Emergence as a construct

History and issues

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Introduction

Emergence, as in the title of this new journal, refers to the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems. Emergent phenomena are conceptualized as occurring on the macro level, in contrast to the micro-level components and processes out of which they arise.

In a wide variety of scientific and mathematical fields, grouped together loosely under the title “complexity theory,” an intense search is now under way for characteristics and laws associated with emergent phenomena observed across different types of complex systems. As a prelude to the study of emergence in organizations, in this article I want to discuss some of the main issues surrounding the explanatory use of the construct of emergence in general, as well as place it in a historical context in order to gain a better grasp on what is unique about its contemporary manifestations.

Although emergent phenomena appear differently in different types of systems, e.g., whether they occur in physical systems or in computer simulations, they share certain interrelated, common properties that identify them as emergent:

- *Radical novelty*: emergents have features that are not previously observed in the complex system under observation. This novelty is the source of the claim that features of emergents are neither predictable nor deducible from lower or micro-level components. In other words, radically novel emergents are not able to be anticipated in their full richness before they actually show themselves.
- *Coherence or correlation*: emergents appear as integrated wholes that tend to maintain some sense of identity over time. This coherence spans and correlates the separate lower-level components into a higher-level unity.
- *Global or macro level*: since coherence represents a correlation that spans separate components, the locus of emergent phenomena occurs at a global or macro level, in contrast to the micro-level locus of their components. Observation of emergents, therefore, is of their behavior on this macro level.
- *Dynamical*: emergent phenomena are not pre-given wholes but arise as a complex system evolves over time. As a dynamical construct, emergence is associated with the arising of new attractors in dynamical systems (i.e., bifurcation).
- *Ostensive*: emergents are recognized by showing themselves, i.e., they are ostensively recognized. Bedeau (1997) refers to their ostensive quality when he defines emergence in terms of simulations such as are found in artificial life (Langton, 1986). Because of the nature of complex systems, each ostensive showing of emergent phenomena will be different to some degree from previous ones.

In respect to its use in scientific explanation, the construct of emergence is appealed to when the dynamics of a system seem better understood by focusing on across-system organization rather than on the parts or properties of parts alone. Yet, appeals to emergence follow more of a continuum than a discrete jump from part to whole (Bechtel and Richardson, 1993; seeFigure 1).

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Fig. 1: Continuum of emergence explanations

Accordingly, the construct of emergence can be employed along with, not in exclusion to, appeals to the functioning of the parts of a system. In fact, it is often the very interplay between the parts and the whole that has been emphasized in studies of complex, self-organizing systems (see Lewin, 1992).

PARTS/WHOLES/GESTALTS

It must be emphasized, however, that there is much more going on with emergent phenomena than has traditionally been included under the whole/part relationship. This can be shown by contrasting the construct of emergence as it is currently used with two similar ideas from the history of western thought: that of a “whole before its parts” and that of “gestalts.”

“Whole before its parts” refers to the granting of explanatory precedence to a whole entity over the parts of which the whole is made up (Tiles, 1989). For example, Aristotle responded to a famous paradox put forward by Zeno through positing a notion of a “whole before the parts.” Zeno insisted that a distance of any length could be divided into an infinite number of shorter segments. This meant that covering the distance required traversing an infinite number of shorter segments. However, traversing an infinite amount of segments would take an infinite amount of time; yet we obviously do cross distances in finite lengths of time!

Aristotle’s answer to Zeno was that a length was first and foremost a whole. True, this whole might be divided into an infinite number of parts—nevertheless, the whole was fundamentally irreducible to those parts. In fact, it was only because a distance was a “whole before its parts” that it could be traversed.

Although the idea of a “whole before its parts” resembles the coherence of emergent structures as consisting of more than a mere collection of the parts, there is a crucial difference between the two constructs: a “whole before its parts” connotes a pre-given coherent entity, whereas emergence, as stated above, is not pregiven but a dynamical construct arising over time.

The non-dynamical nature of a “whole before its parts” can also be seen in one of its more recent embodiments, the concept of a “gestalt” (whole forms or configurations). The modern meaning of “gestalt” had its origin with the German Romantic poet, philosopher, and scientist Johann Wolfgang von Goethe, who used the term to refer to a natural unity that was the endpoint of an entelechetic development out of primordial chaos (Harrington, 1996; this meaning of “gestalt” does indeed seem loaded with notions also found in contemporary complexity theory, such as how order emerges out of chaos). Goethe’s “gestalt” went through various ramifications before it eventually wound up as the basic unit of perception for gestalt psychology; one of whose progenitors, Christian von Ehrenfels, sounded very much like a contemporary complexity theorist when he remarked that perception takes place through recognizing whole patterns: “the whole is greater than the sum of the parts” (Harrington, 1996). Several proto-emergentists borrowed the term “gestalt” for describing emergent phenomena. Nevertheless, like the “whole before its parts,” a gestalt is a pregiven whole and, thus, does not have the dynamical sense of emergence.

The dynamical characteristic of emergence can be better appreciated by considering its association with the arising of attractors that are not pre-given in the sense of a gestalt. New attractors show themselves when a dynamical system bifurcates, this event signifying both a quantitative and a qualitative metamorphosis. These new attractors then dominate the system and thereby allow for the emergence of something radically novel in respect to what came before.

PROTO-AND NEO-EMERGENTISM

PROTO-EMERGENTISM: EMERGENT EVOLUTIONISM

The technical meaning of the term “emergence” as used by complexity theorists is not a new one. It was coined over 100 years ago by the English philosopher G.H. Lewes (1875). Building on J.S. Mill’s earlier differentiation of types of causation, Lewes distinguished between “resultant” and “emergent” chemical compounds coming about from a chemical reaction (Lewes, 1875: 368-9):

> *although each effect is the resultant of its components, we cannot always trace the steps of the process, so as to see in the product the mode of operation of each factor. In the latter case, I propose to call the effect an emergent. It arises out of the combined agencies, but in a form which does not display the agents in action … Every resultant is either a sum or a difference of the co-operant forces … [and] is clearly traceable in its components … the emergent … cannot be reduced either to their sum or their difference (italics added).*

From this quote we can see that “emergent” is very much like the modern usage, in which nonlinear interactivity leads to novel outcomes that are not sufficiently understood as a sum of their parts.

Lewes’s term was borrowed during the 1920s to form the backbone of a loosely joined movement in the sciences, philosophy and theology known as emergent evolutionism (for a history and review see Blitz, 1992). The main proponents of this movement (we shall call it “proto-emergentism” to distinguish it from the “neo-emergentism” of current-day complexity theory) were the animal behaviorist C.L. Morgan (1923), the philosophers Samuel Alexander (1966) and C.D. Broad (1925), and the entomologist W. Wheeler (1926). The concept of emergence was hotly debated and stimulated some of the most significant thinkers of the age, including Alfred North Whitehead.

As a movement, proto-emergentism died out during the 1930s (McLaughlin, 1992), yet the construct of emergence continued to exert an influence, mainly via philosophies of science where it was used as a bulwark against aggressive forms of scientific and philosophical reductionism. This usage of emergence was mostly of a defensive nature, carving out a position between vitalism on one side and reductive mechanism on the other.

When it came to understanding how emergence itself was at all possible, proto-emergentism had few answers. Alexander (1966), for example, said that the appropriate response to an emergent was “natural piety.” In proto-emergentism the process of emergence remained a black box, so that one could discern both the lower-level inputs and the higher-level outputs but not how the lower was transformed to the higher during emergence. However, contemporary complexity theory is proving capable of prying open the black box of emergence due to the advent of high-speed computers, the discovery of pertinent mathematical constructs, and new research methods. As a result, the construct of emergence is acquiring a much surer foundation and usefulness in scientific explanations.

NEO-EMERGENCE: COMPLEXITY THEORY

We can better apprehend the unique features of emergence today in contrast to proto-emergentism by briefly sketching out the scientific and mathematical sources of emergence in complexity theory. The current investigation of complex systems has roots in various, sometimes closely associated, approaches to the study of the dynamics of systems in the physical sciences, mathematics, and computer science going back to the Second World War and its aftermath (seeFigure 2, adapted from Goldstein, 1998).

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Fig. 2: Mathematical and scientific roots of emergence

In the early system sciences of cybernetics, information theory, and general systems theory (seen on the left side of Figure 2), emergent phenomena *per se* were not explicitly the focus of research, since the systems investigated by these earlier approaches were simple, linear and equilibrium seeking, in contrast to the complex, nonlinear, and nonequilibrium systems in which complexity theory is interested. Emergence requires systems with at least the following characteristics (in spite of potential confusion caused by the heterogeneous vocabularies and methodologies of the diverse sources of emergence, there are certain ideas that cut across them):

1. *Nonlinearity*. Although the systems studied by the earlier theories include a degree of nonlinearity to the extent that they were depicted in terms of negative and positive feedback loops that are nonlinear in nature, they include neither the “small cause, large effect” nor the intense focus on nonlinear interactivity found in emergent phenomena.

2. *Self-organization*. Although the term self-organization was occasionally used by earlier systems thinkers, it referred primarily to self-regulatory processes, whereas in complexity theory the term refers to the creative, self-generated, adaptabilityseeking behavior of a complex system. Emergent phenomena are novel structures that confer this adaptability.

3. *Beyond equilibrium (multi-, non-, or far from equilibrium)*. Earlier systems theories explored how systems tend toward a final state of equilibrium or homeostasis (see, for example, the notion of “equifinality” in general systems theory), whereas complexity sciences are far more interested in the “beyond equilibrium” conditions that foster emergence. One of the origins of the radically novel order seen in emergent phenomena is the manner in which far-from-equilibrium conditions allow for the amplification of random events (see Nicolis, 1989). This amplification of random events, in turn, is a key reason for emergence having unpredictable characteristics.

4. *Attractors*. The only “attractor” available to earlier systems theory was a final state of equilibrium, whereas in complexity theory there are different kinds of attractors (e.g., the fixed point, limit cycle, and the so-called strange attractor). As stated above, emergent phenomena are coincident to the new qualitative levels introduced as complex systems enter new attractor regimes.

These four characteristics of complex systems have been extensively studied by the central schools of research making up the backbone of complexity theory (in Figure 2 they are listed downward in the central part of the diagram, immediately to the left of “emergence in self-organizing systems”):

- *Complex adaptive systems theory*, which has been made famous at the Santa Fe Institute and which explicitly uses the term “emergence” to refer to the macro-level patterns arising in systems of interacting agents (see Holland, 1998; Kauffman, 1995; and Langton, 1986);

- *Nonlinear dynamical systems theory*, which as the mathematical grandfather of chaos theory promulgated the central concept of attractors, including the strange attractor that the philosopher of science David Newman (1996) classifies as an authentically emergent phenomenon.

- The *synergetics school*, founded by the German physicist Hermann Haken (1981), which helped initiate the study of selforganization in physical systems and which brought us the crucial idea of an order parameter in explaining the onset of macro-level, coherent phenomena.

- *Far-from-equilibrium thermodynamics*, which was introduced by Ilya Prigogine and which refers to emergent phenomena as dissipative structures arising at far-from-equilibrium conditions (see Nicolis, 1989).

Applications of the construct of emergence for understanding organizational dynamics will need to borrow from all these sources as well as taking advantage of the new insights that are rapidly coming forward as the study of complex systems intensifies.

PHILOSOPHY OF SCIENCE ISSUES

WHAT IS THE ROLE OF EMERGENCE IN EXPLANATION?

As stated above, emergence is appealed to when the configuration of the components of a complex system offers more explanatory insight into the dynamics of the system than do explanations based on the parts alone. Therefore, explanations that include the construct of emergence contain the claim that emergent phenomena are neither predictable from, deducible from, nor reducible to the parts alone. Turning to the new, higher, emergent level for explanation is, then, equivalent to admitting that an explanation of the system's dynamics purely in terms of the lower level of the parts is insufficient. But besides this admission, what explanatory mileage is gained by bringing in the construct of emergence? To answer this question we must take a closer look at the actual role of emergence in scientific explanation.

In fact emergence functions not so much as an explanation but rather as a descriptive term pointing to the patterns, structures, or properties that are exhibited on the macro-level. For example, the hexagonal convection cells seen in the Benard system are emergent phenomena, since they are higher-level patterns representing an across-the-system correlation not present on the lower level of system components (see Nicolis, 1989). Calling the convection cells emergent places them on the appropriate level from which the explanation can proceed. The explanation then elicits the special, higher-level laws that further elucidation of the emergent phenomena. In the case of the Benard cells, this would include determining the far-from-equilibrium conditions that prompt the emergence, measuring the correlation found in the cells, or, in other words, determining the "order parameters" of the emergent level that aid in our understanding of this startling occurrence.

An appeal to emergence is thus a way to describe the need to go to the macro level and its unique dynamics, laws, and properties in order to explain more adequately what is going on. The construct of emergence is therefore only a foundation on which to build an explanation, not its terminus. The proto-emergentists foundered on this issue since, because they had no access to the kinds of processes that are powerful enough to bring about emergent phenomena, they had to be content with a mere designation of something as emergent. But complexity theory can go much further in uncovering the many factors involved in the coming forth of emergent phenomena. That is, complexity theory is developing the necessary tools, methods, and constructs that render the process of emergence less opaque and, thereby, less prone to the tag of "miraculous."

IS EMERGENCE MERELY A PROVISIONAL CONSTRUCT?

Since the heyday of emergent evolutionism, a standard criticism leveled at the idea of emergence has been to contend that it has nothing more than a provisional status, that it is simply an epistemic recognition of the inadequacy of any current theory for deriving macro-level properties from micro-level determinants. When a better theory comes along, appeals to emergence will no longer be necessary since this better theory will be able to predict, deduce and reduce emergent phenomena to micro-level processes (Henle, 1942). Emergence then becomes just a temporary mark for something about which we don't yet know enough, but eventually will.

According to Hempel and Oppenheim (1948), since emergence could only be defined in respect to a specific theory, and since theories are always developing, the construct of emergence will eventually be discarded. Lewes himself inclined to the provisional view of emergence, while proto-emergentists like Morgan and Alexander thought that emergent phenomena were neither deducible nor predictable, even "in principle" (Stephan, 1992). Indeed, for Morgan, the provisional nature of emergence did not account as evidence against its scientific status but rather supported it, since he felt that science always dealt with things of which it did not have perfect knowledge. The issue of the provisional character of emergent unpredictability was an important one for emergent evolutionists, since unpredictability buttressed their claim for the type of novelty they required for their various schemes of cosmic evolution.

It turned out that a better theory did come along to explain the prototypical example of emergence described by the protoemergentists. The better theory was that of quantum bonding, which explained the new properties of compounds in terms of the micro-determinants of their reagents. In fact, the development of the theory of quantum bonding was one of the factors leading to the demise of proto-emergentism (McLaughlin, 1992). It needs to be pointed out, however, that it wasn't emergence itself that was the problem but the examples that the emergentists used to exemplify it. Thus if, following David Newman (1996), we take a strange attractor as an example of an emergent phenomenon, then mathematical theorems support the inviolable unpredictability of this particular emergent at least. Here, an exemplification of emergence can defend itself against the argument that its unpredictability will someday become totally predictable.

To be sure, studies of emergence in simulations (such as the Game of Life) show that unpredictability is only absolute the very first time emergents are observed. Thereafter, the emergent patterns yield to greater and greater unpredictability (see

Poundstone, 1985). But does this mean that emergents are only emergent the first time they are observed? This is, of course, very similar to the issue of whether emergents are merely provisional.

In complexity theory there is a built-in limitation to predictability having to do with the non-analytically solvable nonlinearity of complex systems, such that there will be differences in the emergent phenomena at each turn of their evolutionary trajectory. In effect, there seems to be no end to the emergence of emergents. Therefore, the unpredictability of emergents will always stay one step ahead of the ground won by prediction and, accordingly, emergence will always stay one step ahead of the provisionality argument. As a result, it seems that emergence is now here to stay. Of course, this doesn't mean that there will be no great inroads into making the unpredictability of emergence more predictable. Rather, it goes along with the general reframing of the entire issue of predictability in scientific explanation that complexity theory has begun. Similar to the role of the uncertainty principle in quantum mechanics, the nonlinearity of the complex systems under investigation by complexity theory introduces a degree of unpredictability that even in principle will not completely yield to more and more probing.

EMERGENCE, REDUCTIONISM, AND THE PLURALITY OF LEVELS

Hidden behind the charge of provisionality is a metaphysical, not a scientific assumption: there is only one basic ontological level and the aim of scientific explanation is to reduce all apparently new levels to this primordial level (an example of such reductionism in criticisms of proto-emergence can be seen in Pepper, 1926). We can call this metaphysical assumption "ontological-level monism." This assumption shows itself with respect to provisionality by containing the further assumption that what appears now as an emergent level will, when a better theory of microdetermination comes along, turn out to be reducible to the micro level.

However, scientific explanations need not claim fealty to ontological-level monism. The physicist and philosopher of science Mario Bunge has shown how emergence is a viable construct by sketching out a scientifically founded pluralistic ontology of levels (Blitz, 1992). In a similar vein, the philosopher of science William Wimsatt (1976) has indicated that when selecting a particular level on which to focus our attention, we are doing so on the basis of recognizing that this level consists of entities and their relations that hang together more strongly with one another than they do with other units and relations on other levels. Accordingly, that particular level, in our case the emergent, macro level, should be where one starts one's explanation. As Wimsatt notes, this way of explanation via levels follows from the statistical reference theory of explanation by looking for factors that give a better partitioning of the phenomena into different classes.

Those who cannot accept the possibility of more than one ontological level also cannot accept the possibility of the radical novelty that accompanies the new level coming into being with emergence. They have a bias against real novelty. With nonlinear dynamics and complexity theory, hard-core reductionism of the ontological-level monist variety has finally come upon natural processes that will not yield to the reductionist onslaught because of the very mathematics of such processes. The nonlinear mathematics of these complex systems disallows exact prediction of future states, since the equations governing such systems are not analytically solvable.

In spite of protestations to the contrary, a rigorous philosophical defense can be erected to support a pluralism of levels. Recently, the philosopher of science Carl Gillett (1988) has shown how the ontological commitments of the proto-emergentist philosopher Samuel Alexander can shed light on contemporary ideas on emergence. The recognition of a plurality of levels, moreover, does not require an abandonment of physical causality, as was done, for example, by C.L. Morgan (1923). However, it does require a rethinking of the role of causality in complex systems manifesting emergent processes (see Goldstein, 1996).

One strategy that has been used to support the reality of the emergent level is to attach to it a causal efficacy. For example, the neuroscientist Roger Sperry (1986) argued that the mind emerges out of brain functioning, yet the mind has causal power in affecting the brain. Furthermore, if emergents have causal power, then how can they be merely provisional (see Schroder, 1988)? Of course, this kind of "downward causation" does not come problem free. For example, there is the apparent conundrum of how an emergent that is "caused" by lower-level components in turn has causal power over these lower-level components. Going further down that path will have to be saved for a future article. The point, nevertheless, is that there are various ways of conceiving emergence that give the emergent, macro level its due.

ARE EMERGENTS MERELY EPISTEMOLOGICAL?

Related to the supposed provisionality of emergents is the issue of their ontological status. Are emergent phenomena part of the real, authentic "furniture of the world," or are they merely a function of our epistemological, cognitive apparatus with its ever-ready mechanism of projecting patterns on to the world?

An example of a perceived pattern turning out to be a mere epistemological artifact is offered, in another context, by the evolutionary biologist Richard Dawkins (1996). He describes a photograph of the side of a hill at a certain time of day with sunlight shining from a certain position in the sky. Looking at this scene from a particular vantage point, one can see what appears to be the profile of John F. Kennedy. Of course, JFK is not there on the hill but is merely the confluence of air and wind and seismic patterns and being in the right place at the right time. In a similar vein, the computer scientist John Holland, whose work has been very influential in complexity theory and who has written a book on emergence (see Holland, 1998), makes a distinction between authentically emergent phenomena and what he calls “serendipitous novelty,” such as the play of light on leaves in a breeze.

No one has more clearly remarked on this issue of epistemological status than the chaos and complexity physicist James Crutchfield (1993, pp. 3, 4):

> *Indeed, the detected patterns are often assumed implicitly by analysts via the statistics they select to confirm the patterns' existence in experimental data. The obvious consequence is that “structure” goes unseen due to an observer's biases … It is rarely, if ever, the case that the appropriate notion of pattern is extracted from the phenomena itself using minimally-biased discovery procedures. Briefly stated, in the realm of pattern formation “patterns” are guessed and then verified … At some basic level, though, pattern formation must play a role. The problem is that the “newness” in the emergence of pattern is always referred outside the system to some observer that anticipates the structures via a fixed palette of possible regularities … When a new state of matter emerges from a phase transition, for example, initially no one knows the governing “order parameter” … After an indeterminate amount of creative thought and mathematical invention, one is sometimes found and then verified as appropriately capturing measurable statistics.*

Crutchfield (1993, p. 8) has pointed out that emergent structures elude traditional physics, “since there are not physical principles that define and dictate how to measure natural structure.” Whereas traditional physics has had tools for detecting either complete order or complete randomness, the middle ground of order has been left out. But it is precisely this middle ground that is the locus of emergence. As a consequence, the lack of sufficient frameworks for grasping emergent order is what interferes with accepting emergents as having an ontological status.

Crutchfield's own tactic in addressing the epistemological status of emergence is to examine the *intrinsic* computational capacity effectuated by emergent phenomena, which renders complex systems adaptive. However, defining emergence in terms of an intrinsic computational capacity raises all sorts of scientific and philosophical issues, such as the philosopher John Searle's (1994) contention that computational capacity always contains an external connection so that it is not really totally an intrinsic property. Crutchfield's postulation, nevertheless, like the aforementioned idea of “downward causation,” points to how emergence has the potential of generating self-maintaining mechanisms that serve to distinguish it from subjective impressions, serendipitous novelty, or merely epiphenomenal activity. As the field of complexity theory matures, we can look forward to many more insights into the issue of the ontological/epistemological status of emergents. For now, we simply need to be careful in our recognition of emergent phenomena and continually ask the question of whether the pattern we see is more in our eye than the pattern we are claiming to see.

ORGANIZATIONAL APPLICATIONS OF EMERGENCE: AREAS OF FUTURE RESEARCH

EMERGENCE AND THE INFORMAL ORGANIZATION

Although research focusing explicitly on emergence in organizations is a new field, there already exists a substantial body of work on emergent phenomena that has not been recognized as such because of the lack of a suitable theoretical and methodological framework. Specifically, I have in mind studies of what is typically referred to as the “informal” organization, i.e., spontaneously occurring organizational events, structures, processes, groups, and leadership that occur outside of officially sanctioned channels. Much of this “informal” organization can be considered as authentically emergent in terms of what we have been discussing, and considering it so can provide insights that have not been forthcoming with pre-existing models. For example, complexity theory can aid in uncovering the conditions that lead to the “informal” organization as well as the adaptive role that various aspects of the “informal” organization may play. Indeed, if it can be shown that the “informal” organization offers greater adaptability to an organization, these organizational dynamics will be given more of the attention they deserve, not only by researchers but by the managers of existing organizations.

EMERGENT LEADERSHIP

We can better understand the place of emergence in organizations through a two-by-two grid that relates the source of a organizational structure to its type (Figure 3; “source” refers to whether or not it is imposed, while “type of structure” identifies it as hierarchical or not).

The upper left quadrant displays a hierarchical type of structure, the source of which is self-organized rather than an imposed hierarchy. This is the aforementioned “informal” leadership, which we can henceforward call emergent leadership. Much of the research on emergent leadership is concerned with how leaders emerge in leaderless groups (see for example Kolb, 1997). Recently, Guastello (1998) has used a nonlinear, dynamical perspective to elucidate emergent leadership behavior in groups.

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Fig. 3: Emergence and organizational dynamics

The study of emergent leadership phenomena is ripe for further exploration using the insights of complexity theory on emergence in general. This line of research would offer insight into how potentials for emergent phenomena are inherent in the dynamics themselves, that is, there is a kind of “order for free” (see Kauffman, 1995) that may eventuate in emergent leadership. Studies of emergent leadership need to appreciate the factor of this inherent dynamics before it can establish the significance of the other, non-complexity factors to which it has previously devoted its attention.

EMERGENT NETWORKS

The upper right quadrant, however, is a new area of research opening up due to complexity theory. Sometimes the upper right and lower right are conflated. It must be emphasized that the lower right quadrant, although made popular by total quality management (TQM) and other similar programs and supposed to ensure a participatory work environment, is not emergent in the sense of complexity theory. Instead, team structures are typically imposed and hierarchically driven. Emergent networks, however, the upper right quadrant, represent authentic instances of emergence in organizations as complex systems. Emergent networks can include both intra- and intergroup dynamics and also pertain to the spontaneously arising organizational structures and practices that accompany mergers and acquisitions and the newly shaped strategic alliances that are so rife in our contemporary business world.

An example of an emergent network that also includes emergent leadership can be found in Murnigan and Conlon’s (1991) research into the organizational success factors of string quartets in the UK. The organization of successful quartets was observed to be a function, not of the imposition of an official management structure, but instead of allowing for the emergence of effective strategies, work processes, and leadership roles (see a more in-depth discussion of this in Goldstein, forthcoming). For instance, successful quartets exhibited the emergence of conflict resolution as they rehearsed, whereas unsuccessful quartets tried to resolve these conflicts through imposed rules and roles.

However, this does not mean that all spontaneous occurrences deserve the appellation of emergent and are therefore worthy of study. Indeed, one of the issues confronting researchers will be how to distinguish authentic emergent networks from Holland’s “serendipitous novelty.” Much of this distinction will depend on carefully discerning the adaptive functionality offered by authentic emergent phenomena as opposed to “serendipitous novelty.” But this will then necessitate a deeper investigation of what constitutes an adaptable organization.

Another crucial area of research in emergent networks will be their role in organizational creativity, particularly as the latter can be aided by the impressive strides made in cognitive studies of creativity (see Finke, Smith, and Ward, 1996). These studies in fact portray creative processes in ways that are quite similar to how emergence takes place. Here it is the radical novelty characterizing emergence that needs attention. This radical novelty includes the critical role played by serendipity in organizational creativity. Serendipity, in this sense, has to do with the taking advantage of accidental occurrences that James Austin (1978) has identified in so many scientific discoveries. Indeed, complexity theory is exploring how the structure and properties seen in emergence partly result from the serendipity-like amplification of random events in complex systems. The chance or “noisy” event can be utilized by the organization to explore or test different system configurations and, therefore, may represent an evolutionary response of the social system to changes in the environment (see Allen and McGlade, 1987; and Goldstein, 1994).

However, a caveat is in order here. Emergence can be constructive as well as destructive. Witness, for example, the emergent political divisiveness that occurred in the former Yugoslavia. Therefore, there is a great need to ascertain how to channel the process of emergence in constructive directions. One hint in this regard is the crucial role of firming up organizational boundaries that can contain the powerful currents of self-organizing, emergent processes (see Goldstein, 1994).

Finally, there is the fact that complexity science is only in its infancy. As it matures, better quantitative tools will be coming forth that offer richer ways of studying emergent phenomena. For example, recent work by Dooley and Van de Ven (1998) used various analyses of time series data to understand diverse organizational dynamics. Indeed, emergent phenomena are there for the taking by future researchers.

CONCLUSION

Emergence is not an entirely new topic. Conceptual constructs resembling emergence can be found in western thought since the time of the ancient Greeks, and have at times had a significant impact on intellectual culture. However, emergence is emerging today as a construct of complex, dynamical systems. And what is exciting are the tremendous advances being made in understanding emergent phenomena. These advances are opening up the black box that had previously obscured the real process of emergence.

Since emergent phenomena are ubiquitous in organizations, the advances being made in the study of emergence can only have a huge impact on the study of organizational dynamics. Complexity theory, with its investigation into emergent phenomena, promises to provide both a methodology and a theoretical framework for studying something that is already playing a crucial function in our businesses and institutions.

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