Revisiting Dynamic Capabilities through the lens of Complexity Theory

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ABSTRACT
This paper facilitates a return to the fundamental underpinnings of dynamic capabilities through the language of complexity theory. This new language enables us to disburden dynamic capabilities from its theoretical heritage and independently discuss recent research challenges in this field of investigation. From our short analysis, we conclude that complexity based investigation may be useful to reframe fundamental discussions and disagreements in the recent dynamic capability literature. This paper investigates the potential to understand dynamic capabilities in future projects with the help of complexity theory.

Key words: Dynamic Capability, Complexity Theory, Competitive Advantage, Fitness Landscapes

INTRODUCTION
Recently, the field of strategic management has shown an increasing interest in organisational dynamics (Teece et al. 1997; Chen, 1996; Livengood and Reger, 2010; Farjoun, 2010). One salient construct is an organisational change perspective on capabilities, so-called dynamic capabilities (Teece et al, 1997; Eisenhardt and Martin, 2000; Zollo and Winter, 2002). Dynamic capabilities combine major perspectives such as micro-economics, the behavioural theory of the firm, evolutionary theory and the resource-based view (Augier and Teece, 2009). Dynamic capabilities not only have the potential of integrating former research findings, but coming several steps closer the answer of the ultimate question in strategic management research of how to gain competitive advantage over rivals and over time (Peteraf and Helfat, 2009). This interdisciplinary history has raised serious criticism about the validity and boundaries of the construct (Schreyögg and Kliesch-Eberl, 2007; Arend and Bromiley, 2009).

This paper discusses the essence of dynamic capabilities through the lens of Complexity Theory. We contribute to the field of dynamic capabilities in several ways with this undertaking. First, dissolving dynamic capabilities metaphorically from its theoretical heritage, we can discuss the central features of the construct without the theoretical and conceptual burdens currently plaguing the concept. This approach allows a discussion of the core of dynamic capabilities and helps us to identify the central features which are not tied to the language of preceding theories. It also helps identify future directions this research stream may take. Second, neutral language helps to ignore the rhetorical
hurly-burly around the construct of dynamic capabilities. A clear and less ambiguous use of language reduces sources of confusion and may result in agreement and focused discussion on pestering questions around dynamic capabilities.

A REVIEW ON THE CONCEPT OF DYNAMIC CAPABILITIES

Driven by recent urge to explore the area of dynamics in increasingly global and rapidly changing environments, and new forms of communications through information technologies, the concept of dynamic capabilities was developed to tackle the area of dynamics in a more integrative way. Recent definitions of the concept of dynamic capabilities all include elements from Helfat et al. (2007). They define dynamic capabilities as the “capacity of an organisation to purposefully create, extend, or modify its resource base”. Nevertheless, this definition contains some vague elements that need further discussion and investigation (e.g. Zahra et al., 2006; Wang and Ahmed, 2007, Danneels, 2008). In particular, recent papers have revealed a need for further investigations in the following areas (Barreto, 2010):

Nature: Recent research has used several notions to classify dynamic capabilities. They have been associated with capacities, capabilities, routines, processes, problem-solving, monitoring and orientation. Some authors doubt that the concept of a capability is suitable for the idea of what dynamic capabilities shall represent. There is considerable discussion about their stability as a routine-based concept, about the frequency and direction of patterns and whether dynamic capabilities are empirically identifiable. The interrelations between operational routines and between capability hierarchies are unclear. Further discussions highlight the role of locus of change and components of dynamic capabilities.

Effects of dynamic capabilities: There is a great deal of discussion about the effects of dynamic capabilities. In particular, the relationships around the key constructs are handled in different ways. Most urgent is a clarification of the relationship between dynamic capabilities and performance. Two
differing perspectives seem to be promising. First, the assessment of a direct, but mediated relationship between dynamic capabilities and performance depending on contextual contingencies. Second, moderated and intermediate relationships of aggregated or latent constructs as a result of reconfigurations that influence performance outcomes.

**Mechanisms:** Earlier studies have identified four mechanisms that direct the development of dynamic capabilities. (1) Dynamic capabilities are strongly associated with the balance of exploitative and explorative learning. Learning enables change and strengthens capabilities. (2) Complementarities refer not only to the core products or technologies, but account for the need of add-ons. This mechanism reflects a purchaser perspective. The purchaser has an interest on functionality rather than the product in itself. (3) Coordination is about anticipation and synchronisation of actions. Coordination may be time, location and context dependent. (4) Human agency includes bounded rationality and limitations in information processing. Humans underlie biases that are inherent part of their actions and have significant influence on process outcomes. Part of the interrelation of mechanisms are topics of orientation and identity that have a high influence on learning and the effectiveness of feedback loops (Livengood & Reger, 2010; Agarwal & Selen, 2009). Inherent to these mechanisms is the question of how ideas are put into practice. This includes the “storage” of ideas, since ideas are likely to be forgotten when actors do not follow up on them. These four mechanisms reflect the multidimensionality of the concept of dynamic capabilities; which is partly responsible for some of the criticism which suggests that the conceptual basis of dynamic capabilities has become intraceable. Lavie (2006) suggests three mechanisms dynamic capabilities use to alter the resource base. (a) Substitution is the replacement of existing routines. (b) Transformation is the combination, integration or reconfiguration of existing routines and (c) evolution describes the purposeful development of existing routines. While research has paid attention to each of the mechanisms, there is no coherent framework on the effects of dynamic capabilities and a limited understanding about each of these mechanisms.
**Processes:** Dynamic capabilities have been introduced to better capture the process aspect of capabilities. However, discussions have been couched on an aggregated level, while ignoring the process aspect. Psychological and sociocultural factors play a major role for the building and maintenance of dynamic capabilities, but have hardly been the focus of investigations in this area. The research on micro-foundations of the process aspects would be a promising starting point for developing a better understanding of limitations and the degree of freedom a dynamic capability allows. Paths shape current processes. The dynamics of these paths have been insufficiently explored by Sydow et al. (2009).

**Boundaries:** Designed as an all-inclusive construct of organisational change, dynamic capabilities lack clear boundaries. In particular, two questions have raised the concern of recent studies. First, environmental contingencies have partly been highlighted as central to the construct. Other authors ignore the environment as a relevant factor for research on dynamic capabilities. Second, the types of firms that need dynamic capabilities has been subject to debate. Teece (2009) argues that dynamic capabilities are especially interesting for multinational corporations. Zahra et al. (2006) highlights the implications for small and entrepreneurial firms. The disagreement within these debates on boundary conditions for the concept of dynamic capabilities also reflects the divergence in the literature concerning the effects of dynamic capabilities on performance.

**Outcomes:** Early studies trace dynamic capabilities by superior performance outcomes. This straight causality has been identified as tautological. Organisations that lack dynamic capabilities will not succeed in times of transition and will consequently die. In this sense, dynamic capability have been identified as the core of organisational success in modern and global economies. Their long-term outcomes are a better strategic fit than rivals lacking these capabilities and are consequently improved and better performance outcomes. Zollo and Winter (2002) warn that wrongly identified cause and effect relationships may lead to ineffective resource configurations. A change of performance outcomes should not be mixed with performance improvement. Dynamic capabilities do not only
involve costs for their building and maintenance, they also have to be seen under the perspective of opportunity costs against other change mechanisms such as ad-hoc problem solving (Makadok, 2001).

**COMPLEXITY THEORY IN ORGANISATION STUDIES**

Complexity Theory has a rich theoretical history with the natural sciences; particularly in the areas of biology, chemistry, mathematics and physics. Commenting on Complexity as a body of theory, Mitleton-Kelly suggests that while there is no universal definition, the ‘theories of Complexity provide a conceptual framework, a way of thinking and a way of seeing the world’. (2001:3)

In this paper, Complexity Theory is defined as a paradigmatic framework that allows us to account for human behaviour within a relational world, understood as being self-organising, dynamic and emergent (Mitleton-Kelly 2001; Gould 2009; and Kuhn 2009). This is a shorthand description which speaks to the ways in which systems energetically adapt (dynamism) resulting in previously unseen (emergent) forms. Such adaptations occur in an environment which is also in a constant state of flux. Here we begin to see the different scales (or what you’ll come to know as fractals) in which Complexity operates.

Complexity theory as paradigm is useful in exploring interaction within ‘human experiential space’ (Kuhn and Woog 2007). Such space is characterised as chaotic (unpredictable but understandable with hindsight), multidimensional (constructed through multiple and interrelated connections), non-linear (experience interacts with time) and is organised around attractors. Human agency is an important, but underexplored area in dynamic capability research. While dynamic capabilities recognise a limited capacity to change, it is not clear how the process of change works from the micro-level. Complexity can add to understand the mechanisms of self-organisation under a limited (but across the population varying) capacity to change. Complexity is a suitable tool for that since it assumes constant change which it labels as “dynamic” and the emergence of behaviour on the micro-level without neglecting some kind of effect on the macro-level. It also refers to the inherent
behavioural element of a capability and refers to sensemaking and detailed investigation of the multidimensionality of behaviour. The problem of multidimensionality is tackled by non-linearity between actors reacting to stimuli such as opportunities or threats. This view has several implications. Dynamic capabilities are naturally connected to human agency and sensemaking. As complexity theory tells us, this fact causes a dependence on attractors. In other words, dynamic capabilities are executed only when triggered. This perspective implies questions on the level of these triggers and the recipients of these triggers. A first inquiry in this direction by Agarwal & Selen (2009) do not only show and investigate the complexity of multidimensionality of dynamic capabilities, they also illustrate the existence of triggers on the example of collaboration. There is a debate in the literature on dynamic capabilities about the role of management. Management can act as a trigger, but itself may be the recipient of a trigger. Debates include questions on the degree of change (incremental or radical) and the influence of the management on the capacity to change, as well as the role of the management in orchestrating change. If the management is not fully accountability for the capacity of a firm to change, then research needs to explore where such a capacity is built “behind the back” of the management and what implications this lack of accountability incorporates.

There have been a number of authors whose work suggests that Complexity Theory is best utilised as an analytical tool. Analysis is typically shaped through a set of metaphors commonly used in Complexity informed inquiry (Maguire, 1999; Aram and Noble, 1999; Fotopoulos, 2000; Dent, 2003; Holbrook, 2003; Benvenuto, 2005; Cioffi-Revilla, 2005; Gould, 2009; and Kuhn, 2009). These metaphors allow for the discussion of complex phenomenon without oversimplification.

The metaphors discussed here (sensitivity to initial conditions, attractors, fractals, fitness landscapes and the edge of chaos) are by no means a complete set. Rather, we select them due to limited space in this paper and the wish to use those concepts with highest potential to leverage meaningful discussions on Dynamic Capabilities. These discussions highlight the potential for a future relationship between Dynamic Capabilities and Complexity Theory.
Initial conditions can be conceptualised as any moment of historical importance to the system. Complex systems exhibit great sensitivity to changes in initial conditions. This principle goes by many names, for example the ‘avalanche metaphor’ (Bak, 1996), ‘self-organising criticality’ (Kuhn 2007; and Nunn, 2007) and the common (almost colloquial) ‘Butterfly Effect’ (Dooley, Johnson, and Bush, 1995; and Holbrook 2003). In essence such labels are ‘a compact way of saying that complex systems are nonlinear, inherently unpredictable, and dependent on history’ (Nunn, 2007:99). In dynamic capabilities, it is useful to consider the firm’s resource base as the initial conditions. Through the ‘self-organising criticality’ metaphor, we are able to better explain how dynamic capabilities contribute to a Competitive advantage. For the purposes of analogical example, let us consider the human voice as a resource in communicating a political message. Our first attempt to distribute this message is in the form of a dry lecture. By reconfiguring our use of the resource, we can create a clever satirical song which our audience finds far more engaging. This is a change in our initial conditions. The ability to sing and, as such, the deployment of this resource depends on more factors than only the voice. It depends on its initial quality relative to other voices (in dynamic capability research known as “position”), the training and exercise it has (paths) and the way it is utilised (process). Moreover, position, paths and process depend on contingencies. For example, having a cold diminishes the ability to utilise the voice for singing. In the dynamic capability literature, this phenomenon is known as environmental factors that are contingencies for the execution of dynamic capabilities. On the other hand, a resource (voice) can be used for multiple purposes (singing, speaking, noises etc.). Each use of the resource can have dramatic effects on our ability to communicate. This is somewhat related to the complicated interaction of path and process and the nonlinear implications of changes in one over the other.

Attractors may be understood as the influential force behind the behaviour of complex systems. In simpler terms, attractors are that which attracts. Kuhn (2007) suggests that it is useful to see the sun as an attractor for the planets of the solar system. That is to say, that the planets and their various systems organise themselves around the Sun. In terms of dynamic capabilities, there are two levels of attractors that we need to consider. First (and that which speaks to the fundamental assumptions) is
that dynamically capable firms are organised by ‘competitive advantage’ – this is what drives them to reconfigure. Secondly, we need to consider the role of individuals in situating an organisation in a dynamic environment (chaos).

Fractals describe mathematical patterns in which a scale image is the same as the whole (Mandelbrot, 1977). As a metaphor in organisational studies, fractals allow for the exploration of self-similar (or repeated) patterns of behaviour across different levels of analysis (Kuhn 2009). If dynamic capabilities are considered to be capabilities, it can be logically argued that these constitute repeated patterns of behaviour (Fractals). However, it is not well understood how change can have repeated patterns. Here again, the interrelations, dependence or independence of different levels during change is unexplored. We suggest that a fractal interaction of attractors can be likened to Rothaermel and Hess’ (2007) suggestion that a capacity of change is a combination of the capabilities at the individual, firm and inter-firm level.

Fitness Landscapes is a concept with strong roots in biology and is often used to explain the role of natural selection and adaptation play in evolution. Commenting on landscapes, Kauffman states:

> Adaptation is usually thought of as a process of “hill climbing” through minor variations toward “peaks” of high fitness on a fitness landscape. And natural selection is thought of as “pulling” and adaptation population toward such peaks. We can imagine a mountain range on which populations of organisms are feeling their way to the summits (1995:154).

As a social metaphor, Fitness Landscapes offers an opportunity to explore and understand the self organisation of an organisation around emergent attractors. In terms of Dynamic Capabilities, it encapsulates the need for reconfiguration as a source of competitive advantage. This will be discussed in detail later.
The Edge of Chaos describes a condition where complex entities seem to draw order from chaos. First introduced by Chris Langton as the onset of chaos, the metaphor gained popularity in the social sciences as the Edge of Chaos through the works of Norman Packard in the mid 1980s as a way of describing the chaotic self organisation that leads to innovation (Kaufman 1995; and Kuhn 2007). The edge of chaos is a chaotic and somewhat unstable zone that allows for an emergence of structure and innovation. When the dynamics become too intense, and individuals begin to fear the chaos, the metaphor becomes the chaotic edge (Kuhn, Woog and Hodgson 2003). Here momentum and creativity is lost when individuals begin to see themselves as vulnerable and act accordingly. If we view an organisation as a saucepan of water heating on a stove we may gain a better understanding of the two metaphors. If we turn up the heat on the stove, we see action in the water, the bubbles begin to surface as we approach boiling point. This bubbling stage represents the edge of chaos, a point where the pressure (heat form the stove) is causing the water to act dynamically, if we keep increasing the heat, eventually the water boils and we lose volume as vapour - this is the chaotic edge. Similarly, if we turn the heat down we lose the activity.

The Edge of Chaos speaks directly to the interplay between dynamism and emergence in the landscapes of complex systems. Here we are suggesting the patterns of organisation that result in a competitive advantage are not knowable in a linear sense. Rather, we suggest that the identification of a dynamic capability is contingent on the sense making and self-organisation that occurs in this ‘chaos’.

RESITUATING DYNAMIC CAPABILITIES IN A COMPLEXITY PARADIGM

Two key things this paper has said about DC:

1) Dynamic capabilities are most useful when understood as striving for competitive advantage through reconfiguration of a firm’s resource base. This reconfiguration can either be as a response to, or cause of changes in the environment.
2) Without the ability to change organisations cannot develop or sustain a competitive advantage.

Complexity theory can help this view of the firm by (as we say) dissolving it from its theoretical heritage. In this section of the paper, we draw on the metaphors of complexity to discuss the nature and process of Dynamic Capabilities as well as offer insights into areas for further development.

From the discussions above, we suggest that Dynamic Capabilities can be conceptualised as a firm looking to increase its fitness on a landscape. The behaviours of the firm associated with this concept are considered to be held in place by the ‘competitive advantage attractor’.

Teece et al.’s (1997) triangle of path, position and processes of a firm (borrowed from the theoretical history of DC) suggests that the current position of the firm locates it in its business landscape (a set of initial conditions). The path describes where it comes from and thereby limits future paths. This path could be considered as climbing a peak of fitness. The selection of an adaption strategy (reconfiguration of the resources base) sets the system on a path, progressively climbing the chosen peak. When the firm reaches the peak of its performance it is able to look out across the landscape. Often they will find higher peaks attainable with a different strategy. A firm that is considered ‘dynamically capable’ would then be able to jump from peak to peak. This ‘jump’ is only possible in organisations working at the edge of chaos. We believe that this perspective is a meaningful addition to the explanation suggested by evolutionary theorists who conceptualise dynamic capabilities as constant disequilibria.

The literature surrounding dynamic capabilities suggests that they are the capacity to change as deemed by the principal decision makers (Zahra et al., 2006). It may be useful to consider these decision makers as attractors who have the power and influence to lead the organisation to the edge of chaos in hopes of remerging on a higher peak of fitness. In this chaos, the system is allowed to self-organise (or reconfigure its resource base) into new organisational forms. These forms could be
organised around strange attractors (entirely new situations) or to re-emerge in a previously held patterns.

Contrary to former research approaches, ultimately the question of “what are dynamic capabilities” isn’t considered as important as ‘how do we understand them’. In the language of complexity theory, these capabilities can be broadly painted as a tolerance of chaos and the ability to self-organise around emergent attractors (i.e. an ability to let go of organisational forms so that they can adapt to the new environment). These capabilities can be built through the metaphoric language of complexity which gives us better insight into emergence on the landscape.

**CONCLUDING REMARKS**

This paper started from the assumption that the concept of dynamic capabilities has become somewhat encumbered by its inclusive approach to theorising. Through the language of complexity theory, we have been able to reaffirm the fundamental assumption of dynamic capabilities: that competitive advantage is offered through the rapid reconfiguration (self-organisation) of a firm’s resource base (the initial conditions) in response to emergent market conditions. In the language of complexity, this can be simply stated as the continual search for new peaks of fitness on a landscape.

This interpretation has several implications of how to approach and systematise search which could only be indicated in this short paper. We suggest that a more detailed analysis of the concept of dynamic capabilities through a complexity lens will reveal further clarifications useful for future research. In addition, complexity theory relies on qualitative methods. Dynamic capabilities could greatly benefit from a better accessibility for qualitative research. In our view, recent attempts could not convincingly show that they actually investigate dynamic capabilities and, therefore, have limited impact on developing the concept of dynamic capabilities. Accessibility for empirical methods will to a major part determine the development, usefulness and value of this promising concept.
REFERENCES


