# Predictions Critique 2012 7wk Seniors

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### Short

**Prediction is impossible – linear analysis causes policy failure**

**Sa, 04** – Deug Whan, Dong-U College, South Korea, (“CHAOS, UNCERTA I N T Y, AND POLICY CHOICE: UTILIZING THE ADAPTIVE MODEL,” International Review of Public Administration, vol. 8, no. 2, 2004, scholar)RK

In many cases, a small choice might lead to overwhelming results that generate either a virtuous cycle or a vicious cycle. If future results can be clearly predicted by stability and linearity, this will eliminate difficulties in making choice. Policy choice has been an embarrassment in uncertain or chaotic situations that do not meet desirable conditions. As a result, most major policies **revert back to** the uncertainty and **chaos.** Though the presence of uncertainty in policy procedures is widely known, it has not been determined what influence it wields on policy choice (Morgan and Henruion 1990: Lein 1997: 20). Generally, uncertainty refers to ‘difficulties in predicting the future.’ Naturally, the uncertainty here includes not simply difficulties in predicting the results of various factors and interactions, but also difficulties in predicting different configurations of interactions caused by the effect of such interactions (Saperstein 1997: 103-107). Uncertainty is classified into 3 categories according to source and phase of policy procedures; i) uncertainty from contingency, ii) uncertainty from inter-dependency of constituents, and iii) general uncertainty (Tompson 1967). The uncertainty from contingency arises when it is impossible to predict how the policy environment will change. What results is uncertainty from the interdependency of constituents makes it impossible to predict changes in the relationship between policy matters and constituents. Finally, general uncertainty comes from lack of knowledge about the cause and effect relationship in policy making. The Emergence of Chaos Theory and Characteristics Chaos theory offers theoretical explanations about the world of uncertainty. Chaos theory refers to the study of complex and dynamic systems with orders and patterns emerging from externally chaotic forms (Prigogine and Strengers 1984). The reason chaos theory draws a lot of interest is the highlight of; disorder, instability, diversity, flexibility and disequilibrium. This explains characteristics of rapid social changes in modern times referred to as the age of uncertainty. The focus of the chaos theory as a study is on complex, indeterminate, non-linear and dynamic systems. The main study object chaotic systems are chaotic which are complicated and dynamic. The characteristics of the chaos theory are as follows: The first is its self-organization principle. Selforganization means that the organization is determined by internal factors without any outer interference. That is to say, self-organization is a network of production processes of constituents interrelated with each other, and a system that produces the same network (Varela Maturana and Urife 1974; Jantsch 1980). The chaos theory assumes that order and organization can make an autogenesis out of disorder and chaos through the process of ‘self-organization.’ This also means that setting up conditions for self-organization to naturally take place can result in a reduction of policy failures. The second characteristic is co-evolution, referring to a process in which individual entities constituting a system continually adapt to each other and change. The essential concept of co-evolution, is ‘mutual causality,’ which puts emphasis on mutual evolution where an individual entity evolves entire group and vice versa, not the evolution of the survival of the fittest. It means interdependent species in continual inter-relationships evolve together. For example, if a mutant frog appears with a longer tongue or a frog whose hunting speed is twice as fast, it will have a competitive advantage to the environment and subsequent off-spring will flourish with the superior gene. On the other hand, flies will decrease in number, until a mutant fly appears that has any combination of advantages such as; faster, bad smells frogs avoid, or becomes poisonous, subsequent off-spring will survive and flourish. This is the way frogs and flies coevolve with each other. Therefore, chaos theory regards a variety of paradoxes as an important principle instead of ignoring it or taking it as an exception. Third, the characteristic is the existing Newtonian determinism theory which presumes linear relations where things proceed from the starting point toward the future on the thread of a single orbit. Thus, it also assumes that predictions of the future are on the extended line of present knowledge and future knowledge is not as unclear as the present one (Saperstein 1997: 103107), and that as similar inputs generate similar outcomes, there will be no big differences despite small changes in initial conditions. However, chaos theory assumes that the outcome is larger than the input and that **prediction of the future is fundamentally impossible.**3 Hence, due to extreme sensitivity to initial fluctuations and non-linear feedback loops, small differences in initial conditions are subject to amplifications and eventual different outcomes, known as ‘chaos.’4 Chaos is sometimes divided into strong chaos and weak chaos (Eve, Horsfall and Lee 1997: 106); and goes through a series of orbit processes of close intersections and divisions. In particular, weak chaos is found in the limits that account for the small proportion inside a system, while strong chaos features divisions at some points inside a system, which lead to occupation of the entire system in little time. CHAOS, UNCERTAINTY AND POLICY CHOICE 1. Review of Existing Policy Models Social scientists have tried to explain and predict policy matters, but never have generated satisfactory outcomes in terms of accuracy of predictions. There could be a variety of reasons for this inaccuracy in prediction, but one certain reason is that policies themselves are intrinsically governed by uncertainty, complexity and chaos in policies that produce many different outcomes though they are faced with the same initial internal states, the same environments, and governed by the same causal relationships.

**Only moving away from predictive models can address multiple extinction level impacts**

**Gell-Mann, 97** – Murray, Nobel Laureate in Physics and professor at the Santa Fe Institute and co-chairman of the Science Board (“Chapter 1: The Simple and the Complex,” *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

At this conference, issues of global politics and security will be addressed, including ones specifically concerned with the security of the United States. But security narrowly defined depends in very important ways on security in the broadest sense. Some politicians deeply concerned about military strength appear to resent the idea of diluting that concern by emphasizing a broader conception of security, but many thinkers in the armed services themselves recognize that military security is deeply intertwined with all the other major global issues. I like to discuss those issues under the rubric of sustainability, one of today’s favorite catchwords. It is rarely defined in a careful or consistent way, so perhaps I can be forgiven for attaching to it my own set of meanings. Broadly conceived, sustainability refers to quality that is not purchased mainly at the expense of the future—quality of human life and of the environment. But I use the term in a much more inclusive way than most people: sustainability is not restricted to environmental, demographic, and economic matters, but refers also to political, military, diplomatic, social, and institutional or governance issues—and ultimately sustainability depends on ideological issues and lifestyle choices. As used here, sustainability refers as much to sustainable peace, sustainable preparedness for possible conflict, sustainable global security arrangements, sustainable democracy and human rights, and sustainable communities and institutions as it does to sustainable population, economic activity, and ecological integrity. All of these are closely interlinked, and security in the narrow sense is a critical part of the mix. In the presence of destructive war, it is hardly possible to protect nature very effectively or to keep some important human social ties from dissolving. Conversely, if resources are abused and human population is rapidly growing, or if communities lose their cohesion, conflicts are more likely to occur. If huge and conspicuous inequalities are present, people will be reluctant to restrain quantitative economic growth in favor of qualitative growth as would be required to achieve a measure of economic and environmental sustainability. At the same time, great inequalities may provide the excuse for demagogues to exploit or revive ethnic or class hatreds and provoke deadly conflict. And so forth. In my book, The Quark and the Jaguar, I suggest that studies be undertaken of possible paths toward sustainability (in this very general sense) during the course of the next century, in the spirit of taking a crude look at the whole. I employ a modified version of a schema introduced by my friend James Gustave Speth, then president of the World Resources Institute and now head of the United Nations Development Program. The schema involves a set of interlinked transitions that have to occur if the world is to switch over from present trends toward a more sustainable situation: 1) The demographic transition to a roughly stable human population, worldwide and in each broad region. Without that, talk of sustainability seems almost pointless. 2) The technological transition to methods of supplying human needs and satisfying human desires with much lower environmental impact per person, for a given level of conventional prosperity. 3) The economic transition to a situation where growth in quality gradually replaces growth in quantity, while extreme poverty, which cries out for quantitative growth, is alleviated. (Analysts, by the way, are now beginning to use realistic measures of wellbeing that depart radically from narrow economic measures by including mental and physical health, education, and so forth.) The economic transition has to involve what economists call the internalization of externalities: prices must come much closer to reflecting true costs, including damage to the future. 4) The social transition to a society with less inequality, which, as remarked before, should make the decline of quantitative growth more acceptable. (For example, fuel taxes necessary for conservation adversely affect the poor who require transport to work, but the impact of such taxes can be reduced by giving a subsidy to the working poor—such as a negative income tax—that is not tied to fuel consumption.) The social transition includes a successful struggle against large-scale corruption, which can vitiate attempts to regulate any activity through law. 5) The institutional transition to more effective means of coping with conflict and with the management of the biosphere and human activities in it. We are now in an era of simultaneous globalization and fragmentation, in which the relevance of national governments is declining somewhat, even though the power to take action is still concentrated largely at that level. Most of our problems involving security—whether in the narrow or the broad sense—have global implications and require transnational institutions for their solution. We already have a wide variety of such institutions, formal and informal, and many of them are gradually gaining in effectiveness. But they need to become far more effective. Meanwhile, local and national institutions need to become more responsive and, in many places, much less corrupt. Such changes require the development of a strong sense of community and responsibility at many levels, but in a climate of political and economic freedom. How to achieve the necessary balance between cooperation and competition is the most difficult problem at every level. 6) The informational transition. Coping on local, national, and transnational levels with technological advances, environmental and demographic issues, social and economic problems, and questions of international security, as well as the strong interactions among all of them, requires a transition in the acquisition and dissemination of knowledge and understanding. Only if there is a higher degree of comprehension, among ordinary people as well as elite groups, of the complex issues facing humanity is there any hope of achieving sustainable quality. But most of the discussions of the new digital society concentrate on the dissemination and storage of information, much of it misinformation or badly organized information, rather than on the difficult and still poorly rewarded work of converting that so-called information into knowledge and understanding. And here again we encounter the pervasive need for a crude look at the whole. 7) The ideological transition to a world view that combines local, national, and regional loyalties with a "planetary consciousness," a sense of solidarity with all human beings and, to some extent, all living things. Only by acknowledging the interdependence of all people and, indeed, of all life can we hope to broaden our individual outlooks so that they reach out in time and space to embrace the vital long-term issues and worldwide problems along with immediate concerns close to home. This transition may seem even more Utopian than some of the others, but if we are to manage conflict that is based on destructive particularism, it is essential that groups of people that have traditionally opposed one another acknowledge their common humanity. Such a progressive extension of the concept of "us" has, after all, been a theme in human history from time immemorial. One dramatic manifestation is the greatly diminished likelihood over the last fifty years of armed conflict in Western Europe. Another is, of course, the radical transformation of relationships that is often called "The End of the Cold War." The recent damping-down of long-standing civil wars in a number of countries is also rather impressive. Our tendency is to study separately the various aspects of human civilization that correspond to the different transitions. Moreover, in our individual political activities we tend to pick out just one or a few of these aspects. Some of us may belong to organizations favoring a strong defense or arms control or both, others to the United Nations Association of the United States, others to ZPG or the Population Council, some to organizations plumping for more assistance to developing countries or to ones working for more generous treatment of the poor in our own country, some to organizations promoting democracy and human rights, some to environmental organizations. But the issues dear to these various organizations are all tightly interlinked, and a portion of our activity needs to be devoted to examining the whole question of the approach to sustainability in all these different spheres. It is reasonable to ask why a set of transitions to greater sustainability should be envisaged as a possibility during the coming century. The answer is that we are living in a very special time. Historians tend to be skeptical of most claims that a particular age is special, since such claims have been made so often. But this turn of the millennium really is special, not because of our arbitrary way of reckoning time but because of two related circumstances: a) The changes that we humans produce in the biosphere, changes that were often remarkably destructive even in the distant past when our numbers were few, are now of order one. We have become capable of **wiping out** a very large fraction of **humanity— and of living things** generally—if a full-scale world war should break out. Even if it does not, we are still affecting the composition of the atmosphere, water resources, vegetation, and animal life in profound ways around the planet. While such effects of human activities have been surprisingly great in the past, they were not global in scope as they are now. b) The graph of human population against time has the highest rate of increase ever, and that rate of increase is just beginning to decline. In other words, the curve is near what is called a "point of inflection." For centuries, even millennia, world population was, to a fair approximation, inversely proportional to 2025 minus the year. (That is a solution of the equation in which the rate of change of a variable is proportional to its square.) Only during the last thirty years or so has the total number of human beings been deviating significantly from this formula, which would have had it becoming infinite a generation from now! The demographic transition thus appears to be under way at last. It is generally expected that world population will level off during the coming century at something like twice its present value, but decisions and events in the near future can affect the final figure by billions either way. That is especially significant in regions such as Africa, where present trends indicate a huge population increase very difficult to support and likely to contribute to severe environmental degradation. In general, the coming century, the century of inflection points in a number of crucial variables, seems to be the time when the human race might still accomplish the transitions to greater sustainability without going through disaster. It is essential, in my opinion, to make some effort to search out in advance what kinds of paths might lead humanity to a reasonably sustainable and desirable world during the coming decades. And while the study of the many different subjects involved is being pursued by the appropriate specialists, we need to supplement that study with interdisciplinary investigations of the strong interdependence of all the principal facets of the world situation. In short, we need a crude look at the whole, treating global security and global politics as parts of a very general set of questions about the future.

**The alternative to engage in policy analysis of complexity- key to have preferable political results in a chaotic world**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

In short, there are strict limits within which theorizing based on the premises of complexity theory must be confined. It cannot presently—and is unlikely ever to—provide a method for predicting particular events and specifying the exact shape and nature of developments in the future. As one observer notes, it is a theory "meant for thought experiments rather than for emulation of real systems."18 Consequently, it is when our panacean impulses turn us toward complexity theory for guidance in the framing of exact predictions that the policy payoffs are least likely to occur and our disillusionment is most likely to intensify. For the strides that complexity theorists have made with their mathematical models and computer simulations are still a long way from amounting to a science that can be relied upon for precision in charting the course of human affairs that lies ahead. Although their work has demonstrated the existence of an underlying order, it has also called attention to a variety of ways in which the complexity of that order can collapse into pervasive disorder. Put differently, while human affairs have both linear and nonlinear dimensions, and while there is a range of conditions in which the latter dimensions are inoperative or "well behaved,"19 it is not known when or where the nonlinear dimensions will appear and trigger inexplicable feedback mechanisms. Such unknowns lead complexity theorists to be as interested in patterns of disorder as those of order, an orientation that is quite contrary to the concerns of policy makers. Theorizing Within the Limits To acknowledge the limits of complexity theory, however, is not to assert that it is of no value for policy makers and academics charged with comprehending world affairs. Far from it: if the search for panaceas is abandoned and replaced with a nuanced approach, it quickly becomes clear that the underlying premises of complexity theory have a great deal to offer as a perspective or world view with which to assess and anticipate the course of events. Perhaps most notably, they challenge prevailing assumptions in both the academic and policy-making communities that political, economic, and social relationships adhere to patterns traced by linear regressions. Complexity theory asserts that it is not the case, as all too many officials and analysts presume, that "we can get a value for the whole by adding up the values of its parts."20 In the words of one analyst, Look out the nearest window. Is there any straight line out there that wasn’t man-made? I’ve been asking the same question of student and professional groups for several years now, and the most common answer is a grin. Occasionally a philosophical person will comment that even the lines that look like straight lines are not straight lines if we look at them through a microscope. But even if we ignore that level of analysis, we are still stuck with the inevitable observation that natural structures are, at their core, nonlinear. If [this] is true, why do social scientists insist on describing human events as if all the rules that make those events occur are based on straight lines?21 A complexity perspective acknowledges the nonlinearity of both natural and human systems. It posits human systems as constantly learning, reacting, adapting, and changing even as they persist, as sustaining continuity and change simultaneously. It is a perspective that embraces non-equilibrium existence. Stated more generally, it is a mental set, a cast of mind that does not specify particular outcomes or solutions but that offers guidelines and lever points that analysts and policy makers alike can employ to more clearly assess the specific problems they seek to comprehend or resolve. Furthermore, the complexity perspective does not neglect the role of history even though it rejects the notion that a single cause has a single effect. Rather, focusing as it does on initial conditions and the paths that they chart for systems, complexity treats the historical context of situations as crucial to comprehension. The first obstacle to adopting a complexity perspective is to recognize that inevitably we operate with some kind of theory. It is sheer myth to believe that we need merely observe the circumstances of a situation in order to understand them. Facts do not speak for themselves; observers give them voice by sorting out those that are relevant from those that are irrelevant and, in so doing, they bring a theoretical perspective to bear. Whether it be realism, liberalism, or pragmatism, analysts and policy makers alike must have some theoretical orientation if they are to know anything. Theory provides guidelines; it sensitizes observers to alternative possibilities; it highlights where levers might be pulled and influence wielded; it links ends to means and strategies to resources; and perhaps most of all, it infuses context and pattern into a welter of seemingly disarrayed and unrelated phenomena. It follows that the inability of complexity theory to make specific predictions is not a serious drawback. Understanding and not prediction is the task of theory. It provides a basis for grasping and anticipating the general patterns within which specific events occur. The weather offers a good example. It cannot be precisely predicted at any moment in time, but there are building blocks—fronts, highs and lows, jet streams, and so on—and our overall understanding of changes in weather has been much advanced by theory based on these building blocks....We understand the larger patterns and (many of) their causes, though the detailed trajectory through the space of weather possibilities is perpetually novel. As a result, we can do far better than the old standby: predict that "tomorrow’s weather will be like today’s" and you stand a 60 percent probability of being correct. A relevant theory for [complex adaptive systems] should do at least as well.22 Given the necessity of proceeding from a theoretical standpoint, it ought not be difficult to adopt a complexity perspective. Indeed, most of us have in subtle ways already done so. Even if political analysts are not—as I am not—tooled up in computer science and mathematics, the premises of complexity theory and the strides in comprehension they have facilitated are not difficult to grasp. Despite our conceptual insufficiencies, we are not helpless in the face of mounting complexity. Indeed, as the consequences of turbulent change have become more pervasive, so have observers of the global scene become increasingly wiser about the ways of the world and, to a large degree, we have become, each of us in our own way, complexity theorists. Not only are we getting accustomed to a fragmegrative world view that accepts contradictions, anomalies, and dialectic processes, but we have also learned that situations are multiply caused, that unintended consequences can accompany those that are intended, that seemingly stable situations can topple under the weight of cumulated grievances, that some situations are ripe for accidents waiting to happen, that expectations can be self-fulfilling, that organizational decisions are driven as much by informal as formal rules, that feedback loops can redirect the course of events, and so on through an extensive list of understandings that appear so commonplace as to obscure their origins in the social sciences only a few decades ago.23 Indeed, we now take for granted that learning occurs in social systems, that systems in crisis are vulnerable to sharp turns of directions precipitated by seemingly trivial incidents, that the difference between times one and two in any situation can often be ascribed to adaptive processes, that the surface appearance of societal tranquillity can mask underlying problems, and that "other things being equal" can be a treacherous phrase if it encourages us to ignore glaring exceptions. In short, we now know that history is not one damn thing after another so much as it is many damn things simultaneously. And if we ever slip in our understanding of these subtle lessons, if we ever unknowingly revert to simplistic formulations, complexity theory serves to remind us there are no panaceas. It tells us that there are limits to how much we can comprehend of the complexity that pervades world affairs, that we have to learn to become comfortable living and acting under conditions of uncertainty. The relevance of this accumulated wisdom—this implicit complexity perspective—can be readily illustrated. It enables us to grasp how an accidental drowning in Hong Kong intensified demonstrations against China, how the opening of a tunnel in Jerusalem could give rise to a major conflagration, how the death of four young girls can foster a "dark and brooding" mood in Brussels, how an "October surprise" might impact strongly on an American presidential election, or how social security funds will be exhausted early in the next century unless corrective policies are adopted—to cite three recent events and two long-standing maxims.24 We know, too that while the social security example is different from the others—in that it is founded on a linear projection of demographic change while the other examples involve nonlinear feedback loops—the world is comprised of linear as well as nonlinear dynamics and that this distinction is central to the kind of analysis we undertake. In other words, while it is understandable that we are vulnerable to the appeal of panaceas, this need not be the case. Our analytic capacities and concepts are not so far removed from complexity theorists that we need be in awe of their accomplishments or be ready to emulate their methods. Few of us have the skills or resources to undertake sophisticated computer simulations—and that may even be an advantage, as greater technical skills might lead us to dismiss complexity theory as inapplicable—but as a philosophical perspective complexity theory is not out of our reach. None of its premises and concepts are alien to our analytic habits. They sum to a perspective that is consistent with our own and with the transformations that appear to be taking the world into unfamiliar realms. Hence, through its explication, the complexity perspective can serve as a guide both to comprehending a fragmegrated world and theorizing within its limits.

### Long

**Prediction is impossible – linear analysis causes policy failure**

**Sa, 04** – Deug Whan, Dong-U College, South Korea, (“CHAOS, UNCERTA I N T Y, AND POLICY CHOICE: UTILIZING THE ADAPTIVE MODEL,” International Review of Public Administration, vol. 8, no. 2, 2004, scholar)RK

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**Chaos theory dictates transportation- have to consider complexity in building and maintaining infrastructure.**

**Kockelman and Frazier, 2004** – Frazier is a graduate student researcher at UT, while Kockelman is an assistant professor of civil engineering at UT (Kara and Christopher, “Chaos Theory and Transportation Systems: An Instructive Example”, 9/17/04, <http://www.ce.utexas.edu/prof/kockelman/public_html/trb04chaos.pdf>) //BZ

This paper was motivated by a hypothesis that transportation systems are often chaotic. The difficulty with this hypothesis is that chaos theory presumes system determinism. Since transportation systems involve humans, weather, and other possibly (probably?) random agents, such an assumption is not easy to justify. Thus, chaos theory may not well apply. However, if human behavior is controlled and directed through system laws and restrictions, then outcomes may be determined by system dynamics. And chaos theory may well apply. Strong empirical evidence of chaos is needed for this theory to provide fruitful application in transportation systems modeling. Lack of good data is one concern: small measurement errors may be multiplied during analysis; and data that are not sufficiently extensive or are sampled at the wrong frequency will not accurately capture important system dynamics. Moreover, when selecting a scalar as the raw data source (e.g., traffic counts), logical and/or physical justification is necessary for that measurement’s connection to and dependence on system properties; it must contain the information an analyst aims to extract. Furthermore, whether or not chaos exists, other dynamics may control the overall system evolution. This paper’s traffic flow example is problematic because traffic counts are highly periodic. Indeed, while it seems rather obvious that the periodic portions of the data are deterministic, it is a much bigger step to say that the (chaotic) fluctuations are as well. Therefore, while chaos may exist on a small level, it may be neither discernable nor of (apparent) practical significance. This raises the issue of the usefulness of chaos theory to practitioners. And, if the analytical methods described in this paper do not provide explicit or explanatory models for the data, why use them? On a most basic level, the answer to this is simplicity. Though the methods described here may seem complex at first, they are actually quite easy to implement and are not data intensive; and they facilitate accurate results. Furthermore, the assumptions of chaos theory – that the system is primarily deterministic and that the scalar measurement captures the dynamics of the system – in certain cases not be as restrictive as those of other models. Finally, if the system can be shown to be truly chaotic, then these techniques will probably the only manner through which useful information may be extracted from the system. Chaotic data analysis, though unique, is not excessively complicated, and may serve as a powerful tool to transportation analysts. Many diverse areas could benefit, such as pavement analysis, flight logistics, and land use modeling. Using the techniques discussed in this paper, important properties of a system, such as its nature (periodic/repetitive, chaotic, or random) and its predictability, can be determined. Care must be taken, however, to justify the application of chaos theory to a system, so as not to extract information from a system that is clearly not (or could not be) chaotic. Though one should justify the application of chaos theory to a system (i.e. that it is chaotic), as the ambiguity of the source of chaos in the traffic flow example shows, this may not be necessary for good results. Moreover, and most importantly, while many system properties can be illuminated by chaotic data analysis, certain traditional properties, such as the system’s defining equations, cannot be extracted through it. Even so, chaotic methods hold much promise for the analysis of many nonlinear transportation systems. The methods discussed in this paper by no means cover all analytical techniques utilizing chaos theory. Many important topics have not been included for reasons of focus; these include bifurcation theory and universal scaling in chaotic systems (see Hilborn (2001)). One topic that may be highly useful in the context of transportation systems is symbolic data analysis. In this field, information is extracted from a system based on data abstractions and comparisons. Daw et al. (2001) provide an excellent survey of this topic. Additionally, there exist many freely available programs for analyzing chaotic data . All are based on the premise that many systems harbor almost infinite complexity, and that complexity may be best addressed through application of chaos theory.

**Only moving away from predictive models can address multiple extinction level impacts**

**Gell-Mann, 97** – Murray, Nobel Laureate in Physics and professor at the Santa Fe Institute and co-chairman of the Science Board (“Chapter 1: The Simple and the Complex,” *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

At this conference, issues of global politics and security will be addressed, including ones specifically concerned with the security of the United States. But security narrowly defined depends in very important ways on security in the broadest sense. Some politicians deeply concerned about military strength appear to resent the idea of diluting that concern by emphasizing a broader conception of security, but many thinkers in the armed services themselves recognize that military security is deeply intertwined with all the other major global issues. I like to discuss those issues under the rubric of sustainability, one of today’s favorite catchwords. It is rarely defined in a careful or consistent way, so perhaps I can be forgiven for attaching to it my own set of meanings. Broadly conceived, sustainability refers to quality that is not purchased mainly at the expense of the future—quality of human life and of the environment. But I use the term in a much more inclusive way than most people: sustainability is not restricted to environmental, demographic, and economic matters, but refers also to political, military, diplomatic, social, and institutional or governance issues—and ultimately sustainability depends on ideological issues and lifestyle choices. As used here, sustainability refers as much to sustainable peace, sustainable preparedness for possible conflict, sustainable global security arrangements, sustainable democracy and human rights, and sustainable communities and institutions as it does to sustainable population, economic activity, and ecological integrity. All of these are closely interlinked, and security in the narrow sense is a critical part of the mix. In the presence of destructive war, it is hardly possible to protect nature very effectively or to keep some important human social ties from dissolving. Conversely, if resources are abused and human population is rapidly growing, or if communities lose their cohesion, conflicts are more likely to occur. If huge and conspicuous inequalities are present, people will be reluctant to restrain quantitative economic growth in favor of qualitative growth as would be required to achieve a measure of economic and environmental sustainability. At the same time, great inequalities may provide the excuse for demagogues to exploit or revive ethnic or class hatreds and provoke deadly conflict. And so forth. In my book, The Quark and the Jaguar, I suggest that studies be undertaken of possible paths toward sustainability (in this very general sense) during the course of the next century, in the spirit of taking a crude look at the whole. I employ a modified version of a schema introduced by my friend James Gustave Speth, then president of the World Resources Institute and now head of the United Nations Development Program. The schema involves a set of interlinked transitions that have to occur if the world is to switch over from present trends toward a more sustainable situation: 1) The demographic transition to a roughly stable human population, worldwide and in each broad region. Without that, talk of sustainability seems almost pointless. 2) The technological transition to methods of supplying human needs and satisfying human desires with much lower environmental impact per person, for a given level of conventional prosperity. 3) The economic transition to a situation where growth in quality gradually replaces growth in quantity, while extreme poverty, which cries out for quantitative growth, is alleviated. (Analysts, by the way, are now beginning to use realistic measures of wellbeing that depart radically from narrow economic measures by including mental and physical health, education, and so forth.) The economic transition has to involve what economists call the internalization of externalities: prices must come much closer to reflecting true costs, including damage to the future. 4) The social transition to a society with less inequality, which, as remarked before, should make the decline of quantitative growth more acceptable. (For example, fuel taxes necessary for conservation adversely affect the poor who require transport to work, but the impact of such taxes can be reduced by giving a subsidy to the working poor—such as a negative income tax—that is not tied to fuel consumption.) The social transition includes a successful struggle against large-scale corruption, which can vitiate attempts to regulate any activity through law. 5) The institutional transition to more effective means of coping with conflict and with the management of the biosphere and human activities in it. We are now in an era of simultaneous globalization and fragmentation, in which the relevance of national governments is declining somewhat, even though the power to take action is still concentrated largely at that level. Most of our problems involving security—whether in the narrow or the broad sense—have global implications and require transnational institutions for their solution. We already have a wide variety of such institutions, formal and informal, and many of them are gradually gaining in effectiveness. But they need to become far more effective. Meanwhile, local and national institutions need to become more responsive and, in many places, much less corrupt. Such changes require the development of a strong sense of community and responsibility at many levels, but in a climate of political and economic freedom. How to achieve the necessary balance between cooperation and competition is the most difficult problem at every level. 6) The informational transition. Coping on local, national, and transnational levels with technological advances, environmental and demographic issues, social and economic problems, and questions of international security, as well as the strong interactions among all of them, requires a transition in the acquisition and dissemination of knowledge and understanding. Only if there is a higher degree of comprehension, among ordinary people as well as elite groups, of the complex issues facing humanity is there any hope of achieving sustainable quality. But most of the discussions of the new digital society concentrate on the dissemination and storage of information, much of it misinformation or badly organized information, rather than on the difficult and still poorly rewarded work of converting that so-called information into knowledge and understanding. And here again we encounter the pervasive need for a crude look at the whole. 7) The ideological transition to a world view that combines local, national, and regional loyalties with a "planetary consciousness," a sense of solidarity with all human beings and, to some extent, all living things. Only by acknowledging the interdependence of all people and, indeed, of all life can we hope to broaden our individual outlooks so that they reach out in time and space to embrace the vital long-term issues and worldwide problems along with immediate concerns close to home. This transition may seem even more Utopian than some of the others, but if we are to manage conflict that is based on destructive particularism, it is essential that groups of people that have traditionally opposed one another acknowledge their common humanity. Such a progressive extension of the concept of "us" has, after all, been a theme in human history from time immemorial. One dramatic manifestation is the greatly diminished likelihood over the last fifty years of armed conflict in Western Europe. Another is, of course, the radical transformation of relationships that is often called "The End of the Cold War." The recent damping-down of long-standing civil wars in a number of countries is also rather impressive. Our tendency is to study separately the various aspects of human civilization that correspond to the different transitions. Moreover, in our individual political activities we tend to pick out just one or a few of these aspects. Some of us may belong to organizations favoring a strong defense or arms control or both, others to the United Nations Association of the United States, others to ZPG or the Population Council, some to organizations plumping for more assistance to developing countries or to ones working for more generous treatment of the poor in our own country, some to organizations promoting democracy and human rights, some to environmental organizations. But the issues dear to these various organizations are all tightly interlinked, and a portion of our activity needs to be devoted to examining the whole question of the approach to sustainability in all these different spheres. It is reasonable to ask why a set of transitions to greater sustainability should be envisaged as a possibility during the coming century. The answer is that we are living in a very special time. Historians tend to be skeptical of most claims that a particular age is special, since such claims have been made so often. But this turn of the millennium really is special, not because of our arbitrary way of reckoning time but because of two related circumstances: a) The changes that we humans produce in the biosphere, changes that were often remarkably destructive even in the distant past when our numbers were few, are now of order one. We have become capable of **wiping out** a very large fraction of **humanity— and of living things** generally—if a full-scale world war should break out. Even if it does not, we are still affecting the composition of the atmosphere, water resources, vegetation, and animal life in profound ways around the planet. While such effects of human activities have been surprisingly great in the past, they were not global in scope as they are now. b) The graph of human population against time has the highest rate of increase ever, and that rate of increase is just beginning to decline. In other words, the curve is near what is called a "point of inflection." For centuries, even millennia, world population was, to a fair approximation, inversely proportional to 2025 minus the year. (That is a solution of the equation in which the rate of change of a variable is proportional to its square.) Only during the last thirty years or so has the total number of human beings been deviating significantly from this formula, which would have had it becoming infinite a generation from now! The demographic transition thus appears to be under way at last. It is generally expected that world population will level off during the coming century at something like twice its present value, but decisions and events in the near future can affect the final figure by billions either way. That is especially significant in regions such as Africa, where present trends indicate a huge population increase very difficult to support and likely to contribute to severe environmental degradation. In general, the coming century, the century of inflection points in a number of crucial variables, seems to be the time when the human race might still accomplish the transitions to greater sustainability without going through disaster. It is essential, in my opinion, to make some effort to search out in advance what kinds of paths might lead humanity to a reasonably sustainable and desirable world during the coming decades. And while the study of the many different subjects involved is being pursued by the appropriate specialists, we need to supplement that study with interdisciplinary investigations of the strong interdependence of all the principal facets of the world situation. In short, we need a crude look at the whole, treating global security and global politics as parts of a very general set of questions about the future.

**Complexity theory turns solvency – causal chains are impossible to dictate and disastrous policy effects are inevitable**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

In a system, the chains of consequences extend over time and many areas: the effects of action are always multiple. Doctors call the undesired impact of medications "side effects." Although the language is misleading—there is no criteria other than our desires that determines which effects are "main" and which are "side"—the point reminds us that disturbing a system will produce several changes. Garrett Hardin gets to the heart of the matter in pointing out that, contrary to many hopes and expectations, we cannot develop or find "a highly specific agent which will do only one thing.... We can never do merely one thing. Wishing to kill insects, we may put an end to the singing of birds. Wishing to ‘get there’ faster we insult our lungs with smog."5 Seeking to protect the environment by developing non-polluting sources of electric power, we build windmills that kill hawks and eagles that fly into the blades; cleaning the water in our harbors allows the growth of mollusks and crustaceans that destroy wooden piers and bulkheads; adding redundant safety equipment makes some accidents less likely, but increases the chances of others due to the operators’ greater confidence and the interaction effects among the devices; placing a spy in the adversary’s camp not only gains valuable information, but leaves the actor vulnerable to deception if the spy is discovered; eliminating rinderpest in East Africa paved the way for canine distemper in lions because it permitted the accumulation of cattle, which required dogs to herd them, dogs which provided a steady source for the virus that could spread to lions; releasing fewer fine particles and chemicals into the atmosphere decreases pollution but also is likely to accelerate global warming; pesticides often destroy the crops that they are designed to save by killing the pests’ predators; removing older and dead trees from forests leads to insect epidemics and an altered pattern of regrowth; allowing the sale of an anti-baldness medicine without a prescription may be dangerous because people no longer have to see a doctor, who in some cases would have determined that the loss of hair was a symptom of a more serious problem; flying small formations of planes over Hiroshima to practice dropping the atomic bomb accustomed the population to air raid warnings that turned out to be false alarms, thereby reducing the number of people who took cover on August 6.6 In politics, connections are often more idiosyncratic, but their existence guarantees that here too most actions, no matter how well targeted, will have multiple effects. For example, William Bundy was correct to worry that putting troops into Vietnam might not make that country more secure because deployment could not only lead the North to escalate, but also might "(1) cause the Vietnamese government and especially the army to let up [and] (2) create adverse public reactions to our whole presence on ‘white men’ and ‘like the French’ grounds."7 It seems that the American development of nuclear weapons simultaneously restrained Stalin by increasing his fear of war and made him "less cooperative and less willing to compromise, for fear of seeming weak."8 Indeed, it is now widely accepted that mutual second strike capability not only decreased the chance of nuclear war but also made it safer for either side to engage in provocations at lower levels of violence.9 (Similarly, providing security guarantees to the countries of East Europe might lead them to take harsher stances toward minority ethnic groups and make fewer efforts to maintain good relations with their neighbors.) To mention three more surprising cases, in the fall of 1948 General Clay warned that American budget deficits would be seen in Europe as a forerunner of inflation and so would undermine morale in West Berlin; the American pressure on the Europeans to rearm more rapidly in response to the North Korean attack on the South produced squabbles that encouraged the USSR "to believe that contradictions in the enemy camp ultimately would tear apart the enemy coalition....[and so] undermined U.S. bargaining power"; in 1994 the dollar strengthened after President Clinton hired a powerful lawyer to defend him against charges of sexual harassment: as one currency trader put it, "we were starting to lose faith in him and that helped turn things."10 Interactions, Not Additivity Because of the prevalence of inter-connections, we cannot understand systems by summing the characteristics of the parts or the bilateral relations between pairs of them.11 This is not to say that such operations are never legitimate, but only that when they are we are not dealing with a system. More precisely, actions often interact to produce results that cannot be comprehended by linear models.

**The alternative to engage in policy analysis of complexity- key to have preferable political results in a chaotic world**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

In short, there are strict limits within which theorizing based on the premises of complexity theory must be confined. It cannot presently—and is unlikely ever to—provide a method for predicting particular events and specifying the exact shape and nature of developments in the future. As one observer notes, it is a theory "meant for thought experiments rather than for emulation of real systems."18 Consequently, it is when our panacean impulses turn us toward complexity theory for guidance in the framing of exact predictions that the policy payoffs are least likely to occur and our disillusionment is most likely to intensify. For the strides that complexity theorists have made with their mathematical models and computer simulations are still a long way from amounting to a science that can be relied upon for precision in charting the course of human affairs that lies ahead. Although their work has demonstrated the existence of an underlying order, it has also called attention to a variety of ways in which the complexity of that order can collapse into pervasive disorder. Put differently, while human affairs have both linear and nonlinear dimensions, and while there is a range of conditions in which the latter dimensions are inoperative or "well behaved,"19 it is not known when or where the nonlinear dimensions will appear and trigger inexplicable feedback mechanisms. Such unknowns lead complexity theorists to be as interested in patterns of disorder as those of order, an orientation that is quite contrary to the concerns of policy makers. Theorizing Within the Limits To acknowledge the limits of complexity theory, however, is not to assert that it is of no value for policy makers and academics charged with comprehending world affairs. Far from it: if the search for panaceas is abandoned and replaced with a nuanced approach, it quickly becomes clear that the underlying premises of complexity theory have a great deal to offer as a perspective or world view with which to assess and anticipate the course of events. Perhaps most notably, they challenge prevailing assumptions in both the academic and policy-making communities that political, economic, and social relationships adhere to patterns traced by linear regressions. Complexity theory asserts that it is not the case, as all too many officials and analysts presume, that "we can get a value for the whole by adding up the values of its parts."20 In the words of one analyst, Look out the nearest window. Is there any straight line out there that wasn’t man-made? I’ve been asking the same question of student and professional groups for several years now, and the most common answer is a grin. Occasionally a philosophical person will comment that even the lines that look like straight lines are not straight lines if we look at them through a microscope. But even if we ignore that level of analysis, we are still stuck with the inevitable observation that natural structures are, at their core, nonlinear. If [this] is true, why do social scientists insist on describing human events as if all the rules that make those events occur are based on straight lines?21 A complexity perspective acknowledges the nonlinearity of both natural and human systems. It posits human systems as constantly learning, reacting, adapting, and changing even as they persist, as sustaining continuity and change simultaneously. It is a perspective that embraces non-equilibrium existence. Stated more generally, it is a mental set, a cast of mind that does not specify particular outcomes or solutions but that offers guidelines and lever points that analysts and policy makers alike can employ to more clearly assess the specific problems they seek to comprehend or resolve. Furthermore, the complexity perspective does not neglect the role of history even though it rejects the notion that a single cause has a single effect. Rather, focusing as it does on initial conditions and the paths that they chart for systems, complexity treats the historical context of situations as crucial to comprehension. The first obstacle to adopting a complexity perspective is to recognize that inevitably we operate with some kind of theory. It is sheer myth to believe that we need merely observe the circumstances of a situation in order to understand them. Facts do not speak for themselves; observers give them voice by sorting out those that are relevant from those that are irrelevant and, in so doing, they bring a theoretical perspective to bear. Whether it be realism, liberalism, or pragmatism, analysts and policy makers alike must have some theoretical orientation if they are to know anything. Theory provides guidelines; it sensitizes observers to alternative possibilities; it highlights where levers might be pulled and influence wielded; it links ends to means and strategies to resources; and perhaps most of all, it infuses context and pattern into a welter of seemingly disarrayed and unrelated phenomena. It follows that the inability of complexity theory to make specific predictions is not a serious drawback. Understanding and not prediction is the task of theory. It provides a basis for grasping and anticipating the general patterns within which specific events occur. The weather offers a good example. It cannot be precisely predicted at any moment in time, but there are building blocks—fronts, highs and lows, jet streams, and so on—and our overall understanding of changes in weather has been much advanced by theory based on these building blocks....We understand the larger patterns and (many of) their causes, though the detailed trajectory through the space of weather possibilities is perpetually novel. As a result, we can do far better than the old standby: predict that "tomorrow’s weather will be like today’s" and you stand a 60 percent probability of being correct. A relevant theory for [complex adaptive systems] should do at least as well.22 Given the necessity of proceeding from a theoretical standpoint, it ought not be difficult to adopt a complexity perspective. Indeed, most of us have in subtle ways already done so. Even if political analysts are not—as I am not—tooled up in computer science and mathematics, the premises of complexity theory and the strides in comprehension they have facilitated are not difficult to grasp. Despite our conceptual insufficiencies, we are not helpless in the face of mounting complexity. Indeed, as the consequences of turbulent change have become more pervasive, so have observers of the global scene become increasingly wiser about the ways of the world and, to a large degree, we have become, each of us in our own way, complexity theorists. Not only are we getting accustomed to a fragmegrative world view that accepts contradictions, anomalies, and dialectic processes, but we have also learned that situations are multiply caused, that unintended consequences can accompany those that are intended, that seemingly stable situations can topple under the weight of cumulated grievances, that some situations are ripe for accidents waiting to happen, that expectations can be self-fulfilling, that organizational decisions are driven as much by informal as formal rules, that feedback loops can redirect the course of events, and so on through an extensive list of understandings that appear so commonplace as to obscure their origins in the social sciences only a few decades ago.23 Indeed, we now take for granted that learning occurs in social systems, that systems in crisis are vulnerable to sharp turns of directions precipitated by seemingly trivial incidents, that the difference between times one and two in any situation can often be ascribed to adaptive processes, that the surface appearance of societal tranquillity can mask underlying problems, and that "other things being equal" can be a treacherous phrase if it encourages us to ignore glaring exceptions. In short, we now know that history is not one damn thing after another so much as it is many damn things simultaneously. And if we ever slip in our understanding of these subtle lessons, if we ever unknowingly revert to simplistic formulations, complexity theory serves to remind us there are no panaceas. It tells us that there are limits to how much we can comprehend of the complexity that pervades world affairs, that we have to learn to become comfortable living and acting under conditions of uncertainty. The relevance of this accumulated wisdom—this implicit complexity perspective—can be readily illustrated. It enables us to grasp how an accidental drowning in Hong Kong intensified demonstrations against China, how the opening of a tunnel in Jerusalem could give rise to a major conflagration, how the death of four young girls can foster a "dark and brooding" mood in Brussels, how an "October surprise" might impact strongly on an American presidential election, or how social security funds will be exhausted early in the next century unless corrective policies are adopted—to cite three recent events and two long-standing maxims.24 We know, too that while the social security example is different from the others—in that it is founded on a linear projection of demographic change while the other examples involve nonlinear feedback loops—the world is comprised of linear as well as nonlinear dynamics and that this distinction is central to the kind of analysis we undertake. In other words, while it is understandable that we are vulnerable to the appeal of panaceas, this need not be the case. Our analytic capacities and concepts are not so far removed from complexity theorists that we need be in awe of their accomplishments or be ready to emulate their methods. Few of us have the skills or resources to undertake sophisticated computer simulations—and that may even be an advantage, as greater technical skills might lead us to dismiss complexity theory as inapplicable—but as a philosophical perspective complexity theory is not out of our reach. None of its premises and concepts are alien to our analytic habits. They sum to a perspective that is consistent with our own and with the transformations that appear to be taking the world into unfamiliar realms. Hence, through its explication, the complexity perspective can serve as a guide both to comprehending a fragmegrated world and theorizing within its limits.

**The role of the ballot is an intellectual engagement in good research practices of predictions. This engages in knowledge production that is good for scholarship and complexity.**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

Analytic eclecticism does not constitute an alternative model of research. It is an intellectual stance a researcher can adopt when pursuing research that engages, but does not fit neatly within, established research traditions in a given discipline or field. We identify analytic eclecticism in terms of three characteristics that distinguish it from conventional scholarship embedded in research traditions. First, it proceeds at least implicitly on the basis of a pragmatist ethos, manifested concretely in the search for middle-range theoretical arguments that potentially speak to concrete issues of policy and practice. Second, it addresses problems of wide scope that, in contrast to more narrowly parsed research puzzles designed to test theories or fill in gaps within research traditions, incorporate more of the complexity and messiness of particular real-world situations. Third, in constructing substantive arguments related to these problems, analytic eclecticism generates complex causal stories that forgo parsimony in order to capture the interactions among different types of causal mechanisms normally analyzed in isolation from each other within separate research traditions. This is not the first call for something resembling eclec-ticism. In addition to Lindblom and Cohen, numerous scholars have issued pleas for a more practically useful social science—or, following Aristotle, a “phronetic” social science—oriented more toward social commentary and political action than toward inter-paradigm debates.3 In international relations, prominent scholars, some even iden-tified with particular research traditions, have acknowledged the need for incorporating elements from other approaches in order to fashion more usable and more comprehensive forms of knowledge. For example, Kenneth Waltz, whose name would become synonymous with neorealism, argued in his earlier work: “ The prescriptions directly derived from a single image [of international relations] are incomplete because they are based upon partial analyses. The partial quality of each image sets up a tension that drives one toward inclusion of the others . . . One is led to search for the inclusive nexus of causes.”4 An ardent critic of realist theory, Andrew Moravcsik, would have to agree with Waltz on this point: “The outbreak of World Wars I and II, the emergence of international human rights norms, and the evolution of the European Union, for example, are surely important enough events to merit comprehensive explanation even at the expense of theoretical parsimony.”5 Similarly, in an important symposium on the role of theory in comparative politics, several prominent scholars emphasized the virtues of an “eclectic combination” of diverse theoretical perspectives in making sense of cases, cautioning against the excessive “sim-plifications” required to apply a single theoretical lens to grasp the manifold complexities on the ground.6 As far as programmatic statements go, these views are all consistent with the spirit of analytic eclecticism. Whether these positions are readily evident in research practice, how-ever, is quite another matter. For the most part, social sci-entific research is still organized around particular research traditions or scholarly communities, each marked by its own epistemic commitments, its own theoretical vocabulary, its own standards, and its own conceptions of “progress.” A more effective case for eclectic scholarship requires more than statements embracing intellectual pluralism or multi- causal explanation. It requires an alternative understanding of research practice that is coherent enough to be distinguishable from conventional scholarship and yet flex-ible enough to accommodate a wide range of problems, con-cepts, methods, and causal arguments. We have sought to systematically articulate such an understanding in the form of “analytic eclecticism,” emphasizing its pragmatist ethos, its orientation towards preexisting styles and schools of research, and its distinctive value added in relating academic debates to concrete matters of policy and practice.

## \*\*LINKS\*\*

### Transportation

**Chaos theory dictates transportation- have to consider complexity in building and maintaining infrastructure.**

**Kockelman and Frazier, 2004** – Frazier is a graduate student researcher at UT, while Kockelman is an assistant professor of civil engineering at UT (Kara and Christopher, “Chaos Theory and Transportation Systems: An Instructive Example”, 9/17/04, <http://www.ce.utexas.edu/prof/kockelman/public_html/trb04chaos.pdf>) //BZ

This paper was motivated by a hypothesis that transportation systems are often chaotic. The difficulty with this hypothesis is that chaos theory presumes system determinism. Since transportation systems involve humans, weather, and other possibly (probably?) random agents, such an assumption is not easy to justify. Thus, chaos theory may not well apply. However, if human behavior is controlled and directed through system laws and restrictions, then outcomes may be determined by system dynamics. And chaos theory may well apply. Strong empirical evidence of chaos is needed for this theory to provide fruitful application in transportation systems modeling. Lack of good data is one concern: small measurement errors may be multiplied during analysis; and data that are not sufficiently extensive or are sampled at the wrong frequency will not accurately capture important system dynamics. Moreover, when selecting a scalar as the raw data source (e.g., traffic counts), logical and/or physical justification is necessary for that measurement’s connection to and dependence on system properties; it must contain the information an analyst aims to extract. Furthermore, whether or not chaos exists, other dynamics may control the overall system evolution. This paper’s traffic flow example is problematic because traffic counts are highly periodic. Indeed, while it seems rather obvious that the periodic portions of the data are deterministic, it is a much bigger step to say that the (chaotic) fluctuations are as well. Therefore, while chaos may exist on a small level, it may be neither discernable nor of (apparent) practical significance. This raises the issue of the usefulness of chaos theory to practitioners. And, if the analytical methods described in this paper do not provide explicit or explanatory models for the data, why use them? On a most basic level, the answer to this is simplicity. Though the methods described here may seem complex at first, they are actually quite easy to implement and are not data intensive; and they facilitate accurate results. Furthermore, the assumptions of chaos theory – that the system is primarily deterministic and that the scalar measurement captures the dynamics of the system – in certain cases not be as restrictive as those of other models. Finally, if the system can be shown to be truly chaotic, then these techniques will probably the only manner through which useful information may be extracted from the system. Chaotic data analysis, though unique, is not excessively complicated, and may serve as a powerful tool to transportation analysts. Many diverse areas could benefit, such as pavement analysis, flight logistics, and land use modeling. Using the techniques discussed in this paper, important properties of a system, such as its nature (periodic/repetitive, chaotic, or random) and its predictability, can be determined. Care must be taken, however, to justify the application of chaos theory to a system, so as not to extract information from a system that is clearly not (or could not be) chaotic. Though one should justify the application of chaos theory to a system (i.e. that it is chaotic), as the ambiguity of the source of chaos in the traffic flow example shows, this may not be necessary for good results. Moreover, and most importantly, while many system properties can be illuminated by chaotic data analysis, certain traditional properties, such as the system’s defining equations, cannot be extracted through it. Even so, chaotic methods hold much promise for the analysis of many nonlinear transportation systems. The methods discussed in this paper by no means cover all analytical techniques utilizing chaos theory. Many important topics have not been included for reasons of focus; these include bifurcation theory and universal scaling in chaotic systems (see Hilborn (2001)). One topic that may be highly useful in the context of transportation systems is symbolic data analysis. In this field, information is extracted from a system based on data abstractions and comparisons. Daw et al. (2001) provide an excellent survey of this topic. Additionally, there exist many freely available programs for analyzing chaotic data . All are based on the premise that many systems harbor almost infinite complexity, and that complexity may be best addressed through application of chaos theory.

**Transportation must be analyzed as part of a range of factors impacting IR – the aff’s focus on single issues distracts from key analysis and leaves us unprepared for major catastrophes**

**Mann, 97** – Steven R., Principal Deputy Assistant Secretary of State for South and Central Asian Affairs (“Chapter 6: The Reaction to Chaos,” Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

The argument that I am going to make is that foreign affairs exhibits characteristics of self-organized criticality. Briefly stated, the tenets of self-organized criticality are these: "many composite systems naturally evolve to a critical state in which a minor event starts a chain reaction that can affect any number of elements in the system. Although composite systems produce more minor events than catastrophes, chain reactions of all size are an integral part of the dynamics. According to the theory, the mechanism that leads to minor events is the same one that leads to major events. Furthermore, composite systems never reach equilibrium but instead evolve from one metastable state to the next." What first led me five years back to the metaphor of self-organized criticality was the utter unbelievability of the phrase, "the New World Order." Whatever else we were seeing in international affairs, it was not order. But that phrase has got legs; it even appears in the conference brochure. Leaving aside the unfortunate conspiratorial echoes of that phrase, which have fueled militia paranoia across the US, it is not properly descriptive. I’d suggest instead that what we are actually dealing with is better expressed by the concept of consistent criticality. The international environment is **complex, dynamic,** and **constantly changing.** The world appears as a critical arena. The destruction of the old paradigm of an ordered, bipolar international environment meant therefore that there would be a nostalgic, sometimes obsessive drive to reclaim the idea of a stable international scene. Thus the new world order. And indeed, something other than order is at work here. Look at the out-of-the-ordinary array of international crises that we have experienced in the past five years: Somalia, Haiti, Bosnia, Central Africa, Chechnya. This is not to speak of second-tier crises (from the US view) such as Abkhazia and Kashmir. I believe we are in an environment in which unpredictable transformations lead to constant change in the international environment—yet throughout these various upheavals, the overall system retains a surprising degree of robustness. The model of self-organized criticality wears well in describing this policy environment. In order for events to proceed to the global critical state, there needs to be a sufficiently complex international system in existence. **To achieve truly global criticality**, which is what we are seeing in the Twentieth Century, the following prerequisites were necessary: **efficient** methods of **transportation**; efficient means of mass production; greater freedom in economic competition; rising economic standards, leading to greater weight on ideology [when the struggle for survival is won, there is room for ideology]; efficient mass communication; and an increase in resource demand. I’m **sure this is not an exhaustive list**, but these items occur to me **as necessary preconditions** for global criticality. Talk of global complexity is also a commonplace, usually expressed in terms of "global interdependence." But I think global criticality is a more productive way of thinking of this. Now, you can indeed take this stuff too far. Social sciences are often subjective. Chaos theory has become trendy. It’s easy to overstate the power of a theory. This brings us to the "Is it live or is it Memorex? question." Do chaos and self-organized criticality exist as actual principles of international affairs or are we dealing with perceptions and metaphors? Vice President Gore has called criticality "irresistible as a metaphor." This is true and we need to use caution. Humans have a terrific need for stability and one of the ways we serve this need is through the search for paradigms. We consider reality tamed if we find a classification, a description for it. But I no longer believe in criticality merely as metaphor. I think that the process involved is a "real" one, not a representational one. I believe that the action of international actors is an actual example of a chaotic environment and that out of the interplay of large numbers of actors with great degrees of freedom, we are seeing self-organized criticality on a global scale. The idea of chaos and criticality operating in the social arena is becoming more and more accepted. I read of applications of chaos theory to economics. Especially intriguing to me has been the attention given to dynamical systems theory by psychoanalysts. This strikes me as a bold and plausible application of these theories to the "soft" sciences—sciences where quantification is difficult and the dangers of subjective analysis are high—and I believe we as strategic analysts would do well to study this research. One of these psychoanalysts, Dr. Galatzer-Levy states: "Chaos theory was born out of the recognition of what could not be done." What could not be done. Recall the discomfort I, and I’m sure many of us had as we tried to make sense of the "New World Order." Matching chaos theory to psychoanalysis, Galatzer-Levy writes: "Any reasonably complex system is not predictable in its details over a long period of time. Certainly the human mind is at such a level of complexity." Now, if we are dealing with the product of billions of human minds in an interactive, responsive system, is it not reasonable to believe that chaos theory applies to our particular science? Galatzer-Levy asserts that he finds in psychoanalysis such dynamical phenomena as strange attractors and self-similarity. Earlier, two other analysts, Sashin and Callahan created a model of affect—the emotional response attached to a stimulus—using catastrophe theory. We need to be open to these concepts as actual phenomena, not merely as metaphor. In our own field, we need to take encouragement from what these observers suggest and develop a consistent model of international affairs that incorporates dynamical systems theory. A successful model—if it can be created—will encompass military strategy, trade and finance, ideology, political organization, religion, ecology, mass communication, public health, and changing gender roles. For better or worse, the sum of these topics is foreign affairs today. Twentieth-century history alone has ample evidence for the idea of criticality—though here of course we have again to be careful of subjective interpretation. This century’s history exhibits a recurring pattern, of building to a critical state, catastrophic change, subsequent reordering, and a period of metastability— leading to the next sequence. (Here I’m happy to echo Richard Kugler.) The foreign policy "peaks" of the Twentieth Century I see as the First World War, Second World War, and the end of the Cold War. Consider the massive reordering that we subsume under the shorthand of the First World War: Ten million war dead, innumerable other casualties, the birth of the Soviet state and the surge of international communism, the spread of European revolution, and the great influenza pandemic. The metaphor of the tinderbox is the time-honored one for that period. The new description that makes sense, however, is of a **collection of factors building to criticality.** There is a relatively minor event—the assassination of the Austrian Archduke by a Serb—leading to disproportionate outcomes and massive reordering. So too with the 1939-1945 period. The stage of building to criticality was increasingly evident from 1931 onwards, and we are all familiar with the spectacular change and the fundamental reordering that followed. The collapse of the Soviet Empire is the third instance of global critical change that I’d highlight. The consensus I detect in the conference is that we really do not understand the post-collapse period. The East-West struggle kept a lid on conflict. Communism suppressed the destabilizing phenomena of nationalism and crime by making these, as so much else in the society, state monopolies. Ukrainian nationalism was illegal; Soviet patriotism was mandatory. Criminal gangs were strictly suppressed in the USSR; the nomenklatura, in contrast, was a powerful Cosa Nostra of its own. Now, with the Cold War ended, the state’s monopoly on these enterprises has ended and we are dealing with the unpleasant sequelae of freedom, whether in Chechnya, the Balkans, NagornoKarabakh, or in the rise and spread of the Russian Mafia. In terms of our theory, the degrees of freedom in the system have greatly increased. There’s another way of viewing this, however: the fact that the great Cold War struggle diverted us from the accelerating chaos, the true dynamism, in the world and only now are we perceiving the scale of the global challenges: in terms of environmental disaster, water shortages, climate change, dysfunctional national cultures, and the breakdown of the nation-state. The response to this reordering is by no means complete, and this is a complex and intriguing area. In each of these three cases, World War I, World War II, and the end of the Cold War, **we were unprepared for the sequence and the magnitude of events.** Nations at rest want to believe they will remain at rest.

**Complexity is key to air traffic – prerequisite to the aff**

**Kincaid et al., 08** – Rex K., Department of Mathematics, The College of William and Mary with Natalia Alexanderov, NASA Langley Research Center, and Michael J. Holroyd, Department of Computer Science, University of Virginia (“An Investigation of Synchrony in Transport Networks,” Complexity, Vol. 14, is. 4, 9/2/08, Wiley)RK

A few words about practical matters are in order. We realize that the traditional research in transportation tends to be of a more immediately applied nature. The line of inquiry we are pursuing is very much in its infancy and we cannot even refer (to the best of our knowledge) to similar publications in transportation research. Our only references to similar network investigations are thus far in the realm of the Internet [1, 15]. However, we firmly believe that the ongoing difficulties in implementing profound changes in the present air transportation system (due, in general, to its **immense complexity**) can be, in particular, traced to the lack of predictive modeling. To arrive at predictive modeling—or to understand the limitations of possible modeling—we must start with an investigation into functional relationships that, at first, appear theoretical and somewhat removed from the practicalities of the system. Fortunately, there is a growing recognition of the need for such fundamental inquiries into the nature of complex networks. For instance, a recent NASA Research Announcement explicitly targeted basic research into modeling and active design of transport networks [22]. Thus, we hope that, should an initial emphasis on theory lead to a better understanding of network behavior and to quantitative analysis and design algorithms, we would meet a receptive audience in the transportation community.

### Realism

**Realism fails- it oversimplifies through linear models- complexity theory solves through analysis**

**Hendrick, 2009** – PhD in Conflict Resolution from Bradford University, contributor to the Oxford University Press (Diane, “Complexity Theory and Conflict Transformation: An Exploration of Potential and Implications”, <http://www.brad.ac.uk/acad/confres/papers/pdfs/CCR17.pdf>)//BZ

In international relations Neil E. Harrison makes the case for the value of complexity theory given the unpredictability of events in world politics that has confounded expectations based on existing theories. While there are various explanations proffered for this situation, Harrison sees the tendency of current theories of world politics to work with models of the social world that present it, for analytical purposes, as a simple system as fundamentally misleading. In contrast to realism, that sees political behaviour being driven by essential human characteristics within fixed structures, complexity theory sees world politics as a self- organising complex system in which macroproperties emerge from microinteractions. It is precisely the interactions among interdependent but individual agents within the system that account for the surprising events that defy prediction through the simple models used at the moment. Harrison thus takes the state as a system that is not closed but open to other natural and social systems: “defined as a political system, it is open to technological, cultural and economic systems that influence political choices and processes.” (Harrison, 2006 p. 8) The state is also influenced by other states and by numerous transboundary interactions between major corporations, NGOs, terrorist groups, etc. In such complex systems it is not possible to trace linear causal links: “Despite occasional attempts to bring in domestic politics the state is usually modelled as a unit with exogenous identity and objective interests. This greatly reduces the range of possible causal explanations for any perceived social event, simplifying causal analysis and hypothesis generation and testing.” (Harrison, 2006 p. 11) It is a disconcerting fact that outcomes may have multiple causes and that in different contexts, historically or spatially, the same cause may lead to different outcomes. This cannot be captured by the over-simplified models of international systems. Given the multiple, mutually influencing interactions within social systems it is necessary to look to the evolution of the system rather than to individual events when seeking the causes of observed effects. Complexity theory focuses on processes and relations between components, or in the case of social systems, agents, rather than the components themselves. In a similar criticism to that of Walby, Harrison points to the tendency of theories in international relations to focus on one level of analysis and to present competing theories based on these. Where systems are theorised, they are limited by being presented as nested. Harrison notes that the impact of positive feedback in systems has been acknowledged: “ ‘(I)ntra-national and inter-national events all impinge on one another in a cyclical and ongoing process within which the self-aggravating propensities frequently exceed the self-correcting ones by an unacceptably large amount’ (Singer 1970, 165) thus national elites use rhetoric for domestic political consumption that can incite potential enemies, the public and military desire the psychological comfort of discernible superiority, media amplify inter-nation conflicts, and the benefits of participation in the ideological mainstream preserve the distribution of power and inhibit changes in the historic patterns that transform inevitable conflicts into costly rivalries.” (Harrison, 2006 p. 28) While Walby refers to examples of the importance of the notion of path dependence with reference to differences in development between countries, Harrison sees its relevance at the level of the international state system. Thus development through time is not wholly random and there are limits or constraints created by the prior development of the system that restrict the possible options for change. In this way the international system may change its structure without becoming another system and here Harrison brings the example of the Cold War. While it is true that the Cold War was produced by historical interactions, it is still not possible to claim that it was an inevitable effect of historical causes. The myriad microinteractions that occurred introduce unpredictability into development, especially given the above-mentioned possibility of positive feedback. Harrison is optimistic with regard to the gains from the application of complexity theory to world politics in theoretical but also in policy terms: “This ontological shift from simple to complex systems opens new paths to knowledge and understanding yet incorporates much current knowledge; it validates novel research methods; and theories founded in this approach will generate radically different solutions to policy problems.” (Harrison, 2006 p. 2)

**Realists like Waltz or Mearsheimer fail in predictions – complexity proves**

**Kissane, 2008** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “Thinking about Power in a Complex System”, found online)//BZ

Realists, then, find some common ground whether describing ancient Grecian warfare or twenty-first century nuclear strategies. Key to all is the military element of an international actor’s power. All realists place great emphasis on the military capabilities of actors (whether city-states, Princes, states or superpowers), some even placing all their emphasis on this sole element of power. Some realists, though, expand the notion of what constitutes power in international relations by recognizing a multifaceted notion of power. Economic potential, the power of propaganda over national and international opinion and the capacity to lead are all mentioned as elements of power alongside basic military potential. Realists, too, focus on the power of the most significant actors in the system. For Thucydides and Machiavelli, for example, these are relatively smaller actor such as city-states and Princes that may exist alongside dozens of others in a small geographical region. Alternatively, for Carr, Morgenthau and Waltz the focus is on nation-states, with Mearsheimer narrowing his focus even further to what he refers to as ‘great powers’. While not in all cases explicitly denying that power can be held by an actor other than these, they are secondary to how realists imagine their world of conflicting powers. Central to all the realist approaches, however, is the commitment to the notion of an anarchical international system. Every realist imagines an international political environment where there is no overarching authority, where other actors can never be trusted and where power, as a result, is hoarded by the largest international actors. Realists like Hobbes even argue that the lack of overarching authority is the reason that large international actors emerge and seek power at all. Under anarchy realists opine that power exists only at the highest levels and maintain a focus on those levels to the exclusion of all other levels of political interaction. In short, if it is not happening between states – or in state-backed bodies such as international institutions, for example – then it falls outside of the realm of international politics and discussions of international power are out of place, too. Yet if the international system is assumed to be something other than anarchic, if the base nature and constraints on interactions between international actors is held to be something other than anarchic, it is likely that our understanding of what constitutes power must also change. While realism offers a developed prism by which to comprehend international politics in an anarchic system, a new conception of the international system demands that we seek a new prism by which to imagine, describe, explain and predict it. In the section that follows the basic elements of this alternative understanding of international politics will be outlined, explained and explored and the reasons why such a system demands a new conception of power in international politics posited.

**Realism is too focused on large actors- fosters bad research methods**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

For example, in international relations, realism initially provided a common conceptual apparatus for framing and investigating problems related to the outbreak of war, the formation of alliances, and the distribution of capabilities among states. Similarly, modernization theory in comparative politics provided a common framework for formulating questions and generating comparable data on the relationships between economic, social, and political change across vast expanses of time and space. In both instances, shared boundary conditions and theoretical vocabularies employed by adherents of a research tradition facilitated the production and assessment of new knowledge claims concerning new phenomena. Later, these arguments invited challenges and became foils for newer research traditions, as in the case of neoliberalism and constructivism in inter-national relations or of rational-choice theory and historical institutionalism in comparative politics. Each of these newer traditions distinguished itselfby distinct sets offoun- dational assumptions that facilitated the creation of new problematiques and new analytic frameworks that helped to expand the range of substantive arguments and the stocks of empirical knowledge in its respective field. To the extent that this stylized process is a reasonable representation of the changes that have occurred in the two subfields, it reveals why the emergence of, and competition between, research traditions can expand the fund of ideas, concepts, observations, and theories for a field. These intellectual benefits are valuable and should not be forfeited. However, they come at a high price in the absence of a counterweight in the form of eclectic modes of inquiry. Research traditions establish their identities and boundaries by insisting on a strong consensus on enduring and irreconcilable foundational issues. This, in turn, effectively privileges some concepts over others, rewards certain methodological norms and practices but not others, and places great weight on certain aspects of social reality while ignoring others. In fact, the battles among research traditions recur not because of hardened differences over substantive issues but over preexisting epi- stemic convictions about what kinds ofsocial phenomena are amenable to social analysis, what kinds of questions are important to ask, and what kinds of processes and mechanisms are most likely to be relevant. Research tra-ditions give themselves permission to bypass aspects of a complex reality that do not neatly fit within the metatheo- retical parameters they have established by fiat. These aspects are either “blackboxed,” relegated to “context,” or treated as “exogenous.” Such simplifying moves, while helpful for the purpose of generating elegant knowledge claims about particular aspects of reality, are not independently capable of generating a more comprehensive understanding of complex, multi-faceted problems that interest scholars and policymakers alike. For this purpose, scholarly analysis needs to be more open-ended, proceeding from ontologies that, as Peter Hall notes, embrace “more extensive endogeneity and the ubiquity of complex interaction effects.”14 This is where analytic eclecticism has a distinctive role to play alongside, and in engagement with, different strands ofscholarship embedded in multiple research traditions.

**Politics is a complex system of social dynamics irreducible to the individual level – this causes aberrations that could never be predicted**

**Brown 96** [Thad A. Assistant Professor of Political. Science at UCLA, “Non Linear Politics” from “Chaos Theory in the Social Sciences: Foundations and Applications” LO]

Unfortunately, attempts to analyze complex political behavior often tend to attribute observable cooperation or conflict to the individual. Behavior in politically intricate situations is attributed to higher levels of political information, a deeper understanding of the game's rules, or superior strategies, and of course lots of information (or at least enough information so as not to be duped). Nearly all published theory on the iterative prisoner's dilemma fits into this category. What must be remembered and used to calculate strategies includes: discount values, prior encounters, likely future encounters and associated probabilities, who might use what piece of information to figure out what to do, the cost of keeping information, and so on. Of course, nobody thinks this way. And even if anyone did there is no guarantee that a successful strategy at one time will not be utterly unsuccessful at another. In real political interactions are we left to laws of chance? For decades we have seen glimpses of the complex individual-group nexus that defines politics. For instance, we know political beliefs are often based on socially cued ideologies by proxy. That is, individuals may faithfully reflect and follow over time the beliefs of others who possess developed abstract formulations of politics (Campbell et al. , 1960; Converse 1964). That most voters lack much useful political information or fail to behave rationally is rarely debated anymore (Ferejohn and Kuklinski 1990). But the end of such debates doesn't mean we really understand the mechanism that induces even the most basic forms of political behavior. Turnout is one example. Rational choice theorists still cannot understand why anyone would vote, given the costs relative to proportional influence. Empirical electoral analysts cannot figure out precisely why aggregate voting rates appear to be going down-or are they going up this year? As a good friend in industry says, there is something wrong with this picture. Social dynamics result from sets of local interactions between group members and their interactions with the environment. Logically, such signaling fits within a variety of classical social psychological perspectives that suggest individuals adapt to social environment (Asch 1951; Fetinger 1957) or form impressions about others based on behavioral experiences (Helder 1958). In politics we know that decision makers modify their own behavior and the influence of social environments through self-selection (Schelling 1978; Festinger 1981 ), avoidance (MacKuen 1990), migration (Brown 1988), or a generalized contagion process (Huckfeldt and Sprague 1987, 1988. 1993). Formally treating interactive political behavior within massively diverse collectives is tricky. Interactive behavior is peculiar in that it can neither be predicted nor analyzed by observing sets of individuals cross-sectionally, or even the time series from a given individual or group. Social dynamics and the concomitant social behavior cannot be reduced to individual behavior in the sense that isolated individuals cannot induce the variety and richness of global collective behavior prevalent in any political system. Social and political behavior is by definition holistic and synergetic (Haken 1978, 1983) and must be the product of interacting individuals who can communicate and modify their behavior as a consequence of their interactions. Any time series is a rough statistical characterization of a collective process. A power spectral analysis alone, for instance, cannot decide the dynamical rules that model the time series. Both a deterministic logistic map with maximum parameter values (Mayer-Kress and Haken 1981) and a stochastic system can generate a white noise signal such that a flat spectrum cannot tell which model is correct. Figuring out what drives the show for interactive social behavior poses some interesting problems. In political dynamics there are likely to be spatial and temporal phase transitions. For instance, we know that transition from a pattern selection phase to fully developed turbulence occurs via the intermittency (Kaneko 1989). Non linear interactions would almost demand that abrupt and widespread events occur unexpectedly. How to proceed is the question. Among the possible ways to investigate dynamical politics are simulations of intriguing spatial arrays with cellular automata. Cellular automata are formal dynamical systems with many discrete degrees of freedom. The beauty of automata is that while the rules of interaction are surprisingly simple, complex nonlinearity can be induced by the iterative nature of interaction. As nonlinear systems, cellular automata can display the full array of dynamics of any real , living system, from fixed points to cyclical behavior to chaos. Can political life be the product of simple, primitive models? Cell-space models have been used in physics (Herrmann 1992), chemistry, and biology (Gutowitz 1991 ; Forrest 1991 ), and to a more limited degree in the economic and social sciences to investigate the ecological structure of behavior (von Hayek 1937; Schelling 1971, 1978; Cowen and Miller 1990). In politics, they may represent the potential to "program" the information available and used by entities (voters, groups, elites, nations, or whatever), and hence what we can discern from cellular automata may give us further insight into the information dynamics in real politics.

### Environmentalism

**Nature is the epitome of chaos; trying to control ecology empirically fails**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

Initial behaviors and outcomes often influence later ones, producing powerful dynamics that explain change over time and that cannot be captured by labeling one set of elements "causes" and other "effects." Although learning and thinking play a large role in political and social life, they are not necessary for this kind of temporal interaction. Indeed, it characterizes the operation of evolution in nature. We usually think of individuals and species competing with one another within the environment, thus driving evolution through natural selection. In fact, however, there is coevolution: plants and animals not only adapt to the environment, they change it. As a result, it becomes more hospitable to some life forms and less hospitable to others. Nature is not likely to "settle down" to a steady state as the development or growth of any life form will consume—and be consumed by—others, closing some ecological niches and opening others, which in turn will set off further changes. To some extent, organisms create their own environments, not only by direct actions (e.g., digging burrows, storing food, excreting waste products), but as their very existence alters the microclimates, nutrients, and feeding opportunities that will affect them and others. Indeed, not only does the amount of rainfall influence the vegetation that grows, but the latter affects the former as well. To take a more readily visible example, elephants thrive on acacia trees. But the latter can only develop in the absence of the former. After a while, the elephants destroy the trees, drastically changing the wildlife that the area can sustain and even affecting the physical shape of the land. In the process, they render the area uncongenial to themselves, and they either die or move on. The land is adapting to the elephants just as they are to it. One Maasai put it well: "Cows grow trees, elephants grow grasslands."18 Most consequentially, the very atmosphere that supports current life was produced by earlier forms, many of which could not survive in the new environment: long before humans, species of bacteria were so successful and generated so much pollution that they poisoned themselves.

**Complexity key to climate – complexity denial worse than climate denial**

**Hendrick, 2009** – PhD in Conflict Resolution from Bradford University, contributor to the Oxford University Press (Diane, “Complexity Theory and Conflict Transformation: An Exploration of Potential and Implications”, [http://www.brad.ac.uk/acad/confres/papers/pdfs/CCR17.pdf)//BZ](http://www.brad.ac.uk/acad/confres/papers/pdfs/CCR17.pdf%29//BZ)

The 1990s saw much attention being paid to the link between environment, population and conflict in the context of human security. There are significant debates about the nature of the processes at work and differing conclusions about how, and where, to intervene to reverse downward spirals. Thomas Homer-Dixon is one of the theorists in this field who stresses the value of a complexity approach. He advises that: “At the methodological level, we need to explore how causation works at the interface between the physical/ ecological and social worlds. Environment-conflict research brings us face to face with some of the most intractable issues in philosophy of science, specifically whether causal generalizations describing the social world have the same status as those describing the natural world. Because systems in both these domains are fundamentally complex—characterized by huge numbers of components, causal interactions, feedback loops, and nonlinearity—environment-conflict researchers can gain insights from complexity theory. We urge greater receptivity to the concepts and findings of this rapidly developing field.” (Homer-Dixon, 2000 p. 89) Homer-Dixon is scathing towards those who deny the relevance of complexity approaches rather than taking up the challenge to find new ways to research complex problems: “The problem of complexity exists in the real world. It cannot be wished away by assuming that it resides only in the mind of the researcher. ... Researchers in a variety of fields increasingly acknowledge the reality of complexity and are developing powerful theories to understand complex systems. These theories raise serious questions about conventional (often mechanistic) explanations of social phenomena and about the conventional methodologies used to study these phenomena (Cowan, Pines, and Meltzer, 1994). Rather than denying complexity’s existence, ... social scientists should explicitly acknowledge the problems it creates for their research and try to develop methods—such as those focusing on causal mechanisms—for dealing with it.” (Homer-Dixon, 2006 p. 87)

 **Complexity key to solve warming – individual actors.**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

THE failure to establish an international agreement on climate change at Copenhagen in December 2009 highlights the challenge of managing complex problems at the interface of business and the natural environment (B&NE). Despite the broad consensus on the need for coordinated global action, Copenhagen represented a failure of collective action—and a triumph of inertia—as industries and countries struggled to reconcile narrow conceptions of economic interest with global demands for aggressive action. This unfortunate outcome can be understood in the context of the larger “sociotechnical system” within which business and policymakers are operating: a complex dynamic system comprising economic, technological, social, political, and ecological elements, generating complex interactions and unforeseen outcomes. Yet even as recriminations were flying at Copenhagen, some welcomed the opportunity to move beyond a centralized, top-down model of global climate governance. Instead, they embraced the opportunity for businesses, non-governmental organizations (NGOs), and governmental agencies to experiment with a plethora of innovative approaches to reducing emissions, which offer new opportunities for learning and creative solutions (Hoffmann 2011). Complexity theory provides a grounded theoretical basis for this more optimistic perspective by explaining how networked actors can display adaptive learning and emergent self-organization. In this chapter we examine the contribution of complexity theory to our understanding of B&NE, with a particular focus on climate change as an illustrative and representative example. We use the term “complexity” to refer to a group of concepts derived from systems theory, including complex dynamic systems theory, chaos, and emergence, among other disciplines. These provide insight into systemic tendencies towards patterned behavior, frozen inertia, and sometimes extreme instability. At a macro level, complexity theory explains why systems are often hard to comprehend and forecast, let alone manage and control. Yet complexity also offers micro-level tools and concepts to help innovative organizations improve sustainability through local initiatives of loosely networked agents (Senge et al. 2008). The field thus offers insights for steering systems toward sustainable transitions and enhancing resilience, without the hubris of complete control (Smith, Stirling, & Berkhout 2005).

**Complexity solves warming – addresses root cause of micro level consumption**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

The existing literature on B&NE mostly focuses on the organizational level, where managers have authority and responsibility. While this literature is valuable, as exemplified in this Handbook, the narrow focus can obscure an appreciation of the emergent properties and holistic functioning of the broader sociotechnical system. Some (see Ehrenfeld [Chapter 33]; and Roome [Chapter 34] this volume) emphasize that sustainability is only meaningful as a concept at the system level. Even if firms embrace good environmental practice, the aggregate impact of our global production and consump-tion creates an unsustainable environmental trajectory for the planet and the businesses it sustains. Others (see Banerjee [Chapter 31]; and Gladwin [Chapter 38] this volume) link this dangerous inertia to the wider capitalist system in which business is embedded. Complexity theory provides a link between macro-level analysis of systems and micro-level understanding of organizational initiatives that might contribute toward potential solutions. This presents a critically important research agenda for understanding and potentially overcoming the disjuncture between the beehive of corporate sustainability efforts and the deteriorating state of the planet. Complexity offers new ways of addressing environmental impacts at the system level, such as supply chains (see [Klassen & Vachon [Chapter 15] this volume) and geographic industrial ecologies (see Lifset & Boons [Chapter 17] this volume). Yet many questions remain if complexity theory is to be of practical use. What combination of top-down management and bottom-up initiatives is appropriate? How can points of leverage and influence be identified? What structural changes are needed to systems of finance, corporate governance, and energy pricing? What interventions might facilitate local initiatives and their coalescence into more sustainable production systems?

**Complexity theory key to solve root cause of warming – individual behaviors**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

Complexity theory offers a conceptual framework that incorporates the essential unpredictability of economic and environmental systems with the emergence of distinctive and contingently stable patterns (Anderson et al. 1999; Ormerod 1998). Complexity was originally developed through advances in non-linear mathematics (Thom 1975), thermodynamics (Prigogine & Glansdorf 1971), and computational sciences (Simon 1962). These ideas were quickly adapted to social systems (Ulrich & Probtst 1984) and during the 1990s interest exploded in relation to management and organizations (Ashmos & Huber 1987; Kiel & Elliott 1996; Levy 1994; Merry 1995). Complexity theory goes beyond systems perspectives through advances in deterministic chaos theory (Lorenz 1963), power-law phenomena (Andriani & McKelvey 2009) and computational methodologies (Kauffman 1993; Davis, Eisenhardt, & Bingham 2007). Complexity theory recognizes that economic and environmental systems comprise a multitude of agents, from individuals to large organizations, with distinctive properties at each level. The economy, for example, comprises individual consumers and workers, firms, markets, industries, and national economies. While all these levels are interdependent, higher-level aggregations exhibit “emergent” properties that cannot easily be reduced to the interaction of lower levels (Holland 1998). Macroeconomics, for example, relies on constructs and theories that differ from those relating to individual firms and consumers. Some core properties of complex systems are shown in Table 32.1. Understanding complexity has been a long-standing concern of organization theory (Simon 1962). It offers insights into the emergence of patterned structure and order in higher-level systems, such as the Earth’s climate, economic organizations and social institutions, but also provides methods for finding fundamental relationships and simplicity behind complex phenomena. Complexity helps explain how systems can evolve in unexpected ways, exhibiting dramatic instability (Rudolph & Repenning 2002) and even collapse (McKelvey 1999). The weather, the global climate, and the economy are complex systems that exhibit such chaotic behavior (Brock, Hsieh, & LeBaron 1991). Chaos theory, a core science of complexity, explores systems in which the recursive application of non-linear functions gives rise to highly complex yet patterned behavior. Chaotic systems have several notable characteristics. First, they are unpredictable in the longer term, even though they are driven by deterministic rules. Weather conditions, for example, evolve due to well-understood interactions among variables such as humidity, air pressure, and temperature; however, the non-linear nature of these interactions makes it impossible to predict the long-term evolution of the weather system. The trajectory of chaotic systems such as these is highly dependent on initial starting conditions: the proverbial butterfly could theoretically cause perturbations that are amplified through successive interactions and reverberate throughout the entire weather system. An important corollary is that, although chaotic systems never return to the same precise state, the outcomes have predictable boundaries that generate well-known patterns (Dooley & Van De Ven 1999). Hurricanes emerge in late summer, though we never know their exact timing, path, or strength. Industries exhibit typical patterns of growth and maturity, yet evolve in unpredictable ways. These patterns are shaped by “strange attractors,” structural features of systems that constrain and mold their evolution. The patterns reflect macro-level emergent properties: hurricanes, economic recessions, and social movements exhibit system-wide patterns that are distinct from the properties of the components from which these systems emerge.

**Climate simulations are skewed – not modeled on reality**

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Effective governance presumes an ability to understand a system, forecast its development, and intervene with some confidence regarding the outcomes. Complex dynamic systems present challenges to all three elements of the managerial process. The social world is populated by cognizant, emotional agents whose behavior is essentially unpredictable at the individual level (Stacey 1996 : 187). Even when system function is well understood at the micro-level, forecasting system behavior at the macro-level remains problematic. Simulation models are frequently employed to represent complex systems, because they can better account for iterative and non-linear interactions over time. Weather forecasts, for example, rely on computer simulations that model the atmosphere as a grid whose elements interact in well-defined physical relationships. With a given set of starting conditions, a computer can generate a forecast that is reasonably accurate for about the next five days, and better than random guessing for about ten. Simulations, however, are always simplified, and thus imperfect, representations of reality. First, the fixed-step, finite resolution of computation misses the continuous dynamics at the molecular level exhibited in natural and social systems. Second, starting conditions are not known with perfect accuracy. Third, the specification of relationships does not capture some more subtle feedbacks, for example, regarding clouds and the ocean-land atmospheric interface. Weather forecasters have attempted to improve accuracy by employing faster supercomputers to tackle models with finer temporal and spatial resolution, but the improvement is marginal, because errors in model specification and starting conditions are magnified through iterative calculations. Although climate modeling has made remarkable progress and provides a good fit with the historical record, models do not yet reliably incorporate longer-term shifts in ocean circulation, ice and forest cover, and other factors that make the climate chaotic on longer time scales. Neither do they capture interaction with political and economic systems in a detailed way, beyond some broad scenarios. As a result, we can speculate about positive feedback effects that could lead to collapsing ice caps and runaway warming, but it is very difficult to predict if and when we might pass the critical thresholds.

**Too much bias in climate predictions – only complexity solves**

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The dynamics of complex systems make it hard to recognize the approach of critical thresholds and to take timely action to avoid crises. First, it is hard to differentiate between “normal” fluctuations and more drastic transformations. Hurricane Katrina did not raise many alarms regarding climate change, nor did most observers take the collapse of Bear Stearns as a signal of the onset of the global financial crisis. It is only in retrospect, in conjunction with other data, that we are able to see broader patterns and put such events in context. Moreover, complex systems often have regions which appear relatively calm, even while structural pressures are building up. Prior to the financial crisis in October 2008, data on corporate profits and employment gave little cause for concern, even as rising debt and inflated housing prices generated disequilibrium tensions. Similarly, the climate appears relatively stable to casual observers, despite rapidly rising greenhouse gas concentrations. Fundamentally, the recognition that a crisis demands action is primarily a social and political process. Mass media play a critical role in framing events within a broader narrative context, a role which has been especially evident in the case of climate change (Boykoff, Goodman, & Curtis 2010). Defining a situation as a crisis usually entails allocation of responsibility and demands for redress. However, energy-intense industries and high-emission countries have tried to minimize concern about climate change, presumably because mitigation measures could adversely impact them. Moreover, there are organizational and psychological barriers against recognizing a crisis. We are biased to ignore warnings about catastrophe, and to presume that what appeared to work yesterday will continue tomorrow (Kahneman, Slovic, & Tversky 1982) . Within organizations responsible for complex systems, such as the space shuttle or nuclear power plants, intense organizational pressures frequently silence the expression of valid concerns about risks. These pressures arise from power hierarchies, budgetary pressures, and masculine organizational cultures that deride concerns of risk as weakness (Perrow 1989; Vaughan 1996). Even once an impending crisis has been acknowledged and a need for active intervention recognized, several major impediments to effective action are well explained by complexity theory. The following section explores the difficulties of intervening in complex dynamic systems, including problems of collective action, unintended consequences, and inherent limitations on effective management.

**Plan can’t solve warming – only a complex, layered approach solves**

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Intervention in sociotechnical systems entails coordinated action by large numbers of actors, raising the problem of collective action. Hardin’s (1968) “Tragedy of the Commons” describes the tendency toward inaction in the face of the overuse of a common resource, such as the atmosphere, when private actors can free-ride and have little incentive to change their behavior. Various societal institutions have evolved to address such collective action problems (Ostrom 1990), but large-scale systemic crises require costly measures that demand an often lengthy process to build consensus. In part, such delays and disagreements reflect differences in technical understandings of complex systems. Action on climate change, for example, has been delayed while various parties argue over the best course of action: cap-and-trade versus carbon taxes, nuclear power versus renewable energy. Yet these differences are also deeply political, reflecting the asymmetric ways in which actors perceive that a crisis and remedial action will affect them. The fiercest proponents of action on climate change are the low-lying countries likely to be swamped by rising sea levels. In contrast, the countries and sectors who strongly oppose action tend to be heavily dependent on fossil fuels. Some rich countries might be willing to pay 1-2 per cent of GDP to cut emissions, but developing countries demand massive transfusions of capital if they are to transition from cheap fossil fuels. The failure to reach agreement in Copenhagen was largely due to these deep divisions. Problems of collective action are exacerbated by the need to coordinate multiple forms of intervention in complex dynamic systems. Neither a carbon tax nor a single technological breakthrough will, by itself, solve the climate problem, a point made by Jones (2009) in his system dynamics model of the evolution of the solar industry. Intervention in complex systems is also hindered by the likelihood of undesired and unanticipated consequences. Raising vehicle fuel economy standards reduces the cost of travel per mile, encouraging more car travel. Incentives to raise production of biofuels could raise food prices, and perhaps encourage clearcutting forests. These uncertainties have led some to suggest that complex systems are essentially unmanageable. Perrow’s (1989) study of the nuclear accident at Three Mile Island concluded that catastrophic accidents were “normal” in the context of highly complex socio-technical systems. Even the most carefully designed systems, Perrow argued, could not always prevent occasional human or technological failures from cascading into major disasters. The explosion and massive oil leak from BP’s oil well in spring 2010 highlights the challenge of anticipating every potential eventuality, especially when regulators and managers are under pressure to overlook risks to meet deadlines and profit targets.

**Plan fails- bottom up approach through complexity solves climate change**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

This rise of local initiatives contradicts conventional theories of collective-action which predict that “no one will change behavior and reduce their energy use unless an external authority imposes enforceable rules that change the incentives faced by those involved. This is why many analysts call for a change in institutions at the global level” (Ostrom 2009b: 7). In contrast, Ostrom shows how actors often have local incentives that do not depend on coordinated action: “Even without major taxes imposed on energy at a national level, however, families that decide to invest in better insulation and more efficient furnaces and other appliances, to join a carpool whenever feasible, and to take other energy-conserving actions can save funds over the long run” (Ostrom 2009b: 15). Similarly, cities can enjoy the co-benefits of reducing fossil fuel use, such as cleaner air and improved public health. Ostrom emphasizes that cooperation can emerge within networks of actors when sufficient trust, social capital, leadership, and communication are present, encouraging expectations of reciprocity and mutual learning. She concludes that “many groups in the field have self-organized to develop solutions to common-pool resource problems at a small to medium scale” (Ostrom 2009b: 10). Ostrom’s allusion to self-organization within a “polycentric order” suggests an awareness of the potential for effective approaches to emerge “bottom-up” from networks of actors. The theory of emergence provides understanding of how dynamic systems generate order (Lichtenstein & Plowman 2009; McKelvey 2004) and exhibit “self-organization” (Holland 1998). In this section, we apply this theory to the emergence of business responses to climate change, with models drawn from a range of perspectives including order-creation in complex adaptive systems, far-from-equilibrium conditions that give rise to new opportunities and markets, the critical role of local experiments and learning in emergent systems, and a growing literature on self-organization in supply chains. Far-from-equilibrium conditions Many complexity researchers have argued that far-from-equilibrium conditions—push- ing systems beyond their normal range of activity—is a key factor driving emergence (Meyer, Gaba, & Colwell 2005). Climate change, for example, creates pressures from consumers, activists, competitors, and regulators for change; similarly, resource scarcity is a force for innovation. Perhaps the leading scholarship in this area has been done by Chiles and colleagues (2010) who have developed a “radical subjectivist” approach to show how the uncertainty facing entrepreneurs leads to market divergence, a process stronger than equilibrium-based convergence towards imitation. Divergence increases heterogeneity, the driver for innovation, experimentation, and co-evolution (Lewin & Volberda 1999). The rise of the clean energy sector reflects a slow but persistent system-wide emergence of technologies, regulations, and demand patterns that catalyze the creation and expansion of businesses growing in sheltered market niches. For example, as technologies around solar power develop, business and policy entrepreneurs have identified practices and models that overcome market, technological, and political lock-in. The market begins to “self-organize” as venture capitalists, entrepreneurs, consumers, and regulators interact in a network and create self-sustaining norms, rules, practices, and institutions. Over time, expectations and interactions lead to loosely coordinated self-organization of the market, and the emergence of new technologies and business models. “Thus, entrainment of entrepreneurs’ activity/thought patterns in competitive entrepreneurial markets may spontaneously create a far-from-equilibrium market order that is both heterogeneous and coherent” (Chiles et al. 2010 : 39). Shai Agassi’s Better Place project to create a national replaceable battery infrastructure for pure electric vehicles illustrates how an entrepreneur can mobilize other actors to transform markets and overcome systemic obstacles in infrastructure and scale.

**Modeling through climate complexity is better- best form of simulations and predictions**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

We have presented two very different perspectives on business and the natural environment. The pessimistic macro-view, informed by system dynamics and chaos theory, suggests that environmental externalities and collective action failures are leading to a “tragedy of the commons” The inherent difficulties in understanding and controlling chaotic systems can turn us into unwitting accomplices in the ineluctably unfolding “overshoot and collapse” of natural ecosystems and the businesses embedded within them. However, complexity theory also presents a more optimistic micro-level view of system-wide order emerging from self-organized solutions in local contexts. Between these poles, a number of approaches exist which suggest that a limited degree of prediction and managerial intervention is not only possible but necessary to steer our economic and environmental systems away from catastrophe. Here we take a brief look at several approaches including systems dynamics modeling, and the development of sustainable supply chains and ecodistricts. Many types of complex systems are sufficiently tractable that computational models can provide a degree of forecasting and planning. Global climate models are increasingly able to reproduce the historical record as well as regional features such as the El Nino phenomenon. Likewise, systems dynamics models (Forrester 1971; Sterman 1989) can portray cyclical and chaotic behavior, as well as tendencies toward stability or collapse, providing tools for better understanding threshold effects, unexpected outcomes, and likely responses to intervention (Warren 2004). Using these tools, Jones (2009) found that a sequenced combination of policies such as incentives, information, and research support is much more effective in inducing systemic shifts in an industry than reliance on a single tool such as subsidies. In contrast to modeling approaches that aspire for prediction and control by autonomous agents standing “outside” the system, an emerging environmental literature on managing sociotechnical transitions draws from complexity to emphasize the limited yet tangible power of managers who are inextricably embedded within systems. Managers can steer the path of a system, rather than precisely determine outcomes (Garud & Karnoe 2003). At the same time, actors within the system have differential interests and power, resulting in potential conflicts over the direction in which to steer. This insight prompted Smith & Sterling (2006: 1) to suggest, “In short, we need to move from a view of ‘steering as management’ to an understanding of ‘steering as politics.” Environmentally favorable new technologies and practices often face hurdles because initially they exhibit relatively poor technical and economic performance, as well as being incongruous with existing infrastructure, interests, incumbent firms, and regulations (Geels 2004; Meadowcroft 2005). Thus, the transitions approach points to the importance of “strategic niche management,” encouraging new models to emerge in niches that are protected from the dominant market regime, and the subsequent diffusion and hybridization of innovations into the mainstream in a co-evolutionary process (Kemp, Schot, & Hoogma 1998; Raven 2007). Likewise, sustainable supply-chain management and industrial ecology represent efforts to improve environmental performance at the system rather than firm level. As Lifset & Boons ([Chapter 17] this volume) state, “A central premise of industrial ecology is that environmental problems and remedies should be viewed from a systems perspective.” Klassen & Vachon ([Chapter 15] this volume) similarly argue that organizations can only thrive sustainably when they consider the supply chain as a whole. More specifically, research into supply chains has shown that agents can organize themselves in ways that increase efficiency and improve environmental performance (Choi, Dooley, & Rungtusanatham 2001). Across numerous studies, supply chains have been shown to exhibit self-organization and improve the sustainability of the entire network through adaptive innovation and stronger connections among local firms, suppliers, and customers (Lichtenstein, in press; Pathak et al. 2007; Varga et al. 2009) A similar process of self-organization across economic entities is at the core of industrial ecology (Ehrenfeld 2009) and eco-industrial parks (Rosenthal & Cote 1998). Based on an operational analogy between ecological habitats and industrial regions, the idea is that one or more of the outputs (“waste”) from one business, such as lumberyard scraps, can become the inputs for another business, such as a paper factory. Successful ecoindustrial parks have been set up throughout the world, where each participating firm helps identify and transfer resources that other firms can utilize in their production process (Spiegelman 2003). These adaptive network organizations often connect a wide range of industries, as Klassen & Vachon (Chapter 15) show for the Kalundborg case. Complexity theory, as well as empirical studies, suggests that adaptive self-organization of supply chains requires particular conditions. According to the NK Landscape models (Kauffman 1993), when a system contains agents who are rigidly connected with a very high degree of interdependence, the computational ecology can “freeze up”— what McKelvey (1999) called a “complexity catastrophe”: the system becomes highly inflexible and unable to adapt. Loose networks, in which autonomy is balanced with interdependence, facilitate adaptive experimentation as well as diffusion of the more successful innovations. Complexity research employing agent-based models also points to the value of integrating bottom-up efforts with top-down guidance and structure. Empirical evidence from these models suggests that self-organizing of autonomous agents can create only minimal degrees of order (McKelvey & Lichtenstein 2007) , whereas modern organizations are necessarily composed of seven or eight hierarchical levels (Jacques 1989).

**Macro action fails to solve warming - need a lens a complexity**

**Levy and Lichtenstein, 2011** – Levy is a Professor in Management and Marketing at UMass while Lichtenstein is an associate professor in management at UMass (David and Benyamin, “Approaching Business and the Environment with Complexity Theory”, Oxford Press, http://www.faculty.umb.edu/david\_levy/LevyLicht2011\_complexity\_chap32.pdf) //BZ

Complexity approaches contain a core tension between two perspectives on the dynamic interactions between business and natural environment. A macro-level systems perspective emphasizes structural inertia, misaligned incentives, and failures of collective action. It therefore offers a pessimistic view that we are headed toward environmental overshoot and collapse, with dire consequences for business and society. A more microlevel perspective, however, suggests that under certain conditions, networked actors will engage in a multitude of local initiatives and experimentation, leading to systemic learning and adaptation. A related tension exists in the complexity field between those with confidence that the scientific method can be applied to the development of sophisticated theory and modeling tools, enabling systems to be modeled and controlled, and those who think that complex systems are essentially beyond human management. These tensions are linked, because it is the same characteristics that make complex dynamic systems unpredictable that can facilitate self-organization and emergent order. Within the context of B&NE, our review suggests the need for a complementarity of local experiments and macro-level governance. Locally designed initiatives have considerable energy and creativity, but in order to grow and scale, they require coordination and a favorable context. In the climate case, this implies economic incentives and political pressures for change, national regulations, and international agreements. Together, these provide some predictability, an alignment of expectations across sectors and geographic boundaries, and coordination mechanisms to generate consensus around goals. Even with the failure to reach formal agreement at Copenhagen, a consensus around the 2 degrees Celsius ceiling for global warming emerged out of the debates leading up to the international climate conference in 2009, and now serves as a loose policy coordinating mechanism. However, macro-level processes on their own cannot provide the embedded leadership necessary to solve local sustainability challenges, as this requires local initiatives, expertise and participation by businesses and other organizations in specific industries and geographic regions. Thus, progress requires a combination of action at the local level, with coordinated leadership at higher levels. Ecodistricts and sustainable supply chains illustrate this combination of top-down management and bottom-up self-organization. Regional initiatives for mixed industrial zoning, economic incentives, and integrated infrastructure are often required to initiate the process. Likewise, life-cycle analyses can help identify resource synergies among partner firms. The linkages among the firms, however, need to be enacted by system agents rather than through external forces, in order to generate firm-level commitment and continued innovation.

### Terrorism

**Complexity theory key to solve terrorism – better strategies and information exchanges**

**Beech, 2004** – Lieutenant Colonel in the US Army, US Army War College (Michael, “Observing al qaeda through the lens of complexity theory: recommendations for the national strategy to defeat terrorism”, USAWC Strategy Research Project, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA423895)//BZ>

Reductionist models and tools used by today's senior leaders may not by themselves sufficiently clarify the pervasive ambiguity and complexities presented by the threat of anti-American global terrorism.8 Conversely, alternative theories that bring into focus networks and dynamic systems may help inform a US strategy to defeat global terrorism. The alternative theory this paper examines is Complexity Theory, which as any theory, seeks to explain or gain understanding and comprehension of the environment, behaviors and events around us. Theory provides a lens through which to clarify events and behaviors that might otherwise seem clouded and informs our decisions and actions relative to a set of phenomenon9 Complexity Theory views behaviors and actions as the interrelationship between a great many components parts.10 It refers to these interrelationships or systems as complex, because it is impossible to fully understand these systems by reducing them to an examination of their constituent parts.11 Instead, Complexity Theory holds that interactions produce collective behaviors and characteristics that are not exhibited when the components parts are examined individually.12 This is in contrast with reductionist theories, which seek to comprehend a phenomenon by examining its individual attributes and are insufficient to understand complex networks. Using Complexity Theory as a guide, this paper analyses al Qaeda as part of a global anti-American Islamic terrorist network and develops recommendations to improve the US strategy aimed at defeating terrorists from perpetrating further catastrophic acts against the United States homeland. This paper first describes the fundamental characteristics of Complexity Theory. Using these fundamental characteristics as criteria, this paper analyzes al Qaeda's behaviors to support the proposition that al Qaeda is a highly complex and adaptive network and identifies the elements of Al Qaeda's resilience to the current US counter terrorism strategy. Finally, to best inform a strategy against the terrorist network, this paper examines the underlying origins, conditions and sources upon which the network interdependencies emerge. Understanding the sources of these interdependencies provides evidence regarding al Qaeda's fitness and identifies elements to develop a more comprehensive strategy to defeat it.

### Deterrence

**Deterrence theory fails – unpredictable variables and chaotic international relations overwhelm linear predictions**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

Similarly, the effect of one variable or characteristic can depend on which others are present. Thus even if it is true that democracies do not fight each other in a world where other regimes exist, it would not follow that an entirely democratic world would necessarily be a peaceful one: democracies might now be united by opposition to or the desire to be different from autocracies and once triumphant might turn on each other. (The other side of this coin is that many of the characteristics of democracies that classical Realists saw as undermining their ability to conduct foreign policy—the tendency to compromise, heed public opinion, and assume others are reasonable—may serve them well when most of their interactions are with other democracies.) To further explore interactions it is useful to start with the basic point that the results cannot be predicted from examining the individual inputs separately. I will then move on to the ways in which the effect of one actor’s strategy depends on that of others, after which I will discuss how the actors and their environments shape each other, sometimes to the point where we should make the interaction itself the unit of analysis. First Interactions: Results Cannot Be Predicted From the Separate Actions The effect of one variable frequently depends on the state of another, as we often see in everyday life: each of two chemicals alone may be harmless but exposure to both could be fatal; patients have suffered from taking combinations of medicines that individually are helpful. So research tries to test for interaction effects and much of modern social science is built on the understanding that social and political outcomes are not simple aggregations of the actors’ preferences because very different results are possible depending on how choices are structured and how actors move strategically. Turning to international politics, Shibley Telhami argues that while pan-Arabism and pro-Palestinian sentiment worked to enhance Egyptian influence when Egypt was strong, they made it more dependent on other Arab states when Egypt was weak.14 From the fact—if it is a fact—that nuclear weapons stabilized Soviet-American relations we cannot infer that they would have a similar impact on other rivalries because variables that interact with nuclear weapons may be different in these cases (and of course may vary from one pair of rivals to another). Within the military domain one finds interaction effects as well: two weapons or tactics can work particularly well together and indeed most analysts stress the value of "combined arms" techniques that coordinate the use of infantry, artillery, armor, and aircraft. Events that occur close together also can have a different impact than they would if their separate influences were merely summed. The Soviet invasion of Afghanistan affected American foreign policy very deeply in part because it came on the heels of the Iranian revolution, which undercut American power, disturbed public opinion, and frightened allies. In explaining outcomes, we are prone to examine one side’s behavior and overlook the stance of the other with which it is interacting. Although deterrence theory is built on the idea of interdependent decisions, most explanations for why deterrence succeeds in some cases and fails in others focus on differences in what the defender did while ignoring variation in the power and motivation of the challenger, just as much policy analysis in general starts—and often ends—with the strengths and weaknesses of the policies contemplated and adopted. But one hand cannot clap; we need to look at the goals, resources, and policies of those with whom the actor is dealing. Teachers are prone to make the parallel error of not exploring how shortcomings in our students’ performances on tests may be attributable to the questions we ask.

**US military predictions impossible as irrationality and surprises dictate warfare.**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

Further complexities are introduced when we look at the interactions that occur between strategies when actors consciously react to others and anticipate what they think others will do. Obvious examples are provided by many diplomatic and military surprises: a state believes that the obstacles to a course of action are so great that the adversary could not undertake it; the state therefore does little to block or prepare for that action; the adversary therefore works especially hard to see if he can make it succeed. As an 18th century general explained, "In war it is precisely the things which are thought impossible which most often succeed, when they are well conducted."15 In the war in Vietnam, the U.S. Air Force missed this dynamic and stopped patrolling sections of the North’s supply lines when reconnaissance revealed that the number of targets had greatly diminished: after the attacks ceased the enemy resumed use of the route.16 Both the success and failures of policies are determined interactively. This means that many cases of intelligence failure are mutual—i.e., they are failures by the side that took the initiative as well as by the state that was taken by surprise. Indeed, an actor’s anticipation of what others will do stems in part from its estimate of what the other thinks the actor will do. In many cases of surprise a state sees that a certain move by the adversary cannot succeed and therefore does not expect the other to take it: the U.S. did not expect the Russians to put missiles into Cuba or Japan to attack Pearl Harbor because American officials knew that the U.S. would thwart these measures if they were taken. These judgments were correct, but because the other countries saw the world and the U.S. less accurately, the American predictions were also inaccurate.17

### Middle East

**Middle East predictions are impossible- too many individual actors to linearize relations- complexity theory key**

**Taleb and Blyth, 2011** – Taleb is a Distinguished Professor of Risk Engineering at NYU Polytechnic while Blyth is a Professor of International Political Economy at Brown (Nassim and Mark, “The Black Swan of Cairo” [http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf)//BZ](http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf%29//BZ)

As with a crumbling sand pile, it would be foolish to attribute the collapse of a fragile bridge to the last truck that crossed it, and even more foolish to try to predict in advance which truck might bring it down. The system is responsible, not the compo-nents. But after the financial crisis of 2007-8, many people thought that predicting the subprime meltdown would have helped. It would not have, since it was a symptom of the crisis, not its underlying cause. Likewise, Obama’s blaming “bad intelligence” for his administration’s failure to predict the crisis in Egypt is symptomatic of both the misunderstanding of complex systems and the bad policies involved. Obama’s mistake illustrates the illusion of local causal chains—that is, confusing catalysts for causes and assuming that one can know which catalyst will produce which effect. The final episode of the upheaval in Egypt was unpredictable for all observers, especially those involved. As such, blaming the cia is as foolish as funding it to forecast such events. Governments are wasting billions of dollars on attempting to predict events that are produced by interdependent systems and are therefore not statistically understandable at the individual level. As Mark Abdollahian of Sentia Group, one of the contractors who sell predictive analytics to the U.S. government, noted regarding Egypt, policymakers should “think of this like Las Vegas. In blackjack, if you can do four percent better than the average, you’re making real money.” But the analogy is spurious. There is no “four percent better” on Egypt. This is not just money wasted but the construction of a false confidence based on an erroneous focus. It is telling that the intelligence analysts made the same mistake as the risk-management systems that failed to predict the economic crisis—and offered the exact same excuses when they failed. Political and economic “tail events” are unpredictable, and their probabilities are not scientifically measurable. No matter how many dollars are spent on research, predicting revolutions is not the same as counting cards; humans will never be able to turn politics into the tractable random-ness of blackjack. Most explanations being offered for the current turmoil in the Middle East follow the “catalysts as causes” confusion. The riots in Tunisia and Egypt were initially attributed to rising commodity prices, not to stifling and unpopular dictatorships. But Bahrain and Libya are countries with high gdps that can afford to import grain and other commodities. Again, the focus is wrong even if the logic is comforting. It is the system and its fragility, not events, that must be studied—what physicists call “percolation theory,” in which the proper-ties of the terrain are studied rather than those of a single element of the terrain. When dealing with a system that is inherently unpredictable, what should be done? Differentiating between two types of countries is useful. In the first, changes in government do not lead to meaningful differences in political outcomes (since political tensions are out in the open). In the second type, changes in govern-ment lead to both drastic and deeply unpredictable changes. Consider that Italy, with its much- maligned “cabinet instability,” is economi-cally and politically stable despite having had more than 60 governments since World War II (indeed, one may say Italy’s stability is because of these switches of government). Similarly, in spite of consis-tently bad press, Lebanon is a relatively safe bet in terms of how far governments can jump from equilibrium; in spite of all the noise, shifting alliances, and street protests, changes in government there tend to be comparatively mild. For example, a shift in the ruling coalition from Christian parties to Hezbollah is not such a consequential jump in terms of the country’s economic and political stability. Switching equilibrium, with control of the government changing from one party to another, in such systems acts as a shock absorber. Since a single party cannot have total and more than temporary control, the possibility of a large jump in the regime type is constrained. In contrast, consider Iran and Iraq. Mohammad Reza Shah Pahlavi and Saddam Hussein both constrained volatility by any means necessary. In Iran, when the shah was toppled, the shift of power to Ayatollah Ruhollah Khomeini was a huge, unforeseeable jump. After the fact, analysts could construct convincing accounts about how killing Iranian Communists, driving the left into exile, demobilizing the demo-cratic opposition, and driving all dissent into the mosque had made Khomeini’s rise inevitable. In Iraq, the United States removed the lid and was actually surprised to find that the regime did not jump from hyperconstraint to something like France. But this was impossible to predict ahead of time due to the nature of the system itself. What can be said, however, is that the more constrained the volatility, the bigger the regime jump is likely to be. From the French Revolution to the triumph of the Bolsheviks, history is replete with such examples, and yet somehow humans remain unable to process what they mean.

**Tumultuous areas like the Middle East are impossible to predict, especially in light of the Arab Spring. Linear predictions fail in policy action.**

**Hendrick, 2009** – PhD in Conflict Resolution from Bradford University, contributor to the Oxford University Press (Diane, “Complexity Theory and Conflict Transformation: An Exploration of Potential and Implications”, [http://www.brad.ac.uk/acad/confres/papers/pdfs/CCR17.pdf)//BZ](http://www.brad.ac.uk/acad/confres/papers/pdfs/CCR17.pdf%29//BZ)

So, attempts have been made to introduce complexity theory into thinking about social systems such as organisations, the world political system and the aid and development system Within peace research and practice there is also a move to address the system-like properties of conflicts within a complexity framework. Dennis Sandole seeks to establish that there was early recognition of this in the field, quoting Kenneth Boulding who implied that conflicts operate at the edge of chaos - not completely random but not in equilibrium (Sandole, 1999). Boulding’s insight could be phrased in complexity terms thus: slight perturbations could lead to bifurcation with unpredictable results given the sensitivity to initial conditions and nonliner relations within complex systems: “Human beings are moved not only by immediate pressures but by distant goals that are contemplated in the imagination. These goals are susceptible of change, often of dramatic change, as a result of apparently slight changes in current information. On the other hand, they also have a good deal of stability, and this gives a stability to the system in the large that it may not have in the small.” (Boulding, 1962 p. 24) In particular, intractable conflict qualifies for the epithet “complex”. The dual nature of instability and persistence noted by Boulding seems characteristic of such deep-rooted, long- lasting conflict: “a basic paradox of intractable conflicts: they are essentially stable despite tremendous volatility and change. If we consider the conflict in the Middle East for example, it appears by most accounts intransigent; with a past, present, and future cloaked in hate, violence, and despair. Yet, over the years we have also seen major changes in important aspects of the conflict such as in leadership, policy, regional circumstances, intensification and de-escalation of violence, intragroup divisions, popular sentiment, and international intervention strategies. In other words, we have seen extraordinary changes occur within a context of a pattern of stable destructive relations. This paradox of stability amidst change is evident in intractable conflicts at all levels, from estranged siblings and neighbors to warring ethnopolitical factions. They are at once frozen, unyielding, often persisting in hostile states for generations, yet they are also some of the most volatile and dynamic social processes on earth”. (Coleman, 2007 p. 3) The levels of conflict are mutually influencing from intra-personal through inter-personal to inter-group and international. Where conflicts are intractable (longstanding and deeply rooted) then there will be different conflict episodes within conflict phases reflecting different aspects of the conflict and engaging some of the same issues and parties but also drawing in new elements. The broader political, economic and social context plays into these and the key factors shaping the conflict change over time as leaders, policies, attitudes among the masses become more or less determining of the conflict dynamics (Sandole, 1999); (Mitchell, 2005). The complexity of conflict, in particular intransigent conflict, has then not only to do with the myriad mutually influencing factors but the non-linear relationships between these. In the light of this fact there are those in the field of peace and conflict research and application that have sought to use complexity theory to aid in the analysis of conflict and in the development of strategies for conflict transformation.

**Middle East predictions are like economics, impossible to have good calculations and make good presumptions.**

**Taleb and Blyth, 2011** – Taleb is a Distinguished Professor of Risk Engineering at NYU Polytechnic while Blyth is a Professor of International Political Economy at Brown (Nassim and Mark, “The Black Swan of Cairo” [http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf)//BZ](http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf%29//BZ)

Why is surprise the permanent condition of the U.S. political and economic elite? In 2007-8, when the global financial system imploded, the cry that no one could have seen this coming was heard everywhere, despite the existence of numerous analyses showing that a crisis was unavoidable. It is no surprise that one hears precisely the same response today regarding the current turmoil in the Middle East. The critical issue in both cases is the artificial suppres-sion of volatility—the ups and downs of life—in the name of stability. It is both mis-guided and dangerous to push unobserved risks further into the statistical tails of the probability distribution of outcomes and allow these high-impact, low-probability “tail risks” to disappear from policymakers’ fields of observation. What the world is witnessing in Tunisia, Egypt, and Libya is simply what happens when highly constrained systems explode. Complex systems that have artificially suppressed volatility tend to become extremely fragile, while at the same time exhibiting no visible risks. In fact, they tend to be too calm and exhibit minimal variability as silent risks accumulate beneath the surface. Although the stated intention of political leaders and economic policymakers is to stabilize the system by inhibiting fluctuations, the result tends to be the opposite. These artificially con-strained systems become prone to “Black Swans”—that is, they become extremely vulnerable to large-scale events that lie far from the statistical norm and were largely unpredictable to a given set of observers. Such environments eventually experi-ence massive blowups, catching everyone off-guard and undoing years of stability or, in some cases, ending up far worse than they were in their initial volatile state. Indeed, the longer it takes for the blowup to occur, the worse the resulting harm in both economic and political systems. Seeking to restrict variability seems to be good policy (who does not prefer stability to chaos?), so it is with very good intentions that policymakers unwittingly increase the risk of major blowups. And it is the same misperception of the properties of natural systems that led to both the economic crisis of 2007-8 and the current turmoil in the Arab world. The policy implications are identical: to make systems robust, all risks must be visible and out in the open— fluctuat nec mergitur (it fluctuates but does not sink) goes the Latin saying. Just as a robust economic system is one that encourages early failures (the concepts of “fail small” and “fail fast”), the U.S. government should stop supporting dictatorial regimes for the sake of pseudostability and instead allow political noise to rise to the surface. Making an economy robust in the face of business swings requires allowing risk to be visible; the same is true in politics.

### War

**The aff’s analysis perpetuates a linear view of conflict that undermines military effectiveness and leaves us vulnerable**

**Beyerchen, 97** – Alan D., associate professor of history at Ohio State University, and a fellow of the American Association for the Advancement of Science (“Chapter 7: Clausewitz, Nonlinearity, and the Importance of Imagery,” Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, [http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK](http://www.dodccrp.org/files/Alberts_Complexity_Global.pdf%29RK)

What is the utility of thinking about war—for our potential opponents and ourselves—in nonlinear terms, especially in the high-tech, research-forefront metaphorical terms from the new sciences? For our opponents the usefulness may be the same as it was for Clausewitz. The Germans were underdogs to the French, and Clausewitz wanted to understand and use against the French their linearizing blindspots. He also needed to be the champion of disproportionate effects and unpredictability, for in a linear, predictable world Prussian resistance to Napoleon after 1807 was futile. The opponents of the United States will be looking for our blindspots in an effort to seize opportunities to surprise and shock us. They may also be able to compensate for their disadvantage in military confrontations such as the Gulf War by consciously striving to affect the political context in order to change the conduct of warfare. An understanding of the porousness of the boundaries between politics and war can be a **real weapon** against those who envision those boundaries to be impermeable. We need for our own sake to understand the limitations our imagination places upon us. Linearity is excellent for the systems we design to behave predictably, but offers a narrow window on most natural and social systems. That narrowness sets blinders on our perception of reality and offers a weakness for an opponent to exploit. But if we know our limits, we can minimize the extent and duration of our surprise, reducing its value to someone else. And an expanded sense of the complexity of reality can help us be more successfully adaptive amid changing circumstances. By thinking more constructively about nonlinearity, we might be able to design more robust systems when we need them. A new form of modeling that takes such concepts as self-organization to heart allows structures to bubble up from below rather than be imposed from above. With such tools we might come to understand better the biological and historical processes with which we must deal. And we may come to realize how **conventional, analytical predictive techniques can themselves stimulate a self-defeating, unfulfillable desire to control** more of the real world around us than is truly possible.

**War cannot be reduced to a linear chain of cause and effect – failure to account for the diversity of interacting factors causes the affs predictions to fail**

**Beyerchen, 97** – Alan D., associate professor of history at Ohio State University, and a fellow of the American Association for the Advancement of Science(“Chapter 7: Clausewitz, Nonlinearity, and the Importance of Imagery,” Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, [http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK](http://www.dodccrp.org/files/Alberts_Complexity_Global.pdf%29RK)

Clausewitz also holds that war is the "continuation of policy" by other means. The conventional approach to this definition envisions a compartmentalization of politics (Politik, which also connotes policies) and war in a linear sequence—first comes politics/policies, then war, then politics/policies again to make and maintain peace. Furthermore, these interpretations hold that Politik drives war, but not vice versa. Actually the German word we translate as "continuation" (Fortsetzung) means literally a "setting-forth." This term does not require a sense of leaving something behind in the process; only our linear preconceptions lead us to imagine a norm in which the conduct of war is **insulated from its context.** A different approach emphasizes that Clausewitz believes war is not linear: war is a subset of the political context, and, furthermore, politics and military action interact in a complex, continual feedback process. As is the act of going to war in the first place, every act in war is the "setting forth" of politics/policies. Furthermore, the conduct of any war affects its character. How else could Clausewitz have conceived the relationship between war and Politik, given his understanding of the new relationships created by the nation-state? New tactics and technologies affect the way a war is fought. But consider also the ways in which the Prussian state was forced to undertake deep political and social reform in order to respond to the changed demands of the battlefields of the time, and the ways in which those reforms affected the structure and combat characteristics of the Prussian armies in the field. Experience told Clausewitz that the conduct of war affects its political context, which responds with changed parameters and goals that alter the conduct of war, which affects the political context anew, and so forth. Finally, Clausewitz claims that war is a "remarkable trinity" composed of the primordial passions of the people, the rational policies of the state, and the combination of incidents in battle (good luck or bad luck, the genius of the army commander, accidents with great consequence, etc.). Theory, he says, should be treated as if it were an object suspended among these three points of attraction. Many commentators have taken Clausewitz to mean that war should be treated in linear fashion in the form of a triangle, with lines bisecting each angle to create a static intersection point at which theory resides. But actually, the word translated as "suspended" (schwebend) connotes a hovering or a floating about. The physics demonstration of a pendulum tracing out a highly complex and irreproducible trajectory among three magnets is exactly what Clausewitz had in mind. And it is the quintessential demonstration of a **nonlinear system** highly sensitive to the initial conditions under which it operates. Every war involves **inherent nonlinearities** that pose problems for prediction, and Clausewitz talks about three broad categories of nonlinear factors that make for unpredictability in war. The first is interaction between animate entities that act, react and even preempt. This is not a simple binary opposition, for to Clausewitz much of what matters takes place in the spaces between and around the interacting entities (hence the image of the wrestlers or magnetic fields). His attention is always drawn to where boundaries are complex rather than simple. The second source of unpredictability is what Clausewitz chooses to label "friction." We must keep in mind that this was a term taken from the research forefront of his own day, a high-tech notion from the emerging science of thermodynamics. Clausewitz had in mind that wars are dissipative systems, which in the real world (as opposed to that of pure theory) always suck in and consume people and other limited resources. In another sense he meant with this term the amplification of a microcause to a macro-consequence, in a kind of **cascade of things gone wrong**. This is his more interesting version of the adage that "for want of a nail the shoe was lost, for want of a shoe, ..."5 Clausewitz also regards chance as one of the sources of unpredictability in war. He nowhere offers a concise definition of chance, but it seems to me that he addresses three forms of chance in On War. The first is stochastic phenomena, because Clausewitz repeatedly emphasizes that there are **no firm boundaries** that isolate war from its political context. Another is the amplification of undetectable microcauses, which ties chance and friction together in the **inevitable confusion of war.** And a third is the set of analytical blinders we unavoidably wear in real life, blinders that make us slice up the universe in manageable pieces and then perceive as chance the intersections of some of those slices. None of this means that linearity cannot ever be achieved in war, but it does indicate that linear, predictable relationships are hard to come by. They are also always attained at some **significant cost.** More importantly, our search for and reliance upon proportional and additive relationships creates a set of those **analytical blinders** that constitutes a potential weakness available to our opponents. The purpose of any theory of war for Clausewitz is to explore the entire range of possibilities, including counterfactuals in the sense that physicists understand them. It is not to generate a preconceived set of stable relationships, a checklist of laws valid upon any occasion, "since no prescriptive formulation universal enough to deserve the name of law can be applied to the constant change and diversity of the phenomena of war."6 Instead, theory should be guided by knowledge of past human experience and the best current scientific understanding of reality and natural constraints. According to Clausewitz, history must inform theory and serve to educate the commander. Only in this way can the nonlinear nature of war be understood adequately. This is the import of the images Clausewitz uses so astutely. About Nonlinearity and Imagery Why harp on nonlinearity, much less imagery? Why do they matter? Let us start with nonlinearity. One reason for emphasizing nonlinearity is that it constitutes the well-established mathematical property underlying and making coherent all the faddish-sounding new sciences: deterministic chaos, fractals, self-organizing systems far from thermodynamic equilibrium, complexity and complex adaptive systems, self-organizing criticality, cellular automata, solitons, and so forth. It was in various ways sensed by the ancient Greeks. Newton understood it, although the great French mathematicians of the eighteenth century linearized Newton as they popularized his ideas—much of what we decry as "Newtonian thinking" would actually be better ascribed to Laplace. Clausewitz recognized its importance as an alternative to Laplacian precepts, perhaps because he had such great antipathy toward those things that were French. Yet no one before the late twentieth century could solve the interesting problems posed by many nonlinear equations. There are no analytical techniques that work well, and numerical methods were just too cumbersome and time-consuming. Most scientists just bracketed out the nonlinear elements of their equations and went with the idealized linear approximation. Now computers allow us to go after formerly intractable problems by pursuing numerical solutions.7 The connotations of linearity still drive a great deal of our thinking, especially in mechanics and the many social scientific disciplines that implicitly try to copy the success of mechanics. Linearity offers structural stability and emphasis on equilibrium. It legitimates simple extrapolations of known developments, scaling and compartmentalization. It promises prediction and thus control—very powerful attractions indeed. But linear systems are often **restrictive, narrow and brittle.** They are seldom very adaptive under significant changes in their environment (as Clausewitz clearly understood). Bureaucracy is the quintessential linearization technique in social affairs.

**War is unpredictable – too many variables and events**

**Schmitt, 1998** – Major in the US Marine Corps Reserve, Lecturer at the National Defense University and the Marine Corps School in Quantico (John, “Command and (Out of) Control: The Military Implications of Complexity Theory”, [http://www.dodccrp.org/html4/bibliography/comch09.html)//BZ](http://www.dodccrp.org/html4/bibliography/comch09.html%29//BZ)

War is fundamentally uncertain. War is fundamentally uncontrollable (at least given our current understanding of control). Uncertainty A Sure Thing Nonlinear dynamics suggests that war is uncertain in a deeply fundamental way. Uncertainty is not merely an initial environmental condition which can be reduced by gathering information. It is not that we currently lack the technology to gather enough information but will someday have the capability. Rather, uncertainty is a natural and unavoidable product of the dynamic war: action in war generates uncertainty. The only type of war about which we could achieve certainty would be a system at equilibrium, which would not be war at all. Nonlinear dynamical systems sensitive to initial conditions are intrinsically unpredictable at the microscopic level, but the inability to accurately predict system behavior is not due to insufficient information about the system as was often assumed. Rather, unpredictability is a direct and irreducible consequence of the system’s sensitivity to initial conditions and the nonlinear rules that govern its dynamics. The best we can hope for is to work out probabilities—or, as Hayek suggests, to focus on "prediction of the principle"—and even then the system will surprise us. Promises of a "God’s-eye view" of the battlefield or Admiral Owens’ dream of 95-percent certainty within a 200x200x200-mile battlespace are thoroughly Newtonian concepts that simply do not jibe with the nature of war as a complex phenomenon. The widespread belief that information technology will allow us to blow away the fog of war is a dangerous delusion which fails to understand the complex nature of war.

**War cannot be controlled; it is too complex for linearization**

**Schmitt, 1998** – Major in the US Marine Corps Reserve, Lecturer at the National Defense University and the Marine Corps School in Quantico (John, “Command and (Out of) Control: The Military Implications of Complexity Theory”, [http://www.dodccrp.org/html4/bibliography/comch09.html)//BZ](http://www.dodccrp.org/html4/bibliography/comch09.html%29//BZ)

Complexity suggests it is a delusion to think that we can be in control in war with any sort of certitude or precision. Complexity further suggests the radical idea that the object of command and control is not to achieve control but to keep the entire organization surfing on the edge of being "out of control" because that is where the system is most adaptive, creative, flexible, and energized. Macroscopic Command and Control The turbulence of modern war suggests a need for a looser form of influence—something more akin to the willing cooperation of a soccer team than to the omnipotent direction of the chess player—that provides the necessary parameters in an uncertain, disorderly, time-competitive environment without stifling the initiative of subordinates. Complexity suggests the need for macroscopic command and control. Command and control should not try to impose precise domination over details because the details are inherently uncontrollable. Rather, it should try to provide a broad, meaningful structure to the roiling complexity. Newtonian command and control is microscopic: it attempts to control the system by controlling each particle in the system. Complex war defies microscopic command and control and instead requires macroscopic command and control which "controls" the system by influencing the system parameters and boundary conditions.

### Hegemony

**Unipolarity impossible- in a world of chaos it is impossible to maintain power influence. Long term predictions of international affairs are impossible.**

**Kissane, 2007** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “The possibility for theoretical revolution in international politics”, [http://works.bepress.com/dylankissane/16)//BZ](http://works.bepress.com/dylankissane/16%29//BZ)

From the first two assumptions, it could be assumed that unipolarity in the system is a rare occurrence. If unipolarity is defined as the situation where, within a system, one actor is preponderant and controls more than half of the resources within that system, it should be rare under a chaotic system. This is for two reasons. Firstly, and largely from assumption one, it is understood that polarity will not be stable within a chaotic system. Assuming a system with a significant number and variety of actors (as the international system as described must be} then unipolarity can be expected to be much less common than multipolarity even bipolarity. Imagine, for example, 10 units in a system. There are only 10 ways in which the system could be unipolar but 45 different bipolar pairings and 968 ways the system can be multipolar. With reference to simple probability alone, it seems unlikely that unipolarity would be a normal state of affairs for the international system. Secondly, as it is assumed that actors will seek security to ensure their survival in the system, a sole power that dominates the system - as in a unipolar system - is likely to be interpreted as a threat by at least some of the other actors in the system (Layne 1993; Christensen 2001). Thus, while unipolarity is possible, it is likely to be challenged by other actors and last only a short time. No polar distribution is necessarily unstable In considering polarity, it should also be noted that in a chaotic system no particular polar distribution of power is necessarily more stable or ordered than any other. As Diana Richards has previously shown, under chaos unipolarity, bipolarity and multipolarity all have the potential to be stable. Unlike the anarchy of neorealist theory, chaos does not favour one distribution of power or security to another in terms of bringing stability to the system. As Richards has argued, a chaotic model includes "stable configurations ranging from unipolar, bipolar, tripolar, egalitarian multipolar [and] multipolar” (1993, 69). Interactions impact on non-interacting parties. Finally, and with reference to all three assumptions, in a chaotic system an actor can be sure that their interactions will have effects other than those intended by the actor. With small events having the potential for great impact on the wider system, it is unlikely that interactions between actors can ever be truly 'controlled' or 'limited'. Furthermore, in a chaotic environment it is impossible for actors to predict all of the impacts of their interactions (Gleick 1987, 21). This is not to say that they can predict none - for why else would an interaction take place if some result were not thought in some way to be likely to result? - but they cannot predict all of the impacts and eventual results. Thus, actors are perpetually in a state of being able to draw reasonably accurate short-term predictions about the results of interactions but without being able to draw long-term conclusions.

**Linearization of American hegemony is false- relies on flawed international theory**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ%5C)

Although still comparatively rare in the social sciences, eclectic scholarship is beginning to make an impression in certain fields. Such eclecticism may be identified in relation to distinct strands within a broadly defined research tradition.93 In the interest of brevity, we focus here on eclectic scholarship that cuts across research traditions in the fields of international relations and comparative politics. We neither pretend to offer an adequate summary of the arguments considered, nor assess their substantive accuracy or explanatory power. We do, however, view these works as meeting our three criteria for analytic eclecticism: they take on problems of broad scope, they develop complex causal stories at the level of middle-range theory, and they implicitly seek pragmatic engagement within and beyond the academe. To this extent, we regard these works as reasonable approximations of analytic eclecticism. In the study of international security, Robert Jervis’s American Foreign Policy in a New Era represents a creative move in the direction of eclecticism.94 While the study is focused on the United States’ policies in the post-Cold War era, the analysis is predicated on the assumption that a revolutionary transformation has taken place in the international system: A distinctive kind of security community has emerged, consisting of the most powerful and developed states in the world, each of which has forsaken the use of force in its dealings with other members (as evident in the absence of official war plans). Although many take this state of affairs for granted, Jervis points out that it is a novel phenomenon that needs to be problematized and explained. Even when security communities had emerged in the past, they did not include the most powerful and developed states in the international system. For Jervis, the current security community constitutes “proof by existence of the possibility of uncoerced peace without central authority,”95 and thus requires scholars and policymakers to adjust their theoretical assumptions about states’ perceptions, interests, and behavior. For this purpose, Jervis notes the strengths and limitations of theories embedded in the constructivist, liberal, and realist traditions. These include: constructivist theories emphasizing the norm of nonviolence and an emergent identity shared by capitalist democracies; neoliberal theories stressing the pacifying effects of democratic politics, economic interdependence, and joint membership in international organizations; and realist theories focusing on the presence of external threat, American hegemony, and the logic of nuclear deterrence. Noting that none of these theories can independently explain the emergence or dynamics of the new security community, Jervis proceeds to adopt an eclectic analytic framework that reformulates and combines several causal factors: the belief that territorial conquest is difficult and unnecessary; the recognition of the costs of war, particularly in a nuclear age; and, rooted in the spread of democracy, shifts in identity that reflect a sharp decline in militarism and nationalism as well as a growing compatibility in values among the most advanced major powers. Interestingly, the significance of these factors and the complex manner in which they interact depends on ongoing historical processes. For example, the evolution of the international economy has been marked by a disassociation between territoriality and national prosperity, which has increased the costs of territorial acquisition in relation to potential material benefits. Similarly, the high degree of cooperation among the members of the security community is in part a function of enduring legacies of the Cold War when these states, as members of a common alliance, were socialized to behave as “partners” and set aside conflict as a means to settle their grievances vis-a-vis one another. Significantly, Jervis does not treat his analysis as a purely academic exercise. He is also concerned about the practical implications of his eclectic analysis, specifically in relation to American foreign policy and the responses of other members of the security community. Jervis argues that, as a result of the Bush doctrine, “[w]e are headed for a difficult world, one that is not likely to fit any of our ideologies or simple theories.”96 While pessimistic, the latter prediction is not simply a polemical statement. It derives from Jervis’s recon-sideration ofthe contours of the present international envi-ronment, which requires an urgent updating of conceptions of national interest and of the present course of American policy. In particular, Jervis cautions that unilateral actions by the US since 9/11 have begun to undermine the trust of members of the security community who are increasingly concerned about American hegemony. However, he also notes that other members of the security community, to the extent that they wish to check US hegemony, are adopting new styles of balancing that involve subtle, coordinated efforts to socialize and entrap the US to keep its behavior “within acceptable bounds.”97 Whether or not one concurs with Jervis’ implied prescriptions, his analysis enables a more open-ended discussion among scholars and policymakers about the foreign policy implications of the multiple dimensions of a new, evolving international order.

**Moves to American leadership are unpredictable – too many international interactions**

**Lichtenstein, 2006** – Assistant Professor in Management at UMass (Benyamin, "Complexity leadership theory: An interactive perspective on leading in complex adaptive systems", part of a University of Nebraska-Lincoln Journal, <http://digitalcommons.unl.edu/managementfacpub/8>) //BZ

Traditional, hierarchical views of leadership are less and less useful given the complexities of our modern world. Leadership theory must transi-tion to new perspectives that account for the complex adaptive needs of organizations. In this paper, we propose that leadership (as opposed to leaders) can be seen as a complex dynamic process that emerges in the interactive “spaces between” people and ideas. That is, leadership is a dynamic that transcends the capabilities of individuals alone; it is the product of interaction, tension, and exchange rules governing changes in perceptions and understanding. We label this a dynamic of adaptive leadership, and we show how this dynamic provides important insights about the nature of leadership and its outcomes in organizational fields. We define a leadership event as a perceived segment of action whose meaning is created by the interactions of actors involved in producing it, and we present a set of innovative methods for capturing and analyzing these contextually driven processes. We provide theoretical and practical implications of these ideas for organizational behavior and organiza-tion and management theory. Introduction As twenty-first-century management continues to emphasize decentralized organizing structures and co-evolutionary ecologies of firms, institutions, and markets, there is a growing recognition that traditional top-down theories of leadership are at best overly simplistic (Osborn et al., 2002). That is, leading-edge theorists and the leaders they inform are questioning the assumption that the essence of leadership rests within the character or the characteristic behaviors of effective supervisors (Seers, 2004). Worse, the notion that a leader exogenously “acts on” organizations in order to achieve the leader’s objectives may be misguided in the presence of the insight that orga-nizations are highly complex and nonlinear (Meyer et al., 2005). There is also a growing realization that effective leadership does not necessarily reside within the leader’s symbolic, motivational, or charismatic actions. If leadership is not “in” a leader or “done by” a leader, however, how are we to insightfully conceive exactly what constitutes leadership and from where it originates? A novel approach for answering these questions is grounded in complexity science, namely the notion that leadership is an emergent event, an outcome of relational interactions among agents. In this view, leadership is more than a skill, an exchange, or a symbol - leadership emerges through dynamic interactions (Bradbury and Lichtenstein, 2000). “Complexity leadership theory” investigates the role of leadership in expediting those processes in organizations through which interdependent actions among many individuals combine into a collective venture (Drath, 2001; Meyer et al., 2005). Founding the approach of this paper on complexity theory per se moves us to a whole- systems view and thus away from the more traditional approaches that focus on variables and component parts. Instead, we will focus on: • Expanding the locus of leadership from the isolated, role-based actions of individuals to the innovative, contextual interactions that occur across an entire social system; • Extending current theory and practice by focusing on micro-strategic leadership actions across all organizational levels and across organizational boundaries; • Increasing the relevance and accuracy of leadership theory by exploring how leadership outcomes are based on complex interactions, rather than “independent” variables; • Highlighting the relational foundations of change in emerging organizational fields, through the idea that leadership occurs in the “spaces between” agents; • Providing a new and rich foundation for explaining the constructive process of collective action as well as the influential “behaviors” of collective actors; • Connecting to innovative methodologies that can enrich our understanding of how leadership gets enacted and received in complex environments.

**Attempting for American leadership is flawed – complexity theory disproves the logic of leadership**

**Lichtenstein, 2006** – Assistant Professor in Management at UMass (Benyamin, "Complexity leadership theory: An interactive perspective on leading in complex adaptive systems", part of a University of Nebraska-Lincoln Journal, <http://digitalcommons.unl.edu/managementfacpub/8>) //BZ

Leadership study, indeed society in general, is infatuated with leaders - people who occupy some elevated status or position and to whom we often ascribe some form of “greatness” (Gronn, 2002). The Western mindset about leaders seems ruled by assumptions that leaders have some innate capacity to plan futures, arrive at rational and correct decisions (Bluedorn, 2002), and control social outcomes (Meindl et al., 1985). A new mindset is beginning to emerge, however, which recognizes that social processes are too complex and “messy” to be attributed to a single individual or pre-planned streams of events (Finkelstein, 2002; Marion and Uhl-Bien, 2001). As Finkelstein (2002: 77) put it: “I understand that as researchers we need to simplify very complex processes to study them carefully, but what are we left with when we remove the messiness, the back-and-forth, the reality?” Although the complexity leadership approach redirects emphasis away from the individual as leader, it does not in any way diminish the importance of leadership as an organizational phenomenon; rather, it recognizes that leadership transcends the individual by being fundamentally a system phenomenon (Marion and Uhl-Bien, 2001, 2003; Uhl-Bien et al., 2004; Hazy, 2006). Drawing from complexity science (Marion, 1999), complexity leadership theory offers a new perspective for leadership research by considering leadership within the framework of the idea of a complex adaptive system (CAS). In such systems, relationships are not primarily defined hierarchically, as they are in bureaucratic systems, but rather by interactions among heterogeneous agents and across agent networks. A CAS is comprised of agents, individuals as well as groups of individuals, who “resonate” through sharing common interests, knowledge and/or goals due to their history of interaction and sharing of worldviews. Agents respond to both external pressures (from environment or from other CAS or agents, e.g., leaders) and internal pressures that are generated as the agents struggle with interdependency and resulting conflicting constraints (e.g., when the needs of one agent conflict with those of another). These tensions, when spread across a network of interactive and interdependent agents, generate system-wide emergent learnings, capabilities, innovations, and adaptability. Importantly, such elaborations are products of interactions among agents, rather than being “caused” by the specific acts of individuals described as leaders. A complex systems perspective introduces a new leadership “logic” to leadership theory and research by understanding leadership in terms of an emergent event rather than a person. A complexity view suggests a form of “distributed” leadership (Brown and Gioia, 2002; Gronn, 2002) that does not lie in a person but rather in an interactive dynamic, within which any particular person will participate as leader or a follower at different times and for different purposes. It is not limited to a formal managerial role, but rather emerges in the systemic interactions between heterogeneous agents (Marion and Uhl-Bien, 2001, 2003). Therefore, complexity leadership includes a descriptive analysis examining the conditions and dynamic processes of these interactions and the emergent phenomena that they call forth: “There is a growing sense that effective organization change has its own dynamic, a process that cannot simply follow strategic shifts and that is longer and subtler than can be managed by any single leader. It is generated by the insights of many people trying to improve the whole, and it accumulates, as it were, over long periods.” (Heckscher, 1994: 24) In other words, “leaders” in the formal sense can enable the conditions within which the process occurs, but they are not the direct source of change.

**Military modernization is counterproductive – it maintains the same linear expectations for war and undermines readiness**

**Mazarr, 97** – Michael J., editor of the Washington Quarterly and director of the New Millennium Project at the Center for Strategic and International Studies (“Chapter 11: Chaos Theory and U.S. Military Strategy: A ‘Leapfrog’ Strategy for U.S. Defense Policy,” Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

To get a sense of how far the U.S. military is from a truly revolutionary response to the knowledge and information era, one need only hold D’Aveni and Hamel’s advice up against the reality of military planning as we do it today. However much fast-paced, overthehorizon, anti-traditional thinking—the kind demanded by the knowledge era—is going on in the military, that sort of mindset is clearly not guiding U.S. force structure planning today. In our quaint notion of a "hedge" against a Soviet Union that does not exist and our unreal (though undeniably comfortable) planning guide of "two (nearly) simultaneous regional contingencies," we are about as far away from out-of-the-box thinking as could be imagined. Take, for example, our current approach to the Revolution in Military Affairs (RMA). In its true form, this concept represents the introduction of knowledge-era concepts and structures into warfare. And yet the existing DoD plan, at least in the medium-term, is not to achieve an RMA at all, but to graft elements of that revolution onto a military force still representative of industrial-era, attrition-style warfare. Examples of this practice are easy to come by. A modern tank equipped with the global positioning system (GPS) and advanced cellular communications systems is not revolutionary, any more than an unstealthy attack aircraft with laser-guided bombs. A stealthy bomber raining cluster bombs on an advancing tank division is not revolutionary. Nor is an aircraft carrier equipped with fancy electronic countermeasures and radar detection systems. All of these capabilities—the capabilities on display in the Gulf War—represent **evolutionary advances** within the same mode of fighting that has prevailed, in some senses, since about 1940, and in others for **hundreds of years**. Part of the confusion arises from the use of the term "information warfare," the term of art that attempts to capture the knowledge era’s influence on war. Mastery and use of information is indeed at the core of the RMA. But this mastery does not simply involve adding one last bit of detail into a World War II-style tank outfit—as if, had Patton’s tanks been equipped with the GPS, his divisions would have embodied the RMA. Rather, the true RMA represents an entirely new manner of warfare, using information, long range precision strike, and other tools to destroy an enemy’s ability and will to fight without closing on the battlefield and exchanging tank fire; without sending vulnerable aircraft deep into hostile airspace; and without deploying aircraft carriers close to an enemy coast. The incrementalist notion of the RMA is ultimately **self-defeating.** It violates GellMann’s injunction that a period of rapid change is the time when it is most important to think comprehensively rather than narrowly. It **indefinitely postpones** the day when the U.S. military will truly depart from deeply-entrenched doctrines and routines and embrace the truly **revolutionary** elements of the **new era** in warfare. It guarantees that the lion’s share of procurement and research and development funds will be devoted to slightly modified versions of weapons in regular use for almost a century. Incrementalism—the time-honored planning approach of every major bureaucracy everywhere—**constitutes a mortal threat** to our achievement of a true revolution in military affairs: If it is pursued bit by bit, added on to existing pre-RMA systems in appliqué fashion,7 it will not be revolutionary at all. It will instead perpetuate old ways of conducting warfare and delay the time when the U.S. military enjoys the full advantages of the RMA. The potential for a mortal threat to the RMA exists in part because of our budgetary predicament. As most U.S. military planners are now well aware, a crisis of defense policy is upon us, a crisis stemming from a simple, but lethal, mismatch between budgets, force structure, and modernization. The United States today has a small and steadily shrinking defense budget supporting a large force designed to fight two simultaneous regional wars. As a result, only modest amounts of long-term research and development or modernization are taking place. Not only does this situation make it impossible for the United States to implement the RMA in the coming decades; it makes it unlikely that we will maintain a high-quality, modern military force of any sort. The numbers alone are startling—and for the most part, they are undisputed. No one denies the reality of the budget shortfall.8 The force outlined in the Bottom-Up Review of Defense Priorities is underfunded by between $50 billion and $300 billion over five years. Put another way, to fully fund the BUR force, the United States ought to be spending in the neighborhood of 4 percent of GNP, while currently planned budgets will fall below 3 percent. This shortfall could manifest itself in three places: in force structure; in readiness; or in modernization. Because of the Clinton administration’s military strategy of twin regional contingencies, it has felt unable to reduce force structure much beyond that of the Bush years. And because of the political and military costs of allowing combat readiness or training to slip, the administration has refused cutbacks in those areas as well. As is now well-known, the result of these decisions has been to focus the effect of the budget shortfall on the third area of military spending: the United States has gutted modernization and research and development to pay for a relatively large, very ready force-in-being. Acquisition spending is down by 60 percent between 1987 and 1995. Research and development budgets will fall 40 percent from 1987 through 1999, and what is left focuses mainly on modifications and upgrades of existing systems rather than on developing new ones. The obvious consequence of slowed modernization is a military with aging equipment. By the year 2010, the average age of tanks in the U.S. military will be 21 years; of utility helicopters, nearly 30 years; of navy fighter aircraft, 15 years; of attack submarines and surface ships, 16 years; of air force fighter-attack aircraft, 20 years; and of air force bombers and transport planes, 35 years.9 These statistics tell a simple tale: the United States government has decided to mortgage the future of the military to its present. Slashing modernization in favor of force structure and readiness means a stronger military today in exchange for a weaker military tomorrow. "Modernization," General John Shalikashvili has said, "is tomorrow’s readiness"10 —and it is the only route to the RMA. Without R&D and procurement, without new investments in tomorrow’s military in addition to mortgage payments on today’s, the RMA will never become a reality. This kind of strategy would make sense if the United States faced immediate and serious threats that mandated a very large, very ready military. But this is not the case; the United States does not now face a major global rival, and will not face one for at least several years. Regional predators like Iran and North Korea will succumb to a much smaller U.S. force, and the threat they pose is blatant enough and far enough outside the mainstream of world politics that we can expect to assemble coalition efforts to defeat these aggressors. On the other hand, ten years from now we might face much more serious military threats. The predators, if they still exist in their present, hostile form, may be stronger, with new weapons and larger militaries. And one or another major power may undertake a path toward regional aggression. "Our most serious" threats, says Columbia professor Richard Betts, "will come down the road rather than tomorrow morning."11 There is much to be said for constraining existing capabilities to invest in modernization that would produce a stronger military ten years hence. The Need for a Leapfrog Strategy Such an approach is available through what this essay will term the "leapfrog strategy." Its core idea is simple: the United States should free up additional money for investments in future defense capabilities, by reducing its force structure and continuing to budget the planned increase in modernization funds beginning in FY1997; and it should invest that money, as well as the lion’s share of existing procurement budgets, in RMA technologies, skipping one generation of advanced weapons systems now slated for procurement. In the process it should take the advice of D’Aveni and Hamel and treat strategy and force structure as revolutionary notions; in the fast-moving knowledge era, standing still **invites disaster.** By abandoning the idea of incremental modernization and striking out toward a truly new generation of weapons, the leapfrog strategy forces U.S. defense planners to abandon their appliqué model of the RMA and **rethink** doctrine, organization, and strategy from the ground up. Currently, the Defense Department intends to purchase weapons over the next ten years that represent largely evolutionary advances over existing systems. Thus DoD will spend, in 1996 and 1997 alone, a billion and a half dollars to upgrade the M1 tank and the Bradley fighting vehicle; nearly half a billion dollars on a new artillery piece and its supply vehicle; and $400 million on a light, direct-fire tank. It will spend $500 million on the Comanche helicopter; $2 billion on the V-22 tilt-rotor aircraft; billions of dollars on new aircraft carriers and frigates; over $2 billion on various new models of the F/A-18 fighter-bomber; and roughly another $2 billion on new or upgraded F-15 and F-16 aircraft and the roots of a new generation of tactical combat planes.12 Yet, in the context of the RMA, many of these systems are doomed to obsolescence. Stealthy aircraft are of course an element of the RMA. But large surface ships, heavy armored vehicles, and non-stealthy aircraft will in coming years simply serve as magnets for advanced precision-guided weapons—and, perhaps, weapons of mass destruction as well. The truly advanced warfare of the twenty-first century will not be fought by aircraft carriers, tanks, and fighters as we now understand them, but by a very different sort of military force based around the principles of the RMA—speed, agility, synergy, information dominance, and lethal, long-range precision strike. In many ways, the traditional systems can be thought of as a provisional generation of military technology, trapped between the highest expressions of pre-RMA military systems and the RMA itself. They might be called the Neanderthal Generation because, in an evolutionary sense, they are akin to Neanderthal Man: highly advanced, extremely intelligent, but doomed to extinction as a truncated line on the evolutionary tree. Recognizing these facts, the leapfrog strategy would skip this generation of technology in favor of a research and development and procurement strategy designed to bring the Revolution in Military Affairs into being by the year 2010.

### Economy

**Economic predictions are subjective – the aff’s model can’t account for relationships between actors**

**Arthur, 95** – W. Brian, Morrison Professor of Economics and Population Studies, Stanford University (“Complexity in Economic and Financial Markets,” Complexity, vol. 1, no. 1, April 1995, https://www.google.com/search?num=100&hl=en&q=%E2%80%9CComplexity+in+Economic+and+Financial+Markets%E2%80%9D&oq=%E2%80%9CComplexity+in+Economic+and+Financial+Markets%E2%80%9D&aq=f&aqi=g-K2g-mK1&aql=&gs\_l=serp.3..0i30l2j0i5i30.286168.287687.0.288309.2.2.0.0.0.0.135.258.0j2.2.0...0.0.cIhmcawH2B4)RK

Actions taken by economic decision makers are typically predicated upon hypotheses or predictions about future states of a world that is itself in part the consequence of these hypotheses or predictions. When we attempt to model how such predictions might be generated we become stymied: the predictions some economic agents might form depend on the predictions they believe others might form; and the predictions these might form depend upon the predictions they believe the original group might form. Predictions or expectations can then become self-referential and deductively **indeterminate**. This indeterminacy pervades economics and game theory. This paper argues that in such situations agents predict not deductively, but inductively. They form **subjective expectations** or hypotheses about what determines the world they face. And these expectations are formulated, used, tested, and possibly changed, in a world that forms from others’ subjective expectations. This yields individual expectations trying to prove themselves against others’ expectations. The result is an ecology of co-evolving, possibly **ever-changing expectations.** The resulting dynamics often can be analyzed only by computation. Inductive expectation formation is illustrated in an artificial computer-based stock market. Coevolution of expectations explains phenomena seen in real markets that appear as anomalies to standard finance theory.

**Their input-output understanding of the economy doesn’t account for the complexity of human behavior – their predictions become self-referential and fail**

**Arthur, 95** – W. Brian, Morrison Professor of Economics and Population Studies, Stanford University (“Complexity in Economic and Financial Markets,” Complexity, vol. 1, no. 1, April 1995, https://www.google.com/search?num=100&hl=en&q=%E2%80%9CComplexity+in+Economic+and+Financial+Markets%E2%80%9D&oq=%E2%80%9CComplexity+in+Economic+and+Financial+Markets%E2%80%9D&aq=f&aqi=g-K2g-mK1&aql=&gs\_l=serp.3..0i30l2j0i5i30.286168.287687.0.288309.2.2.0.0.0.0.135.258.0j2.2.0...0.0.cIhmcawH2B4)RK

One way to look at the economy, the standard way in fact, is to view it in physical terms as a collection of activities, technologies, and needs, all interacting though a market system peopled by decision-making agents such as firms, banks, consumers, and investors. A very different way—the one I want to explore here—would be to view the economy in psychological terms: as a collection of beliefs, anticipations, expectations, and interpretations; with decision-making and strategizing and action-taking predicated upon these beliefs and expectations. Of course, the two views are related. Activities follow from beliefs and expectations. And beliefs and expectations are mediated and sculpted by the physical economy they find themselves in. Why might a psychological or cognitive view of the economy be useful? Economic agents make their choices based upon their current beliefs or hypotheses (I will use these terms along with the jargon terms expectations or predictions) about future prices, or future interest rates, or competitors’ future moves, or the future character of their world. And these choices, when aggregated, in turn **shape the prices, interest rates, market strategies, or world** these agents face. The beliefs or hypotheses that agents form in the real economy are largely **individual and subjective.** They are often private. And they are constantly tested in a world that forms from their and others’ actions—a world that is ultimately formed from their and other agents’ subjective beliefs. Thus at a sub-level, we can think of the economy ultimately as a vast collection of beliefs or hypotheses, constantly being formulated, acted upon, changed and discarded; all interacting and competing and evolving and coevolving; forming an ocean of ever-changing, predictive models-of-the-world. This view is useful, I believe, because it forces us to think about how **beliefs create economic behavior**—and how economic outcomes create beliefs. And it leads to different insights. Beyond the simplest problems in economics, this ecological view of the economy becomes inevitable; and it leads to a **world of complexity.** The standard way to handle predictive beliefs in economic analysis is to assume identical agents who possess perfect rationality and arrive at shared, logical conclusions or expectations about the situation they face. When these expectations induce actions that aggregatively create a world that validates them as predictions, they are in equilibrium and are called rational expectations. Rational expectations are useful in demonstrating logical equilibrium outcomes and analyzing their consequences. But in the real world they **break down easily.** If some agents lack the computing power to deduce the posited outcome; or if some arrive logically at different conclusions from the same data (as they might in a pattern recognition problem); or if there is more than one rational expectations equilibrium with no means to coordinate which is chosen; then some agents may deviate in their expectations. And if some deviate, the world that is created may change, so that others should logically predict something different and deviate too. And so **rational expectations** can **unravel easily.** Unless there are special circumstances, **they are not robust.** There is a game in economics that illustrates this unraveling of rational expectations beautifully. It is the Guessing Game, where N players choose a number between 0 and 100, and the winner is the one closest to 2/3 of the average guess (see Nagel [16]). Obviously here, beliefs of what constitutes a good guess depend on one’s view of others’ beliefs of what constitutes a good guess. Now, uniform predictions of zero would constitute rational expectations; they would be self-validating in that if agents expected other agents to choose zero they should also choose zero. Therefore expectations that everyone will choose zero would be in equilibrium. And no other real number, if chosen by all, would constitute an expectational equilibrium. But does that mean that zero will necessarily be chosen? If I, as a reference player, suspect that some players—or even one player—may choose non-zero, then logically I ought to choose non-zero. And if I believe that others believe that someone may choose non-zero, I will deduce that they too will choose non-zero. Thus beliefs that some may choose non-zero lead others to expect non-zero and choose non-zero. The game leads to a self-referential sequence of “If they choose x, I and others should choose y. But if I and others choose y, they will have to choose z.” There is no closure here, and ultimately beliefs or expectations in this game are deductively indeterminate, no matter how logical or rational the agents are.1 Consider as a second example my Bar Problem (Arthur [2]). One hundred people must decide independently each week whether to show up at their favorite bar (El Farol in Santa Fe, say). The rule is that if a person predicts that more that 60 (say) will attend, he will avoid the crowds and stay home; if he predicts fewer than 60 he will go. This seems innocuous; but it destroys the possibility of long-run shared expectations. If all believe few will go, than all will go, thus invalidating these expectations. And if all believe many will no, no one will go, invalidating those expectations. Predictions of how many will attend depend on others’ predictions, and others’ predictions of others’ predictions. Once again there is **no rational means** to arrive at deduced a-priori predictions. These two problems are of course toy problems, concocted like the famous Prisoner’s Dilemma to make a point. But they illustrate a foundational difficulty in economics. Where forming expectations means predicting an aggregate outcome that is formed in part from others’ expectations, expectation formation can become self-referential. The problem of logically forming expectations then becomes ill-defined, and **rational deduction finds itself with no bottom ground to stand upon.** This indeterminacy of expectation-formation is by no means a rarity or anomaly within the real economy. On the contrary, **it pervades all of economics and game theory.**

**Markets can't be quantified and linearized; they are based on individual beliefs and perspectives. Mere numbers and data can't make predictions, only complexity theory predicts accurate trends.**

**Arthur, 1995** – Professor at Santa Fe Insitute, Professor of Economics and Population Studies at Stanford University (W. Brian, “Complexity in Economic and Financial Markets”, <http://tuvalu.santafe.edu/~wbarthur/Papers/Complexity_Jnl.pdf>)//BZ

We can conclude that given sufficient homogeneity of (unbiased) beliefs, the standard equilibrium of the literature is upheld. The market in a sense in this regime is essentially “dead.” As the dial of heterogeneity of initial beliefs is turned up, the market undergoes a phase transition and “comes to life.” It develops a rich psychology and displays phenomena regarded as anomalies in the standard theory but observed in real markets. The inductive, ecology-of-expectations model we have outlined is by its definition an adaptive nonlinear network (Holland [11]). In its heterogeneous mode it displays complex, pattern-forming, non-stationary behavior. We could therefore rename the two regimes or phases simple and complex. We conjecture that actual financial markets live within the complex regime. C o n c l u s i o n An economy of course, does indeed consist of technologies, actions, markets, financial institutions and factories—all real and tangible. But behind these, guiding them and being guided by them on a sub-particle level are beliefs: the subjective expectations, multiple hypotheses, and half-hoped anticipations held by real human beings. Beliefs can be mutually reinforcing, or mutually competing. They can arise, get a footing, become prominent, fall back, and disappear. They can be generated privately by theoretical reasoning or by pattern recognition; they can be transmitted from one agent to another. They shape in aggregate the macro economy; they give rise to the movements of financial markets; they direct flows of capital internationally; they govern strategic behavior; and they govern investment. They are the DNA of the economy, and they are everywhere dense. When beliefs form an ocean of interacting, competing, arising and decaying entities, occasionally they simplify into a simple, homogeneous equilibrium set. More often they produce complex, ever-changing patterns. Within the most significant parts of the economy, interacting, non-equilibrium beliefs are unavoidable, and with these so is a world of complexity.

**Investment disad: unpredictable scenarios in the economy take money from taxpayers, reflected through the financial catastrophes of the investment banks.**

**Taleb, 2011** –a Distinguished Professor of Risk Engineering at NYU Polytechnic (Nassim, “The Great Bank Robbery”,http://www.project-syndicate.org/print/the-great-bank-robbery)//BZ

NEW YORK – For the American economy – and for many other developed economies – the elephant in the room is the amount of money paid to bankers over the last five years. For banks that have filings with the US Securities and Exchange Commission, the sum stands at an astounding $2.2 trillion. Extrapolating over the coming decade, the numbers would approach $5 trillion, an amount vastly larger than what both President Barack Obama’s administration and his Republican opponents seem willing to cut from further government deficits. That $5 trillion dollars is not money invested in building roads, schools, and other long-term projects, but is directly transferred from the American economy to the personal accounts of bank executives and employees. Such transfers represent as cunning a tax on everyone else as one can imagine. It feels quite iniquitous that bankers, having helped cause today’s financial and economic troubles, are the only class that is not suffering from them – and in many cases are actually benefiting. Mainstream megabanks are puzzling in many respects. It is (now) no secret that they have operated so far as large sophisticated compensation schemes, masking probabilities of low-risk, high-impact “Black Swan” events and benefiting from the free backstop of implicit public guarantees. Excessive leverage, rather than skills, can be seen as the source of their resulting profits, which then flow disproportionately to employees, and of their sometimes-massive losses, which are borne by shareholders and taxpayers. In other words, banks take risks, get paid for the upside, and then transfer the downside to shareholders, taxpayers, and even retirees. In order to rescue the banking system, the Federal Reserve, for example, put interest rates at artificially low levels; as was disclosed recently, it also has provided secret loans of $1.2 trillion to banks. The main effect so far has been to help bankers generate bonuses (rather than attract borrowers) by hiding exposures. Taxpayers end up paying for these exposures, as do retirees and others who rely on returns from their savings. Moreover, low-interest-rate policies transfer inflation risk to all savers – and to future generations. Perhaps the greatest insult to taxpayers, then, is that bankers’ compensation last year was back at its pre-crisis level. Of course, before being bailed out by governments, banks had never made any return in their history, assuming that their assets are properly marked to market. Nor should they produce any return in the long run, as their business model remains identical to what it was before, with only cosmetic modifications concerning trading risks. So the facts are clear. But, as individual taxpayers, we are helpless, because we do not control outcomes, owing to the concerted efforts of lobbyists, or, worse, economic policymakers. Our subsidizing of bank managers and executives is completely involuntary. But the puzzle represents an even bigger elephant. Why does any investment manager buy the stocks of banks that pay out very large portions of their earnings to their employees? The promise of replicating past returns cannot be the reason, given the inadequacy of those returns. In fact, filtering out stocks in accordance with payouts would have lowered the draw-downs on investment in the financial sector by well over half over the past 20 years, with no loss in returns. Why do portfolio and pension-fund managers hope to receive impunity from their investors? Isn’t it obvious to investors that they are voluntarily transferring their clients’ funds to the pockets of bankers? Aren’t fund managers violating both fiduciary responsibilities and moral rules? Are they missing the only opportunity we have to discipline the banks and force them to compete for responsible risk-taking? It is hard to understand why the market mechanism does not eliminate such questions. A well-functioning market would produce outcomes that favor banks with the right exposures, the right compensation schemes, the right risk-sharing, and therefore the right corporate governance. One may wonder: If investment managers and their clients don’t receive high returns on bank stocks, as they would if they were profiting from bankers’ externalization of risk onto taxpayers, why do they hold them at all? The answer is the so-called “beta”: banks represent a large share of the S&P 500, and managers need to be invested in them. We don’t believe that regulation is a panacea for this state of affairs. The largest, most sophisticated banks have become expert at remaining one step ahead of regulators – constantly creating complex financial products and derivatives that skirt the letter of the rules. In these circumstances, more complicated regulations merely mean more billable hours for lawyers, more income for regulators switching sides, and more profits for derivatives traders. Investment managers have a moral and professional responsibility to play their role in bringing some discipline into the banking system. Their first step should be to separate banks according to their compensation criteria. Investors have used ethical grounds in the past – excluding, say, tobacco companies or corporations abetting apartheid in South Africa – and have been successful in generating pressure on the underlying stocks. Investing in banks constitutes a double breach – ethical and professional. Investors, and the rest of us, would be much better off if these funds flowed to more productive companies, perhaps with an amount equivalent to what would be transferred to bankers’ bonuses redirected to well-managed charities.

### IR

**Long term predictions are ludicrous as too many actors over a long period of time cannot be linearized. Complexity theory anticipating short term predictions is necessary for international relations.**

**Kissane, 2007** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “The possibility for theoretical revolution in international politics”, [http://works.bepress.com/dylankissane/16)//BZ](http://works.bepress.com/dylankissane/16%29//BZ)

From these three assumptions - chaos, security seeking and interaction - can be extracted a series of predictions about the international system. Drawing on the first assumption, it becomes clear that long-term prediction of the system is impossible, but that short-term predictions and even medium-term predictions are likely to be accurate (Gleick 1987,18). This is generally due to the fact that very small irregularities and unmeasured impacts within the system feedback into the system producing larger and larger change over time (Jervis 1997, Chapter Four). The 'butterfly effect', which is described as the possibility that the flutter of a butterfly’s wings in Beijing can cause a hurricane in Florida, is an example of such feedback. Indeed, in the weather we have a chaotic system that is largely predictable short term (for example, the chance of rain in the morning), somewhat predictable in the medium term (for example, it is likely to be sunny next weekend) but almost entirely unpredictable long-term (for example, it will be 32°C on December 21st 2009). The cumulative effect of 'butterfly-level' events conspire to defeat even the most advanced weather model, leaving meteorologists without much of a long-term prediction other than summer will be warmer than winter (Young 2002). Of course, the weather also provides us with an example of 'butterfly-level' events that do not feedback into the system. That is, while a butterfly may have an impact on the wider system, it can also not have an impact (Kissane 2006, 95). If every event in the system affected the entire system, prediction would likely be impossible. So while prediction long-term is impossible or, at the least, unlikely, there remains the possibility and reality that chaotic systems can be predicted in the short and medium term. The meaning of security is self-constructed but socially effected Drawing on the latter two assumptions, as security is an actor-constructed notion, variation in definition is likely when comparing actors. However, as actors are 'social' - that is, they interact - there are also likely to be some regularity in definition between actors of a similar type. The ability of actors to construct their own notion of what security is allows for variation between actors in that definition. Thus, it is likely that some actors will define security in military terms, some in economic terms and some in terms of simple survival (Bellamy and McDonald 2004). These differences in the definition of security may reflect differentials in power, status or culture; whatever the reason for the difference in definition, the most basic underlying explanation is that the actor has constructed its own definition of security. Thus, it would not be unusual for some state actors, for example, to seek security by banding together and pooling sovereignty (for example, in the EU) and others to attempt to become more fully independent (for example, Iran) (Smith 2000, 33). However, as it is also assumed that actors interact, it is assumed that there will be some processes of socialisation evident in the interactions. Thus, we would expect that there would be some similarities emergent among certain types of actors that are common to all (or almost all) other actors of that type. Thus, for nation-states we might find that almost all will attempt to increase security through the maintenance an armed defence force; for multinational corporations (MNCs) we might find that almost all attempt to increase security through increased economic profitability; for NGOs we might find that almost all are of a ‘progressive’ political nature (assumed to be better for survival in the system, as they understand it).

**Long term predictions impossible – chaos theory and multiple variables proves
Kissane, 2010** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “The Illusion of Anarchy: Chaos, Complexity and the Origins of World War One”, found online)//BZ

Finally, in a chaotic system we would expect that long-term prediction is not only unlikely but also truly impossible. Again returning to the example of the chaotic climate system, it is clear that short-term prediction is possible. After all, most meteorologists can predict with reasonable accuracy the weather for the following day and, in reality, many laypersons can do the same. In the medium term, prediction is less likely to be correct, though it would still be most likely correct to claim that there will be a significant difference in temperature between January and August even if the exact difference is unknown. In the long-term, however, it is impossible to predict the chaotic climate outside of such general rearms as 'summer will be warmer than winter' or 'there will be more snow in Switzerland than the Sahara'. The multiplication effect of billions of unit and system levels events leads to a situation where the future is unpredictable in all but the most general terms - something useless to, say, a fisherman wanting to know whether some weekend will be rainy in some future time and place. A chaotic international system would exhibit similar traits. Long-term prediction would prove impossible outside of general terms. While short-term prediction and even medium-term prediction would remain of some utility (for example, 'next week the US will still be the world's leading power') long-term prediction will be impossible and such predictions are just as likely to be wrong as right (for example, 'the US will be the world's leading power in 2100'). Perhaps some correlations can be drawn between the predictions of pundits at the dawn of the 20th century - who imagined that the Concert of European powers would reign in peace and authority for years to come and the situation at the close of that same century: Russia collapsed, Germany peaceful, Japan demilitarised, the US in power, China rising, the UK and France with mere memories of domination and Austria- Hungary ceasing to exist as an entity at all. It would seem, then, that there is at least a case to be made for the international system being a chaotic one rather than an anarchic one. With the implications of chaos including the three mentioned above, it is clear that the analysis, explanation and prediction of international affairs by international relations scholars must also evolve with this changing concept of the system. Thus, let us turn to an example from within Central and Eastern Europe from the last century in order to demonstrate the difference between anarchic and chaotic interpretations of the international system. This paper turns, then, to the debate on the reasons for the outbreak of World War One.

**Linear modeling of international relations is impossible**

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Developing a theory of international politics demands that, like a map maker, the theorist decide which elements are important enough to include and which can be safely excluded without affecting the utility of the end product. Mapping a theory of international political chaos, however, complicates such choices as it is not at all clear what calculus can be used to determine which elements should be included and what weight is to be afforded to them when they are. This problem of interdependence under political chaos is similar to the problems natural scientists faced when adapting their inadequate linear models to what were found to be chaotic systems. Indeed, the example and experience of meteorologists and climatologists in the 1950s and 1960s are similar to the experiences of international relations theorists today who seek to consider the international system as chaotic. Drawing on the experiences of those meteorologists, a potential solution to the problem of interdependence is found whereby the chaos theorist in international relations to the problem of interdependence. This solution - a change in the expectations of the theorist as to what their theories can and should be able to accomplish as well as a change in the methodology by which assessment and predictions are made - allows for the analysis of a chaotic international system without necessarily excluding any particular element of that system nor always including the same elements in the assessment of an international situation. The resultant map of the international system both embraces the complexity of politics under chaos as well as offering an explanation of that system that the analyst can use to find their way in the world and that, after all, is the goal of every cartographer of the international system.

**IR predictions impossible - thousands of actors affect actions in a chaotic sphere.**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

That a deep sense of uncertainty should pervade world affairs since the end of the Cold War is hardly surprising. The U.S.-Soviet rivalry, for all its tensions and susceptibility to collapsing into nuclear holocaust, intruded a stability into the course of events that was comprehensible, reliable, and continuous. The enemy was known. The challenges were clear. The dangers seemed obvious. The appropriate responses could readily be calculated. Quite the opposite is the case today, however. If there are enemies to be contested, challenges to meet, dangers to avoid, and responses to be launched, we are far from sure what they are. So uncertainty is the norm and apprehension the mood. The sweet moments when the wall came down in Berlin, apartheid ended in South Africa, and an aggression was set back in Kuwait seem like fleeting and remote fantasies as the alleged post-Cold War order has emerged as anything but orderly. Whatever may be the arrangements that have replaced the bipolarity of U.S.-Soviet rivalry, they are at best incipient structures and, at worst, they may simply be widespread disarray. Put differently, a new epoch can be said to be evolving. As indicated, it is an epoch of multiple contradictions: The international system is less dominant, but it is still powerful. States are changing, but they are not disappearing. State sovereignty has eroded, but it is still vigorously asserted. Governments are weaker, but they can still throw their weight around. At times publics are more demanding, but at other times they are more compliant. Borders still keep out intruders, but they are also more porous. Landscapes are giving way to ethnoscapes, mediascapes, ideoscapes, technoscapes, and finanscapes, but territoriality is still a central preoccupation for many people.3 Sorting out contradictions such as these poses a number of difficult questions: How do we assess a world pervaded with ambiguities? How do we begin to grasp a political space that is continuously shifting, widening and narrowing, simultaneously undergoing erosion with respect to many issues and reinforcement with respect to other issues? How do we reconceptualize politics so that it connotes identities and affiliations as well as territorialities? How do we trace the new or transformed authorities that occupy the new political spaces created by shifting and porous boundaries? The cogency of such questions—and the uncertainty they generate—reinforce the conviction that we are deeply immersed in an epochal transformation sustained by a new world view about the essential nature of human affairs, a new way of thinking about how global politics unfold. At the center of the emergent world view lies an understanding that the order which sustains families, communities, countries, and the world through time rests on contradictions, ambiguities, and uncertainties. Where earlier epochs were conceived in terms of central tendencies and orderly patterns, the present epoch appears to derive its order from contrary trends and episodic patterns. Where the lives of individuals and societies were once seen as moving along linear and steady trajectories, now their movement seems nonlinear and erratic, with equilibrium being momentary and continuously punctuated by sudden accelerations or directional shifts. Accordingly, the long-standing inclination to think in either/or terms has begun to give way to framing challenges as both/and problems. People now understand, emotionally as well as intellectually, that unexpected events are commonplace, that anomalies are normal occurrences, that minor incidents can mushroom into major outcomes, that fundamental processes trigger opposing forces even as they expand their scope, that what was once transitional may now be enduring, and that the complexities of modern life are so deeply rooted as to infuse ordinariness into the surprising development and the anxieties that attach to it. To understand that the emergent order is rooted in contradictions and ambiguities, of course, is not to lessen the sense of uncertainty as to where world affairs are headed and how the course of events is likely to impinge on personal affairs. Indeed, the more one appreciates the contradictions and accepts the ambiguities, the greater will be the uncertainty one experiences. And the uncertainty is bound to intensify the more one ponders the multiplicity of reasons why the end of the Cold War has been accompanied by pervasive instabilities. Clearly, the absence of a superpower rivalry is not the only source of complexity. Technological dynamics are also major stimulants, and so are the breakdown of trust, the shrinking of distances, the globalization of economies, the explosive proliferation of organizations, the information revolution, the fragmentation of groups, the integration of regions, the surge of democratic practices, the spread of fundamentalism, the cessation of intense enmities, and the revival of historic animosities—all of which in turn provoke further reactions that add to the complexity and heighten the sense that the uncertainty embedded in nonlinearity has become an enduring way of life. In some corners of the policy-making community there would appear to be a shared recognition that the intellectual tools presently available to probe the pervasive uncertainty underlying our emergent epoch may not be sufficient to the task. More than a few analysts could be cited who appreciate that our conceptual equipment needs to be enhanced and refined, that under some conditions nonlinear approaches are more suitable than the linear conceptual equipment that has served for so long as the basis of analysis, that the disciplinary boundaries that have separated the social sciences from each other and from the hard sciences are no longer clear-cut, and that the route to understanding and sound policy initiatives has to be traversed through interdisciplinary undertakings.4

**IR theory fails- it is impossible and paralyzing to consider every single actor in the system, prefer sweeping predictions that while are not perfect, at least lead to action and praxis.**

**Kissane, 2007** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “The possibility for theoretical revolution in international politics”, [http://works.bepress.com/dylankissane/16)//BZ](http://works.bepress.com/dylankissane/16%29//BZ)

The Problem of Interdependence arises from the nature of chaos itself. If, as has been explained above, an individual can have an effect on a region, which in turn has an effect on a state and then an institution and, finally the system as a whole, where does the theorist start their analysis? It is surely impossible to account for the actions of every human on the planet and the implications of all of their actions on the wider system, yet a chaotic system, by definition, is one in which such small permutations at the individual level can effect the entire system and all other actors within it. To employ a simile, a theory that attempts to account for all of the individuals on the planet is much like an atlas that attempts to display every pot hole and white line of a city street to scale: it may be correct but it certainly dos not simplify the system to the point where it would be of any use to someone trying to plan a route through a busy city. Thus, it would seem that the theorist has to make a choice as to which actors or level of interdependence they will restrict their analysis to. For example, and taking inspiration from the theoretical realists, the chaotic theorist might restrict their analysis to states alone. Similarly, and drawing on the work of institutionalists, the theorist might consider states and those large intergovernmental organisations (the UN and the EU, for example) which can be held to be significant actors at the international or system level. But again and by definition, in a chaotic system actors at the sub-state and subinstitution level are important factors in the events that occur within the system. Thus, while it is necessary for the sake of a comprehensible theory that the number and nature of the actors assessed is limited, it is also antithetical to the chaotic approach to exclude actors, which may have a significant effect on events in the system, so arbitrarily. Consider, for example, an analysis of post-September 11th politics without reference to Osama bin Laden or al-Qaeda. While a chaotic explanation for global politics would highlight the role that such "super-empowered individuals”, as Thomas Friedman would label them, have at the international level, a chaotic analysis limited only to states or international institutions would fail to engage with such groups. A less recent example of an individual agent having a significant impact on the international system can be found in Gavrilo Princip and the assassination of Archduke Franz Ferdinand in Sarajevo, an event eventually leading to World War One in Europe (Kissane 2006). If the analysis is restricted to the larger units in the international system, as it would seem necessary to do, then such individual actors and their system-rocking acts will be missed. Thus, in analysing the particular sensitive and complex interdependence of a chaotic system, the theorist constructing a chaotic theory of international politics must find a way to overcome the necessary theoretical limiting of a system that is without limits.

**While nations appear to act in predictable ways, small fluctuations in the system make their actions unpredictable**

**Saperstein 96** [Alvin, professor of physics at Wayne State, “The Prediction of Unpredictability: Applications of the New Paradigm of Chaos in Dynamical Systems to the Old Problem of the Stability of a System of Hostile Nations,” in Chaos Theory in the Social Sciences, supra, at 139, 152. LO]

Turning now to international relations, whose understanding is part of the political and social sciences, the corresponding technology is international policy making, with its subset, international security policies. If we truly understand the international system, we should be able to make successful policy, that is, policy whose desired outcome, given the existing system and starting configurations, actually occurs (see , e .g., Saperstein 1990). In the past, a successful international security policy meant that a nation obtained what it wanted, either without having to resort to war or by winning its wars without unreasonable costs to itself. That is, the international system, of which the nation is a part, either doesn't change to the detriment of the nation or, at the very least, the component of the system encompassing the nation thrives even if the rest of the system is fundamentally changed. In the present nuclear age, a war between major nuclear powers is unlikely to leave either the world system or any of its subcomponents intact. Hence, a major goal of any international policy has to be the avoidance of such a war. Thus, the symbiotic science must be able to predict the outbreak of war. If that science could also predict the outcome of a war, there would be no need for the war. Nations often strive for overwhelming military strength in the hope of ensuring (predicting) their success in. the event of war. They have often been unsuccessful in this prediction because of the large uncertainties in the reactions of their potential opponents. Considering war as a chaotic process (see, e.g., Clausewitz 1982), like a turbulent flow over boulders, it may be possible to predict its outbreak but not its outcome-that is, which side of the boulder gets a given portion of churning water or which side wins the war. A science of international relations that only dealt with probabilities could lead to no policy technology and hence would be useless. Testing of probabilistic arguments requires an ensemble of identical systems, whereas we only have one such system-our real world. Thus, a scientific conclusion that there is a likelihood of nuclear war will be treated as a prediction of certainty; the corresponding policy will almost certainly be avoided. In such a situation, probabilistic predictions such as "likely" or "unlikely" (where is the separation?) will be treated by policymakers as "yes" or "no," which are the results of a definitive or deterministic science. Hence, we seek a science of international security with at least some deterministic aspects. Can we postulate a system of competing, hostile states to be deterministic? Experience indicates that nations respond to one another's actions in reasonably determined ways- at least for major actions and responses. If these patterns of action and response didn 't exist, there would be no political science, and perhaps no history, of international relations-just readings of tea leaves or goat's entrails! But why should we expect deterministic behavior of a collection of nations, given that each one is composed of many, many individuals, each of whom often acts in an unpredictable, chaotic manner? An answer-that deterministic behavior of entities exists precisely because of the random nature of large numbers of their subentities is obtained by analogy to the physicist's description of a gas. Such a gas is a collection of an enormous number of randomly moving molecules whose precise description requires a similarly enormous number of stochastic variables. Yet its overall physical behavior is deterministically described by a few gas variables, such as pressure and temperature, each a complex average over the many molecular variables. On a gross scale of observation these few gas variables usually change smoothly, though on a very fine scale they exhibit random minor fluctuations, mirroring the underlying random molecular variables. So we might expect the behavior of modem nations to be governed by a relatively few deterministic variables, each a complex average over the behaviors of each of its multitudinous population. The usual goal is to find rules governing these variables, admitting that there will be occasional minor fluctuations- a love affair or assassination at the higher levels of government or society- not subject to these rules. My additional goal is to see how a system, evolving according to such rules, responds to such fluctuations.

**Models of international relations are inherently unstable – at best they can be used for slow experimentation**

**Saperstein 96** [Alvin, professor of physics at Wayne State, “The Prediction of Unpredictability: Applications of the New Paradigm of Chaos in Dynamical Systems to the Old Problem of the Stability of a System of Hostile Nations,” in Chaos Theory in the Social Sciences, supra, at 139, 152. LO]

Crisis instability in the international system usually implies a configuration in which small insults can lead to major changes-the loss of a nail leads to the loss of a shoe ...to the loss of a kingdom; an assassination of a minor duke can lead to the deaths of millions and the profound transformation of the world system. Such instability represents the loss of control and the great potential of war. This parallels the definition of chaos (Schuster 1988): small disturbances of a deterministic mathematical system lead to disproportionately large changes in the system and the consequent loss of control. Prediction of unpredictability in a system is a prediction of the onset of chaos-soft or hard. The range between soft and hard chaos among nations is the range between minor and major loss of control in international relations. It is the range between the possibility of loss of an unspecified soldier in a given battle, the winning or losing of that battle, of the war, and of the existent world system. We postulate that the presence of hard chaos, in a theoretical system modeling the international system of competing nations, is a representation of major crisis instability and of the extreme likelihood of the outbreak of major war in the real world being modeled. If the prediction of hard chaos is believable, then the international security policies associated with that part of the model leading to the onset of chaos should be avoided. A useful analogy is to the testing of a new aircraft to determine its behavior under a wide variety of desirable and undesirable circumstances. lf the theoretical model (either purely mathematical or based upon wind tunnel modeling) indicates that certain maneuvers a.re likely to lead to loss of control and possible loss of plane and crew, the pilots will be instructed to avoid those maneuvers-even if they would lead to otherwise desirable results. Even if the model is not sufficiently complete to indicate how the aircraft will behave in the danger zone but is believable in predicting the existence of the loss-of control zone, that would be sufficient to mandate changing policy so as to stay away from that zone. Thus, if the prediction of unpredictability in an international system· is believable, the ability to make such predictions, even if incomplete in details, can be used to answer political science questions as well as to help determine practical national security policy. Thus we must face the question: is the prediction of unpredictability believable in an incomplete model? If the onset of chaos portends the outbreak of war, can we believe a model's prediction of war even though the extent and outcome of the war are not predicted and may not even be describable by the model? Is the prediction of instability (or stability) of a model itself stable in the face of expansions of the model to include more relevant aspects of the system? Will a model's prediction of chaos be softened or disappear as more variables and/or more complicated interactions are added to the model? . A formal answer to the above question requires a working knowledge of the complete model, knowledge that doesn't exist. If it did, the question would be irrelevant!) In its place, we must rely on analogy with other systems-usually from mathematics or physics- where complete models, and their incomplete component models, exist and are used. Mathematical experience with dynamical systems indicates that "chaos first appears in the neighborhood of non-linear resonances" (Reichl 1992, 14), where new variables first make their impact upon the system. There is no experience of such chaotic regions disappearing as new variables arc introduced. Empirical experience with fluids indicates that chaos (turbulence) appears earlier and stronger when new variables, such as temperature differences and heat flows, become important in the system. Theoretical experience with specific mathematical models of real phenomena (the Navier-Stokes equation for fluid flows; the recursive equations' modeling of the evolution of tripolar systems from bipolar ones [Saperstein 1991], developed later in this chapter) suggests that the regions of stability (areas of absence of chaos) decrease in extent when additional variables come into play. We thus presume that qualitative (gross) predictions of the loss of model stability arc much more believable (more stable) than are the quantitative (detailed) predictions from the same model. Hence, the prediction of hard chaos in a model reasonably representing the international system of competing nations is a fair warning to policymakers: embarkation upon the modeled course of action is to be done with extreme dread and care. However, a contrary prediction of model stability is not an absolute assurance of system stability; complacent acceptance of the corresponding policy is not warranted since a more faithful, more complete model of the system in which the policy is being applied may very well allow chaotic breakdown. Similarly, when exploring theoretical questions about the international system, the appearance of chaos in an appropriate model portends the breakdown of stability in the system; however, stability of the model does not necessarily imply a corresponding stability in the system.

### Military Core

**Complexity theory is key to military readiness – making cognizant predictions is necessary for the military.**

**Saperstein, 97** – professor of physics at Wayne State (Alvin, “Complexity, Chaos, and National Security Policy: Metaphors or Tools?, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch05.html>) //BZ

One of the prime reasons for our failure to successfully deal with Iraq—a "sovereign" element in the Newtonian system—is that we fear to deal with its possible break-up. Similarly, there were important confusions in our society in anticipating and dealing with the break-up of the Soviet Union. Our policies towards China have also suffered from these confusions. In the Newtonian scheme-of-things, nations are sovereign states and deal only with each others’ sovereigns. "Infringing upon sovereignty" is severely frowned upon. It is clear that we still speak to such a world, though we no longer live it. It is not evident to me that a single metaphor/tool—like chaos—is available or useful to us in dealing with a world system characterized by "complexity." Instead of specific new tools, these metaphors can contribute to the development of the new attitudes required for the more complex modern world. They can help sharpen minds dulled by a Newtonian world view so as to be alert to all new possibilities. (It should be obvious that such alertness and openness was always present in some outstanding historic leaders whose minds were, perhaps, not so overburdened with Newtonian simplicities.) Above all, we have to be alert to (and be able to respond to) the possibility of bifurcation21 (Fig.6a) of the existing system into very different possible worlds, containing new and different elements interacting in novel ways. Such bifurcations may occur at national levels—where nations rise and fall, where they are of interest to the strategist, and at local levels—of tactical interest, where military, governmental, or corporate units are created or destroyed. Though these bifurcations are contingent, the probabilities of their occurrence, and their outcomes, are not structureless; familiarity and insight into the fundamental aspects of the system can lead to clues as to when the probabilities of such change are large, and when they are small. Thus we shall need very flexible diplomats and soldiers at all levels.22 (The metaphors of complexity may be helpful in recruiting as well as in educating them.) They will have to be very knowledgeable about past behavior of the system and its elements—as determining the chances for radical transformation of the system. They will have to be open and adaptable to the new and novel which may confront them - with or without rational anticipation.23 Clearly, the new policy makers will have to be thoroughly cognizant of the relevant elements of anthropology, sociology, and psychology, as well as history. Knowledge of the functioning of existing governments, their departments or military units, will not be sufficient, as these elements may be bubbling-up or dissolving into the inchoate foam of people and groups below. Not only are flexibility and imagination required for attaining one’s ends in a complex system. The ends themselves will often be shifting and/or unclear. In some cases it may be desirable to fragment competing parties ("divide and conquer"—e.g., the British role in India); in other cases to consolidate them (create alliances or nations—e.g., the creation of Yugoslavia24). Of utmost importance is the recognition that the policymaker can help direct these shifts, by influencing the elements at a lower level than those of the system of interest; e.g., in a system of nations, it may be advisable to attempt to influence their individual citizens.25 So much for the sanctity of national sovereignty!

**Complexity in warfare is necessary for preponderance – increases success of military**

**Schmitt, 1998** – Major in the US Marine Corps Reserve, Lecturer at the National Defense University and the Marine Corps School in Quantico (John, “Command and (Out of) Control: The Military Implications of Complexity Theory”, [http://www.dodccrp.org/html4/bibliography/comch09.html)//BZ](http://www.dodccrp.org/html4/bibliography/comch09.html%29//BZ)

According to practically any definition of the term "complexity," war qualifies as a complex phenomenon. In what could qualify as an excellent description of complexity theory, Clausewitz wrote: The military machine—the army and everything related to it—is basically very simple and therefore seems easy to manage. But we should bear in mind that none of its components is of one piece: each piece is composed of individuals, every one of whom retains his potential of friction...A battalion is made up of individuals, the least important of whom may chance to delay things or somehow make them go wrong. Complexity theory deals with the study of systems which exhibit complex, self-organizing behavior. A complex system is any system composed of numerous parts, or agents, each of which must act individually according to its own circumstances and requirements, but which by so acting has global effects which simultaneously change the circumstances and requirements affecting all the other agents. Complex systems are based on the individual "decisions" of their numerous agents. It is not simply the number of parts that makes a system complex (although more parts can certainly contribute to complexity): it is the way those parts interact. A machine can be complicated and consist of numerous parts, but the parts generally interact only in a designed way. This would be structural complexity. Instead, the type of complexity which most interests us is interactive complexity, by which the parts of a system interact freely in interconnected and unanticipated ways. Each agent within a complex system may itself be a complex system—as in the military, in which a company consists of several platoons and a platoon comprises several squads—creating multiple levels of complexity. But even if this is not so, even if each of the agents is fairly simple in itself, the interaction among the agents creates complexity. This is a significant contradiction of the Newtonian paradigm: simple causes can lead to complicated, disorderly behavior. ("Everything in war is simple," Clausewitz wrote, "but the simplest thing is difficult.") The result is a system which behaves in nonlinear, complicated, unpredictable and even uncontrollable ways. Each agent often affects other agents in ways that simply cannot be anticipated. With a complex system it is usually extremely difficult, if not impossible, to isolate individual causes and their effects, since the parts are all connected in a complex web. The element of chance, interacting randomly with the various agents, introduces even more complexity and disorder. One of the defining features of complex systems is a property known as emergence in which the global behavior of the system is qualitatively different from the behavior of the parts. No amount of knowledge of the behavior of the parts would allow one to predict the behavior of the whole. Emergence can be thought of as a form of control: it allows distributed agents to group together into a meaningful higher-order system. In complex systems, structure and control thus "grow" up from the bottom; they are not imposed from the top. Reductionism simply will not work with complex systems: the very act of decomposing the system—of isolating even one component—changes the dynamics of the system. It is no longer the same system. War is clearly a hierarchy of complex systems nested one inside another. From the largest military formation down to the individual rifleman, war consists of agents adapting to their environments—which include enemy agents—and in the process changing the environments of all the other agents. Some of the processes in war may be deterministically predictable, some are deterministically chaotic, and some are probably purely stochastic. There are probably universals—variables or constants which show up in every mix—but no two battles, campaigns, or wars ever exhibit the same mix or system dynamic. Even the same system may behave differently under different regimes or conditions. Under certain parameters—near equilibrium, before bifurcation—the system may actually behave in a fairly Newtonian way. Witness the Gulf War, for example, which I suggest was an unusually linear manifestation of war, in part because of low levels of interaction between the opposing sides. Under other parameters—when the system is forced farther from equilibrium—the same conflict may become very complex or even "go chaotic." The result is an infinitely complicated and continuously changing problem set that qualifies as mathematically unsolvable.

**Complexity theory solves great power wars – viewing war as complex is net beneficial**

**Schmitt, 1998** – Major in the US Marine Corps Reserve, Lecturer at the National Defense University and the Marine Corps School in Quantico (John, “Command and (Out of) Control: The Military Implications of Complexity Theory”, [http://www.dodccrp.org/html4/bibliography/comch09.html)//BZ](http://www.dodccrp.org/html4/bibliography/comch09.html%29//BZ)

The Newtonian paradigm offers a neat, clean and intellectually satisfying description of the world—and of war. There is only one problem: it does not match most of reality. When distilled to this level, the Newtonian model of war is manifestly ridiculous. When we reduce it to these terms, I think few people would argue that war is actually this way. And yet, much of the current American approach to command and control is based precisely on the unquestioned assumption of this model. Futurist Alvin Toffler states that while some parts of the universe may operate like machines, these are closed systems, and closed systems, at best, form only a small part of the physical universe. Most phenomena of interest to us are, in fact, open systems, exchanging energy or matter (and, one might add, information) with their environment. Surely biological and social systems [of which war is one] are open, which means that the attempt to understand them in mechanistic terms is doomed to failure. This suggests, moreover, that most of reality, instead of being orderly, stable, and equilibrial, is seething and bubbling with change, disorder, and process. The Newtonian paradigm was so compelling, so neat, so logical—in short, so "right"—that it saw and imposed regularities where none existed. For the sake of finding solvable problems, science simplified reality by assuming an idealized world. It connected the discontinuities and linearized the nonlinearities—in short, it simply ignored all the countless inconsistencies and surprises that make the world—and war—such a complex and interesting problem. The evidence is unmistakable: the Newtonian paradigm no longer satisfactorily describes most of our world (if it ever did). Science is slowly coming to recognize that the world is not remotely an orderly, linear place after all. We need a new paradigm, and once again science may provide the catalyst. It is not after all a Newtonian battlefield: it is a nonlinear dynamical battlefield.

**Complexity theory in warfare solves the military – more effective missions and strategies**

**Schmitt, 1998** – Major in the US Marine Corps Reserve, Lecturer at the National Defense University and the Marine Corps School in Quantico (John, “Command and (Out of) Control: The Military Implications of Complexity Theory”, [http://www.dodccrp.org/html4/bibliography/comch09.html)//BZ](http://www.dodccrp.org/html4/bibliography/comch09.html%29//BZ)

Rather than thinking of a military action as an "operation," a predetermined plan unfolding with machinelike order and procedural precision, we should think of the action as an "evolution," a system adapting over time in response to its environment. Better yet, we should think of military action as a form of coevolution, our system evolving in response to what the enemy does and the enemy system evolving at the same time in response to us. Complexity suggests that, just as evolution does not have a predetermined destination, military plans should not prescribe detailed end-state conditions which are instead always changing in response to developments. We should not think of a plan as a closed-form solution to a problem but as an open architecture which maximizes evolutionary opportunities. A good plan becomes the basis for adaptation through evolution. Planning is "solution by evolution" rather than "solution by engineering." Synchronization Out Of Sync One military command and control concept that does not mesh well with complexity theory is synchronization. Synchronization and other Newtonian models are invalidated as general operating systems. They may work moderately well within those narrow parameters under which the system behaves relatively tamely. Synchronization falls flat when faced with a complex system which does not exhibit mechanistic dynamics. In fact, healthy complex adaptive systems tend to behave asynchronously—multiple agents acting independently of one another in response to local conditions. Complexity suggests the superiority of loosely coupled, modular plans which do not rely on synchronized control for their unity of effort. Such plans allow greater latitude in execution and, importantly, are more easily modified and repaired than synchronized ones. Where synchronization occurs, it should be the result of local cooperation between agents rather than of centralized direction. Satisfice, Don’t Optimize Complexity suggests it is rarely worth the effort trying to find the perfect plan or reach the perfect decision. It simply will not happen: there are too many interconnected variables. As geneticist John Holland has said, in a complex system "there’s no point in imagining that the agents in the system can ever ‘optimize’ their fitness ... The most they can ever do is to change and improve themselves relative to what the other agents are doing." Instead, we should try to satisfice—find a solution that works locally and exploit the results. Excellence Can Only Start At The Bottom Evolution moves from the simple to the complex. Healthy complex systems evolve by chunking together healthy simpler systems. Attempts to design large, highly complex organizations from the top down rarely work, if ever. This merely confirms what successful military organizations have long recognized: success starts at the small-unit level. Build strong, adaptable squads and sections first. Train and equip them well—which includes giving them ample time to train themselves (i.e., to evolve). Give them the very best leaders. Give those leaders the freedom and responsibility to lead (i.e., let them act as independent agents). Then chunk the teams and squads together into increasingly larger units. In Closing: Continuous Adaptation The physical sciences have dominated our world since the days of Newton. Moreover, the physical sciences have provided the mechanistic paradigm that frames our view of the nature of war. While some systems do behave mechanistically, the latest scientific discoveries tell us that most things in our world do not function this way at all. The mechanistic paradigm no longer adequately describes our world—or our wars. Complex systems—including military organizations, military evolutions, and war—most definitely do not behave mechanistically. Enter complexity. Complexity encourages us to consider war in different terms which in turn point to a different approach to the command and control of military action. It will be an approach that does not expect or pursue certainty or precise control but is able to function despite uncertainty and disorder. If there is a single unifying thread to this discussion, it is the importance of adaptation, both for success on the battlefield and for institutional survival. In any environment characterized by unpredictability, uncertainty, fluid dynamics, and rapid change, the system that can adapt best and most quickly will be the system that prevails. Complexity suggests that the single most important quality of effective command and control for the coming uncertain future will be adaptability.

## \*\*IMPACTS\*\*

### Policy Failure

**Their linear model makes decisionmaking inefficient and un-adaptive – only the alt leads to better policies**

**Maxfield, 97** – Alan D., consulting professor at Stanford University, vicechairman of the board of trustees of the Santa Fe Institute, a governor of Rice University (“Chapter 8: Complexity and Organization Management,” Complexity, Global Politics, and National Security, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, [http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK](http://www.dodccrp.org/files/Alberts_Complexity_Global.pdf%29RK)

Although humans are the adaptive element in every organization, it does not follow that any organization will be adaptive. In fact, there is a deeply embedded metaphor in our society that works strongly against adaptable organizations—the metaphor of the organization as a machine. The metaphor grew naturally out of the last great social paradigm shift, the Industrial Revolution, in which science based on Newtonian physics led to the development of machines that replaced humans and animals as sources of energy for creating and transforming artifacts. A machine is a system of carefully designed parts interconnected in a precise way to accomplish a function repeatedly and reliably. The key to a machine is that each part has a known, predictable behavior in the system, and that the interconnection of the parts results in the result for which the system is designed. If one makes an analogy to human organizations, in which human beings are the component parts, there is the immediate problem that human behavior can be **quite unpredictable.** The answer to this, inspired by the work of Frederick Taylor [4] early this century, is to analytically determine the one best way to do each task, then train people to do it this way, and insist on reliable conformity—standard operating procedures. In a similar fashion, the interaction of the human components of the organization is carefully defined—who communicates with whom about what, who has responsibility for what. Since variability in results is to be avoided, authority to permit deviations from standard procedures is invested in only a few key individuals. We are all familiar with the end result of applying the machine metaphor—organizations that have precisely defined organization charts with many hierarchical levels, volumes of procedures defining most activities of the organization, and most major decision-making vested in a few central individuals at the end of long chains of authority. Staff organizations, mostly isolated from direct contact with the external environment, spend endless hours (aided by the writings of business school organization theorists) worrying about the "best" way to organize people into functional blocks, how these blocks should relate and communicate, designing "optimal" work flows and methodologies (aided by systems and operations research theorists). By their **very design**, such organizations do not allow for **rapid adaptivity and innovation** in response to external change. What capabilities they do have for change are vested in a very few people, rather than harnessing the cognitive capabilities of every member of the organization. Suppose that, rather than using the machine analogy, we use instead the complex adaptive systems metaphor in thinking about organization structure and design, and view our organization as one CAS made up of many other CASs, namely the human members, and attempting to survive in an environment of many other CASs, with whom we must both cooperate and compete. Then, by the properties of such systems, we know there will be an inherent tendency for self-organization among employees, that continual evolution (read change) will be required in all aspects of our activities, that our external environment is not static but co-evolving with us, and that we can expect periods of very rapid change interspersed with periods of slower change. How then should we design our organization? Pretty clearly, it should be the antithesis of the machine-derived model. It should feature few rigid operating procedures, it should have great flexibility in organization structure, it should have widely delegated decision authority with short authority chains, and it should be very sensitive to changes in its external environment. These are indeed the features of successful high-tech organizations; in fact, I submit that these features now characterize almost all high-tech organizations as a result of Darwinian selection over many generations of evolution.

**Prediction is impossible – linear analysis causes policy failure**

**Sa, 04** – Deug Whan, Dong-U College, South Korea, (“CHAOS, UNCERTA I N T Y, AND POLICY CHOICE: UTILIZING THE ADAPTIVE MODEL,” International Review of Public Administration, vol. 8, no. 2, 2004, scholar)RK

In many cases, a small choice might lead to overwhelming results that generate either a virtuous cycle or a vicious cycle. If future results can be clearly predicted by stability and linearity, this will eliminate difficulties in making choice. Policy choice has been an embarrassment in uncertain or chaotic situations that do not meet desirable conditions. As a result, most major policies **revert back to** the uncertainty and **chaos.** Though the presence of uncertainty in policy procedures is widely known, it has not been determined what influence it wields on policy choice (Morgan and Henruion 1990: Lein 1997: 20). Generally, uncertainty refers to ‘difficulties in predicting the future.’ Naturally, the uncertainty here includes not simply difficulties in predicting the results of various factors and interactions, but also difficulties in predicting different configurations of interactions caused by the effect of such interactions (Saperstein 1997: 103-107). Uncertainty is classified into 3 categories according to source and phase of policy procedures; i) uncertainty from contingency, ii) uncertainty from inter-dependency of constituents, and iii) general uncertainty (Tompson 1967). The uncertainty from contingency arises when it is impossible to predict how the policy environment will change. What results is uncertainty from the interdependency of constituents makes it impossible to predict changes in the relationship between policy matters and constituents. Finally, general uncertainty comes from lack of knowledge about the cause and effect relationship in policy making. The Emergence of Chaos Theory and Characteristics Chaos theory offers theoretical explanations about the world of uncertainty. Chaos theory refers to the study of complex and dynamic systems with orders and patterns emerging from externally chaotic forms (Prigogine and Strengers 1984). The reason chaos theory draws a lot of interest is the highlight of; disorder, instability, diversity, flexibility and disequilibrium. This explains characteristics of rapid social changes in modern times referred to as the age of uncertainty. The focus of the chaos theory as a study is on complex, indeterminate, non-linear and dynamic systems. The main study object chaotic systems are chaotic which are complicated and dynamic. The characteristics of the chaos theory are as follows: The first is its self-organization principle. Selforganization means that the organization is determined by internal factors without any outer interference. That is to say, self-organization is a network of production processes of constituents interrelated with each other, and a system that produces the same network (Varela Maturana and Urife 1974; Jantsch 1980). The chaos theory assumes that order and organization can make an autogenesis out of disorder and chaos through the process of ‘self-organization.’ This also means that setting up conditions for self-organization to naturally take place can result in a reduction of policy failures. The second characteristic is co-evolution, referring to a process in which individual entities constituting a system continually adapt to each other and change. The essential concept of co-evolution, is ‘mutual causality,’ which puts emphasis on mutual evolution where an individual entity evolves entire group and vice versa, not the evolution of the survival of the fittest. It means interdependent species in continual inter-relationships evolve together. For example, if a mutant frog appears with a longer tongue or a frog whose hunting speed is twice as fast, it will have a competitive advantage to the environment and subsequent off-spring will flourish with the superior gene. On the other hand, flies will decrease in number, until a mutant fly appears that has any combination of advantages such as; faster, bad smells frogs avoid, or becomes poisonous, subsequent off-spring will survive and flourish. This is the way frogs and flies coevolve with each other. Therefore, chaos theory regards a variety of paradoxes as an important principle instead of ignoring it or taking it as an exception. Third, the characteristic is the existing Newtonian determinism theory which presumes linear relations where things proceed from the starting point toward the future on the thread of a single orbit. Thus, it also assumes that predictions of the future are on the extended line of present knowledge and future knowledge is not as unclear as the present one (Saperstein 1997: 103107), and that as similar inputs generate similar outcomes, there will be no big differences despite small changes in initial conditions. However, chaos theory assumes that the outcome is larger than the input and that **prediction of the future is fundamentally impossible.**3 Hence, due to extreme sensitivity to initial fluctuations and non-linear feedback loops, small differences in initial conditions are subject to amplifications and eventual different outcomes, known as ‘chaos.’4 Chaos is sometimes divided into strong chaos and weak chaos (Eve, Horsfall and Lee 1997: 106); and goes through a series of orbit processes of close intersections and divisions. In particular, weak chaos is found in the limits that account for the small proportion inside a system, while strong chaos features divisions at some points inside a system, which lead to occupation of the entire system in little time. CHAOS, UNCERTAINTY AND POLICY CHOICE 1. Review of Existing Policy Models Social scientists have tried to explain and predict policy matters, but never have generated satisfactory outcomes in terms of accuracy of predictions. There could be a variety of reasons for this inaccuracy in prediction, but one certain reason is that policies themselves are intrinsically governed by uncertainty, complexity and chaos in policies that produce many different outcomes though they are faced with the same initial internal states, the same environments, and governed by the same causal relationships.

**Reductionist understandings of political science lead to policy failure – empirically proven by the wars in Iraq and Afghanistan**

**Srnicek ’10** [Nick, PhD Student at London School of Economics and Political Science “Conflict Networks: Collapsing the Global into the Local” Journal of Critical Globalisation Studies, Issue 2 (2010) <http://lse.academia.edu/NickSrnicek/Papers> LO]

This leads us to the issue of interactions between actors. The standard natural science perspective is to see a closed realm of causal interactions between physical entities, yet this viewpoint presumes the rigid and absolute Nature/Culture divide that was rejected earlier. On the other hand, the standard social science perspective is to reduce as many effects as possible to as few causes as possible (the explanatory parsimony principle). While this principle may produce elegant theoretical systems, as an ontological theory it fails, and as a pragmatic theory for producing effects, it also underestimates the complexity involved in any given phenomenon. This is a crucial flaw in attempts to make social science relevant for policy initiatives or activist movements, i.e. those forced to face up to the complexity of the world. Parsimony may be graceful for the theorist, and simplifying for a decision-maker, but if the Iraq and Afghanistan fiascoes have reminded us of anything, it is that simple theories are useless (or worse, harmful) in the real world. Moreover, the drive to parsimony and simplicity reduces knowledge to a series of abstractions that exist nowhere and that are in need of explanation themselves. As Jane Bennett (2005, p. 455) argues: The active power of assemblages [i.e. actor-networks] is concealed under the rubric of (social) structures, (cultural) contexts, (religious) settings, (economic) climates, or (environmental) conditions – terms which denote passive backgrounds or, at most, states of affairs whose sole power is the negative one of constraint or resistance. Structures, surroundings, contexts, and environments name background settings rather than spirited actants. To remedy this reduction of the active power of an actor-network, we raise Bruno Latour’s distinction between ‘intermediaries’ and ‘mediators’. Whereas the former refers to actors who cleanly propagate the causes that instigate them (e.g. explanations in the form of “an individual is a mere puppet of social forces”, or “the individual is playing a functional, structural role”), the latter refers to actors who transform the forces that pass through them. Rather than a social force acting smoothly on an individual (regardless of how many actors it must pass through), the notion of mediators highlights the role that each actor plays in contributing to the propagation of any action. This entails a number of significant consequences. First, the entire chain of a network becomes potentially significant to understanding the effects. In actornetwork theory’s terms, we must ‘trace’ the connections – a necessarily empirical and patient project. Second, ontologically speaking, reduction becomes not an a priori assumption (e.g. “the phenomenon is clearly caused by power relations, or by knowledge epistemes, or by balances of power, etc.”), but rather something which must itself be slowly and painstakingly constructed. The work of reduction in science is something that takes numerous scientists, and numerous experiments, to produce. Third, the division between the global and the local – the mystery that we started this paper with, becomes resolvable. The gap between the two becomes reconfigured in terms of a chain of mediators; the way in which they affect each other is through this network of actors which links them in a highly specific configuration. ANT’s renewed definition thus gives scientific meaning to the emergence of such distinctions, and provides concrete answers as to how the global interacts with the local

**Policy analysis fails without complexity – only the alt prevents wrong predictions and self-fulfilling prophecies**

**Schuster, 08** – Peter, Editor in Chief of Complexity (“Are There Recipes for How to Handle Complexity?” Complexity, Vol. 14, is. 1, 7/31/08, Wiley)RK

Complexity reaches a new and more involved dimension in situations where predictions influence the outcome of processes. Two well-studied examples from different disciplines are predictions of the stock market in economics and the placebo effect in medical therapy. If a reliable analyst makes the prediction that the stocks of a company will lose because of the expectation of an unsuccessful year, people will start to sell and the stocks will indeed fall no matter whether the assumption for the prediction was right or wrong. We are dealing with **a case of self-fulfilling prophecy.** I find the second example even more remarkable. Large-scale investigations provided strong evidence for the placebo effect, [14] in particular, with pain release and antidepression drugs. Instead of the usual medication, a harmless and ineffective compound is given to the patient, and the feelings of the candidate are recorded. A recent study reported that more than 70% of the placebo group felt the expected result of the effective drug. Even more impressive is the so-called nocebo effect: The candidates are informed about side effects of the drug that is not applied to them, but they nevertheless develop the negative symptoms. Complexity research in this area is a great challenge because it has to combine all our present knowledge from science, medicine, and psychology. Decisions of individuals in extremely complex situations are often facilitated by simple empirical strategies [15, 16]. These intuitive strategies— often called fast and frugal decisionmaking—seem to be innate to human brains. The basic concept is to apply simple and inexpensive heuristics rather than sophisticated considerations, to decide fast but to be prepared to revise a decision if necessary. Such fast and frugal heuristics use simple rules for (i) guiding search for information, (ii) stopping search, and (iii) decision making. I illustrate by two examples. In case one does not know the answer to multiple-choice questions, it is the best strategy to take the most familiar alternative. The largest city should be chosen out of a collection: Choose one that you know and that you assume to be large. The other heuristic is important for sailors and pilots: if an object approaching you stays for some time in the center of your visual field, change direction as fast as possible and at an angle as large as possible in order to avoid collision. Interestingly, most of the recently developed guidelines for decisionmaking in emergency situations follow essentially unconscious intuitions. However, there are also cases where so-called gut feelings are **entirely wrong**, because we got no phylogenetic preparation. This is unfortunately true for many challenges of our modern, man-made world. Probability estimates are one example. Otherwise people would stay away from gambling. Complexity research is one of the most important fields for the future, because it is essential for our societies and their decision makers to know, for example, what can be predicted and where begins the realm of the unpredictable. ‘‘Fast and frugal’’ strategies can represent an optimal tool for an individual, but they are **doomed to fail** when they are applied on a national or international level for two reasons: (i) the consequences of a wrong decision may be too large, and (ii) revisions after enormous investments may become impossible. Therefore, complexity research based on scientific and mathematical analysis of problems and model studies by computer simulation—becoming more and more reliable the more empirical data we have at hand—**are indispensable** and will—hopefully—be integrated as one source of information into political decisions.

**Even if they win solvency, linear planning makes their impacts inevitable**

**James, 96** – Glenn E., Major in the USAF (“IV How Can We Use the Results? Exploiting Chaos Theory,” *Chaos Theory,* Naval War College, Newport Paper Number Ten, October 1996, http://www.au.af.mil/au/awc/awcgate/navy/np10.pdf)RK

At this point the reader should have some intuition for the common features of Chaos. An enormous number of systems exhibit chaotic dynamics; many of these systems are relevant to military decision making. But how can we use Chaos to make better decisions or design new strategies? Even if we accept the idea that Chaos can be applied to strategic thinking, shouldn’t we leave this high-tech brainstorming to the analysts? Absolutely not! As Gottfried Mayer-Kress points out, if we fail to learn the basic applications of Chaos theory, our naiveté could lead to unfortunate consequences. We may, for example, fall into the trap of thinking that successful short-term management allows total control of a system; we may have unnecessary difficulty in making a diagnosis from available short-term data; or we may apply inappropriate control mechanisms that can produce the **opposite of the desired effect.**45

**Complexity theory turns solvency – causal chains are impossible to dictate and disastrous policy effects are inevitable**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

In a system, the chains of consequences extend over time and many areas: the effects of action are always multiple. Doctors call the undesired impact of medications "side effects." Although the language is misleading—there is no criteria other than our desires that determines which effects are "main" and which are "side"—the point reminds us that disturbing a system will produce several changes. Garrett Hardin gets to the heart of the matter in pointing out that, contrary to many hopes and expectations, we cannot develop or find "a highly specific agent which will do only one thing.... We can never do merely one thing. Wishing to kill insects, we may put an end to the singing of birds. Wishing to ‘get there’ faster we insult our lungs with smog."5 Seeking to protect the environment by developing non-polluting sources of electric power, we build windmills that kill hawks and eagles that fly into the blades; cleaning the water in our harbors allows the growth of mollusks and crustaceans that destroy wooden piers and bulkheads; adding redundant safety equipment makes some accidents less likely, but increases the chances of others due to the operators’ greater confidence and the interaction effects among the devices; placing a spy in the adversary’s camp not only gains valuable information, but leaves the actor vulnerable to deception if the spy is discovered; eliminating rinderpest in East Africa paved the way for canine distemper in lions because it permitted the accumulation of cattle, which required dogs to herd them, dogs which provided a steady source for the virus that could spread to lions; releasing fewer fine particles and chemicals into the atmosphere decreases pollution but also is likely to accelerate global warming; pesticides often destroy the crops that they are designed to save by killing the pests’ predators; removing older and dead trees from forests leads to insect epidemics and an altered pattern of regrowth; allowing the sale of an anti-baldness medicine without a prescription may be dangerous because people no longer have to see a doctor, who in some cases would have determined that the loss of hair was a symptom of a more serious problem; flying small formations of planes over Hiroshima to practice dropping the atomic bomb accustomed the population to air raid warnings that turned out to be false alarms, thereby reducing the number of people who took cover on August 6.6 In politics, connections are often more idiosyncratic, but their existence guarantees that here too most actions, no matter how well targeted, will have multiple effects. For example, William Bundy was correct to worry that putting troops into Vietnam might not make that country more secure because deployment could not only lead the North to escalate, but also might "(1) cause the Vietnamese government and especially the army to let up [and] (2) create adverse public reactions to our whole presence on ‘white men’ and ‘like the French’ grounds."7 It seems that the American development of nuclear weapons simultaneously restrained Stalin by increasing his fear of war and made him "less cooperative and less willing to compromise, for fear of seeming weak."8 Indeed, it is now widely accepted that mutual second strike capability not only decreased the chance of nuclear war but also made it safer for either side to engage in provocations at lower levels of violence.9 (Similarly, providing security guarantees to the countries of East Europe might lead them to take harsher stances toward minority ethnic groups and make fewer efforts to maintain good relations with their neighbors.) To mention three more surprising cases, in the fall of 1948 General Clay warned that American budget deficits would be seen in Europe as a forerunner of inflation and so would undermine morale in West Berlin; the American pressure on the Europeans to rearm more rapidly in response to the North Korean attack on the South produced squabbles that encouraged the USSR "to believe that contradictions in the enemy camp ultimately would tear apart the enemy coalition....[and so] undermined U.S. bargaining power"; in 1994 the dollar strengthened after President Clinton hired a powerful lawyer to defend him against charges of sexual harassment: as one currency trader put it, "we were starting to lose faith in him and that helped turn things."10 Interactions, Not Additivity Because of the prevalence of inter-connections, we cannot understand systems by summing the characteristics of the parts or the bilateral relations between pairs of them.11 This is not to say that such operations are never legitimate, but only that when they are we are not dealing with a system. More precisely, actions often interact to produce results that cannot be comprehended by linear models.

**Determinism fails for predictions, causes serial policy failure – world is too chaotic for linearization**

**Saperstein, 97** – professor of physics at Wayne State (Alvin, “Complexity, Chaos, and National Security Policy: Metaphors or Tools?, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch05.html>) //BZ

It is important to stress that determinism does not imply predictability. Prediction implies connections of necessity (not of probability!) between non-perfectly well-defined states of the system separated by finite time intervals. In order to rationally predict future behaviors of a system, we must know its present state. If the future knowledge so obtained is roughly comparable in quality to the present knowledge, the prediction is successful. But present knowledge is never perfect. There are always measurement errors in any determination of the present state. The resultant non-perfectly well-defined present state encompasses a number of possible starting states. The rules determining future states must be applied to each of these starting states. Thus, given any deterministic model, implicit or explicit, upon which predictions are to be based, a range of "paths into the future" are possible (see Fig. 1b,1c). Furthermore, any such model depends upon parameters obtained from necessarily imperfect observations. Hence even a perfectly determined initial state of the system allows a range of future outcomes in any reasonable predictive modeling. The result of these two imperfections of observation is that any set of rationally ascertained system rules, which transfer realistically obtained present knowledge of the system into the future, will result in a range of possible outcomes—a range of uncertainty. If this future range of uncertainty is large compared to the range of present knowledge, the quality of prediction is impaired. If this future range covers all possible outcomes of the system (Fig. 1c), no knowledge of the future is possible—prediction (and hence rational policy making) is impossible. If the rules governing the system are "linear,"12 the range of future outcomes is always comparable to the range of input uncertainties (Fig. 1b): prediction is possible, and therefore useful to the policy maker. If the system rules are non-linear13 (as are most systems involving competing human beings, wherein the policy of one party must not only include the desired goals of each party but also the response of the other parties’ progress toward those goals14), the system may display extreme sensitivity to small changes in input or system parameters (Fig. 1c). This behavior, called "chaos," (see, e.g., Schuster 1988) makes prediction—and hence control of future behavior of the system—difficult or impossible. However, it may be possible to predict whether or not a system will display chaotic behavior. This possibility, as shown in the following section, allows the policy maker to avoid dangerous behavior. Hence the ability to predict unpredictability is a very useful tool in policy making (Saperstein 1986).

**Acting on linear predictions creates more disasters, turns the case.**

**Taleb and Blyth, 2011** – Taleb is a Distinguished Professor of Risk Engineering at NYU Polytechnic while Blyth is a Professor of International Political Economy at Brown (Nassim and Mark, “The Black Swan of Cairo” [http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf)//BZ](http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf%29//BZ)

Both the recent financial crisis and the current political crisis in the Middle East are grounded in the rise of complexity, interdependence, and unpredictability. Policymakers in the United Kingdom and the United States have long promoted policies aimed at eliminating fluctuation— no more booms and busts in the economy, no more “Iranian surprises” in foreign policy. These policies have almost always produced undesirable outcomes. For example, the U.S. banking system became very fragile following a succession of pro-gressively larger bailouts and government interventions, particularly after the 1983 rescue of major banks (ironically, by the same Reagan administration that trum-peted free markets). In the United States, promoting these bad policies has been a bipartisan effort throughout. Republicans have been good at fragilizing large corpora-tions through bailouts, and Democrats have been good at fragilizing the government. At the same time, the financial system as a whole exhibited little volatility; it kept get-ting weaker while providing policymakers with the illusion of stability, illustrated most notably when Ben Bernanke, who was then a member of the Board of Governors of the U.S. Federal Reserve, declared the era of “the great moderation” in 2004. Putatively independent central bankers fell into the same trap. During the 1990s, U.S. Federal Reserve Chair Alan Greenspan wanted to iron out the economic cycle’s booms and busts, and he sought to control economic swings with interest-rate reductions at the slightest sign of a downward tick in the economic data. Furthermore, he adapted his economic policy to guarantee bank rescues, with implicit promises of a backstop—the now infamous “Greenspan put.” These policies proved to have grave delayed side effects. Washington stabilized the market with bailouts and by allowing certain companies to grow “too big to fail.” Because policymakers believed it was better to do something than to do nothing, they felt obligated to heal the economy rather than wait and see if it healed on its own. The foreign policy equivalent is to support the incumbent no matter what. And just as banks took wild risks thanks to Greenspan’s implicit insurance policy, client governments such as Hosni Mubarak’s in Egypt for years engaged in overt plunder thanks to similarly reliable U.S. support. Those who seek to prevent volatility on the grounds that any and all bumps in the road must be avoided paradoxically increase the probability that a tail risk will cause a major explosion. Consider as a thought experiment a man placed in an artificially sterilized environment for a decade and then invited to take a ride on a crowded subway; he would be expected to die quickly. Likewise, preventing small forest fires can cause larger forest fires to become devastating. This property is shared by all complex systems. In the realm of economics, price controls are designed to constrain volatility on the grounds that stable prices are a good thing. But although these controls might work in some rare situations, the long-term effect of any such system is an eventual and extremely costly blowup whose cleanup costs can far exceed the benefits accrued. The risks of a dictatorship, no matter how seemingly stable, are no different, in the long run, from those of an artificially controlled price. Such attempts to institutionally engineer the world come in two types: those that conform to the world as it is and those that attempt to reform the world. The nature of humans, quite reasonably, is to in-tervene in an effort to alter their world and the outcomes it produces. But government interventions are laden with unintended— and unforeseen—consequences, particularly in complex systems, so humans must work with nature by tolerating systems that absorb human imperfections rather than seek to change them.

**Controlling variables based on linear predictions exaggerates the disaster, replicating the economic collapse of 2008.**

**Taleb and Blyth, 2011** – Taleb is a Distinguished Professor of Risk Engineering at NYU Polytechnic while Blyth is a Professor of International Political Economy at Brown (Nassim and Mark, “The Black Swan of Cairo” [http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf)//BZ](http://jamesshinn.net/wp-content/uploads/2011/04/The-Black-Swan-of-Cairo.pdf%29//BZ)

What is needed is a system that can prevent the harm done to citizens by the dishonesty of business elites; the limited competence of forecasters, economists, and statisticians; and the imperfections of regulation, not one that aims to eliminate these flaws. Humans must try to resist the illusion of control: just as foreign policy should be intelligence-proof (it should minimize its reliance on the competence of information-gathering organizations and the predictions of “experts” in what are inherently unpredictable domains), the economy should be regulator-proof, given that some regulations simply make the system itself more fragile. Due to the complexity of markets, intricate regulations simply serve to generate fees for lawyers and profits for sophisticated derivatives traders who can build complicated financial products that skirt those regulations. DON’T BE A TURKEY The life of a turkey before Thanksgiving is illustrative: the turkey is fed for 1,000 days and every day seems to confirm that the farmer cares for it—until the last day, when confidence is maximal. The “turkey problem” occurs when a naive analysis of stability is derived from the absence of past variations. Likewise, confidence in stability was maximal at the onset of the financial crisis in 2007. The turkey problem for humans is the result of mistaking one environment for another. Humans simultaneously inhabit two systems: the linear and the complex. The linear domain is characterized by its predictability and the low degree of interaction among its components, which allows the use of mathematical methods that make forecasts reliable. In complex systems, there is an absence of visible causal links between the elements, masking a high degree of interdependence and extremely low predictability. Nonlinear elements are also present, such as those commonly known, and generally misunderstood, as “tipping points.” Imagine someone who keeps adding sand to a sand pile without any visible consequence, until suddenly the entire pile crumbles. It would be foolish to blame the collapse on the last grain of sand rather than the structure of the pile, but that is what people do consistently, and that is the policy error. U.S. President Barack Obama may blame an intelligence failure for the government’s not foreseeing the revolution in Egypt (just as former U.S. President Jimmy Carter blamed an intelligence failure for his administration’s not foreseeing the 1979 Islamic Revolution in Iran), but it is the suppressed risk in the statistical tails that matters—not the failure to see the last grain of sand. As a result of complicated interdependence and contagion effects, in all man-made complex systems, a small number of possible events dominate, namely, Black Swans. Engineering, architecture, astronomy, most of physics, and much of common science are linear domains. The complex domain is the realm of the social world, epidemics, and economics. Crucially, the linear domain delivers mild variations without large shocks, whereas the complex domain delivers massive jumps and gaps. Complex systems are misunderstood, mostly because humans’ sophistication, obtained over the history of human knowledge in the linear domain, does not transfer properly to the complex domain. Humans can predict a solar eclipse and the trajectory of a space vessel, but not the stock market or Egyptian political events. All man-made complex systems have commonalities and even universalities. Sadly, deceptive calm (followed by Black Swan surprises) seems to be one of those properties.

### War

**Scenario planning on international conflicts fails –miscalculation and war**

**Jervis, 97** – professor of international affairs at Columbia (Robert, “Complex Systems: The Role of Interactions”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch03.html>) //BZ

Because actions change the environment in which they operate, identical but later behavior does not produce identical results: history is about the changes produced by previous thought and action as people and organizations confront each other through time. The final crisis leading to World War II provides an illustration of some of these processes. Hitler had witnessed his adversaries give in to pressure; as he explained, "Our enemies are little worms. I saw them at Munich."21 But the allies had changed because of Hitler’s behavior. So had Poland. As A.J.P. Taylor puts it, "Munich cast a long shadow. Hitler waited for it to happen again; Beck took warning from the fate of Benes."22 Hitler was not the only leader to fail to understand that his behavior would change his environment. Like good linear social scientists, many statesmen see that their actions can produce a desired outcome, all other things being equal, and project into the future the maintenance of the conditions that their behavior will in fact undermine. This in part explains the Argentine calculations preceding the seizure of the Falklands/Malvinas. Their leaders could see that Britain’s ability to protect its position was waning, as evinced by the declining naval presence, and that Argentina’s claim to the islands had received widespread international support. But what they neglected was the likelihood that the invasion would alter these facts, unifying British opinion against accepting humiliation and changing the issue for international audiences from the illegitimacy of colonialism to the illegitimacy of the use of force. A similar neglect of the transformative power of action may explain why Saddam Hussein thought he could conquer Kuwait. Even if America wanted to intervene, it could do so only with the support and cooperation of other Arab countries, which had sympathized with Iraq’s claims and urged American restraint. But the invasion of Kuwait drastically increased the Arabs’ perception of threat and so altered their stance. Furthermore, their willingness to give credence to Iraqi promises was destroyed by the deception that had enabled the invasion to take everyone by surprise. Germany’s miscalculation in 1917 was based on a related error: although unrestricted submarine warfare succeeded in sinking more British shipping than the Germans had estimated would be required to drive Britain from the war, the American entry (which Germany expected) led the British to tolerate shortages that otherwise would have broken their will because they knew that if they held out, the U.S. would rescue them.23 The failure to appreciate the fact that the behavior of the actors is in part responsible for the environment which then impinges on them can lead observers—and actors as well—to underestimate actors’ influence. Thus states caught in a conflict spiral believe that they have little choice but to respond in kind to the adversary’s hostility. This may be true, but it may have been the states’ earlier behavior that generated the situation that now is compelling. Robert McNamara complains about how he was mislead by faulty military reporting but similarly fails to consider whether his style and pressure might have contributed to what he was being told.24 Products of Interaction as the Unit of Analysis Interaction can be so intense and transformative that we can no longer fruitfully distinguish between actors and their environments, let alone say much about any element in isolation. We are accustomed to referring to roads as safe or dangerous, but if the drivers understand the road conditions this formulation may be misleading: the knowledge that, driving habits held constant, one stretch is safe or dangerous will affect how people drive—they are likely to slow down and be more careful when they think the road is dangerous and speed up and let their attention wander when it is "safe." It is then the road-driver system that is the most meaningful unit of analysis. In the wake of the sinking of a roll-on roll-off ferry, an industry representative said: With roro’s, the basic problem is that you have a huge open car deck with doors at each end. But people are well aware of this, and it is taken into account in design and operation. You don’t mess around with them. There have not been too many accidents because they are operated with such care.25 Similarly, we often refer to international situations as precarious, unstable, or dangerous. But, again, if statesmen perceive them as such and fear the consequences, they will act to reduce the danger—one reason why the Cuban missile crisis did not lead to war was that both sides felt that this could be the outcome if they were not very careful. Nuclear weapons generally have this effect. Because statesmen dread all-out war, international politics is safer than it would otherwise be, and probably safer than if war were less destructive. Conversely, like drivers on a "safe" stretch of road, decision-makers can behave more recklessly in calmer times because they have more freedom to seek unilateral gains as well as needing to generate risk to put pressure on others. For example, the relaxation of Anglo-German tensions after 1911 may have misled both countries into believing that they could afford dangerous tactics in 1914. Circular Effects Systems can produce circular effects as actors respond to the new environments their actions have created, often changing themselves in the process. In international politics, perhaps the most important manifestation of this dynamic is the large-scale operation of the security dilemma—i.e., the tendency for efforts to increase a state’s security to simultaneously decrease the security of others. Because states know that they cannot rely on others in the unpredictable future, they seek to protect themselves against a wide range of menaces. Thus in the 1930s Japan, which was heavily dependent on resources from outside its borders, sought to expand the area it controlled. Immediate economic needs generated by the world-wide depression increased but did not create this impulse. Nor were they brought on by specific conflicts with the Western powers. Rather what was driving was the fear that conflict might be forced upon Japan in the future, which meant that to remain secure Japan needed raw materials and larger markets. The result was the conquest of Manchuria, followed by a larger war with China, and then by the occupation of Indochina. Each move generated resistance that made the next action seem necessary, and the last move triggered the American oil embargo, which in turn pushed Japan into attacking the West before it ran out of oil. Had Japan been secure, her aggression would not have been necessary; it was the fear of an eventual war with the West that required policies that moved Western enmity from a possibility to a reality. (Of course a further irony is that World War II led to the reconstruction of international politics and the Japanese domestic system that brought Japan security, economic dominance of South East Asia, and access to markets around the world.) Despite the familiarity of the idea that social action forms and takes place within a system, scholars and statesmen as well as the general public are prone to think in non-systemic terms. This is often appropriate, and few miracles will follow from thinking systemically because the interactive, strategic, and contingent nature of systems limits the extent to which complete and deterministic theories are possible. But we need to take more seriously the notion that we are in a system and to look for the dynamics that drive them. A distinguished student of genetics summarized his perspective in the phrase: "Nothing in biology makes sense except in the light of evolution."26 Very little in social and political life makes sense except in the light of systemic processes. Exploring them gives us new possibilities for understanding and effective action; in their absence we are likely to flounder.

**Complexity key to stop escalating conflicts- prevents flashpoints**

**Saperstein, 97** – professor of physics at Wayne State (Alvin, “Complexity, Chaos, and National Security Policy: Metaphors or Tools?, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch05.html>) //BZ

It is clear that successful military and political policy makers have always entertained the potentiality of chaos and have sought the tools of redundancy and flexibility of resources to deal with that possibility. The only new tool to deal with chaos presented here is the engineering tool of attempting to predict crisis instability and then avoid it or be prepared to live with it. Quantitative dynamical models of the system of interest may be useful in making such predictions. If they are inadequate or unavailable, verbal models have a long history, and potentiality, of use. If the leaders of the pre-WWI European states had recognized that the railroad schedule-dominated mobilization of their troops was a source of great crisis instability (Tuchman 1962, van Creveld 1989), perhaps they would have avoided starting—and being trapped by—the process. But this recognition would have required that the chaos metaphor be more commonly found in the "intellectual air" of turn-of-the-century Europe than was the case in that rapidly industrializing Newtonian-reductionist society. Given a Newtonian paradigm, the policymaker strives to be efficient in reacting to a given "field of endeavor"; chaos is to be avoided or dealt with by overwhelming force and/or redundant means of force delivery. The present world seems to require a Prigoginean outlook: don’t accept the battlefield or the world system as a fixed given. The complexity, or adaptive self-organizing, metaphor should be very useful for the necessary education, recruitment, planning, and thinking required to deal with and survive our future. However, no obvious specific tool—like predicting crisis instability—comes to mind. The metaphor require that one should always be contemplating the future. And, among these considerations for the future, always include attempts to change the field of endeavor itself. Hence, it may not be useful for the policymaker to always look for the uniquely "best solution." It may be necessary to settle for a local temporary maximum—a good solution, rather than the best. In the elastic fabric of our present and future world, the "perfect" is often the enemy of the "good." When all is said and done, on a strategic level, the most useful aspect of the chaos and complexity metaphors is to remind us and help us to avoid falling into chaos.26

**The high risk - low probability chains of events in the affirmative’s impact scenarios rely on a flawed security logic that justified the wars in Iraq and Afghanistan.**

**Kessler 08** [Oliver professor of Sociology at University of Bielefeld, “From Insecurity to Uncertainty: Risk and the Paradox of Security Politics” Alternatives 33 (08), 211-232 LO]

The problem of the second method is that it is very difficult to "calculate" politically unacceptable losses. If the risk of terrorism is defined in traditional terms by probability and potential loss, then the focus on dramatic terror attacks leads to the marginalization of probabilities. The reason is that even the highest degree of improbability becomes irrelevant as the measure of loss goes to infinity.50 The mathematical calculation of the risk of terrorism thus tends to overestimate and to dramatize the danger. This has consequences beyond the actual risk assessment for the formulation and execution of "risk policies": If one factor of the risk calculation approaches infinity (e.g., if a case of nuclear terrorism is envisaged), then there is no balanced measure for antiterrorist efforts, and risk management as a rational endeavor breaks down. Under the historical condition of bipolarity, the "ultimate" threat with nuclear weapons could be balanced by a similar counterthreat, and new equilibria could be achieved, albeit on higher levels of nuclear overkill. Under the new condition of uncertainty, no such rational balancing is possible since knowledge about actors, their motives and capabilities, is largely absent. The second form of security policy that emerges when the deterrence model collapses mirrors the "social probability" approach. It represents a logic of catastrophe. In contrast to risk management framed in line with logical probability theory, the logic of catastrophe does not attempt to provide means of absorbing uncertainty. Rather, it takes uncertainty as constitutive for the logic itself; uncertainty is a crucial precondition for catastrophies. In particular, catastrophes happen at once, without a warning, but with major implications for the world polity. In this category, we find the impact of meteorites, Mars attacks, the tsunami in South East Asia, and 9/11. To conceive of terrorism as catastrophe has consequences for the formulation of an adequate security policy. Since catastrophes happen irrespectively of human activity or inactivity, no political action could possibly prevent them. Of course, there are precautions that can be taken, but the framing of terrorist attack as a catastrophe points to spatial and temporal characteristics that are beyond "rationality." Thus, political decision makers are exempted from the responsibility to provide security-as long as they at least try to preempt an attack. Interestingly enough, 9/11 was framed as catastrophe in various commissions dealing with the question of who was responsible and whether it could have been prevented. This makes clear that under the condition of uncertainty, there are no objective criteria that could serve as an anchor for measuring dangers and assessing the quality of political responses. For example, as much as one might object to certain measures by the US administration, it is almost impossible to "measure" the success of countermeasures. Of course, there might be a subjective assessment of specific shortcomings or failures, but there is no "common" currency to evaluate them. As a consequence, the framework of the security dilemma fails to capture the basic uncertainties. Pushing the door open for the security paradox, the main problem of security analysis then becomes the question how to integrate dangers in risk assessments and security policies about which simply nothing is known. In the mid 1990s, a Rand study entitled "New Challenges for Defense Planning" addressed this issue arguing that "most striking is the fact that we do not even know who or what will constitute the most serious future threat."51 In order to cope with this challenge it would be essential, another Rand researcher wrote, to break free from the "tyranny" of plausible scenario planning. The decisive step would be to create "discontinuous scenarios . . . in which there is no plausible audit trail or storyline from current events"52 These nonstandard scenarios were later called "wild cards" and became important in the current US strategic discourse. They justified the transformation from a threat-based toward a capability-based defense planning strategy.53 The problem with this kind of risk assessment is, however, that even the most absurd scenarios can gain plausibility. By constructing a chain of potentialities, improbable events are linked and brought into the realm of the possible, if not even the probable. "Although the likelihood of the scenario dwindles with each step, the residual impression is one of plausibility."54 This so-called Othello effect has been effective in the dawn of the recent war in Iraq. The connection between Saddam Hussein and Al Qaeda that the US government tried to prove was disputed from the very beginning. False evidence was again and again presented and refuted, but this did not prevent the administration from presenting as the main rationale for war the improbable yet possible connection between Iraq and the terrorist network and the improbable yet possible proliferation of an improbable yet possible nuclear weapon into the hands of Bin Laden. As Donald Rumsfeld famously said: "Absence of evidence is not evidence of absence." This sentence indicates that under the condition of genuine uncertainty, different evidence criteria prevail than in situations where security problems can be assessed with relative certainty.

**Predictions will always be exaggerated due to our innate psychologic need to construct enemies.**

**Jacobs 10** [Tom, journalist, “An Omnipotent Enemy Confronts Us”, <http://www.miller-mccune.com/politics/the-comforting-notion-of-an-all-powerful-enemy-10429/>]

We have seen the enemy, and he is powerful. That’s a recurring motif of contemporary political discourse, as generalized fear mutates for many into a fixation on a ferocious foe. Partisan rhetoric has turned increasingly alarmist. President Obama has difficulty getting even watered-down legislation passed, yet he is supposedly establishing a socialist state. The Tea Party is viewed as a terrifying new phenomenon, rather than the latest embodiment of a recurring paranoid streak in American politics. Osama bin Laden is likely confined to a cave, but he’s perceived as a threat large enough to justify engaging in torture. According to one school of thought, this tendency to exaggerate the strength of our adversaries serves a specific psychological function. It is less scary to place all our fears on a single, strong enemy than to accept the fact our well-being is largely based on factors beyond our control. An enemy, after all, can be defined, analyzed and perhaps even defeated. The notion that focusing our anger on a purportedly powerful foe helps mitigate our fears was first articulated by cultural anthropologist Ernest Becker in his 1969 book Angel in Armor. It has now been confirmed in a timely paper titled “An Existential Function of Enemyship,” just published in the Journal of Personality and Social Psychology. A research team led by social psychologist Daniel Sullivan of the University of Kansas reports on four studies that suggest people are “motivated to create and/or perpetually maintain clear enemies to avoid psychological confrontations with an even more threatening chaotic environment.” When you place their findings in the context of the many threats (economic and otherwise) people face in today’s world, the propensity to turn ideological opponents into mighty monsters starts to make sense. In one of Sullivan’s studies, conducted during the 2008 presidential campaign, a group of University of Kansas undergraduates were asked whether they believed enemies of their favored candidate (Obama or John McCain) were manipulating voting machines in an attempt to steal the election. Prior to considering such conspiracy theories, half were asked to consider the truth of statements such as “I have control over whether I am exposed to a disease,” and “I have control over how my job prospects fare in the economy.” The other half were asked to assess similar statements on relatively unimportant subjects, such as “I have control over how much TV I watch.” Those who were forced to contemplate their lack of control over significant life events “reported a stronger belief in opponent-led conspiracies,” the researchers report. In another study, the student participants were randomly assigned to read one of two essays. The first stated that the U.S. government is well-equipped to handle the economic downturn, and that crime rates are declining due to improved law enforcement. The second reported the government is not at all competent to cope with the recession, and crime rates are going up in spite of the authorities’ best efforts. They were then presented with a list of hypothetical events and asked to pick the most likely cause of each: A friend, an enemy, or neither (that is, the event happened randomly). Those “informed” that the government was not in control were more likely to view a personal enemy as responsible for negative events in their lives. In contrast, those told things are running smoothly “seemed to defensively downplay the extent to which enemies negatively influence their lives,” the researchers report. These studies suggest it’s oddly comforting to have someone, or something, you can point to as the source of your sorrows. This helps explain why Americans inevitably find an outside enemy to focus on, be it the Soviets, the Muslims or the Chinese. Given that society pays an obvious price for such illusions, how might we go about reducing the need for “enemyship?” “If you can somehow raise people’s sense that they have control over their lives and negative hazards in the world, their need to ‘enemize’ others should be reduced,” Sullivan said in an e-mail interview. “In our first study, for instance, we showed that people who feel dispositionally high levels of control over their lives did not respond to a reminder of external hazards by attributing more influence to an enemy. Any social structure or implementation that makes people feel more control over their lives should thus generally reduce (though perhaps not completely eliminate) the ‘need’ or tendency to create or attribute more influence to enemy figures. “In our third study, we showed that if people perceived the broader social system as ordered, they were more likely to respond to a threat to personal control by boosting their faith in the government, rather than by attributing more influence to an enemy. So, again, we see that the need to perceive enemies is reduced when people are made to feel that they are in control of their lives, or that there is a reliable, efficient social order that protects them from the threat of random hazards. “One could imagine, then, that circumstances which allow all citizens to be medically insured, or to have a clear sense of police protection, could reduce the tendency to seek out enemy figures to distill or focalize concerns with random, imminent threats**.”** Sullivan also offers two more personal potential solutions. “If people have such inherent needs for control and certainty in their lives, they should try to channel those needs as best they can into socially beneficial pursuits,” he says. “Lots of people pursue science, art and religion — just to give a few examples — as means of boiling down uncertainty about the world into clear systems of rules and engagement with reality, creating small domains for themselves in which they can exert a sense of mastery. Insofar as these pursuits don’t harm anyone, but still provide a sense of control, they can reduce the need for enemyship. “A final solution would be to encourage people to simply accept uncertainty and lack of control in their lives,” he adds. “Some meaning systems — Taoism for example — are rooted in this idea, that people can eventually accept a certain lack of control and eventually become resigned to this idea to the extent that they no longer react defensively against it.” So there, at least, is a practical place to begin: Less MSNBC and more meditation.

### Extinction

**Linear models can't predict of catastrophic events, resulting in existential catastrophes resulting from a failure to anticipate the deficiency of linear models to perceive disaster.**

**Yudkowsky, 2008** - Research Fellow at the Singularity Institute for Artificial Intelligence (Eliezer, “Cognitive biases potentially affecting judgment of global risks”, peer edited by the Singularity Institute, [http://singularity.org/files/CognitiveBiases.pdf)//BZ](http://singularity.org/files/CognitiveBiases.pdf%29//BZ)

Taleb (2004) suggests that hindsight bias and availability bias bear primary responsibility for our failure to guard against what Taleb calls Black Swans. Black Swans are an especially diﬃcult version of the problem of the fat tails: sometimes most of the variance in a process comes from exceptionally rare, exceptionally huge events. Consider a financial instrument that earns $10 with 98% probability, but loses $1000 with 2% probability; it’s a poor net risk, but it looks like a steady winner. Taleb (2001, 81–85) gives the example of a trader whose strategy worked for six years without a single bad quarter, yielding close to $80 million—then lost $300 million in a single catastrophe. Another example is that of Long-Term Capital Management, a hedge fund whose founders included two winners of the Nobel Prize in Economics. During the Asian currency crisis and Russian bond default of 1998, the markets behaved in a literally unprecedented fashion, assigned a negligible probability by LTCM’s historical model. As a result, LTCM began to lose $100 million per day, day after day. On a single day in 1998, LTCM lost more than $500 million (Taleb 2004). The founders of LTCM later called the market conditions of 1998 a “ten-sigma event.” But obviously it was not that improbable. Mistakenly believing that the past was predictable, people conclude that the future is predictable. As Fischhoﬀ (1982) puts it: When we attempt to understand past events, we implicitly test the hypotheses or rules we use both to interpret and to anticipate the world around us. If, in hindsight, we systematically underestimate the surprises that the past held and holds for us, we are subjecting those hypotheses to inordinately weak tests and, presumably, finding little reason to change them. The lesson of history is that swan happens. People are surprised by catastrophes lying outside their anticipation, beyond their historical probability distributions. Why then are we so taken aback when Black Swans occur? Why did LTCM borrow $125 billion against $4.72 billion of equity, almost ensuring that any Black Swan would destroy them? Because of hindsight bias, we learn overly specific lessons. After September 11th, the U.S. Federal Aviation Administration prohibited box-cutters on airplanes. The hindsight bias rendered the event too predictable in retrospect, permitting the angry victims to find it the result of “negligence”—such as intelligence agencies’ failure to distinguish warnings of Al Qaeda activity amid a thousand other warnings. We learned not to allow hijacked planes to fly over our cities. We did not learn the lesson: “Black Swans occur; do what you can to prepare for the unanticipated.” Taleb (2004, 7–8) writes: It is diﬃcult to motivate people in the prevention of Black Swans. . . . Prevention is not easily perceived, measured, or rewarded; it is generally a silent and thankless activity. Just consider that a costly measure is taken to stave oﬀ such an event. One can easily compute the costs while the results are hard to determine. How can one tell its eﬀectiveness, whether the measure was successful or if it just coincided with no particular accident? . . . Job performance assessments in these matters are not just tricky, but may be biased in favor of the observed “acts of heroism”. History books do not account for heroic preventive measures.

**Failure to adopt complexity causes multiple extinction level impacts**

**Gell-Mann, 97** – Murray, Nobel Laureate in Physics and professor at the Santa Fe Institute and co-chairman of the Science Board (“Chapter 1: The Simple and the Complex,” *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

At this conference, issues of global politics and security will be addressed, including ones specifically concerned with the security of the United States. But security narrowly defined depends in very important ways on security in the broadest sense. Some politicians deeply concerned about military strength appear to resent the idea of diluting that concern by emphasizing a broader conception of security, but many thinkers in the armed services themselves recognize that military security is deeply intertwined with all the other major global issues. I like to discuss those issues under the rubric of sustainability, one of today’s favorite catchwords. It is rarely defined in a careful or consistent way, so perhaps I can be forgiven for attaching to it my own set of meanings. Broadly conceived, sustainability refers to quality that is not purchased mainly at the expense of the future—quality of human life and of the environment. But I use the term in a much more inclusive way than most people: sustainability is not restricted to environmental, demographic, and economic matters, but refers also to political, military, diplomatic, social, and institutional or governance issues—and ultimately sustainability depends on ideological issues and lifestyle choices. As used here, sustainability refers as much to sustainable peace, sustainable preparedness for possible conflict, sustainable global security arrangements, sustainable democracy and human rights, and sustainable communities and institutions as it does to sustainable population, economic activity, and ecological integrity. All of these are closely interlinked, and security in the narrow sense is a critical part of the mix. In the presence of destructive war, it is hardly possible to protect nature very effectively or to keep some important human social ties from dissolving. Conversely, if resources are abused and human population is rapidly growing, or if communities lose their cohesion, conflicts are more likely to occur. If huge and conspicuous inequalities are present, people will be reluctant to restrain quantitative economic growth in favor of qualitative growth as would be required to achieve a measure of economic and environmental sustainability. At the same time, great inequalities may provide the excuse for demagogues to exploit or revive ethnic or class hatreds and provoke deadly conflict. And so forth. In my book, The Quark and the Jaguar, I suggest that studies be undertaken of possible paths toward sustainability (in this very general sense) during the course of the next century, in the spirit of taking a crude look at the whole. I employ a modified version of a schema introduced by my friend James Gustave Speth, then president of the World Resources Institute and now head of the United Nations Development Program. The schema involves a set of interlinked transitions that have to occur if the world is to switch over from present trends toward a more sustainable situation: 1) The demographic transition to a roughly stable human population, worldwide and in each broad region. Without that, talk of sustainability seems almost pointless. 2) The technological transition to methods of supplying human needs and satisfying human desires with much lower environmental impact per person, for a given level of conventional prosperity. 3) The economic transition to a situation where growth in quality gradually replaces growth in quantity, while extreme poverty, which cries out for quantitative growth, is alleviated. (Analysts, by the way, are now beginning to use realistic measures of wellbeing that depart radically from narrow economic measures by including mental and physical health, education, and so forth.) The economic transition has to involve what economists call the internalization of externalities: prices must come much closer to reflecting true costs, including damage to the future. 4) The social transition to a society with less inequality, which, as remarked before, should make the decline of quantitative growth more acceptable. (For example, fuel taxes necessary for conservation adversely affect the poor who require transport to work, but the impact of such taxes can be reduced by giving a subsidy to the working poor—such as a negative income tax—that is not tied to fuel consumption.) The social transition includes a successful struggle against large-scale corruption, which can vitiate attempts to regulate any activity through law. 5) The institutional transition to more effective means of coping with conflict and with the management of the biosphere and human activities in it. We are now in an era of simultaneous globalization and fragmentation, in which the relevance of national governments is declining somewhat, even though the power to take action is still concentrated largely at that level. Most of our problems involving security—whether in the narrow or the broad sense—have global implications and require transnational institutions for their solution. We already have a wide variety of such institutions, formal and informal, and many of them are gradually gaining in effectiveness. But they need to become far more effective. Meanwhile, local and national institutions need to become more responsive and, in many places, much less corrupt. Such changes require the development of a strong sense of community and responsibility at many levels, but in a climate of political and economic freedom. How to achieve the necessary balance between cooperation and competition is the most difficult problem at every level. 6) The informational transition. Coping on local, national, and transnational levels with technological advances, environmental and demographic issues, social and economic problems, and questions of international security, as well as the strong interactions among all of them, requires a transition in the acquisition and dissemination of knowledge and understanding. Only if there is a higher degree of comprehension, among ordinary people as well as elite groups, of the complex issues facing humanity is there any hope of achieving sustainable quality. But most of the discussions of the new digital society concentrate on the dissemination and storage of information, much of it misinformation or badly organized information, rather than on the difficult and still poorly rewarded work of converting that so-called information into knowledge and understanding. And here again we encounter the pervasive need for a crude look at the whole. 7) The ideological transition to a world view that combines local, national, and regional loyalties with a "planetary consciousness," a sense of solidarity with all human beings and, to some extent, all living things. Only by acknowledging the interdependence of all people and, indeed, of all life can we hope to broaden our individual outlooks so that they reach out in time and space to embrace the vital long-term issues and worldwide problems along with immediate concerns close to home. This transition may seem even more Utopian than some of the others, but if we are to manage conflict that is based on destructive particularism, it is essential that groups of people that have traditionally opposed one another acknowledge their common humanity. Such a progressive extension of the concept of "us" has, after all, been a theme in human history from time immemorial. One dramatic manifestation is the greatly diminished likelihood over the last fifty years of armed conflict in Western Europe. Another is, of course, the radical transformation of relationships that is often called "The End of the Cold War." The recent damping-down of long-standing civil wars in a number of countries is also rather impressive. Our tendency is to study separately the various aspects of human civilization that correspond to the different transitions. Moreover, in our individual political activities we tend to pick out just one or a few of these aspects. Some of us may belong to organizations favoring a strong defense or arms control or both, others to the United Nations Association of the United States, others to ZPG or the Population Council, some to organizations plumping for more assistance to developing countries or to ones working for more generous treatment of the poor in our own country, some to organizations promoting democracy and human rights, some to environmental organizations. But the issues dear to these various organizations are all tightly interlinked, and a portion of our activity needs to be devoted to examining the whole question of the approach to sustainability in all these different spheres. It is reasonable to ask why a set of transitions to greater sustainability should be envisaged as a possibility during the coming century. The answer is that we are living in a very special time. Historians tend to be skeptical of most claims that a particular age is special, since such claims have been made so often. But this turn of the millennium really is special, not because of our arbitrary way of reckoning time but because of two related circumstances: a) The changes that we humans produce in the biosphere, changes that were often remarkably destructive even in the distant past when our numbers were few, are now of order one. We have become capable of **wiping out** a very large fraction of **humanity— and of living things** generally—if a full-scale world war should break out. Even if it does not, we are still affecting the composition of the atmosphere, water resources, vegetation, and animal life in profound ways around the planet. While such effects of human activities have been surprisingly great in the past, they were not global in scope as they are now. b) The graph of human population against time has the highest rate of increase ever, and that rate of increase is just beginning to decline. In other words, the curve is near what is called a "point of inflection." For centuries, even millennia, world population was, to a fair approximation, inversely proportional to 2025 minus the year. (That is a solution of the equation in which the rate of change of a variable is proportional to its square.) Only during the last thirty years or so has the total number of human beings been deviating significantly from this formula, which would have had it becoming infinite a generation from now! The demographic transition thus appears to be under way at last. It is generally expected that world population will level off during the coming century at something like twice its present value, but decisions and events in the near future can affect the final figure by billions either way. That is especially significant in regions such as Africa, where present trends indicate a huge population increase very difficult to support and likely to contribute to severe environmental degradation. In general, the coming century, the century of inflection points in a number of crucial variables, seems to be the time when the human race might still accomplish the transitions to greater sustainability without going through disaster. It is essential, in my opinion, to make some effort to search out in advance what kinds of paths might lead humanity to a reasonably sustainable and desirable world during the coming decades. And while the study of the many different subjects involved is being pursued by the appropriate specialists, we need to supplement that study with interdisciplinary investigations of the strong interdependence of all the principal facets of the world situation. In short, we need a crude look at the whole, treating global security and global politics as parts of a very general set of questions about the future.

**Without complexity, inevitable crisis instability and nuclear war
Saperstein, 97** – professor of physics at Wayne State (Alvin, “Complexity, Chaos, and National Security Policy: Metaphors or Tools?, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch05.html>) //BZ

Analogously, if it were reasonable to mathematically model the world system of nations, a chaotic mathematical system would be a good metaphor for a crisis—unstable world. Being able to predict the critical "Reynolds number" for such a world model would be very important for the policy maker whose goal was to avoid crisis unstable conditions with their concomitant high probabilities for the outbreak of war (Saperstein 1984).16 (In the modern political/weapons-of mass-destruction world, there are no "test pilots" and we are all potentially sacrificial passengers.) In a Newtonian world paradigm (or in a Newtonian approximation to a Prigoginean world view), the notion of national security—and the goals of the corresponding policy makers—are fairly straightforward. Policy must be framed so as to either avoid war or to reap the benefits of winning a war (whose win can be "guaranteed" with associated costs less than expected gains). In either case, the prime goal is to maintain control of the future, to retain predictability and hence avoid crisis instability. Given a reasonable mathematical model of the system for which policy is being made, it can be used to explore for system characteristics which allow transition to chaos. The policymaker must then studiously avoid the corresponding behaviors or conditions. An example of interest to the strategist of bipolar nuclear arms races (in the context of the S.U. - U.S. Cold War) is the modeling of the Strategic Defense Initiative, the proposal during the Reagan Presidency to deploy a massive system of ground-based and space-based defenses against strategic-ranged ballistic nuclear missiles. The model (Saperstein and Kress 1988) presumed that each of the two antagonists would deploy similar offensive and defensive systems against the other (Fig. 3). The deployment numbers would be determined in response to the opponent’s deployed weapons numbers; the result is a non-linear interactive system whose stability can be investigated by conventional means: introduce a small disturbance into the system and compute how it grows. As expected, there are starting configuration numbers (of offensive and defensive missiles) for which the perturbations remain small, others for which they grow greatly and rapidly (Fig. 4). The latter configurations are the crisis-unstable systems which are to be avoided by the relevant strategic planners.17 The same paradigm has been used to explore questions of more academic interest. Using a non-linear Richardson18 model of the arms race between competing nations, a comparison (Saperstein 1991) was made of the stability region of three-nation systems (Fig.5a) with that of two-nation systems (Fig.5b). The former was found to be smaller than the latter, indicating that it is more difficult to stabilize a tri-polar world than a bi-polar world, a conclusion which has also been drawn by many "conventional" non-mathematical political scientists. Another concordance between the results of mathematical modeling of international systems and conventional analysis has been that a system of democratic states is less likely to have wars than a system including oligarchic states. The model conclusions (Saperstein 1992a) result from the differing values of the Richardson-type parameters19 stemming from democratic versus oligarchic societies. The differences arise since the (Newtonian) nation entities of the Richardson model, and hence their interactions, result from averages over a larger Newtonian model whose elements are the nation’s decision makers—citizens, politicians, officials—a large class in the democratic state, a small group in the oligarchic state. In the latter case, the interaction parameters resulting from the average are more likely to be large enough to produce an unstable system. Finally, a comparative stability analysis was made of systems of competing nations, each looking out for its individual security, versus systems of alliances, shifting so as to maintain a "balance of power" (Saperstein 1992b). Again, the result—that it is easier to stabilize a balance-of-power system—was expected from conventional political analysis. In all of the above cases, the chaos metaphor was used to steer policy makers away from potentially dangerous crisis instability situations—away from chaos. Alternatively, when war and its associated chaos is unavoidable, there is the traditional approach to the chaos of battle, an approach used by successful military planners whether or not they recognized or used the chaos metaphor. Since small perturbations can lead to largely different outcomes ("For want of a nail, a shoe was lost,... a kingdom was lost.") one appropriate response (characteristic of the U.S. military since Grant) has been to always deploy overwhelming forces, if they can be made available. (Have more than enough horses, so that the loss of a few would make no difference.) That is, the statistical fluctuations which mimic chaos usually scale as the square-root of N, the number of significant elements. For large enough N, the relative fluctuations are unimportant. An alternative to increasing the sizes of the force units available (the Newtonian elements of the system) is to increase the number of different types, their flexibility and rapid adaptability to changes. Have horses, mules, people, jeeps, well trained and available to carry out the required tasks. Better yet, have available alternative sets of tasks and immediate goals, which will lead to the final desired goal—if you can’t take that hill, take the other one. It is clear here that the new chaos metaphor offers no new tools to the military planner though, as has been previously suggested, it may significantly aid the military educator.

## \*\*ALTERNATIVE\*\*

**The alternative to engage in policy analysis of complexity- key to have preferable political results in a chaotic world**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

In short, there are strict limits within which theorizing based on the premises of complexity theory must be confined. It cannot presently—and is unlikely ever to—provide a method for predicting particular events and specifying the exact shape and nature of developments in the future. As one observer notes, it is a theory "meant for thought experiments rather than for emulation of real systems."18 Consequently, it is when our panacean impulses turn us toward complexity theory for guidance in the framing of exact predictions that the policy payoffs are least likely to occur and our disillusionment is most likely to intensify. For the strides that complexity theorists have made with their mathematical models and computer simulations are still a long way from amounting to a science that can be relied upon for precision in charting the course of human affairs that lies ahead. Although their work has demonstrated the existence of an underlying order, it has also called attention to a variety of ways in which the complexity of that order can collapse into pervasive disorder. Put differently, while human affairs have both linear and nonlinear dimensions, and while there is a range of conditions in which the latter dimensions are inoperative or "well behaved,"19 it is not known when or where the nonlinear dimensions will appear and trigger inexplicable feedback mechanisms. Such unknowns lead complexity theorists to be as interested in patterns of disorder as those of order, an orientation that is quite contrary to the concerns of policy makers. Theorizing Within the Limits To acknowledge the limits of complexity theory, however, is not to assert that it is of no value for policy makers and academics charged with comprehending world affairs. Far from it: if the search for panaceas is abandoned and replaced with a nuanced approach, it quickly becomes clear that the underlying premises of complexity theory have a great deal to offer as a perspective or world view with which to assess and anticipate the course of events. Perhaps most notably, they challenge prevailing assumptions in both the academic and policy-making communities that political, economic, and social relationships adhere to patterns traced by linear regressions. Complexity theory asserts that it is not the case, as all too many officials and analysts presume, that "we can get a value for the whole by adding up the values of its parts."20 In the words of one analyst, Look out the nearest window. Is there any straight line out there that wasn’t man-made? I’ve been asking the same question of student and professional groups for several years now, and the most common answer is a grin. Occasionally a philosophical person will comment that even the lines that look like straight lines are not straight lines if we look at them through a microscope. But even if we ignore that level of analysis, we are still stuck with the inevitable observation that natural structures are, at their core, nonlinear. If [this] is true, why do social scientists insist on describing human events as if all the rules that make those events occur are based on straight lines?21 A complexity perspective acknowledges the nonlinearity of both natural and human systems. It posits human systems as constantly learning, reacting, adapting, and changing even as they persist, as sustaining continuity and change simultaneously. It is a perspective that embraces non-equilibrium existence. Stated more generally, it is a mental set, a cast of mind that does not specify particular outcomes or solutions but that offers guidelines and lever points that analysts and policy makers alike can employ to more clearly assess the specific problems they seek to comprehend or resolve. Furthermore, the complexity perspective does not neglect the role of history even though it rejects the notion that a single cause has a single effect. Rather, focusing as it does on initial conditions and the paths that they chart for systems, complexity treats the historical context of situations as crucial to comprehension. The first obstacle to adopting a complexity perspective is to recognize that inevitably we operate with some kind of theory. It is sheer myth to believe that we need merely observe the circumstances of a situation in order to understand them. Facts do not speak for themselves; observers give them voice by sorting out those that are relevant from those that are irrelevant and, in so doing, they bring a theoretical perspective to bear. Whether it be realism, liberalism, or pragmatism, analysts and policy makers alike must have some theoretical orientation if they are to know anything. Theory provides guidelines; it sensitizes observers to alternative possibilities; it highlights where levers might be pulled and influence wielded; it links ends to means and strategies to resources; and perhaps most of all, it infuses context and pattern into a welter of seemingly disarrayed and unrelated phenomena. It follows that the inability of complexity theory to make specific predictions is not a serious drawback. Understanding and not prediction is the task of theory. It provides a basis for grasping and anticipating the general patterns within which specific events occur. The weather offers a good example. It cannot be precisely predicted at any moment in time, but there are building blocks—fronts, highs and lows, jet streams, and so on—and our overall understanding of changes in weather has been much advanced by theory based on these building blocks....We understand the larger patterns and (many of) their causes, though the detailed trajectory through the space of weather possibilities is perpetually novel. As a result, we can do far better than the old standby: predict that "tomorrow’s weather will be like today’s" and you stand a 60 percent probability of being correct. A relevant theory for [complex adaptive systems] should do at least as well.22 Given the necessity of proceeding from a theoretical standpoint, it ought not be difficult to adopt a complexity perspective. Indeed, most of us have in subtle ways already done so. Even if political analysts are not—as I am not—tooled up in computer science and mathematics, the premises of complexity theory and the strides in comprehension they have facilitated are not difficult to grasp. Despite our conceptual insufficiencies, we are not helpless in the face of mounting complexity. Indeed, as the consequences of turbulent change have become more pervasive, so have observers of the global scene become increasingly wiser about the ways of the world and, to a large degree, we have become, each of us in our own way, complexity theorists. Not only are we getting accustomed to a fragmegrative world view that accepts contradictions, anomalies, and dialectic processes, but we have also learned that situations are multiply caused, that unintended consequences can accompany those that are intended, that seemingly stable situations can topple under the weight of cumulated grievances, that some situations are ripe for accidents waiting to happen, that expectations can be self-fulfilling, that organizational decisions are driven as much by informal as formal rules, that feedback loops can redirect the course of events, and so on through an extensive list of understandings that appear so commonplace as to obscure their origins in the social sciences only a few decades ago.23 Indeed, we now take for granted that learning occurs in social systems, that systems in crisis are vulnerable to sharp turns of directions precipitated by seemingly trivial incidents, that the difference between times one and two in any situation can often be ascribed to adaptive processes, that the surface appearance of societal tranquillity can mask underlying problems, and that "other things being equal" can be a treacherous phrase if it encourages us to ignore glaring exceptions. In short, we now know that history is not one damn thing after another so much as it is many damn things simultaneously. And if we ever slip in our understanding of these subtle lessons, if we ever unknowingly revert to simplistic formulations, complexity theory serves to remind us there are no panaceas. It tells us that there are limits to how much we can comprehend of the complexity that pervades world affairs, that we have to learn to become comfortable living and acting under conditions of uncertainty. The relevance of this accumulated wisdom—this implicit complexity perspective—can be readily illustrated. It enables us to grasp how an accidental drowning in Hong Kong intensified demonstrations against China, how the opening of a tunnel in Jerusalem could give rise to a major conflagration, how the death of four young girls can foster a "dark and brooding" mood in Brussels, how an "October surprise" might impact strongly on an American presidential election, or how social security funds will be exhausted early in the next century unless corrective policies are adopted—to cite three recent events and two long-standing maxims.24 We know, too that while the social security example is different from the others—in that it is founded on a linear projection of demographic change while the other examples involve nonlinear feedback loops—the world is comprised of linear as well as nonlinear dynamics and that this distinction is central to the kind of analysis we undertake. In other words, while it is understandable that we are vulnerable to the appeal of panaceas, this need not be the case. Our analytic capacities and concepts are not so far removed from complexity theorists that we need be in awe of their accomplishments or be ready to emulate their methods. Few of us have the skills or resources to undertake sophisticated computer simulations—and that may even be an advantage, as greater technical skills might lead us to dismiss complexity theory as inapplicable—but as a philosophical perspective complexity theory is not out of our reach. None of its premises and concepts are alien to our analytic habits. They sum to a perspective that is consistent with our own and with the transformations that appear to be taking the world into unfamiliar realms. Hence, through its explication, the complexity perspective can serve as a guide both to comprehending a fragmegrated world and theorizing within its limits.

**Instead of a reliance on a single model or prediction, openness to complexity cultivates research and theory**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

Hirschman’s position is not without empirical backing. In a study of judgmental accuracy under different modes of decision-making, Philip Tetlock has suggested that grossly inaccurate forecasts are more likely to result when experts behave like “intellectually aggressive hedgehogs,” relying on a single parsimonious approach to explain many things and depending excessively upon “powerful abstractions to organize messy facts and to distinguish the possible from the impossible.”16 Better forecasts are more likely when experts behave more like “eclectic foxes” who are able “to blend hedgehog arguments” and improvise ad hoc solutions in a rapidly changing world rather than becoming “anchored down by theory-laden abstractions.”17 More recently, Scott Page has argued that long-term progress and innovation are more likely when a society or group depends less on singular solutions offered by brilliant individuals or like-minded experts and instead pools together a broader range of ideas generated by diverse groups of people. Based on his studies of a wide range of social and institutional settings, Page contends: “collections of people with diverse perspectives and heuristics outperform collections of people who rely on homogeneous perspectives and heuristics.”18 In the context of Ancient Greece, Josiah Ober makes a similar observation in the process of analyzing how Athens emerged as the “preeminent Greek polis by a very substantial margin.” The key, Ober argues, was “the distinctive Athenian approach to the aggregation, alignment, and codification of useful knowledge . . . dispersed across a large and diverse population. . . .”19 What all of these authors are suggesting in quite different ways is that, whatever the immediate intellectual payoffs of employing a particular approach, reliance on any one perspective involves tradeoffs that become increasingly costly in the absence of complementary and countervailing efforts to draw upon multiple and diverse approaches. Analytic eclecticism is such an effort, a means for social scientists to guard against the risks of excessive reliance on a single analytic framework and the simplifying assumptions that come with it. Importantly, the accommodation of analytic eclecticism does not imply the marginalization of scholarship embedded in research traditions. The value added by analytic eclecticism depends after all upon demonstrating how different sorts of findings and mechanisms emerging from existing research practices can be reconceptualized and integrated as elements of more complex explananda. Analytic eclecticism’s distinctive utility stems from its awareness of the strengths and tradeoffs of the approaches employed by existing traditions, and from its recognition of the particular intellectual gains generated by these traditions in relation to substantive problems. In fact, what keeps analytic eclecticism from devolving into a perspective in which “everything matters” is the presumption that the analyses produced within research traditions are valuable for the purpose of identifying many of the factors that are likely to matter most. The objective of analytic eclecticism is to uncover how these factors matter in relation to specific research questions, not to generate an ever- expanding list of all imaginable causal factors that can influence world politics. Eclectic scholarship that is inattentive to theories embedded in research traditions runs the risk of missing important insights, reinventing the wheel, or producing analyses that appear idiosyncratic or unintelligible to other scholars. The distinctiveness of analytic eclecticism arises from its effort to specify how elements of different causal stories might coexist as part of a more complex argument that bears on problems of interest to both scholars and practitioners. This requires engaging and utilizing, not displacing, the well-organized research efforts undertaken by committed adherents of various traditions. Of course, when drawing upon theories or narratives developed in competing research traditions, there is the danger of theoretical incoherence linked to the problem of incommensurability across traditions. The incommen-surability thesis, as articulated by Paul Feyerabend among others, argues that the concepts, terms, and standards used in one theoretical approach, because they are formulated on the basis of distinct assumptions about knowledge in the context of distinct theoretical vocabularies, are not interchangeable with those used in another theoretical approach.20 Thus, an eclectic theory drawing upon research traditions founded on competing ontological and episte- mological principles can produce an artificial homogeni- zation of incompatible perspectives along with a host of unrecognized conceptual problems that subvert the aims of the theory.21

**Systems are complex – the aff’s attempt to act on a linear understanding of causality fails and should be replaced**

**Gell-Mann, 97** – Murray, Nobel Laureate in Physics and professor at the Santa Fe Institute and co-chairman of the Science Board (“Chapter 1: The Simple and the Complex,” *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

A history of the U.S. Constitutional Convention of 1787 may make much of the conflicting interests of small states and large states, slave states and free states, debtors and creditors, agricultural and urban populations, and so forth. But the compromises invented by particular individuals and the role that such individuals played in the eventual ratification of the Constitution would also be stressed. The outcome could have been different if certain particular people had died in an epidemic just before the Convention, even though the big issues would have been the same. How do we think about alternative histories? Is the notion of alternative histories a fundamental concept? The fundamental laws of nature are:(1) the dynamical law of the elementary particles— the building blocks of all matter— along with their interactions and(2) the initial condition of the universe near the beginning of its expansion some ten billion years ago. Theoretical physicists seem to be approaching a real understanding of the first of these laws, as well as gaining some inklings about the second one. It may well be that both are rather simple and knowable, but even if we learn what they are, that would not permit us, even in principle, to calculate the history of the universe. The reason is that **fundamental theory is probabilistic** in character (contrary to what one might have thought a century ago). The theory, even if perfectly known, predicts not one history of the universe but probabilities for a **huge array of alternative histories**, which we may conceive as forming a branching tree, with probabilities at all the branchings. In a short story by the great Argentine writer Jorge Luis Borges, a character creates a model of these branching histories in the form of a garden of forking paths. The particular history we experience is co-determined, then, by the fundamental laws and by an inconceivably long sequence of **chance events**, each of which could turn out in various ways. This fundamental indeterminacy is exacerbated for any observer—or set of observers, such as the human race—by ignorance of the outcomes of most of the chance events that have already occurred, since only a very limited set of observations is available. Any observer sees only an extremely coarse-grained history. The phenomenon of chaos in certain nonlinear systems is a very sensitive dependence of the outcome of a process on tiny details of what happened earlier. When chaos is present, it still further amplifies the indeterminacy we have been discussing. Last year, at the wonderful science museum in Barcelona, I saw an exhibit that beautifully illustrated chaos. A nonlinear version of a pendulum was set up so that the visitor could hold the bob and start it out in a chosen position and with a chosen velocity. One could then watch the subsequent motion, which was also recorded with a pen on a sheet of paper. The visitor was then invited to seize the bob again and try to imitate exactly the previous initial position and velocity. No matter how carefully that was done, the subsequent motion was quite different from what it was the first time. Comparing the records on paper confirmed the difference in a striking way. I asked the museum director what the two men were doing who were standing in a corner watching us. He replied, "Oh, those are two Dutchmen waiting to take away the chaos." Apparently, the exhibit was about to be dismantled and taken to Amsterdam. But I have wondered ever since whether the services of those two Dutchmen would not be in great demand across the globe, by organizations that wanted their chaos taken away. Once we view alternative histories as forming a branching tree, with the history we experience co-determined by the fundamental laws and a huge number of accidents, we can ponder the accidents that gave rise to the people assembled in this room. A fluctuation many billions of years ago produced our galaxy, and it was followed by the accidents that contributed to the formation of the solar system, including the planet Earth. Then there were the accidents that led to the appearance of the first life on this planet, and the very many additional accidents that, along with natural selection, have shaped the course of biological evolution, including the characteristics of our own subspecies, which we call, somewhat optimistically, Homo sapiens. Finally we may consider the accidents of genetics and sexual selection that helped to produce the genotypes of all the individuals here, and the accidents in the womb, in childhood, and since that have helped to make us what we are today. Now most accidents in the history of the universe don’t make much difference to the coarse-grained histories with which we are concerned. If two oxygen molecules in the atmosphere collide and then go off in one pair of directions or another, it usually makes no difference. But the fluctuation that produced our galaxy, while it too may have been insignificant on a cosmic scale, was of enormous importance to anything in our galaxy. Some of us call such a chance event a "frozen accident." I like to quote an example from human history. When Arthur, the elder brother of King Henry VIII of England, died—no doubt of some quantum fluctuation—early in the sixteenth century, Henry replaced Arthur as heir to the throne and as the husband of Catherine of Aragón. That accident influenced the way the Church of England separated from the Roman Catholic Church (although the separation itself might have occurred anyway) and changed the history of the English and then the British monarchy, all the way down to the antics of Charles and Diana. It is the frozen accidents, along with the fundamental laws, that give rise to regularities and thus to effective complexity. Since the fundamental laws are believed to be simple, it is mainly the frozen accidents that are responsible for effective complexity. We can relate that fact to the tendency for more and more complex entities to appear as time goes on. Of course there is no rule that everything must increase in complexity. Any individual entity may increase or decrease in effective complexity or stay the same. When an organism dies or a civilization dies out, it suffers a dramatic decrease in complexity. But the envelope of effective complexity keeps getting pushed out, as more and more complex things arise. The reason is that as time goes on frozen accidents keep accumulating, and so more and more effective complexity is possible. That is true even for non-adaptive evolution, as in galaxies, stars, planets, rocks, and so forth. It is well-known to be true of biological evolution, where in some cases higher effective complexity probably confers an advantage. And we see all around us the appearance of **more and more complex** regulations, instruments, computer software packages, and so forth, even though in many cases certain things are simplified. The tendency of more and more complex forms to appear in no way contradicts the famous second law of thermodynamics, which states that for a closed (isolated) system, the average disorder ("entropy") keeps increasing. There is nothing in the second law to prevent local order from increasing, through various mechanisms of self-organization, at the expense of greater disorder elsewhere. (One simple and widespread mechanism of self-organization on a cosmic scale is provided by gravitation, which has caused material to condense into the familiar structures with which astronomy is concerned, including our own planet.)Here on Earth, once it was formed, systems of increasing complexity have arisen as a consequence of the physical evolution of the planet over some four and half billion years, biological evolution over four billion years or so, and, over a very short period on a geological time scale, human cultural evolution. The process has gone so far that we human beings are now confronted with **immensely complex** ecological and social problems, and we are in urgent need of better ways of dealing with them. When we attempt to tackle such difficult problems, we naturally tend to break them up into more manageable pieces. That is a useful practice, but it has **serious limitations.** When dealing with any nonlinear system, especially a complex one, **it is not sufficient to think of the system in terms of parts or aspects identified in advance**, then to analyze those parts or aspects separately, and finally to combine those analyses in an attempt to describe the entire system. Such an approach is not, by itself, a successful way to understand the behavior of the system. In this sense there is truth in the old adage that the whole is more than the sum of its parts. Unfortunately, in a great many places in our society, including academia and most bureaucracies, prestige accrues principally to those who study carefully some aspect of a problem, while discussion of the big picture is relegated to cocktail parties. It is of crucial importance that we learn to supplement those specialized studies with what I call a crude look at the whole. Now the chief of an organization, say a head of government or a CEO, has to behave as if he or she is taking into account all the aspects of a situation, including the interactions among them, which are often strong. It is not so easy, however, for the chief to take a crude look at the whole if everyone else in the organization is concerned only with a partial view. Even if some people are assigned to look at the big picture, it doesn’t always work out. A few months ago, the CEO of a gigantic corporation told me that he had a strategic planning staff to help him think about the future of the business, but that the members of that staff suffered from three defects: • They seemed largely disconnected from the rest of the company. • No one could understand what they said. • Everyone else seemed to hate them. Despite such experiences, it is vitally important that we supplement our specialized studies with serious attempts to **take a crude look at the whole.**

## \*\*AT\*\*

### Framework

**The role of the ballot is an intellectual engagement in good research practices of predictions. This engages in knowledge production that is good for scholarship and complexity.**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

Analytic eclecticism does not constitute an alternative model of research. It is an intellectual stance a researcher can adopt when pursuing research that engages, but does not fit neatly within, established research traditions in a given discipline or field. We identify analytic eclecticism in terms of three characteristics that distinguish it from conventional scholarship embedded in research traditions. First, it proceeds at least implicitly on the basis of a pragmatist ethos, manifested concretely in the search for middle-range theoretical arguments that potentially speak to concrete issues of policy and practice. Second, it addresses problems of wide scope that, in contrast to more narrowly parsed research puzzles designed to test theories or fill in gaps within research traditions, incorporate more of the complexity and messiness of particular real-world situations. Third, in constructing substantive arguments related to these problems, analytic eclecticism generates complex causal stories that forgo parsimony in order to capture the interactions among different types of causal mechanisms normally analyzed in isolation from each other within separate research traditions. This is not the first call for something resembling eclec-ticism. In addition to Lindblom and Cohen, numerous scholars have issued pleas for a more practically useful social science—or, following Aristotle, a “phronetic” social science—oriented more toward social commentary and political action than toward inter-paradigm debates.3 In international relations, prominent scholars, some even iden-tified with particular research traditions, have acknowledged the need for incorporating elements from other approaches in order to fashion more usable and more comprehensive forms of knowledge. For example, Kenneth Waltz, whose name would become synonymous with neorealism, argued in his earlier work: “ The prescriptions directly derived from a single image [of international relations] are incomplete because they are based upon partial analyses. The partial quality of each image sets up a tension that drives one toward inclusion of the others . . . One is led to search for the inclusive nexus of causes.”4 An ardent critic of realist theory, Andrew Moravcsik, would have to agree with Waltz on this point: “The outbreak of World Wars I and II, the emergence of international human rights norms, and the evolution of the European Union, for example, are surely important enough events to merit comprehensive explanation even at the expense of theoretical parsimony.”5 Similarly, in an important symposium on the role of theory in comparative politics, several prominent scholars emphasized the virtues of an “eclectic combination” of diverse theoretical perspectives in making sense of cases, cautioning against the excessive “sim-plifications” required to apply a single theoretical lens to grasp the manifold complexities on the ground.6 As far as programmatic statements go, these views are all consistent with the spirit of analytic eclecticism. Whether these positions are readily evident in research practice, how-ever, is quite another matter. For the most part, social sci-entific research is still organized around particular research traditions or scholarly communities, each marked by its own epistemic commitments, its own theoretical vocabulary, its own standards, and its own conceptions of “progress.” A more effective case for eclectic scholarship requires more than statements embracing intellectual pluralism or multi- causal explanation. It requires an alternative understanding of research practice that is coherent enough to be distinguishable from conventional scholarship and yet flex-ible enough to accommodate a wide range of problems, con-cepts, methods, and causal arguments. We have sought to systematically articulate such an understanding in the form of “analytic eclecticism,” emphasizing its pragmatist ethos, its orientation towards preexisting styles and schools of research, and its distinctive value added in relating academic debates to concrete matters of policy and practice.

**Openness to complex scenarios extends beyond academia- it spills over into good research practices and political implementation.**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

We discuss these examples of eclectic scholarship for the purposes of illustration only. Our hope is simply to have established here, in no more than a preliminary manner, the distinctiveness and potential utility of analytic eclecticism in fields in which there already exist established research traditions**.** The works discussed above take on socially important problems formulated so as to bypass or transgress the theoretical boundaries established by specific research traditions. Moreover, each of the works makes a conscious effort to transcend restrictive assumptions about which aspects of social reality are more fundamental, choosing to develop more complex causal stories featuring the interplay of a wide range of mechanisms**.** And each features a clear, if implicit, pragmatic engagement with substantive dilemmas that extend beyond the academe into the world of policy and practice. Conclusion: The Challenges and Payoffs of Analytic Eclecticism Eclectic approaches are not without costs and risks. We have already considered above **t**he potential dangers of theoretical incoherence linked to the possible incommensurability of research traditions**.** These dangers**,** we realize,are serious.But, as we noted above, they are also ubiquitous in political science even when practiced more conventionally. **I**ncommensurabilitycan, in principle**,** exist across theories within research traditions as well as across applications of the same theory in different contexts**.** More importantly, as we noted above, the problem is not entirely insurmountable, at least in the context of pragmatist inquiry**.** Although caution is required, there are possibilities for the intersubjective translation of specific theoretical constructs once these are detached from the metaphysical principles or epistemic commitments associated with contending research traditions**.** There remains the problem of how eclectic scholars can demonstrate the quality and utility of their work to those working in diverse research traditions. By its very definition, eclectic scholarship lacks a Lakatosian “protective belt” that can shield substantive analyses from questions about core premises and assumptions. It also lacks the kinds of epistemic norms and uniform standards that enable research traditions to evaluate individual contributions and proclaim some degree of internal progress. Equally problematic is the fact that an eclectic approach is likely to draw a wider range of criticism informed by the varied standards and practices of varied research traditions. This does not justify forgoing eclectic inquiry, however. Rather, it puts the onus on eclectic researchers to demonstrate their attentiveness to standards and expecta-tions associated with different research traditions. While the particular criteria employed by any one research tradition may not be appropriate for evaluating explicitly eclectic approaches, eclectic scholars do need to be clear about their own evidentiary standards for different pieces of their arguments, and about the reliability of particular sources in the eyes of the research communities thattypically handle those sources. By self-consciously pursuing a broad understanding of the assumptions, practices, limitations, and objectives of alternative research traditions, a particular eclectic treatment can develop its own problem-specific set of “cross-epistemic judgments”108 that can be used to assess the quality and reliability of the individual observations, interpretations, logics, and sources employed in an eclectic causal story**.** This differs little from the challenge faced by social scientists who rely on historical scholarship and who must make judgments about the quality of information in light of contending traditions of historiography.109

**The alt resolves the shortcomings of the current scientific method**

**Hosseinie and Mahzoon, 11** – \*Radmarz, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University, and \*\*Mojtaba, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University (“Irreducibility and emergence in complex systems and the quest for alternative insights,” Complexity, vol. 17, is. 2, November/December 2011, article first published 6/23/11, Wiley)RK

SUGGESTIONS FOR SOME METAPHYSICAL REFINEMENTS

Attempting to resolve a dilemma like emergence, we have to surpass the conventional metaphysics and try to grasp a more profound insight of the universe. This is tantamount to a partial fulfillment of man's search and sustained quest for the identification of the essential elements of nature, which of course derives from his faith and conviction that they indeed exist. Such underlying essential elements can in no sense be incidental, either phenomenologically or in the laws that condition the phenomena incurred in various realm of scientific experience. An essential feature is thrust toward unity in diversity, which is of the utmost prominence and is intricately mingled with almost every property of the nature. Trying to logically deduce this postulate leads to a paradox. As Hegel has emphasized, this essential becomes understandable only in the **realm of intellect**, which begins at the utmost ability of reason. Every profound metaphysical structure that attempts to unravel the scientific paradoxes like emergence has to encounter the essential concept of unity in diversity in its predicates, and considers it in its axiomatic agenda. All scientific laws from different disciplines have a few common obligations, which implicitly accompany them. These obligations encompass scientific laws and rule them as their souls. Two of these obligations are symmetry and optimality. Most of the scientific laws implicitly obey these rules. Although in different disciplines and for different laws, the interpretation of symmetry and optimality are not alike, the simple essence of each of them seems to be identical. Even in a more profound metaphysics, they seem to unify under a more fundamental principle. Our metaphysical system must deal with these two essential rules and intelligently discover their efficacious status in the universe. The metaphysical features we discussed above must be complied and synchronized in a metaphysical system. Here, we illustrate briefly an outline of our suggestive method. Imagine this puzzle: build four triangles by six equal match sticks. As we know, this problem is not solvable in the plane, or in other words, it is impossible to solve it if we bound ourselves to planar purview. The solution is a tetrahedron, which is a spatial configuration. Many paradoxes of science are similar to this puzzle. We would successfully solve them if we **transcend our perspective**. The correct way to insightfully understand and analyze the nature is not reduction but transcendence. Metaphysically, a substantial whole and its constitutional parts are almost of no metaphysical distinction, and holism in physical sense is equilevelar to reduction but in different direction. Holism and reduction deal with different scopes and functional scales of a system. The metaphysical method we state here is perpendicular to both reductionism and holism. We name this method transcendentionism. Detailed discussion about this method requires further elaborative essays. However, briefly speaking, transcendentionism deals with a completely different type of cause, which we call transcendental or existential cause. This cause is a metaphysical concept and is not objective, rather it is deductive and its necessity would be proved by logical inference. Based on this transcendental causality, we will be able to illustrate an imaginary big picture of the universe (and for every natural system) which is metaphorically like a cone. At the higher and hidden levels of this cone, existential causes complementarily combine, which is the source of symmetry and optimality of laws of the nature. The combinations of existential causes are their projections on the lower level. These projections are existential causes for further lower levels. Consequently, there would be a hierarchy for each and every system, in which there exists a single cause at its vertex and potentially infinitely many projections at its base. This structure justifies the postulate of unity in diversity. Such metaphysical approach is applicable in mathematics and is conjectured to be capable to substitute a fundamental theory in place of the set theory.

**Better risk analysis accesses best impact calculus- proves try or die risk equations wrong**

**Brown, 2011** – Professor of Operations Research Deparment at the Naval Postgraduate School (Gerald, “Making Terrorism Risk Analysis Less Harmful and More Useful: Another Try”, [http://faculty.nps.edu/gbrown/docs/MakingTerrorismRiskAnalysisLessHarmfulandMoreUseful.pdf)//BZ](http://faculty.nps.edu/gbrown/docs/MakingTerrorismRiskAnalysisLessHarmfulandMoreUseful.pdf%29//BZ)

5. Better risk analysis is easy. We have tried, by exposition and example, to show that correctly applying existing techniques of applied probability, modeling, and optimization can provide useful insights for guiding effective allocation of limited defensive resources. Unfortunately, feeding expert judgments into the Risk = Threat × Vulnerability × Consequence framework is not how to do it—for example, because the framework omits crucial information needed to predict and manage risks (such as correlations among terms, or bangfor-the-buck information about risk reductions achieved by implementing different subsets of possible actions); because its key terms are not well deﬁned (Cox 2008); because our experts often lack the information needed to provide useful estimates, even if the concepts made sense; and because the framework has never been shown to produce good results (e.g., better than random). Better risk analysis is easy, but requires replacing the TVC approach with more useful analyses. Ezell concludes with a brief account of the “substantial resources” that the U.S. government has been investing in “research to develop and test new theories and approaches,” and of a ﬁve-year debate “about PRA good vs. PRA bad.” This misses the fact that whether PRA is good or bad—or, rather, useful or useless—depends on how it is done. Rather than continuing to devote “considerable resources” to creating simplistic, unvalidated, and lowperforming “new theories and approaches” such as the TVC framework, we believe that the United States would be served far better by having competent risk analysts apply well-established techniques from operations research and risk analysis to model uncertainty and to robustly improve our infrastructure resilience and defensive resource allocations. Techniques of reliability analysis, causal modeling, simulation-optimization, robust and hierarchical optimization, and diversiﬁcation and hedging of investment portfolios against uncertainties can demonstrably do far more than expert judgments and TVC calculations, for a fraction of the cost, to make our infrastructures more secure and resilient to natural and manmade attacks. To get there, however, we must stop denying that the TVC framework has fundamental logical and practical ﬂaws that make it invalid for risk assessment. Ezell prefaces his paper with the aphorism: “All models are wrong, but some are useful.” However, there is no guarantee that TVC models are useful in general, or usually, for correctly assessing attack risks or setting priorities, for reasons discussed in our paper and its references (e.g., that TVC typically omits the information that attackers use to decide when and where to attack). While the TVC framework offers simplicity, it conﬁnes analysis within a framework that does not best serve the operators and planners who are working diligently to protect our people and infrastructure. It is time to adopt more useful analytics. We must also stop pretending that our experts can produce predictively useful probabilities as in puts to the framework when they lack adequate information; stop pouring money into “research” to develop simplistic and ﬂawed “new approaches” that do not address the fundamental limitations of the current approach; and start replacing it with sound predictive and prescriptive techniques, such as those listed above. Only by vigilantly identifying, discussing, acknowledging, and rejecting ﬂaws in approaches put forth under the name of “risk analysis” can professional risk analysts protect the long-term credibility and value of their profession. In our opinion, the TVC framework is a prime example of a currently fashionable approach that should not be used, and competent risk analysts should inform their clients of its deep technical ﬂaws and use better analytics instead. Our reasons are fully explained in our paper and its references. We appreciate this opportunity to summarize some of them.

**Complexity makes direction based policy making useless – prefer an open ended approach**

**Saperstein 96** [Alvin, professor of physics at Wayne State, “The Prediction of Unpredictability: Applications of the New Paradigm of Chaos in Dynamical Systems to the Old Problem of the Stability of a System of Hostile Nations,” in Chaos Theory in the Social Sciences, supra, at 139, 152. LO]

One of the peculiar challenges of Complexity for the public policymaker – as opposed to, say, a biologist, computer scientist, chemist, mathematician, or even social scientist – is that the nonlinearity and unpredictability it posits as being fundamental characteristics of complex systems are profoundly subversive of how we have traditionally understood public policymaking. Complex adaptive systems are said to be highly sensitive to initial conditions, as well as potentially subject to a variety of both positive and negative feedback loops that act either to amplify or dampen the effect of exogenous perturbations. As a result, although the development of such systems is not random, it nonetheless essentially entirely unpredictable over the long term. This fundamental unpredictability introduces great challenges for the public policymaker, because it seems to explode the very idea that the complex adaptive social systems of the human world may be purposefully manipulated in order to bring about specific desired situational outcomes. What is public policymaking about, after all, if not deliberately creating perturbations in the current state of affairs in order to produce a specific, desired situational outcome at some point in the future? Complexity insights may lend themselves well to innovations in the policymaking process whereby linear strategic planning paradigms are replaced by scenario based approaches designed to maximize relevant decision-makers’ repertoire of adaptively responsive behaviors with which to confront unpredicted systemic perturbations. Complexity may also help us improve nuclear C2 systems, recognize the need to bring a wide range of institutional players together in addressing “wicked problems,” understand the dangers of nuclear proliferation, and ascertain ways to impede the organizational effectiveness of terrorist adversaries. These are valuable things indeed. And of course there is wisdom, too, simply in knowing when one is facing a really hard challenge. But Complexity would seem to provide great frustrations for anyone wishing to go further into affirmative, direction-focused policymaking, for it presents a difficult paradox. Even as Complexity seems to offer the potential for even very small policy inputs to bring about transformative change in a complex adaptive social system – the result of nonlinearity and positive feedback loops, in a kind of policy-world analogue to Edward Lorenz’s famous “butterfly effect” – it also seems to suggest that many such deliberate perturbations are likely to have no significant impact at all. (Complex systems are often quite resilient, being able to absorb significant perturbations without undergoing system-transformative effects.) Indeed, the extreme sensitivity of complex systems to initial conditions and the very potential for nonlinear feedback that makes it possible for small inputs to have dramatic effects also suggests that a policymaker will not be able to predict just what effects, if any, his intervention will have – or even whether they will be “good” or “bad.” As has been said of complex systems more generally, their “sensitive dependence on initial conditions is profoundly disruptive of the ability to develop rational expectations, especially when any stochastic shocks are present,”18 and indeed Complexity Theory actually denies the possibility of long-term predictions.19 Systems as complex as human society are expected to be characterized by significant and irreducible uncertainties,20 and if “[a]ny effort at long-term prediction in nonlinear systems is highly suspect” under the best of circumstances, it is surely “impossible to make long-term predictions concerning group interactions” in society.21 Complexity scholars have long recognized that applying its insights to the understanding of human systems offers us, in Ilya Prigogine’s words, “both hope and threat.” It offers “hope, since even small fluctuations may grow and change the overall structure,” but it also contains a sort of threat, “since in our universe the security of stable, permanent rules seems gone forever.”22 In Thad Brown’s delightful description, if it is true that “[t]he purpose of theory is to make nature stand still when our backs are turned, [as] Einstein reportedly said,” political scientists must confront the fact that “nature often laughs and dances around behind us.”23 In this sense, complexity seems quite unkind to theorists. From a policymaker’s perspective, however, the problem is more insidious than just teaching us lessons in impermanence and insecurity, or confounding our ability to articulate an explanatory model. Complexity is particularly subversive of policymaking because of its implications for our ability to control the world around us. If the animating idea of public policymaking is to apply effort and resources today in order to bring about a desired change in the future state of affairs, Complexity seems to subvert its very core. If Michael McBurnett is right, for instance, the opinion shifts associated with U.S. primary election campaigns have “a positive Lyapunov exponent,”24 perhaps the most important thing this demonstrates is that they cannot be predicted. This sort of conclusion is very problematic for the policymaker, for as Saperstein has observed, “[t]he possibility of prediction implies the possibility of deliberate control.” “If prediction is not possible,” however, “there is no way of knowing the outcome of a given act or policy, which is synonymous with saying control doesn’t exist.”25 And if, in turn, there is no control, what do we have policymakers for?

**Openness to complexity is necessary for good research methods and finding solutions to issues**

**Sil and Katzenstein, 2010** – Sil is an Associate Professor of Political Science at the University of Pennysylvania while Katzenstein is a Professor of International Studies at Cornell (Rudra and Peter, “Analytic Eclecticism in the Study of World Politics: Reconfiguring Problems and Mechanisms across Research Traditions”, part of UPenn articles collection, [http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf)//BZ](http://www.polisci.upenn.edu/faculty/RSEclectic2010.pdf%29//BZ)

This article defines, operationalizes, and illustrates the value of analytic eclecticism in the social sciences, with a focus on the fields of comparative politics and international relations. Analytic eclecticism is not an alternative model of research or a means to displace or subsume existing modes of scholarship. It is an intellectual stance that supports efforts to complement, engage, and selectively utilize theoretical constructs embedded in contending research traditions to build complex arguments that bear on substantive problems of interest to both scholars and practitioners. Eclectic scholarship is marked by three general features. First, it is consistent with an ethos of pragmatism in seeking engagement with the world of policy and practice, downplaying unresolvable metaphysical divides and presumptions of incommensurability and encouraging a conception of inquiry marked by practical engagement, inclusive dialogue, and a spirit of fallibilism. Second, it formulates problems that are wider in scope than the more narrowly delimited problems posed by adherents of research traditions; as such, eclectic inquiry takes on problems that more closely approximate the messiness and complexity of concrete dilemmas facing “real world” actors. Third, in exploring these problems, eclectic approaches offer complex causal stories that extricate, translate, and selectively recombine analytic components—most notably, causal mechanisms— from explanatory theories, models, and narratives embedded in competing research traditions. The article includes a brief sampling of studies that illustrate the combinatorial potential of analytic eclecticism as an intellectual exercise as well as its value in enhancing the possibilities of fruitful dialogue and pragmatic engagement within and beyond the academe.

**The world is inherently unpredictable. Accepting this is the only way to true freedom.**

**Eve et al 96** [Dr. Raymond A. Eve is a Professor-Sociology & Anthropology at UTA, Sara Horsfall professor of sociology at Texas Wesleyan University, Mary E. Lee President of Texas Distance Learning Association, “Foreward: Chaos and Social, Science” in “Chaos, Complexity, and Sociology: Myths, Models, and Theories” LO]

Traditional hard science bases its canons of proof on the successful prediction of the results of controlled experiment or observation in a context of agreement which established fact and mathematical and logical coherence. Much of the universe, given reasonable margins of random variation and a license to describe it in statistical rather than absolute terms, can be well understood in this way. This method, which has proved enormously useful and will continue to do so, is now shown to have limits; the new science shows us what they are and how other methods can take up where the traditional ones leave off. The possibility of predicting an event relies on two assumptions: chat the chain of causes is recoverable and chat the universe is fundamentally deterministic in its nature. If the capacity for straightforward prediction is conceived of as comprising the sum total of understanding, what we have learned from the investigation of complex feedback situations is, on the face of it, dispiriting. One discovery is that the initial conditions of a process may be irrecoverable: any chain of reasoning one might try to use to establish them would require the examination of an exponentiating number of possible earlier states, each of which in turn has an exponentiating number of originating conditions, and so on. A second discovery is that since such processes are critically dependent on their initial conditions-what is known as the "butterfly effect"-and a starting point arbitrarily close to the true one could produce quite different results, there is no way of even approximating those conditions using traditional methods of inference. A corollary is chat if we are given a set of initial conditions, even which great exactness, the interactions among the elements of such a system will rapidly overwhelm any algorithm for their solution, as when destinations are continually added to the traveling salesman problem in mathematics. Thus it looks as if we may have to abandon the close dependence of proof on prediction. It might be argued that those parts of the universe that behave in nonlinear ways are still deterministic in theory, though not in practice, in the sense that we are not yet able to establish the chain of determination. In other words, all we need to solve the traveling salesman problem is a big enough and fast enough computer. If this argument held, we would be back on the familiar ground of traditional science, which has always been able to argue consistently that the world is deterministic but that the limits of present human observation prevent us from establishing cause in many cases. But we know now thatthis inability to establish the chain of causal connection is not just a limitation in practice, solvable for instance by improved instrumentation or measurement, but a limitation in theory: there is not enough time or information-processing power in the universe to complete the necessary calculations. The computer would have to be growing at a rare faster than the speed of light and miniaturizing itself below the threshold of the quantum graininess of space. And if causal determination in such cases is true in theory bur theoretically impossible to establish in practice, determinism as a universal proposition begins to approach the condition of a metaphysical assertion, neither provable nor unprovable, of the type that Ludwig Wittgensrein showed to be meaningless. Thus the first great root offered by the new science is the concept of the inherently unpredictable situation-a situation unpredictable in itself not just by virtue of the limits of its observer. We are spared the labor of attempting to predict such situations and thus can devour our efforts to understanding them in different ways, for "unpredictable" does not necessarily mean "unintelligible," or inaccessible to knowledge and understanding. Prediction may in such cases simply nor be one of the handles by which a thing can be cognitively picked up, but there may be others. Another way of putting this is to say that freedom now recovers its meaning as a word usable by science and philosophy. In a knowably deterministic universe, freedom is either a nonsense word or a word mistaken in its usual definition. The same could even be said for a deterministic universe whose chain of determining causes could never be observed or established but only if there were an absolute separation between ontology and epistemology, that is, between what a thing is and how it is known. But, as we shall see, the new science confirms the message that has been coming to us from a number of sources already, such as quantum mechanics: that the observer and the observed cannot be detached from each other and that observation knowing is an ontological event. If the future of parts of the universe is inherently unknowable, that is an ontological fact about them, giving the attribution to them of causal determination the status of a religious act of faith. What can be predicated of them is freedom. And freedom now becomes a rich and useful concept, reciprocally defined by, and suggesting ways to understand, nonlinear complexity.

**Their reductionist science is too limited to adequately describe the world – new approaches that account for complexity are key**

**Hosseinie and Mahzoon, 11** – \*Radmarz, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University, and \*\*Mojtaba, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University (“Irreducibility and emergence in complex systems and the quest for alternative insights,” Complexity, vol. 17, is. 2, November/December 2011, article first published 6/23/11, Wiley)RK

THE QUEST FOR ALTERNATIVE INSIGHTS IN FOUNDATIONS OF SCIENCE The obscure status of contemporary science encountering the concept of complexity in systems has not remained unobserved by most of scientists. According to our brief survey, it is obvious that the concept of emergence **has become a dilemma.** As Humphreys26 remarked, we are now in the midst of a tangle of familiar issues none of which have easy solution. Kim2 urged that contemporary emergentism is inherently unstable and it threatens to collapse into either reductionism or more serious forms of dualism. He also asserted that downward causation has “paradoxical nature”2. However, we may unravel this paradoxical nature by reforming our scientific theories and/or methods. The request of science to more profound explanatory and unifying theories has been commonly mentioned recently and urged by some sophisticated scientists and philosophers, of some who have already begun the discovery of such theories. Mitchell5 remarks that what is required is a “richer conceptual framework” to explain dynamically the reciprocal causations between the emergent property and its constituent parts. Kim15 asserts that the downward causation has to be founded on a stronger theoretical base. Wójcicki21 emphasizes our mathematical theories to be “too weak” to adequately capture the relations between the fundamental laws and the phenomena we seek to explain. Kauffman and Clayton12 urge that biology presently lacks a “theory for the organization of processes”; and that no adequate theory of the organization of many biological processes currently exists in scientific or philosophical literature, “even in outline”12. Kim asserts an adequate “theory for organization” to be missing in the current emergentism–reductionism debates2. Goldstein27 believes that none of our mathematical methods and computer simulations offers much promise in detecting the emergent levels. These authors, amongst many others, have suggested some alternative approaches to obviate the paradox of emergence. Goldstein suggests considering the emergent level as a new “natural kind,” i.e., a construct reflecting how nature is parsed according to its observed regularities. Novel natural kind constructs appear when science, mathematics, or philosophy introduces new ways of looking at nature leading to the recognition of regularities not perceived before. He believes that as natural kinds become more accepted they will be taken as theoretical primitives27. Bickhard and Campbell7 adopt the notion of “process organization” based on quantum field theory as an explaining reason for generation of emergent properties in systems. Alberts proposes “essentialism” instead of reductionism. He advocates a method of simplification without reduction based on essentialism. He emphasizes that we must simplify without losing the essence of the system and/or behavior28. These proposals, how much clever they are, cannot resolve the dilemma of emergence. The authors of this essay believe that the concept of emergence is superfluous, and we are potentially capable to overcome this paradox, at least to some extent. All events and entities in the world have certain causes and are therefore epiphenomena. If we are not capable of understanding the cause of a so called emergent event, it does not mean that it does not exist! We would attain to understand and explain this causality by innervating our scientific methods with wiser theories. To achieve these theories, we need to fundamentally reform our interpretation of universe by empowering our intellect. Toward this goal, we have to recline on a more powerful and profound philosophical structure to underlie our scientific paradigms. Scientific paradigms have become mature enough to pervade their domains far to their boundaries and now they require **fundamental reform**, i.e., scientific revolution. This enterprise, however, requires strong insight and innovation, either in philosophy and science. Bohm many years ago emphasized that physics has become more and more dogmatic and mechanical25. Collier remarked the need for new innovative change in foundations of science and mentioned the important flaws in contemporary science: “This [change] requires creativity and openness that is not necessarily encouraged in current scientific training” (p. 10)29. He insightfully added: “If we don't open up our methodology, however, we risk being as foolish as the drunk who lost his watch in the alley, but looks for it under the street lamp because the light is brighter there” (p. 10)29. Lieber1 wisely emphasized many years ago: “We need a new paradigm, that is, **we must invent new modes of experimentation**” (p. 9); i.e., we need a scientific revolution. He added: “[D]eep facts [in science] … necessarily demand a universal correspondence between all modes of experimentation and that science in its present state… is essentially limited… by a particular mode of experimentation” (p. 5)1. The recent attention to emergence is an evidence for such a quest; as Bersini et al.22 noticed, the reason of concern about emergence in the last 10 years is the general conversion of science towards an “integrative view” of the nature. SOME PHILOSOPHICAL WITHDRAWALS IN CONTEMPORARY SCIENCE There are many phenomena in the world not reducible to a set of separate individuals. Nevertheless, we employ such a set of reduced individuals as alphabetic constituent in order to study the phenomena. We actually invent and acquire those individuals as a language for the ease of studying the system. For example, a symphony is not actually composed from combinations of music notes. A composer uses music notes as an instrument or a language for writing, documenting, and transferring music composition to others, but the music is not actually made of the notes. The composer generates the music as an intuitional big picture in mind. This big picture is an irreducible picture. Actually, a scientist who attains to understand a truth, holds such a big picture about that truth in her mind. She must be cautious not to misguide her insights by forging the truth to be only definable and explainable by the reduced alphabets, to be understood and acknowledged by other scientists. Every scientific definition or theory in this sense amounts a kind of reduction; which spontaneously **destructs** the corresponding original **truth.** Physics is very expert in this type of destructive reductionism. Most of physical quantities have been defined in this way. Mass is a very familiar example. Originally, mass is a very special revelation of a global mysterious truth we conceptually name matter. We reduce this revelation to a mere quantity. Then reduce this quantity to be just a number. This sequential reduction is not withdrawal by itself. The crisis happens when we forget that the number per se is just a reduced picture of reality and is not the very truth at all! Consequently, we misunderstand the truth with its reduced picture. Many physical concepts such as mass, energy, and force are reduced pictures of a whole. We have reduced them in an appropriate way to become quantifiable. When we talk about matter, if we forget that we actually talk about a mysterious truth with inherent potential for, say, life; then we have to impel ourselves that life emerges from this crude meaningless matter. We must not forget that physical theories and concepts are not facts. Physics by itself **is a reduced view of nature.** If we really quest for a more sincere understanding of the universe, we have to illustrate the so-called big picture of the universe scientifically; just as what a musician does when composes music. All sciences have to work closely together to illustrate a more truthful picture of the world. Physical theories and entities would be far from reality if we isolate physics from other sciences. Of course, phenomena of other sciences would be emergent according to this isolated science!

**We shouldn’t focus debate on contrived internal link scenarios – humility and realistic claims lead to more educational policy discussions.**

**Tetlock & Gardner 11** [Philip Tetlock is a professor of organizational behavior at the Haas Business School at the University of California-Berkeley, AND Dan Gardner is a columnist and senior writer for the Ottawa Citizen and the author of The Science of Fear, received numerous awards for his writing, including the Michener Award, M.A. History from York, "OVERCOMING OUR AVERSION TO ACKNOWLEDGING OUR IGNORANCE" July 11 [www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/](http://www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/%22%20%5Ct%20%22_blank) LO]

The optimists are right that there is much we can do at a cost that is quite modest relative to what is often at stake. For example, why not build on the IARPA tournament? Imagine a system for recording and judging forecasts. Imagine running tallies of forecasters' accuracy rates. Imagine advocates on either side of a policy debate specifying in advance precisely what outcomes their desired approach is expected to produce, the evidence that will settle whether it has done so, and the conditions under which participants would agree to say "I was wrong." Imagine pundits being held to account. Of course arbitration only works if the arbiter is universally respected and it would be an enormous challenge to create an analytical center whose judgments were not only fair, but perceived to be fair even by partisans dead sure they are right and the other guys are wrong. But think of the potential of such a system to improve the signal-to-noise ratio, to sharpen public debate, to shift attention from blowhards to experts worthy of an audience, and to improve public policy. At a minimum, it would highlight how often our forecasts and expectations fail, and if that were to deflate the bloated confidence of experts and leaders, and give pause to those preparing some "great leap forward," it would be money well spent. But the pessimists are right, too, that fallibility, error, and tragedy are permanent conditions of our existence. Humility is in order, or, as Socrates said, the beginning of wisdom is the admission of ignorance. The Socratic message has always been a hard sell, and it still is—especially among practical people in business and politics, who expect every presentation to end with a single slide consisting of five bullet points labeled "The Solution." We have no such slide, unfortunately. But in defense of Socrates, humility is the foundation of the fox style of thinking and much research suggests it is an essential component of good judgment in our uncertain world. It is practical. Over the long term, it yields better calibrated probability judgments, which should help you affix more realistic odds than your competitors on policy bets panning out. Humble works. Or it is at least superior to the alternative.

**The aff’s contrived internal link chains center around flawed scholarship that destroy the educational value of debate.**

**Berube 2000** [David, Associate Proff of Speech Communication and Director of Debate at the University of South Carolina. Contemporary Argumentation and Debate, [http://www.cedadebate.org/CAD/index.php/CAD/article/viewFile/248/232](http://www.cedadebate.org/CAD/index.php/CAD/article/viewFile/248/232%22%20%5Ct%20%22_blank) LO]

The lifeblood of contemporary contest debating may be the extended argument. An extended argument is any argument requiring two or more distinct causal or correlational steps between initial data and ending claim. We find it associated with advantages to comparative advantage cases, with counterplan advantages. with disadvantages, permutation and impact turnarounds, some kritik implications. and even probabilistic topicality arguments. In practice, these often are not only extended arguments. they are causal arguments using mini-max reasoning. Mini-max reasoning is defined as an extended argument in which an infinitesimally probable event of high consequence is assumed to present a highly consequential risk. Such arguments, also known as low probability high-consequence arguments, are commonly associated with "risk analysis” The opening statement from Schell represents a quintessential mini-max argument. Schell asked his readers to ignore probability assessment and focus exclusively on the impact of his claim. While Schell gave very specific reasons why probability is less important than impact in resolving this claim, his arguments are not impervious to rebuttal. What was a knotty piece of evidence in the 1980s kick-started a practice in contest debating which currently is evident in the ubiquitous political capital disadvantage codenamed "Clinton." Here is an example of the Clinton disadvantage. In theory, plan action causes some tradeoff (real or imaginary) that either increases or decreases the President's ability to execute a particular agenda. Debaters have argued the following: Clinton (soon to be Gore or Bush) needs to focus on foreign affairs. A recent agreement between Barak and Assad needs presidential stewardship. The affirmative plan shifts presidential focus to Nigeria that trades off with focus on the Middle East. As a result. the deal for the return of the Golan Heights to Syria fails. Violence and conflict ensues as Hizbollah terrorists launch guerilla attacks into northern Israel from Lebanon. Israel strikes back. Hizbollah incursions increase. Chemical terrorism ensues and Israel attacks Hizbollah strongholds in southern Lebanon with tactical nuclear weapons. Iran launches chemical weapons against Tel Aviv. Iraq allies with Iran. The United States is drawn in. Superpower miscalculation results in all-out nuclear war culminating in a nuclear winter and the end of all life on the planet. This low-probability high-consequence event argument is an extended argument using mini-max reasoning. The appeal of mini-max risk arguments has heightened with the onset of on-line text retrieval services and the World Wide Web, both of which allow debaters to search for particular words or word strings with relative ease. Extended arguments are fabricated by linking evidence in which a word or word string serves as the common denominator, much in the fashion of the sorities (stacked syllogism): A α B, B α C, C α D, therefore A α D. Prior to computerized search engines, a contest debater's search for segments that could be woven together into an extended argument was incredibly time consuming. The dead ends checked the authenticity of the extended claims by debunking especially fanciful hypotheses. Text retrieval services may have changed that. While text retrieval services include some refereed published materials, they also incorporate transcripts and wire releases that are less vigilantly checked for accuracy. The World Wide Web allows virtually anyone to set up a site and post anything at that site regardless of its veracity. Sophisticated super search engines, such as Savvy Search® help contest debaters track down particular words and phrases. Searches on text retrieval services such as Lexis-Nexis Universe® and Congressional Universe® locate words and word strings within n words of each other. Search results are collated and loomed into an extended argument. Often, evidence collected in this manner is linked together to reach a conclusion of nearly infinite impact, such as the ever-present specter of global thermonuclear war. Furthermore, too much evidence from online text retrieval services is unqualified or under-qualified. Since anyone can post a web page and since transcripts and releases are seldom checked as factual, pseudo-experts abound and are at the core of the most egregious claims in extended arguments using mini-max reasoning. In nearly every episode of fear mongering ... people with fancy titles appeared .. .. [F]or some species of scares ... secondary scholars are standard fixtures .... Statements of alarm by newscasters and glorification of wannabe experts are two telltales tricks of the fear mongers' trade. . . : the use of poignant anecdotes in place of scientific evidence, the christening of isolated incidents as trends, depictions of entire categories of people as innately dangerous .... (Glassner 206, 208) Hence, any warrant by authority of this ilk further complicates probability estimates in extended arguments using mini-max reasoning. Often the link and internal link story is the machination of the debater making the claim rather than the sources cited in the linkage. The links in the chain may be claims with different, if not inconsistent, warrants. As a result, contextual considerations can be mostly moot. Not only the information but also the way it is collated is suspect. All these engines use Boolean connectors (and, or, and not) and Boolean connectors are dubious by nature. Boolean logic uses terms only to show relationships - of inclusion or exclusion among the terms. It shows whether or not one drawer fits into another and ignores the question whether there is anything in the drawers. . . . The Boolean search shows the characteristic way that we put questions to the world of information. When we pose a question to the Boolean world, we use keywords, buzzwords, and thought bits to scan the vast store of knowledge. Keeping an abstract, cybernetic distance from the source of knowledge, we set up tiny funnels .... But even if we build our tunnels carefully, we still remain essentially tunnel dwellers. Thinking itself happens only when we suspend the inner musings of the mind long enough to favor a momentary precision, and even then thinking belongs to musing as a subset of our creative mind. . . . The Boolean reader, on the contrary, knows in advance where the exits are, the on-ramps, and the well-marked rest stops. . . . The pathways of thought, not to mention the logic of thoughts, disappear under a Boolean arrangement of freeways." (Heim 18, 22-25) Heim worries that the Boolean search may encourage readers to link together nearly empty drawers of information, stifling imaginative, creative thinking and substituting empty ideas for good reasons. The problems worsen when researchers select word strings without reading its full context, a nearly universal practice among contest debaters. Using these computerized research services, debaters are easily able to build extended mini-max arguments ending in Armageddon. Outsiders to contest debating have remarked simply that too many policy debate arguments end in all-out nuclear war: consequently, they categorize the activity as foolish. How many times have educators had contest debaters in a classroom discussion who strung out an extended mini-max argument to the jeers and guffaws of their classmates? They cannot all be wrong. Frighteningly enough, most of us agree. We should not ignore Charles Richet's adage: "The stupid man is not the one who does not understand something - but the man who understands it well enough yet acts as if he didn't" (Tabori 6). Regrettably, mini-max arguments are not the exclusive domain of contest debating. "Policies driven by the consideration of low risk probabilities will, on the whole, lead to low investment strategies to prevent a hazard from being realized or to mitigate the hazard's consequences. By comparison, policies driven by the consideration of high consequences, despite low probabilities, will lead to high levels of public investment" (Nehnevajsa 521). Regardless of their persuasiveness, Bashor and others have discovered that mini-max claims are not useful in resolving complex issues. For example, in his assessment of low probability, potentially high-consequence events such as terrorist use of weapons of mass destruction, Bashor found simple estimates of potential losses added little to contingency planning. While adding little to policy analysis, extended arguments using mini-max reasoning remain powerful determinants of resource allocation. As such, they need to be debunked. Experts agree. For example, Slavic advocates a better understanding of all risk analysis since it drives much of our public policy. "Whoever controls the definition of risk controls the rational solution to the problem at hand. If risk is defined one way, then one option will rise to the top as the most cost-effective or the safest or the best. If it is defined another way, perhaps incorporating qualitative characteristics or other contextual factors, one will likely get a different ordering of action solutions. Defining risk is thus an exercise in power" (699). When probability assessments are eliminated from risk calculi, as is the case in mini-max risk arguments, it is a political act, and all political acts need to be scrutinized with a critical lens.

### Perm

**The permutation is a totalitarian imposition of rationalizing order on complexity; reject the totalizing compromise that cedes agency.**

**Gordon, 2003** –Professor of Philosophy at Rochester (Dr. Kerry, “The Impermanence of Being: Toward A Psychology Of Uncertainty”, accessed from Michigan Journal Database)//BZ

I have a recurring dream: I am lost at sea. Murderous waves crash down, a gale howls. Barely able to stay afloat, I thrash about, panic-stricken. Without direction, I have no idea how to get to safety. The feeling is utter chaos. Desperate, I’m bailing like a madman, trying to empty the ocean with a bucket. I am, as Alice would say, running twice as hard as I can to stay exactly where I am. Through my confusion and despair, I hear whispered words, “Lord help me for my boat is so small and your sea is so immense.” This is the point when I inevitably wake up. Naturally, I am greatly relieved that it has only been a dream, until it dawns on me that there’s not much difference between my dreaming and waking life. Making my way through the day, I am indeed overwhelmed by a sea of detail that I can’t ever seem to get a handle on—family, finances, health, job—all the variables of my life rushing toward me in flood of chaotic uncertainty. This is not my beautiful life. Where are the security and order that was promised me? All my carefully constructed truths, everything I have counted on and identified with, seems suddenly false or lost or changing. And when I pick up the morning newspaper, there’s more. Not only my life but the whole world seems to be deconstructing. I’m back in my dream—drowning in a sea of uncertainty. Having practiced for many years as a psychotherapist, I have good reason to believe that I am not alone in my anxiety; it is common to a great majority of those of us living in the modern industrialized world. In Care of the Soul, one of the most widely read books of the past decade, psychologist Thomas Moore (1992) lists emptiness, a loss ofcore values, and the general malaise ofmeaningless- ness as hallmarks of our culture. It is hard to deny Moore’s assertion. Only pick up a copy of Time magazine or turn on the TV. Everywhere we look, images of discord and dissent remind us that the political, economic, and social structures we once held as inviolable are rapidly eroding. Our typical response to chaos is an instinctual drive to impose order and regain control. Our fear of uncertainty often impels us toward irrational and sometimes bizarre behavior. As in my dream where I am trying to empty the ocean with a bucket, such neurotic activity does little to assuage our anxiety and may even serve to increase it. And neither should we imagine that only individuals can be affected in this way. Stalinism, Nazism, McCarthyism, and fundamentalism of all stripes are examples of the kind of irrationality of which institutions and governments are capable in the name of order. Rollo May (1977) stated that totalitarianism “may be viewed as serving a purpose on a cultural scale parallel to that in which a neurotic symptom protects an individual from a situation of unbearable anxiety” (p. 12). His further statement that “people grasp at political authoritarianism in the desperate need for relief from anxiety” (May, 1977, p. 12) suggests that perhaps, in the end, it is precisely our resistance to chaos and uncertainty and our almost pathological need to impose order where there may, in fact, be none at all, that is the cause of so much of our dis-ease. I am reminded of the words of systems theorist Kenneth Boulding, who warned that we always “run into the temptation of imposing an order on the universe which may not really be there” (Stamps, 1980, p. i). The human need for order, given the apparent unpredictability of the natural world, is probably as old as history. This explains why universal laws have been the holy grail sought by science. The evolution of the classical scientific paradigm, beginning with Newton, reflects a 350-year progression toward this goal. Establishing the existence of universal laws has allowed us to encounter the world with enormous confidence and creativity. And although there is no doubt that this is one of the great accomplishments of Western culture, something has gone terribly awry. When we fail to distinguish between discovering order in nature and imposing order on nature, we have lost relationship with the very thing we yearn to know. Whereas once we were students of nature, looking to her for meaning, we now denigrate her in the belief that it is our inalienable right to have dominion. There can be little doubt that the classical scientific paradigm has provided “the means for systematically acting on the world, for predicting and modifying the course of natural processes, for conceiving devices that can harness and exploit the forces and material resources of nature” (Prigogine & Stengers, 1984, p. 37). That being the case, it would be naive to suggest that science has been a purely empirical endeavor devoted solely to the pursuit of knowledge. The human power drive, to have dominion over the natural world, is also at play here.

**Perm fails- ideological bias coopts complexity theory**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

So it is understandable that both the academic and policy-making communities are vulnerable to searching for panaceas. Aware they are ensconced in an epoch of contradictions, ambiguities, and uncertainties, and thus sensitive to the insufficiency of their conceptual equipment, officials and thoughtful observers alike may be inclined to seek security through an overall scheme that seems capable of clarifying the challenges posed by the emergent epoch. Complexity theory is compelling in this regard. The very fact that it focuses on complex phenomena and presumes that these are subject to theoretical inquiry, thereby implying that complex systems are patterned and ultimately comprehensible, may encourage undue hope that humankind’s problems can be unraveled and effective policies designed to resolve them pursued. Stirring accounts of The Santa Fe Institute, where complexity theory was nursed into being through the work of economists, statisticians, computer scientists, mathematicians, biologists, physicists, and political scientists in a prolonged and profoundly successful interdisciplinary collaboration, kindled these hopes.5 The stories of how Brian Arthur evolved the notion of increasing returns in economics, of how John H. Holland developed genetic algorithms that could result in a mathematical theory capable of illuminating a wide range of complex adaptive systems, of how Stuart Kauffman generated computer simulations of abstract, interacting agents that might reveal the inner workings of large, complicated systems such as the United States, of how Per Bak discovered self-organized criticality that allowed for inferences as to how social systems might enter upon critical states that jeopardize their stability, of how Murray Gell-Mann pressed his colleagues to frame the concept of co-evolution wherein agents interact to fashion complex webs of interdependence—these stories suggested that progress toward the comprehension of complex systems was bound to pay off. And to add to the sense of panaceas, expectations were heightened by the titles these scholars gave to their works written to make their investigations meaningful for laymen. Consider, for example, the implications embedded in Holland’s Hidden Order6 and Kauffman’s At Home in the Universe7 that creative persistence is worth the effort in the sense that eventually underlying patterns, a hidden order, are out there to be discovered.8 There are, in short, good reasons to be hopeful: if those on the cutting edge of inquiry can be sure that human affairs rest on knowable foundations, surely there are bases for encouragement that the dilemmas of the real, post-cold war world are susceptible to clarification and more effective control. Never mind that societies are increasingly less cohesive and boundaries increasingly more porous; never mind that vast numbers of new actors are becoming relevant to the course of events; never mind that money moves instantaneously along the information highway and that ideas swirl instantaneously in cyberspace; and never mind that the feedback loops generated by societal breakdowns, proliferating actors, and boundary-spanning information are greatly intensifying the complexity of life late in the 20th Century—all such transformative dynamics may complicate the task of analysts, but complexity theory tells us that they are not beyond comprehension, that they can be grasped. I do not say this sarcastically. Rather, I accept the claims made for complexity theory. It has made enormous strides and it does have the potential for clarifying and ultimately ameliorating the human condition. Its progress points to bases for analytically coping with porous boundaries, societal breakdowns, proliferating actors, fast-moving money and ideas, and elaborate feedback loops. But to stress these strides is not to delineate a time line when they will reach fruition in terms of policy payoffs, and it is here, in the discrepancy between the theoretical strides and their policy relevance, that the need to highlight theoretical limits and curb panacean impulses arises.

**Rejection is key – allowing the aff solidifies their ideology and undermines the alt**

**Chapman, 04** – Jake, renowned systems thinker and former professor of energy systems at the Open University (“Preface to the second edition,” *System failure Why governments must learn to think differently*, Second edition, First Published 2002, second edition 2004, Demos, http://www.demos.co.uk/files/systemfailure2.pdf)RK

System Failure offered some answers to these questions, but underestimated the deeper fears involved. Managers who cannot control are afraid of being regarded as ineffective or weak. policymakers who are paralysed by unpredictability are regarded as ditherers – and again ineffective. In both cases they are likely to be replaced by people who claim that they can control and predict. So adopting a systemic perspective may challenge an individual’s self-esteem, their perceived worth in the world and their career. These fears can be addressed by making an explicit virtue of a systemic approach – but in a culture which is focused on delivery and control it will require support and acceptance from those above. Learning difficulties System Failure argues strongly for learning as the key way to handle complexity and its associated lack of predictability and control. It includes a detailed analysis of the obstacles to learning that exist within government and the civil service. However, that analysis omitted the biggest obstacle of all – namely the presumption of knowing best. This presumption **completely closes the door to any learning experience** – if one already knows the answer or knows best there is no need to learn anything. As with mechanistic thinking there is a great deal in the culture that reinforces this attitude. People who are promoted to higher positions of authority interpret their promotion as a validation of their knowing best. Politicians who are elected interpret it as an endorsement of their views. And within Whitehall there is sense that people there know best – if only because to be a senior civil servant in Whitehall one has to outshine one’s peers. Knowing best not only closes the door to learning, it also closes off the possibility of understanding other perspectives. Individuals andagencies with different perspectives – and hence different preferences, priorities and action plans – are dismissed in terms of vested interests or political opposition (both of which may be true, but neither of which affords a manager or policy-maker to ignore the perspective).

### Empirics!

**Empirics fail – they ignore too many factors**

**Chapman, 04** – Jake, renowned systems thinker and former professor of energy systems at the Open University (“Preface to the second edition,” *System failure Why governments must learn to think differently*, Second edition, First Published 2002, second edition 2004, Demos, http://www.demos.co.uk/files/systemfailure2.pdf)RK

In System Failure I argue that the dominant approach to policymaking was based on mechanistic and reductionist thinking. This is actually more deeply embedded in our culture, particularly the culture of government, than I had appreciated. A conversation with a civil servant, politician or senior public sector manager will yield a large number of phrases based upon the notion that government and organisations are machine-like: ‘stepping up a gear’, ‘changing direction’, ‘driving through change’, ‘the machinery of government’ and ‘policy levers’ are common examples – and there are many more. Describing policy and public service issues in terms of ‘delivery’ is another. One can ‘deliver’ a parcel or a pizza, but not health or education. All public services require the ‘customer’ to be an active agent in the ‘production’ of the required outcomes. Education and health care initiatives simply fail if the intended recipients are unwilling or unable to engage in a constructive way; they are outcomes that are co-produced by citizens. Mechanistic thinking also underlies some of the approaches to improving policy-making – for example, the so-called ‘evidence based’ approach. It may seem self-evident that a policy based on ‘evidence of what works’ is bound to be more effective than one without such a basis. However, the notion that it is possible to obtain evidence of what works includes a number of presumptions that are **clearly not universally true.** First, it presumes that the evidence collected in one context will apply in another. In other words it presumes that context is relatively unimportant or is sufficiently similar. This is demonstrably not the case for all the public services. Policies which improve crime, health and education in Tunbridge Wells can be expected to be quite different from those required in Burnley or a deprived estate in Manchester. As is slowly being recognised, context is critical and varies significantly. Secondly, the ‘evidence-based’ approach presumes a linear, or at least unproblematic, relationship between cause and effect. In fact, complex systems involve **hundreds of nested feedback loops**, which result in **significantly non-linear behaviour**. Change in such systems is at least as much to do with internal structure as with external interventions. And thirdly, the evidence on which policy is based is inevitably quantitative and statistical and as such conceals as much as it reveals. Unintended consequences, which occur in all areas of public policy, are **systematically ignored** because the evaluation only measures the intended outcomes. Also it is usually impossible to link policy and interventions unambiguously because too many other variables are also changing.

### Experts!

**Experts and models fail at predicting or preventing terrorism- attempts are only illusory and waste millions of dollars, while still casting citizens to risk of an existential attack.**

**Brown, 2011** – Professor of Operations Research Deparment at the Naval Postgraduate School (Gerald, “Making Terrorism Risk Analysis Less Harmful and More Useful: Another Try”, [http://faculty.nps.edu/gbrown/docs/MakingTerrorismRiskAnalysisLessHarmfulandMoreUseful.pdf)//BZ](http://faculty.nps.edu/gbrown/docs/MakingTerrorismRiskAnalysisLessHarmfulandMoreUseful.pdf%29//BZ)

3. The poor performance of expert judgments about future political and conﬂict events is well established by empirical studies. Ezell writes that “The authors’ implication that the U.S. intelligence community’s judgment on our adversaries is less useful than purely random guesses is presented without proof and is aloof . . .”. In fact, we do prove (constructively, via our ﬁrst example) that any judgment of an adversary’s attack probabilities can be self-defeating, and hence strictly less accurate than a purely random guess, if the adversary uses the judgment to decide where to attack. More importantly, we stated that: “Although we have made these points here using simple hypothetical examples, empirical research also abundantly conﬁrms the inability of our best experts to usefully predict what other nations, combatants, or political leaders will actually do: expert probability judgments for such events tend to be slightly less useful than purely random guesses [Tetlock 2005]” (emphasis in original). The references we cite support our claims. Ezell objects that, for DARPA’s Integrated Crisis Early Warning System (ICEWS), “the standards for accuracy are high—80% accuracy and 70% precision.” But, our original point stands. The following warning, from an evaluation of the actual (not desired) performance of the ICEWS system, shows why the “high standards” to which Ezell refers do not translate to high predictive accuracy in practice. We early on discovered that we could come close to achieving our benchmark performance metrics [80% accuracy and 70% precision] using naıve models, which ¨ included lagged values of the EoI [Events of Interest] dependent variable, and a small number of policyirrelevant correlates like size of population, presence or absence of mountainous terrain, and the like. Though such a naıve model may retrospectively achieve accept- ¨ able levels of overall performance, it is useless for real world applications . . . [M]odels that rely on dependent variable lags, as seen above, provide only an illusion of high performance or goodness of ﬁt. A naıve model con- ¨ taining only lags of the dependent variable may score well on indicating the presence of some EoIs, but will miss every new onset and cessation of conﬂict, literally by deﬁnition. The illusory good performance metrics also operate as a disincentive to continue the search for more insightful, actionable crisis antecedents. (O’Brien 2010, emphases added) The public derives no beneﬁt from “the illusion of high performance.” We suggest that, rather than retrospectively overﬁtting regression models to past data, and then misleadingly advertising that “the standards for accuracy are high—80% accuracy and 70% precision,” it is more useful to recognize that such models do not perform well prospectively; that they are too often “useless for real world applications” (or nearly so) in reducing terrorism risks; and that we need to deal with this fact. . Poor risk analysis threatens us all. Ezell’s passionate defense that “[m]any of these intelligence analysts risk their lives collecting data and making these difﬁcult estimates” provides no guarantee that the resulting estimates are valid or useful. We believe they are not because the TVC framework does not ask the right questions or elicit relevant information for predicting risks, as explained in our paper. (It is also far from clear just what is life-threatening about making up numerical estimates for threat, vulnerability, or consequence numbers—a task frequently assigned to junior staff in various organizations competing for DHS dollars.) Of course, using a framework that is incapable of predicting how what we do will affect risk—as the discussion of Tables III and IV of our paper shows is the case for the TVC framework—may put the lives of other citizens at risk, by allocating defensive resources where they do little or no good, or even do harm, as shown in our examples. But the occupational hazards of guessing at “TVC” numbers are not self-evidently lifethreatening, or even career-limiting, for those involved.

### Models!

**Linear analysis ensures policy failure – turns case**

**Sa, 04** – Deug Whan, Dong-U College, South Korea, (“CHAOS, UNCERTAINTY, AND POLICY CHOICE: UTILIZING THE ADAPTIVE MODEL,” International Review of Public Administration, vol. 8, no. 2, 2004, scholar)RK

Arguments have arose that state that in a rapidly changing policy environment, limitations exists to explaining new policy phenomena with the Newtonian paradigm based on the assumption of order, stability, and equilibrium. The existing policy paradigm based on certainty and generality has difficulty in diagnosing and resolving such policy phenomena as modern society assumes more diversities, complexity, disorder, instability, and disequilibrium.1 Policy studies based on the Newtonian paradigm have emphasized stability, order, equilibrium that focus on how to secure policy objectives, achieve certainty, and rationality through enforcement means (Howlett and Ramesh 1995: 139). The prime examples are the rational model, the incremental model, which flourished heated argument until the mid-1960s, and the garbage can model in the 1970s. The basic assumptions of these models were grounded on certainty (or limited certainty), that current policies had continuity over some period of time linearly up to the future, as stability and equilibrium were normal, those policies out of the normality range were regarded as exceptions. The policies that failed to accomplish intended objectives, were considered, policy failures (Barry 1992; Kempe 1996; Amey Albrecht and Amir 1997; Ascher 1999; Scott 1999) and were attributed to; poor policy design, incompetent administrations, problems in implementation of policies, and interference of political process (Birkland 2001: 1 8 7 ) . As chaotic situations increase in complex phenomena, uncertain changes and non-linear developments have become general. The existing policy models have been losing ground in the explanation of such phenomena. Though the Newtonian policy paradigm is useful in some areas (Elliott and Kiel 1997), the status quo where **complex policy situations** are under way **desperately calls for a new policy model** which can offer appropriate explanations and solutions.2 In most cases, policies are considered dynamic evolutionary processes which create patterns different from old policies through incessant interactions with the given environment. In this sense, modern policies can be seen as adaptive evolutionary processes and should be considered dynamic while the existing policies are static. In point, policies should orient themselves to co-evolutionary ways of settling problems. In particular, such policies have structures in which a variety of sub-systems connected with each other by non-linear feedback loops interact in a non-linear way. Governments face very difficult times of choosing policies that deal with the management of incremental uncertainty, chaos and complexity (Kiel 1994; Johnson and Burton 1994). This paper aims to develop a new theory model to aid governmental policy choice and establish utility in this era of uncertainty and chaos.

**An infinite number of variables that can all alter the outcome of an event make predictions impossible.**

**Suteanu 5** [Cristian, associate professor at St. Mary’s University, “Complexity, Science and the Public : The Geography of a New Interpretation” Theory Culture Society 2005 22: 113 LO]

Events that are unique are not supposed to teach us anything and therefore their relevance is generally viewed as questionable (Todorov, 1995). Studies of complex systems contradict this idea. They confirm scientifically something that was known for a long time, although it seemed to clash with classic theory: unique or rare events can be relevant; birth and death are obvious examples. Each life is unique, social trajectories are unique, but this does not affect their relevance. This problem is particularly restrictive in the natural sciences, where reproducibility is key. Events have to be reproducible in order to become meaningful. It is right here, at the core of the hard sciences, that complexity has altered the link between the classic meaning of reproducibility and the relevance of an event. Starting from studies on natural phenomena (Lorentz, 1963), it was found that in many practical situations, systems exhibit a significant sensitivity with respect to what are called ‘initial conditions’. This means that if some process started in slightly different circumstances, its evolution would have been different. How different? How fast do the paths of two scenarios diverge, if they start from almost identical, but still different, conditions? This can be specified, and one way of doing so is to compute the so-called Lyapunov exponent (Peitgen et al., 1992). If the Lyapunov exponent is positive (a hallmark of ‘chaos’, in the scientific sense), it means that the paths diverge very fast, exponentially, and the larger the value, the faster the divergence: or, in other words, the higher the sensitivity to initial conditions. This sensitivity is a guarantee that, in fact, each trajectory, each evolutionary scenario, is unique. A huge diversity of expression can be generated by one and the same kind of process, simply because it starts from different situations. Thus, a rich variety of phenomena can be produced (Abraham and Shaw, 1984). As is often the case, such a discovery also led to biased interpretations. The idea that the so-called ‘path dependence’ is the one essential feature of market evolution, based on an overemphasis of the role of ‘random’ events, has been justifiably criticized (Liebowitz and Margolis, 1990). Complex systems involving social and economic aspects rely on numerous interactions at different scales: the systems as such may be more or less sensitive to small events. Depending on when they occur, on where they occur and on the circumstances which surround them, such events may pass without a noticeable trace, or they may produce effects that become amplified to the point of reaching a large part of the system and representing what we call a ‘crisis’ (Bak et al., 1988). It is Per Bak’s merit to have revealed the significance of cumulative actions and their effects with regard to interactions among different scales (Bak, 1996). His theory shows why it is challenging to predict the outcome of a single isolated event, which will be followed by numerous interactions, in circumstances in which the details keep changing. Considering the problem the other way round – trying to figure out the detailed facts after they have developed into a large event – is, in principle, also problematic, as shown by theoretical studies (Suteanu et al., 1997).

**Linear models fail for predictions- misses all minor events**

**Saperstein, 97** – professor of physics at Wayne State (Alvin, “Complexity, Chaos, and National Security Policy: Metaphors or Tools?, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch05.html>) //BZ

The role of the policy maker, whether in a domestic or an international system, is to master the system: to be able to take actions now which will lead to desirable events, or avoid undesirable events, in the future. Thus he/she must be able to predict the outcome of current activities: if I do A, A’ will result; if I do B, B’ will result, etc. Prediction is the transfer of knowledge of a system from its present to its future. The ability to make such transfers is usually based upon an understanding of the system—unless recourse is made to auguries or direct communications from a transcendental power. Excluding the roles of divination or divinity, we must help the rational policy maker to understand in order to master. It is clear that the set of metaphors which underline our thoughts and discussions about the political world determine our responses to matters of war and peace.3 Action often follows theory. (But purely pragmatic responses—not the best, but adequate—are often resorted to by some societies with some success. Non-theoretical societies do survive, sometimes.) Moreover, we also recognize that our metaphors may also shape that political world.4 The "field of endeavor," within which we are trying to find appropriate responses, is not itself fixed apriori; its contours may be molded by our metaphors; the topographic maps relied upon by the competing forces may be altered by the plans and actions of these forces. Hence policy and response are easier and more effective, the more appropriate the available metaphors. It should also be clear that the new metaphors will be helpful in educating that majority of citizens, soldiers, and statesmen which have not experienced chaos and complexity due to the apparent simplicity of the bi-polar world view of the last half-century. It may be easier to have university freshman and military cadets read modern works on complexity and chaos (e.g., Gleick 1987, Waldrop 1992) than have them study Thucydides or von Clausewitz. Metaphors also determine the social acceptability of presenting ideas publicly, thus subjecting them to criticism and possible action. For example, without the intellectual possibility of the dissolution of nations, i.e., complexity, few conceived of (and thus planned for) the end of the Soviet Union (and even fewer for that of its Cold War partner, the U.S.). The new intellectual paradigms should focus attention on the underlying world political realities—chaos and complexities which have always been there, sometimes obscured to many, but always recognized by some. It is important to recognize that our metaphors, just as our goals, the "fields of competition and endeavor," and the events themselves, are constantly changing as a result of our formulating ideas, exploring our world, and attempting to control events and reach goals. We must be careful not to imbed our ideas and "world-pictures" in stone since the stone of the world is often brittle and ruptures catastrophically, or flows and deforms like lava. "He that will not apply new remedies must expect new evils, for time is the greatest innovator." (Philosopher-statesman Francis Bacon, 17th century)

**Predicting events in complex systems is beyond the limits of science – causation is determined by variables that don’t always interact with one another.**

**Vaughan 99** [Professor of Sociology at Columbia, “The Dark Side of Organizations: Mistake, Misconduct, and Disaster” Annual Review of Sociology, Vol. 25 (1999), pp. 271-305 LO]

The search for linearly-founded laws is a search for predictive ability. If we can establish the relationships so that our formalised linear mathematical models are indeed isomorphic with the real world, and our ideal method for doing this is usually thought to be the controlled experiment,9 then we can predict what will happen in a given set of circumstances, provided we have accurate measures of the initial state of the system. Once we can predict, we can engineer the world and make it work in the ways we want it to. We can turn from reflection to engagement. This is a wholly honourable project so far as I am concerned. It is the technological foundation of modernity itself. The trouble is that much, and probably most, of the world doesn’t work in this way. Most systems do not work in a simple linear fashion. There are two related issues here which derive from the non-linearity of reality, despite the availability of non-linear mathematical models which can sometimes be used in place of the general linear model and its derivatives. The first, which is generally discussed in the literature on chaos, is extreme sensitivity to initial conditions in non-linear systems. The classic, and by now well-known, expression of this is in relation to weather systems. Efforts to model weather systems in mathematical terms are faced with the major – and indeed essentially insurmountable – problem that variations in initial conditions of the scale of the force of a butterfly’s wing beat can produce vastly different weather outcomes over quite short time periods. The problem that this raises is one of measurement in terms of accuracy. Lorenz originally encountered the phenomenon when he re-ran some weather data by re-inputting print-out results which were accurate to three decimal places instead of to the six the computer used in internal calculations. Re-inputting data produced very different outcomes because the measures differed in the fourth decimal place. It has to be stressed that the existence of chaotic outcomes of this kind does not involve an abandonment of causality in principle. If we could measure to the degree of accuracy we need then we could model the system, albeit in non-linear terms, and then we could predict what the outcome of changes would be. In practice we can’t. It is precisely this practical limit – that word: ‘limit’ – which seems to set a boundary on science and science-derived technology. This is why the idea of chaos is so attractive to postmodernists. Science seems to have come to the end of its capacities. Rationality seems to be exhausted as a general project. Is it hell as like! Before turning to robust chaos, the basis of that robust rejection of postmodernism as state of mind,10 I want to pick up on the social sciences’ experience of non-linearity through encounters with interactions. The word ‘interaction’ here is not being used in the general sociological sense to describe social interactions among individuals, but in the statistical sense where in the simplest three variable case, the relationship between two variables is modified by the value of a third. This sort of thing crops up all the time in sociology. The issue is that in the social world, and in much of reality including biological reality, causation is complex. Outcomes are determined not by single causes but by multiple causes, and these causes may, and usually do, interact in a non-additive fashion. In other words the combined effect is not necessarily the sum of the separate effects. It may be greater or less, because factors can reinforce or cancel out each other in non-linear ways. It should be noted that interactions are not confined to the second order. We can have higher order interactions and interactions among interactions. It is in principle possible of course to calculate interaction terms and enter them into linear models, and there are statistical programmes (elements in SPSS and the dedicated package GLIM) which exist to do exactly this. What this amounts to is the creation of new variables in the linear equation which represent the interaction among the measured variables. In essence the complexity is locked away in the interaction term. Once there are lots of variables in play this is, to say the least, a difficult business, and it always worries me because it seems to be a way of ignoring the complex character of the reality being investigated. In practical terms in contexts where chaos exists, the effect of interactions is to make the issue of precision of measurement even more important. The effects of interactions are not additive either in themselves or in relation to measurement errors. This means that complex causes can easily generate chaotic outcomes.

### Can still make some predictions

**It’s impossible to even know the factors that could influence the outcome of an event – makes meaningful predictions a pipe dream**

**Suteanu 5** [Cristian, associate professor at St. Mary’s University, “Complexity, Science and the Public : The Geography of a New Interpretation” Theory Culture Society 2005 22: 113 LO]

Contrary to previous expectations, scholars recognized that not only prediction is challenging: even the delineation of the system to be studied is problematic (Prigogine and Stengers, 1986). Sometimes one cannot know in advance what factors should be considered and what factors should be ignored. In other words, the ‘objects’ we mentioned above are not really given. More often than not, they must be constructed. Object definition is a process based on hard choices. The criteria we apply to make these choices are not clearly given either: they may be in part the product of hidden assumptions and concealed factors, as skilfully shown by Midgley (1994). In some cases, the problem becomes even more difficult: far from equilibrium, apparently negligible factors can suddenly turn out to be decisive for the behaviour of the system. This statement alone would have been sufficient for the face of scientific studies to change. From the realization that initial conditions may seriously affect the later evolution of a system, a new understanding of the nature of prediction emerged. Since the slightest difference in initial conditions can involve important differences, which grow over time with respect to system behaviour, there are intrinsic limits concerning prediction. We can never know the initial conditions with infinite precision; so we cannot know how the system will evolve either. All we can have is an approximation of system behaviour for the coming time interval; the longer the interval, the lower the accuracy of prediction. When the accuracy decreases exponentially with time – which is the case for many systems in everyday life – we cannot make meaningful predictions beyond a certain time interval. Previously, the lack of precision in forecasts was considered simply a consequence of inadequate technology or knowledge. Improvements in technology and advancements in theory were supposed to push the limits of predictability as far as we wanted. We suddenly had to realize that, in the case of chaotic systems, our knowledge of system behaviour improves less and less, to the point of becoming imperceptible, even when the information collection process improves dramatically. The Lyapunov exponent becomes thus a symbol of the scientifically proven limited capability of science with respect to prediction.

**It is impossible to accurately predict political events - systems are too complex and an infinite number of variables can drastically alter outcomes.**

**Tetlock & Gardner 11** [Philip Tetlock is a professor of organizational behavior at the Haas Business School at the University of California-Berkeley, AND Dan Gardner is a columnist and senior writer for the Ottawa Citizen and the author of The Science of Fear, received numerous awards for his writing, including the Michener Award, M.A. History from York, "OVERCOMING OUR AVERSION TO ACKNOWLEDGING OUR IGNORANCE" July 11 [www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/](http://www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/%22%20%5Ct%20%22_blank) LO]

But only to some extent, unfortunately. Natural science has discovered in the past half-century that the dream of ever-growing predictive mastery of a deterministic universe may well be just that, a dream. There increasingly appear to be fundamental limits to what we can ever hope to predict. Take the earthquake in Japan. Once upon a time, scientists were confident that as their understanding of geology advanced, so would their ability to predict such disasters. No longer. As with so many natural phenomena, earthquakes are the product of what scientists call "complex systems," or systems which are more than the sum of their parts. Complex systems are often stable not because there is nothing going on within them but because they contain many dynamic forces pushing against each other in just the right combination to keep everything in place. The stability produced by these interlocking forces can often withstand shocks but even a tiny change in some internal conditional at just the right spot and just the right moment can throw off the internal forces just enough to destabilize the system—and the ground beneath our feet that has been so stable for so long suddenly buckles and heaves in the violent spasm we call an earthquake. Barring new insights that shatter existing paradigms, it will forever be impossible to make time-and-place predictions in such complex systems. The best we can hope to do is get a sense of the probabilities involved. And even that is a tall order. Human systems like economies are complex systems, with all that entails. And bear in mind that human systems are not made of sand, rock, snowflakes, and the other stuff that behaves so unpredictably in natural systems. They're made of people: self-aware beings who see, think, talk, and attempt to predict each other's behavior—and who are continually adapting to each other’s efforts to predict each other’s behavior, adding layer after layer of new calculations and new complexity. All this adds new barriers to accurate prediction. When governments the world over were surprised by this year's events in the Middle East, accusing fingers were pointed at intelligence agencies. Why hadn't they seen it coming? "We are not clairvoyant," James R. Clapper Jr, director of national intelligence, told a hearing of the House intelligence committee. Analysts were well aware that forces capable of generating unrest were present in Tunisia, Egypt, and elsewhere. They said so often. But those forces had been present for years, even decades. "Specific triggers for how and when instability would lead to the collapse of various regimes cannot always be known or predicted," Clapper said. That is a considerable understatement. Remember that it was a single suicidal protest by a lone Tunisian fruit seller that set off the tumult, just as an infinitesimal shift can apparently precipitate an earthquake. But even after the unrest had begun, predicting what would follow and how it would conclude was a fool's errand because events were contingent on the choices of millions of people, and those choices were contingent on perceptions that could and did change constantly. Say you're an Egyptian. You're in Cairo. You want to go to the protest but you're afraid. If you go and others don't, the protest will fail. You may be arrested and tortured. But if everyone goes, you will have safety in numbers and be much likelier to win the day. Perhaps. It's also possible that a massive turnout will make the government desperate enough to order soldiers to open fire. Which the soldiers may or may not do, depending in part on whether they perceive the government or the protestors to have the upper hand. In this atmosphere, rumors and emotions surge through the population like electric charges. Excitement gives way to terror in an instant. Despair to hope. And back again. What will people do? How will the government react? Nothing is certain until it happens. And then many pundits declare whatever happened was inevitable. Indeed, they saw it coming all along, or so they believe in hindsight.

**Regardless of knowledge acquired predictions are near impossible. We should instead approach politics slowly and deliberately, experimenting in the small scale in order to reach solutions.**

**Tetlock & Gardner 11** [Philip Tetlock is a professor of organizational behavior at the Haas Business School at the University of California-Berkeley, AND Dan Gardner is a columnist and senior writer for the Ottawa Citizen and the author of The Science of Fear, received numerous awards for his writing, including the Michener Award, M.A. History from York, "OVERCOMING OUR AVERSION TO ACKNOWLEDGING OUR IGNORANCE" July 11 [www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/](http://www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/%22%20%5Ct%20%22_blank) LO]

So we are not blind but there are serious limits to how far we can see. Weather forecasting is a useful model to keep in mind. We joke about weather forecasters but they have some good mental habits we should all practice: making explicit predictions and revising them in response to clear timely feedback. The net result is that weather forecasters are one of the best calibrated of all professional groups studied—up there with professional bridge players. They have a good sense for what they do and do not know. But well calibrated does not mean omniscient. As weather forecasters well know, their accuracy extends out only a few days. Three or four days out, they are less accurate. Beyond a week, you might as well flip a coin. As scientists learn more about weather, and computing power and sophistication grow, this forecasting horizon may be pushed out somewhat, but there will always be a point beyond which meteorologists cannot see, even in theory. We call this phenomenon the diminishing marginal predictive returns of knowledge. In political and economic forecasting, we reach the inflection point surprisingly quickly. It lies in the vicinity of attentive readers of high-quality news outlets, such as The Economist. The predictive value added of Ph.Ds, tenured professorships and Nobel Prizes is not zero but it is disconcertingly close to zero. So we should be suspicious of pundits waving credentials and adopt the old trust-but-verify mantra: test the accuracy of forecasts and continually be on the lookout for new methods that improve results. We must also accept that even if we were to do this on a grand scale, and our forecasts were to become as accurate as we can possibly make them, there would still be failure, uncertainty, and surprise. And The World In Whatever-The-Next-Year-Is would continue to look quite different from the world in whatever the next year is. It follows that we also need to give greater consideration to living with failure, uncertainty, and surprise. Designing for resiliency is essential, as New Zealanders discovered in February when a major earthquake struck Christchurch. 181 people were killed. When a somewhat larger earthquake struck Haiti in 2010, it killed hundreds of thousands. The difference? New Zealand's infrastructure was designed and constructed to withstand an earthquake, whenever it might come. Haiti's wasn't. Earthquakes are among the least surprising surprises, however. The bigger test is the truly unexpected shock. That's when the capacity to respond is critical, as Canada demonstrated following the financial meltdown of 2008. For a decade prior to 2008, Canada's federal government ran budgetary surpluses and used much of that money to pay down accumulated debt. When the disaster struck, the economy tipped into recession, and the government responded with an array of expensive policies. The budget went into deficit, and the debt-to-GDP ratio rose, but by both measures Canada continued to be in far better shape than most other developed countries. If further shocks come in the immediate future, Canada has plenty of capacity to respond—unlike the United States and the many other countries that did not spend a decade strengthening their fiscal foundations. Accepting that our foresight will always be myopic also calls for decentralized decision-making and a proliferation of small-scale experimentation. Test the way forward, gingerly, one cautious step at a time. "Cross the river by feeling for the stones," as the wily Deng Xiaoping famously said about China's economic liberalization. Only madmen are sure they know what the future holds; only madmen take great leaps forward. There's nothing terribly controversial in this advice. Indeed, it's standard stuff in any discussion of forecasting and uncertainty. But critical caveats are seldom mentioned.

### Gotta make predictions

**Studies show that predictions are rarely better than random guesses. Only incorporation of complexity and the uncertainty can improve accuracy.**

**Tetlock & Gardner 11** [Philip Tetlock is a professor of organizational behavior at the Haas Business School at the University of California-Berkeley, AND Dan Gardner is a columnist and senior writer for the Ottawa Citizen and the author of The Science of Fear, received numerous awards for his writing, including the Michener Award, M.A. History from York, "OVERCOMING OUR AVERSION TO ACKNOWLEDGING OUR IGNORANCE" July 11 [www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/](http://www.cato-unbound.org/2011/07/11/dan-gardner-and-philip-tetlock/overcoming-our-aversion-to-acknowledging-our-ignorance/%22%20%5Ct%20%22_blank) LO]

That is all too typical. Despite massive investments of money, effort, and ingenuity, our ability to predict human affairs is impressive only in its mediocrity. With metronomic regularity, what is expected does not come to pass, while what isn't, does. In the most comprehensive analysis of expert prediction ever conducted, Philip Tetlock assembled a group of some 280 anonymous volunteers—economists, political scientists, intelligence analysts, journalists—whose work involved forecasting to some degree or other. These experts were then asked about a wide array of subjects. Will inflation rise, fall, or stay the same? Will the presidential election be won by a Republican or Democrat? Will there be open war on the Korean peninsula? Time frames varied. So did the relative turbulence of the moment when the questions were asked, as the experiment went on for years. In all, the experts made some 28,000 predictions. Time passed, the veracity of the predictions was determined, the data analyzed, and the average expert's forecasts were revealed to be only slightly more accurate than random guessing—or, to put more harshly, only a bit better than the proverbial dart-throwing chimpanzee. And the average expert performed slightly worse than a still more mindless competition: simple extrapolation algorithms that automatically predicted more of the same. Cynics resonate to these results and sometimes cite them to justify a stance of populist know-nothingism. But we would be wrong to stop there, because Tetlock also discovered that the experts could be divided roughly into two overlapping yet statistically distinguishable groups. One group would actually have been beaten rather soundly even by the chimp, not to mention the more formidable extrapolation algorithm. The other would have beaten the chimp and sometimes even the extrapolation algorithm, although not by a wide margin. One could say that this latter cluster of experts had real predictive insight, however modest. What distinguished the two groups was not political ideology, qualifications, access to classified information, or any of the other factors one might think would make a difference. What mattered was the style of thinking. One group of experts tended to use one analytical tool in many different domains; they preferred keeping their analysis simple and elegant by minimizing “distractions.” These experts zeroed in on only essential information, and they were unusually confident—they were far more likely to say something is "certain" or "impossible." In explaining their forecasts, they often built up a lot of intellectual momentum in favor of their preferred conclusions. For instance, they were more likely to say "moreover" than "however." The other lot used a wide assortment of analytical tools, sought out information from diverse sources, were comfortable with complexity and uncertainty, and were much less sure of themselves—they tended to talk in terms of possibilities and probabilities and were often happy to say "maybe." In explaining their forecasts, they frequently shifted intellectual gears, sprinkling their speech with transition markers such as "although," "but," and "however." Using terms drawn from a scrap of ancient Greek poetry, the philosopher Isaiah Berlin once noted how, in the world of knowledge, "the fox knows many things but the hedgehog knows one big thing." Drawing on this ancient insight, Tetlock dubbed the two camps hedgehogs and foxes. The experts with modest but real predictive insight were the foxes. The experts whose self-concepts of what they could deliver were out of alignment with reality were the hedgehogs.

**Their reductionist science is too limited to adequately describe the world – new approaches that account for complexity are key**

**Hosseinie and Mahzoon, 11** – \*Radmarz, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University, and \*\*Mojtaba, Department of Solid Mechanics, School of Mechanical Engineering, Shiraz University (“Irreducibility and emergence in complex systems and the quest for alternative insights,” Complexity, vol. 17, is. 2, November/December 2011, article first published 6/23/11, Wiley)RK

THE QUEST FOR ALTERNATIVE INSIGHTS IN FOUNDATIONS OF SCIENCE The obscure status of contemporary science encountering the concept of complexity in systems has not remained unobserved by most of scientists. According to our brief survey, it is obvious that the concept of emergence **has become a dilemma.** As Humphreys26 remarked, we are now in the midst of a tangle of familiar issues none of which have easy solution. Kim2 urged that contemporary emergentism is inherently unstable and it threatens to collapse into either reductionism or more serious forms of dualism. He also asserted that downward causation has “paradoxical nature”2. However, we may unravel this paradoxical nature by reforming our scientific theories and/or methods. The request of science to more profound explanatory and unifying theories has been commonly mentioned recently and urged by some sophisticated scientists and philosophers, of some who have already begun the discovery of such theories. Mitchell5 remarks that what is required is a “richer conceptual framework” to explain dynamically the reciprocal causations between the emergent property and its constituent parts. Kim15 asserts that the downward causation has to be founded on a stronger theoretical base. Wójcicki21 emphasizes our mathematical theories to be “too weak” to adequately capture the relations between the fundamental laws and the phenomena we seek to explain. Kauffman and Clayton12 urge that biology presently lacks a “theory for the organization of processes”; and that no adequate theory of the organization of many biological processes currently exists in scientific or philosophical literature, “even in outline”12. Kim asserts an adequate “theory for organization” to be missing in the current emergentism–reductionism debates2. Goldstein27 believes that none of our mathematical methods and computer simulations offers much promise in detecting the emergent levels. These authors, amongst many others, have suggested some alternative approaches to obviate the paradox of emergence. Goldstein suggests considering the emergent level as a new “natural kind,” i.e., a construct reflecting how nature is parsed according to its observed regularities. Novel natural kind constructs appear when science, mathematics, or philosophy introduces new ways of looking at nature leading to the recognition of regularities not perceived before. He believes that as natural kinds become more accepted they will be taken as theoretical primitives27. Bickhard and Campbell7 adopt the notion of “process organization” based on quantum field theory as an explaining reason for generation of emergent properties in systems. Alberts proposes “essentialism” instead of reductionism. He advocates a method of simplification without reduction based on essentialism. He emphasizes that we must simplify without losing the essence of the system and/or behavior28. These proposals, how much clever they are, cannot resolve the dilemma of emergence. The authors of this essay believe that the concept of emergence is superfluous, and we are potentially capable to overcome this paradox, at least to some extent. All events and entities in the world have certain causes and are therefore epiphenomena. If we are not capable of understanding the cause of a so called emergent event, it does not mean that it does not exist! We would attain to understand and explain this causality by innervating our scientific methods with wiser theories. To achieve these theories, we need to fundamentally reform our interpretation of universe by empowering our intellect. Toward this goal, we have to recline on a more powerful and profound philosophical structure to underlie our scientific paradigms. Scientific paradigms have become mature enough to pervade their domains far to their boundaries and now they require **fundamental reform**, i.e., scientific revolution. This enterprise, however, requires strong insight and innovation, either in philosophy and science. Bohm many years ago emphasized that physics has become more and more dogmatic and mechanical25. Collier remarked the need for new innovative change in foundations of science and mentioned the important flaws in contemporary science: “This [change] requires creativity and openness that is not necessarily encouraged in current scientific training” (p. 10)29. He insightfully added: “If we don't open up our methodology, however, we risk being as foolish as the drunk who lost his watch in the alley, but looks for it under the street lamp because the light is brighter there” (p. 10)29. Lieber1 wisely emphasized many years ago: “We need a new paradigm, that is, **we must invent new modes of experimentation**” (p. 9); i.e., we need a scientific revolution. He added: “[D]eep facts [in science] … necessarily demand a universal correspondence between all modes of experimentation and that science in its present state… is essentially limited… by a particular mode of experimentation” (p. 5)1. The recent attention to emergence is an evidence for such a quest; as Bersini et al.22 noticed, the reason of concern about emergence in the last 10 years is the general conversion of science towards an “integrative view” of the nature. SOME PHILOSOPHICAL WITHDRAWALS IN CONTEMPORARY SCIENCE There are many phenomena in the world not reducible to a set of separate individuals. Nevertheless, we employ such a set of reduced individuals as alphabetic constituent in order to study the phenomena. We actually invent and acquire those individuals as a language for the ease of studying the system. For example, a symphony is not actually composed from combinations of music notes. A composer uses music notes as an instrument or a language for writing, documenting, and transferring music composition to others, but the music is not actually made of the notes. The composer generates the music as an intuitional big picture in mind. This big picture is an irreducible picture. Actually, a scientist who attains to understand a truth, holds such a big picture about that truth in her mind. She must be cautious not to misguide her insights by forging the truth to be only definable and explainable by the reduced alphabets, to be understood and acknowledged by other scientists. Every scientific definition or theory in this sense amounts a kind of reduction; which spontaneously **destructs** the corresponding original **truth.** Physics is very expert in this type of destructive reductionism. Most of physical quantities have been defined in this way. Mass is a very familiar example. Originally, mass is a very special revelation of a global mysterious truth we conceptually name matter. We reduce this revelation to a mere quantity. Then reduce this quantity to be just a number. This sequential reduction is not withdrawal by itself. The crisis happens when we forget that the number per se is just a reduced picture of reality and is not the very truth at all! Consequently, we misunderstand the truth with its reduced picture. Many physical concepts such as mass, energy, and force are reduced pictures of a whole. We have reduced them in an appropriate way to become quantifiable. When we talk about matter, if we forget that we actually talk about a mysterious truth with inherent potential for, say, life; then we have to impel ourselves that life emerges from this crude meaningless matter. We must not forget that physical theories and concepts are not facts. Physics by itself **is a reduced view of nature.** If we really quest for a more sincere understanding of the universe, we have to illustrate the so-called big picture of the universe scientifically; just as what a musician does when composes music. All sciences have to work closely together to illustrate a more truthful picture of the world. Physical theories and entities would be far from reality if we isolate physics from other sciences. Of course, phenomena of other sciences would be emergent according to this isolated science!

### No effect

**Even minor events trigger a massive butterfly effect**

**Rosenau, 97** – professor emeritus of international affairs at George Washington (James, “Many Damn Things Simultaneously: Complexity Theory and World Affairs”, Complexity, Global Politics, and National Security, <http://www.dodccrp.org/html4/bibliography/comch04.html>) //BZ

It follows from the vulnerability of complex adaptive systems to punctuations of their equilibrium and tumultuous phase transitions that small, seemingly minor events can give rise to large outcomes, that systems are sensitive at any moment in time to the conditions prevailing at that moment and can thus initiate processes of change that are substantial and dramatic. Examples of this so-called "butterfly effect" abound. Perhaps the most obvious concerns the way in which an assassination in 1914 triggered the onset of World War I, but numerous other, more recent illustrations can readily be cited. It is not difficult to reason, for instance, that the end of the Cold War began with the election of a Polish Pope more than a decade earlier, just as the release of Nelson Mandela from prison was arguably (and in retrospect) an event that triggered the end of apartheid in South Africa.16 Sensitivity to Initial Conditions Closely related to the power of small events is the premise that even the slightest change in initial conditions can lead to very different outcomes for a complex adaptive system. This premise can be readily grasped in the case of human systems when it is appreciated that the processes of emergence pass through a number of irreversible choice points that lead down diverse paths and, thus, to diverse outcomes. This is not to imply, however, that changes in initial conditions necessarily result in unwanted outcomes. As the foregoing examples demonstrate, the power of an altered initial condition can lead to desirable as well as noxious results, an insight that highlights the wisdom of paying close attention to detail in the policy-making process.

**The butterfly effect proves how infinitesimal actions can create sweeping effects, proving complexity theory to be me inclusive and accurate compared to linear predictions.**

 **Kissane, 2007** – assistant dean at the Centre d'Etudes Franco-Americain de Management, lecturer at the University of South Australia, PhD from the University of South Australia in International Relations theory (Dylan, “The possibility for theoretical revolution in international politics”, [http://works.bepress.com/dylankissane/16)//BZ](http://works.bepress.com/dylankissane/16%29//BZ)

The butterfly effect - in reality just the popular name for the more correct 'sensitive dependence on initial conditions' - suggests that it is possible that the flutter of a butterfly's wings in Beijing can be responsible for producing a hurricane in South America (Thietart and Forgues 1995, 21). This sensitive dependence on initial conditions is common to all chaotic systems, being found everywhere from meteorology to economics and political science to physics (Lorenz 1963; Brock et al 1991; Richards 1993; Reinhardt 1997). Chaotic systems derive their variety from this sensitive dependence and, as a result, are largely unpredictable long-term. A related element of chaotic systems is the importance of unit or individual unit events to have wide- ranging effects on the wider system. Interactions, even those limited to just two primary units, can and do affect all other units in the system. However, although we know it is possible for such unit level effects to have significant system level impacts, it is either impractical or impossible to collect and analyse such data. In effect, our models are never truly complete and, therefore, never truly correct (Justan 2001). However, the importance of such unit level events on the wider system should not be overemphasised. As has been argued elsewhere: ...not every butterfly creates a distant storm every time it moves from flower to flower. Should this be the case then there would be no stability at all within the climatic system and even short-term predictions - for example, the likelihood of rain tomorrow - would become impossible. Thus, it should be noted, that just as these small events can impact on the wider system in significant ways, they could also not impact on the system in significant ways. There is no compulsion implied, only possibility which, in turn, ensures that the chaotic system is sometimes driven by these tiny events and, at other times, does not react at all, despite being faced with perhaps millions of such small interactions at a time (Kissane 2006,95). Chaotic systems may not seem chaotic. To the observer or analyst they may appear stochastic or even cyclical; indeed, some systems, which were previously thought to be linear or cyclical, have since proved chaotic upon closer study (Gleick 1987, 315-316). It is the argument of this paper that the widely assumed anarchy of the international system can also be considered another misinterpretation of a chaotic system. The fact that there is no overarching authority in the system may make the system anarchic by definition, but it does not exclude the possibility that it is actually chaotic. It might be said that whereas in an anarchic system nobody is in control, in a chaotic system everyone is in control and - in effect - nobody seems to be in control. This is more than a semantic difference - indeed, as the structure of a chaotic international system is outlined in the following section it will become clear that this difference between anarchy and chaos is what provides the chaotic theory with its explanatory edge.

### Entropy

**Localized complexity is possible – our argument isn’t contradictory to entropy**

**Gell-Mann, 97** – Murray, Nobel Laureate in Physics and professor at the Santa Fe Institute and co-chairman of the Science Board (“Chapter 1: The Simple and the Complex,” *Complexity, Global Politics, and National Security*, ed. David S. Alberts and Thomas J. Czerwinski, National Defense University, http://www.dodccrp.org/files/Alberts\_Complexity\_Global.pdf)RK

The tendency of more and more complex forms to appear in no way contradicts the famous second law of thermodynamics, which states that for a closed (isolated) system, the average disorder ("entropy") keeps increasing. There is nothing in the second law to prevent local order from increasing, through various mechanisms of self-organization, at the expense of greater disorder elsewhere. (One simple and widespread mechanism of self-organization on a cosmic scale is provided by gravitation, which has caused material to condense into the familiar structures with which astronomy is concerned, including our own planet.)Here on Earth, once it was formed, systems of increasing complexity have arisen as a consequence of the physical evolution of the planet over some four and half billion years, biological evolution over four billion years or so, and, over a very short period on a geological time scale, human cultural evolution.