COVID-19 As an Environmental Kick to the U.S. Healthcare System

A Complexity Perspective

Alexander Dawoody, Ph.D.

COVID-19 As an Environmental Kick to the U.S. Healthcare System
A Complexity Perspective

Alexander Dawoody, Ph.D.

Since the 17th Century, researchers had interpreted the world according to classical mechanic and Newtonian theories. Research had emphasized the importance of objective reality, rationalism, critical mass, force, gravity, inertia, forms, linear time and motion, order, closed-system, reason, and logic in analyzing natural and social phenomenon (Dawoody, 2003).

The whole was analyzed by breaking it into parts and each part was examined separately in fixed time and space. Such analysis was devoid of subjectivity and the personal experiences of the observer. Objectivity was emphasized and a "one-size-fits-all" model was advocated in natural and social science inquiries. Particularity in social sciences, researchers had to follow such a methodology, removing their own personal experiences from the inquires and designing "toolboxes" of uniform and non-subjective procedures. Instrumentalism thus became the norm. Weber's bureaucracy (1905), Taylor's Scientific Management (1911), Brownlow's POSDCoRB (1934), and Simon's bounded rationality (1947) are examples of such instrumental approach to inquiry. Other examples include linear progression and the process of "erroring" all that is considered as deviant (O'Sullivan and Rassel, 1999). These approaches sum up the traditional view of dynamic systems from a perspective of a predictable world.

The above approaches are incomplete models in interpreting systems, just as the Newtonian theories are incomplete models in physics. Objective measures on their own do not see, feel, or have values. The multitude of human factors and ambiguities that make up reality are not tangible. What the nonlinear new sciences offer is perspective and perception (Capra, 1975). The crisis of the healthcare system today in handling COVID-19 is an example. To seek means of precision and control suggested by the request for practical applied tools is not what reality has to offer.

The universe, according to classical Newtonian sciences is described clockwise. Time and motion are reversable, and phenomenology is reduced to parts, functions, and building blocks. Such a reductionist approach extends to dynamic systems as well by focusing analysis on rule-based procedures. The focus, hence, becomes on planning, design, control, and prediction. As a result, understanding a phenomenon will lack the human experience. By applying the classical Newtonian mechanics into the understanding of systems, researchers will have to collapse all other possible interpretations within the dynamics of nonlinear systems and follow the rigidity of rationality and one-dimensional interpretation, instead of a pluralistic and multi-dimensional view of reality (Dawoody, 2003).

System studies should be one of many coplanarity paradigms emerging in inquires. The complexity sciences are of value in the evolution of dynamic systems by incorporating the valuable elements of positivism with rationalism. Reality, as such, will take us from a dissipative arrangement to an adaptive structure capable of fitting with the emerging phenomenon. Neither form nor function alone can dictate recognizing environmental or structural shifts within a system. Change remains constant and along with it, adaptability, and measures.

Change is never random, and systems do not take off in bizarre new direction. It is the system's need to maintain itself that may lead it become something new and different. A system changes to preserve itself (Wheatley, 1999).

An important concept to also consider is the dynamics of collapse. This dynamic is referred to as "bifurcation", or, "phase shift." As the self-organizing order emerges out of the interaction of elements within the system's limiting parameters (its older basin) and the system becomes more complex in responding to changing context (as we are witnessing with the healthcare system and their response to the environment created by COVID-19), such a system becomes unstable and the older order starts to collapse. The collapse, if not prevented through artificial engineering, will allow for the emergence of a new order through self-organization that will be better capable of dealing with changes in the environment.

Systems, as such, collapse. Generally, there are two types of systemic collapse: natural and human made. The first is the inevitable bifurcation that flows from the increasing complexity of systemic disorder and the emergence of a new order. The latter is the result of cognitive and behavioral dysfunction (Dawoody, 2003). This is known as folly collapse and is an epiphenomenon of human interactions that inevitably lead to catastrophe (Brem, 1999). If we examine the current response to COVID-19 we witness these types of folly collapse dynamics. We can summarize them as follows based on Brem (1999)'s notion:

- Collapse Dynamics of the First Kind: This is related to procedural accidents. These types occur when the system develops an over (or under) attachment to rigid processes regardless of contextual appropriateness. Such use of rigidity will lead to a system become unable to anticipate problems or responding to them in a timely and appropriate manner. We witnessed such dynamics by the federal government's response to the pandemic.
- Collapse Dynamics of the Second Kind: This type of collapse is rooted in human fear of change and artificial engineering aimed at stabilizing the outdated systemic order. Rather than replacing an outdated system, policymakers instead continue tweaking it to make it work until the system is overloaded. We see such artificial engineering in the Congressional CARE package as a response to COVID-19.
- Collapse Dynamics of the Third Kind: This type of collapse is related to "systemic accidents" where a system designed to work in one context is made to address a problem in another context. We witnessed this in policymakers' attempt to utilize programs designed for prior health crisis (such as Ebola or the Flu) in responding to COVID-19.

However, as tension and the potential for catastrophic collapse increases so does the opportunities for creative reorganization. Between order and disorder there is an opportunity for creativity arises out of destruction. As the older order collapses a new one will emerge. Changes in the relationship between the system's internal function and its response to environmental stimuli will create a feedback mechanism that amplify these changes and lead to the breakup of existing structures. Unexpected outcomes and behaviors then will follow (Dawoody, 2003). The healthcare system's responsibilities as such are to anticipate change (not predicting them, since prediction is futile), welcoming the process without artificial engineering, allow for natural collapse to take hold, and participate in the process through coordination (instead of control).

Whatever we call reality is revealed to us through active construction of participation. An open system has the capacity to respond to change and recognize itself at a higher level of organization. Chaos becomes a critical player, an ally of emergence that can provoke a system to self-organize into new form of being (Prigogine and Stengers, 1984).

Not all systems, however, move into chaos. If a system becomes unstable it will move first into a period of oscillation, swinging back and forth between different states. After this oscillation stage the next state is chaos, and it is then when the wild gyrations begin (Wheatley, 1999). Phase space within a chaotic behavior is, as such, as new way of wild and rich behavior displayed often by mathematical equations. In such a phase space the system operates within a basin of attraction. This figurative basin is when the system explores numerous possibilities, wandering to different places and sampling new configurations (Elliott and Kiel, 1996).

The emerging paradigm of this dynamics has profound implications. It demonstrates that instability and disorder are not only widespread in nature but also essential to the evolution of complexity in the universe. What we can learn from our healthcare system' response to COVID-19 is to shift our focus from the quest for certainty to the appreciation of uncertainty and the enormity of potentials generated by disorder.

Instability triggered by nonequilibrium environmental kicks (such as COVID-19 pandemic) will always lead to further dissipation and entropy regardless of how much we wanted to prevent it by maintaining the current structure. This is true in all facets of life (such as education, business, healthcare, politics, and public service). Instability in turn leads to the appearance of further instabilities. The farther from equilibrium state the system becomes the more probability for its internal processes increases whereby the system becomes unfattenable to any given fluctuation (De Greene, 1996).

The problem for researchers is how to measure such a chaotic behavior?

In a system increasing in entropy the number of possible states evolving from the initial distribution will increase overtime (Brown, 1996 a). In a chaotic system (such as our healthcare system), information about the system decreases over time when measured against the initial stage (let us assume February 2020 as the initial stage in the healthcare system' response to the pandemic). If subsequent measures are not made, we will know less and less about the phenomenon and systemic capacities for responding over time. With a second (and continuous) set of measures, however, we can end up with more information about both the environmental kick itself (COVID-19) and the healthcare system responding to it that would have been possible at the beginning.

As for measuring dimensions, the ideas of linear measures are not directly related to the number of dimensions of the space containing these sets. This problem was solved by Caratheodory who gave us a definition of the *d*-dimensional measure of a set in an *n*-dimensional space.

Caratheodory's notion of dimension was later generalized by Hausdorff to describe sets of non-integer dimensions. Such sets with non-integer dimensions are called "*fractal sets*" (Ding, Grebogi and York, 1997).

Another concept of dimension is the *capacity* introduced by Kolmogorov. The advantage of the capacity dimension is that it is much easier to measure from data. The value of the capacity dimension for a chaotic attractor (such as COVID-19) indicates how much information is necessary to specify the location of points in the set within a given accuracy (Ding and Yorke, 1997).

Time averages of functions are standard measures of asymptotic behavior in a dynamical system. They take on special relevance for chaotic systems. Renyi introduced a spectrum of dimensions characterizing probability distributions (Dawoody, 2003). The simplest among them is the information dimension. It indicates how fast the information necessary to specify a point on the attractor increases as the number of bits of accuracy is increased. Another related dimension is the Lyapunov dimension, which is determined by the Lyapunov Exponents of the system (Ding and Yorke, 1997). The Lyapunov characteristic exponents of dynamical systems measure the average rate by which the distant points become stretched or compressed after just one interaction (Brown, 1996).

Because the time evolution is self-independent from its own history, predicting the long-term behavior of chaotic systems is an interesting exercise. The process does not come to rest in a stable equilibrium but instead comes to occupy large patches of state space. Analysis, thus, is difficult because stable and unstable states are strewn together in extremely complicated ways (Brow, 1996b).

According to Prigogine and Stengers (1984), chaotic motions imply that phase-space volume is expanding in certain direction and decreasing in others. This new paradigm encompasses nonlinearity, nonrationality, mutual causality, nonequilibrium, irreversibility, stochasticity/ determinism, uncertainty, opportunity, and choice (De Green, 1996).

One of the features mentioned above that is of extreme importance in understanding our response to COVID-19 is mutual causality. Mutual causality includes random components that at any given set of starting conditions will lead to different end points. Random kicks are then combined with systemic relations to transform the system in unpredictable ways. Systems (such as our healthcare system) frequently move from kick to kick, one pattern of transformation kicked into another. The transformation stemming from these kicks, according to Morgan (1986) settle into a new pattern of relations that is eventually kicked by another incident or pattern of chance connections. The federal government's response to the pandemic kicking to the presidential election is an example of such pattern.

The boundaries in a system becomes visible as the system explores its space of possibilities. The order is already present. It has now become discernible (Little, 1999). This process then results in self-organizing. The process succeeds in certain newness because it takes place in a system that is nonlinear. In a nonlinear world, every slight variation can amplify into completely unexpected results and the slightest variation can lead to catastrophic results. We are witnessing this almost daily in the global response and preparedness in dealing with the pandemic.

A possible remedy to this is to challenge viewing living systems as open systems and open to their environments. According to the Chilean scientists Humberto Maturana and Francisco Varela, living systems are open to an environment that offers a new perspective for understanding the logic through which living systems change (Morgan, 1986). The central idea of living systems (also called autopoiesis) is that a living system is one organized in such a way that all its components and processes jointly produce those self-same components and processes, thus establishing an autonomous, self-producing entity. Autopoietic systems are self-organizing in that they produce and change their own structure as well as their own components (Maturana and Varela, 1980).

In saying that living systems are autonomous Maturana and Varela are not saying that systems (such as our healthcare system) are completely isolated. The closure and autonomy to which they refer is organizational. They are saying that living systems close in on themselves to maintain stable patterns of relations, and that is this process of closure or self-reference that ultimately distinguishes a system as a system (Maruyama, 1963). The example of the healthcare system to uphold the scientific standards and depolarizing the COVID-19 vaccine is an example of such autonomy.

Autopoiesis theory sees all living and dynamic systems as continually self-producing through the processes that make them and not through some relationship with an environment. The system's production of components is entirely internal and does not depend on an input-output relation with the system's environment, using energy and material that is already present within the system's boundaries (Little, 1999). As such, our healthcare system, for example is continually self-producing itself regardless of COVID-19. Yes, it is impacted by COVID-19 as a kick in its environment, and such a kick can cause instability within the healthcare's own internal dynamics that will lead to chaotic behavior and a new structure emerging out of the dissipating order. However, the system of healthcare itself is using its own energy and material within its own boundaries in order to self-produce and self-organize.

Autopoietic systems, such as our healthcare system, not only produce themselves but also continually renew themselves in ways that maintain the integrity of their structure. The interrelations between the components of our healthcare system define the transformations the system may undergo. Thus, what specifies our healthcare system is the set of relations between its components, independent of the components themselves.

Two important underlying principles are worth mentioning here: *structural determinism* and *organizational closure*. All systems consisting of components are structure-determined, which is to say that the actual changes within the system depend on the structure itself at that particular instant. Any change in such a system must therefore be a structural change (Little, 1999).

However, within structurally determined systems are systems that are organizationally closed. An organizationally closed system is one in which all possible states of activity always lead to further activity within itself. Organizationally closed systems do not have external inputs that change their organization, nor do they produce outputs in terms of their organization. While autopoiesis is maintained, the system's changes are determined by its structure, not by the environment. An example of an organizationally closed system with a structurally determined system is the Electoral College system (organizationally closed system) within our election system (structurally determined system).

Maturana and Varela base their argument on the idea that living systems are characterized by three principles: autonomy, circularity, and self-reference. These principles lend the systems the ability to self-create or self-renew. Maturana and Varela coined the term “autopoiesis” to refer to this capacity for self-production through a closed system of relations. They contend that the aim of such systems is ultimately producing themselves (Maturana and Varela, 1980).

Reality, as such, is an irreducible complex constant and no single theoretical description can exhaust it. The irreducible diversity of the physical world, for example, is a fundamental tenant in postmodernism. We interfere with the atomic processes in order to observe them, and we interact with the system to an extent that the system is unable to be brought of as having an existence independent of our observation (Overman and Loraine, 1996).

The philosophical issue then becomes is whether the whole universe owes its existence to the fact that it is being observed by intelligent begins or it exists regardless or such observation? This is similar to the notion that if a tree fell in the forest and there was no one to hear it, would it still make sound?

To answer such a philosophical question, we refer to quantum theory. According to quantum theory, the implication of our participatory relation with reality is that the quantum world is holistic in the sense that the parts are in some sense in touch with the whole. This does not mean that the observer interprets the outcome subjectively, but rather the act of observation determines the outcome. One, as such, cannot position oneself outside and remain neutral (Evans, 1996). All possible things happen in some branch of reality and each one of these realities is determined (Kiel, 1999).

In conclusion, the French mathematician Laplace argued that from knowledge of the initial state of the universe comes an exact knowledge of its final state. In the real-world exact knowledge of the initial state, however, is not achievable. No matter how accurately the velocity of a particular particle is measured, one can demand that it be measured more accurately. Although we may recognize our inability to have such exact knowledge, we typically assume that if the initial conditions of two separate experiments are almost the same then the final conditions will be almost the same (Campbell, 1969).

In understanding COVID-19 and the best-case scenario in responding to it by our healthcare system, the new sciences of complexity teach us that such an assumption is false. We must reject the old worldview of dualism and the Cartesian egocentrism, as well as the Newtonian linearity that gave us the belief that creativity and order are generated by the rational capacity of the human brain alone. The new sciences of complexity, on the other hand, allow us to see both diversity and complexity as representing living systems’ tendency to be inclusive and to create life forms and structures that will sustain their own diversity. These new sciences do not offer mythological relief for social problems, such as a proper response to a pandemic. According to this view, the problems of function within a system are not even necessarily methodological but rather ontological. That is, the new sciences of complexity do not simply offer more information about how to lead better. Rather, they question the basic logic of systemic structure and its function within an interrelated and symbiotic environment (Dennard, 1996).

Aristotle saw scientific inquiry as asking nature the question: why are things the way they are? We answer Aristotle’s question with: “because.” Then, we categorize “because” in four causal categories: material causes, efficient causes, formal causes, and final causes.

No longer we are to assume our existence tell us anything concrete about the pre-existing states of reality. We are no longer constrained by a single ontological model to interpret the world. Truth can now be seen not as an attribute inherit in an entity (such as government) or event (such as a pandemic) but as the meaning we attribute to that entity or event.

Reference

Brem, R. J. (1999). The Cassandra Complex. In Morcol, G. and L. F. Dennard (Ed.), *New Sciences for Public Administration and Policy, Connections and Reflections*. Burke, VA: Chatelaine Press.

Brwon, T.A. (1996a). Measuring Chaos Using the Lyapunov Exponent. In Dennard, L. and E.E. Kiel (Ed.), *Chaos Theory in the Social sciences.* Ann Arbor: The University of Michigan Press.

Brown, T.A. (1996b). Nonlinear Politics. In Dennard, L. and E.E. Kiel (Ed.), *Chaos Theory in the Social Sciences*. Ann Arbor: The University of Michigan Press.

Brownlow, L. (1934). The New Role of the Public Administrator. *National Municipal Review*, 23: 248-251.

Campbell, D.T. (1969). Variation and Selective Retention in Socio-Cultural Evolution. *General Systems*, 16: 69-85.

Capra, F. (1975). *The Tao of Physics*. NY: Wildwood House.

Dawoody, A. (2003). *The Matriarch As a Leader and the Metaphors of Chaos and Quantum Theories*. Bloomington, IN: 1st Book Library.

De Greene, K.B. (1996). Field-Theoretical Framework for the Interpretation of the Evolution, Instability, Structural Change, and Management of Complex Systems. In Dennard, L. and E.E. Kiel (Ed.), *Chaos Theory in the Social Sciences*. Ann Arbor: The University of Michigan Press.

Dennard, L.F. (1996). The New Paradigm in Science and Public Administration. *Public Administration Review*, 56(5):495-499.

Ding, M., C. Grebogi, and J.A. Yorke. (1997). Chaotic Dynamics. In Grebogi, C. and J.A. Yorke (Ed.), The Impact of Chaos on Science and Society. Tokyo: United Nations University Press.

Elliott, E. and L.D. Kiel. (1996). *Chaos Theory in the Social Sciences*. Ann Arbor: The University of Michigan Press.

Evans, K.G. (1996). Chaos as Opportunity: Grounding a Positive Vision of Management and Society in the New Physics. *Public Administration Review*, 56(5): 491-494.

Kiel, D. L. (1999). The Sciences of Complexity and Public Administration. In Morcol, G. and L. F. Dennard (Ed.), *New Sciences for Public Administration and Policy, Connections and Reflections.* Burke, VA: Chatelaine Press.

Little, J.H. (1999). Governing the Government. In Morcol, G. and L. F. Dennard (Ed.), *New Sciences for Public Administration and Policy, Connections and Reflections.* Burke, VA: Chatelaine Press.

Maruyama, M. 91963). The Second Cybernetics: Deviation Amplifying Mutual Causal Processes. *American Scientist*, 51: 164-179.

Maturana, H. and F. Varela. (1980). *Autopoiesis and Cognition: The Realization of the Living.* London: Reidl.

Morgan, G. (1986). *Images of Organization*. Beverly Hills: Sage Publications.

O'Sullivan, E. and G.R. Rassel. (1999). *Research Methods for Public Administration*. NY: Longman.

Overman, S.E. and D.T. Loraine. (1994). Information for Control: Another Management Proverb? *Public Administration Review*, 56(5): 487-491.

Prigogine, I. and I. Stengers. (1984). *Order Out of Chaos*. NY: Bantam Books.

Simon, H. (1947). *Administrative Behavior*. NY: Macmillan.

Taylor, Frederick. (1967/1911). *The Principles of Scientific Management.* NY: Norton.

Weber, M. (1994/1905). *The Methodology of the Social Sciences*. NY: Free Press.

Wheatly, M.J. (1999). *Leadership and the New Science*. San Francisco: Berrett-Koehler Publishers.