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Learning from the Anthropocene: Adaptive Epistemology and Complexity in Strategic Managerial Thinking

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Abstract: Turbulence experienced in the business and social realms resonates with turbulence unfolding throughout the biosphere, as a process of accelerating change at the stratigraphic scale termed the Anthropocene. The Anthropocene is understood as a multi-dimensional limit point, one dimension of which concerns the limits to the lineal epistemology prevalent since the Age of the Enlightenment. This paper argues that future conditions necessitate the updating of a lineal epistemology through a transition towards resilience thinking that is both adaptive and ecosystemic. A management paradigm informed by the recognition of multiple equilibria states distinguished by thresholds, and incorporating adaptive and resilience thinking is considered. This paradigm is thought to enhance flexibility and the capacity to absorb influences without crossing thresholds into alternate stable, but less desirable, states. One consequence is that evaluations of success may change, and these changes are considered and explored as likely on-going challenges businesses must grapple with into the future.

Keywords: epistemology; resilience thinking; adaptive management; anthropocene

1. Introduction

Over the last few decades, a shift has occurred in the natural sciences and the way that scientists construe the relationship between humans and nature [1]. Although these commentators consider this an ontological shift, here it is argued that this is actually an epistemological shift that now allows for ontological linkages between coupled social and ecological systems (SES) to be explicitly recognised. The significance of this compels these systems to be thought of as coupled and reciprocally influential. One consequence of this is to recognise that the organism and its environment constitute the "unit of survival", such that we are "learning by bitter experience that the organism which destroys its environment destroys itself" [2] (p. 483).

In this conceptual paper, we recognise the need for business managers to strategically adapt to the reality that there can no longer be any such thing as a "business-as-usual" scenario under the rapidly changing world of the Anthropocene, and hence introduce an ecosystemic epistemology to support managers in undertaking such a fundamental transformation towards ensuring that their business concerns are more adaptive and resilient in preparation for multiple future scenarios. The current COVID-19 crisis provides a topical example of such unforeseen circumstances; it is hoped that the following paper will contribute to both a practical appreciation of these concepts and the opportunity for further research related to them.

By the start of the 21st century, accumulated evidence led stratigraphers to propose that humanity had presided over significant modifications to the planetary system at a scale that ushered in a new geological epoch they termed the Anthropocene, or age of the human [3–5]. The new epoch is characterised not only by the atmospheric greenhouse effect of climate change [6,7], but by a series of other impacts including, amongst others, hydrological systems [8], land cover and habitat fragmentation [9], advancing a sixth mass extinction event [10] and transgressing 'safe operating spaces' in complex biochemical and geophysical cycles [11,12]. When taken together, these and other similar events signal profound impacts on the planetary systems within which humanity is embedded and upon which it is existentially dependent.

While the origins of the Anthropocene have been variously attributed to the emergence of agriculture [13], the Industrial Revolution and the magnification of our own metabolic capacities by several hundred orders of magnitude [14], there is growing consensus that the origin point for the Anthropocene can be traced to the nuclear detonations of the Trinity tests in 1945 [15]. The evidence of human impacts on the biosphere is overwhelming. There is almost unanimous consensus that the climate *is* changing, and more troubling, that efforts to keep the increase in global temperatures to below a 2 °C increase over pre-industrial levels are failing [16,17]. Even conservative emission scenarios place the planetary system on a positive feedback trajectory that exceeds a safe and habitable zone for huge areas of the planet [16,18–20]. The likely outcomes are escalating resource and climate wars, mass migrations, disruptions to social and economic infrastructure, and dire widespread poverty and chaos [21–23], with inevitable and significant impacts on various industries and organizations [24,25]. Climate change is seen as a 'super wicked problem', pointing towards the complexity of the problem, the uncertainty of cause and effects, and the urgency of solving it [26]. In light of the bleak forecast, it seems prudent that resources be shifted into developing ways of adapting to a rapidly changing set of circumstances, and to focus on building local and regional resilience [27,28].

Against the context of such widespread and far-reaching dynamics, it is difficult to even imagine how businesses could *not* be affected. Even using conservative and optimistic greenhouse gas emission values, modelled scenarios for climate change impacts have led some science historians, and others, to posit the collapse of Western civilisation as we know it [29–31]. From such forecasts, it is doubtful that any extant business model, as currently configured, will be able to maintain viability under such conditions. However, until such time as catastrophe strikes, businesses have a diminishing window of opportunity to shift their strategic thinking in ways that may help absorb the anticipated turbulence such dystopian future scenarios suggest we are on track for and to reduce their contribution to those scenarios.

While one might hope that such projections do not come to pass, the prudent option for businesses is to broaden the strategic worldview to take cross-scalar systemic influences into account. This paper introduces managers to the concepts of panarchy, ecosystemic epistemology, and adaptive management as potential contributions to accommodating cross-scalar influences in their planning repertoire. The next sections will explore how systems thinking underpins the concept of resilience and questions the reliance on lineal, and predictive, managerial thinking. This is then expanded to consider what resilience thinking might look like in a managerial context before considering how this, in turn, might contribute to the adaptive capability that is required to manage in conditions of increasing uncertainty and what transdisciplinary skills might be required to enable this.

2. Systems Thinking Revisited

Since the early 1990s, and particularly with the publication of *The Fifth Discipline* [32], business managers have been exposed to a wealth of ideas drawn from a range of disciplines, including that of systems thinking (e.g., [33,34]). Those already familiar with systems theory will be comfortable thinking in terms of relationships, feedback loops, equilibrium states, and so on. They have also had the opportunity to apply them to their own organizations, but it is probable that these new ways of thinking about relationships were inwardly directed [35], mapping out and seeking to influence the

relationship among departments, functions, or work streams and may have extended outside of the boundary of the organization to include the supply chain as one set of relationships, and the demand (or consumer/client) chain as another (e.g., [36]). In even more rare circumstances, systems thinking might have been applied to considering market place dynamics and competition.

Part of the methodology of systems thinking is to bound the system of interest. That is, to decide what is included within the boundary of the system, what is considered important, what is excluded and of lesser importance. Again, this is standard practice in applied systems methodology and it helps clarify the focal system so that it can be further investigated. The analyst distinguishes a perspective taken as an observer, and the character attributed to that distinguished focal system is constituted in the perspective taken by the observer.

The discipline of second-order cybernetics (or systems thinking) is an attempt to explicitly map the observer into the system observed [37,38]. Put differently, if the boundaries of the system of interest are determined by the observer, then the observer's epistemological fingerprint is all over the focal system. But the complexity quickly multiplies because the fingerprints of any observer also express assumptions about the observed system's network of relations, the dynamics of reciprocating influences, and evaluations made about whether these are to be included in the process of distinguishing what constitutes a system of interest. In other words, a system doesn't exist until such time as it is brought forth by an observer in the act of distinguishing the system [39]. Bateson considered this process of distinction and how it generates information as the "difference which makes a difference" [2] (p. 453; original emphases removed), itself denoting relationships among the variables.

Consequently, the boundaries of a focal system are fluid depending on the observer's distinctions and there is no perspective from outside the system to validate the distinctions. A distinction can only be validated with respect to its viability [34,36], or the degree to which it is adequate [40], that is, whether or not it fits a set of criteria. Using this criterion of viability to evaluate the validity of how systems are bounded is not unproblematic, because it collapses into recursivity when the criteria for viability are acknowledged to also have been determined by an observer. As a result, systems analysts have to be both humble, for they cannot claim any access to perfect knowledge, and also open or receptive to alternate perspectives.

This paper proposes two arguments. The first is that the boundaries of the focal system are extended to include not only all businesses, but the economic system itself which is nested within the social system, which in turn is nested within the ecological system of the biosphere [41]. The biosphere system is a convenient limit point because events outside of the planet's atmospheric boundaries tend to affect life at scales of time far beyond our common concerns; this also suggests that the 'bottom line' is ecological and not economic. This also resonates with Elkington's [42] recent criticism of the use of his Triple Bottom Line model and more specifically the trade-off accounting approach. His call to rethink the system points towards the current inability of business approaches to deal with the complexity and uncertainty of wicked problems [43].

When business is located within a nested hierarchy of system scales, it becomes meaningful to start mapping the influence of variables at these larger scales on the focal systems, such as activity within the economic sector. It reminds, or possibly informs, business managers that the site of day-to-day operations does not exist as an island but is intimately connected with changes that are going on at different scales including the scale of planetary processes [44], such as climate change [7,45] and the advent of the Anthropocene [3,5].

The second argument advocates for prudence to be exercised when developing strategies for working within the context of systemic fluctuations, and proposes that managers draw on ways of thinking and acting that are adequate in terms of scalability and reflexivity. An ecosystemic epistemology [46,47] called resilience thinking is considered as a potential contribution [48]. As a way of thinking, it has been enacted through a coherent set of practices from the domain of natural resource management that enable actors to adaptively manage processes under conditions of change

and uncertainty [49,50], and offers an alternative to lineal thinking which gives rise to command and control strategies for increasing efficiencies and maximising yields [51].

As noted earlier, this is intended as a conceptual paper introducing business managers to a set of concepts located within a broader ecosystemic epistemology (e.g., [2,41]). In so doing, we seek to build upon the earlier work of systems researchers and theorists [32,34–36] by applying these ideas to some of the challenges faced by businesses as they navigate the uncertainties of the Anthropocene through locating these within an ecological frame of reference [43]. Our contribution here is to test these concepts for their broader explanatory value and degree of 'fit' [40] with some of these challenges, and to encourage subsequent research into how these might be operationalised directly given specific and concrete applications. Consequently, in the following section we discuss these concepts in more detail, and thereafter explore their applicability within the business domain.

3. Epistemological Transitions from Lineal to Ecosystemic and Resilience Thinking

It is proposed that the Anthropocene epoch represents a limit point in at least a dual sense. First, it is a limit to human endeavour as it is currently imagined and predicated on the idea of unlimited growth and unending progress [43]. It is increasingly self-evident that a finite planetary system cannot support infinite growth, and that the continual utilisation of minerals and organisms as commercial resources undermines the capacity of the planet to dilute and process humanity's wastes and sustain life. Hence, the Anthropocene represents a limit point to the *modus vivendi* of modern Western civilisation.

The Anthropocene also represents a second limit point resulting from the first. This stands as a stark reminder of the limitations to a way of thinking or epistemology originating with the Enlightenment. On one hand, such thinking reduces the world to disconnected and atomised components, and on the other, positions the relationship between *Homo sapiens* and the rest of Nature as predicated on control, mastery, and competition. This is the narrative of humanity, in the spirit of Bacon, Newton, and Descartes, as bending and subduing Nature to do man's (sic) bidding [52,53]. There are, of course, also extensive examples of cultures that do not pursue this approach but act in unison with nature and/or respond to its vagaries without the illusion of control [54].

3.1. Lineal and Ecosystemic Epistemology

The reductionistic way of thinking is referred to, following Bateson [2], as 'lineal' rather than linear, as it neither describes geometric space, nor does it have the capacity to loop back on itself. As noted above, the lineal epistemology is characterised by a reductionism through which wholes are broken apart analytically into constituent parts and the concept of feedback removed. The potential for reflection may also be restricted to the general reproduction of what has gone before rather than the need to consider how contexts are emergent, i.e., qualitatively different, and requiring of a correspondingly adaptive response.

It is important to point out in passing that what is meant here by epistemology is not the same as a 'mental model'. A mental model is a representative explanation of how the world is thought to work [55,56], and as such is shaped and informed by one's epistemology. Epistemology is broader in that it not only includes ways of understanding how the world is thought to work, it also references the processes through which explanations are generated, what is selected or excluded from attention, the critical and analytical techniques by which the boundaries for knowledge generation processes are defined [46].

Lineal epistemology struggles to adequately account for systems and their complex and changing relationships. Although few might admit to living within a lineal epistemology, its influences permeate many aspects of life, including the dominant economic model which pursues limitless growth on a finite planet. Such thinking is characterised by the bracketing of experience that excludes recognition of reciprocal and mutually specifying influences among interacting processes, such as between systems and their contexts.

A further, more subtle impact of a lineal epistemology is how it endorses the mythology of progressivism – that the next generation will automatically be better, more advanced, than the previous. This cultural narrative underpins the economic model that holds growth as the prime objective, and by which the success of a business is judged [43]. The myth of progressivism has its origins in the admirable and noble attempt to improve well-being through "progressively diminishing the pains and frustrations imposed on human beings by their situatedness in a world of experience structured by time and space" [30] (p. 47). Progressivism expresses a "deep seated human craving" [30] (p. 66), and exposes the tragedy of the Anthropocene as the logical end point of an epistemology that seeks to subdue nature and the deprivations of human existence as a means of bettering the human condition. The price for doing so has led to the point where this ambition now arcs backwards as a clear existential threat to human well-being.

One alternative to this epistemology is to think ecosystemically in a way which explicitly "emphasizes ecology, relationship, and whole systems [and is] attuned to interrelation, complexity, and context" [46] (p. 14). Ecosystemic epistemology incorporates a second-order cybernetic influence of the observer on the system that is bounded and observed [57,58], leading to the implication that the observer is also always a practitioner, immersed in the circularity of enacting a world. Doing so changes how the world is perceived which in turn recursively changes the scope for further action [59].

This is to recognise that epistemology is neither neutral nor passive, but constructs and shapes the world as much as it enables its perception and sense making [60–62]. Epistemology is potentially transformative and an ecosystemic epistemology signals a "revisioned mode of engagement with knowledge, subjectivity, politics, ethics, science, citizenship, and agency that pervades and reconfigures theory and practice" [47] (p. 5).

3.2. Resilience Thinking

The preceding section briefly outlined a relationship between the emerging Anthropocene as a limit point expressing the ultimate logic of a lineal epistemology and its motivation behind the myth of progress. It is important to reiterate that this desire for progress and the betterment of the human condition are not to be construed as expressing malicious intent or even that they are inherently wrong, because it can be legitimately argued that related decisions, incremental as they were, were made with the best of intentions for the most part, although other motives have certainly played their part [63]. But acknowledging the ambitions and intentions of our ancestors cannot blunt the sharp impacts and future uncertainties associated with the Anthropocene. It is increasingly evident that to weather the storms of the future a different way of thinking and mode of practice are necessary.

Anticipated impacts from climate change and the Anthropocene on business and economic sector actors occur within a panarchy of nested systems hierarchies. Panarchy describes hierarchical cross-scale effects as a set of adaptive cycles interacting at different scales, wherein the states of systems at one scale affect the states of systems at larger and smaller scales [64–66]; indeed, as discussed above, they emerge as qualitatively new phenomena and contexts. From the perspective of business and economic actors, the next larger scale is a context of meaning rendering focal systems intelligible as a dynamic pattern of perturbation and systemic resilience to change.

A common use of the term 'resilience' describes a condition in which something bounces back after being disturbed. Here resilience is thought of as a property of a system that exists within a given singular equilibrium state, beyond which it is considered broken [67]. In popular psychology, for example, following a trauma, if someone returns to work and carries on 'as before', the equilibrium state is the way of acting prior to the traumatic event, and by returning to this state description, the employee demonstrates resilience. In engineering terms, a bridge may sway and buckle in high winds, but as long as it returns to its starting conditions and can be used as before, it is considered to be resilient. This is *not* the meaning of resilience as it is used in the present discussion; the employee is in a new place because of this history and the condition, and perception, of the bridge may also have been altered although not in such a way that compromises its core attributes.

Resilience thinking as referenced here begins from a different set of assumptions proposing that any system has multiple stable states, multiple equilibria, any one of which is valid with respect to the state dynamics of a system, albeit not equally so from the perspective of an observer [68,69]. In other words, the value attributed to alternate stable states is a second-order cybernetic attribute, and is not inherent to the system itself. A system with multiple equilibria occupies one region of stability at a time as a result of conditions, or 'restraints' with reference to a double description of events [2,70], that keep it in that region of stability. These conditions might be imagined as the depth of a basin of attraction. Where basins are shallow, a system can flip across a threshold and occupy an alternate stable state. Therefore, if an analyst can determine the conditions that maintain the depth of a basin, these become the focal point of interventions to prevent the system from flipping into an alternate state. Inversely, by identifying the threshold conditions for a system's stability basin, by reducing the height of the threshold, a system can be triggered to cross into another stability region.

From this description of alternate stable states, the resilience of a system does not concern how quickly a system reoccupies its starting conditions; instead, systemic resilience refers to the amount of pressure or influence a system can take before it changes state, before it crosses a threshold and occupies an alternate – and potentially undesirable – stable state [71]. Resilience is therefore not a valued characteristic in itself; the mere fact of a system's resilience is neither a positive nor a negative. These are attributes appropriate to the observer only. Some states may be resilient to change and be deleterious, such as a eutrophic lake; others might be beneficial, such as the capacity of the human digestive system to keep intestinal flora in check to maintain a productive biome.

The value that resilience thinking contributes to the present discussion is two-fold. First, it illustrates the need for practitioners to recognise threshold states and what influences reduce or heighten those thresholds according to a set of preferential criteria or parameters (see Table 1). Second, it reminds practitioners that stability is such only within a certain range or basin of conditions and does not reflect a steady state.

Table 1. Summary of parameters characterising systemic resilience.

Parameter	Reference
Operate while maintaining modular systems that are not too overconnected to reduce the impacts of shocks.	[72]
Tolerate and work adaptively with variability without attempting to impose command and control strategies.	[51]
Incorporate real costs for products and services (e.g., the costs of pollination and water purification), rather than the discounted costs achieved through externalisation, to make explicit the actual donor-side value of goods and services as a counter-balance to what the market will bear.	[73]
Tighten the strength and speed of feedbacks within a system to improve anticipation, and responses taken, to address thresholds.	[74]
Cultivate a learning environment for innovation and experimentation, an approach consistent with the multi-level perspective (MLP) (see also [75]) and one of the key tasks in successful strategic niche management activities (see also [76]).	[77]
Incorporate systemic redundancies, especially in governance arrangements.	[78,79]
Retain and cultivate social (e.g., cultural, economic, etc.) and ecological (e.g., biological, landscape) systemic diversity.	[80]
Attend to and track 'slow' variables and identify the thresholds that lie across their trajectories.	[81]
Build and contribute to trust and social networks and other forms of social capital.	[82]

3.3. Enhancing Resilience for Business Practice

There are some implications, then, for business practice. Businesses predicated on an engineering resilience will design for predictability and fail-safe conditions in which optimum and efficient performance is highly valued. The design posits only two state conditions for the focal system: it either works or it does not. When it does not work it is thought to be broken. Business design does not entertain multiple equilibria through which a system traverses. The engineered system is

streamlined and designed to bounce back to its starting conditions if it is stressed. This is viable, in most cases, for engineered systems which are complicated, but not complex; i.e., they can be deconstructed and reconstructed.

However, in complex systems, such as the organization of the business itself, comprising workers, clients, managers, shareholders, suppliers, and regulatory authorities, engineering resilience is inadequate to deal with the dynamic systems that are in process. For such systems, ecological resilience is a more appropriate way of thinking about change and its management and the recognition that systems can occupy, and circle through, multiple stable states. This contrasts with the idea of engineered resilience which recognises whether or not a system is working and the speed at which it returns to the desired starting conditions. As the examples above suggested, engineered resilience is of course essential – the production line needs to run and the bridge needs to be safe – but neither the line nor the bridge exists in isolation; they impact upon and are impacted upon, numerous other systems and factors. An improved line will potentially put stresses on other parts of the system, both technological and human, and a closed bridge will impact upon supply chains, land values and journeys to work, hospital, school, etc. Similarly, failures up-line will affect production and high winds could close the bridge; both are outside the control of the system of interest.

Before moving on to discuss adaptive management as a set of practices enacted within an ecosystemic epistemology such as resilience thinking, it is useful to note that ecological resilience concerns dynamic and complex systems far from equilibrium. As systems exhibiting multiple stability domains are separated by threshold conditions, transitions beyond these thresholds may trigger a bifurcation that generates dissipative structures coalescing around emergent and alternate stable states [83]. Ecological resilience describes systems characterised by self-organization, discontinuous change, non-linear behaviour, and shifting, dynamic stability landscapes [84], and which may vary in their degree of sensitivity to perturbating influences.

Such systems, be they the workforce of a business, the natural resources a business draws on as raw material, the customer base it relies on, the governance and policy frameworks within which it maintains its legitimacy, the economy within which it thrives, or the education and training systems it relies on for personnel skills development, are complex and adaptive and as such do not respond well to micro-management and command and control strategies. In fact, as has been well-documented, these systems often collapse and become dysfunctional under such management regimes [51,85]. Consequently, a different managerial approach is required and is discussed in the following section.

4. Managing Adaptively under Conditions of Uncertainty

Because social-ecological systems (SES) are complex with multiple stable states, of which few may be desirable or offer conditions favourable to human habitation, how such systems are managed requires a different approach than that enabled by lineal epistemologies. One of the more significant shifts is that with an ecosystemic epistemology one now incorporates into their planning the amplification and dampening effects of influences moving at different rates and across scales. The Holocene epoch represents a stability domain that, geologically speaking, is relatively brief at 11,500 years against a geological time-span of some 4.54 billion years since the planet was formed [86]. However, since the 1650s, and accelerating technologically since 1945, there has been a rapid accumulation in the levels of atmospheric greenhouse gases, and a multitude of other significant changes to the planetary system. These are slow-moving variables which are beginning to drive this relatively brief stability domain, the Holocene, towards a threshold beyond which point the system is at risk of 'flipping' into a new post-Holocene zone, the Anthropocene epoch.

A transition from one stability region to another may take several generations before it stabilises and coalesces around a different equilibrium region. Of course, how favourable that new domain will be for human life cannot be anticipated. What can be anticipated, however, is that the transition phase, the threshold dynamic, is one of increasing heat, droughts, floods, and extreme weather events, amongst other changes. The challenge for businesses, ecologists, social scientists, politicians, and others

concerned with complex systems is to find ways of managing and shaping these processes adaptively to try to maintain the current stability basin's resilience to perturbation.

What then would managing adaptively for resilience look like as a mode of practice? By far the majority of experiences in adaptive management are within the domain of natural resource management systems. These coupled SES involve dynamic processes of balancing demand pressures against supply opportunities. However, trees do not grow according to plan, and pests do not hold off from invasion because it is inconvenient to the economic bottom line of a supply business.

One of the early pioneers of adaptive management strategies provides a useful comparison summarising the differences between 'conventional' and adaptive approaches, as represented in Table 2.

Table 2. Comparison between conventional and adaptive management attitudes (after [49] (p. 351)).

Conventional Management Strategies	Adaptive Management Strategies
(1) Seek precise predictions	(1) Uncover range of possibilities
(2) Build prediction from detailed understanding	(2) Predict from experience with aggregate responses
(3) Promote scientific consensus	(3) Embrace alternatives
(4) Minimise conflict among actors	(4) Highlight difficult trade-offs
(5) Emphasise short-term objectives	(5) Promote long-term objectives
(6) Presume certainty in seeking best action	(6) Evaluate future feedback and learning
(7) Define best action from a set of obvious alternatives	(7) Seek imaginative new options
(8) Seek productive equilibrium	(8) Expect and profit from change

Adaptive management may therefore be characterised as a learning-through-doing approach to governance and resource management that proceeds through the exploration of multiple alternative approaches to achieve objectives, using scenarios to explore potential outcomes based on the current level of knowledge, implementing one or more of these approaches, and monitoring and evaluating the impacts. These evaluations are then fed back into the management strategy repertoire to inform future scenario building and planning activities. Organizations that adopt adaptive management as a mode of practice, operating within an ecosystemic epistemology, could draw more explicitly on action research methods to evaluate the viability of its managerial decisions and practices.

Adaptive management and action research are closely aligned in both philosophy and practice [87]. When action research (AR) is understood as a "form of research that generates knowledge claims for the express purpose of taking action to promote social change and social analysis" [88] (p. 6), the managerial approach described as adaptive management incorporates a similar element. Systems thinking itself might serve as a grounding for action research, helping to orient social organizational systems away from command and control managerial approaches, in the recognition of imperfect knowledge, in knowing and acknowledging that we do not know [33].

But adaptive management is not without its problems [50], and should in no way be seen as a panacea for working with complex adaptive systems. Indeed, a 2014 meta-review of the adaptive management literature found that practitioners tended to learn less about the ecosystems they managed and more about governance and about learning itself, albeit predominantly in single-loop (incremental) rather than either double-loop (paradigm changing), or deutero (reflective and action based) learning iterations [2,89,90]. Indeed, there were relatively few examples of managers of ecological systems engaging meaningfully with societal stakeholders [90] and, as will be developed in the following section, this is a constraint facing the business sector as well. Moreover, as Davoudi [91] points out, there are limitations to applying ecosystemic epistemology directly to social systems.

The following section of this paper explores some potential ways of bridging the lineal and the ecosystemic epistemologies. In particular, how such bridging might afford business systems the opportunity to adopt adaptive management perspectives that enable them to locate themselves as a system nested within a panarchy [41,66] of other systems, both larger and smaller. In turn, this may help businesses to develop an approach to improving their own resilience through actively seeking to

invest in the resilience and adaptive capacities of their inter-relationships with other nested systems. This will inevitably require the existence of redundant capability (i.e., through excess financial, social and human capital) and the protection of ecological capital.

5. Some Implications for Business Practices

As observed earlier, the business community has not been averse to learning from elsewhere, and many of these ideas will already be familiar to business practitioners at least since the publication of Senge's *The Fifth Discipline* [32], if not before. Moreover, systems metaphors are liberally peppered throughout management and knowledge management journals, and have been for decades (e.g., [92–95]). But despite this wealth of literature and research, what constrains the business sector then from weathering turbulence and generating future sustainability and resilience?

This might be accounted for by appreciating that when a systemically informed organization is aligned with a lineal objective, any benefits generated by that systems thinking are subsumed by the lineal focus and judgements. Systems thinking is simply utilised as a new tool or technique plied into reductionistic service rather than supporting reflection and the need to generate 'appropriate redundancy' as core to the optimal use of resources (this tendency is also expressed in the limited application of the Triple Bottom Line model [42], as noted earlier.) Redundancy is often seen as pejorative, whereas, in the form of excess capacity—economic, social and possibly ecological—it can underpin contingencies and the potential to adapt. Without it, some advantages might be leveraged, but the full benefits cannot be realised because the novel epistemology is bounded by the constraints of the dominant mode of thinking. Lemon, Craig and Cook [35] argue that one example of the failure of this dominant mode of thinking is the reliance on measures and targets which on the face of it appear sensible (e.g., call centres satisfying customers within two minute calls), but inevitably turn in on themselves; i.e., away from responding to the external and chaotic environment, such that calls are terminated before the two minutes so that the target is not breached and an additional call ensues. Two of the four propositions put forward in the Lemon et al. [35] paper are relevant to this discussion:

1. It is essential that the procedures and performance measures attached to one part of a linked process do not lead to behaviours that restrict capability elsewhere. Where performance measures are used, they must be in the context of the whole process—and take account of the operating environment;
2. The freedom to act outside of a rule/role boundary requires reciprocated trust.

The current flux reported by business and economic actors may be the result of three interwoven developments. First, it appears that the application and insights accrued from the influence of systems thinking on management and organizational learning and development have tended only to be focused inwardly. The application has been only into the organization itself, often in an attempt to streamline the organization, to make it more efficient and viable. This results in abstracting or isolating the organization from the wider (socio-cultural and social-ecological) environment context within which it is situated and maintains its viability. Again from a supply chain management perspective, focus is predominantly set on seeking competitive advantage for the focal organization by controlling its suppliers, rather than seeking a shared strategic partnership serving triple bottom lines [96]. Consequently, the impacts of the next larger scale systems have not been adequately factored into account; this would enable managers to recognise that the turbulence encountered is the ripple effect of much wider system effects, and that these require inclusion in strategic planning.

Second, the emphasis in competitive businesses has been on increasing efficiencies and reducing redundancies, a strategy that runs counter to the resilient system characteristics summarised in Table 1. In order to enhance competitive advantage, multi-national enterprises relocated parts of their production processes to offshore locations, resulting in fragmented supply chains, extended across multiple continents [96]. As a result, business organizations have tended to become more brittle, fragile, and vulnerable to perturbations unless they have significant financial resources (economic redundancy) to rely on to weather the turbulence. This has been evidenced during the COVID-19

pandemic which has disrupted global supply chains [97]. To counteract this, businesses may benefit from the interpretation of resilience thinking and the application of some of its tenets to workforce planning and operational design. Aiming for maximum efficiency and the elimination of redundancy, economic and otherwise, are not long-term viable strategies as the capacity of a business to absorb shock is exponentially reduced.

Finally, and related to the second point, businesses are hampered by the cyclopean focus on increasing profits in a lineal trajectory, often with disastrous consequences for their own business, as well as for the community systems in which they are embedded, exemplified by both the financial sector as a result of the 2008 crash and the BP Deep Water Horizon disaster (e.g., [98]). With this singular focus on the economic bottom line, all decisions are filtered through this selection process, and experimentation and innovation are increasingly risky except for the largest and most well-resourced companies. Even then, shareholders might expect CEOs to marshal profits towards increasing returns rather than on investing in increased redundancy, contingency, as an insurance policy against something that *might* happen at some unspecified point in the future. This has recently been brought to the forefront by the COVID-19 pandemic and the difficulties encountered in providing front-line NHS staff with appropriate personal protective equipment (PPE) [97,99].

Engagement decisions are therefore filtered through the lens of whether or not doing so will (positively) influence the company's economic bottom line. For many businesses, of course, this is a legal requirement of their articles of incorporation and the expectation of shareholders, and to do otherwise would release a great many CEOs into unemployment. Moreover, there are exceptions, more broadly under the banner of corporate social responsibility (CSR) endeavours which, even when putting aside a cynical deconstruction of the motivations of some corporations, do appear to make an effort to build bridges between direct corporate interest and capacities, and the benefit to, and investment in, non-business communities [100]. As such, increasing attention towards the environmental and social dimensions of the TBL (triple bottom line) can become part of the organization's culture (e.g., [101]), as well as potentially contribute to resilience. Increasing linkages with a diverse range of actors also helps increase resilience, while overconnectedness with a constrained set of actors decreases it [102].

Because the business and economic sector is embedded within the social system, which in turn is embedded within the ecological system, it is necessary that business actors recognise that they are both subject to the ripple effects of changes occurring at these next higher systems levels, and also that, due to the gravity the economic sector attracts within social systems, it also contributes to the ripple effect at higher systems levels. The flow of influence is in both directions, from the higher systems to the lower, and from the lower to the higher. Strategies to operate within any level must therefore take into account the impact on and influences of the adjoining system scales [44] and the corresponding rates of speed and slowness of the variables (or drivers of change) involved at each scale of the panarchy. By extension, a strategy should enable the organisation or system to reflect, and respond to, the complexity of the environment within which it is situated. This is consistent with the concept of Requisite Variety which was developed by the cyberneticist Ross Ashby [103,104] and initially applied to biological systems..

In addition to recognising and explicitly working within the awareness of larger and smaller scale embeddedness, businesses may have to reconsider the degree to which their operational models exclude redundancies and innovation in favour of streamlining for efficiencies because overconnected and low redundant systems are fragile to shocks and therefore increasingly exposed to risk, while a disinvestment in innovation reduces the capacity for creative alternatives to be explored.

Businesses also need to ensure that they are able to access tight feedbacks from the adjoining systems with which they communicate, and in the process develop social capital and trust as currencies among different communities of actors. Business can play an important social role, e.g., by pursuing blended value, or reducing dysfunctional effects on stakeholders [105]. This means widening the focal concern to incorporate other forms of capital than profit (social, human, ecological capitals),

and contributing to enhancing the communities that they identify as their customer base and the local spatial (regional and national) communities in which their capital investments are located.

Finally, working from within an ecosystemic epistemology, it is important to recognise that knowledge is partial and, as noted earlier, subject to the distinctions drawn that demarcate a system of interest, so that different actors will embody a range of reflective knowledge with which to act reflexively. Consequently, an emphasis on being tentative in the generation and utilisation of knowledge is prudent, adopting a safe-fail rather than a fail-safe approach to R&D, one that incorporates an ethos aligned with that of action research and adaptive management. In this way, learning is an on-going process involving planning, implementing, evaluating, and planning cycles that, with tighter feedback loops, enable enhanced granularity in identifying and responding to the influence of slow variables in adjoining scale systems.

These proposals are not intended to imply that businesses don't already engage in some, even all, of these measures. For those that already do, they might serve to confirm that doing so is consistent with an ecosystemic epistemology which, in turn, is better equipped to deal with changes and adaptations involving complex system dynamics. For those businesses that do not already apply such insights, while there are no guarantees for the future given the impact extent and severity of the Anthropocene, it is also clear that lineal thinking is no longer appropriate, nor does it embody the capacity for adaptation to change.

6. Conclusions

This paper has explored the conditions of system-wide turbulence and disruption to previously taken-for-granted stabilities. The analysis has advanced that the experiences of uncertainty and change currently being encountered in the business sector are an echo of, or resonate with, changes underway at the biospheric scale in what has been termed by stratigraphers the Anthropocene epoch. This emerging epoch marks the limit point of both the Holocene, the 11,500-year period that favoured the development of *Homo sapiens,* as well as marking the limit point of the lineal epistemology which, it is claimed, is what brought humanity to the threshold of such radical change.

To diagnose the condition is one thing; coming up with possible interventions, let alone a prognosis, is quite another. This paper recognises the limitations pointed out by Davoudi [91] regarding the application of ecosystemic epistemology to social systems and argues that the best one might strive for is coupled social-ecological systems and the enhancement of systemic resilience and adaptive capacity. An alternate epistemology to the lineal, reductionist thinking that has been prevalent in Western civilisation since at least the Enlightenment has been proposed as ecosystemic in order to emphasise its acknowledgement of complex relationships, the situatedness of experience, and the partiality of knowing.

Ecosystemic epistemology has been linked to the adaptive managerial and governance practice, and is consistent with the promotion of systemic resilience and adaptive capacity. Some final consideration might be given to the skills that are required to underpin this ecosystemic approach. The authors argue that it is important for actors to accept, and work with, uncertainty through the systematic communication and assimilation of systems thinking and an appreciation of how social, economic and environmental processes are interconnected, irreversible and potentially grounded in an ecological bottom line. This transdisciplinary starting point is also relevant to all actors and agencies, whether they be academic, practitioner or community stakeholders and, as such, also requires the ability of those actors to appreciate, or recognise, other perspectives and to communicate in an appropriate manner across organisational and agency boundaries, i.e., empathy for the other and/or communication with a sense of audience. In closing, it is prudent to recall that these suggestions cannot make reassuring promises, nor do they come with any guarantee. Indeed, much of the previous discussion on the multi-scalar nature of managerial resilience inevitably focuses on large organisations that themselves influence the opportunity space [54] for organisations behind them in the supply chain. We have to be careful that the creation of adaptive capacity by larger and more powerful organisations

that have the luxury of strategic flexibility is not at the expense of those who are constrained in their ability to create redundancy—spare capacity—i.e., the smaller enterprises, the poor, etc.

In the spirit of this paper, these are points for practical experimentation, testing and learning, and for research relating to them. The alternatives are not reassuring, and while the future, as ever, remains unpredictable, the Anthropocene is a stark and blunt reminder that, if there are any guarantees at all, one would be in the enduring astuteness of Heraclitus' observation that the only permanence is change.

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