as variations in finches in the Galapagos Islands, we are investigating a situation where there has been time for the co-evolutionary process to work through and where the species that have evolved and the niches they occupy are relatively stable unless there is a substantial change in conditions. In contrast, organisations, arguably, are trying to find a way to succeed in an environment which is constantly changing - and perhaps never more so than at present.

Secondly, humans have the ability to develop intentions and to design strategies and take actions; so the way organisations fare is at least in part due to direct and planned action; these actions and strategies may, even so, not achieve what was intended, but strategising would not seem to be an option for Darwin's finches! Thirdly, humans have the potential for beliefs - and beliefs arguably influence intentions and actions. We will also reflect on the importance of beliefs to the co-evolutionary process and to resilience.

4.1 Relevance to organisational strategy

Can the research on finches find a resonance with the strategic choices open to organisations? One could perhaps translate the outcomes (as summarised in section 3) in the following way. When the market is thin and fluctuating, it would seem advantageous to provide products and services that will appeal to a range of consumers (ie to generalise); when the market is buoyant and can support many players, it would seem appropriate to specialise. In this way we are associating the population of finches with the population of organisations and the 'resources' are the consumers.

The population ecology view of organisations as exemplified by Hannan and Freeman (1977) assert that the intentions or learning or adaptive abilities of organisations are largely unimportant (1977:957) – so in their view the success and survival of organisations is largely as a result of fit with environmental conditions, as with the finches. They introduce the concept of specialisation or generalisation as strategies. They state that 'specialisation is always favoured in stable environments' (1977:958) and that fluctuations in the environment are best handled through generalisation (1977:956); both comments accord with Allen (1976)'s findings summarised in the statistical relationship stated on page 10 of this paper.

It is tempting to suggest that broad strategies are always more robust as the diversity in resources and capabilities is necessarily maintained when offering generalised products and services of broad functionality; it will be less likely that 'un-necessary' resources will be discarded. However, as Allen's work on finches showed, if capabilities and characteristics are too broad, there is vulnerability to invasion as others can compete for some of the same resources. It would seem that the most resilient approach in rich markets is to develop more that one specialised offering – ie to have a portfolio. In that way the advantage of a focused specialised offering can be gained, but, through occupying more than one niche, underlying resource diversity is maintained - which can allow re-grouping and reshaping of offerings if circumstances change. Hannan and Freeman (1977: 948), on a similar vein, suggest that maintaining '*excess capacity'* and maintaining some '*organisational slack'* will allow some potential for adapting to changing circumstances.

It is interesting to consider ways in which organisations, or populations of organisations, differ from an ecology in nature. One could argue that a group of organisations with similar characteristics could constitute a 'species' and that they could compete with other groups, who are approaching the market with different offerings and/or approaching the market in different ways. How to classify organisations into groupings and decide which are morphologically similar and which are distinct is more problematic. Which characteristics are of central importance? Is it size or structure or practices or business strategies? It is unclear how to define organisational 'species' and develop some criteria for 'morphological distinctions' in a robust fashion. In addition, organisations compete not only with organisations offering similar products or services but also they compete for the buying power of consumers who must balance their needs across the whole range of requirements – including food, transport, housing and so on. So, in considering what we can learn for organisations from ecological parallels, it is as if we were to try and understand the evolution of finches in situations where there are numerous other fauna competing for a share of the same resources.

The organisational ecology view, as exemplified by Hannan and Freeman (1977) positions organisations as the 'animals' of the ecology and consumers as the 'resources to consume'. It would also be possible to relate to the concept in a different fashion and regard consumers as the individual 'ani-

mals', who are given choices, by organisations, of differing goods to consume. We would see the problem from the other direction, where organisations shape consumers rather than consumers shape organisations. This is equally valid and, indeed in co-evolutionary perspectives how organisations shape the market and how the market shapes organisations would be explored concurrently (eg Lewin 1999). We will not develop this argument further in this paper.

4.2 Timescales

Hannan and Freeman raise the issue of timescale; they introduce the idea of assessing the grain of the environment (1977:958); that is to say, are the timescales of durations of states in the environment short or long in relation to organisational life? They make the point that if fluctuations are short, organisations must have the capacity to respond to them without having the time to make substantive structural changes – ie they must be generalist; if fluctuations have a longer timeframe, then structural change leading to specialisation is possible. This is not dissimilar to the situation faced by ecologies, except in their case we do not have to question whether Darwin's finches or other fauna or flora had enough time to respond in an evolutionary sense, to differing and fluctuating environments. There is equivalence, however, to the short-term changes that can be experienced by organisations in that resource fluctuations for the finches may be seasonal or perhaps cycle over a few years.

There are many suggestions that in our current world situation, change is increasingly fast and possibly irreversible. It does not seem as if we have plenty of time to allow the conditions for incremental and slow co-evolving responses to work through. How can we at the same time survive and be successful with current business opportunities and consumer behaviour and yet prepare for what might happen in the future? How can we be specialised 'enough' to compete now and yet find ways of maintaining the underlying diversity of resources in our organisations so we can adapt as and when circumstances change? How can we make judgments as to whether our times are indeed merely turbulent, in the sense that there will be highs and lows varying around a norm – or whether the world is changing or tipping into radically new forms in an irreversible way? So, in order to decide how best to achieve resilience, we must make a judgment as to how far and fast the underlying environmental conditions will change.

4.3 Intention

In what ways do social systems differ from ecological systems such as Darwin's finches? As discussed in the previous section, there is the issue of timescale; second there is the issue of intention. Humans have the ability to develop intentions and in principle can act deliberately and collectively in the light of information, speculation and foresight. Organisations can thus in principle try to assess likely future trends and changes to their environments, and then create strategies to allow major repositioning or more organic adaptation. From this perspective an ecological discourse, although perhaps not sufficient in itself, can suggest organisational strategies and show which of these seem more effective under which conditions – in other words the ecological perspective can illuminate the contingent options to be considered. However the **judgement** about the future – the extent of likely changes and whether such changes are merely fluctuations rather than step changes – becomes, perhaps, the key determinant in choosing how to go forwards in a way which might lead to success and survival.

Miller and Friesen (1978) considered whether organisation strategies could be defined archetypally and then explored which archetypes were best fitted to particular environmental conditions. They defined the environment in terms of *dynamism*, as manifested by the amount and unpredictability of change, *heterogeneity*, defined as the degree of differences in competitor tactics, consumer tastes, channels of distribution and *hostility* as evidenced by the degree of competition, shortages, sever regulatory restrictions and unfavourable demographic trends, The first two categories seem attuned to what we have referred to, in the previous paragraph, as environmental fluctuations; the latter category, hostility, is more closely attuned to the possibility of step change (although in this case only the possibility of negative step change is included).

Miller and Friesen (1978) found that two types of firms were best placed to handle high dynamism and high hostility in the environment; these were 'the adaptive firm in a very challenging environment' and 'the innovators'. They found that the adaptive firm devoted much effort to tracking and analysing information, that a very assertive effort was devoted to product-market innovation and that the firms were largely decentralised and organic. In contrast the innovators selected a niche, were highly proactive in creating new product-market orientations as things change but placed less attention on scanning, communications and gathering intelligence. It is interesting to note that the adaptive firm has a generalised strategy and the innovative firm a specialised strategy; both place much emphasis on responding to changes in the environment with product-market innovation. The adaptive firm develops judgment through scanning and analysis and looks for changes in this way whilst the innovators place more emphasis on being close to the market place and fast to respond. So in terms of strategies for resilience in changing environments, the adaptive firm in particular adds a cerebral, intentional intelligence-driven angle to its choice of generalist strategy. Thus it could be argued that the firms position themselves in a way that makes sense from the ecological perspective, while in addition use the human abilities of creating intentions - to choose particular approaches and choose to take action fast.

Miller and Friesen's work did not include any examples of firms that have survived very radical step changes in their environments. Perhaps scenario planning and other techniques for constructing images of the future may give an additional advantage if we do face radical changes?

4.4 The role of belief

Our worldviews shape the way we frame and make sense of the information we perceive about the world, to what we choose to pay attention and how we then act. Reason (2001:4) make this point very clearly; Allen and Varga (2007) have shown that our worldview, our ways of knowing and what we value all inter-relate and self-reinforce – indeed do themselves self-organise. What we believe directs our attention; it is then often 'easy' to confirm our beliefs by unconsciously being selective about what we explore and how we interpret the outcomes.

So, paying attention to how we and others frame the world could be perceived as a most crucial and central aspect of our drive for resilience; if we think we can create resilience through fiercely guarding the status quo, or dominating others or driving for growth at the expense of finite resources, then these beliefs may drive out behaviour in a sufficiently consistent and coherent fashion to evoke potentially irreversible outcomes.

Chance and necessity; diversity and belief

Complex systems thinking as a worldview, like other worldviews which emphasise participation and emergence, would strongly question our ability to control, to know, to predict. Miller and Friesen's findings discussed in the last section identifying the qualities of firms able and willing to adapt created resilience in the era of the 1970s; but perhaps these attributes will not be sufficient to help us find strategies to cope with even faster change and turbulence if that occurs? To be resilient under such conditions may need a greater focus on learning through action, adapting methods as outcomes emerge; greater cooperation, less certainty of the results of analysis of the market place whilst at the same time a greater willingness to grapple with future scenarios, uncomfortable as some of these may be. Similar ideas are expressed by Reason (2001).

5. Summary and conclusions

We have discussed the idea that resilience does not only relate to retaining the same identity in the presence of change and disturbance, as sometimes suggested, but also can be seen as a way of shifting to new state or states deemed advantageous against some defined criteria. We have explored how these two aspects of resilience can be understood from a complex systems perspective and shown that maintaining diversity within an ecology, or with organisations and their environments, is a key determinant of the ability to be resilient. We have taken an ecological example, Darwin's finches, and shown that both forms of resilience occurred under different circumstance. We have then related this ecological example to human organisation and found a resonance with the work of Hannan and Freeman (1977).

We have considered in what ways human organisations differ from ecologies and discussed the impact of timescales, and the role of intentions and beliefs.

We conclude that it is important for organisations to maintain 'slack', diversity of resources and, in general, adopt a portfolio strategy in order to stay resilient. Equally, through Miller and Friesen's work, we add that organisations that are proactive in gathering and analysing intelligence about changing environments and reacting quickly to that intelligence seem best able to be resilient as things change. Furthermore we posit that, if changes to the environment affecting organisations accelerates - as seems not unlikely - then an ability to devise scenarios about the future and really pay attention to what could happen, is going to be an increasingly important factor in choosing effective strategies. Finally, we suggest that, as worldviews tend to drive intentions and actions, then within what worldview decision-makers operate is important to explore. We suggest that the complexity worldview, which emphasises the participative and emergent nature of our world, is increasingly relevant, as it leads us away from paradigms of certainty and control; these notions of certainty and control can be unhelpful in complex, inter-connected and fast-changing situations.

We consider that we will be more resilient if we accept that building our interpretive frameworks through our continuing experiences and actions in necessarily an exploration process with no end, since learning is always incomplete, imperfect and contains luck as well as judgment. We suggest that being prepared to challenge our perspectives, accept uncertainty and allow diversity – and continuing to question what that means in practice – is the way to build resilience; it is of course a political question as to whose resilience we attempt to build.

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