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The complexity continuum, Part 1: hard and soft theories

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Abstract

Purpose – Complex systems adapt to survive, but little comparative literature exists on various approaches. Adaptive complex systems are generic, this referring to propositions concerning their bounded instability, adaptability and viability. Two classes of adaptive complex system theories exist: hard and soft. Hard complexity theories include Complex Adaptive Systems (CAS) and Viability Theory, and softer theories, which we refer to as Viable Systems Theories (VSTs), that include Management Cybernetics at one extreme and Humanism at the other. This paper has a dual purpose distributed across two parts. In Part 1, the purpose of this paper is to identify the conditions for the complementarity of the two classes of theory. In Part 2, the purpose is to explore (in part using Agency Theory) the two classes of theory and their proposed complexity continuum.

Design/methodology/approach – A detailed analysis of the literature permits a distinction between hard and softer approaches towards modelling complex social systems. Hard theories are human-incommensurable, while soft ones are human-commensurable, therefore more closely related to the human condition. The characteristics that differentiate between hard and soft approaches are identified.

Findings – Hard theories are more restrictive than the softer theories. The latter can embrace degrees of "softness" and it is explained how hard and soft approaches can be mixed, sometimes creating Harmony.

Originality/value – There are very few explorations of the relationship between hard and soft approaches to complexity theory, and even fewer that draw in the notion of harmony.

Keywords Harmony, Agency theory, Humanism, Adaptive complex, Human-commensurability

Paper type Research paper

Introduction

There are a variety of complexity related theories on the scientific horizon, but there are very few comparative explorations of these. The interest of this paper lies in adaptive complex systems, a generic term that refers to systems that are essentially non-equilibrium and have bounded stability – a condition that requires a system to put in effort to maintain stability through adaptation. This is a theory building paper and therefore does not address issues of theory validity. Its purpose is to explain how a range of adaptive system theories in the field of complexity relate. It is set up in two parts. Part 1 formulates a framework that distinguishes between hard and softer theories, and it explains that they may be represented on a continuum. In Part 2 of the paper, the continuum is more carefully examined, and hard and softer theories are considered from a more philosophical perspective.

In hard theories, agents are *objects* in a behavioural system that can be manipulated in some way, hence those who adhere to such theories might be called behaviouralist. Agents as objects have only tangible properties (i.e. variables like height, weight, money, [. . .]). Hard theory also often uses formal language, which is explicit, precise and specific (mathematics or logic). According to Ruiz *et al.* (1994), formal modelling languages reduce the vagueness and ambiguity of informal language descriptions. They also allow for validation of completeness and consistency through "proofs" and bridge the gap between the informal model and system design. However, they suffer from a limit to their practical usefulness,

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often not being sufficiently expressive to deal with real-world applications. They are also complex and hard to read, and their construction is difficult, error prone and expensive.

Soft theories often use informal natural languages with syntactic structures through which narratives are presented that may lack precision, thus making it more difficult to validate or verify theoretical arguments (Evens *et al.*, 1999). Here, agents are *subjects* having both tangible and intangible[1] properties, and the latter cannot be directly measured. The involvement of intangibles indicates limits to any capacity to take meaningful measurements (Carayannis, 2004). The density of the intangibles that define a subject in a theory determines its degree or relativity of softness. That there may be degrees of softness suggests that hard and soft theories lie on a hard-soft continuum.

Therefore, a hard-soft theory continuum maintains object-subject perspectives. To better understand such a continuum, it is useful to explore the relationship between hard and soft theories a little further. Prigogine (1967, 1980) developed hard theory intended to explain how, under uncertainty, systems at the edge of stability can survive. Prigogine and Stengers (1984) express this as a theory of adaptive change, explaining how under complexity and uncertainty, systems may need to adapt as they move toward instability. Morin (2006) notes that Prigogine's theory of change generally relates to appearances that are superficial or illusory: apparently, phenomena arise in a confused and dubious manner as inquirers seek, during a search for comprehension, to explore behind those appearances for the hidden order of authentic reality. Complexity allows for a condition in which multiple agents interact in ways that are not easily discernible, with unclear consequences (Mielkov, 2013). Complexity can most simply be described in terms a set of relatable elements having relational interconnections that are uncertain, indeterminate and with possible inherent contradictions, though a few general principles can explain the phenomena that they generate (Morin, 1990).

The development of theory can occur through two elements: substructure[2] and superstructure. For Mahoney (2004) substructure would be constituted as a "hard core" of a theory that is often axiomatic. In contrast, superstructure is composed of propositions that conceptually *enrich* the substructure. Such a superstructure may result in a formal theoretical framework (Yolles *et al.*, 2012), or testable variable relationships may be established in deterministic (U-Tantada, 2018) or uncertainty (Frey, 1998; Farquhar and Brajnik, 1995) contexts.

Thus, Beer's management cybernetics began as a hard theory through his management cybernetic substructure. It also acts as a foundation for Beer's superstructural and soft Viable System Model (VSM), as well as through the introduction of such intangibles as spirit (Lauritsen *et al.*, 2006). A general theory of viable systems originated with Schwarz *et al.* (1988) and Schwarz (1994) that initially introduced a hard substructure. It developed a soft capability through the creation of a superstructure that permitted, for instance, the introduction of consciousness (Schwarz, 1991, 1996). The substructure was partly based on Prigogine's theory of stability, but it also draws on works such as that of Maturana and Varela (1979) and their conception of self-production/autopoiesis. It functions as a foundation for the superstructure that embraces propositions that include subjective agents with relative perspectives and active principles of consciousness (Guo *et al.*, 2016).

It has been suggested that hard and soft theory rest in a single continuum, then if so this suggests that they can coexist under certain circumstance. In this paper, interest will lie in clarifying the relationship between hard and soft systemic approaches concerned with complexity, and how balance may emerge between them and what that might mean. It should be noted that in Part 2 of this paper we shall set hard and soft theories in a framework that is related to critical realism, and this will result in broader hard-soft framework. This will in due course allow hard complexity theory to be related to viable

systems theory (VST) and its extreme of humanism, and it will be shown that harmony relates to critical realism.

It has been said that theories can be distinguished according soft-hard and formal-informal classifications, but another option is also possible. This comes from Morin (2006) who explains that theories of complexity may be either *restricted* or *general* in their capacity to make statements about reality. Theories of the first type often tend to be hard formal approaches to complexity. Illustrations of such theories are Complex Adaptive Systems or CAS (Holland, 2006) and viability theory (Aubin, 2011). Like CAS, viability theory is concerned with adaptive complex systems under uncertainty, with interest in evolutionary living processes. Theories of the second type may or may not take softer approaches to complexity. In softer approaches agents are subjects having both tangible and intangible properties that can contribute to agent dynamics beyond the directly observable object dynamics of hard theories. Theories that refer to viability (when a system manages to survive through adaptation to changing situations) are included here, and they may be called VSTs. As previously noted, examples of VST include Beer's (1959, 1979) substructural management cybernetics and superstructural VSM, and Yolles' (2006) knowledge cybernetics which has manifested into agency theory (Guo *et al.*, 2016). Its superstructure has developed as mindset theory (Fink and Yolles, 2018b). Both take agents as subjects and involve intangibles like consciousness and spirit. At an extreme of VST, there lies the theory of humanism which, according to Meyer *et al.* (1997), concerns human beings as integrated persons actively and consciously striving towards the actualisation of their potential, i.e. thereby elaborating their viability. They exist in a subjective experiential world, see human nature as positive, and focus on conscious individual processes as an active participant in the determination of their behaviour. Further, Madigan (1999, p. 1, Huxley, 1961) explains Huxley's view that humanism is about creating an:

> [...] understanding of man and his relations with the rest of his environment [...] It must be organized round the facts and ideas of evolution, taking account of the discovery that man is part of a comprehensive evolutionary process, and cannot avoid playing a decisive role in it.

So, humanism may therefore be seen substantively as a viability theory of intangibles with interest in evolutionary processes.

We have indicated that not all general theories are soft, and an example is Prigogine's (1980) general theory of system survival that, together with other works (Gershenson and Fernandez, 2012), has become important in understanding the complex dynamics of living viable systems – those able to survive through adaptation through processes of self-organisation. General narrative approaches like that of Prigogine and Stengers, (1984) may have their basis in formal theory, like that of Prigogine's (1947, 1967) thermodynamic theory of non-equilibrium irreversible systems and its extension (Bishop, 2003) into statistical mechanics (Prigogine, 1962).

To develop a hard-soft continuum theory in the field of complexity, we initially adopt the following structure. Distinctions will be made between hard and soft human activity system paradigms. Following this Morin's concepts of restricted and general complexity will be considered and related further to hard and soft theory. One of the distinctions between these paradigms is the capacity to attribute causes to the social system dynamic. As such, a section of causal attribution will be provided, which can be related to the intangible attributes of subjects.

Now, to further arguments, it should be noted that one of the issue of complexity theories concerns their ability to make predictions[3] under uncertainty about behaviour. This is because complex systems involve a plurality of micro-level individual agents. They have

individual behaviours (micro-behaviours) that are not collectively coherent. It is therefore problematic to determine a relationship between these micro-behaviours and the macro-behaviour of the system as a composite whole. However, there is an argument that predictability under uncertainty is feasible if one not only distinguishes between micro and macro behaviours but also recognises the development of meso generic rule structures that arise as a set of influential generic rules that connect micro and macro behaviours. A section will therefore also follow on meso generic rules.

Hard theories take agents to be objects, and as such are human-incommensurable – indicating that the subjective attributes of human beings are not commensurable with theory in which individuals and their idiosyncratic qualities are denied functionality to any dynamic processes. In contrast, soft theories are human-commensurable, this latter connected with humanism and harmony. The nature of humanism will be considered in due course, but at this juncture it may be said that it stands against inhumanity, a condition which results from the socio-political abuse of human rights and human capital that diminish human value for some entities benefit. Exploration of humanism and its relationship to complexity will be undertaken, as will be ideas concerning how it might become significant through paradigm shifts.

It should be noted that in the complexity context of this paper interest lies in theory and their paradigms (which also includes values and modes of practice). In other words, reference is being made to harmony theory. This should not be confused with the term harmony developed in mindset agency theory (Yolles and Fink, 2014c, 2014d, 2014a, 2014b; Fink and Yolles, 2018a, 2018b) that characterises personality through a set of attitudinal traits, one of which is harmony. The harmony trait was determined originally from Sagiv and Schwartz's (2007) theory of values, and it represents a specific set of properties that may be reflected in the orientation of a personality. Thus, the main commonality between the harmony trait and the harmony paradigm is coincidence in name.

Hard and soft human activity systems

Von Bertanaffy explains that the field of systems has two fronts. The first front centres on what we shall refer to as hard complexity. Here, von Bertanaffy (1968, p. 34) sees a system as an organised complexity that may be expressed in terms of the existence of strong or nontrivial non-linear interactions, concepts that have come to underpin the nature of complexity. There is also:

> [. . .] predominantly a development in engineering science in the broad sense, necessitated by the complexity of "systems" in modern technology, man-machine relations, programming and similar considerations which were not felt in yesteryear's technology but which have become imperative in the complex technological and social structures of the modern world. Systems theory, in this sense, is preeminently a mathematical field, offering partly novel and highly sophisticated techniques, closely linked with computer science, and essentially determined by the requirement to cope with a new sort of problem that has been appearing (von Bertalanffy, 1968, p. 7).

These developments in complexity constitute a formal hard science where issues to be explored have a determinate complexity, and for pragmatic purposes they adopt quantitative inquiry or verifying approaches, where all variables in a model can be measured directly in terms of quantities.

Von Bertanaffy's second front concerns what we may call soft complexity, which is orientated towards "trends of humanistic and organismic psychology, with emphasis on the creative side of human beings, on the importance of individual differences, on aspects that are non-utilitarian and beyond the biological values of subsistence and survival – this and more is implied in the model of the active organism" (von Bertalanffy, 1968, p. 194). There is

also the organismic principle of "spontaneous activity" the "humanistic" principle of "symbolic functions" which must be basic in system-theoretical consideration (von Bertalanffy, 1968, p. 219). This approach, which arises with Maslow (1969), is concerned with choice, creativity, values, self-realisation, meaningfulness and self-actualisation (fulfilment of one's potential), to positively transform society. It too, therefore, recognises complexity through human relationships. It is a soft approach in that it recognises the role of the cognitive observer and adopts qualitative inquiry approaches, where variables are assessed according to their attributes or qualities. Issues that need to be examined concern a plurality of fuzzy or indeterminate problems requiring techniques to improve how issues are described and perhaps diagnosed. Modelling approaches tend to be informal (inherently implicit, e.g. narratives) and general.

Von Bertanaffy's description of the two fronts relate to the notions of hard and soft, which will therefore be considered more fully. Hard system thinking in the field of complexity refers to agents as objects with tangible attributes. In soft system thinking agents are subjects having strategic orientations, and have both tangible and intangible attributes (Yolles, 1999). This tangible-intangible mix leads to the notion of relative softness, determined by the relative importance of subjectivity and intangibility in a theory. These subjectivities include strategic and other attributes/qualities that may have some functional impact within the dynamic system to which the agent belongs. Illustrations of agency strategic attributes are purposefulness, and personality involving consciousness to which agent perspectives are connected.

Consider therefore a proposition about the relative softness of a system theory. We can define this as being determined by the density of intangibles (relative to some standard) that are significant to the theory. This can be supported by noting that whatever framework is being used to model complex issues, the activity involves problem structuring: modelling a situation to determine its constitution as a definable problem. When theory is used to inquire into complex situations they need to be structured. As part of this structuring process, methods/methodologies arise intended to resolve the problem. These emanate from the theory and often involve problem structuring methods that constitute techniques by which an improved understanding of conceptual relationships in complex situation can be mode.

It may be argued that another distinction between hard and soft modelling is that in the latter problem structuring methods are constituted as a defined propositionality. Consistent with our earlier comment on the substructure/superstructure, Jackson (1969) notes that Beer's (1979) management cybernetics paradigm is essentially machine thinking, but this was then complemented with soft insights from the organism and brain metaphors. These eventually achieve hegemony in Beer's VSM which has developed into a methodological inquiry approach (Yolles, 1999). Pickering (2004) makes an argument that is consistent with that of Jackson, noting that the extension into the soft VSM has attributes that include notions of individual and group consciousness. This additionally supports the proposition that Beer's cybernetic theory constitutes a substructural hard approach to self-organisation (Beer, 1959, Pickering, 2004), complemented by a superstructural soft approach (the VSM). Emerging from the theory that underpins VSM are a set of methodological propositions that provide a capacity for inquirers to inquire deeply into the attributable causes for structural/process faults in the organisation being investigated (Yolles, 1999). Thus, VSM has propositional problem structuring methods theoretically incorporated into the modelling of situations through the creation of structuring/process propositions. An illustration of this is Beer's recursive proposition that all viable systems have properties of recursion representing different focusses of consciousness (Pickering, 2004). It arises from a universal definition of viability. Here, viable systems are recursive – a mathematical notion describing

any system in which the parts are characteristically the same as the whole. Thus, the same form recurs at all levels throughout the system, and by the same token the system under study must be embedded in a larger system with the same characteristics (Walker, 2018). This is elaborated on by Espejo and Gill (1997) who note that the generic principle of recursion in viable systems concerns the architecture of complex organisations, based on the premise that all living systems are composed of a series of viable sub-systems each with self-organising and self-regulatory characteristics, and where each sub-system may contain further sub-systems.

Thus, Beer's theoretical architecture connects both hard and soft approaches. That they may occur through the dual creation of substructure and superstructure is not material, and is consistent with Pollack's (2009; Pidd, 2004) view that *pure hard* and *pure soft* inquiry approaches are extreme points on a continuum on which other in-between points exist. As inquiry approaches arise from theory, the idea that pure hard and pure soft theory also exist on such a continuum is also valid. This clearly implies that models may vary in their degree of softness, given a framework that permits flexibility. Hard frameworks appear to be too constrained by their propositions to permit any degree of soft flexibility permitting deeper structured inquiry to identify causal attribution, a term we shall explain shortly.

Stafford Beer was aware of the complex nature of situations involving people and their purposes, and this formulated his management cybernetics paradigm such that it could embrace soft principles. This is illustrated in his discussion of purposefulness within the context of the term "pathological autopoiesis", depicting a situation in which an agency (acting for an organisation) is more likely to fail when its executives take more interest in their own welfare than that of the organisation. The Western recession of 2007 reflects this, resulting from neoliberal policies prior to the millennium that disengaged regulative constraints on the Western banking systems, allowing them to profiteer (against the interests of borrowers) by intentionally engaging the sub-prime market – which describes those who in the longer term would be unlikely to sustain their mortgage loan repayments, with obvious results (Ferguson, 2010). Part of the theory in Beer's paradigm involves conceptualisations about *viable* organisations that are purposeful, adaptive and able to maintain their long-term stability. The concept of viability was picked up by Eric Schwarz in his attempt to apply the dynamic concepts of chaos and complexity to self-organisation systems that change and evolve, and as part of this he generated what we refer to as Schwarzian VST. This has been migrated to Agency Theory (Guo *et al.*, 2016).

Let us return to von Bertanaffy's distinctions of complexity classification and their connection with notions of hard and soft. Prigogine's (1947) hard formal theory of non-linear thermodynamics and dissipative structures (elaborated on and contextualised by Nicolis, 2009) is concerned with mechanical systems. However, Prigogine (1980) also used informal language to provide a more general explanatory narrative about order and self-organising structures. However, the approach did not soften. This is because while he discussed the nature of the observer, it was in purely behaviouralist terms where individuals are still agents without intangible properties. Prigogine's interest lay in spontaneously organising systems that formed into a series of complex structures. In due course the term complex adaptive systems arose, its popularity likely attributable to Waldrop (1992). The term had been coined earlier, arising from the work by Stuart Kaufman that began in the 1960s (Lansing, 2003). The context of Waldrop's (1992) interest was in human activity systems and concerned explanations for their survival.

With the second front of soft theory, von Bertalanffy seemed to have had Stafford Beer's (1966) substructural management cybernetics and its superstructural elaboration to VSM in mind. Beer (2004) adopts a soft trend towards humanistic and

organismic psychology, and it is clearly reflective of complexity through human relationships. While not formulated specifically in terms of complexity, it takes interest in systems that are both uncertain and viable, where uncertainty is a property of complexity. While this uncertainty relates to the relationship between the system as a whole and its parts, Beer's approach centres on the system's functional survival through adaptation to change through processes of self-organisation. Thus, in Beer's (1979) VSM (which began as a metaphor of the human biological system), viability is maintained by making deep inquiry into the system (guided by various propositions), to uncover relationships and to diagnose and resolve any structural and/or process faults (Yolles, 1999).

All complexity approaches are semantically consistent with respect to their common interests in describing adaptive, interactive and evolutionary characteristics of complex systems (Ruitenbeek and Cartier, 2001; Gunderson and Holling, 2001). These systems teeter on the boundary of stability, only thus manging to maintain their viability, and hence their durability. They constitute a holistic unit (called a macro-unity by Morin, 1999) that has a plurality of (micro) parts. The behaviours of this micro-plurality are local (micro-space) phenomena, which do not directly apply to the behaviour of the macro-unity whole. Consistent with this, the change process may involve emergence, constituted through properties that a system develops, and that the micro-plurality is devoid of. Having synergy with the humanism paradigm, that of complexity has interest in the relationship between the (macro-unity) whole and the (micro-plurality) parts, recognising that micro-plural to macro-unity causality is non-attributable under complexity, as the micro-plurality interconnections are uncertain and do not directly reflect on the macro-unity. Interest from here on will in part lie in exploring the meso as a demonstrable virtual extension of a complex adaptive system.

Restricted and general complexity

Complexity is constituted as a paradigm (Malaina, 2015) and is set within the context of complex systems which adapt to stay viable and to survive. Two components have already been identified for this: restricted and general complexity. Morin (2006, p. 6) notes that restricted complexity adopts a hard approach to modelling, being restricted to systems which can be considered complex because empirically they are presented in a multiplicity of interrelated processes, interdependent and retroactively associated. This is also consistent with interdisciplinarity, which enlarges the number of processes to be considered. If one searches for laws of complexity, Morin tells us that we are taking complexity as a kind of wagon behind the truth locomotive that produces laws. Malaina (2015) notes that restricted complexity seeks to find the hidden regularities of complexity and the refinement, as much as possible, in complex system modelling. The approach has been developed by authors like Murray Gell-Mann, John Holland, Stephen Wolfram, Stuart Kauffman and Robert Axelrod, usually associated with the Santa Fe Institute in the USA. Adopting a formal language, models of situations develop using computational approaches such as multi-agent techniques. Observable phenomena are collectively seen as being objective, as uncertain and unpredictable dynamics emerge through local interactions of its components.

As an example of restricted complexity, following on from the ideas of Waldrop (1992), formal theories of adaptive complex systems have arisen that are referred to as complex adaptive systems (CAS). Holland (2006) defines CAS as systems that have many parts or components, called agents, that interact and adapt or learn, and the approach adopted embraces formal (mathematical) nonlinear dynamic systems theory. The approach is also inherently interdisciplinary, drawing strongly from complexity science, systems theory,

control theory and network theory, and weakly from related fields such as statistical mechanics, artificial intelligence, game theory and optimisation (Brownlee, 2007; Dooley, 2007). It adopts an essentially quantitative and algorithmic approach to inquiry (Malaina, 2015, p. 4) and seeks rules that can be represented in a computer that indicate an agent's capacity to act in response to conditions, and where a set of actions constitute behaviour for a given situation that is constituted as a sequence of executed rules (Holland, 2006).

In contrast, general complexity relates to the organisation of knowledge and is paradigmatic in the sense that a paradigm is a simplification of the controls in classical science, that imposes (Morin, 2006, pp. 6-7):

> a principle of reduction and a principle of disjunction to any knowledge, [where there should be] [. . .] a paradigm of complexity that would impose a principle of distinction and a principle of conjunction. In opposition to reduction, complexity requires that one tries to comprehend the relations between the whole and the parts. The knowledge of the parts is not enough, the knowledge of the whole as a whole is not enough, if one ignores its parts; one is thus brought to make a come and go in loop to gather the knowledge of the whole and its parts. Thus, the principle of reduction is substituted by a principle that conceives the relation of whole-part mutual implication. The principle of disjunction, of separation (between objects, between disciplines, between notions, between subject and object of knowledge), should be substituted by a principle that maintains the distinction, but that tries to establish the relation. The principle of generalized determinism should be substituted by a principle that conceives a relation between order, disorder, and organization. Being of course that order does not mean only laws, but also stabilities, regularities, organizing cycles, and that disorder is not only dispersion, disintegration, it can also be blockage, collisions, irregularities.

The classification of general complexity typically offers informal models, having been developed through authors like Ilya Prigogine, Heinz von Foerster, Humberto Maturana, Francisco Varela and Stafford Beer. Malaina (2015) explains that general complexity draws epistemological subjective implications of a knowing subject, is descriptive, explores the properties of self-organisation and autonomy through processes of observation and can be transdisciplinary. It can also highlight the degree of ignorance an agent (as a subject) has about some object of attention, and the processes of internalisation and assimilation (the latter integrating perceived reality into a cognitive structure) through which the agent is able to cognitively reconstruct the object despite a lack of information.

Causal attribution

There is another distinction between hard and softer approaches in complexity. In the study of adaptive processes, particularly in human activity systems, there is often an interest in identifying who or what is responsible for certain outcomes so that viability can be maintained. Ruitenbeek and Cartier (2001, p. 7) refer to this as the causal attribution of credit (in particular in relation to its capacity to model political policy making), elaborating on the meaning of this in the following way:

> Complex systems that have persisted for long periods of time show a remarkable resilience; they tend to self-correct. Many of these systems are not sentient, and have no explicit manager or policy-maker in charge. They do have feedback mechanisms; the feedback systems reveal adaptive behaviour. Human systems are somewhat different, of course, in that they involve sentient beings and the feedbacks often *seem to* involve policy interventions. But a key point is that, in a complex system, regular concepts of causality – what complex systems theory calls 'attribution of credit' – disappear and it is virtually impossible to say that a given policy intervention has indeed kept the system afloat. We therefore prefer to start the discussion with a relatively blank slate. Somewhat perplexingly, this blank slate also

> means that we must entertain the possibility that all efforts at policy intervention may be futile.

However, irrational the abandonment of causal attribution may seem from a soft perspective, it is central to hard theory like CAS, effectively making it a form of behaviouralism (Wogu, 2013). Whether causative attribution is possible in a theory is not determined by Morin's general/restricted complexity classification, but rather by whether it has a hard or softer classification. Thus, for instance, in Prigogine's work in general complexity, attribution of credit is not an option, while in Beer's theory of viability it is (by adopting inquiry techniques to explore causative attributes for system issues through deep second-order cybernetic processes). Thus, while Prigogine's and Beer's narratives are both part of general complexity, there is still a cleavage in the softness distinction that each adopts. Where no attribution of credit is sought, approaches rather delve into the capacity of a system to adapt through self-organisation using feedback mechanisms that can result in system imperatives for adaptive behaviour (Dooley,1997). This lack of causative attribute is explained by Holland (2006, p. 2) who notes that:

> The credit assignment problem arises because overt information about performance (payoff, reward, reinforcement, or the like) is often irregular and partial. That is, an agent's performance is the result of an intricate skein of interactions extending over space and time. It is rare that there is information that overtly picks out "stage-setting" options that lead to later improvements in performance.

While this perspective is consistent with the notion of events having a multiple causality, in soft systems techniques are available to inquire into and track that causality, resulting in multiple causal credits to macro-unity outcomes. Ultimately then, soft adaptive complex systems approaches that enable causal attribution may be referred to as VST.

The complexity paradigm, like that of the humanist paradigm, may involve sentient human participants in processes of analysis. While systems involving sentient directives may *seem to* involve interventions in hard systems, Ruitenbeek and Cartier (2001, p. 7) note that according to the regular concepts of causality, there is no attribution of credit since sentience becomes just another element in the complexity process, and it is almost impossible to determine that a given intervention has facilitated a particular process of adaptation, and in what way. The inability to attribute credit to sentience may be referred to as human-incommensurability, in contrast to its opposite, human-commensurability (a term suggested by Mielkov, 2013). A reflection of this hard approach comes from Schneider and Somers (2006) who explore the dynamics of human activity organisations in which sentience exists, but where creditable attributes for the causal attribution for change are not sought.

Complex adaptive systems and meso generic rules

Scientific propositions have traditionally followed authors like Newton, La Place, and Descartes, and these postulate that natural systems were essentially stable and well-behaved, and reductionism and determinism can be used to make reliable predictions about behaviours (Capra, 1982). This entailed a principle of disjunction that separates objects, disciplines, notions, subject and objects of knowledge (Morin, 2006). A contrary perspective arrived with adaptive complex systems (Klijn, 2008; Miller and Scott, 2007), which saw natural systems as inherently unstable, managing to survive through self-organisation using processes of emergence and feedback. Morin (2006) asserts that every agent seen as a complex system has a whole that is composed of parts, and scientific interest lies in the *relation* between the whole and the parts. Developing on von Bertalanffy (1968), Morin

(1990) notes that it is also concerned with actions among complex units which are themselves composed of interactions. As illustration, a biological organism is not defined by its cells, but rather by the actions taking place among the cells that constitute it. Its organisation is defined by the interactions that occur between its components, which give such attributes as constructive coherence, order, regulation, structure to the interactions. So, agencies as adaptive complex systems adhere to a principle that centres on relations between order, disorder and organisation. Order here refers to laws, stabilities, regularities and organising cycles, while disorder is dispersion, disintegration, blockage, collision and irregularity. This approach has been used, for instance, to explore assemblies of elements that come together to form living cells, or the development of human activity systems for which examination is made (for instance) on how organisations change (Dooley, 1997).

Earlier the idea of *the whole* was introduced. Morin (1990, p. 3) clarifies the concept by noting that it is effectively a macro-unity, with parts or components that have two identities: an individual one which is irreducible to the whole, and a common one that reflects the membership of the whole. The macro-unity has parts that, by implication, constitute a complex micro-plurality. The purpose for Morin to introduce the term *macro* was to illustrate the significance of the whole as something entire that needs to be considered as a one indivisible thing, at least in respect of its macro-behaviour. It is possible to elaborate on this terminological tendency, where the relationship between the behaviour of the parts of an adaptive complex system and its whole can be explained not only in terms of macro-micro, but also through the introduction of meso in a macro-meso-micro relationship. Under complexity, the behaviours of the micro-plurality are not deterministically aliened, and thus a system's overall (macro-unity) behaviour cannot be determined by knowledge of the behaviour of its (micro) parts. Nor can the inherent emergent properties it has be predetermined by an analytical specification of the properties of the system components (Byrne, 2009). However, such emergence can be reflected in meso attributes of the system (that might be referred to as a set of principles, laws or generic rules that govern it), that is able to orientate the whole (macro) system in some way, and where this is known it can provide some degree of behavioural predictability.

Dopfer *et al.*'s (2004) study of the relationship between macro, meso and micro attributes of a system defines the nature of the meso. It is a rule assembly that controls structure and process, and it has affects that occur through its population of actualisations. Micro refers to the individual carriers of rules and the systems they organise, and macro consists of the overall structure of systems constituted through the meso. Thus, micro refers to individuals (or groups of them) that compose the system; meso refers to the generic rules that arise from some dominating assembly that facilitates macro structures and processes (that result in behaviour) through their actualisations; macro refers to the whole system with its behaviour. Here then, micro behaviours coalesce into meso formative structures, and their actualisations can be manifested as macro imperatives for behavioural orientations. Meso functionality can be taken as knowledge rule structures (which may or may not be generic), and connections are made between elements that exist both within and beyond the system in question. The rule structures are relational complementary rule bundles, but to predict macro system behaviour only generic rules are relevant.

Meso generic rules may occur as a natural consequence of the interaction between the set of behaviours of its micro parts. However, where consciousness is deemed to be a component of a complex system, meso generic rules may also reflect this. Scientific inquiry, once seen as something an observer undertook when examining some disconnected object of attention, has in due course come to involve conscious human beings having intention (Lucas, 1976; Yolles and Fink, 2013a, 2013b) and becoming, as Mielkov (2013) explains, human-

commensurable. So, in complex situations human-commensurable paradigms can provide explanations about behaviour through meso actualisations that involve consciousness and intention, while human-incommensurable paradigms do so devoid of evaluable causal attributive consciousness for change. Thus, for instance, the development of living cells from specific interactions between natural ingredients (Lane *et al.*, 2018) does not involve conscious intention from a science perspective, but rather centres on complex mechanisms. Now a study of how organisations change may be undertaken from a complex human-incommensurable approach (Dooley, 1997). However, a human-commensurable one ensures that the meso attribute of higher conscious and intention are involved that can enrich causality in an analysis (Yolles and Fink, 2014c, 2014d, 2014a, 2014b).

In modelling adaptive complex systems, the use of a macro-meso-micro explanation can be particularly useful, as it generalises inquiry into systemic causal attributes. It has previously been said that human-incommensurable adaptive complex systems are a component of complexity paradigms, and human-commensurable adaptive complex systems are a component of the humanist paradigm. In the former, interest lies in structures associated with meso actualisations, while in the latter individual cognitive attributes may become an interest that are capable of being expressed as meso generic rule structures and their consequential actualisations.

A meso case illustration

Complexity draws on a few general principles that can explain behavioural outcomes under change (Morin, 1990). How this might occur is explained by Whitley (1992, 1994, 1998, 1999) through his neoinstitutional business systems theory (Yolles, 2016). It is also explained through economic theory by Dopfer *et al.* (2004) who indicate that in evolving systems a macro-meso-micro relationship exists, the meso representing generic rules (or principles or laws) that arise in the system, and to which macro-unity causality is associated. By implication, these generic rules also suggest a feedback influence that could create some tendencies among social micro-behaviours that could redirect system development. An illustration of this is relatively easy. Consider the emergence of meso generic rules with respect to the role of social media in political campaigning. Individuals in society have political micro-behaviours (through voting) that are determined by their own cognitive position. Social media are constituted through platforms on which individuals microscopically establish links through which meso generic rules may emerge. This has occurred using social robots (bots). An example is the chatbot, an algorithm designed to hold a conversation with a human (Ferrara *et al.*, 2016). Such algorithms are rule-based, so that when they populate a social media platform their rules, when related to a class or group of entities, can become meso generic. This capacity is only realised when the bots begin to influence individuals within groups that populate the platform. As Ferrara *et al.* (2016, p. 97) indicate:

> Analyses of Twitter posts around the Boston marathon bombing revealed that social media can play an important role in the early recognition and characterization of emergency events. But false accusations also circulated widely on Twitter in the aftermath of the attack, mostly due to bots automatically retweeting posts without verifying the facts or checking the credibility of the source [. . .]. A second category of social bots includes malicious entities designed specifically with the purpose to harm. These bots mislead, exploit, and manipulate social media discourse with rumours, spam, malware, misinformation, slander, or even just noise. This may result in several levels of damage to society. For example, bots may artificially inflate support for a political candidate [. . .] this kind of abuse has already been observed: during the 2010 US midterm elections, [where] social bots were employed to support some candidates and smear their

> opponents, injecting thousands of tweets pointing to websites with fake news. A similar case was reported around the Massachusetts special election of 2010. Campaigns of this type are sometimes referred to as *astroturf* or Twitter bombs [. . .] [These bots] can give the false impression that some piece of information, regardless of its accuracy, is highly popular and endorsed by many, exerting an influence against which we haven't yet developed antibodies. Our vulnerability makes it possible for a bot to acquire significant influence, even unintentionally. Sophisticated bots can generate personas that appear as credible followers, and thus are more difficult for both people and filtering algorithms to detect. They make for valuable entities on the fake follower market, and allegations of acquisition of fake followers have touched several prominent political figures in the US and worldwide.

Samuel *et al.* (2016) explain that political agents make use of political bots in *astroturfing* to manipulate public opinion and create scaffolding for human control. This scaffolding, when acting on a class or group of relatable entities, constitutes the meso generic rule base. In the context of this illustration, the class is defined by a set of personality characteristics to which the scaffolding has directed relevance.

This brings one to the control process that occurs through feedback from meso generic rules to individual agents affecting their micro-behaviours. On social medium platforms like Facebook, people may be exposed to cognitive positions that are susceptible to manipulation by an appropriate scaffolding. *Astroturfing* can be persuasive when used in the microtargeting of the susceptible individuals having certain personality characteristics, for the purposes of political position entrapment. Such targeting has been permitted by Facebook, even though it delivers messages created through a fabric of mistruths and misdirection. This has occurred in the US 2016 elections as it has in the 2016 UK Brexit (*Br*itish *exit*) referendum in which Britain was to decide whether it should exit from membership of the European Union (Cadwalladr, 2017a). Reports indicate that those with interests to do so engaged in microtargeting through which individual agents using the platform and having responsive personality profiles are targeted for influence (Observer Editorial, 2018). The influence occurs darkly by surreptitiously delivering meso scaffolding which, in a political context, operates as a regulative framework that can direct development by targeting at least one component class of the macro-unity. For the targeted class, the scaffolding attempts to ensnare individuals and redirect their voting behaviours thereby delivering a different the macro-behaviour. This happened, it has been argued, during the Brexit referendum in the UK in 2016, when a political group called Vote Leave psychologically profiled susceptible individuals, non-transparently microtargeting them with hidden messages in order to influence their voting behaviour (Cadwalladr, 2017b; Krueger, 2018; Risso, 2018). While sceptics, who may be implicit supporters of Brexit, argue that the scaffolding cannot influence outcomes, they produce no evidence for the ineffectiveness of microtargeting by Vote Leave. However, there is evidence that it does have influence and hence can affect outcomes (Kraus, 2018). As a consequence of this micro-targeting, it is feasible that result of the referendum and hence the direction of UK development has been altered.

A cultural dimension

The characteristics of personality referred to above have a deeper meso determinant. This can be discussed within the context of humanism, where the meso generic attributes of the humanistic paradigm can be elaborated on by considering ideas from Lewin's (1935) force field theory of society, and in building on these using the notions from Sorokin's (1937, p. 42) socio-cultural dynamics. Consider that a macro human activity system can divide its micro population into two broad sub-populations, one with a material cultural orientation in which

money is most important, and another with a cognitive orientation where (cognitive) ideas are most important. For simplicity, let us assume that if most of the population are materialists, then there emerges a dominating influence of materialist perspectives that drive behaviours[4]. Having said this, in human activity systems, cognition also has a role, and hence it is unlikely that one will find a system that is purely materialistic with no cognitive attributes, or vice versa – though in theory this is possible. Perhaps, an illustration of such tendencies might arise when examining forms of extreme right or left wing political despotic system, in which subjects are dismissed as objects that may denude people of their human rights and accord some ideologically defined benefit. Human activity systems will conform to the dominant cultural orientation, this becoming a basis for a meso generic rule that will orientate the system towards future macro-behaviour. Thus, consider the formation of a meso generic rule by reflecting on Sorokin's proposition that in any given culture, one of two alternative forces exist that can vector social processes and behaviours. The behaviour of the system, then, will reflect the dominant cultural force. Two forces are identified that mutually interact, called *Sensate* and *Ideational*. Following Sorokin (1957, pp. 33-34), these are respectively defined as materialistic and cognitive where:

(1) Ideational mentality implies the acceptance of the validity of inner experience through which the whole external world is seen according to the patterns and traits it creates.

(2) Sensate mentality implies the validity of perception, rests entirely or, mainly, on man's external sense organs and is characterised by materialism, empiricism, mechanisticism, determinism, quantitativism.

For Sorokin, the Sensate and Ideational forces exist in permanent interaction, and while in any human activity system one normally dominates, force alliances may develop given the right conditions, as explained below.

Sensate and Ideational cultural forces are epistemically independent (Russell and Carroll, 1999, p. 3; De Cooman and Troffaes, 2004), so that they always simultaneously exist, one often taking cultural dominance over the other. Epistemic independence indicates that the knowledge resulting from a social orientation that it determines is reciprocally irrelevant with respect to the other in terms of the value of the knowledge possessed (Vicig, 2000). The change in the dominance of one force over the other implies a shift in the meso generic rules that influences macro-behaviour. If the Sensate force dominates, then more socially relevant outputs are material in nature, while if the Ideational force dominates, then the socially relevant outputs are more cognitively oriented. While dominance may occur for one cultural force (thus diminishing the social relevance of the other), epistemic independence also allows for both to simultaneously maintain some degrees of importance, when an *Idealistic* balance may occur in which a *stable* balance between Sensate and Ideational forces occur. This can be a relatively rare condition in which Sensate and Ideational forces are mutually supportive, leading to a harmony between material application of cognitive creativity, for example when ideas are used to create material advantage. However, a mix between Sensate and Ideational forces will always occur during cultural change. Mostly, these are not stable, coinciding with cultural value conflicts.

An underpinning of complexity and humanism

Sensate scientific inquiry embraces forms of human-incommensurable positivism, while ideational inquiry embraces forms of human-commensurable constructivism. The positivist view holds that people see the world because that is how it is. This is as opposed to a

constructivist view that the world is seen through people's perception, from which they construct reality either individually (Piaget, 1950) or socially (Vygotsky, 1978).

The traditional positivist approach posits that factual knowledge comes from positive information arising from observable experience of natural phenomena (and their properties and relations). It develops from sensate sources filtered by experience and is cognitively processed according to coherent reasoning that conforms to logical principles. Positivist inquirers are thus seen as objective and meaning exists independently of consciousness – an inquirer just needs to look hard enough to find it.

Positivism requires that statements emerging from a theory should not only be positive, but also testable. However, in a complex world this can be problematic because statements that may first appear to be simple may be quite complex and convoluted, are not easily susceptible to testable hypotheses. To address this, post-positivism arose, linking the observer as subject to the object being observed rather than demanding objectivity through the observer standing apart from human subjectivity (Fischer, 1998). Post-positivism assumes that reality exists, but can never be fully understood or explained, given both the multiplicity of causes and effects and the problem of social meaning – it is therefore a natural underlying philosophy for the study of complexity. Objectivity serves as an ideal, but it requires a critical community of interpreters to confirm this. Post-positivists do not believe that any individual can see the world perfectly as it really is, and hence they are edged towards the perspective of interpretivists/constructivists. There is a view that they are "closet constructivists"[5] (Myers, 1999), but this seems not to be the case since a single unique reality, rather than a plurality of possible realities, is deemed to exist. In contrast, constructivists allow for there to be perhaps as many perspectives about reality as there are observers of it. All scientific inquiry is deemed biased, all observations are theory-laden, and objectivity is social, rather than individual, permitting critique from others in a social. For Fischer (1998), post-positivists are "interpretive consensusists" who accept empirical data through consensus which then becomes knowledge through interpretative interaction with the perspectives of others through "learning conversations."

The paradigm of complexity (Gunaratne, 2003) is post-positivist. It was influenced by Progogine's (1947) hard formal study of non-linear thermodynamics. It developed into the informal extension of Prigogine (1980), Prigogine and Stengers (1984) and Nicolis and Prigogine (1989) among others, and it explains how complex systems are able to fall into and out of chaos. Schwarz (1994) adopted these insights and coupled them with others (including those of Maturana and Varela, 1979) to develop a theory of self-organisational processes with a hard substructural subsystem and a relatively soft supersystem. Standing against this is humanism, essentially an interpretivist position that is cognitive, and posits that human interest and purpose are inherently components of scientific inquiry. Access to reality can only occur through interpretive media like language, and through shared meanings that are socially constructed and arise through consciousness. The humanistic approach can be elaborated on by defining three attributes that it possesses (Warmoth, 1996):

(1) an epistemology that admits the centrality of human experience as basic data, where all human knowledge ultimately represents interpretations of human experience;

(2) an emphasis on holistic theoretical models; and

(3) an advocacy of value-based and value-affirming social science.

These three attributes conform to a systemic perspective. Von Bertanaffy (1968) noted the limitations of positivist thinking in social theory and the movement towards the more holistic modelling of individuals as active personality systems, using symbolism (this defined as an internal cognitive representation of an external reality).

For Warmoth (1996), humanism implies exploration of perspectives that are:

- phenomenological (where reality as deemed to exist through conscious reflection of experience thereby creating conditions for objectivity);
- social constructionist (where jointly constructed understandings of reality are created through socially shared propositions); and
- transdisciplinary, where (for instance) the resolution of problems is not sought through the perspectives of a single discipline, a frequent requirement where complexity is involved.

Warmoth also advocates that humanism extends beyond philosophical positioning to embrace relational (and often egalitarian) socio-political orientations that have:

- a systematic exploration of the relationship between person, community, and society;
- the challenge of decreasing academic marginality (through adaptation, with the reconstruction of self in rapidly changing societies) and increasing (cultural) diversity (e.g. through ethnic and gender equality and its implications); and
- a developing concept of deep democracy that would extend it from the political to the cultural and economic arenas, perhaps through an increased centring on local as opposed to centralised social systems.

For Meilkov (2013), this deep democracy would refer in humanism to culturally determined political behaviour, as opposed in complexity paradigms to technologically determined political behaviour, the latter providing a practical means by which policy is socially engineered. An example of such a technology is a bureaucracy and how it implements policy (Yolles, 2018).

Conclusion

Discussion has occurred to identify different dimensions of the relationship between complexity and viable system theories. To do this the paper has introduced the idea of a hard-soft theory continuum that respectively maintain object-subject perspectives, and which themselves will (in Part 2 of this paper) be shown to relate to external-internal analytical orientations. Terms like hard and soft theory, object and subject, tangible intangible, and restricted and general complexity have been introduced. Ensuring that there is no confusion concerning the terms introduced here, and how they may relate one to another, it will be useful to explain them, as shown in Table I.

Hard theories tend to be formal and surrounded by limited narrative explanations. Soft theories may include formal language to represent (usually behavioural) aspects of their definition, but they often centre on informal natural language. Hard and soft theories that are orientated towards complexity coexist on a hard-soft continuum. Hard theories exist at an extreme end, while soft theories may be relatively soft and take any position on the continuum, from considering behaviourism to considering only cognition at the other extreme. Hard theories tend to be classified under restricted complexity, while soft theories tend to be classified under general theories. However, these classifications are variable. For instance, Holland's CAS is a hard theory with

Concept	Nature	Alternative Concept	Nature
Hard theories	These involve agents taken to be objects in a dynamic system and data measures are quantitative	Soft theories	These involve agents taken to be subjects in a dynamic system where data measures may be quantitative or qualitative
Object/ objective	An agent with tangible attributes	Subject/ subjective	An agent with intangible as well as tangible attributes
Tangible attributes	A property of an agent that can, when identified, be directly measured (e.g. height, weight, money)	Intangible attributes	A property of an agent that, when identified, cannot be directly measured, and may include forms of "capital" like natural, human (including personality), social, cultural, structural and stakeholder
Formal language	Explicit, precise and specific (e.g. mathematics or logic). Allows for validation of completeness and consistency through formal proofs. Suffers from a lack of pragmatic usefulness due to inability to deal with real-world applications, can be hard to understand and read, and can be error prone	Informal language	Inherently implicit natural languages with syntactic structures through which narratives are presented that may lack precision or specificity, thus making it more able to identify specificities, and it can also be difficult to validate or verify theoretical arguments
Human-incommensurable theories	Does not assign attributive causality to system processes; agents may have tangible attributes	Human-commensurable theories	Can assign attributive causality to system processes, and permit agents to have both intangible and tangible attributes
Agent	An actor that exerts power or has the power to act and has the capacity to interact with others and can (normally) adapt and learn		
Relatively soft	An agent that has behaviour and cognition, and the degree of importance of cognition to the theory is indicative of its relative softness. This degree is expressed as the relative density of the intangibles significant to a theory, indicative of a balance between cognitive and behavioural influences		
Restricted complexity	Formal models which can be considered complex because empirically they are presented in a multiplicity of interrelated processes, interdependent and retroactively associated. Assumed that hidden complexity regularities exist		
General complexity	Draws epistemological subjective implications of a knowing subject, is descriptive, explores the properties of self-organisation and autonomy through processes of observation. Can also highlight the degree of ignorance an agent (as a subject) has about an object of attention, and the processes of internalisation and assimilation (which integrates perceived reality into a cognitive structure) through which the agent is able to cognitively reconstruct the object despite the lack of information		

Table I.
The related nature of the terms introduced in this paper

agents taken as objects, uses formal language and is classified under restricted complexity. Beer's management cybernetics is a human-incommensurable substructural theory, but it has an embedded superstructural theory referred to as the VSM that is soft and human-commensurable. The substructure and superstructure taken together are classed under general complexity. Broadly, Beer's approach is also a VST that has been responsible for the rise of what is called second-order cybernetics. Schwarz produced an alternative VST that is essentially third order cybernetics. It is a new framework that has emerged as a compilation of several disparate theories,

beginning with that of Prigogine and embracing that of Maturana and Varela. It started as a hard, semi-formal theory in the 1980s through its propositions and narratives, where agents are objects. It developed soft attributes with agents as subjects, embracing principles of human-commensurability. It has further developed both its hard quantitative and soft qualitative aspects through knowledge cybernetics. As a part of general complexity, it has explored some aspects of formality, but these have not been elaborated. Humanism can also be described as an extremely soft theory of complexity, concerned with similar attributes to other theories of complexity.

Hard and soft approaches to modelling adaptive complex systems have relatable interests. They are both concerned with exploring adaptive processes of systems such that they survive through self-organisation, and both hard formal and relatively soft informal processes of change can be explained through the concept of generic meso attributes the actualisations of which result in imperatives for behaviour. *This stands against the traditional view that macro behaviour cannot be predicted from an assembly of micro behaviours under complexity*. Generic meso attributes may belong to either a human-incommensurable complexity paradigm, as it involves no components of conscious intention that can be causally attributed to behaviour, or a human-commensurable humanist paradigm which does. In either case, adaptive complex systems adapt through processes of self-organisation that are a response to imperatives arising from change in their complex internal and/or external environments. The introduction of conscious attributes in adaptive complex systems can make them more complex, with their additional dimensions of consideration. While human-incommensurable meso generic rules may exist for human populations that explain their patterns of behaviour, human-commensurable meso generic rules that emerge from attributes of consciousness have greater likelihood in explaining patterns of behaviour, where consciousness and intention is involved.

Adapting an argument by Mielkov, it has been said that the orientation between Sensate and Ideational cultural orientations is consistent with the complexity or humanism paradigm. In the case that a dominating balance between the two exists, then the harmony paradigm emerges. This is only possible because Sensate and Ideational cultural forces are epistemically independent.

In the following Part 2 of this paper, the complexity and humanist paradigms will be examined further, and consideration of a harmony valence between them will be made that will also embrace the philosophical perspectives of both complexity and humanism. Agency theory will then be used to explore the dynamic relationship between complexity, humanism and harmony, doing this by setting agency up as a methodological inquiry system. Illustration will be provided through explaining the rise of mixed methods (as a harmony paradigm) during inquiry into complex human activity systems.

Notes

1. Intangibles may include both social positives and negatives some of which are properties of an agent, other properties of its environment. Examples of intangibles are (Peñaflor, 2011; Watts *et al.*, 2003): natural capital (like natural resources, harvesting use/abuse, waste management/mismanagement); human capital (like personality attributes, commitment, skills and expertise, knowledge/ignorance, dysfunctional egoism, personal corruption, consciousness and individual cognitive competencies such as knowledge and capability: Canibano *et al.*, 1999), social capital (like trust, loyalty, sharing, factionalism, inequality gap, ideological violence including institutionally codified racism, sexism, classism), cultural capital (like community and family

values, beliefs and practices for development, animosity to outsiders), structural capital (like community organisation and disorganisation, local/global elites, material violence such as physical coercion and terror, denial of rights and resources, restriction of mobility) and stakeholder capital (like social support systems, civil society, corruption or criminal networks).

2. Superstructure is a term used by Karl Marx, who distinguished between base/substructural attributes of an economic system that are comprised of the forces and relations of production, and superstructural ones which refers to forms (or modes) of production. In the construction industry, substructure as a foundation for an edifice, while the superstructure is constituted by the contextually defined structures added to it that give it significance and meaning. Here, substructure is the base/core of a theory, and a superstructure additional propositional theory. Now a theory is constituted as a set of propositions arrived at through a process of continuing abstractions with a purpose of creating a generalised statement aimed at explaining a phenomenon. It offers a basis for understanding, analysing, and designing ways to investigate a set of conceptual relationships explaining that phenomenon. Where it can be defined in terms of a substructural core, it will have a superstructural framework of purposeful propositions able to deliver a model to represent a specific component of that phenomenon.

3. The term prediction is typically restricted to hard theory. More general within the field of complexity is the term anticipation (Poli, 2009; Wallis, 2010), which will be assumed when the word prediction is used. Essentially, anticipation refers to the identification of future behaviours by agents (Yolles, 2006). To anticipate agent behaviour, it must have invariant features from which behaviour arises. Anticipation may be of two types. *Weak* anticipation is based on a model of the system and enables the identification of future behaviours. *Strong* anticipation occurs through an agent's structural properties with influence from its strategic process. Agents that self-organise are anticipatory. Self-production/autopoiesis can be seen in terms of environmental pressures that produce perturbing changes to which the agent reacts through its own processes, and that have operations triggered within the agent that are governed by a principle of conservation of form. Operative attributes of the agency involve strong anticipation that conditions the way that it responds to environmental perturbations in its behaviour. Strategic processes involve weak anticipation because they are model-based and are an interpretation of the environment that occurs from an examination of behavioural perturbations.

4. The situation is more complex than a simple statistical relationship, as there may be arbiters of a social power (Foucault, 1972) that may also play an influencing role here, connected for instance with the relationships we have with ourselves and the mutual ways in which control by others and self occurs.

5. The term closet here refers to a state of concealment and incorrectly implies that post-positivists are secretly constructivists without their admitting it.

References

Aubin, J.P. (2011), *Viability Theory: New Directions*, Springer Science and Business Media.

Beer, S. (1966), *Decision and Control*, John Wiley, Chichester.

Beer, S. (2004), "Ten pints of beer: the rationale of Stafford beer's cybernetic books (1959-94)", *Kybernetes*, Vol. 33 Nos 3/4, pp. 828-842.

Beer, S. (1959), *Cybernetics and Management*, English U. Press, London.

Beer, S. (1979), *The Heart of the Enterprise*, Wiley, Chichester.

Bishop, R.C. (2003), *Nonequilibrium Statistical Mechanics in the Early Years: Similarity Transformations between Deterministic and Probabilistic Descriptions*, arXiv.org > physics > arXiv:physics/0304018v3, 5th May, available at: https://arxiv.org/pdf/physics/0304018.pdf (accessed July 2018).

Brownlee, J. (2007), *Complex Adaptive Systems, Technical Report 070302A, Complex Intelligent Systems Laboratory, Centre for Information Technology Research, Faculty of Information Communication*

Technology, Swinburne University of Technology, Melbourne, available at: https://pdfs.semanticscholar.org/44de/012ccf9ff522ab6ed6dfb66c75e39e986be1.pdf (accessed July 2018).

Byrne, D. (2009), "Working within a complexity frame of reference – the potential of `integrated methods' for understanding transformation in complex social systems", *Communication for Social Change (CFSC) Consortium's Paper for UNAIDS on Expanding the Monitoring and Evaluation of Social Change Communication for HI V/AIDS Prevention*.

Cadwalladr, C. (2017a), "Robert mercer: the big data billionaire waging war on mainstream media", *The Guardian*, 26th February, available at: www.theguardian.com/politics/2017/feb/26/robert-mercer-breitbart-war-on-media-steve-bannon-donald-trump-nigel-farage (accessed July 2018).

Cadwalladr, C. (2017b), "The great British Brexit robbery: how our democracy was hijacked", *The Guardian*, May 7th, available at: www.theguardian.com/technology/2017/may/07/the-great-british-brexit-robbery-hijacked-democracy (accessed July 2018).

Canibano, L., García-Ayuso, M.P., Sánchez, M. and Ole, M. (1999), "Measuring intangibles to understand and improve innovation management", Preliminary Results Paper presented at the OECD International Symposium. Measuring and Reporting Intellectual Capital: Experience, Issues, and Prospects. Amsterdam, 9-11 June, available at: www.oecd.org/sti/ind/1947863.pdf (accessed July 2018).

Capra, F. (1982), *The Turning Point*, Bantam, Toronto.

Carayannis, E.G. (2004), "Measuring intangibles: managing intangibles for tangible outcomes in research and innovation", *International Journal of Nuclear Knowledge Management*, Vol. 1 Nos 1/2, pp. 49-67, available at: www.researchgate.net/profile/Elias_Carayannis/publication/228686322_Measuring_intangibles_Managing_intangibles_for_tangible_outcomes_in_research_and_innovation/links/55194ea80cf2d241f3562e76/Measuring-intangibles-Managing-intangibles-for-tangible-outcomes-in-research-and-innovation.pdf (accessed July 2018).

De Cooman, G. and Troffaes, M.C.M. (2004), "Coherent lower previsions in systems modelling: products and aggregation rules", *Reliability Engineering and System Safety*, Vol. 85 Nos 1/3, pp. 113-134.

Dooley, K.L. (1997), "A complex adaptive systems model of organization change", *Nonlinear Dynamics, Psychology, and Life Sciences*, Vol. 1 No. 1, pp. 69-97.

Dopfer, K., Foster, J. and Potts, J. (2004), "Micro–meso–macro", *Journal of Evolutionary Economics*, Vol. 14 No. 3, pp. 263-279.

Espejo, R. and Gill, A. (1997), *The Viable System Model as a Framework for Understanding Organizations*, Phrontis Limited and SYNCHO Limited, available at: www.researchgate.net/profile/Raul_Espejo/publication/265740055_The_Viable_System_Model_as_a_Framework_for_Understanding_Organizations/links/54dc62140cf23fe133b14526/The-Viable-System-Model-as-a-Framework-for-Understanding-Organizations.pdf (accessed June 2018).

Farquhar, A. and Brajnik, G. (1995), "A semi-quantitative physics compiler, WIT transactions on information and communication technologies", Vol. 10, doi: 10.2495/AI950191.

Ferguson, C.H. (2010), "Inside job, documentary film about the development of the 2008 financial crisis", available at: http://en.wikipedia.org/wiki/Inside_Job_%28film%29 (accessed April 2014).

Ferrara, E., Varol, O., Davis, C., Menczer, F. and Flammini, A. (2016), "The rise of the social bot", *Communications of the ACM*, Vol. 59 No. 7, pp. 96-104, available at: https://cacm.acm.org/magazines/2016/7/204021-the-rise-of-social-bots/fulltext (accessed July 2018).

Fink, G. and Yolles, M. (2018a), "Affect and cognition, part 1: 'cross-fire' interaction model", *Kybernetes*, Vol. 47 No. 1, pp. 80-96.

Fink, G. and Yolles, M. (2018b), "Affect and cognition, part 2: affect types and mindset types", *Kybernetes*, Vol. 47 No. 1, pp. 99-107.

Fischer, F. (1998), "Policy inquiry in postpositivist perspective", *Policy Studies Journal*, Vol. 26 No. 1, pp. 129-146.

Foucault, M. (1972), "The archaeology of knowledge", in heridan Smith, A.M. (Trans), Pantheon Books, New York, NY.

Frey, H.C. (1998), "Quantitative analysis of variability and uncertainty in energy and environmental systems", in Ayyub, B.M. (Ed.), Chapter 23 in *Uncertainty Modeling and Analysis in Civil Engineering*, CRC Press, Boca Raton, FL, pp. 381-423, available at: www.pmi.org/learning/library/knowledge-elicitation-techniques-risk-assessment-8178 (accessed July 2018).

Gershenson, C. and Fernandez, N. (2012), "Complexity and information: measuring emergence, self-organization, and homeostasis at multiple scales", *Complexity*, Vol. 18 No. 2, pp. 29-44.

Gunaratne, S.A. (2003), "Thank you newton, welcome Prigogine: 'unthinking' old paradigms and embracing new directions. Part 1: theoretical distinctions", *Communications*, Vol. 28, pp. 435-455.

Gunderson, L. and Holling, C.S. (2001), *Panarchy: Understanding Transformations in Human and Natural Systems*, Island Press, Washington, DC.

Guo, K., Yolles, M., Fink, G. and Iles, P.A. (2016), *The Changing Organisation: an Agency Approach*, Cambridge University Press, Cambridge and New York, NY.

Holland, J.H. (2006), "Studying complex adaptive systems", *Jrl Syst Sci and Complexity*, Vol. 19, pp. 1-8, available at: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/41486/11424_2006_Article_1.pdf;sequence=1,accessedMay2018

Huxley, J. (1961), *The Humanist Frame*, Allen and Unwin, London.

Klijn, E.H. (2008), "Complexity theory and public administration: what's new; key concepts in complexity theory compared to their counterparts in public administration", *Public Management Review*, Vol. 10 No. 3, pp. 299-317.

Kraus, R. (2018), "How well does 'microtargeted psychographic advertising' work anyway?" Mashable, 24th May, available at: https://mashable.com/2018/03/24/how-microtargeted-ads-affect-behavior/?europe=true (accessed July 2018).

Krueger, J.I. (2018), "The personality of Brexit voters: openness predicts best", *Psychology Today*, 16th June 2016, available at: www.psychologytoday.com/us/blog/one-among-many/201606/the-personality-brexit-voters (accessed July 2018).

Lane, N., Allen, J.F. and Martin, W. (2018), "How did LUCA make a living? Chemiomosis in the origin of life", *BioEssays*, Willy-Blackwell, doi: 10.1002/bies.200900131/.

Lansing, J.S. (2003), "Complex adaptive systems", *Annual Review of Anthropology*, Vol. 32 No. 1, pp. 183-204, doi: 10.1146/annurev.anthro.32.061002.093440, available at: www.researchgate.net/publication/235737529_Complex_Adaptive_Systems (accessed June 2018).

Lauritsen, P., Kiilerich Madsen, S. and Olesen, F. (Eds) (2006), Pickering, A., (The Science of the Unknowable: Stafford Beer's Cybernetic Informatics), Nielsen, K., N., (Cybernetics and New Ontologies: An interview session with Andrew Pickering), Working Papers from Centre for STS Studies, Department of Information and Media Studies, University of Aarhus, available at: http://sts.au.dk/fileadmin/sts/publications/working_papers/Pickering_-_Science_of_the_Unknowable.pdf (accessed July 2018).

Lewin, K. (1935), *A Dynamic Theory of Personality*, McGraw-Hill, New York, NY.

Lucas, R.E. Jr, (1976), "Econometric policy evaluation: a critique", *Carnegie-Rochester Conference Series on Public Policy*, Vol. 1, pp. 19-46.

Madigan, T.J. (1999), "Evolutionary humanism revisited: the continuing relevance of Julian Huxley", *Religious Humanism*, Vol. 33 No. 1, pp. 73-82, available at: http://huumanists.org/publications/journal/evolutionary-humanism-revisited-continuing-relevance-julian-huxley (accessed July 2018).

Mahoney, J. (2004), "Revisiting general theory in historical sociology", *Social Forces*, Vol. 83 No. 2, pp. 459-490.

Malaina, A. (2015), "Two complexities: the need to link complex thinking and complex adaptive systems science", *Emergence: Complexity and Organization*, doi: 10.emerg/10.17357.3f8320a4b0c3add74ffda2959beec5b2, 31 March, 1st Ed., available at: https://journal.emergentpublications.com/article/two-complexities/ (accessed January 2018).

Maturana, H.R. and Varela, F.J. (1979), *The Tree of Knowledge*, Shambhala, London.

Meyer, W.F., Moore, C. and Viljoen, H.G. (1997), *Personology: From Individual to Ecosystem*, Heinemann, Johannesburg.

Mielkov, I.A. (2013), "Human-commensurable systems: from complexity to harmony, systems", *Systems*, Vol. 1 No. 1, pp. 79-94.

Miller, J.H. and Scott, E.P. (2007), *Complex Adaptive Systems: an Introduction to Computational Models of Social Life*, Princeton University Press, Princeton.

Morin, E. (1990), *From the Concept of System to the Paradigm of Complexity*, Science avec conscience, new edition, Points/Seuil, Paris, Originally an inaugural address to the Congress de l'A.F.C.E.T. Versailles, November 1977, and originally published in Science avec conscience, Paris, Fayard, (1982), pp. 172-189.

Morin, E. (1999), *Seven Complex Lessons in Education for the Future*, United Nations Educational, Scientific and Cultural Organization, Paris.

Morin, E. (2006), "Restricted complexity, general complexity, presented at the colloquium intelligence de la complexité: épist émologie et pragmatique", Cerisy-La-Salle, 26th June 2005, Translated from French by Carlos Gershenson. Also see Restricted Complexity, General Complexity, available at: http://cogprints.org/5217/1/Morin.pdf

Myers, M.D. (1999), "Qualitative research in information systems", available at: www.auckland.ac.nz/msis/isworld/index.html (accessed 2001).

Nicolis, G. (2009), "Thermodynamic theory of stability, structure and fluctuations", *Pure and Applied Chemistry*, Vol. 22 Nos 3/4, p. 379392.

Nicolis, G. and Prigogine, I. (1989), *Exploring Complexity*, W.H.Feeman and Co., New York, NY.

Observer Editorial (2018), "The observer view on digital campaigning being an existential threat to democracy", *The Observer*, 29th July, available at: www.theguardian.com/commentisfree/2018/jul/29/the-observer-view-on-digital-campaigning-threat-to-democracy (accessed July 2018).

Peñaflor, P.E.C. (2011), "Intangible assets and the search for a new development paradigm: redefining concepts of wealth, poverty and development", Working paper for the Centre for Conscious Living Foundation, February, available at. www.cclfi.net/sites/default/files/Intangible_assets.pdf (accessed July 2018).

Piaget, J. (1950), *The Psychology of Intelligence*, Harcourt and Brace, New York, NY.

Pickering, A. (2004), "The science of the unknowable: Stafford Beer's cybernetic informatics", *Kybernetes*, Vol. 33 Nos 3/4, pp. 499-521, available at: www.researchgate.net/publication/243461341_The_science_of_the_unknowable_Stafford_Beer%27s_cybernetic_informatics, accessedJune2018.

Pidd, M. (2004), "Complementarity in systems modelling", in Pidd, M. (Ed.), *Systems Modelling: Theory and Practice*, John Wiley and Sons, Chichester, pp. 1-20.

Poli, R. (2009), "The many aspects of anticipation", *Foresight*, Vol. 12 No. 3, pp. 7-17, available at: https://pdfs.semanticscholar.org/b63f/9b480ac8cd96999f281892caba100baacc79.pdf (accessed June 2018).

Pollack, J. (2009), "Multimethodology in series and parallel: strategic planning using hard and soft OR", *Journal of the Operational Research Society*, Vol. 60 No. 2, pp. 156-167.

Prigogine, I. (1947), *Etude Thermodynamique Des Phdnomènes Irréversibles*, Desoer, Liege, Republished in English in 1961 by Interscience, New York, NY.

Prigogine, I. (1962), *Non-Equilibrium Statistical Mechanics*, Wiley, New York, NY.

Prigogine, I. (1967), *Introduction to Thermodynamics of Irreversible Processes*, 3rd ed. Interscience, Wiley, New York, NY.

Prigogine, I. (1980), *From Being to Becoming: Time and Complexity in the Physical Sciences*, Freeman, San Francisco, CA.

Prigogine, I. and Stengers, I. (1984), *Order out of Chaos: Man's New Dialogue with Nature*, Flamingo, London,.

Risso, L. (2018), "Harvesting your soul? Cambridge analytica and brexit", in Jansohn, C. (Ed.), Brexit Means Brexit?, y Akademie der Wissenschaften und der Literatur, Mainz, pp. 75-90, available at: www.adwmainz.de/fileadmin/user_upload/Brexit-Symposium_Online-Version.pdf#page=75 (accessed July 2018).

Ruitenbeek, J. and Cartier, C. (2001), "Invisible wand: adaptive co-management as an emergent strategy in complex bio-economic systems", Occasional Paper No. 34, Centre for International Forestry Research, Bogor 16680, Indonesia, ISSN 0854-9818, available at: www.cifor.org/publications/pdf_files/OccPapers/OP-034.pdf (accessed June 2018).

Ruiz, R., van Harmelen, F., Aben, M. and van de Plassche, J. (1994), "Evaluating a formal modelling language", in Schreiber, S. and Van de, V. (Eds), *Proceedings of the 8th European Knowledge Acquisition Workshop (EKAW'94)*, LNAI 867, pp. 26-45, *Springer Verlag*, available at: www.cs.vu.nl/~frankh/postscript/EKAW94.pdf (accessed July 2018).

Russell, J.A. and Carroll, J.M. (1999), "On the bipolarity of positive and negative affect", *Psychological Bulletin*, Vol. 125 No. 1, pp. 3-30.

Sagiv, L. and Schwartz, S.H. (2007), "Cultural values in organisations: insights for Europe", *European J. International Management*, Vol. 1 No. 3, pp. 167-190.

Samuel, C., Woolley, S.C. and Howard, P.N. (2016), "Political communication, computational propaganda, and autonomous agents", *International Journal of Communication*, Vol. 10, pp. 4882-4890.

Schneider, M. and Somers, M. (2006), "Organizations as complex adaptive systems: implications of complexity theory for leadership research", *The Leadership Quarterly*, Vol. 17 No. 4, pp. 351-365.

Schwarz, E. (1991), "From thermodynamics to consciousness. a model for evolution", *Proceedings of the 35th Annual Meeting of the International Society for the Systems Sciences, Östersund*, Vol. I, p. 235, *Pour plus d'information sur la science des systèmes, visitez le site de l' International Society for the Systems Sciences*.

Schwarz, E. (1994), "A trandisciplinary model for the emergence, self-organisation and evolution of viable systems", Presented at *the International Information, Systems Architecture and Technology, Technical University of Wroclaw, Szklaska Poreba, Poland*.

Schwarz, E. (1996), "The future evolution of consciousness as a dialogue between individuals and society", *Proceedings of the 40th Annual Meeting of the ISSS, Budapest*, pp. 629-642.

Schwarz, E., Aragno, M., Beck, H., Matthey, W., Remane, J., Chiffelle, F., Gern, J.P., Luigi Dubied, P.L. and Bühle, P. (1988), *La révolution des systems: une introduction à l'approche systémique: conférences interfacultaires données à l'Université de Neuchâtel, Secrétariat de l'Université, DelVal, Neuchâtel, Cousset*.

Sorokin, P. (1937), *Social and Cultural Dynamics*, in 4 volumes, Amer, Book, Co, NY, pp. 1937-1942, Reprinted in 1962 by Bedminster Press, New York, NY.

Sorokin, P.A. (1957), *Social and Cultural Dynamics: A Study of Change in Major Systems of Art, Truth, Ethics, Law and Social Relationships*, Revised and abridged in one volume by the author, Porter Sargent Publisher, Boston.

U-Tantada, S. (2018), "Influential Driving Factors for Corporate Performance: the Case of Small and Medium Enterprises in Thailand", Doctoral dissertation presented at the Institution of International Studies, Ramkhamhaeng University.

Vicig, P. (2000), "Epistemic independence for imprecise possibilities", *International Journal of Approximate Reasoning*, Vol. 24 Nos 2/3, pp. 235-250.

Von Bertalanffy, L. (1968), *General System Theory: Foundations, Development, Applications*, George Braziller, New York, NY.

Vygotsky, L.S. (1978), *Mind in Society*, Harvard University Press, Cambridge, MA.

Waldrop, M.M. (1992), *Complexity: The Emerging Science at the Edge of Order and Chaos*, Touchstone, New York, NY, available at: https://uberty.org/wp-content/uploads/2017/04/Waldrop-M.-Mitchell-Complexity-The-Emerging-Science-at-Edge-of-Order-and-Chaos.pdf (accessed June 2018).

Walker, J. (2018), *An Introduction to the Viable System Model as a Diagnostic and Design Tool for co-Operatives and Federations; Appendix 1: Levels of Recursion*.

Wallis, S. (2010), *Cybernetics and Systems Theory in Management: Tools, Views and Advancements*, IGI Global.

Warmoth, A. (1996), "Humanistic psychology and humanistic social science", *Humanity and Society*, Vol. 22 No. 3, pp. 2-7.

Watts, R.J., Williams, N.C. and Jagers, R.J. (2003), "Sociopolitical development", *American Journal of Community Psychology*, Vol. 31 Nos 1/2, pp. 185-194.

Whitley, R. (1992), *European Business Systems: Firms and Markets in Their National Contexts*, Sage Publications, London.

Whitley, R. (1994), *Business Systems*, Manchester Business School, Manchester.

Whitley, R. (1998), "Internationalization and varieties of capitalism: the limited effects of cross-national coordination of economic activities on the nature of business systems", *Review of International Political Economy*, Vol. 5 No. 3, pp. 445-481.

Whitley, R. (1999), *Divergent Capitalisms: The Social Structuring and Change of Business Systems*, Oxford University Press, Oxford.

Wogu, I.A.P. (2013), "Behaviouralism as an approach to contemporary political analysis: an appraisal", *International Journal of Education and Research*, Vol. 1 No. 12, p. 1012, available at: www.ijern.com/journal/December-2013/35.pdf (accessed June 2018).

Yolles, M. (2016), "Linking business and financial systems in the market economy: the case of China", *International Journal of Markets and Business Systems*, Vol. 2 No. 3, pp. 171-205.

Yolles, M. (2018), "Governance through political bureaucracy: an agency approach", *Kybernetes*, doi: 10.1108/K-09-2017-0329.

Yolles, M. and Fink, G. (2013b), "Modelling mindsets of an agency", *Journal of Organisational Transformation and Social Change*, Vol. 11 No. 1, pp. 69-88.

Yolles, M. and Fink, G. (2014c), "The sustainability of sustainability", *Business Systems Review*, Vol. 3 No. 2, pp. 1-32.

Yolles, M., Fink, G. and Frieden, R. (2012), "Organisations as emergent normative personalities: part 2, predicting the unpredictable", *Kyberenetes*, Vol. 41 Nos 7/8, pp. 1014-1049.

Yolles, M.I. (1999), *Management Systems: A Viable Approach*, Financial Times Pitman, London.

Yolles, M.I. (2006), *Organizations as Complex Systems: an Introduction to Knowledge Cybernetics*, Information Age Publishing, Greenwich, CT.

Yolles, M.I. and Fink, G. (2013a), "Exploring the common roots of culture, politics and economics", *Business Systems Review*, Vol. 2 No. 2, pp. 1-57.

Yolles, M.I. and Fink, G. (2014a), "Personality, pathology and mindsets: part 1 – agency, personality and mindscapes", *Kybernetes*, Vol. 43 No. 1, pp. 92-112.

Yolles, M.I. and Fink, G. (2014b), "Personality, pathology and mindsets: part 2 – cultural traits and enantiomers", *Kybernetes*, Vol. 43 No. 1, pp. 92-112.

Yolles, M.I. and Fink, G. (2014d), "Personality, pathology and mindsets: part 3 –pathologies and corruption", *Kybernetes*, Vol. 43 No. 1, pp. 135-143.

Further reading

Beer, S. (1972), *The Brain of the Firm*, Wiley, Chichester.

Beer, S. (1962), "Towards the automatic factory", in von Foerster, H. and Zopf, G. (Eds), *Principles of Self-Organization: Transactions of the University of IL Symposium on Self-Organization, Robert Allerton Park*, 8 and 9 June, 1961 [sic: actually 1960], *Pergamon, New York, NY*, pp. 25-89, Reprinted in Beer, How Many Grapes Went into the Wine? Stafford Beer on the Art and Science of Holistic Management (New York, NY: Wiley, 1994), pp. 163-225.

Evans, A., France, R., Lano, K. and Rumpe, B. (1999), "The UML as a formal modeling notation", in Bezivin, J. and Muller, P.-A. (Eds), *The Unified Modeling Language, Workshop UML'98: Beyond the Notation*, Springer Verlag Berlin, LNCS 1618.

Fisher, G. (2012), "Chaos versus complexity, synthesis", available at: www.syntgesisips.net/blog.chaos-versus-complexity/ (accessed March, 2018).

Hesse-Biber, S.N. (2010), *Mixed Methods Research: merging Theory with Practice*, The Guilford Press, New York, NY and London.

Jackson, M.C. (1969), "Creative holism: a critical systems approach to complex problem situations", *Systems Research and Behavioral Science*, Vol. 23, pp. 647-657.

Krueger, J.I. (2016), "The personality of brexit voters: openness predicts best", Psychology Today, 16th June, available at: www.psychologytoday.com/us/blog/one-among-many/201606/the-personality-brexit-voters (accessed July 2018).

Kuhn, S.T. (1970), *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago.

Maslow, A.H. (1959), *Human Values*, Harper Brothers, New York, NY.

Maslow, A.H. (1969), "The farther reaches of human nature", *The Journal of Transpersonal Psychology*, Vol. 1 No. 1, pp. 1-9.

Mielkov, I.A. (2016), "The hierarchy of values in the contemporary science", *Review of European Studies*, Vol. 8 No. 2, pp. 149-158.

Prigogine, I. (1987), "Exploring complexity", *European Journal of Operational Research*, Vol. 30 No. 2, pp. 97-103.

Rescher, N. (2005), *Cognitive Harmony: The Role of Systemic Harmony in the Constitution of Knowledge*, University of Pittsburgh Press, Pittsburgh.

Schwarz, E. (1997), "Towards some holistic cybernetics: from science through epistemology to being", *Cybernetics and Human Knowing*, Vol. 4 No. 1, pp. 17-50.

Thom, R. (1989), *Structural Stability and Morphogenesis: an Outline of a General Theory of Models*, Addison Wesley, Reading M.A.

Wiek, A., Withycombe, L., Redman, C. and Banas Mills, S. (2011), "Moving forward on competence in moving forward sustainability research and problem solving", *Environment Science and Policy for Sustainable Development*, Vol. 53 No. 2, pp. 3-13, available at: www.academia.edu/501206/Moving_Forward_on_Competence_in_Sustainability_Research_and_Problem_Solving_Environment_Magazine_53_2_3-13,accessedJune2018

Wiek, A., Withycombe, L. and Redman, C.L. (2011a), "Key competencies in sustainability: a reference framework for academic program development", *Sustain Science*, Vol. 6, pp. 203-218, available at: http://sustainability.psu.edu/fieldguide/wp-content/uploads/2015/08/WIEK-ET-AL-COMPETENCIES.pdf,accessedJune2018

Yolles, M. and Frieden, B.R. (2006), "Sociohistory: an information theory of social change", in Frieden, R. and Gatenby, R.A. (Eds), *Exploratory Data Analysis Using Fisher Information*, Springer-Verlag.

Yolles, M.I. (2007), "The dynamics of narrative and antenarrative and their relation to story", *Journal of Organizational Change Management*, Vol. 20 No. 1, pp. 74-94.

Yolles, M.I. and Fink, G. (2015c), "A general theory of generic modelling and paradigm shifts: part 1 - the fundamentals", *Kybernetes*, Vol. 44 No. 2, pp. 283-298.

Yolles, M.I. and Fink, G. (2015a), "A general theory of generic modelling and paradigm shifts: part 2 - cybernetic orders", *Kybernetes*, Vol. 44 No. 2, pp. 299-310.

Yolles, M.I. and Fink, G. (2015b), "A general theory of generic modelling and paradigm shifts: part 3 - the extension", *Kybernetes*, Vol. 44 No. 2, pp. 311-328.

Zetterberg, H.L. (1997), "The study of values", in Swedberg, R. and Uddhammar, E. (Eds), *Sociological Endeavor*, Selected Writings, City University Press, Stockholm, pp. 191-219.

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