| Title | Examining the use of new science metaphors in the learning organisation |
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| Author(s) | Ng Pak Tee |
| Source | *The Learning Organization, 16*(2), 168-180 |
| Published by | Emerald (www.emeraldinsight.com/) |

# Examining the use of new science metaphors in the learning organisation

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## Abstract

**Purpose** – In recent years, the new science has become popular in management literature. This involves the use of metaphors from the field of science (e.g. mathematics, chemistry, physics and biology) in the field of management. This paper aims to examine the use of new science metaphors in learning organisation (LO) discourse and research.

**Design/methodology/approach** – This paper is a theoretical analysis of the use of new science metaphors in LO discourse and research. In particular, the paper illustrates the potential value of such metaphors through four examples and explores the issue of appropriate application and interpretation.

**Findings** – This paper shows that using new science metaphors in the field of the LO can enrich the understanding and practice of LOs. However, one has to adopt a reflexive approach so that one is more critically aware of the assumptions behind their usage. This will lead to a more appropriate application and interpretation of such metaphors in context.

**Practical implications** – Subject to careful application and interpretation, new science metaphors can be useful in helping one appreciate the intricate dynamics of change; that a lack of one's control does not imply that the situation is out of control; that the measurement of outcomes in itself affects the development of an LO; and that paradoxes are "normal" in the dynamics of LO development.

**Originality/value** – This paper provides an analysis of the use of four new science metaphors in LO, namely complexity and chaos, living systems, uncertainty principle and wave-particle duality. It discusses how these metaphors may enrich the understanding and practice of the LO. This paper also discusses a reflexive approach towards new science metaphor usage that encompasses four issues of separation, representation, enunciation and routinisation.

**Keywords** Learning organizations, Metaphors, Sciences, Complexity theory, Chaos theory

**Paper type** Conceptual paper

## 1. Introduction

The notion of a learning organisation (LO) is arguably one of the biggest breakthroughs in management thinking of the last few decades (Mintzberg *et al.*, 1998). It is popular because many companies recognise that learning gives them their competitive advantage and effectiveness. The significance of LOs derives from their ability to learn more quickly than their competitors, which is considered the only sustainable competitive advantage. According to Lloyd and Maguire (2002), the critical focus for future sustainable organisational success will be on what the organisation knows about itself and its environment, and not the transient structure and detailed processes. Organisations, teams and individuals need to engage in a continuous loop of learning to sustain agility and organisational transformation.

Rich research has been done in the area of the LO. There are of course the "classic" works of scholars, such as Senge (1990), Argyris and Schon (1978, 1991), Revans (1982) and Schein (1993). There is also a lot of multi-faceted work done more recently, such as

the work by Örtenblad (2001) to differentiate organisational learning and LO, and by Hall (2005) to explore the biological nature of knowledge in an LO.

In recent years, the new science has become popular in management literature (Petzinger, 1999). This involves the use of metaphors from the scientific field (e.g. mathematics, chemistry, physics and biology) in the field of management. This paper argues that using such new science metaphors in the field of LO can enrich the understanding and practice of the LO. To support this argument, this paper provides four examples of the use of new science metaphors in the LO as illustrations. However, to balance the advocacy, the paper suggests that there is a limitation to the usage of such metaphors. In using these metaphors, the paper advocates the adoption of a reflexive approach so that users of the new science metaphors are more critically aware of the assumptions behind their usage. This will lead to a more appropriate application and interpretation of such metaphors in the context of use. This paper starts by reviewing the usage of metaphors in management literature.

## 2. The usage of metaphors

Metaphors are essential in creating and communicating meaning (Morgan, 1980, 1983). A metaphor is created when a term used normally in one system is transferred to another, thus illuminating some pertinent aspects of the latter. Many ideas and thoughts are largely metaphorical and unconscious (Lakoff and Johnson, 1999). If these metaphors are consciously explored and deliberated, then the understanding of organisations as a phenomenon may be explored metaphorically (for example, Bolman and Deal, 1997; Palmer and Dunford, 1996). Different metaphorical devices, such as images, can be used to generate perspectives on organizational realities, giving managers a wider range of insights and options (Morgan, 1993, 1997).

The use of metaphors is not new. Already, many researchers, consultants and organisational leaders are using management approaches inspired by and modelled after insect colonies, flocks of birds, schools of fish and even the human body system. Scientists and social scientists are also placing great hope for the future on the integration of mathematical models, simulations, and the use of metaphor and analogy to understand reality more completely. It is a holistic approach, which integrates the sciences with the humanities and philosophy (Coveney and Highfield, 1995).

Therefore, not only will the use of metaphor enhance the conceptual understanding of LOs, but it will also open up practical possibilities for practitioners and consultants (Stewart, 2001). Different metaphors allow possibilities for a broader, more imaginative and more illuminative interpretation of the LO concept (Stewart, 2001). By challenging the ways that people think about and understand it through new metaphors, there is a possibility of re-describing it and opening up new ways of doing things, thus leading to better LO practices. According to Marshall (1997, p. 177):

> [...] building on discoveries in fields as diverse as quantum physics, chaos mathematics, evolutionary biology, neuroscience, cognitive science, and systems theory, revolutionary insights about the universe, the natural world, and human learning have all converged into a new understanding of how human systems continue to grow, evolve, and learn (or change). Although these disciplines seem either remote from or irrelevant to designing and leading twenty-first-century organizations, the new learning they provide allows us to re-conceptualise the language and professional discourse of organizational learning and leadership and to discard the cause-and-effect mental models that have grounded them in the past.

There are many who describe the LO as an entity. For example, according to Senge (1990, p. 3), the LO is an organisation "where people continually expand their capacity to create results they truly desire; new and expansive patterns of thinking are nurtured; collective aspirations are set free; people are continually learning to learn together". Garvin (1993) defines it as an organisation skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insights. Ng (2004) describes a LO as one in which all members of the organisation are individually and collectively willing in heart and in mind to go deeper and broader in their learning process. These are functional definitions what a LO is.

However, Garratt (1999, p. 206) describes it differently, going through a metaphorical route:

[...] the learning organisation is more an aspiration for a continuous process rather than a single product. It is an aspiration which energises people for very long periods of time ... I have never yet met a learning organisation in my terms. It is a vision which motivates, stretches and leverages the organisation for the long term. In China we have classical drawings and paintings of the five-clawed Dragon Emperor always stretching out to grasp the flaming pink pearl of knowledge. He never reaches it. But he never stops trying. I see learning organisations like that.

This metaphorical interpretation allows a richer understanding and deeper appreciation of the LO. Rather than to ask the exact location of the end stage and measure how far away they are from it, the understanding of the LO as an ideal, an aspiration and a process allows practitioners to focus on its the different developmental aspects. Senge (1997, p. 17) later also wrote:

We are taking a stand for a vision, for creating an organization we would like to work within and which can thrive in a world of increasing interdependency and change. It is not what the vision is, but what the vision does that matters.

Therefore, a metaphor can help practitioners to focus on the utility of the LO concept and allow a vision of it to drive organisational change and ideal.

## 3. Metaphors from the new science

The new science is part of the broad paradigm shift in management thinking away from the mechanistic thinking that dominated the twentieth century (Petzinger, 1999). During the twentieth century, the classical administrative principles and practices of scientific management (e.g. Taylor, 1911) were widely accepted as guidelines for the development of effective organizations. The large bureaucratic form became institutionalized as the dominant and normative model of organization. However, at the end of the twentieth century, with the advancement of quantum physics that undermined the mechanistic assumptions of classical physics, the development of chaos theory in large dynamical systems, and other related developments in the fields of chemistry, biology, ecology and environmental science, an interdisciplinary field of complexity sciences emerged to describe and examine the characteristics of complex systems. Referred to as the new science, descriptions of the core characteristics of such complex systems provide insights into how organizations may function more effectively in the new global and connected knowledge economy (Capra, 1996; Marion, 1999; Wheatley, 1994).

This paper now discusses a few metaphors from the new science to show their possibilities and usefulness. In particular, this paper will discuss:

- Complexity and chaos – helpful in appreciating the intricate dynamics of change.
- Living systems – helpful in appreciating that a lack of one's control does not imply that the situation is out of control.
- Uncertainty principle – helpful in appreciating that the measurement of outcomes in itself affects the development of a LO.
- Wave-particle duality – helpful in appreciating that paradoxes are "normal" and will lead one to a deeper appreciation of the dynamics of LO development.

### Complexity and chaos

Without doubt, the current LO literature is rich. However, the appreciation of the intricate dynamics of change is not as strong as the development of ideas and tools to implement the LO. For example, shared vision is a good concept. Many tools have been developed to elicit a shared vision. But in real life, shared vision is never truly completely "shared" and the process of building a shared vision is probably more complex than clinical. Without a good understanding of the dynamics, many organisations create "shared visions" by having retreats, sum-aggregating everyone's input, cascading the resulting "vision" and assuming that "shared vision" has been accomplished. Quite often, this results in frustration and cynicism. For another example, the discipline of systems thinking requires an understanding of the structure and behaviour of systems to find leverage points but does not adequately describe the dynamics of change associated with "systemic interventions". Therefore, one major area where an LO may be enriched is an understanding of the dynamics at play in its learning and change processes. Here complexity and chaos theories can be illustrative and insightful.

In a way, complexity is built on the foundation of systems thinking. However, complexity asserts that in many systems, the interactions among parts are non-linear, highly inter-twinned and magnified over a multitude of iterations, making a clinical solution to the system or even an accurate prediction of outcome virtually impossible. When the interactions cause system fluctuations of high disorder, the resulting situation is described as chaos (e.g. Lorenz, 1963; Gleick, 1987).

Complexity and chaos theories offer the management world a few metaphors to appreciate the dynamics of LOs at the human-to-human level. First, there is the butterfly effect, which is now a popular metaphor. According to the butterfly effect, tiny fluctuations in a non-equilibrium system can have considerable impact on its output and the butterfly effect describes how that impact comes about. It shows how a small action at leverage points, suggested by systems thinking, can have a very big effect (this does not mean that every single action at leverage point leads to a butterfly effect). It also offers an insight into how a small communication lapse between two persons, leading to a mental model misalignment, can be magnified through an intricate web of communication processes and can cause a major misunderstanding in the whole organisation.

At the organisational level, chaos theory also offers a now famous metaphor – the edge of chaos (Langton, 1990). Operating at the edge of chaos is a process of creating the state of change in which complexity, tending towards chaos, is balanced with sufficient stability. This is one of the most important functions of the newly defined management roles (Smith and Saint-Onge, 1996). The exact location of the balance point is hard to define and is probably dynamic itself, but it is the concept and hence

the awareness of the need for a suitable balance that is powerful. It is very useful to think of the development of the LO through this metaphor. If the organisation is too structured and hence stable, then it offers little scope for personal mastery, empowered learning and innovation. However, if the organisation is too unstructured and fluid, then there may be confusion and its value-creation chain may break down.

Perhaps the power of using the complexity metaphor lies in that it is a "pictorial" appreciation of reality, descriptive rather than predictive. Instead of reductionism, the metaphor really enables global and systemic vision as LO requires. As an example, a weather system is chaotic. It is unpredictable over the long term. But it is not utter confusion. It has a pattern. It takes shape over time. A deeper examination will reveal a coherent pattern emerging in the iterative operations of the system's nonlinear laws. With that, it is possible to predict seasons, but not more than a short time into the future. So chaos is not completely unpredictable. It is just that one has to think pictorially rather than clinically, appreciate an evolving picture rather than a snapshot.

It is impossible to see that order until one is able to watch the system evolve over a good period of time and to look at it taking shape. When one looks moment to moment at a highly dynamic system, all that is visible is "random" movements and total unpredictability. But when one is able to watch the system develop over time, one can perceive the order that emerges out of the chaos. In LO language, this would be to see the behaviour over time. However, using complexity to enrich the concept, instead of seeing the graph of a variable over time, one will be more attuned to fractals, geometric shapes and topologies. With this understanding, instead of rushing into establishing "shared vision" as an event one point in time, one will then be more patient to see shared vision as an evolutionary process. Shared vision evolves, involving multiple iterations of the interactions between the mental models of people, taking shape as it moves along.

Such metaphors are cognitive pathways toward a deeper appreciation of the dynamics underlying the LO. They will not prescribe a recipe for management action (Sullivan, 1999). But, by offering a picture of higher quality, they suggest guidelines about the nature of appropriate management principles, encouraging practitioners to find the appropriate practice suitable for the context.

### Living systems

It is now common to describe the complex networked human social organisation using the metaphor of an evolving living system (Capra, 1996; De Geus, 1997). In the past, the predominant set of lens has led many to adopt a Newtonian imagery of the organization as machines and human beings as mechanical parts of machines. But when one switches to seeing organisations as complex living systems, then one observes a lot of self-organising processes among human agents in the organisation, just like the way living systems organise, reorganise and manage themselves (Wheatley, 1994). In fact, the "real" and "living" world is a world of interconnected networks, where disturbances in one part of the system create major impacts far from where they originate (Wheatley, 2007).

Living systems grow, thrive and constantly re-create themselves in their environment. No human agent appears to be in control, yet the systems will sustain or even transform themselves. For example, with the right conditions (light, air and nutrients), plants will grow and a whole forest can emerge. There is no need to pull the plants to help them grow. If a plant cannot get the sunlight, it will know how to bend

itself in another direction where sunlight is available. There is no need to organise a forest.

Actually, the phrase "learning organisation" is already a metaphor borrowed from a human system (a learning human being). Now human learning occurs quite naturally – a tourist will soon learn where to eat and where to shop. Could organisational learning be something that occurs quite naturally too? This brings to mind the idea of the community of practice (CoP). People will self-organise in the learning process in order to get real work done.

A CoP is an informal aggregation defined not only by its members, but also by the shared manner in which they do things and interpret events (Lave and Wenger, 1991; Brown and Duguid, 1991; Eckert, 1993). A CoP is therefore a set of people who "share a concern, a set of problems, or a passion about a topic, who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger *et al.*, 2002, p. 4). Tennant (1997, p. 77) declares that "new knowledge and learning are properly conceived as being located in communities of practice". Compared with formalised training, an employee probably learns more about relevant know-how in an organisation by interacting with other employees daily, doing work and asking questions at the same time.

A CoP is a way of viewing how learning in an organisation actually takes place, not a new way to organise learning within the organisation. The organisation has already been done by the members themselves, occurring naturally and meaningfully, much like the trees in the forest. Through complex responsive processes, knowledge is created and transformed through networks of human interaction (Stacey, 2001). Based on this metaphor, there are implications for LO.

In an organisation, there is always a collection of many self-organising CoPs. Real learning is taking place. The real challenge is to nurture these communities so that powerful team learning can be facilitated. But the problem is that instead of capitalising on the naturally occurring phenomenon, many organisations ignore it and look instead for instant results through top-management ordained systems and structures, while calling them "systemic interventions" and blaming LO for being ineffective when they fail to deliver the results.

Therefore, one of the biggest problems in developing LO is anxiety. Many organisations are anxious over a loss of control. But the real problem is not the loss of control. The real problem is the loss of one's control – something people crave for. Machine metaphors have an appeal because people are in control. But machines are not very good metaphors when depicting the organic nature of "learning". When people self-organise around meaningful practice issues, powerful team learning takes place. If one dictates the formation of committees and dialogue groups, what results may be disinterested individuals coming together by force than by choice. Many initiatives launched in the name of LO are actually mechanisms to lessen one's own anxiety. Work improvement teams are set up and the number of meetings and suggestions are tracked so that one can tell oneself and others that the organisation is now practising organisational learning. These are not "systemic interventions" because they are not "systemic" in the first place.

A related anxiety is that for results. Garratt (1999, p. 206) wrote that:

> I have plenty of telephone calls from organisations "wanting a learning organisation quickly", often by next month.

The understanding of LO can be enriched by the living system metaphor: one cannot order a tree to grow quicker. But with the right conditions, nature will take its course. But again, many organisations fail to appreciate that their so-called "systemic interventions" are merely attempts at forcing a quick result. Many real "systemic interventions" are actually provisions of right conditions and they take time to bear fruit.

*The uncertainty principle*

The uncertainty principle, from the field of applied mathematics and theoretical physics, illustrates how measurement itself is not merely an unobtrusive snapshot of reality. It is an intervention in the system and powerfully affects the organisation and its development.

The essence of the uncertainty principle is that at the quantum level, it is impossible to simultaneously know with certainty the velocity and location of a moving particle. To illustrate why this is so, imagine a particle moving in space. To find out its exact location at a point in time, one has to shine a light on it. But the moment a light is shone on it, it picks up the "extra" energy from the light source and changes its velocity and location. The act of measurement affects the outcome of measurement. Another illustration is the measurement of the temperature of a beaker of water at a point in time. In order to measure the temperature, one has to introduce a thermometer into the beaker. However, the thermometer will absorb heat from the water. The resulting measured temperature is not the same as the temperature of the water at that point of time. The moment one measures a feature of an object, one has changed the object itself.

The uncertainty principle, applied metaphorically, offers a very powerful insight into organisational reality. There have been efforts to develop measures for a LO (e.g. Yang *et al.*, 2004). However, according to Blackman (2006), the desire of many organisations to measure the organisational learning that is undertaken can undermine actual knowledge development because of the way that the organisation measures and monitors its own performance in this area. Therefore, the act of measuring how much of a LO the organisation is affects the nature of the LO itself. While it may facilitate empirical research to define LO clinically so that one can measure where the organisation is on a scale, the moment a scale is defined, the act has changed the nature of the organisation.

The tool of measurement is itself a player in the dynamics. There never is an absolutely "independent" tool of measurement. A teacher teaching in a classroom will behave differently if he or she is being observed as part of an appraisal process. An examination may be the "worst" medium to measure the intelligence of a student. The measurement tool is an active player in the system – it changes behaviour. Therefore, when an organisation tracks and measures the number of LO activities carried out, it has changed the nature of LO in the organisation.

Of course, the difficult question to answer is whether there is a design principle for LO based on the implications of the uncertainty principle. Does that mean one should not measure? Of course not. A good argument for the need to measure is that this will ensure that learning is occurring and being sustained (Garvin, 1993; Watkins and Marsick, 1993). However, one has to be more appreciative of what one measures and how one measures so that learning is not actually impeded by measurement. According to Blackman (2006), instead of measuring learning targets, it may be more facilitative and fruitful to measure the organisational propensity to learn and the range

and types of knowledge generated. The design of measurement systems should be open (Blackman and Henderson, 2005) and be able to develop and reward alternative behaviours that could break through current mental models (Blackman, 2006).

*Wave-particle duality*
The wave-particle duality (this is the scientific name of the phenomenon), also from the field of applied mathematics and theoretical physics, illustrates how paradoxes are actually "normal" and the acceptance instead of elimination of paradoxes will powerfully affect the appreciation of LO and its development. Young's famous experiment, with the monochromatic light source and double slits, tells us that light exhibits both wave and particle properties at the same time. Neither description is a complete description of light. Yet these two descriptions cannot be reconciled – a wave cannot be a particle and a particle cannot be a wave. This duality and simultaneity of wave and particle nature of light "forces" on one the idea that paradoxes are "normal".

In fact, if one cannot embrace paradoxes, one finds oneself facing greater contradictions. The dominant way of thinking is to eliminate paradoxes. But this insight tells one that paradoxes are to be embraced as realities. They are two sides of the same coin, not two ends of a continuum. In fact, proponents of the utility of paradoxes within organisations argue that where there are paradoxes, instead of seeking coherence to reduce cognitive dissonance, the inconsistencies should become the focus of dialogue so that they may generate new theories-in-use (Poole and Van De Ven, 1989; Blackman, 2006).

Therefore, the LO is a destination and journey at the same time. Systems thinking is seeing forest and seeing trees at the same time. The outcome of LO efforts are predictable and unpredictable at the same time. They are paradoxes but they are not contradictions. They offer a better appreciation of LO.

Even the use of metaphors in LO can be paradoxical. The traditional Newtonian view of gravity is a linear force between two objects. In General Relativity, gravity is an invisible geometry of space-time around matter. Things move, not because of a force, but because it is a natural property of the space-time curvature that matter "flows" along its curvature. Using this metaphor, "organisational vision" may be viewed either as a linear drawing force or a space-time curvature. With the wave-particle duality in mind, perhaps it is more powerful conceptually to see it as both.

Stacey (2001) is of the opinion that systems thinking does not describe reality. In a way, that is true. But it depends on the lens that is used. Consider the metaphor of a river. If one desires a river to change course, one would put in a structure such as a dam or sandbar. The river changes course. At the macro level, structures drive behaviour, as systems thinking puts it. However, at the micro level, every water molecule's movement is still random. There is "chaos". There is no discernible pattern until things are seen from a vantage point of view. It is a river that has just changed course. Similarly, "systemic changes" do not guarantee that every individual flows along with the system (otherwise the idea of personal mastery will be meaningless). At the macro level, the organisation has changed course. At the micro level, people's behaviour may be the exact opposite of what the systemic change is supposed to achieve. Which picture is more "real"? The paradox is that both pictures, seemingly contradicting, are real. One has to embrace and appreciate both pictures.

## 4. Addressing the problems with using new science metaphors in LO

The use of metaphor is not without its limitations. It is difficult to translate a metaphor into more precise and objective language, thus making rigorous testing and measurement elusive (Alvesson, 1992). However, it is possible to understand the quality of a metaphor from its "generative powers". According to Brown (1976), there are three types of metaphors in increasing generative power. The first type is a didactic or illustrative device. It carries meaning across clearly. The second type is a model. A model may be thought of as a metaphor whose implications have been spelt out. The third type is the root metaphor, a paradigm from which many models may be derived or generated. A good metaphor "stops us in our tracks. It offers us a new awareness" (Brown, 1976, p. 173).

Even so, the most interesting, illuminating and enriching metaphors are not really explanations. They are merely a source of insights or practical ideas. While there is scope in using metaphors to generate insights into the complexity of organisational learning, it is important to remember that insights from metaphors are not the same as an explanation of the actual dynamics at play. So, new science metaphors can help LO researchers to imagine what occurs during certain phases of change and what occurs during the process of individual and group learning in developing LOs. The descriptors may describe overall patterns in such phases. However, they may not be explanations for specific situations or predictors for future outcomes of specific situations. They are certainly not intended to generate specific strategies for managing specific situations. Therefore, the notion of using complexity theory purely as metaphor has been challenged by authors such as Fuller and Moran (2000), who criticize the use of complexity metaphors without the notions being grounded within organizational research.

Moreover, metaphors may also be applied and interpreted inappropriately. Not every innovation can be explained by a sweeping statement that says that "it is because the organisation is operating at the edge of chaos". Without wisdom, leaders and managers may take decisions based on erroneous metaphorical representations of their business situations. For example, launching an advertisement and expecting a "butterfly effect" to take place; or blaming every catastrophe on the "butterfly effect" when it is just a sheer unwise business move.

To address this, Palmer and Dunford (1996, p. 702) advocate a "reflexive response" to the problem of metaphor usage, where "a range of competing positions exists about how metaphors should be applied". Because of the fundamental differences underlying ontology and epistemology that exist across the different social sciences, it is difficult to develop a dogmatic meta-framework of rules of metaphor usage. Therefore, the viable alternative is to adopt a position of reflexivity where organisational analysts and researchers "become critically aware of the assumptions that lie behind their use of metaphors" (Palmer and Dunford, 1996, p. 702). The four issues identified for organisational change are applicable to new science metaphors in LO, namely separation, representation, enunciation and routinisation (Palmer and Dunford, 1996). This paper now illustrates each of these four issues using a new science metaphor.

### Separation

The issue of separation is about the validity of distinguishing literal language from metaphorical language. It is difficult to develop hard and fast rules for separating literal from metaphorical language (Hausman, 1989). What is literal to one may be metaphorical to another. Consider the word "complex". It can be used both literally and

metaphorically. Therefore, faced with a sentence such as "organisational learning is a complex process", LO researchers have to be careful to distinguish the type of usage that is intended. It may mean that it is a process that exhibits the features of "mathematical complexity". However, in everyday usage, it may be limited to mean that it is difficult to describe the process fully and completely. The former implies the latter while the latter may not imply the former.

*Representation*
Representation here refers to the extent in which the metaphors can depict reality. The use of a metaphor of course assumes that there is a similarity between the metaphor and the object of discussion. In using new science metaphors, LO researchers have to reflect upon the extent to which they assume that the metaphors can depict reality. For example, using the living system as a metaphor for the LO is appealing because living systems can learn and the metaphor highlights the organic nature of learning processes within the organisation. However, LO researchers have to reflect upon the extent to which this metaphor represents reality. Consider the use of autopoiesis (Maturana and Varela, 1987; Mingers, 1989) as a metaphor for an organisation. Autopoiesis or auto self-creation characterizes the nature of living systems, for example a biological cell. The cell comprises various nucleic acids and protein components and is organized into structures such as the nucleus, membrane, cytoplasm and various organelles. These structures, based on a continuous influx and outflow of material and energy, produce the components, which, in turn, continue to maintain the structure that organises and utilises these components. However, if a LO is merely autopoietic, then the dynamic learning (in this case represented by the continuous influx and outflow of material and energy) will only serve to maintain the organisational structure. There is no room for a breakthrough. Autopoiesis cannot adequately represent or depict the reality of organisations because organisations can be transformed. Therefore, there is a limit to the degree of representation by the metaphor of the object or situation.

*Enunciation*
Enunciation is another important factor to consider. Who enunciates the metaphor and the context in which it is used is important. A metaphor may be treated as a clinical replacement for an equivalent literal expression to describe an object and is independent of the relationship between user and beholder. A metaphor may also be considered as a device that produces and transfers meaning from user to beholder based on the interaction between the metaphor and object, and the relationship between the user and beholder. Consider the metaphor of "chaos". Strictly speaking, as it is used in the sciences, "chaos" does not imply randomness and messiness. Instead it refers to complex patterns whose precise pathways defy prediction by any known means. But when the board chairman says that the company is in chaos, he is probably not referring to "complex patterns whose precise pathways defy prediction by any known means". Rather, he is expressing his frustration at the mess he found the organisation in, created perhaps by the CEO and the senior staff!

*Routinisation*
The issue of routinisation directs LO researchers' attention to reflect on the rules that they apply to legitimate their usage of a certain metaphor. It involves a reflection on the standards of evaluation whereby some metaphors are considered more appropriate

than others. Otherwise, once certain metaphors are "routinised", it becomes very difficult to analyse their suitability and the conditions under which they were applied in the first place. This leads to an issue of separation. Consider the word "paradox". Using the wave-particle duality metaphor, this paper posits in one of the previous sections that the LO is a destination and journey at the same time and that such a paradox is to be embraced as reality. However, not every situation in a LO is a paradox. Many facets are logical and straightforward. But as new science language finds its way into LO literature, more people will assert that "LO is a paradox" without considering its metaphorical validity in context. Once routinised, it may be abused and will transfer unintended meaning.

## 5. Conclusion

This paper has explored some new science metaphors, namely complexity and chaos, living systems, uncertainty principle and wave-particle duality and discussed how these metaphors may enrich the understanding and practice of the LO. In using these metaphors, it is important to adopt a reflexive approach so that users of the new science metaphors are more critically aware of the assumptions behind their usage. In particular, this reflexive approach should encompass four issues of separation, representation, enunciation and routinisation in order to consider whether the metaphor will provide useful developments and insights for learning. This will lead to a more appropriate application and interpretation of new science metaphors in LO discourse and research.

Metaphors from the new science will continue to find their way into management literature and in particular LO literature. This can be a positive development. If the LO is understood as one where change is driven by learning and the interpretation is left open, then potentially, with insights generated from the new science metaphors, there can be more interpretations and applications of the LO in the management world.

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