Framework for Resolving Paradox in Social Systems. What can History Teach Us?

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Abstract: Learning paradox emerges when the organization confronts areas of increased environmental complexity constituted by a cognitive structure that interprets that complexity inadequately. A trans-disciplinary perspective of complexity theory is applied to enrich organizational paradox theory with descriptions of dynamics and complex adaptive systems (CAS). A process based model of an organization seen as CAS is described as a micro-foundational framework for understanding how a paradox emerge. The model is applied to groundbreaking paradoxes from the history of philosophy and science to demonstrate its validity. I have analyzed the historical paradoxes to find commonalities in the resolution process. Four propositions are crafted based on qualitative analysis. The propositions are first, analyzed related to the central events in the historical paradoxes; second, related to the process-based complex adaptive system model of a social system; third, related to the theory of paradox found in organizational and management literature. The paper intends to inform a multi-paradigmatic approach to understand the dynamics of paradox in organizations seen as social systems.

Keywords: Paradox, social system, adaptation, cognition

INTRODUCTION

Søren Kierkegaard once said: “The supreme paradox of all thought is the attempt to discover something that thought cannot think”. Individuals and organizations experience this paradox as we face challenges in a more complex environment, equipped with simplistic mental models and categories of thoughts. Acting upon (or observing) categories that once corresponded to phenomenon in the environment, suddenly lead to contradictory results. The observing individual or organization may even experience as if the two poles, while contradictory, are also interrelated. We have what has been characterized as a learning paradox (Lewis, 2000). A learning paradox emerges when beliefs or assumptions fail to keep up with the external changes (Cannon, 1996). This is relevant as environments become increasingly global, interconnected and competitive in a world of constant change and disruptive innovation. When organizations ignore dramatic changes in their environment,
learning paradoxes may emerge as the existing world-view and belief system is exposed to increased complexity in the environment. How leaders respond to such situations may be a fundamental determinant of an organization’s fate.

Literature on paradox in organizational studies has developed much and currently represents an alternative to more traditional contingency theory (Schad et al. 2016). The paradox perspective seeks to explore how organizations can attend to competing demands simultaneously, accept tension inside the organization, and create balance in dynamic equilibriums (Smith and Lewis, 2011). In a recent review article (Schad et al. 2016), the authors give an extensive overview of current literature on paradox, and categorize published studies to derive at a meta-theory with principles to help extend future research. Their analysis suggests that management scholars have increasingly oversimplified the phenomenon of a paradox, ending up with reductionist, static and incomplete theories. In their meta-theory, the topic of dynamics is one of areas identified. Despite a general understanding that social paradoxes are dynamic by nature and stems from dynamics in social systems (Braathen, 2016), there is limited research that explores paradox in complex adaptive social systems and enables a process perspective. In this article I will base the analysis of learning paradox on a pure process philosophy of an organization seen as a social complex adaptive system. The objective is to enable descriptions of paradox in organizations based on process and dynamics. The description should seek to integrate existing literature with a possibility to utilize concepts and insight from complex adaptive systems theory.

The second objective is to explore if it is possible to learn from history when dealing with learning paradox. History of science and philosophy holds a number of paradoxes that have been faced by the scientific social system. The events have often emerged surprisingly and out of the blue, contradicting fundamental world views, and lead to great perplexity and despair. However, the energy and momentum created by the paradox have also provided some of the greatest breakthroughs in history with massive implications on our current lives (Al-Kahlili, 2012). Should it not therefore be an opportunity to study both how paradox emerged and how they were resolved? Is it possible to find common factors in the resolution of these historical paradoxes? Out of eight historical paradoxes studied, I will describe three historical cases: 1) Paradox of Reality - situated in ancient Greece; 2) Paradox of Space - situated in the development of non-Euclidian geometry; 3) Paradox of Time - situated in the development of thermodynamics. Based on a grounded theory approach, I will promote a framework of four principles found to be common and foundational when resolving the paradoxes. The principles will be discussed with respect to the events of the historical paradoxes. Further, discussed relative to a process based CAS model of the organization, and finally, related to current exemplars on paradox management in the organizational literature. The hope is that practitioners may find support in the framework when navigating the dire straits where paradox hides.
CASE STUDIES

Use of Historical Cases

One might ask why I have chosen to use historical case studies instead of current examples from existing organizations? While the disadvantages might be obvious, not being present to obtain the same richness in the observation, there are other advantages with the historic paradoxes. First, the clarity of the paradox itself and how it represented a fundamental challenge to the scientific community (and to the world). In modern organizations the experience of a paradox may be vague and sometimes we experience the symptoms of the paradox rather than the paradox itself. One can only speculate that the historical paradoxes had some of the same attributes at the time, however, history has matured our understanding, and ‘crystalized’ with clarity the core of the paradox. The historical paradoxes that I studied belonged to the domain of science or philosophy. Their nature was addressing real world phenomenon, and yet had the clarity of logical paradoxes. The contradictions were real, however, as we shall see were all resolved as learning paradoxes as a consequence of epistemic changes in the social system. Second, the historical paradoxes are well documented and the information is open, transparent and accessible to everyone. The events are generally well known, and open for interpretation into a theoretical perspective. Third, paradox that emerges in social systems usually takes time to resolve and it might be difficult to conduct longitudinal studies that follow its entire life span. The historical cases show how these paradoxes existed over decades and even thousands of years. The light of history shines on the development and provides clarity of important events.

I will continue to briefly introduce the three historical cases. I will introduce the historical context, the emergence of the paradox and the resolution of the paradox. I will then go on to describe the emergence of a learning paradox as an epistemic process in a complex adaptive system. Finally, I will discuss the principles from commonalities found among the historical case studies related to the resolution of the paradoxes.

Paradox of Reality

The first historical case is about our conception of the reality we live in and how categories we develop relate to the external environment. We go back to the ancient Greek group of Pythagoreans following the famous philosopher and mathematician Pythagoras (ca. 570-490 BC). Unlike the common opinion, Pythagoras was in his time perceived less of a mathematician and more of a religious leader for his followers (Huffman, 2005 ). In their religion, reality was a mathematical structure where the gods were purely intellectual beings. If the external reality was a mathematical structure, numbers and ratios could represent all relationships in this reality. The intuitive numbering system at that time would be the natural
numbers (1,2,3…), and the Pythagoreans would find numbers and ratios governing structures in nature, in constructions, and in musical harmonies. The confirmation of the categories reinforced the Pythagorean belief system with ratios and natural numbers as an expression of the gods linking it to a divine experience. The world as mathematical structures would form the ontology in the Pythagorean philosophy, and the numbers, ratios and mathematical theorems the epistemic framework.

Hippasos of Metapontum, was one of the followers and disciples of Pythagoras. He studied geometry and in particular the dodecahedron which consists of twelve pentagons. In his study he accidently discovered that the sides and diagonal of a square are incommensurable; i.e. it is impossible to measure the length of the diagonal in units of the sides of the square. By this he brought the first learning paradox to life - stating that the ratios of natural numbers, and as such, the true proof of God’s existence, is also false and impossible. The paradox represented a complete breakdown of the Pythagorean philosophy. Poor Hippasos was expelled by the Pythagoreans and drowned at sea. According to the Pythagoreans this was punishment from the gods for his indiscretion after he was said to be leaking the information (Sorenson, 2005).

The Pythagorean learning paradox was indicative of another problem facing the Greeks. This was the relation of the discrete to the continuous, brought into light by Zeno of Elea, who questioned whether quantities are discrete and composed of a finite number of units of a given size. The Greek conception dictated that "whole numbers represent discrete objects, and a commensurable ratio represents a relation between two collections of discrete objects" (Kline, 1972). Zeno sought to prove this by formulating his famous paradoxes, which demonstrated the contradictions inherent in the widely accepted worldview at that time. While Zeno’s paradoxes intended to accurately demonstrate the deficiencies in the current beliefs, they were not regarded as proof of any alternative.

From this, paradoxes were to be suppressed to avoid ontological distinctions of being and non-being to exist at the same time. In Metaphysics, Aristotle states the three classic laws of thought, and hereby the law of contradiction: a statement cannot be true and not true at the same time. In Metaphysics he gives three different versions 1) Ontological, 2) Psychological, and 3) Logical. Scientists throughout centuries would avoid contradictions and paradox in order to be aligned with the Aristotelian logic.

Almost 2000 years passed before the ancient Greek paradoxes were resolved. This was not by a rule of prohibition, but rather by expanding the mathematical universe and by generalization of thought. The Pythagorean paradox was resolved by the generalization in the space of numbers, specifically irrational numbers as a generalization of the real and rational numbers. The paradoxes of Zeno were resolved by modern calculus during the 17th century with prominent contributors as Gottfried Leibniz and Isaac Newton. Calculus describes continuous change, and the two complementary theories of differential and integral calculus were
generalizations over a fundamental understanding of how of infinite series may converge to a well-defined limit.

Even if the ancient Greek paradoxes were resolved, they still remind us of the power inherent in paradox, and the corresponding impotency stemming from a statement of impossibility. Our ontological and epistemological foundation of reality is challenged, however opens up to creativity and new development.

Paradox of Space

The search for the proof of Euclid’s fifth postulate, the parallel axiom was 2000 years old when the German mathematician G.S. Klügel (1793-1812) in 1763 published his dissertation where he critiqued 28 attempted proofs and concluded correctly that none of them were valid. The main motivation for all of this effort was that Euclid’s parallel postulate was not self-evident and intuitive as the four other axioms of Euclidian geometry. Klügel’s critique caught the attention of the Hungarian mathematician Wolfgang Bolyai (1775-1856) who then struggled his whole life with the proof without progress. In despair he writes to his son, Janos Bolyai (1801-1860), also a mathematician, discouraging him from following him in the study of parallelism. ‘You must not attempt this approach to parallels…I have traversed this bottomless night, which extinguished all light and joy of my life. I entreat you, leave the science of parallels alone’ (Witt-Hansen, 1985).

This, of course, had the opposite effect, on young Janos Bolyai who started his work immediately, and he did indeed succeed. He proved that the fifth postulate is independent of the other axioms of geometry, and that other consistent geometries can be constructed on its negation. An axiomatic system is said to be consistent if it lacks contradictions, and Bolyai exploited this fact to conduct an indirect proof. He would test if a negated version of the parallel postulate would lead to any contradictions. If it did, the postulate would be valid. If it did not, it would be proof that the postulate was in fact independent from the other axioms and hence ‘just a postulate’ outside the axiomatic system of Euclidian geometry.

The denial of the parallel postulate is much more than a logical paradox in an axiomatic system. It is more than discussions over semantics. It violated our fundamental intuition of space. Our understanding of space dictate our entire understanding of the world around us, and was fundamental for philosophy, physics, mathematics and more. Euclid’s axioms were defined as true, and at the same time it could be proven to be false and invalid.

One of the prominent figures upholding a worldview of the Euclidian geometry was Emanuel Kant. In his Critique of Pure Reason, he states that our intuition of space is a priori and synthetic and that the Euclidian axioms are articulated manifestations of this a priori understanding. Further, Kant’s reasoning would dictate that our a priori and synthetic intuition of space is a prerequisite for all a posteriori experience. Kant’s work contributed to the
unrivaled place of honor the Euclidian geometry held among branches of human knowledge. This situation personally challenged the famous mathematician Gauss. While he was diligently working on the subject of parallelism, he published nothing out of fear for the reactions if he even appeared to attack its validity. In a letter of 1831 he writes: “In the last few weeks I have begun to put down a few of my Meditations (on parallels) which are already to some extent forty years old. These I had never put in writing … I wished that it should not perish with me” (Lewis, 1920).

Alongside Bolyai and Gauss, the Russian mathematician Nikolai Lobacevskij worked on parallelism with a different approach. It was in fact Lobacevskij that first published a proof of the parallel postulate in 1826. We know that Lobacevskij worked independently from Bolyai and Gauss, and his approach is complementary to the one of Bolyai. Lobacevskij continued together with Riemann to found what is now called non-Euclidian, or elliptic and hyperbolic, geometries.

If three different geometries are equally valid, can we still maintain that our intuition of space is a priori, or is it in fact a posteriori? These questions depend on whether non-Euclidian geometry is a pure logical and mathematical construct, or if it exists in an empirical space. The transition into non-Euclidian geometry was not only a game of language and semantics of mathematics, but did also have a physical and empirical counter part. Using terms of Bertrand Russel, space and the nature of it cannot upon the ‘solvent influence of critical reflection’ be doubted. Many years later Einstein’s theory of general relativity, demonstrated that the empirical space is indeed non-Euclidian. Rudolf Carnap stated that, “we must distinguish between pure or mathematical geometry and physical geometry…Mathematical geometry holds indeed a priori, as Kant asserted, but only because it is analytical. Physical geometry is indeed synthetic; but it is based on experience and hence does not hold a priori” (McFarlane, 1995).

In some sense the paradox of the parallel postulate was laid to rest. However, its spirit marches on. When and where can the axioms of our world be inconsistent and incomplete and generate paradox? If the axioms, the pillars of our belief systems, can be replaced by its contradictory, could other truths be false?

Paradox of Time

If the parallel postulate paradox challenged our understanding of Space, the next paradox challenged our understanding of time and how it relates to our physical and biological reality. The paradox emerged at a time when the dominating belief system was based on Isaac Newton’s laws of motion and gravity, and saw the world as deterministic and mechanic. Pierre Simon Laplace’s described the possibility of a theoretical ‘intellect’ that could calculate any past, present and future state of the universe, given a particular position and momentum of the
objects. “We may regard the present state of the universe as the effect of its past and the cause of its future…. (The intellect) would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes” (Laplace, 1902). The world was a machine, a ‘clock-work universe’. Newtonian physics would support that the laws of motion governing the universe were time symmetric, which meant that any process involving physical objects was reversible. Time was a ‘sliding knob’ that could rewind or fast-forward any development.

In this era of certainty and deterministic physical laws, a new paradox of learning was brewing. It emerged from activities in the discipline of mathematics and theoretical physics, but also from empirical and phenomenological experience; and most of all, it was based in common knowledge. Common knowledge tells us that heat flows from hot to cold, never the reverse. Common knowledge tells us that the smell of coffee spreads in its available volume, never the reverse. Or in the words of Rudolf Clausius, “There is no thermodynamic process whose sole effect is to extract a quantity of heat from a colder reservoir and deliver it to a hotter reservoir” (Callender, 2001). The challenge was the start of what we now know as one of the greatest discoveries in physics, thermodynamics.

The first to articulate the foundation for a new theory was Jean-Baptist Joseph Fourier. Fourier combined pure mathematics and insights into observational physics with his 1807 groundbreaking work, *Theorie de la Propagation de la Chaleur dans les Solides*. In short, he described in mathematical terms the conduction of heat in solids. The surprising element in Fourier’s theory was that it showed universal validity, yet it was independent of the Newtonian mechanical laws of physics. In fact, Fourier perceived the phenomenon of heat transfer as of a different nature, and one that made application of Newtonian mechanics, according to him, impossible (Witt Hansen, 1985). So we can see how a learning paradox would emerge as the current worldview of universal laws was now contradicted by a new set of universal laws. At the center of this contradiction was the concept of time. In the world of thermodynamics time is directional and irreversible. Heat may only flow from hot to cold, never the reverse. Where gravity may influence the acceleration of a physical object, heat, on the other hand, may change the state and nature of the object, never to return to its original. The asymmetric time of the laws of thermodynamics was contradictory and independent of the time symmetric laws on motion and gravity in mechanics.

Fourier challenged the universal validity of mechanics from a mathematical perspective; however, the science of thermodynamics was mainly developed from empirical and phenomenological attempts of engineers trying to improve the steam engines during the industrial revolution. The main contributors were Sadi Carnot, Rudolf Clausius and William Thomson Kelvin. They were concerned with macroscopic phenomenon such as temperature, pressure and volume and how different properties behave at equilibrium. Their work would found the general laws of thermodynamics, based upon observations of relationships between
particular macroscopic parameters and justified by the fact they are empirically adequate. No further justification of these laws was to be found at this stage in the details of microphysics. Whether the microphysics underlying these variables were seen as atoms governed by laws of motion, or as a turbulent fluid, was largely irrelevant.

Later in the 19th century Ludwig Boltzmann made the bridge between the macroscopic laws of thermodynamics with the laws of microphysics. The idea that gases did in fact consist of atoms and molecules in movement had been explored by James Clerk Maxwell who demonstrated how the mechanics of individual molecules would lead to different distributions of molecular speed (Wolfram, 2015). Building on Maxwell’s work, Boltzmann was able to prove the thermodynamic laws based on microscopic mechanics of atoms and molecules. The new statistical mechanical theory of Boltzmann was based in Newtonian mechanics, however generalized, by adding the notion of uncertainty and probability. Boltzmann put part of the paradox to rest by bridging the world-view based on Newtonian mechanics with the new world-view on thermodynamics.

However, the new insight that time is irreversible remained as a principle yet to be integrated and understood. It was still not clear where, on the macroscopic or on the microscopic level, we could find the asymmetry of time. It appeared as if irreversibility on the macroscopic level could still stem from microscopic reversibility, and it led to other famous paradox (Joseph Loschmidt's reversibility paradox and Ernst Zermelo's recurrence paradox) that prevented Boltzmann's irreversibility from being anything but statistical (Callender, 2001).

The scientific community continued to struggle with the paradoxes of time reversibility for decades. The theory of thermodynamics suffered “from certain limitations, as it (could not) be used for the study of irreversible processes but only for reversible processes and transitions between different states of equilibrium. Many of the most important and interesting processes in Nature (physical, biological and social) are irreversible” (Nobel Institute press release, 1977). The paradox was resolved by Ilya Prigogine who was awarded the Nobel Prize in Physics in 1977 for his contributions to non-equilibrium thermodynamics, particularly the theory of what he called "dissipative structures." These are physical, chemical and biological systems in ‘far from equilibrium’ conditions that appear to develop "order out of chaos". Prigogine’s dissipative systems are also known as complex systems and have been extended from physical, chemical and biological systems to social systems. As for biological systems, matter and energy flows through the "dissipative" structures. (Prigogine, Stenger, 1984). Prigogine demonstrated that the dissipative systems exhibited time as irreversible.

**EMERGENCE OF PARADOX IN COMPLEX SOCIAL SYSTEMS**
The question that begs an answer is whether paradox in nature exists, or is a consequence of our own belief systems, held by individuals or by social systems? On one hand, paradox has been studied as a ‘thing’ by logicians, philosophers and psychologists (Quine, 1976), however, the general understanding indicates that a paradox is cognitively and socially constructed (Luscher and Lewis, 2008). I will see the social system of the scientific community as a complex adaptive social system. My analysis intends to describe how the historical paradoxes are learning paradoxes, and arose as the system faced increased complexity in its environment, while equipped with an information processing architecture that reduced the complexity in an inadequate way, leading to contradictory and counter-intuitive situations.

If a paradox, with its contradictory and counter-intuitive polarities is cognitively constructed it requires that the social system must be able to perform certain cognitive operations. I will not fall for the temptation of equaling cognitive operations in a social system with the cognitive system of the human mind, however, argue that there are collective cognitive processes performed by human organizations that exceed the mere aggregate of the cognitive activities performed by their individuals. Further, that social systems are themselves cognitive agents in their environment with a set of cognitive operations that shows resemblance of qualities in human cognition (Leonartowicz, Weinbaum, Braathen, 2016). Implicitly in this, social systems are complex and adaptive and belong to a class of systems called complex adaptive systems (CAS) (McQuade and Butos, 2009).

Social Systems seen as Dynamics and Process

The social system may be described as a complex system based purely on process and dynamical features. The word complex stems from the Latin word *complectre*, meaning to be entwined, twisted together, or weaved together. The word system means a whole compounded by parts. Hence, a complex system consists of parts that are connected so that it is difficult to separate them. A social system can be seen as a complex system of interactions; i.e. a set of connections in the form of a stable pattern of interactions between a variety of individuals (Winter, 2013; Luhmann, 1995). What connects us to other people is action of communication, and what connects us to the physical resources is the re-action with them and the communicating feedback we get. When we see the organization as an emergent stable pattern of joint activity, we base our grounding ontology on (inter) action (Heylighen and Beigi, 2016), and we stand in the tradition of process philosophy (Rescher, 2000). A dynamic process based description is based on action, change and process, rather than on qualities of substance in the physical world.

From the historical paradoxes, we can study correspondence and communication between individuals that express their thoughts and indicate their cognitive process. However, their actual formative cognitive process leading up to the communication is only indirectly visible. It is on a different level in a hierarchy of natural complex systems; i.e. the psychic system. The
psychic system of the individual mind cannot be part of the description of the social system, even though its influence and relevance is obvious. In terms of Nicholas Luhmann, we may say that there is a *loose coupling* between the psychic and the social system (Luhmann, 1995), where the individual psychic system is considered the *micro-environment* to the social system (Braathen, 2016). This is similar to any description of natural systems; e.g. the description of a cell as a dissipative biological system will not describe the mechanics of the individual physical elements of carbon and oxygen.

**Distinctions and Categories - Building Blocks of the Paradox**

From a process perspective, we may find dynamics of interaction between agents in the system, and between the agents in system and challenges from the environment (Heylighen, 2016). The reaction with challenges from the environment constitutes the most basic type of operation whereby the system observes a *difference*, as the reaction will introduce a new state in the system. This operation leads the way for the system to draw a *distinction* (Luhman, 2002), as the fundamental cognitive operation of a social system. At its core, a distinction is a separation of the being from the non-being (Spencer Brown, 1969). All distinctions inherently contain a possible paradox. Once we try to observe both sides of the distinction, a paradox appears. Non-being and being exist at the same time, and the unity of the two parts become a paradox, but unobservable to the system.

Every new distinction introduces a new *variety*, a new state, in the system. Further, the positive value of the distinction opens up for a *connection* being made between new distinctions and existing distinctions. From the contribution on selective retention of Donald Campell (Campell, 1974), we may assume that only sets of connections with a stable configuration is retained and selected after undergoing changes and possible transitions through unstable states. Hence, there is a natural complexification process with the two basic properties of evolution: variety and connection (selection). The evolutionary complexification process leads to new complex systems of varieties and connections that carry enriched and higher order unit of meaning, whose verification cannot be obtained by a single operation (Luhmann, 2002). We may define such stable structures of variety, constrained by stable connections, as *categories* (Braathen, 2016). Further, following the same complexification process, we may see complex systems of categories evolving into structural hierarchies of categories (Simon, 1962), to constitute a social system’s ‘belief system’ (Braathen, 2016).

The fundamental distinctions are formed as a consequence of interactions with challenges in the environment. However, a *category* is based on distinctions of a different nature; i.e. the distinctions drawn in the unmarked space spanned by all possible combinations of variety and connections. The *category* is therefore based on distinctions drawn in the internal state space of the system itself, and hence not directly from reactions with the environment. For the category to uphold its ‘organization’, the system needs to be closed and self maintained which
means that it maintains an invariant structure in spite of a constant dynamic process of interactions within the system and with challenges from the environment (micro or macro) (Dittrich et al, 2007). The category as a stable organization, i.e. closed and self maintained, and as based on distinctions in the internal state space, belong to a ‘closed’ system separated from the environment, and hence form the boundary of the system towards its macro-environment. The boundary as a ‘cognitive membrane’ is a set of categories that is shared and upheld by interaction (communication) in the system (Luhmann, 1995).

The triangle studied by the Pythagoreans was a geometrical form drawn in a two-dimensional space and as such a distinction drawn by a form in an unmarked space (Spencer Brown, 1969). The inside of the distinction had a positive connecting value to new distinctions that were made; e.g. sides of the triangle and the hypotenuse. The natural numbers was an ancient distinction, originating in our re-action with the physical world, from the need for counting and ordering of objects in the environment, evolving into categories of numerals to represent numbers. The ratios of numbers and how they related to more complex phenomenon as for example musical harmonies was a result of further evolution in complexity of the categories. The categories of musical harmony and ratios of natural numbers had connective value to another complex category of the Gods. Through the positive value of being in the distinctions and categories, complex systems of categories would emerge that constituted the ‘internal’ Pythagorean belief system. The belief system with its categories would be closed and self maintained in a dynamic equilibrium with the environment. The categories of the ‘closed’ belief system would form the boundary between the social system of the Pythagorean and the environment. The pattern of interactions was a process that reduced the complexity of the environment into a system of connected distinctions and categories. The discovery of the incommensurability of Hippasos introduced a new distinction that disruptively introduced significantly more complexity from the environment. The internal complex system was surprisingly inadequate and unable to process this complexity and this ‘glitch’ in the cognitive process was the first indication that a paradox was emerging.

When a system ‘reenters’ the operation of observation, now holding a particular distinction, it is called recursive. A recursive process uses the results of its own operations as the basis for further operations. Hence, what is undertaken is determined in part by what has occurred in earlier operations. The recursive process will act as a confirmation of consistency, where the states of the system that has been produced, serves as criteria for the acceptance and rejection of further operations (von Foerster, 1984).

The distinctions made by Euclid in his axiomatic system were a representation of our basic intuition of space as a fundamental type of re-action with our environment. The recursive confirmation of the distinctions is continuous and constantly on-going, and would strengthen and reconfirm the categories. Emanuel Kant’s Critique of Pure Reason (1781) contributed to the affirmation of the Euclidian categories by defining our intuition of space as a priori and synthetic. The connective positive values of the inside of the distinctions of the axioms were
the basis for the development of more complex categories of geometry. The connection between the four axioms and the parallel postulate was intuitively there from our a priori and a posteriori understanding of space, however, it was impossible to consistently demonstrate how the connective value of the axioms could dictate the parallel postulate. When Bolyai proved that the parallel postulate could not be derived by the axiomatic system, the cognitive processing system experienced another ‘glitch’ sensing the approaching paradox of space. The new complexity of the non-Euclidian geometry was not yet observed, but the proof of impossibility departed from the dynamic equilibrium that the system experienced in its current environment.

Adaptation and Dynamics

Complex adaptive systems are shown to adapt to changes in its environment to maintain fitness (Heylighen, 1996). We find the foundation behind a social system’s drive to seek fitness and to uphold its function on the basis of Maturana and Varela’s concept of autopoiesis, originally developed for biological systems (Maturana and Varela, 1991). The concept has proven to be useful to studies of social systems, and in particular developing its interdisciplinary character through systems theory (Cadenas and Arnold, 2015). Adaptation to environment may be seen from two perspectives. First, changes in the environment may introduce new re-actions with variety and distinctions with following connections inside the system. With the introduction of variety and connections the complexity evolves incrementally to counteract and compensate for perturbations from the environment. This follows Ashby’s law of requisite variety, where the system needs at least the same variety of possible actions as the variety of challenges from the environment (Ashby, 1958). Second, we may see changes in the environment that are too radical, too disruptive and of a dynamic nature where the system no longer can uphold its function with its present structure. The system itself needs to change, to reorganize, in order to support the continuity and coherence of the whole.

The introduction of thermodynamics demonstrated a theory with universal validity, yet independent and contradictory to the Newtonian mechanics of that time. The cognitive system of distinctions and categories would experience inadequate reduction of the complexity in the environment into two separate and contradictory belief systems. This paradoxical experience is intolerable as the system is loosing coherence between the experience and the cognitive understanding of the environment. The system will need to depart from its state of dynamic equilibrium to seek new alternatives. The adaptive process would include introducing new variety of distinctions and create stable connections into new complex systems of categories. Boltzmann’s work introduced a new distinction of probability related to the position and motion of an atom. The distinction had a positive connective value to the Newtonian mechanics on one side, while it also validated the thermo-dynamical laws over an integral
volume. The need to change the understanding of a more complex environment would drive the adaptation of the system of categories. The adaptation process is a coevolution process of the categories as complex systems of varieties of distinctions and connections (Heylighen, 1995). As for the time-paradox introduced by thermodynamics, the adaptation process lasted over a century with contributions from mathematics, physics and philosophy.

From the historical paradoxes, we see that fundamental categories as space, time and numbers are challenged at the center of the paradoxical experience. In a dynamic process-based description of a social system, we may say that the paradox represent a type of limit cycle around an attractor (von Foerster, 1984 ), that correlate to the stable equilibrium (Dittrich et al, 2007) of the category seen as a complex system of connected distinctions. The paradox exists as a limit cycle when the state of a system’s category, re-acting with the new complexity of the environment, is offset from its equilibrium, and observations of new distinctions lead to a contradictory result (Braathen, 2016).

In order for a system to escape the limit cycle, it must adapt its categories and by doing so change the dynamic landscape of attractors. In a more simplistic contradictory situation we may find that adaption of a category from re-actions with the environment leads to a dialectic process and a spiral back to equilibrium. For a disruptive situation represented by a paradox, the required adaptation process is more fundamental. Hippasos’ proof of incommensurability, Bolyai contradictory proof of the parallel postulate, and Fourrier’s rejection of Newtonian mechanics in heat transfer, belonged to a rare set of historical events, when someone was able to prove something impossible. In this sense, annihilating existing categories and radically change the dynamic landscape of the systems state space. In the historical paradoxes, the adaptation process required new categories with new sets of distinctions and connections. The radical expansion and generalization in their solution represented a new degree of freedom in the space of the categories. The generalization of natural numbers to irrational numbers, Euclidian understanding of space into several non-Euclidian geometries, Newtonian mechanics of motion and gravity transformed into thermodynamics, relativity and quantum mechanics. The new degrees of freedom increase the acceleration of adaptation and coevolution of the categories leading to emergent new levels in a complex system hierarchy. The emergence of new levels happen as a meta-system transition (Turchin, 1977; Heylighen, 1995 ) from the lower levels and create a continuity and permanence found in natural complex hierarchies (Simon, 1962). A new meta-level in the structural hierarchy of categories may increase the number of possible stable states of categories on the level below, and hence increase the functional fitness (expand the world view) of the system. In the transition into several consistent non-Euclidian geometries, our intuitive perception of space as postulated by Euclid becomes a special case and one out of several dynamic equilibriums in our complex system of categories relating to space.
RESOLVING PARADOX – A PRINCIPLE FRAMEWORK

In my studies of the historical paradoxes I used grounded theory method to seek and discover emergent patterns in the information, and to search for temporal integration of the core concepts that would explain how the paradox was resolved (Glaser et al, 1999). Historical data from the paradoxes were collected and coded. Categories and principles were formed and related to theory in complex adaptive systems and current theory of paradox in organizational literature. In the following I will present four principles crafted from the study of the historical paradoxes.

Principle I: Postulate of Impotence

The postulate of impotence will call the paradox from being implicitly present to become explicitly recognizable. To prove something impossible is usually much harder than the opposite task, and a proof of impossibility may transform a vague paradoxical experience into a clearly articulated paradox. The historical paradoxes are extraordinary because they exhibit such postulate of impotence through a proof of impossibility. Hippasos’ observation of incommensurability, Bolyai’s argumentum ad absurdum, and Fourier’s dismissal of Newtonian mechanics for heat transfer were all proofs of impossibilities and postulates of impotence.

In the organizational literature on paradox, the initial phase of managing a paradox in organizations is to accept the paradox (Pool & van de Ven, 1989). According to Smith and Berg (1987), in order to escape the paralyzing cycles caused by the paradox, the actors must reclaim the polarized emotions and immerse themselves within the tensions. This calls for the management’s courage to confront the paradox by making them discussable (Piderit, 2000). “Staying with the paradox makes it possible to discover a link between opposing forces and opens up the framework that gives meaning to the apparent contradictions” (Vince and Broussine, 1996). Confronting the paradox may include explicitly differentiating and articulating the opposing poles to amplify their valued distinction, but also to accentuate how they are interrelated (Smith, 2014). The articulation of distinct poles and their relationship is the first step in reframing the organizational belief-system (Bartunek, 1984). This includes clarification of mixed messages that invoke contradictions. The extant frame of reference is violated, in order for the organization to experience a ‘shock’ where it sees its own limiting beliefs (Lewis, 2008).

The well-studied tension between exploration and exploitation may serve as an example. Increased competitive pressures encourage firms to develop both explorative and exploitative capabilities. There is a demand for the flexibility and risk inherent in exploration, while continuing exploitation for enhanced efficiency. The paradox was articulated by March (1991) in his article, Exploration and exploitation in organizational learning, where he accentuated
the two conflicting strategies and how they interrelate. The associated belief-systems would dictate contradictory organizational structures and practices. Exploration is rooted in variance-increasing activities, learning by doing, and trial and error methods; while exploitation is rooted in variance-decreasing activities, structure, and disciplined problem solving (Smith, 2014). March’s contribution was articulating and accentuating the poles and their interrelationship of a paradox that was already experienced by firms competing in a more dynamic market. By confronting the paradox, March would initiate new development among researchers as well as practitioners in order to resolve the paradox.

From the description of the organization as a complex adaptive system this equals a change in the state space of categories as discussed above. By differentiation of the poles, the attractors increase in their strength, or new attractors are introduced which changes the dynamic landscape. We may also find that the articulation of the paradox annihilates existing categories held by the system that also changes the overall state space. The interrelatedness may invoke or uphold dynamics leading to limit-cycles as described above.

**Principle II: Increasing the Degrees of Freedom through Generalization**

Resolving the Pythagorean and ancient Greek paradoxes required expansion and generalization of mathematical concepts used to describe a more complex observation of physical reality. By generalizing numbers to include irrational numbers, and by expanding calculus to include infinity and continuous time, the paradoxes disappeared. Similarly, the expanded plurality of non-Euclidian geometry generalized our understanding of space, and forced us to accept that our intuitive version of the Euclidian geometry is only a special case of a set of more general geometries. Finally, the theories of thermodynamics challenged the closed and consistent world-view of Newtonian mechanics, to include a general theory of heat where our understanding of time and certainty required an expanded frame of reference.

By redefining fundamental categories, the frame of reference and belief-system is expanded for a social system. In a complex system description we may say that this expansion introduces a new degree of freedom in the system’s state space. New degrees of freedom will not only change the categories, their strength and their internal dynamic, but would change the ‘shape’ of the state-space for the system entirely. New degrees of freedom in the state space would exponentially increase the new set of varieties of distinctions and connections the hierarchy of categories could include, and would accelerate the co-evolution process. A radical co-evolution may lead to the emergence of new levels in the complex hierarchy of categories through meta-system transitions (Turchin, 1977; Heylighen, 1995). While a particular configuration of categories would represent the system’s frame of reference of the environment, a new level would allow multiple set of potential stable configurations of the
system. When a new hierarchical level emerges, the degree of freedom in the system’s state space increase, and the disruptive shift in the dynamics of the system could finally break the limit-cycle of the paradox and start the search for a new set of dynamic equilibriums. New levels in the category hierarchy increase the functional fitness of the system’s belief system relative to its more complex environment.

In theory of paradox in organizational research, similar approaches to the principle of generalization include acceptance and transcendence of the paradox (Schad et al, 2016). Acceptance entails opening tensions to a dialogue that may foster more constructive and creative considerations. This implies that the actors and the organization must learn to live with paradox, and that the shift in perspective offers a sense of freedom (Schneider, 1999). Transcendence on the other hand implies the capacity to think paradoxically. Watzlawick et al (1974) explain how actors and organizations need to break out of first-order thinking and engage in second-order reflection. First order thinking includes incremental alterations to existing reasoning, logic and behaviors. Second order reflection requires the organization to critically examine extant assumptions to reframe perception of opposites, and develop a more complex repertoire of understanding and behaviors matching the challenges from the environment. Second order reflection may introduce new concepts or a new perspective and create a synthesis of the opposing poles in the paradox. If we believe that the learning paradox stem from conceptual limitations or flaws in our understanding and assumptions, it is necessary to introduce new categories or theory.

Poole and Van de Veen (1989) describe how a synthesis process, initiated by Giddens (1985) resolved the example of the structure:action paradox in organizational theory. The tension stems from the contradictory yet interrelated perspective of an organization. On one hand, the organization may be seen as a structure, often conceptualized by its degree of formalization, centralization and complexity. The contingency approach accentuates the causal effects between different variables of structure and the effect it has on individual action. On the other hand, most theorists would agree that organizations are social action systems. One may claim that it is precisely the recurrent patterns of individual’s intended actions that are the source of the organizational structure. The reciprocal nature of structure and action is evident to common sense and has been acknowledged by scholars of organizational theory (Parson, 1968; Coleman, 1990). Action requires structure, yet structure only exists through action.

After examining the different yet interrelating perspectives of action and structure in an organization (Coleman, 1990), Giddens (1985) introduced the concept of structuration: the process of production and reproduction of social systems via members’ application of rules and resources. This “assumes (that) structures have a dual nature: They are both the medium and outcome of action. Structures make action, and hence the existence of social systems, possible. Nevertheless, structures only exist as they are continuously produced and reproduced in interaction” (Poole and Van de Ven, 1989). Central to the process of structuration was the concept of modality: the individual actor’s appropriation of structure for use in a particular
action context. As an example an individual may use a computer system as an institution in action, producing and reproducing a mode of structural interpretation. The system determines the structural features available for appropriation, and limits the possible actions of the individual. The individual’s actions add to the reproduction of the structural institution of the system.

Giddens’ synthesis and introduction of the concept of structuration and modality encompassed the tension between structure and action into a single coherent theory. The theory was derived by accepting and exploring the two opposing perspectives while critically examining assumptions and frames of reference through second order reflections.

**Principle 3: Resilience from Complementary Perspectives**

The resolution of the historical learning paradoxes would produce new and synthesized theories based on generalized and expanded concepts. The introduction of new theories leads to new frames of reference and new world-views of the social system. As seen from the historical paradoxes the principle of impotence and the process of generalization, would lead to more than one complementary and coherent theory emerging from the same paradox. For the ancient Greek paradox Newton and Leibniz both put forward a comprehensive theory of calculus; Leibniz starting first with integration, and Newton following with differentiation. Newton accused Leibniz of plagiarism, however, both were given credit for developing calculus independently. The story of Newton and Leibniz shows how different perspectives may be perceived as competing, but over time, are complementary and integrated into a coherent and more resilient theory.

Similarly, the paradox of space was resolved by the independent non-Euclidian geometries of Lobacevskij, Gauss and Riemann. The models were complementary and consistent, and describe our current understanding of space. The empiric observation of time-space relationship added to the complexity of the description, and thus also to the resilience of the world-view. Finally, the theories of thermodynamics were developed with similar complementarity between the empirical, phenomenological laws of Clausius and Carnot, and the statistical mechanics description of Bolzmann.

Also in the organizational literature we find how new frames of reference emerge out of the paradox and grow resilient through a set of complementary perspectives and theories. The complementary perspectives may evolve from spatial and temporal separation in the organization of opposing thesis in the paradox (Poole and Van de Ven, 1989), or from new concepts and theory developed in the generalization and synthesis process described above. The *structure:action* paradox may even serve as a meta-dialogue on the topic. In this research, I am studying how organizations can be described as complex adaptive systems and how it adds to the theory of paradox. My approach to complex social systems is based in action
ontology, and is complementary to organizations treated as substance of objects, people, and resources. On the matter of structure::action, complexity theory will describe how CAS self organize and create structures based on interactions in the system (Holland, 2014). However, the structures imposed on the system will also dictate the possible patterns of interactions and how complexity is constrained. Giddens’ defined *modality* as the appropriation of a structural element by an individual. In the CAS perspective of a social system, the modality equals a stable, i.e. closed and self maintained, set of interactions between individuals, or between individuals and a physical resource. For example, this may be the interaction between an individual and a computer system, a template, or a contract. If the set of interactions are stable, the structural fitness of the social system will increase (Heylighen, 1999). If the product (output) from the set of interactions is perceived valuable by another part of the system, a (selected) connection is made, and the functional fitness of the system increases relative to its environment (Heylighen, 1999). Complementary, yet consistent with Giddens’ theory, the interaction/modalities ‘used’ frequently reinforce the structure and become more important, whereas those less frequently ‘used’ decay. Thus, theory of complex adaptive systems complement organizational theory with a different, but valid description of structure and action.

Whether an organization can live with complementary ideas, theories and perspectives comes down to management’s strategy of acceptance rather than defensiveness. With acceptance of the complementary yet sometimes competing perspectives, virtuous cycles that drive development. Over time the distinctions in the two perspectives are connected to form a unified and stable frame of reference for the organization. On an individual level this requires cognitive and behavioral complexity, and emotional equanimity that foster the collective openness (Schneider et al, 1999). On an organizational level it requires dynamic capabilities (Smith et al, 2011). A dynamic capability is the set of process and routines that alters the operational capabilities in a shifting environment (Teece et al., 1997). Dynamic capabilities may act as vicarious selectors (Campell, 1973) to explore how two complementary perspectives may be integrated into processes and routines in the organization (Braathen, 2015).

**Principle 4: Sustainability through permanence**

When extending the frame-of-reference with increased complexity, we need consistency where valid definitions and categories in our existing world-view are preserved. We need to understand under which circumstances the more general rules employed contain special cases under which the rules were derived. The sustainability of a new theory or perspective depends on its ability to connect and accommodate existing categories with permanence. From the historical paradoxes we saw how the understanding of space in Euclidian is contained as a special case inside the non-Euclidian geometry. For the paradox of time, we saw how theory
of dissipative systems could integrate the reversibility of Newtonian mechanics on a micro level with the irreversibility of thermodynamics in higher order macro level systems. Another example is the transition from Newtonian mechanics to Einstein’s relativity theory that gives a permanent perspective on behavior of physical objects contingent upon speed. Finally, we see how the extended concept of irrational numbers contains the ratios of natural numbers defined by the Pythagoreans.

The organization’s belief system may be described as a complex structural hierarchy of categories (Braathen, 2016). From the description of the organization as CAS, we see that the paradox exists as limit cycle in existing stable (closed and maintained) belief-systems in the organization. In order for a new more complex belief-system to emerge, the extended distinctions and categories must positively connect in niches of the existing system, or introduce a new connected level that constrain variations on the levels below (Heylighen, 1999). If it existed independently, without connective value to the existing system, the explanatory power of the category system would vanish. One particular stable set out of the constrained variety of possible sets might be the special case of a more general theory derived.

In the context of organizational studies, the principle of permanence correlates to the organization’s drive for consistency and uncertainty reduction when challenged by disruptive change (Tushman and O’Reilly, 1996). The extended frame of reference must accommodate and integrate existing understanding, to be represented in routines and individual behavior. A cognitive process on the organizational and individual level is needed to align and integrate new categories into a consistent cognitive framework (Weick et. al, 2005). The cognitive frames are mental templates through which the organization and managers/employees filter knowledge and direct actions (Walsh, 1995). The role of the senior management is critical to sustain organizational permanence and performance in this process (Smith and Tushman, 2005). The executive role must facilitate the synthesis and extended perspectives in to concrete action, to reconcile contradictory or inconsistent forces, instincts, interests and ideals. This entails shifting levels of analysis to identify potential linkages, and to maintain attention on possible synergies and virtuous cycles, and innovation that initiate convergent processes (Poole and Van de Ven, 1999).

CONCLUSION

Early philosophers and scientists offer great insight into the complexity of paradoxes. Their insight were hard-earned and derived from groundbreaking historical events. “(A) review of Paradox in the management domain suggests that we benefit from revisiting these origins to inform our future research” (Schad et. al, 2016). In this study I have exploited a set of these historical paradoxes to extrapolate the main events and processes. Three fundamental paradoxes regarding epistemology and ontology of physical reality, space and time was briefly described in this article.
In order to capture the true dynamic phenomenon of paradox, we must seek a multi-paradigmatic and interdisciplinary approach, leveraging different worldviews and underlying assumptions (Schad et. al, 2016). A set of cross-paradigm theories backed by empirical studies will contribute to a meta-theory of paradox as the locus of organizational tensions and their management across multiple contexts and variables. Complexity theory seeks to understand the foundation and implication of complexity as well as the dynamics of complex adaptive systems. Complexity theory is applied to all types of complex adaptive system including biological, social and cultural systems. In this article I have argued that a description of an organization as a complex adaptive system based on process and action will contribute to a consistent micro-foundational model for how paradox emerges in social systems and how the principles of resolutions may be understood.

Further, I have argued that basic cognitive operations of drawing distinctions and forming categories are preformed by the social system itself. The system of categories forms the frame of reference for the organization and is by nature a stable, i.e. closed and self-maintained, internal complex structural hierarchy. The ‘cognitive membrane’ forms the boundary between the social system and its environment. It is through the frame given by the cognitive membrane that input (challenges) from the environment are coded into interactions, communication and routines. The learning paradox emerges when the organization, with an simplistic system of categories, fail to maintain the principle of requisite variety to code a more complex environment in an adequate way. The ‘glitch’ in cognition leads to viscous cycles that we experience as paradoxical. In complex systems theory the concept may be described as limit-cycles in the category state space and is a type of dynamic equilibrium. By analyzing the historical paradoxes, we could see clear resemblance between documented historical events and the conceptual frames derived from complex systems theory.

The historical paradoxes studied had severe impact on human history and civilization. Each of them perplexed and paralyzed the scientific social system, and represents the main paradigmatic shifts in history of science as described by Kuhn (1962). They also form an excellent foundation for empiric studies as they are well documented, and events and communication are ‘crystalized’ and transparent to everyone. By studying a set of the historical paradoxes I have carefully tried to craft four principles found to be present and valid in the process leading up to resolution of the learning paradoxes. In the analysis, the principles are first, related to the three historical paradoxes described in this article; second, related to the process-based complex adaptive system model of a social system; third, related to the theory of paradox found in organizational and management literature. The intention was to build an interdisciplinary bridge to support a multi-paradigmatic perspective on paradox theory for organizations. Further, to guide practitioners in their navigation of a landscape of tension and paradoxes inspired by insights from history.
BIBLIOGRAPHY


