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Published version

PRICE, Ilfryn (2012). The strategic and the stratigraphic: a working paper on the dynamics of organisational evolution. In: EURAM 2012, Rotterdam, June 2012.

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Abstract

Despite large debates over fundamental issues a broadly evolutionary paradigm of organisations is growing in legitimacy. It may though be preferable to replace the metaphor of the organisation as an organism with the literal assertion that both social organisations are ecologies (Weeks and Galunic, 2003). They are still classes of complex systems maintained, and specified by, replicators (or schemata Gell Mann 1994) but the interactor is not necessarily the individual organisation, or population of organisations. Conceptual evolution has been argued as a post-Kuhnian analysis of the scientific process (Hull 1988), a rival economic paradigm (references in Hodgson 1993), a view of strategy (e.g. Lloyd 1990) and an explanation of organisational transformation and learning (Price and Evans 1993, Price 1994, 1995).My concern in this paper is to raise awareness of events, both external and systemic, in the stratigraphic record and argue for more attention to their equivalents in what we might call the strategygraphic. The causes of extinction events may be genuinely external to the system affected or they may be internal when the success of a particular replicator system disturbs a wider systemic balance. Strategic scale parallels of both forms of extinction event can be argued in commercial and technological history.

Keywords Organisational evolution, Punctuated equilibrium, Narrative ecology, memetics, stratigraphic dynamics

1. Introduction

Evolutionary approaches to organization theory, especially Population Ecology, have emphasised the search for variation, selection and retention at many levels without, arguably, paying attention to either process or dynamics over time. Modern geology has largely abandoned a uniformitarian paradigm (e.g. Benson, 2003; Bryson, 2003). Modern biology, especially molecular genetics, has meanwhile made great advances in the microscopic understanding of evolutionary processes in DNA based systems. As Shepherd and McKelvey (2009) note evolutionary approaches in organizational science have yet to make comparable progress particularly when one considers there are at least two major divisions of the subject and a larger corpus of scholars for whom evolution or ecology, as the terms are used in organisational studies, is at best a metaphor and at worst a metonym for the 'snake pit' culture (Darwin et al., 2002). As Volberda and Lewin (2003) observe Pfeffer's (1993) 'weed-patch' of organizational theory remains a justifiable metaphor. The field is a veritable tangled bank of competing narratives.

I do not intend here to enter that bank, and have expressed a view that would explain it as a narrative ecosystem in two pending papers (Price 2012a; 2012b). I want instead to step back and revisit the question of what macro-evolutionary phenomena, revealed from the stratigraphic[1] column, might contribute to understanding organisational evolution and hence

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[1] Both stratigraphy and strategy incidentally illustrate the mutation of meaning that I have argued (2012a) might be the source of variation in organizational evolution. Stratigraphy derives from the Latin stratum or layer a word whose etymology derives from a stratum has a horse blanket, on which a *strategus*, or general, would expect to be seated (Valpy, 1828 p448)

strategy. Such macro-phenomena add, I would argue, to the evidence for genuine selection processes operating on organisations. I reprise, in the spirit of a working paper, firstly a set of arguments advanced by Price and Shaw (1998) and secondly an update on evolutionary dynamics informed by current understandings of geo / biological history. The items are raised, to prompt questions rather than suggest developed theory. They update some ideas introduced by Price and Kennie (1997) but not subsequently elaborated.

2. Theoretical summary

I first argued for organisations as Complex Adaptive or Evolving Systems in 1995. They share (Waldrop 1992 citing original work by Holland) attributes of relationships, complex order, evolution, natural hierarchy and strategy. Consider each in turn:

Relationships

Individual organisms, and complete species, live in ecological niches defined by their relationship to other members of a particular ecological system. Within that set of relationships individual players, and whole species, compete for differential survival. (Note that I am deliberately avoiding a discussion of exactly which entities - genes, individuals or species - compete and what competition means in this context). An organisation is likewise an entity in which is found a web of relationships and economic transactions with other players. Contra the view of organisations as interactors many are better considered ecologies in their own right (Weeks and Galunic, 2003). There is again a competition for their differential survival. Both economy and ecology are characterised by the repeated interactions of component agents.

Maintenance of complex order

One of the best definitions of life is owed to Richard Dawkins (1986):

> *a property of improbable complexity possessed by an entity that works to keep itself out of equilibrium with its environment.*

To use Dawkins's most graphic example a dead pigeon thrown into the air obeys the laws of physics, describes a perfect parabola and falls back to earth. A live one disappears over the county boundary; its component parts working together to maintain their collective entity against the force of gravity. Maintaining complex order in apparent defiance of the second law of thermodynamics distinguishes both organisms and organisations. As Price and Shaw (1998) put it:

> *A typhoon raging its way across the South China Sea feeds on a temperature and humidity gradient to generate short-lived, destructive order but it is order that decays as the energy which created it dissipates. Hong Kong Island, which receives its share of the dissipation is, in purely geological terms, a complex set of rocks, not exactly duplicated anywhere else in the world but those rocks do no work to maintain themselves as an entity. They are rapidly recycled in destructive mud slides following a typical typhoon. Meanwhile Hong Kong Island teems with complexity and energy: energy that has created one of the most densely settled, vibrant and architecturally challenging cities on the planet: in a location that almost defies logic. Would rational planners chose to build a city of elaborate skyscrapers on slopes of rotting rock prone to torrential storms and violent mud slides? Given a free choice perhaps not, yet the dynamic, metastable, confluence*

> *that is Hong Kong's economy exists, grows and survives. The myriad companies that contribute to a whole such as Hong Kong each possess the ability to maintain some form of order as, by definition, does any organisation.*

Evolution

Organic species evolve and adapt, through natural selection, in their system of repeated interactions. Such selection, played out over time produces all the infinite variety of organic designs. The resulting dynamics in the history of CASs are the central concern of the next section of this paper.

Hierarchy

Biological hierarchy, the phylogenetic order, is well established. Similar but much more fluid hierarchies exist in social and economic agents. People group themselves into organisational units, units into companies and companies into networks of specialist relationships. Languages split from common roots and ultimately divide themselves into dialects. Analogous hierarchies exist in religions or scholarly disciplines though none are as clear cut, rigid or fixed as is an organic species. Cladistics, a classification method originally derived from linguistics and applied to biological systematics (Hull, 1988) can be used to classify technological history (McCarthy, et al., 1997) while Lord and Price (2001) illustrated the reverse; reconstruction of known history via similarity analysis of postulated memetic characteristics. Lunn et al. (2004) applied the method to emergent behaviour by firms entering a new market.

Strategies which anticipate the future

At first glance it may seem strange to consider an organism having a strategy, an anticipation of the future, but in one sense a gene can be considered exactly that. It is a strategic algorithm (Dennet 1995); an explicit set of instructions which says, given the right context, build a body to this set of parameters, anticipating an environment in which that body will successfully occupy an ecological niche. The instructions are of course based on a projection of the past; an implicit assumption that the rules of the game for the next generation will be the same as they are for the present one. A gene can do no more than pass on the routine of a past success.

An organisation anticipates the future through the strategy it follows, explicitly or implicitly. Strategy concerns the design, the unique capabilities, the relationships by which the company accesses resources, and perpetuates itself at a node within its own web of relationships. A company has, in theory, a freedom to define the future that no genetic agent can ever possess. In practice, however, many strategies boil down no more than an anticipation that past formulae will continue to succeed in the future (Mintzberg, 1994). Even in organisations whose management have embraced change as a permanent need, unwritten rules (Scott-Morgan 1994, Price 1993, 1994, 1995), paradigms, industry recipes, common mental models and traditions, all too frequently conspire in presuming that the future will be much as was the past. Breslin (2012) offers a recent example/

But are there differences?

The comparison of biologic and cultural evolution, especially when presented in such a potted form, can appear seductively simplistic. As several writers have observed, it is easy to overlook key differences. Gould (1991) elegantly expressed them as speed, interbreeding, and the transmittal of acquired characteristics.

Organic species are defined as incapable of interbreeding. Once formed a species (or a gene) is a distinct entity, in principle forever[2]. Organisational entities can, in theory, merge and blend at will. In practice, significant barriers stop individuals or groups cross-pollinating, learning from one another. Witness the familiar 'not-invented-here' response to exchange of ideas along even one corridor of a firm, the difficulties that speakers of any two languages have in appreciating each other or the schisms and disciplines of most academic disciplines. Pfeffer's (op cit) 'weed-patch' of organizational theory shows little tendency to mental inter-breeding as methodological nuances compete for hegemony.

An organism cannot pass on acquired characteristics. Interactions with the environment do not affect the genes. That fundamental tenet - part of the central dogma of modern biology - distinguishes Darwinian from Lamarckian evolutionary theory. Cultural and technological evolution is normally regarded as essentially Lamarckian though Geoffery Hodgson and Thorbjørn Knudsen have argued, independently and together (e.g. 2006) that replication in the domain of social evolution, and selection of replicators, does not in fact meet the test of being replication of acquired characteristics. The patterns (Price and Shaw 1998) an organisation acquires, as well as the patterns embodied in culture and language, are passed on through education and cultural programming. But even this distinction is blurred by the fact that we are not the only species with the capacity to transmit acquired knowledge. Blue tits living near humans learnt, and taught their young, to drink from milk bottles, a niche that has now largely vanished from their landscape. Foxes have discovered the possibilities of urban and suburban environments, learning to forage from garbage bins. As even the response of

[2] Whether this is true for bacteria and archea is increasingly a moot point.

wild species to recent technological and economic developments shows, the evolution of behaviours which do not require genes as agents of transmittal can be orders of magnitudes faster.

Equilibrium shifts. The dynamics of Complex Evolving Systems over geological time

My original argument for selection processes in organisational learning (Price, 1995) drew heavily on David Hull's (1988) hypothesis of conceptual selection. Change and innovation occur in the organisational equivalent of peripheral isolates; in biology small reproductively isolated populations. The history of life on earth revealed by the fossil record is one of punctuated equilibrium, long periods of stability interrupted by -relatively- fast changes. Organisations display a similar pattern.

In the earth sciences in 1995 a scientific revolution was underway as the traditional Lyellian paradigm of gradual change was being challenged by the increasing realisation of the importance of events. Over the last thirty or so years geologists, aided by the technological developments fostered by offshore oil exploration (e.g. Payton 1977) have come to realise that the constant operation of the same physical processes can produce discontinuous rates of change (Ager, 1973; Gould, 1987). The physical features of the earth reveal periodic, abrupt (sometimes absolutely and at others on the time scale of a geologist where abrupt might mean a few thousand as opposed to a few million years) changes in physical environments interspersed with long periods of geological stability. The new metaphor for the history of life on earth is Ager's Life of a Soldier - *Long periods of boredom interspersed with short moments of Terror.*

Events in the stratigraphic record

The biological record shows a similar discontinuity. Species, and ecosystems, once formed remain stable for periods of time much longer than is represented by evolutionary events (once again ‘event’ is used in a geological sense). The history of life is punctuated, at many scales, by episodes of wholesale change when old ecosystems are terminated in mass extinctions and new ones arise in their place (e.g. Eldredge, 1991). Kauffman (1993) uses data tabulated by Raup (1986) to argue that the organic system shows, over time, a departure from pure self-organised criticality with an in built tendency towards the preservation of a particular order. The question arises as to whether the *Life of a Soldier* dynamic is a property only of the biological system or whether it is also a property of the evolving organisational system. If it is what implications arise for strategy and strategic leadership? What causes equilibrium shifts in stratigraphic systems and what parallels might there be in strategic systems?

A fully orthodox Darwinian, or more strictly neo-Darwinian, view holds that extinctions are simply the result of the chance evolution of fitter biological capabilities. Hence for example once life hit on multi-celled technology - itself incidentally an argument for collaboration and symbiosis playing a part in evolution (Margulis and Sagan, 1986) - it was simply too good a trick in design space (Dennett, 1995). Likewise mammals, from this paradigm, displaced dinosaurs because they were intrinsically superior in some fashion. Elaborate hypotheses as to the nature of that superiority ignored the reality of mammals existing for more than 100 million years in the ‘nocturnal nooks and crannies of a dinosaur world’ (Gould ,1989).

The dinosaur’s demise has become an almost paradigmatic example of adherence to a prevailing paradigm; in this case that of gradualism or geologically uniformitarianism. The unravelling of the evidence for 10 km diameter asteroid crashing into the sea off southern

Mexico has become a well told story (e.g. Benton, 2003). For the preceding 130 million years, dinosaurs and mammals had co-existed but dinosaur genes dominated the ecology of the time. For some reason, perhaps a propensity to hibernate, our ancestors survived the impact when dinosaurs did not; and were free to radiate into all the newly vacated ecological niches. Plants also seized the moment. With the demise of the great grazers they took the opportunity to cover as much land as possible in forests and ushered in a new age of Carbon deposition[3].

Despite theories which have tried to generalise the end Cretaceous impact theory to all mass extinctions, or even to argue a regular periodicity to such events (Raup, 1986), few extinctions can be shown to have such a dramatic cause. Few have such a magnitude. Some are global. Many are confined to particular parts of the earth's surface and are enabled by geological contingency. Some two million years ago, for example, the appearance of the Isthmus of Panama, exposed the indigenous South American fauna to competition that destroyed most of it larger species.

In either of these two extreme examples however, the causes of either extinction event can be said to have been unconnected with the system affected. No serious astronomical theory has argued the end Cretaceous asteroid impact as being influenced by the earlier evolution of the physical or biological systems on the planet. No feasible property of biological evolution in either North or South America influenced the global tectonic plates whose juxtaposition created the Isthmus of Panama.

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[3] The widespread Tertiary Brown Coal or Lignite or the waxy oil of, especially, Northern China

Conventional geological treatment of mass extinctions has always sought such external causes. Geology just happened and biology responded. Only recently, influenced in part by Lovelock's Gaia hypothesis, have geologists have begun to appreciate systemic links between the evolving biosphere and the physical environment. Hence prokaryotic bacteria poisoned the earth's early atmosphere with oxygen, destroying - once the surplus could no longer be absorbed as ferric oxide in banded iron formations - a large part of their habitat. The first successful colonisation of terrestrial habitats by plants may have produced as a side effect, extinction events in the late Devonian ocean. The first great age of plants, the late Carboniferous culminated in the fixation of so much atmospheric CO2 as biomass that it induced a global ice age. The ensuing collapse of the tropical rainforest biome arguably triggered, or at least created conditions for, a radiation in tetrapod evolution (Sahney et al., 2010).

Niche Construction

From one perspective these, and other examples might be seen as niche construction on a planetary scale. More strictly, as defined (Odlin-Smee, 2003), niche construction refers to a process whereby organisms, in modifying their immediate environment by activities such as dam building or burrowing alter the selection pressures in a local ecosystem hence for Laland et al. (2000) "Environments are partly determined by independent environmental events (for example, climatic, geological, or chemical events), but also partly by ancestral niche construction". I am drawing attention here to the operation of the phenomenon on much grander scales, hence the model of Figure 1 (modified from Price and Kennie, 1997)

	Niche Construction	External Change
Change to the non-biotic environment	Extinction caused by changes to external environments coupled to the evolving system.	Extinction caused by physical factors external to the system.
	Evolution of the fitter	**Arrival of the fitter**
Change to the biotic environment	Extinctions/ evolutionary radiations caused purely by the development of new biological capability.	Extinction due to biological competition but new competitors introduced due to external causes.

Figure 1 Four types of extinction event

I am generalising niche selection somewhat but seeking to distinguish biotic phenomena, i.e. those induced by new biological competitors, from abiotic, those due to other changes in the wider environment. Another question to ask is whether they are systemic, i.e. linked by feedback to the system affected or uncoupled. Combining the two distinctions allows the proposed classification of extinction events (Figure 1). The evidence from the record of evolution in biological, or coupled biological/geological, adaptive systems suggests that all four can be distinguished as fundamental shifts in an ecological equilibrium. If one accepts the basic tenet of Complex Adaptive Systems theory, namely that social and commercial systems are also evolutionary it raises the question as to whether a similar classification of events can be seen in organisational systems. If so, are the strategic imperatives, and leadership issues, different in each class?

Equilibrium shifts in organisational ecologies

Evolution of the fitter

Organisational theorists who have explored evolutionist positions, whether as metaphor or theory, have tended to what would in the above model be termed a biotic and gradualist stance. Organisational evolution is seen as a process of displacement of older less well adapted technologies or strategies by newer forms. Hence, for example, Tylecote's (1993) argument that economic longwaves or Kondriatev cycles, are driven by the evolution of new technological 'styles'; Rothschild's (1992) exposition of the economic process as a selective competition between technologies; Lloyd's (1990) view of commercial competition as a selection process between competing strategic memes (stremes) or the mainstream population ecology arguments of selection between competing routines and competencies. If one accepts the basic premises of a competitive economic process and an evolution of technological capabilities, then the existence of evolution of the fitter events in the strategic record seems clear and documented at several scales. Some of the clearest examples come with the growth of new industries or markets enabled by technological developments. Arthur (1994) draws attention to the role contingency and positive feedback play in determining the eventual dominant technological format, that emerges in such situations (see also Gould's discussion of the evolution of the QWERTY keyboard). Moore (1993) emphasises how firms which succeed in building lasting positions in such new industries maintain a hold on a critical capability and build a web of dependant and interdependent players. Webs of related firms succeed in systems that are simultaneously competitive and collaborative. The strategic leadership challenge can be characterised as entrepreneurial, visualising, and building a sustainable niche in the emergent economic system.

When new technologies enable a new ecology the evolutionary history is similar in both the stratigraphic and the strategic domains. The evolution of multi-celled life forms triggered a wave of biological experimentation, recorded for example in the famous Burgess Shale (Gould, 1987) followed by consolidation into a smaller subset of successful biologic designs. The emergence of new technologies and industries shows the same pattern with a wave of innovation and experimentation followed by consolidation to a mature market (Moore, 1993). Consider, for example, the dot-com bubble at the turn of the millenium.

In a mature system, one that has reached an Evolutionary Stable State, the existing players' selective interests are served by maintaining the system to which they are adapted. For example the QWERTY keyboard, a design which evolved to slow down the speed of typing, still maintains a lock on data entry to computers replicated even in 'i-technology'. An existing technological style, or simply a set of traditions, can similarly lock innovation out of a mature economic system until the equilibrium is punctured by one of the other classes of event distinguished above. Are these the only forms of organisational evolution?

External Crisis

The archetypical external crisis is probably still the K T extinction event and its likely cause in a meteorite impact. Other extinctions have been more plausibly linked to major episodes of volcanism. Cultural evolution may be too recent, in geological terms to have witnessed equivalent catastrophic events though a potential examples would be the still debated role of the eruption of the Santorini Caldera in the demise of the Minoan Civilization, or the mini ice-age which is assumed to have contributed to the demise of early Norse settlements in western Greenland[4]. The long term impact of the 2011 Japanese Tsunami remains to be evaluated. It also represents an interesting example of conventional wisdom ignoring unwelcome evidence[5]

Arrival of the fitter

It is less difficult to point to technological developments changing an evolutionary balance. Containers have revolutionised transport and facilitated the shift of manufacturing to China. The transition is genuinely Darwinian in that a superior competitor destroys an existing ecology however the initial threat is external. For those whose position is threatened the strategic necessity is to develop, fast enough, the capability to respond to a changed competitive situation. The reality is all too often different. An established pattern seeks to maintain, as long as it can, barriers to the new competitor; a situation which, almost inevitably, makes the final crash worse when it comes. The longer term survivors are those who learn to play by new rules, shifting their competitive pattern to meet the incoming threat. Contrast the fortunes of Liverpool and Felixstowe.

Biologic species placed in such a position, exposed to a new competitor for their ecological space do not often have a choice. Their speed of adaptation is constrained by their genetic codes; systems with their own survival imperative (Dawkins, 1976). Human minds,

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[4] Whose occupants clung to the memes of their parent society rather than adopt technology from the Inuit (Diamond, 2004 discussed by Price, 2009)

[5] http://throughthesandglass.typepad.com/through_the_sandglass/2011/03/ignoring-tsunami-records-hubris-complacency-or-just-human-nature.html accessed 03 April 2012

individually and collectively in organisations, carry similar codes or traditions which seek their own replicative survival. Individuals and organisations trapped in these pre-existing patterns all too often find it impossible to evolve fast enough to meet a new challenge (Price, 1995; Price and Shaw, 1996). The strategic leadership challenge is to foster a shift in the thinking patterns and habits which have enabled an organisation to survive in an older ecosystem.

Systemic niche modification

More common may be a feedback event wherein the demise of the existing dominant ecosystem is due to wider environmental change that is itself ultimately a response to the success of a particular ecosystem. Any social organisation which outlives the resource base that sustains it risks such a crisis. A dramatic, and well contained, example is, the collapse of the Easter Island Civilisation (Diamond, 1993). The feedback in commercial systems need not however be strictly environmental. Any dominant pattern of thinking, or organization, which sees its continued pre-eminence as pre-ordained, risks triggering a crisis out of its own short-sightedness. IBM, yielding strategic dominance of the emergent PC ecology to Microsoft and Intel (Moore, 1993) could be said to have precipitated a crisis of their own making.

Discussion

I can sympathise with a reviewer who took the position that the fore going did not do more than raise some tricky technical issues then drop them. My intention was not however to solve all these tricky issues. It was to seek to raise the reader's awareness to the fact that the historical record of biological evolution, and life on earth, is not a simple record of continuous steady-state variation, selection and retention. It is episodic with a variety of causes to extinction events. Superficially it seems that a similar set of extinction events can be seen in the two classes of CAS. It remains to be tested by empirical case study whether the classification of strategic events suggested here proves to have general validity. The study of strategy from a modern evolutionary perspective is still a largely untested field. Questions worthy of further investigation include the distinction of separate classes of event, and the question of the degree to which generic strategies and leadership issues vary in different change situations.

There may also be differences in cultural evolution. Some events are initiated not by a new competitor but rather by the chance extinction of the previous ecosystem by some agent unconnected with the system itself. The result is new competitive space into which survivors can move, evolving new forms in the process. In commercial systems this is probably the hardest class of event to recognise. Human systems constitute such a small part of the total planet ecology that it is not clear to what extent any event can be argued as being independent of another part of the system. The difference may boil down to the degree of coupling between the event and the agents affected. Hence for example changes in government policy that create or deny strategic space to particular industries could be said to qualify. To distinguish this class of strategic events from the first two it is necessary to ask whether the loser, the industry or technological style that is rendered extinct suffers because of an inherent inferiority or whether its demise and replacement is largely a matter of chance. A case can, for example, be made that the current National Health Service is being replaced, by dictat, by alternative managerial approaches without the resulting service being more effective and efficient than the previous. A topic meriting further consideration is the question of whether technology enabled competition can be considered as a genuine external event where a particular market sector is concerned. In the UK the traditional high street opticians have been displaced by chains such as vision express, leaving niches dependant on extra service and high fashion. Professional service firms threatened by of on-line access to data inj the 1990s (Kennie and Price, 1997) have seen their ecology hugely challenged; a phenomenon that may yet threaten another professional ecosystem - Higher Education - (Kennie and Price, 2012).

Acxknowledgements

My interests in organizational ecology have benefitted especially from discussions down the years with Dermot Breslin, Kate Distin, Ian Ellison, Lily Evans, Jameson Gill, Michael Lissack, Andrew Lord, Ian McCarthy, Geetha Narayan Tudor Rickards, Rory Ridley-Duff, Ray Shaw and David Smith.

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