Outline

Introduction

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Complexity and Nascent Disciplines

Introduction

Some Project Background

This was first written in 2016 as the first appendix to the first book of a pilot project, the *Declaration and Transformation Enterprise*. That pilot project focuses on a perspective of American Democracy that uses the lens of some nascent disciplines. That perspective recognizes American Democracy as a complex adaptive system built on a foundation of American citizenry as the source of authority for the governmental structure. That pilot project morphed into the trilogy, *American Democracy Endangered*.

The danger to American Democracy, a complex adaptive system, is from internal sources as well as from external threats. The prevailing logic in dealing with both kinds of dangers rests on the dominant disciplines of the twentieth century. The internal sources of danger are discussed in all three books leading to making the case for a *Declaration of Reform* advocated in the third book of the series, *American Democracy: The Declaration, Pursuit, and Endangerment***.**

The Great Recession, rooted in capital market freeze and the collapse of the housing bubble, is a recent manifestation of an outcome of the shortfall of the application of mainstream twentieth century disciplines to the neglect of the nascent disciplines. These are disciplines born in the late twentieth century, but destined to flourish in the twenty-first century. It is all that fast

A Michael Lewis book (published shortly after the onset of the Great Recession), *The Big Short: Inside the Doomsday Machine*, has an epigram. It is a quotation from what Leo Tolstoy wrote in 1897:

> The most difficult subjects can be explained to the most slow-witted man if he has not formed any idea of them already; but the simplest thing cannot be made clear to the most intelligent man if he is firmly persuaded that he knows already, without a shadow of a doubt, what is lad before him.

This discussion of complex adaptive systems is focused on nascent disciplines, especially complexity and network science. Complexity is sometimes classified as complexity theory, referring to the understanding of dynamic systems. Sometimes the classification is as complexity science referring to a branch of science, admittedly in a nascent stage. Our concern is with complexity as a discipline.

Disciplines are discussed in all three books of this pilot project. In the first book it is simply applied in the paradigm. In the second book it applied in the analogy to denominations in religion. In the third book, it is as a prelude to what I am calling for leading to what may become a new discipline, ***Societal Biology: The Body and Mind of Society.*** In that third book (*American Democracy: The Declaration, Pursuit, and Endangerment*), fifth chapter, Building a New Paradigm, the quote of my summary of a presentation by Steven Jay Kline in his *Conceptual Foundations for Multidisciplinary Thinking* is as follows:

> "..... [Steven Jay Kline] … identifies eight steps in the development of a discipline, not necessarily taken in a particular order. The first four are as follows:
>
> 1. Selection of a class of systems with an associated set of problems…
> 2. Observations of the behavior within the class of systems…
> 3. Organization of the observations into taxonomy…
> 4. Formation of 'rules' that describe the phenomena within the taxonomy either as a whole or for particular sub-domains. [See pages 199-200]
>
> The 'rules' concept refers to a very broad array of relationships defined with various degrees of rigor. The other four steps refer to the process of refining the rules in order to better represent the system. Depending on the complexity of the system, one may develop a 'grand theory' or settle for descriptions of relationships that represent behavior associated with a set of problems.[i] "

Kline, earlier in the book (especially in chapter 6), discusses two types of systems. A quote about them is as follows: "...inert, naturally occurring objects on the one hand and social and sociotechnical systems on the other suggests a question. Do the two kinds of systems have qualitatively distinct behaviors, and perhaps require different kinds of 'rules'? "

He continues on the same page [80] with two definitions.

"An Entire Paradigm will denote: a principle that applies to every system in the class, without exceptions.

An Entire Invariant Paradigm will denote: a paradigm that predicts that all systems in the class will have the same behavior, in detail, for all ties in all places."

The second, "An Entire Invariant Paradigm," is what dominated science for the several centuries after the Scientific Revolution. It focuses on cause and effect as the explanations derived by experimentation in an inductive philosophy of falsifiability.[ii] It uses models built on linear relationships. It works well for the "naturally occurring objects." The "social and sociotechnical systems" have nonlinear relationships. That condition calls for analytics that go beyond what prevailed for the several centuries after the Scientific Revolution.

An Overview of Nature of Complex Systems

The nature of complex systems is that they contain emergent properties resulting from the interaction of entities within the system. Additionally, the entities[iii] adapt to changes in their environment. As a result, complex systems evolve; they change their structure.

Altering the structure of a complex adaptive system is a very powerful way to alter the outcomes that impact its inhabitants. The great uncertainty of the outcomes generated by an event, internal or external, arises from the nonlinearity in the system. That uncertainty arises because of the emergent nature of the system and contingencies that arise in the evolutionary process.[iv]

The *Entire Invariant Paradigm* used by science since the Scientific Revolution works, within limitations, for *inert, naturally occurring objects* because it is based on linear relationships of cause and effect. The primary limitation is that the evidence of cause and effect is established by experiments that operate on the basis of inductive logic. Thus, the premise of the relationship is falsifiable[v]; but it is tested to see that it holds. The confidence that is placed in the premise as reflecting reality is related to the rigor of the tests, as well as knowledge of experience of the relationship. That confidence is further affected by the perspective of the viewer.

Deductive logic is more rigorous in that it may prove the relationships analytically. The proof, however, is only as valid as the initial premise, including a variety of postulates. Thus, the proof of a straight line representing the shortest distance between two points works for Euclidean geometry. That geometry is based on working on a flat space. Working on curved space as with a globe calls for a negation of one of Euclid's postulates.[vi] This may be seen by drawing a line on a globe of the world that connects two points in the world.

The best we can do with complex adaptive systems, as compared to systems of inert naturally occurring objects, is to have principles that apply to every system in the class. The behavior of agents in the system (meaning people representing themselves in the American Democracy discussion) varies with the changed environment. So if we were listing principles for a complex adaptive system we would include the idea that *people may adjust their behavior based on a changed environment.* However, we

would not include a principle that specified how people would necessarily behave as though they were *inert, naturally occurring objects.*

The social sciences have suffered from *physics envy* in trying to use the rigor of linear relationships for nonlinear systems. In recent decades there has been a shift towards use of biological analogies so as to better reflect the organic nature of societal systems. The linear models for components of nonlinear systems may work for a component at a point in time, but additional analytics are essential for understanding dynamic systems and improving outcomes.

The Selection of Analytics

The selection of analytics for strategic decisions intended to improve on outcomes is highly dependent on the nature of the problem. Problems emerge from a variety of conditions so that the stage of development is a first concern; it impacts the level at which the problem is attacked. The characteristics of the problem change as it evolves so that the principle characteristic will affect the nature of analytics that can best foresee outcomes from intervention. And, then, the scale of the problem makes a difference. That is not only the size of the network in which it exists but the levels of networks involved in its generation and amelioration.

Level of the Problem

Curing What Has Already Happened

Curing what has already happened is dealing with an outcome that has already manifested itself. The analytics may focus on actually changing the condition such as restoring health or providing housing. Or, it may be in rectification in the form of some compensation somewhat in-kind or as an alternative.

The range of analytics is wide because the cure options are wide. In health, setting fractures is quite different from treating a disease that has progressed. In housing, dealing with homelessness is different from dealing with shortage of supply at prevailing prices.

Preventing Specific Problems from Occurring

Preventing specific problems from occurring is based on identifying the potential problem and an intervention in the system to avert the problem. In health, inoculations for immunization are a good example. In housing, averting the problem is somewhat more complex. One example, however, is to identify households that are at risk, and provide gap assistance to avoid the homelessness from eviction for nonpayment of rent or from foreclosure from financial default.

Structuring the System for Self-correction

Structuring the system for self-correction involves analytics that deal with the emergent processes that produce the conditions that foster the problem. In the health case of fractures, going beyond prevention there are cases where fractures will self-heal in an acceptable manner even though resetting the bones would be an option. In the case of health, many would-be illnesses are averted because the infection is counteracted by the body's immune system which has been strengthened by proper diet.

In the case of housing, the occurrences of homelessness could be lessened by the strengthening of the employment and income situation of the breadwinners. One candidate for the greatest tragedy of the twenty-first century impacting a variety of societal problems, including health and housing, but also the quality of life for retirees, is the Great Recession.

That disruption to the economy was preventable had the structure of American Democracy had better analytics been used in both the public and private sector. As for the private sector, that obviously includes the industry side. But it also includes the consumers and the electorate.

All of this is leading to a strategy that would tilt the use of analytics toward structuring the complex adaptive systems to better performance. That involves discipline development and dissemination. Among the nascent disciplines is *translational science*, described in medicine as "from bench to bed." The thrust of this pilot project, *Declaration and Transformation Enterprise*, is to get that same process advanced in the arena of American Democracy.

The Principle Characteristic of the Problem

The *principle characteristic* of the problem as discussed by Liz Johnson in her article, "A call for complexity: integrated models to solve complex policy problems," falls into four categories. The sequence in which this discussion will discuss them is as follows: are (1) simple, (2) complicated, (3) chaotic, and (4) complex.

The article from which some of the discussion is drawn appears in *Mind & Society: Cognitive Studies in Economics and Social Sciences,* Volume 14, Number 2. That is a special issue on "Complexity Modeling in Social Sciences and Economics." Its sources heavily noted and included here by reference to the Johnson article.

Simple as a Principal Characteristic

Simple, as a principal characteristic, refers to "cause-effect relationships [-] perceivable, predictable, and repeatable." That and the other three categories of principle characteristics are excerpted from an exhibit credited to Cynefin. The point for this discussion is that this is the easiest category for mainstream science.

Complicated as a Principal Characteristic

Complicated, as a principal characteristic, refers to the "potentially knowable [-] cause-effect relationships separated in time and space." In my view, there is an interaction of simple relationships when interconnected produces a complicated system. These may be modeled with closed models and reflect the impact of motion in one set of relationships to the rest of the system. That is done in standard science.

Chaos as a Principal Characteristic

Chaos as a principal characteristic of a system is characterized by cause-effect relationships not being perceivable. It is an unordered system. It may become self-organized into a complex system.

Complexity as a Principal Characteristic

Complexity as a principal characteristic of a system is retrospectively coherent in contrast to the incoherence of chaos. The cause and effect relationships although repeatable in simple and complicated models are not repeatable in complexity models because of emergence and contingency. The result is a great uncertainty of outcomes compared to simple and complicated systems.

As an example of the nature of complexity science when applied to economic issues consider the following exhibit that appeared in an article titled "A new paradigm for real estate valuation?" It was published in the Journal of Property Investment & Finance, Vol. 29, in 2011, authored David Wyman, Maury Seldin, and Elaine Worzala.

Exhibit 1: Five Core Concepts of Complexity Economics

Concepts	Complexity Economics
Dynamic	Open, dynamic, non-linear, far from equilibrium
Agents	Agents subject to errors and biases; adapt and learn over time; modeled individually
Networks	Networks of relationships change over time; model interaction of agent
Emergence	No distinction between micro- and macroeconomics; macro patterns are emergent result of micro-level behaviors and interactions
Evolution	Evolutionary process of differentiation, selection, and amplification provides system with novelty

Adapted from Beinhocker (2006, 97)

Some Modeling Implications of Complexity

Some modeling implications of complexity are summarized in the following table from an article titled "Hidden complexity in housing markets: a case for alternative models and techniques" by David Wyman, Elaine Worzala, and Maury Seldin. It is published in the *International Journal of Housing Markets and Analysis*, Vol. 6 No. 4, 2013.

Table 1: Modeling Implications of Complexity Economics

	Meaning	Implications
Agents	Learning, adaptable and non-rational	Simulate alternative behavioral strategies by agent-based modeling
Higher Order	Multiplicity of equations describe the layers of networks and interactions	Open to disaggregation of data and granularity in analysis
Emergence	Micro-level behaviors lead to properties in macro patterns not in micro level	Model variety of emergent macro patterns
Non-Linearity	Lack of a consistent proportionality in relationships	Model all inputs – even small inputs can lead to discontinuities

Feedback Loops	Past signals influence future signals in time and space	Can amplify or dampen non-linearity effects in time and space
Time Sensitivity	Short-term inputs can have adverse, non-predictive long-term impacts	Presumed corrective actions can be counter-intuitive over time and space
Policy Insensitivity	Insensitive to parameter changes as non-linear effects dominate system	Need to alter incentives and structure of the system
Summary	Open, dynamic, non-linear system	Markets can operate far from equilibrium and there are many layers/agents to consider

Source: Adapted from Beinhocker (2006), Forrester (1969)

The Scale of the Structure of Networks in which the Problem Exists

The scale of the structure of networks in which in which the problem exists refers to the number of levels of networks in the structure. For example, the networks in the human body include cells, tissues, and organs. There are emergent properties created from the interactions in a network micro to the next higher level. The more levels involved, the greater the complexity.

As an example of a relatively simple analysis by a potential mortgage borrower, consider the analyses involved in a single level of a network in the mortgage finance arena. The potential borrower may consider numerous potential lenders and/or mortgage loan originators in the network of mortgage loan origination.

When mortgage loans were originated by local lenders who carried the loans on their books for the life of the loan, the local mortgage market, an emergent characteristic of the micro networks in which the variety of potential borrowers searched for their loans, was a little more complex. There were two levels of networks. It moved to the third level when the originators sold the loan to an entity that bundled the loans and engaged in a network in which other institutions also bundled mortgages.

When bundled mortgages were sliced into tranches, segments with different priorities of claims, and the like segments were bundled, and rated as to credit quality, the market for those derivatives emerges at the next higher levels of networks. It got even more complex when credit default swaps were introduced ostensibly to provide insurance against loss, but subtly to provide a vehicle by which to short the mortgage market.[vii]

A Strategic Approach to Analytics Selection

A strategic approach to analytics selection may be based on the criteria for favorable outcomes. Those criteria influence the question posed. In simple and complicated problems, the criterion may be a reliable quantification of the relationships so as to predict the outcome. An example is where to place the fulcrum of a lever to determine the weight necessary to raise a heavier object to a balance point. The balance point is an information item for an outcome.

For a father and daughter on a teeter-totter moving the father closer or farther to the fulcrum is a simple process. An even simpler process may be moving the daughter since the distance the daughter mover gives a finer tuning; but it may not be simpler if the daughter is very young. For some construction work, a mathematical calculation may be appropriate. In both the teeter-totter and construct work examples the fulcrum point is predictable by mathematical calculations, but trial and error in the first case is adequate.

In complexity cases, the uncertainty of outcomes makes a significant difference in approach. From a strategic point of view, it makes a difference of where one stands. That may be thought of as location. Using logic from real estate investment strategy, a critical element is the combination of timing and location. However, instead of physical location of the real estate itself, the location refers to the position of one's sense of place in two contexts.

The first context is one's immediate self interest. The discussion is going to focus on cases in capital markets starting with financial markets catering to people with "limited borrowing experience or limited financial resources," to borrow a phrase from an article by David Lazarus of the *Los Angeles Times* appearing in the December 25, 2015 *Tampa Bay Times*. The article reports that Clearwater Clarity Services, Inc. had illegally accessed credit files of thousands of consumers nationwide. The article reports that according to the Consumer Financial Protection Bureau (CFPB), "Clarity used them to generate sales leads for firms that make 'small-dollar loans to consumers who have thin credit files.'" Clarity and its owner were fined $8 million for the illegal access.

The director of CFPB, Richard Cordray, commented on the critical role that the credit report plays in the lives of consumers, as did Linda Sherry speaking for Consumer Action (a consumer advocacy group). The information goes beyond that normally provided in credit reports and is significant in that *the thinness of the credit files* can be of importance in the financial capital markets that bundle loans, slice the bundles into tranches, and bundle tranches. In the case of the subprime crisis, it went even further. These derivative assets were used for credit default swaps leveraging the impact of default.

It is easy to see that the analytics of targeting consumers who have thin credit files can produce FICO scores that are not as reliable as those with longer records. What is difficult to see that thin FICO scores were among the many variables that impacted the subprime crisis and capital market freeze that led to the Great Recession. An excellent explanation is in the Michael Lewis book in *The Big Short: Inside the Doomsday Machine.*

The David Lazarus article is titled "Lessons of mortgage collapse seem lost." The analytics for targeting people with "limited borrowing experience or limited financial resources" as a market segment is easy if the information is available. The analytics of the consequences are quite complex. So, in the case of the subprime crisis, the best that one could do was to use the percentage of thin credit reports when selecting collateral debt obligations to short. Very few investors were astute enough to sort out the

variables such as thin credit scores and a variety of interest rate terms in a process of making a selection.

The sense of place for an individual in a short-term investment context as to immediate self interest can require a wide range of analytics. The sense of place in the social capital context is quite complex. Sometimes a short cut of moral behavior may be used or even just legal behavior. But, it takes a legal structure that facilitates the emergence of a market structure that provides a level playing field and related conditions that that let the invisible hand do what Adam Smith envisioned when he used the term. It also takes the moral behavior that was associated with his original use of the term in his first book, *The Theory of Moral Sentiments*.

The idea here is to understand the system, and maybe only parts of it. As an example of analytics selection for dealing with a complex adaptive system consider the case of the subprime mortgage financing structure that facilitated the housing bubble and capital market freeze that led to the Great Recession. That structure evolved with the creation and use of derivatives.

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[i] The preceding and much that follows is taken from an essay titled "Roots of Modern Disciplines" published as a *Supplement to the ASI Newsletter: Spring 2003.* It was later that year included in a monograph, *The Challenge to our Thought Leaders* by Maury Seldin.

[ii] As discussed in Essay/Chapter 4 of American Democracy, "The modern scientific method is pretty much based on the concept of *falsifiability,* the idea that the scientific value of a proposition is enhanced by its *verifiability*, but unless there is some way that it could be proven false its scientific value is diminished. Thus, much scientific work is in experimentation in which it has the potential of showing the proposition false, but the stronger the test and the greater the survival, the higher the quality of knowledge.

[iii] The "entities" are typically called *agents* in complexity science. In network science they are called *nodes.* The term *agents* is not used to mean a fiduciary representative (a typical use in business). Rather it denotes people or organizations in our discussion. This is akin to the use of the term agents in chemistry.

[iv] See discussion by Steven Jay Gould quoted in the Epilogue (Chapter 6 of Volume II, American Democracy: The Declaration, Pursuit, and Endangerment. Also note the context. An excerpt from that chapter is as follows:

> The scientific processes were heavily tilted to the reductionist approach of digging deeper into the constituent parts. For centuries, that was the thrust of science, but in the latter part of the 20th century recognition of the *emergent properties* of substances triggered the spawning of nascent disciplines of *network science* and *complexity science* and impacted broadening the base of science.
>
> The reductionist approach supported the idea of the commonality of principles. That commonality of principles was championed by Edward O. Wilson in his book *Consilience: The Unity of Knowledge* (1998). Understanding consilience serves at least two purposes. First, in facing most of the issues calling for a strategic approach to decision making, more than one discipline is involved. One can blend the disciplines by using the idea that there is a commonality of principles. Thus, great expertise may not be required in the multiplicity of disciplines. If it is, then the approach is best organized by assembling a group of experts in the various discipline and working as a team. That was the approach used in getting a man to the moon.
>
> A second purpose served by understanding consilience is in discipline development. Wilson's great rival, Steven Jay Gould, took exception to Wilson on more than one occasion. One such occasion is discussed in my essay of as a newsletter supplement Spring 2004 – *"The Collective Mind."* It is also in the appendices in the appendix The Collective Mind. An excerpt follows.

Reductionism Revisited. Reductionism has some merits. It is the problems that need attention. Stephen Jay Gould, in his last book, *The Hedgehog, the Fox, and the Magister's Pox: Mending the Gap Between Science and Humanities*, identifies two problems in his discussion of consilience. One is *contingency.* The other is *emergence.*

The concept of *contingency* relates to the non-predictability arising out of historical accidents. There are some elements of randomness, chaos theory, or just plain chance that adversely affect predictability. This does not mean to assert that there are not other instances that are not predictable. The criticism of reductionism is that it asserts that all is predictable from the reduction to the constituent parts. It is this reduction to constituent parts that we call analyses that turns out to be useful. The merit of reduction is that some things are predictable because they are divisible into parts and the relationship among the parts provides the predictability. This form of analytical process may be very useful, but it is a valid criticism to say that it is not necessarily the only way of predicting outcomes.

This brings to the second point, *emergence.* Gould writes of *emergence* as

> "…the entry of novel explanatory rules in complex systems, laws arising from 'nonlinear' or 'nonadditive' interactions among constituent parts that therefore, in principle cannot be discovered from the properties of parts considered separately (their status in the 'basic' sciences that provide the fundamental explanation in classically reductionist models). [Page 202.]

[v] Falsifiability is used in the sense of testability.

[vi] That postulate is the "parallel postulate." It states "*If l is any line and P is any point not on l , then there are no lines through P that are parallel to l .*"

[vii] See *The Big Short: Inside the Doomsday Machine* by Michael Lewis.