Facilitating learning and innovation in organizations using complexity science principles

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Abstract

Difficulties have been encountered in communicating the meaning and value of complexity science principles to people in organizations. While one school of thought in the literature holds that it is not necessary to attempt to communicate the principles transparently, one set of researchers set out to develop a range of tools and a workshop session to do just this, and called it ‘The Complexity Starter Kit’. The Complexity Starter Kit features a six-day calendar and ‘water—cooler’ area posters, an exercise class and group sensemaking session, and an online knowledge development tool with group discussion boards. This paper describes the Complexity Starter Kit at high level, proposes its usefulness in the context of innovation, and provides an overview of educational strategies that facilitate learning about complexity science, a consideration of the ways in which these correlate with complexity science, and how this informed the development of the Complexity Starter Kit.

Innovation: The need for learning and complexity science

Rothwell (1994) proposes five generations of models of innovation: the technology push model; the market pull model; the coupling model; the integrated model; and, fifth generation — the systems integration and networking model. These models have been developed and implemented in industry, to greater and lesser degrees, over the course of the last fifty years. While the fifth generation model seeks to incorporate a systems thinking perspective on the processes of innovation, recent recognition of the phenomenon of discontinuous, or disruptive innovation, in addition to new literature from the complexity science domain, suggests that the fifth generation model may be in need of further refinement.

Discontinuous innovation, also referred to as ‘disruptive innovation’, ‘transformational innovation’ or ‘paradigm shift innovation’, is said to deliver major change and creates new value networks that eventually replace traditional mainstream markets with a new value proposition (Moore, 1995). As such, environmental conditions prevalent with this type of innovation are said to be characterized by high competency-destroying turbulence and technical and market uncertainty — in essence, creating a shake up for previously dominant players. Such discontinuity can be brought on by a range of triggers, including, for example, the emergence of new technologies and markets, changes in a political regime or social attitudes and behavior, or, the introduction of new business models such as low cost airlines, for example, Ryanair. Subsequent disruptive innovations require new skills, abilities, and knowledge (Tushman & Anderson, 1986). While continuous innovation could operate within mental frameworks based on clear and accepted rules of the game, discontinuous innovation means there are no clear rules, and that these emerge over time, with a high tendency toward lack of clarity and high ambiguity. While continuous innovation was suited to path-dependent strategies and refined, stable operating routines, discontinuous innovation calls for path-independent strategies based on an emergent, probe and learn approach, where operating patterns are emergent and ‘fuzzy’ (Dvir, et al., 2004).

Theory has sought to address these challenges experienced in practice and one domain offering highly relevant resources is that of complexity science. In their proposition of innovation in manufacturing as an evolutionary complex system, Rose-Anderssen, et al. (2005) demonstrated how a complex systems view could provide an overall conceptual framework for thinking about innovation and for considering how this helps to provide understanding and advice for the organization of new product development in different circumstances. At the project level, Harkema (2003) advocates the use of a complex adaptive perspective on learning within innovation projects and argued in favor of applying a complex adaptive approach to evaluate and analyze learning and innovation processes. In line with this, she suggests that a manager’s perception of reality should acknowledge that reality is not static and linear, but complex, dynamic and nonlinear, and as such unpredictable. Meanwhile, Fonseca (2002) views innovation from the perspective of complex responsive processes of relating and describes innovation in this way as a new patterning of our experiences of being together, as new meaning emerges from ordinary, everyday conversations that take place in the working environment. In this vein, Stacey (2000, 2001, 2003a, 2003b) and Stacey, et al. (2000) have suggested that analogies from the complexity science domain can help us learn about, and make sense of, such experiences.

What has been missing in this regard is a set of tools to help initiate, and begin to facilitate, learning about complexity science in a way that will enable individuals in the context of innovation, or indeed any other context, to understand their work and interactions with others by means of it. While the case has been made that it is of use to apply complexity science to the domain of innovation, no means have been provided to address this issue. This paper, however, presents a set of tools that do.
Experiential learning

For the purposes of this paper, Kolb’s (1973, 1979, 1984) ideas concerning experiential learning and the learning cycle are of relevance and are described here in more detail. Kolb and Fry (1975) presented their applied theory of experiential learning, which Kolb (1984) later elaborated upon, and on which research has been carried out and expanded upon into the fields of business, management and with specific types of application made in organizational contexts (Garvin & Ramsier, 2003; Paul & Mukhopadhyay, 2004; Van Reekum, 2005). In proposing a continual process of learning, Kolb (1979) presented the learning cycle (see adapted representation of this in Figure 1), which is based on the notion that learning is a cyclical process which needs to contain elements of each quadrant of the cycle before learning is possible. This cycle is described in the following way:

“Immediate concrete experience is the basis for observation and reflection. These observations are assimilated into a ‘theory’ from which new implications for action can be deduced. These implications, or hypotheses, then serve as guides in acting to create new experiences” (Kolb 1973: 2).

![Kolb's Learning Cycle](image)

Fig. 1: Kolb’s Learning Cycle

Kolb’s learning cycle became pivotal in many theories tying learning to organizational activities and organizational survival, for example, in terms of arguing in favor of giving employees time to reflect what is going on, and how things could be tackled differently (Easterby—Smith, 1990: 5):

“David Kolb of MIT clearly has a good point when he stresses that learning from experience should be a cyclical process involving a period of Experience followed by a separate period of Reflection. Ideally this should be followed by a chance to put all the different pieces of the puzzle together (Conceptualizing) and possibly a reasonably risk—free opportunity to test out this new understanding through Experimentation. That should lead to further Experience, and so on.”

How this has been integrated in organizational practice and applications can be seen particularly in the literature pertaining to organizational learning, the learning organization, and the learning company.

Organizational learning, the learning organization, and the learning company

Experiential learning was a major inspiration to Argyris and Schön (1978), Revans (1982) and Garrat (1987), who were early proponents of organizational learning and the learning organization, as were Senge (1990), Easterby-Smith (1990), and Pedler, et al. (1991). Pedler, et al. (1991) talked about the idea of the learning company, which they defined as “an organization that facilitates the learning of all its members and continuously transforms itself.” The aim of this endeavor was to:
The choice of the term ‘learning company’, as opposed to ‘learning organization’ was grounded in the preference of the authors, who felt that while the word ‘organization’ had connotations of an abstract and lifeless mechanism, the word ‘company’ on the other hand conveyed the idea of a group of people engaged in a joint enterprise, “in everyday terms we ‘accompany’ others and talk of doing things ‘in company’”. So we use the word ‘company’ for any collective endeavor and not to identify or give preference to a particular legal form or ownership pattern” (Pedler, et al., 1991: 1). This conception of the learning company was, therefore, more heavily grounded in the importance of the people who were the members of the learning company. These people could include, for example, employees, owners, customers, suppliers, neighbors, the environment and even competitors. In order for a company to realize itself as a learning company, Pedler, et al. advocated a radical transformation in the form and character of what was already there, and said that this change could be facilitated through the deployment of the right tools, for example, through: an electronic learning net – a company intranet with open access to data and the facilitation of group discussion; self and peer assessment; personal development plans; story-telling; and, self-development groups (Pedler, et al. provide 101 such tools).

The focus of such tools was sharpened when Easterby-Smith (1990) presented advice to help facilitate organizational learning, which included learning about organizational learning, promoting experimentation, and regulating awareness. Easterby-Smith advocated that people become aware of the learning process by starting with their own learning experiences, by reflecting on past experiences. The examples and the reasons why these people think they have managed to learn in the past should then become the focus of discussion. Making the link and transferring this to organizational learning was then to be done by providing illustrations from their own experiences of organizations learning or failing to learn from their mistakes, either from the present or a past organizations in which people have worked. Easterby-Smith also advocated flexibility in the organizational structure and the need to introduce necessary slack into the organization so that people could have time to reflect on what was going on, and how things might be tackled differently. Easterby-Smith suggested that an obsession on the part of the organization with activity and the need to keep the product coming out at the other end was one of the biggest hindrances to organizational learning, and thus the need to refer back to Kolb’s cycle of learning, which advocated steps of action, reflection, conceptualization and experimentation, (Easterby-Smith, 1990).

In this context, the use of narrative has been recognized as a facilitative learning tool that bridges reflection and performance (Ramsey, 2005). However, individuals have different learning styles, and therefore the methods and means by which they learn best will depend largely on factors relating to learning styles and preferences. In terms of individual learning styles, Boyle (2005) draws on the learning styles theory literature and describes the perceptual, physiological, sociological, psychological, environmental, and emotional elements and preferences of learning that differ from person to person. Perceptual elements, he explains, affect the way we learn and retain information, and this category includes six main learning styles: auditory; visual picture; visual text; tactile; kinesthetic; and, verbal (internal) kinesthetic. Boyle argues that individuals have personal preferences or strengths in at least one of these styles of learning, but that this differs from person to person. These styles and their implications for learning are represented in Figure 2.

![Boyle's six perceptual elements diagram](image.jpg)

**Fig. 2: Boyle’s (2005) six perceptual elements, affecting the way we learn and retain information**

Boyle’s (2005) sociological elements category impacts on learning styles through how we interact with others and our preferences for learning with others. These include:

- Avoid sudden and massive restructurings.
- Design and create organizations which are capable of adapting, changing, developing and transforming themselves in response to the needs, wishes and aspirations of people, inside and outside; enable companies to realize their assets without predatory takeovers; flex without hiring new leaders, and;
The psychological elements refer to how people differ in the ways they absorb information, either in terms of being global or analytic processors, and impulsive or reflective processors. While an analytic processor learns facts sequentially, with one fact following another, a global processor requires a big picture first and real life application. Some, says Boyle, are combinations of the two. And, he adds, an impulsive processor is likely to shout out an answer before others get a chance, while a reflective processor needs time to think about their answer before providing one. These learning styles and preferences need, therefore, to be considered when designing and implementing any learning programme and accompanying tools and methods.

The learning strategies, styles, and preferences, outlined above were all taken into consideration and found to correspond with various aspects of complexity science, as suggested below.

Complexity science

In the context of dominant schools of thought in the complexity science domain, on the one hand, Stacey (2003a, 2003b) and Griffin (2002), approach complexity science critically, and with a keen interest in the implications it brings to bear on humans, their interactions, and what emerges from them through self-organization. On the other hand, Weick’s (2001) perspective is more solutions orientated, and his interest in complexity is one that encourages flexible thinking by management in the face of impending disaster. Olson & Eoyang (2001) propose an interesting combination of the above. Their work, as with that of others (Eoyang & Berkas, 1999; Harkema, 2003; Axelrod & Cohen, 1999; Fuller & Moran, 2001; Fleming & Sorenson, 2001; Dooley, 1996; Morel & Ramanujam, 1999), is based on the direct application of complexity science-based thinking to the organizational domain — specifically, in terms of complex adaptive systems (CAS). All three views can be seen to be enhanced if put in the context of Kolb’s learning cycle and related to a person’s ongoing experience within the context of the organization.

The theory of complex adaptive systems (CAS) originated in the natural sciences and articulates how interacting agents in systems adapt and coevolve over time, and who, through their interactions, produce novel and emergent order (see Figure 3, below) in creative and spontaneous ways. Latterly, academics and practitioners in the domain of organizational science have applied principles of complexity science to the way both organizations and the people in them interact and operate (Beinhocker, 1998, 2001; Horgan, 1995; Pascale, 2001; Plexus, 1998; Santosus, 1998). In this way, implications for organizational strategy, for example, correlate closely with what Mintzberg, et al. (1998) refer to as the ‘learning school’, where strategy formation is acknowledged to take place as an emergent process, and the ‘cultural school’, where strategy formation is seen as a collective process. This coheres tangibly with Pedler, et al.’s (1991) definition of the learning company, outlined above, and therefore suggests the potential involvement of anyone and everyone involved in the process of conducting and interacting with business.

CAS is presently the most commonly accepted view of complexity science, pervading the literature and practice, and is most likely the understanding Weick (2001) — mentioned above — has rested his theorizing upon. According to Olson and Eoyang (2001), a complex adaptive system (CAS) behaves or evolves according to three key principles:

1. Order is emergent as opposed to hierarchical;
2. The system’s history is irreversible, and;
3. The system’s future is often unpredictable.
The agents within the complex adaptive system are thought to behave according to simple rules in their local, and random, interactions with one another, and power is decentralized (Johnson, 2001). In line with this, Stacey describes complex adaptive systems in the following way:

“A complex adaptive system consists of a large number of agents, each of which behaves according to some set of rules. These rules require the agents to adjust their behavior to that of other agents. In other words, agents interact with, and adapt to, each other” (2003a: 237).

In the context of learning about complexity science in general and about the potential of decentralization as a key lesson from the metaphor of the complex adaptive system in particular, Resnick (1998) advocated a mixture of observation, participation, construction, invention, and experimentation in order to develop strong intuitions and rich understanding, and he put this forward as a challenge for educators and educational developers. This resonates again with Kolb’s learning cycle and also coheres with Easterby-Smith’s (1990) suggestions for how to integrate employee learning based on reflections of experiences into organizational learning.

However, in addition to the view of complex adaptive systems, an alternative perspective is offered by Stacey (2001, 2003a) and Griffin (2002), who propose the theory of ‘complex responsive processes of relating’ (CRPR), for understanding human relating. In CRPR, humans are understood to have both freedom of choice and the ability to view organizations ‘as if’ they act as an entity in their own right, whilst not actually being an entity at all. This view follows that of Mead (1934), who worked with the idea that there is in reality no split between the individual and the social. In the context of this view, the observer experiences the dynamics of human interaction with the subject of his/her enquiry personally, as opposed to the complex adaptive system view which seems to position the observer outside the system being discussed (Stacey, 2003a; Griffin, 2002). Stacey develops his argument in favor of using complexity science principles as analogies that resonate strongly with human experience, and — similarly to Kolb, Easterby-Smith, and Resnick — stresses the importance of acknowledging in this context the importance of feelings, the importance of reflection-in-action, and the importance of abstract thinking (Stacey, 2001). In tandem with this is the possibility to explore how specific complexity science ideas could be used as analogies in order to make sense of complex responsive processes of relating. Therefore, it is the personal resonance with complexity science that individuals encounter that becomes important, and, increasingly so it seems, in the business world. Lewin (1999), validates this thought:

“In our conversations with business people we saw that there was powerful resonance between their thinking about their organizations and what is known about the world of biology. This interest in applying a complexity perspective to business organizations is growing... After all, most of us work in organizations of one sort or another, and so the world of business represents the most immediate experience of complex systems on a day-to-day basis.” (Lewin, 1999: xi)

The change management area has been one such field of application and therefore an opportunity to use narrative as a facilitative learning tool to bridge the reflection and performance (Ramsey, 2005). Smith (1999, 2003), and Smith and Saint-Onge (1996) have argued that unfreezing management mindsets, or not allowing them to set, was critical to the acceptance of new ideas in a change management process in one organization. They did this by changing individual learning through the re-structuring of roles and grounding them in principles fundamental to complexity science, e.g., autonomy. They report placing great emphasis on action learning and communities of practice as a way to generate space for dynamic knowledge conversion and emerging relationships. As such, complexity science principles inspired their implemented approach. The authors noted, however, that in spite of limited ‘management take-up’ of ‘complexity and chaos’, ‘management mindset’ remained an inhibitor
to the ‘take-off’ regarded necessary to allow such principles to have any great and long-lasting impact. Dominant management 

mindsets, suggested the authors, stood in the way of potential implicit or explicit impacts on the exploration and/or adoption of 
these ideas. The dominant mindset preventing this was described as a ‘mechanistic’ one. To combat this mechanistic mindset, 
arguing in favor of “aggressive organizational redesign, based on the emergent principles of chaos and complexity, with due 
regard for people-factors,” Smith (2003) recommended that the rules of organizational structure, tools and processes be re- 
designed to enable a radical change in the way people in organizations think and behave, the way they interact and the 
environment in which they interact, therefore increasing the potential for new contexts and patterns to emerge. In doing so, 
however, Smith advocated a strategy whereby mention of complexity science and its principles should be avoided, and instead 
merely used by those whose task it is to re-design the organization in order to foster a climate where the principles of complexity 
science could flourish.

This paper acknowledges a different view though, and advocates instead that through an ‘awareness creation phase’ grounded 
transparently in complexity science principles, managers and other organizational employees can be quickly and effectively 
introduced to complexity science and undergo a substantial move in mindset through the use of tools and methods based on 
Kolb’s learning cycle and the other authors already mentioned. This then lays the foundation to allow individuals to learn 
interdependently (Stacey, 2003a) about the meaning of complexity science principles in their own organizational contexts, and 
goes a long way towards creating the kind of environment Smith talks about, but without the probably large incumbent expense.

The Complexity Starter Kit

The awareness creation phase developed was supported by a module called the ‘Complexity Starter Kit’ (Webb, et al., 2004). This included:

- A visually high-impacting six-day calendar — one day per principle;
- A half-day workshop — with a game based on the metaphor of the complex adaptive system where agents follow 
simple rules (instructions in this case) and are also acting according to their own free will; and;
- A follow-up web-based tool to further develop understanding, and to provide a link to the next phase and module of the 
process.

The purpose of this first module is threefold:

1. To introduce the terminology of six complexity principles;
2. Create an experience around them to facilitate personal understanding in a group situation and from which to relate the 
   principles to working life, and;
3. To enable group sensemaking and knowledge development to continue after the workshop by means of interactive 
discussion over time with other colleagues.

The Starter Kit calendar

The importance of time in reference to understanding human action in a theoretical way is emphasized by Stacey’s theory of 
complex responsive processes of relating (2001, 2003a). The use of a temporal metaphor to indicate the relevance of the past, 
present and future to the here and now, in reference to patterns of human action and conversation arising out of human 
interaction, was fundamental to the development of certain aspects of the Complexity Starter Kit. The idea of using a six day 
calendar (see Figure 4) with accompanying water-cooler posters rested on this theoretical position, with the accompanying 
assumption that participants in this awareness creation phase would begin to make sense of the six complexity principles by 

themselves, and with other work colleagues, in terms of their own frame of reference before they got to the next stage of the 
Starter Kit, the Exercise Class and Game.

The visually high-impacting nature of the materials used on the calendar and posters presented in Figure 4, above, added an 
extra dimension of stimulation for potential participants. As was noted recently by McKenzie & James (2004), the value of the 
aesthetics of learning in the context of complexity should not be underestimated. This was also appreciated by participants in 
the implementation of these calendars and posters. Participants receive the calendar and water cooler posters seven days 
before the Exercise Class and Game, along with instructions to familiarise themselves with some ‘key complexity concepts’.
This provides opportunity for the experiential learning cycle to begin, starting with reflection and abstract conceptualization, in addition to a narrative building exercise encouraged through personal reflection and interaction with others. In terms of learning preferences and styles adhered to, this part of the Complexity Starter Kit is deployed so as to make use of visual text and verbal kinesthetic learning styles, in addition to leveraging the visual picture style. Regarding sociological learning preferences, this part of the Complexity Starter Kit caters for those preferring to learn alone; those preferring to learn alone and then interacting with others after having had time to think things through; and, learning in pairs or small groups. The tool is not authority-orientated however, as it particularly avoids this because of the aspect of decentralization fundamental to the nature of complex adaptive system theory. This part of the Starter Kit is good for analytic processors, who can learn the new vocabulary sequentially, as well as global processors, who are given an introduction to the ‘bigger picture’, which is then followed by real life application in the second part of the kit. This first part of the kit gives the reflective processor time to think about the new words before the next stage of the endeavor.

On the seventh day after receiving the calendar and posters, participants engage in the Exercise Class and Game, a half-day workshop.

![Fig. 4: The Complexity Starter Kit calendar and posters](Image)


![Fig. 5: The Complexity Starter Kit](Image)

*Fig. 5: The Complexity Starter Kit*  
Calendar and posters; exercise class and experience game; and, follow-up pop-up.

**The Starter Kit exercise class and experience game**

This workshop is an exercise and experience by name and nature. It begins with the Experience Game, the design of which was based firmly on the metaphor of the complex adaptive system. A facilitator, as an objective observer, tells the group (from 4 to a maximum of 25 people) that they will receive a card with 4 instructions on it and that they must carry out all their instructions written on the card. Most of the cards have different and conflicting instructions, but all cards have one instruction that is the same: ‘Free choice: do something that does not negate your prior instructions’. This mirrors the application of the spatial metaphor provided by the theory of complex adaptive systems to humans, i.e., the idea that system agents interact while following simple rules and out of this system-wide adaptation occurs — like ants and bees, but with the addition of free-will. The big difference here of course is that the instructions — or simple rules — are provided for those taking part in the game, whereas in real life the ‘rules’ are not predetermined in this way. Therefore the game is understood to mirror the idea of the complex adaptive system, and not replicate it.

As one complexity science expert said in a validation workshop session, the potential of this game to ‘unhook’ participants from their normal way of perceiving things is great (Webb, et al., 2004). While playing the game participants both encounter obstacles and reach compromise in attempting to carry out their instructions. After this event the group is facilitated through a
sensemaking session based on the six principles:

- Self-organization and emergence;
- The edge of chaos;
- Diversity;
- History and time;
- Unpredictability, and;
- Pattern recognition.

All of which can be used very well to describe examples of human interaction in the experience just encountered. This conversation is easily transformed into one where the participants can use the principles to talk about their own experiences of working in their respective organizations. Full details and facilitator instructions can be found in the project book (Webb, et al., 2004). This second part of the kit builds in the extra dimensions of Kolb’s learning cycle and leverages the action and experimentation which took place in the game through a facilitation of discussion, reflection and necessary abstraction and conceptualization based on their experience. This discussion is used as a basis to move to reflecting on organizational experiences and making sense of them by means of the complexity science principles. This part of the kit caters to learning styles and preferences relating to kinesthetic, tactile, verbal kinesthetic and visual picture strengths; sociological elements of preference relating to group or team work; and, psychological elements of preference corresponding with a combination of reflective and impulsive processors.

After taking part in this workshop, participants are introduced to the web-based Follow-Up Pop-Up, the third part of the Complexity Starter Kit — each stage of the Complexity Starter Kit is represented visually in Figure 5. To ensure continuity, the same graphics are used here as in the Starter Kit Calendar, but at this stage the six principles are expanded upon in terms of anecdotal content and explanation. In addition, thought-provoking questions are left as rhetorical prompts, or to provide the basis of online group dialogue in order to further develop knowledge on and around the six principles. The time-based interdependent learning concept was deployed here as well, the idea being in this case that participants continue to learn by taking time out over the week following the workshop to take part in subjective sensemaking in conversation with others in their work place. This third part of the kit continues to repeat iterations of Kolb’s learning cycle and enables further experimentation, reflection and abstract conceptualization to take place. This part of the kit caters more for those with learning styles and preferences relating to visual text strengths, and a type of verbal kinesthetic facilitated by online discussion. The reflective processing encouraged also of course makes use of strengths relating to visual picture learning styles.

This paper has focussed on the Complexity Starter Kit as a means to transparently ground interventions in complexity science principles and thereby communicate them in a more easy-to-understand and user-friendly way. The Starter Kit also potentially provides the opportunity to integrate learning about and by means of complexity science principles into any pre-existing innovation strategy or organizational learning programme, while considering the learning styles and preferences of the individuals taking part.

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