General complexity

A philosophical and critical perspective

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Abstract

In this paper we argue that a rigorous understanding of the nature and implications of complexity reveals that the underlying assumptions that inform our understanding of complex phenomena are deeply related to general philosophical issues. We draw on a very specific philosophical interpretation of complexity, as informed by the work of Paul Cilliers and Edgar Morin. This interpretation of complexity, we argue, resonates with specific themes in post-structural philosophy in general, and deconstruction in particular. We argue that post-structural terms such as différance carry critical insights into furthering our understanding of complexity. The defining feature that distinguishes the account of complexity offered here to other contemporary theories of complexity is the notion of critique. The critical imperative that can be located in a philosophical interpretation of complexity exposes the limitations of totalising theories and subsequently calls for examining the normativity inherent in the knowledge claims that we make. The conjunction of complexity and post-structuralism inscribes a critical-emancipatory impetus into the complexity approach that is missing from other theories of complexity. We therefore argue for the importance of critical complexity against reductionist or restricted understandings of complexity.

Introduction

The current popular and scientific interest in the notion of complexity makes it one of the most prolific scientific research areas today. Although the idea of 'complexity theory' started as a 'scientific amalgam[1] emerging from the natural sciences,[2,3,4,5,6] many of the concepts became popular through the appropriation and generalisation thereof in post-World War II developments in the fields of General Systems Theory,[7] Cybernetics,[8] and Artificial Intelligence.[9,10] Soon thereafter other fields of study extended their research scope to exploring the practical implications that the study of complex phenomena could have for their areas of interest. The considerable growth in the number of recent publications on complexity and complex systems shows that the economy of concepts that inform contemporary theories of complexity have been taken up with enthusiasm in a variety of academic disciplines such as business management,[11,12,13,14] sociology,[15,16] systems biology,[17,18] health sciences,[19] and educational studies.[20]

However, despite the recent uptake of theories of complexity in a diverse number of subject fields, the impact and reception thereof in the field of philosophy has not been as significant as one would expect. Publications that examine the philosophical importance of complexity are most common in the field of philosophy of science,[21,12,23,24] but only a handful of authors discuss the notion of complexity from a continental perspective.[25,26,27,28,12,29]

In this paper we argue that a rigorous understanding of the key concepts and implications of complexity reveals that the underlying assumptions that inform our understanding of complex phenomena are deeply related to general philosophical issues, specifically criticality and normativity. For this purpose, we draw on a very specific philosophical interpretation of complexity, as informed by the work of Cilliers[28,30,31] and Morin.[32,33,34] Although the broad philosophical themes that are addressed in this paper may not be new to the informed reader, the specific contribution of this paper lies in showing how complexity (as a field of study in its own right, with a different genealogy to that of philosophy) generates the same type of critical normative insights that are found in the history of philosophy (especially in the Kantian, Nietzschean, structural, and post-structural traditions). We specifically aim to tease out the common philosophical concerns in complexity and post-structuralism in order to substantiate the claim that complexity is a philosophical problem;[29] but also in order to develop, and to enrich, the philosophical understanding of complexity.

Given the plethora of definitions of complexity, it is useful to clarify what we mean by a philosophical understanding of complexity, before embarking on the analysis. In this paper, we explore and present an argument for, what Paul Cilliers defines as, 'critical complexity'.[35] Critical complexity is premised on a philosophical understanding of complexity in which the main assumption is that complex phenomena are irreducible, but the irreducible nature of complexity cannot be understood from a human perspective. The only manner in which to engage with complexity is through modelling, which necessarily implies a reduction (and therefore a distortion) of the system under study. Objective knowledge of complex systems is therefore impossible, and an awareness of this imperfect engagement with complex systems is denoted by the use of the word 'critical'. Critical complexity therefore concerns an *attitude* that we assume when thinking about, and dealing with, complex systems.[36] In short, we understood complex systems as inherently (or ontologically) complex. Complex thinking denotes the manner in which

one engages with these systems, and therefore concerns both psychological claims (i.e. the attitude with which we approach complex systems) and epistemological claims (i.e. the thought-processes or models that we apply to understand our complex realities).

In section 1 and 2, we elaborate on our understanding of complexity (at the hand of both the complexity and philosophical literature). In section 3, we explore the differences between critical complexity and other, more restricted, notions of complexity. The consequences that critical complexity holds, as well as the reasons for why complexity is a philosophical problem, constitute the focus of section 4.

Systemic complexity and the loss of reference

A complex system does not exist independently from the parts that constitute it.[37,28] Hence, complexity is simultaneously a combination of the attributes of a system (ontological) as well as a 'function of our present understanding of the system'[38] (epistemological). The challenge inherent to modelling complex systems arises from the imbrication of the ontological attributes of complex systems and the epistemological strategies that we use in order to understand them.[1] As stated in the introduction, this means that there is no objective position from which to study complex phenomena. Two consequences follow from this understanding of complex systems. Firstly, the traditional distinction between subject and object cannot be maintained;[2,39,34] and secondly, complex systems are conceptualised as radically open and contextual.[40,41] This is because the boundaries between the system and the environment collapse to such an extent that it is impossible to determine a neutral position from outside the system from where to observe and study the system.

In philosophical terms, these insights theoretically situate the study of complex phenomena within a postmodern paradigm[3] of thought,[28,42,43,44,45,16] and specifically within the field of study known as post-structuralism.[39,46,47,48,29] Post-structuralism is a post-metaphysical position, since the possibility of knowledge based on transcendental categories or notions of truth, consciousness, being, or alterity are denied.[49,48] This shift from transcendence to immanence, as well as the implications arising from this shift, is variously described in the work of philosophers such as Gilles Deleuze, Niklas Luhmann, Jacques Derrida, Alain Badiou, Michel Henry, and Francois Laruelle.[49]

Although it is beyond the scope of this paper to analyse the specific contributions of each of these philosophers, in general terms one can state that post-structuralists argue that it is not possible to develop knowledge generating practices or epistemological theories from some objective or 'external historically advanced position'.[50] With the loss of objectivity, all knowledge is in principle only partial knowledge, and is further generated from the understanding that there can be no meta-position that legitimises the framing practices that we employ in our theories. This relates to discourses that argue for the 'loss of the outside' or 'loss of reference'. In this regard, Rasch and Knodt[48] argue that:

> *The modernity of science is marked by the famed and often lamented "loss of reference," i.e., the assertion that science can no longer lay claim to represent the world as it is and can therefore no longer serve as a non-contingent, authoritative source of knowledge.*

The loss of reference or 'decentring' of structure is further described by Derrida[51] as:

> *the moment when in the absence of a centre or origin, everything becomes discourse — provided we can agree on this word — that is to say, a system in which the central signified, the original or transcendental signified, is never absolutely present outside a system of differences.*

The insight that there is no final reference point to which we can appeal, or objective means through which we can access reality, is not unique to post-structuralism. Pragmatism and hermeneutics are, for example, two other well-established philosophical traditions that also work with the idea of a loss of a metaphysical anchor point. These traditions attempt to settle metaphysical disputes and reduce the inherent systemic complexity on the basis of practical considerations, and seek to define truth or justified true belief in terms of the pre-established norms governing the ideal speech community[52] or a scientific community of practice.[53,54,55]

However, we argue that the central difference between these latter traditions and post-structuralism hinges on whether complexity is taken seriously or not. Those working in the fields of pragmatism and hermeneutics attempt to reduce the complexity of the objects under study to the extent that complexity is theorised away, whereas post-structural theorists — as with complexity theorists — embrace this complexity and try to account for it in their theories.

In order to begin to better understand a complexity-motivated response to the loss of origin or of an objective reference point, we turn to Derrida's discussion on George Bataille,[56,57] who seeks to deal with the challenges of complexity — defined as a systemic problem — in terms other than pragmatic or empiricist considerations.

George Bataille: Restricted and general economies

Bataille argues that the traditional political economy[4] is essentially a closed economy, which frames itself against an unknowable outside, and which consequently restricts its analysis to a very narrow utilitarian logic, wherein the production, and especially consumption, of resources are limited to the immediate ends that they serve. Bataille labels this mode of analysis 'restricted', because it is based on the assumption that all social activity can be reduced to utilitarianism[5]. Given this description, we argue that both pragmatism and hermeneutics are premised on the notion of a restricted economy. The central problem with this model is that it does not take into consideration the excesses, or so-called waste, produced by a system. The impact that such surpluses have is therefore not reflected upon, but is instead relegated to the outside of the system. Thus, restricted economies are unable to account for non-utilitarian forces that act upon the system. It is for this reason that restricted economies struggle to explain the occurrence of such phenomena as war, sacrifice, or eroticism because these tend towards pure loss; there is no gain in such expenditure.

Against the notion of restricted economy, Bataille argues for the notion of a 'general economy' (or 'sovereignty'[56] as he labels it). A general economy tries to incorporate the aspects of life that are considered pure expenditure into its frame of analysis. In other words, general economics aim to simultaneously account for certain aspects of utilitarian and pure expenditure. By drawing our attention to the space of the general economy, Bataille seeks to 're-economise' our thinking by reintroducing excess into the frames that we employ when attempting to describe economies in utilitarian terms.

In his discussion of Bataille's work, Derrida[51] aims to maintain the radical nature of Bataille's critique whilst at the same time illustrating the impossibility of a 'pure excess' without an economy to which it corresponds. In other words, Derrida tries to maintain the critique of utilitarianism which Bataille argues for, whilst also proclaiming the impossibility of a truly excessive economy. In this regard, Derrida argues that it is only possible to speak of one economy (of one discourse); it is senseless to postulate two different types of economy, one restricted and the other excessive or general. When we speak of a general economy, it is not an economy separate from a restricted economy. Rather, it is a single economy which is open to both random chance events and predictability. It allows for the possibility of destruction, but is also robust enough to deal with the play of forces originating from inside the system or from the system's relationship with its environment.[51] In other words, through employing a double-logic, Derrida seeks to draw our attention to a notion of economy that is both conservative and excessive. Derrida[51] argues as follows in his reading of Bataille:

> *It is not a question of subordinating the slidings and differences of discourse, the play of syntax, to the entirety of an anticipated discourse. On the contrary. If the play of difference is indispensable for the correct reading of the general economy's concepts, and if each notion must be reinscribed within the law of its own sliding and must be related to the sovereign operation, one must not make of these requirements the subordinate moment of a structure.*

Hence, we must deal with the excess of meaning by finding a balance between two strategies. Firstly, we cannot exclude the excesses as if they exist in some mysterious, unknowable form, 'outside' of our understanding of the world; as if — in Derrida's words — they exist in their own context. The inaccessible, the unknowable, in this regard, is not some mystical force outside of restricted economies that guides their interactions. In this regard, Derrida[58] writes:

> *This unnameable is not an ineffable Being which no name could approach: God, for example. This unnameable is the play which makes possible nominal effects, the relatively unitary and atomic structures that are called names, the chains of substitutions of names in which, for example, the nominal effect différance is itself enmeshed, carried off, reinscribed, just as a false entry or a false exit is still part of the game, a function of the system.*

Yet, secondly, we also cannot assume that we can master this excess. We cannot comprehensively capture meaning. The excess will always remain, and it is neither mystical nor simply that which we have as yet to master. The general economy draws attention to the fact that this excess is always a by-product of reason. We cannot escape excess; rather, it must exist for there to be meaning.

Edgar Morin: Restricted and general complexity

The discussion on Derrida's understanding of economy sheds some light on what it means to think of complexity as a systemic property, which serves to frustrate both a clear ontological understanding of the world and a clear epistemological understanding of the models that we employ to understand our world. However, the implications of this argument become clearer if we consider Edgar Morin's distinction (following Bataille) between two notions of complexity, namely 'restricted complexity' and 'general complexity'[6]. These two paradigms of complexity constitute a conceptual classification (or typology) based on different responses to complex phenomena. In the restricted paradigm, complexity is treated as a problem that can be overcome (complex problems are understood as complicated problems); whereas in the general paradigm, complexity is treated

as an ontological fact, which holds certain epistemological and cognitive implications for the manner in which we deal with complexity.

Although the traditional approach to science is referred to in order to describe restricted complexity, it is certainly not our claim that all scientific approaches to complexity necessarily correspond to the restricted paradigm, or that all philosophical engagements with complexity are necessarily based on the general paradigm. Rather, in drawing attention to these two paradigms, we — following Roberto Poli[59] — wish to argue that the difference between them constitutes a difference in type, and not of degree. This difference 'is based on two different ways of understanding complex systems, namely through decomposition into smaller parts [i.e. reductionism] and through functional analysis.[59] Taking note of this difference is important, since complicated or restricted problems are often confused with complex or general problems, which, in practice, means that our solutions are inadequate. This is because complicated problems can be solved, whereas complex problems cannot — they can only be transformed or modified. It is furthermore important to take note of this argument, given the fact that 'complex systems are the generic, normal case, while complicated systems are highly distinctive, special, and therefore rare.[59] Below follows a more detailed account of these two paradigms:

Restricted complexity

As with Bataille's concern with restricted economies of analysis, Morin[33] argues that classical science deals with the problem of complexity by means of rejecting complexity from the field of science. In this paradigm, it is believed that we can reduce the world to a set of fundamental laws or algorithms, and that the only imposition to generating and accessing these rules is either technology or the limited human mind. That is, classical science aims to reduce complexity to a level at which the unique problems that we face when dealing with complex systems are not taken into consideration.

According to Morin,[33] this rejection of complexity is achieved at the hand of three explanatory principles. The first of these principles is determinism, which implies that all future and past events must be known within the present state of a system. The principle of determinism states that a complex system rests on a neat, linear, historical trajectory; and, on the basis of its current state, we can trace, as well as predict, the present and future states of the system.[60] The second explanatory principle adopted is that of reduction. Reductionism is the assumption that we can know 'any composite from only the knowledge of its basic constituting elements'.[33] The reductionist argument states that a system consists simply of the sum of its parts and that the higher interactions in a system can be easily reduced to a set of lower interactions. Finally, classical science argues for the explanatory principle of disjunction, which 'consists in isolating and separating cognitive difficulties from one another, leading to the separation between disciplines, which have become hermetic from each other'.[33]

All three explanatory principles of classical science are predicated upon the idea that a scientist can objectively and comprehensively know what is essential to the functioning and survival of a system; and can thereby reduce, divide, and allocate the separate parts for study. Hence, the central complexity insight, i.e. that complex systems do not exist independently from their constituent parts, is dismissed in this approach. Due to this, Morin argues that in the restricted complexity approach one still 'avoids the fundamental problem of complexity. To some extent, one recognises complexity, but by decomplexifying it'[33], which is to say that the restricted approach to complexity does not deal with complex problems. It denies the nature of complex problems by treating them as complicated problems.

Poli[59] argues that the popularity of this paradigm is based on the view that '"physics is the queen of science"'.[59] Although the restricted paradigm is often the correct approach when it comes to physics (since many of the problems in physics are highly specific and, hence, complicated), Poli argues that a problem arises when this approach is extended to the other sciences (i.e. biology and all the human and social sciences). These latter sciences are based on different assumptions, and operate under more general constraints. For this reason, they should also be based on a different paradigm, which conceives of the modelling relation differently. In this regard, a much more suited paradigm is that of general complexity.

General complexity

The general approach to complexity holds that, as much as we try, the world is too complex, and systems are too contingent to reduce them to defining laws. Rather than shying away from the problem of complexity by aiming to restrict and reduce the field of this problematic in order to cater for the demands of an elusive universal truth, general complexity theorists confront the problem of complexity, whilst keeping in mind the need to model – even if such models are always only constructed from a limited vantage point. The strategy of general complexity is to recognise, and to work with, the dilemma of reductionism. In this regard, general complexity theorists support weak reductionism, whereby it is argued that despite the necessity of reducing complexity through modelling in order to generate meaning, such reductions will never be complete or accurately portray the phenomena under question. With regard to the general approach to complexity, Morin[32] writes:

In opposition to reduction, complexity requires that one tries to comprehend the relations between the whole and the parts. 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.

Hence, general complexity points towards a new epistemology of complex systems that examines the relationships between the parts, as well as the parts themselves. Strong reductionism — i.e. the view that it is possible to reduce the world to a fundamental set of principles — thus ceases to be viable in this approach, as the focus of analysis shifts away from the parts to the contingent and context-dependent sets of relationships between the parts as determined by the functions or activities exerted by the system.[59] Yet, the system's function is dependent on a context that cannot be totally mastered, which means that every observation or model is limited and partial. This denies us the possibility of employing simple and universal models when describing complex phenomena. The best we have are models that are useful, but provisional.

Another difference between restricted complexity and general complexity, which follows from the above argument, is that general complexity requires self-conscious modelling. Whereas restricted complexity theorists work with the assumption that their models are comprehensive and complete, general complexity theorists are forced to reflect critically on the very assumptions that render their models intelligible. Morin proposes that general complexity theorists use models in a restricted manner, but also acknowledge that these models are simple renditions of a world defined by heterogeneity. We necessarily exclude when we model, but these exclusions continue to impact on both our models and on the systems in which these models function.

Thus, similar to the manner in which Derrida argues for the space of the general economy within the restricted economy, Morin seeks to draw our attention to the status of our models, as products of both the assumptions and the exclusions that we make when trying to understand complex phenomena. Both thinkers thus agree that, in order to understand complex phenomena, it is important to employ, and be aware of, this double-logic. Since, as previously mentioned, complex — rather than complicated — systems are the norm, it is useful to explore the consequences that an engagement with complex systems holds in more detail.

Complex phenomena and the logic of *différance*

As argued above, the complexity approach necessitates a shift in focus from material components (i.e. a structural analysis) to the dynamic interaction and organisation of systemic components (i.e. a functional analysis).[61,1,59] This shift also challenges traditional notions of causality and methodology, as the characteristics of complex phenomena — including the notions of *self-organisation*, *non-linearity* and *emergence* — point to the fact that there can be no centralised point of control or original organising principle that can be traced as the single locus of control or mechanism that explains the existence of complex phenomena. Rather, instead of an original cause, there are numerous different and simultaneous causes that interact dynamically and that lead to the emergence of complex phenomena. This process of self-organisation also demonstrates the fact that in a complex system, 'each part/process is at once cause and effect, a means and an end'.[62] To elaborate: complex systems are 'self-referential, every part owes its existence/explanation to the organization of the remaining parts' and a remarkable feature of complex (and especially living) systems is that 'their parts interact, modify and create themselves so as to realize an autonomous self-fabricated, self-organized whole'.[62]

This loss of central and linear control, and the implications that it holds for causality in the organisational process of complex systems, is reminiscent of the notion of 'decentred structure' employed by de Saussure[63] and Levi-Strauss[64] in structuralism. The structuralists challenge traditional theories of representation that assume a necessary relationship between the symbols or words that we use to create meaning, and the corresponding objects in the world. De Saussure,[63] in particular, argues that the meaning of a given signifier is determined on the basis of its position within the linguistic system, and not because it is endowed with positive content that is represented in the mind. All we have, in other words, is a dynamic system of differences, where every event or every speech act is itself made possible by prior structures.[65] Yet, despite this important insight into the nature and functioning of language, Cilliers[39] suggests that structuralists still endorse a view 'similar to approaches in restricted complexity, they believed that if you worked hard enough, you could uncover the structure of the system, and thus 'get it right'.[7]

In contrast to the structuralist viewpoint, deconstruction (as an example of a post-structural position) radicalises this de-centeredness of meaning or organisation, and further suggests that 'the(se) structures of differences can never be determined and, therefore, that meaning can never be completed'.[66] Hence, the poststructuralist view of organisation is a further development or radicalisation of the structuralist view of de Saussure and conceives of organisation (or meaning) as 'never present in the sign; meaning is always dispersed within the totality of signs and generated by a totality of unstated tactics.[66] For Cilliers,[39] the logic of post-structuralism, and in particular the movement of deconstruction, expresses the organisation of general complexity very well:

The very structures which make meaning possible introduce distortion in the system of relationships. These structures, sometimes called hierarchies, can therefore not be final, but are in constant transformation, both through external intervention and by their own dynamics. This process is what is often called 'deconstruction' — a term which has nothing to do with destruction.

And:

> *A complex system can be seen as a network of dynamic nonlinear relationships. These relationships can be equated with Derrida's notion of traces. The dynamics of the system is a result of all the interactions in the system, but since this interaction also consists of multiple simultaneous nonlinear feedback, with a constant flow of energy through it, it operates in a state far from equilibrium. This perpetual activity is in effect a form of différance. This notion is extremely useful to describe the way in which the emergent properties of the system can manifest themselves, yet be in constant transformation.*[39]

Différance, defined as 'the systematic play of differences', not only refers to the spacing of difference, but also to the necessity of spacing, as the means by which elements are related to one another (spacing as difference). Whereas the 'spacing of difference' is a passive spacing, 'spacing as difference' constitutes an active movement in time.[67] *Différance* is, therefore, both a spatial and a temporal concept, where the meaning of an element constantly differs (*differ)* from the meaning of other elements, but where meaning and identity are also constantly deferred (*différer*). This means that identity is constituted by relational difference (de Saussure's insight), but also that — *because* identity is constituted by difference — an element's 'own' constitution as an autonomous or fully complete entity' is always deferred (27). Derrida[58] writes that '[i]t is because of *différance* that the movement of signification is possible', which means that *'[d]ifférance* [like play] is neither a word nor a concept',[68] but rather the condition of possibility for conceptuality and concepts as such.[69]

Différance also establishes the relationship between a restricted and a general economy, precisely because it is 'not preceded by the originary and indivisible unity of present possibility'. Indeed, Derrida[70] goes on to argue that *différance* 'is the economical concept, and since there is no economy without différance, it is the most general structure of economy, given that one understands by economy something other than the classical economy of metaphysics, or the classical metaphysics of economy.' The temporal nature of *différance* (to defer), implies that what is noise or excess today may be central to our understanding of the system tomorrow, as we gain new means of interpretation or new understandings of the system. In this light, there can only be provisional discriminators between noise and structure, or excess and order. Furthermore, because the inside and the outside of the system are a product of the boundaries that we draw of the system rather than something essential to the system itself,[71,72,73] the notions of difference (i.e. discrimination within the system) and heterogeneity (i.e. noise from the vantage point of the system) cannot be neatly distinguished from each other, as it is often the heterogeneity of the context that defines which differences will be acknowledged within the model.

What makes it possible to model systems is the fact that *différance* remains undecided between activity and passivity.[28,58] 'Pockets of stability' make it possible to provisionally model a system. However, it must always be remembered that any model is contingent upon the context under which it is established.[28] If we grant this context-dependent nature of models, then we must also realise that models have to be reinterpreted and critically re-evaluated in each new context in which they are deployed. The process of *différance* thus creates the possibility for the deployment of a restricted economy in our creation of models, whilst simultaneously precluding the finality of such a restriction. In other words, *différance* allows for both a positive dimension (i.e. it makes models possible) and a negative dimension (these models can never be comprehensive nor complete).

The above point can also be reformulated in the language of complexity: since the study of complex phenomena entails the study of emergent properties of elements that constitute the system through self-organisation, causes can become effects and *vice versa*. This again affirms the view that our models are distorted, but in this case, it is not because of our limited knowledge (which also causes distortions), but because of the fact that models are static representations of a necessarily fluid reality. As such, our methodologies and ways of thinking about the world must be guided by thought strategies that can function 'with and in uncertainty'.[34]

Consequences: Thinking complexity and critique together

In the preceding analysis, we argued for a critical approach to complexity, which is premised on the view that most systems are, by nature, complex. This view of complex systems, in turn, holds epistemological consequences for how we think about, and model, these systems (i.e. for how we create meaning), since we cannot understand complexity in all its complexity.

The central challenge to modelling is thus due to the imbrication of the ontological attributes of complex systems and the epistemological strategies that we use in order to understand them. This challenge is partly the result of the loss of a fixed reference point or meta-position against which we can measure our models. Models are always partial and distorted representations of the system under study, through virtue of two reasons. Firstly, complexity cannot be reduced or modelled without omitting certain aspects of the system under study; and, secondly, models are static renditions of fluid reality, which is defined by the workings of *différance*. The loss of reference is therefore not only due to the fact that we do not have access to an objective, simple reality (which would make complexity merely an epistemological problem), but because such a simple or objective reality does not exist due to the absence of a centre or origin (which also means that there is no central organising principle in a complex system).

Although we still appeal to utilitarian criteria, the loss of reference implies that the excesses generated by complexity necessarily

frustrate any utilitarian calculus. In other words, we are forced to engage with not only the restricted, but also the general aspects of any economy of meaning (although these general aspects cannot be fully understood). Admittedly there are some systems (or sub-economies) that can be treated in a utilitarian fashion (or according to the paradigm of restricted complexity) due to their complicated nature. However, most systems are complex; as such, it is important to understand the dynamics of complexity as these dynamics need to be taken into account when generating models, and hence meaning.

The view of complexity forwarded in this paper is premised on self-critical thought strategies. Yet this does not mean that the critical disposition is negative. It is true that critical complexity theorists cannot claim the same level of assertiveness or confidence in their theories and solutions that those working within the restricted paradigm can. However, this does not mean that knowledge production is a relativist or vague exercise or that critical complexity merely acts as a critical corrective to other strategies, even though this is often viewed as the case. Critical complexity is concerned with the limits of knowledge and questions concerning the conditions for generating knowledge claims about complex phenomena.[30,31,34,74] As such, these positions highlight our inadequacy to know 'complexity in all its complexity', which creates an opening for critique to come alive. Moreover, such an acknowledgement also necessitates that we grapple with the 'unavoidability of the limitations of human understanding'.[75] This linking of the notion of complexity to critique further recalls Kristeva's[76] attempt to classify the emerging field of cybernetics, especially Wiener's research on models, as a resource for developing a 'science of critique' that could be extended to mean a 'critique of science'; and, in particular, a critique of scientists' efforts to pacify an unruly world with simple and all-encompassing models.

The critical stance that informs the general approach to complexity also characterises the post-structural approach to philosophy, and again affirms the view that complexity theory shares some basic concerns with the critical philosophical tradition. The critical imperative that can be located in a philosophical interpretation of complexity exposes the limitations of totalising theories (or master narratives) and subsequently calls for a modest attitude with regard to knowledge generation. The modest attitude prompts us to remain distrustful and self-critical, and thereby to avoid a happy complacency with regard to our theories and scientific accomplishments, and to instead seek out creative alternatives that may challenge the fundamental assumptions underlying any system of thought. This attitude is a response to the insight that our knowledge of complex phenomena is always incomplete and that we can never arrive at a point where we have learnt all that there is to know.[31] As such, it fosters continual learning and an open-ended scientific approach, in which knowledge of complex phenomena is framed as provisional.[31] Critical complexity exposes the limit of the 'epistemological field'[77] and offers a form of critique on the course of 'doing science as usual'.

Implicit in the above argument is the acknowledgement of the normative dimension of critical complexity. In speaking of modest positions, which are also critical positions, Cilliers[35] writes the following:

What is at stake, however, is not an *apology* for modesty, but an argument for the *importance* of modesty. My central claim will be that the failure to acknowledge the complexity of a certain situation is not merely a *technical* error, it is an *ethical* one. The argument is thus not for a *weak* position, but for a *responsible* one.

Rather than referring to a system that dictates right action, the ethics of complexity draws attention to the constitutive nature of knowledge that is inherent to any deep engagement with complex phenomena.[78] Normativity is necessarily introduced into modelling. It is the outcome of recognising that our models do not correspond with an objective reality, but are instead the product of judgement calls, convenience, and the tools that we use when modelling our realities. Normativity is thus intricately bound to the act of interpretation, and implies an awareness of both the nature and limitations of interpretation. It is the challenge posed by the imbrication of the ontological and epistemological dimensions of complexity that introduces a normative dimension when engaging with complex phenomena, and that undergirds the critical mindset. Furthermore, given the loss of a reference point, ethics becomes a processural rather than a merely substantive concern. The logic that informs the ethics of complexity is similar to that of deconstruction, which Wood[79] describes as 'a recursive modality' that functions in service of 'an always renewable openness'. Therefore, it is the ethics of complexity that commits us to the critical imperative, and that serves as the justification for the critical enterprise.

Ultimately, the notion of critical complexity offers the possibility to change how we situate and orient ourselves in the world, and how we can think and act differently in the world. There is a restorative quality hidden in critical complexity, which discerns it from other (mostly restricted) interpretations of complexity on the one hand and other philosophical positions (pragmatism and hermeneutics) on the other. Critical complexity advocates a relentless awareness and openness to the excesses of meaning, which protects us from an attitude of resignation.

Hence, the uniqueness of critical complexity is situated, in the first place, in how this understanding of complexity marks a difference to other interpretations of complexity. It signals the convergence of critique, normativity, and complexity as expressed in the general economy of the double bind. It institutes the conjunction of complexity and/as critique. This conjunction inscribes a critical-emancipatory impetus into the complexity approach which is missing in other theories of complexity. To be sure, the recognition of complexity constitutes both a critique of our framing strategies and epistemological allegiance and offers a tool (a mode of critical practice) with which different knowledge generating strategies or interventions can be explored.

Conclusion

The arguments presented in this article were aimed at bringing a general, critical approach to complexity into conversation with philosophical discourse, specifically the tradition of post-structuralism so as to highlight the common areas of interest between these paradigms, and, thereby, to draw attention to the philosophical nature of complexity (defined primarily in terms of normativity and critique). Post-structural (especially Derridean) ideas were presented in order to highlight this critical, normative dimension of complexity. However, it must also be noted that, although critical complexity and Derridean philosophy share a similar spirit, Derrida never explicitly worked with the notion of complexity (even though he was implicitly sensitive to complexity). Our point is not to equate Derridean philosophy with critical complexity, but to show how a serious engagement with complexity necessitates the type of epistemological, cognitive, and paradigmatic shifts that characterise the moves from modernism to postmodernism and from structuralism to post-structuralism. Morin[34] writes that '[w]hat affects a paradigm, that is, the vault key of a whole system of thought, affects the ontology, the methodology, the epistemology, the logic, and by consequence, the practices, the society, and the politics.' In exploring the general, critical view of complexity in detail, we hope to have introduced the reader to some of the implications that emerge from a serious engagement with complexity.

Footnotes

[1] Part of the argument we make below for 'general' or 'critical' complexity is that it assists us in dealing with this bind.

[2] It is to be noted that the impossible division between subject and object does not imply a radical constructivism that denies the existence of an independent object. Rather, a more nuanced distinction is proposed in the paradigm of complexity, wherein one both 'supposes the world and recognises the subject,' but simultaneously 'positions one and the other in a reciprocal and inseparable way'.[34] In other words, subject and object are both constituted relationally and are thus structurally linked. Morin[34] argues that this view can best be described by the notion 'co-constructivist', which means that 'we construct our perception of the world, but with the help of the world which, as it were, lends us a hand.'

[3] There are several interpretations of the term 'postmodern'. Cilliers,[31] Woermann[29] and Hermanus[46] offer detailed arguments for why a *rigorous* understanding of the notion 'postmodern' does not subscribe to a position that implies a non-reflective justification for relativism or anarchy.

This paper supports a rigorous or sophisticated interpretation of postmodernism, where the goal is to uncover the blind-spots in an overly-confident understanding of modernist rationality. Informing this understanding, is the work of Lyotard[80] in which the 'grand narratives' of modernism are distrusted[81] and wherein there is a self-critical attitude towards the limitations of modernist rationality.[82] The rigorous (or 'radical') interpretation of postmodernism is often marked by its interest in 'otherness,*différance*, the decentering of the subject, in fragments, fissures, in power/knowledge regimes' and is distinguishable from 'older varieties of reactionary anti-modernism' critique;[83] (italicised in original text). However, finding and justifying grounding positions for norms and judgements, and legitimising critical interventions, still remain a challenge — even from the vantage point of this position.[84]

[4] Although the term 'economy', as it is employed here, may share similarities with the financial or political uses of the term, our interest is primarily in its *philosophical* usage. In this reading, the meaning of the term 'economy' rests on a tradition beginning with Hegel, and re-read by Bataille and Derrida. For further discussion of this term in relation to philosophy and complexity, see Human and Cilliers.[88]

[5] We adopt a broader definition of the utilitarianism than is the case in philosophical utilitarianism. In our understanding, utilitarianism includes the belief that comprehensive calculation and complete reduction of the system to its parts is possible. The utility of the system therefore partly sits in its ability to be completely controlled and understood.

[6] For a discussion of restricted and general complexity in relation to the notion of economy, see Human and Cilliers.[88] For a discussion of restricted and general complexity in relation to the notion of critique, see Preiser, Cilliers and Human.[36]

[7] This relates to the assumptions in which a restricted understanding of complexity is grounded. These assumptions claim that complexity can be quantified and calculated. In terms of structuralism, this gives rises to the view that meaning is fixed and operates within a closed system.[39]

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