REFLECTIONS ON INTERNATIONAL RELATIONS THEORY AND ITS RELEVANCE TO THE TWENTY-FIRST CENTURY: THE NEED TO INCORPORATE A COMPLEX APPROACH

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ABSTRACT

This paper focuses on the problem that security studies has not adequately incorporated complex analytical methods. Current analytical methodologies used in social sciences adhere to reductionist approaches. This approach is useful under certain conditions, but the world has changed a great deal since end of the cold war, and the comfortable familiarity of the bipolar competition between the two superpowers is no longer relevant. Complex analyses deal with the interactions between agents, and coactions of agents in a given environment. Feedback is pervasive in such systems, and can lead to criticality events, phase transitions, and adaptations by the system. There is interplay, therefore, between the micro-level behavior of self-organizing agents and the macro-level characteristics of the system that are sensitive to bottom-up perturbations. This paper will survey the current analytical approaches to theorizing about war and international politics to identify whether there is a problem, if it is getting worse, and then examine how complex analyses may be the solution by supplementing deterministic methods. Theory is fundamental to comprehension, and necessary for individuals at the highest level of government to understand and advance the interests of their country in the international arena. Thus, for strategic thinking to advance, theory must advance; for theory to advance, security studies should embrace complex analytical techniques already being applied in the hard sciences.
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Introduction

Every generation confronts a unique set of issues. The previous generation faced down an enormous peacetime competition between the United States, its allies, and way of life based on free markets, private ownership, free expression and entrepreneurialism on one hand, and the Soviet Union, its allies, and a way of life based on central planning, collectivization, police-state and bureaucratic control on the other. A new generation in the West came of age as the Soviet system collapsed; it is a generation that too often takes for granted the hardship and sacrifice of their forbearers. It is this generation that must confront the complex challenges facing the United States in the twenty-first century.

The cold war was as much a contest of ideas as it was of arms. Ideas are profoundly important because they are fundamental to our comprehension of things. The power of ideas comes from their abstractness, and it is from abstractions that we develop more complex notions like capitalism, communism, religion, and the state. These are powerful and cherished ideas for which people are willing to lay down their life or put someone else’s life down. Guiding the United States through the post-cold war world will require ideas that reflect and respect the challenges facing the United States.

It is the hypothesis of this examination that the security studies field oversimplifies conditions for theories; it uses linear deterministic analytical methods that are insufficient for insights needed about phenomena like war and international politics in the twenty-first century. The field should shift from a solely deterministic approach to one that includes dynamic aspects as well. This is not to assert that linear theoretical models should be discarded; they do have tremendous merit under certain conditions, particularly by simplifying complicated issues so
they may be understood by practitioners of security. However, security studies is poised to embrace complex problems facing practitioners today that defy simple solutions through the adoption of dynamic analytical methods that are already being applied in the hard sciences. Geopolitics is obviously complex, but it is becoming more so as technological advancement coupled with population increase and scarcity of resources agitates traditional notions of war and politics. To obtain useful insights about security in the contemporary global environment will require augmenting the field’s deterministic analytical approach with a dynamic approach.

This essay does not assert an “either/or” choice between linear and dynamic analyses. The two approaches are complementary, and supplement one another. Scholarly debates have taken place on the subject between John Mearsheimer and Eliot Cohen during the 1980s in the journal *International Security*, and again in the early 1990s between Robert Pape and Barry Watts in the journal *Security Studies*. However, Watts observes that proponents of competing paradigms tend to talk past one another.¹ The problem is that these paradigms – linear and dynamic – should not be in competition because each is insufficient alone. It is a false choice to have to pick between them because both are necessary to our understanding of war and international politics.

The clearest analogy for understanding this relationship may be found in the hard sciences. Michael Riordan and Lillian Hoddeson note that in the early years of the twentieth century the “classical” image of reality, emphasizing continuity and stability, gave way to fragmentation and change. This was true in a number of fields, but figured most prominently in the scientific community as traditional notions of Newtonian mechanics gave way to quantum

mechanics – the study of electrons, photons, and other atomic-scale phenomenon where matter and energy interact in a complex fashion and exhibit both particle-like and wave-like behavior.\(^2\) In a sense, Newtonian mechanics became a victim of its own success because it gave scientists the ability to understand inanimate phenomena to a point, after which phenomena becomes more dynamic and the very paradigm that brought science to this point turns out to have limited application for theorizing in the new realm beyond it. This does not mean that traditional physics no longer has application in modern society, only that there is more to be understood and that traditional analysis must be supplemented – not supplanted – with new methods appropriate to the phenomena at hand.

This essay seeks to bridge the gap between the linear deterministic approach to theorizing about war and politics and the dynamic complex approach. There is a great deal of literature on war and international politics. Although the ground has been thoroughly plowed, there is still a great deal about these subjects for which we have no idea. The writing continues in the hope of turning over something new that enhances our understanding, but nothing of use can be found unless one uses the appropriate analytical methods for tilling the intellectual soil. To offer something relevant to our understanding of war and politics, one must understand and utilize analytical methods rooted in both linear and nonlinear thinking.

The linear methods, pioneered by Newton and applied to security studies, have enjoyed a successful reputation, but there are sharp limits to what it can accomplish in social studies because social conditions are complex. There is a successful but lesser known tradition for understanding these conditions that may be traced backwards from the contemporary Andrew W.

Marshall to the canonical Carl von Clausewitz. This essay will bring these traditions into better focus in order to understand how they complement instead of compete with one another. To bridge these two traditions, this essay will be broken up into four broad sections that will answer the following questions: Does Security Studies have a Problem? Is it Getting Worse? What is the Solution? And, finally, so what – what is the point of this and how is it applicable to contemporary security issues?

The impetus for this examination is the underlying assumption that theory is necessary to inform strategic thinking by practitioners. Theory is based on ideas, and ideas are fundamental to one’s comprehension of things. The manner in which a state comprehends itself and its interests in the global context is necessary for strategic thinking about how to secure those interests. A state, however, is itself an abstract idea and cannot think or strategize. It is up to the citizens of the state, at the highest levels of government, to comprehend the state’s interests in the global context and come up with strategies to secure those interests. In an increasingly dynamic complex world, practitioners of security must think in dynamic complex terms that reflect and respect the problems the United States faces in securing interests. To strategize in a global context means one must understand the world, and one’s understanding is based on theory. Thus, theory and strategy are inextricably linked.

War and politics have always been complex, but the world is becoming more complex as the rate of communication between individuals, between individuals and organizations, between organizations, between organizations and states, between states, and between individuals and states increases by compounded orders of magnitude beyond the rudimentary communication skills of the small bands of individuals that our species evolved in. Social science has always
required a dynamic approach to complement the linear one, but the problem is becoming more acute as the world grows in complexity. The complexity is further exacerbated as advancements in telecommunications, information-technology, biotechnology, transportation, and guided weaponry proliferate. In short, the world as it is today is very different from the world as it was at the end of World War II. Every generation faces a unique set of challenges. How each generation copes with its challenges are based on its ideas, that is, how challenges are perceived and in what context. If this generation is to cope with the uncertainties ahead that may challenge the United States and its role in the world, it will need dynamic ideas suited to the task.

**Does Security Studies have a Problem?**

The first question to ask is whether the theoretical models currently used and taught in the security studies field are appropriate to the task of understanding twenty-first century challenges. It is the hypothesis of this examination that linear models are insufficient alone. Because the linear approach to theorizing is the dominant model taught in security studies, the answer is yes, the field has a problem.

Most analytical methods used in theories of war and international politics, and social science more broadly, are derived from the paradigm of Newtonian mechanics. Named for Isaac Newton, it traces its origin to the European renaissance and reformation when old superstitions were challenged and supplanted by the scientific method as an approach to understanding natural phenomena through the use of hypotheses, observation, and experimentation. This approach was immortalized in 1687 with the publication of Newton’s *Philosophiae Naturalis Principia*
Mathematic. The book’s focus was on understanding physics, but by the early twentieth century
the paradigm had filtered down to other fields of study like the social sciences. Today, strategic
studies at the graduate level mostly uses the framework provided in Philosophiae Naturalis
Principia Mathematic for studying war and international politics.

The methods pioneered by Newton have enjoyed a successful reputation, but there are
general limits to what it can accomplish in the hard sciences, and severe limits to what it can
accomplish in the social sciences. Today, Newtonian mechanics is elementary science. Hard
science recognizes the importance of Newton’s contribution, but the paradigm is “no longer
widely embraced” when trying to ascertain the nature of complex phenomena like quantum
mechanics and nonlinear dynamics. Thus, the scientific community has moved beyond
deterministic theories, yet its principles are still taught at the graduate level in the field of
security studies. According to Steven Mann, our view of reality rests on scientific paradigms,
but the strategic community has been unable to adapt advances in modern science to advances in
strategic thought. For strategic thinking about the United States to advance, linear deterministic
methods should be supplemented with nonlinear methods currently being applied in the hard
sciences.

To reiterate, the traditional approach to theorizing about war and politics has enjoyed
success since the end of the Second World War. That was a horrific war, and it has been
summed up appropriately by Michael Geyer as “apocalyptic.” When the dust finally settled, the
Allies bifurcated along ideological lines between the Soviet Union and its allies in the East, and

4 Steven Mann, “Chaos Theory and Strategic Thought,” Parameters (Autumn 1992), 54.
5 Michael Geyer, “German Strategy in the Age of Machine Warfare, 1914-1945,” from Peter Paret, editor, Makers
the United States and its allies in the West. The concept of bipolarity was introduced as a term to simplify and understand this competition, and the relationship was understood through a linear strategic calculus that presumed “if” the United States did “x,” “then” the Soviet Union would likely do “y.” The “if/then” formula is linear and deterministic (within an admitted range of probability), and it is straight out of Newton’s scientific method explored in *Philosophiae Naturalis Principia Mathematica*.

For example, during the cold war, the stakes involved between the two sides were enormous, and the prospect of nuclear war was very real. To come to terms with this, politicians and generals, according to Lawrence Freedman, turned to the academic community for guidance in policy, and from this relationship emerged “cherished formulas” with terms like containment, flexible response, and détente.\(^6\) Traditional approaches to theory were useful in this process. For example, containment was a vision based, in part, on George Kennan’s theory that if the United States was “patient, but firm and vigilant” over the long-term, then it would prevail due to the antecedents that most of the industrial centers were in Western hands and that the Soviet Communist system was unsustainable over the long term.\(^7\)

Deterrence, a much older concept, became highly fashionable as well. In 1966, Thomas Schelling published *Arms and Influence* to explore aspects of deterrence relevant to the nuclear standoff between the United States and Soviet Union. He noted that it is the threat of damage that makes one yield; deterrence is about intentions and a persuasive threat or a fierce display may deter.\(^8\) Thus, if a state makes a credibly fierce threat to retaliate, then the enemy may be

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\(^7\) Steven Hook and John Spanier, *American Foreign Policy Since World War II*, CQ Press (2010), 38.

deterred from initiating conflict. Schelling's model adheres to the traditional "if/then" approach to theory.

The traditional linear approach, therefore, did have a great deal of useful application during the cold war and it is still useful today, but it needs to be supplemented. One may argue that linear theoretical models that simplify reality provide us with most of what we need to know. To be sure, industrialization, penicillin, and numerous other wondrous advancements were discovered or made possible through the "if/then" approach to theory. But it is the nonlinear approach of quantum mechanics that has enabled the information age – a technological and social revolution that brought households and individuals the personal computer, mobile electronic devices, three-dimensional printers, complex computing, and a host of biomedical advances that utilize lasers, nanotechnology, and gene therapy. So too it should be with theories on war and international politics. The "if/then" approach helped the United States cope with and ultimately emerge victorious from the cold war. It must be supplemented, however, with new approaches to analysis to improve our knowledge about the world so that the United States may strategize better in the twenty-first century.

The security studies field is poised to embrace new analytical methods, but it currently remains entrenched in the traditional approach. In 1979, Kenneth Waltz published his Theory of International Politics. Although Waltz admits that the "if/then" approach does not necessarily provide certainties because a correlation between variables, even a high one, does not warrant the assertion that a causal relationship exists,⁹ he nevertheless uses the "if/then" model for hypothesizing and reinforced it as the most fruitful approach to theorizing. Today, Stephen Van Evera and other social scientists argue that theorizing should always be formatted in such "if A

then B' statements, where A is the independent variable and B is the dependent variable. The relationship between variables is illustrated with an arrow diagram, A → B. This is a simplification, but Van Evera argues that theories can “always” be arrow diagramed, and a theory that cannot be arrow-diagramed is not a theory at all.\(^{10}\) One may complicate the A → B diagram with antecedent conditions and a host of intervening, conditional, and study variables to arrive at a theory that looks like the diagram in Figure 1. The diagram in Figure 1 is fundamentally linear because the arrows all point in one direction. It is complicated due to the number of variables involved, but it is not complex because it moves linearly in only one direction—the variables act and react, but there is no interaction between them. Complexity involves messy loops and resonances among antecedents and consequents; it involves unforeseen and often untoward conjunctions and alterations, most of them probabilistic in nature. When low probability complications come into play, the best laid plans often go awry. Thus, Clausewitz could have never diagnosed the concept of friction if he had used a linear, deterministic approach.

![Figure 1](image)

Figure 1.\(^{11}\)

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There are limits to the amount of useful knowledge in war and politics that can be obtained from linear-based theories. As described by Alan Beyerchen, "linear" applies in mathematics to a system of equations whose variables can be plotted against each other in a straight line. If the behavior of a system can be appropriately broken into parts and compartmentalized, it may be classified as linear, even if it is described by a complicated equation with many terms.\(^{12}\) This approach to theorizing also runs the risk of falling into the belief that truth is won and explanation achieved through accumulation of more and more data, when in reality the number of pieces that might be taken as parts of the problem are infinite.\(^{13}\) As Alan Beyerchen points out, linearity is always attained at some significant cost, and the purpose of any theory for Clausewitz is to explore the entire range of possibilities—it is not to generate a preconceived set of stable relationships.\(^{14}\) Thus \(A \rightarrow B\) analyses are often unreliable because the consequent \(B\) may depend on, not \(A\) alone, but \(A\) in conjunction with \(C\) and \(D\) or \(E\) and \(F\) or \(G\); and moreover \(B\) may come about without \(A\) at all but in conjunction with other complex antecedents. Interactive relationships, unlike those of inanimate physical objects, are highly complex and sensitive to even the smallest variable. In short, the useful knowledge that may be gathered from the linear approach will be limited as this paradigm does not correspond with social reality because social systems are characterized by complex interactions, and there is no interaction in linear systems.

For example, the 1985 book *Polarity and War* illustrates conclusively that matters of war and international politics cannot be understood entirely through linear theoretical models.

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*Polarity and War* is a collection of essays by political scientists who used data from J. David Singer’s Correlates of War project begun in 1963 at the University of Michigan. Michael Wallace’s contribution concludes that the early theorists’ hopes of finding a simple relationship between polarization and war have been disappointed by the studies undertaken to date; there is a general consensus that the relationship is “neither linear nor constant over time.” David Garnham’s conclusions concur with Wallace in noting that many systemic analyses of the occurrence of international war have focused on attributes like the size of the system, magnitude of alliance commitments, tightness and discreteness of poles, and the distribution of power, but based on the work of Deutsch, Singer, Waltz, Rosecrane, and Bueno de Mesquita, one might conclude that there is a “curvilinear” relationship between the independent and dependent variable. Curvilinear means nonlinear, and introducing the concept of curved relationships between variables raises the possibility that if the lines are curved enough instead of straight, as in Van Evera’s arrow-diagrams, then the variables may eventually feedback into the system. Richard Stoll and Michael Champion underscore the findings of their colleagues in noting that the evidence generated so far concerning the linear relationship between quantitative indices of polarity and international conflict is anything but unambiguous. Jack Levy also states that the empirical evidence to date suggests a “non-linear relationship” between the distribution of power and stability. Thus, *Polarity and War* represents an attempt to force linear-based Newtonian thinking on complex phenomena, and in doing so falsified the conception that these matters can

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be forced to yield to it. War and international politics are nonlinear phenomena. The traditional approaches to modeling have proven useful under a certain range of conditions, but understanding these phenomena more fully will require the security studies field to embrace scientific concepts that correspond more accurately with complex social phenomena.

This section asked the question whether the theoretical models currently used and taught in the security studies field are appropriate to the task. The answer is that while they are helpful to some extent, they are insufficient alone for gaining a better understanding of complex social problems in the twenty-first century. John Schmitt writes that for the sake of finding solvable problems, social science connected the discontinuities and linearized the nonlinearities; it simply ignored all the countless inconsistencies and surprises that make the world such a complex and interesting place. We need a new paradigm, Schmitt states, and once again science may provide the catalyst.\textsuperscript{19} Thus, for strategic thinking to advance, theory must advance; for theory to advance it must cease making the category mistake of solely applying linear concepts developed for inanimate phenomena to complex, nonlinear, animate and interacting social systems.

Because the traditional linear approach is still the dominant method in the field of security studies, it appears that the field does have a problem. This translates into a broader problem for the United States since many practitioners of security are graduating with degrees in security studies from institutions that have not yet embraced complex analytical methods.

Is the Problem Getting Worse?

The second question to ask is whether the problem of universally applying deterministic conditions to security studies is getting worse. Since the end of the cold war, the problem has gotten worse as traditional theoretical models have not kept pace with changing global conditions. Despite decades of work, Jack Levy explains that no widely accepted theory of the causes of war exists and little agreement has emerged on the methodology through which these causes might be discovered. Instead, the literature is characterized by a proliferation of competing and often contradictory theories.20 This, in turn, leads to a proliferation of competing and often contradictory policies among practitioners without an overarching grand vision for the United States in relation to the broader world. During the cold war, policies varied from one administration to the next, and sometimes even within the same administration, but the grand vision was always containment of the Soviet Union. There is no grand vision for the United States today, and the original conditions for simplification, such as bipolarity, that allowed traditional theories to provide a useful cold war grand vision no longer apply. The changing global conditions combined with a lack of an overarching grand vision means the problem of using deterministic models in the security studies field is getting worse.

The dominant contenders in international relations theory today are neorealists, liberal institutionalists, and constructivists. None of these theoretical models can withstand attacks on their approach, and none have been able to provide practitioners with a vision that can help inform strategic thinking. The reason for this is that they are all firmly rooted in the traditional linear approach to gaining knowledge. It is beyond the scope of this essay to examine the three

theoretical models at length. Because realist theories are cited the most, and because even liberal institutionalists and constructivists use some realist assumptions, this essay will examine a few examples of contemporary realism in greater detail to see whether the deterministic conditions they use correspond with reality. These will include Kenneth Waltz’s balance of power theory, Stephen Walt’s balance of threat, Randall Schweller’s balance of interest, and offense-defense theory developed by Robert Jervis, Stephen Van Evera, and others.

Balance of Power

The concept of a balance of power is an age old one, but it was canonized in theoretical literature by Waltz. Waltz’s Theory of International Politics has more than one assertion, but the point that stands out most is his belief that the conduct of states has always been the same and is guided by structural constraints of anarchy and self-help, and these constraints make balancing imperative for survival. If states are to survive then they must balance against stronger powers. Secondary states, Waltz argues, if they are free to choose will flock to the weaker side because it is the stronger side that threatens them. From the theory, one would predict a strong tendency toward balance in the system, and Waltz asserts that balances recurrently form. Again, if a stronger power arises, then states will balance against it for survival.

Waltz’s Theory does not withstand historical scrutiny. Fareed Zakaria notes that Waltz’s form of realism rests on the assumption that international politics remains constant over time, and therefore his theory should apply across history. The historian Paul Schroeder, however, finds that Waltz’s generalizations about the repetitiveness and prevalence of balancing in

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international politics do not hold water. For example, during the Napoleonic wars, the First Coalition (1792-1797) was formed against France at a time when France was militarily extremely weak. Once France’s real revolutionary power became apparent, states began leaving the coalition or bandwagoning with France. The same thing happened to the Second Coalition (1789-1801). Schroeder found that every major power in Europe, except for Great Britain, at some point or another bandwagoned with France during the Napoleonic wars.

It is easy to find other historical examples that falsify the theory of balancing. For instance, by the ninth century B.C., the Assyrians had conquered Babylonia and adjacent territories. The king of Judah initially tried to form a balancing coalition against Assyria in which Syria would rebel in the north, Egypt would strike in the south, and Judah would keep things boiling in the center. However, the balancing coalition fell apart when Syria and Egypt cut separate deals with Assyria, and left Judah standing alone. In the end, Judah also paid tribute to Assyria – essentially becoming a vassal. Thus, the kingdom of Judah tried to form a balancing coalition, but was betrayed by her allies who bandwagoned with the more powerful Assyria instead of balancing against it. Judah then chose to bandwagon with Assyria too.

A third historical example may further drive the point. E.H. Carr, in his book the Twenty Years’ Crisis, observes that when France was militarily supreme in Europe during the 1920s, a number of smaller powers grouped themselves under her aegis, but when Germany’s military strength eclipsed that of France, most of these powers made declarations of neutrality or veered

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to the side of Germany.26 Again, in practice we see the opposite of Waltz's theory that weaker states band together against the stronger.

A fourth example is the United States today. The enlargement of NATO after the cold war and the emergence of the United States as the sole superpower runs counter to the logic that states join together to balance against the most powerful state.27 Without question, the United States is militarily the most powerful country in the post-cold war environment, with global power projection capabilities that can land guided munitions on fixed targets at virtually any coordinates targeted by the global positioning system. After twenty years of American dominance in military capabilities, no balancing coalition has formed and there is no evidence of one forming in the foreseeable future. Jack Levy and William Thompson survey the explanations among realists: Kenneth Waltz and Christopher Layne insist that balancing will eventually occur; others argue that the relatively benign intentions of the United States keep it from being perceived as a threat; John Mearsheimer believes that offshore balancers do not provoke balancing coalitions; and Stephen Brooks and William Wohlfforth argue that balance of power theory predicts balancing to prevent the rise of a hegemon, but ignores the question of what happens after a state has already achieved dominance. In the end, Levy and Thompson conclude there is no evidence to imply a balancing coalition will never form against a global power, only that the mere existence of a dominant state does not necessarily trigger such a coalition.28 It has been roughly twenty years since the cold war ended, and there is no evidence

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of countervailing coalition to check the United States. Theorists are having trouble understanding this, and balance of power theories in particular are at a loss.

It is not difficult to find historical examples that defy Waltz’s theory. Schroeder explains that Waltz’s assumptions of the unchanging and repetitive nature of balancing through the ages may make his theory simple, parsimonious, and elegant, but they also make it unhistorical, unusable, and wrong. This is supported by Dan Byman and Kenneth Pollack, who state that while Waltz and others claim that parsimony must be an important criterion for judging the value of a theory, parsimony is not more important than accuracy. This is not to claim that balancing never occurs – it most certainly does – but it occurs alongside many other behaviors and strategies that states use to advance their interests. Thus, under certain conditions one may find Waltz’s theory holds up, but the interaction and coactions of states in the international environment is a dynamic and highly variegated process – not a deterministic one.

**Balance of Threat**

Stephen Walt, dissatisfied with Waltz’s analysis of the balance of power, proposed a different approach to the subject: “balance of threat.” Unlike Kenneth Waltz, Stephen Walt gives greater acknowledgement to the concept of bandwagoning in international politics. Bandwagoning, according to Walt, is adopted as a form of appeasement or as a means to share in

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the spoils of victory. Thus, it is chosen either for defensive or offensive reasons. Walt believes that states either balance or bandwagon depending on the nature of the threat. If a state is threatening, then other states will either balance against it or bandwagon with it by giving in to its demands.

Stephen Walt’s balance of threat theory qualifies balance of power in certain respects by showing that it is not simply the most powerful state that brings about balancing, but the most threatening state. However, Paul Schroeder still critiques this by noting that Stephen Walt’s balance of threat does not really help answer the question of which of the strategies that recur across history (neutrality, institutional arrangements, bandwagoning, balancing) or which combination of them prevailed in each instance. Moreover, as noted by E.H. Carr, many countries formerly allied to France defected to Germany when its power eclipsed France, but surely Nazi Germany was more threatening than France. Balance of threat simply asserts that if A (threatening state) then B (balancing) or C (bandwagoning), but does not explain what motivates the choice between B and C, and leaves out options D (neutrality) and E (institutional arrangements), and fails acknowledge the possibility of combinations of these responses in light of the interactions between multiple states over time.

Randall Schweller also critiques Walt’s theory in observing that the concept of bandwagoning was defined too narrowly by Walt as giving in to threats – as if it were the opposite of balancing. Balancing, according to Schweller, is driven by the desire to avoid losses,

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whereas bandwagoning is driven by the opportunity for gain.\textsuperscript{34} Schweller goes on to state that bandwagoning is far more common than Walt suggests because he has overlooked the opportunistic aspect of bandwagoning and the alliance choices of states that pose threats as well as those of states that respond to threats.\textsuperscript{35} Thus, Stephen Walt clarifies some of Waltz’s original theory, but still uses deterministic conditions that preclude his approach from being able to explain war and international politics.

\textit{Balance of Interest}

Randall Schweller, unsatisfied with Stephen Walt’s balance of threat theory, offers balance of interest to explain war and international politics. Balance of interest refers to the costs a state is willing to pay to defend its values relative to the costs it is willing to pay to extend its values. It refers to the relative strengths of status quo and revisionist states. This analysis is more complex than Waltz or Walt. By analogy he explains that very satisfied powerful states are lions, satisfied less powerful states are lambs allied to the lions, while dissatisfied powerful states are wolves, and dissatisfied less powerful states are jackals that bandwagon with the wolves to challenge the lions and eat the lambs.\textsuperscript{36} Thus, bandwagoning is commonly done in the expectation of making gains, while balancing is done for security and it always entails a cost.


Schweller's analysis sheds more light on war and international politics than Walt or Waltz, and his analogy of lions and lambs versus wolves and jackals does have some explanatory power, but he still defines bandwagoning too narrowly and his use of terms like "satisfied" and "dissatisfied" are vague, weak terms. Balance of interest theory is good because it looks at war and international politics through a lens of gains versus losses, which implies a degree of interaction and chance, making it more complex than its predecessors.

For example, Daniel Kahneman has observed in experiments that people have a preference for risk when considering gains and losses. If given an opportunity to certainly lose $100 or a 50 percent chance to win $50, but an equal chance to lose $200, the gamble is more attractive to most people than the sure loss. John Mearsheimer applies this concept to international relations, but does so in a deterministic manner. He observes, for example, that great power rivalry will sometimes produce a stable international order, but the great powers will continue to look for ways to increase their shares of world power — if a situation presents itself, then they will undermine the stable order. In practice, a state that is growing in power may perceive that it has more to gain from bucking the system than working in it, even if doing so entails the potential for loss because adhering to the status quo entails certain loss relative to the expected gains from challenging the system.

The above example helps reinforce balance of interest, but the problem with Schweller's analysis is that he also defines bandwagoning too narrowly in that it only applies to jackals. Lambs bandwagon as well insofar as they are free-riding on security provided by the lions.

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situation presents itself for a lamb to increase its share of power, it does not necessarily follow that it will act upon it. The difference is that lambs see greater gains from operating in the system than by bucking it. Free riding is bandwagoning with the status quo. Thus, Schweller's balance of interest is a vast improvement over the theories of Kenneth Waltz and Stephen Walt, but because it also rests on deterministic conditions it misses the opportunity to explain the differences of perceived costs and benefits for free riding on a system versus challenging it. In short, Schweller's balance of interest is unable to explain what leads a lamb to become a wolf—what changes in the perception between gains and losses?

*Offense-Defense Theory*

Offense-defense theory, developed by Robert Jervis, Stephen Van Evera, and others asserts that war is more likely when states can conquer each other easily. When defense has the advantage security will be more plentiful. If defense has the advantage, and states can distinguish between offensive and defensive weapons, then the effects of anarchy and the security dilemma can be dampened.39

There are several problems with the deterministic conditions of offense-defense theory as it practically applies to real-world security issues. First, how does one distinguish advantages between offense and defense? The most common approach is to reduce military competitions to measurable, quantifiable comparisons. In the past, such metrics have been Weapons Effectiveness Indicator/Weighted Unit Value (WEI/WUV) and armored division equivalent (ADEs). However, this approach reduces complex issues of war and international politics into algebra. Philip Karber and others explain that one must consider qualitative aspects of forces,

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including the relative capabilities of technology, the structure and organization of units, and tactical and operational deployment. Other variables such as leadership, morale, and training are also important.\textsuperscript{40} These important variables are difficult if not impossible to quantify.

For example, WEI/WUV metrics score combat units based on quantity of nine major categories of weapons systems and their relative quality.\textsuperscript{41} WEI/WUV’s shortcomings have been illustrated by applying them to the Battle of France in 1940, where the Allies potential combat effectiveness exceeded the Germans on a theater-wide basis by a ratio of 1.03:1.\textsuperscript{42} On that quantitative basis, one might have expected a long and protracted campaign or even a stalemate. Yet, the Germans enjoyed a smashing overall success. To break the theater-wide comparison into sectors shows that in the central sector the force ratio favored the Germans 4.2:1.\textsuperscript{43} However, this reductionism does not explain the battle because even with this advantage the German breakout in the central sector was not assured. Robert Doughty shows that traffic jams of German armor units in the Ardennes Forest and difficulties crossing the Meuse River provided the French with an opportunity to halt the German advance.\textsuperscript{44} Historians Williamson Murray and Alan Millet explain the real explanation for the battle’s outcome was in the quality of German leadership from generals to non-commissioned officers, and that their excellence in tactics and operations was what won the day – not quantified ratios between offense and defense capabilities.\textsuperscript{45} Stephen Biddle echoes this in observing that analyses considering material alone

\textsuperscript{40} Philip Karber, Grant Whitley, Mark Herman, and Douglas Komer, \textit{Assessing the Correlation of Forces: France 1940}, McLean, VA: BDM Corporation (June 18, 1979), 1.

\textsuperscript{41} Philip Karber, Grant Whitley, Mark Herman, and Douglas Komer, \textit{Assessing the Correlation of Forces: France 1940}, McLean, VA: BDM Corporation (June 18, 1979), 1.

\textsuperscript{42} Philip Karber, Grant Whitley, Mark Herman, and Douglas Komer, \textit{Assessing the Correlation of Forces: France 1940}, McLean, VA: BDM Corporation (June 18, 1979), 2-9.

\textsuperscript{43} Philip Karber, Grant Whitley, Mark Herman, and Douglas Komer, \textit{Assessing the Correlation of Forces: France 1940}, McLean, VA: BDM Corporation (June 18, 1979), 4-7.

\textsuperscript{44} Robert Doughty, “Almost a Miracle,” \textit{The Quarterly Journal of Military History}, Vol. 2, No. 3 (Spring 1990), 51.

may be “little better than blind guesses.” The thing of critical importance is how soldiers and military organizations behave in combat. Andrew Marshall sums the issue up: “numbers of men, numbers of weapons says nothing about the actual capabilities of the forces of one country to deal with another.” In short, it is difficult if not impossible to know whether the offense or defense has an absolute advantage in war.

Another example is the United States versus Iraq. Stephen Biddle recounts that in 1991 there was a massive effort using state-of-the-art methods and the nation’s best analysts to estimate losses the United States might suffer in a war against Iraq. These analyses “radically overestimated United States losses;” virtually all were way off, and a majority “off by more than an order of magnitude.” Conversely, in 2003, it appeared a war against Iraq would be relatively quick and painless. Although the fight against Iraq’s conventional forces proved relatively easy, the fight against insurgents and terrorists was long, costly, and far more complex for United States forces.

Another problem with offense-defense theory is that it does not account for changes in weapons. Martin Shubik observes that every new system of offense generates a new system for defense. Decades earlier, J.F.C. Fuller asserted this fact and called it the “constant tactical factor” in which every improvement in weapons has eventually been met with a counter-

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improvement.\textsuperscript{51} This is echoed by Michael Schrage who notes that the co-evolution of measure and counter-measure escalation is one of the touchiest topics in modern warfare in which expensive measures are being conjured up against ever-cheaper counter-measures.\textsuperscript{52} It is very difficult to know whether offense or defense has the advantage because states are continuously procuring new weapon systems and innovating novel uses of existing ones. Moreover, weapons development is often conducted in secret, complicating the actual application of offense-defense theory that much further.

Offense-defense theory has limited value because it reduces war and international politics to measurable quantities. It ignores chance, which clearly plays a role. Robert McQuie notes that, historically, attackers have been able to win even though force ratios were unfavorable and vice-versa.\textsuperscript{53} It is for all these reasons that the deterministic conditions of offense-defense theory have limited practical use in real-world security matters. This is not to say that one should ignore military assessments and balances of forces between oneself and a potential opponent, it is only that one must be cognizant of the fact that absolute advantage between offense and defense can never be fully known between competitors.

All of the above theories, as well as a multitude of others that were not discussed, provide useful insights, but they are encumbered by their adherence to reductionist conditions. Ultimately, the real test for all these theories is how they may be applied to strategy for national security. Many of the theorists cited have applied their theoretical models to the post-cold war environment, and the policy recommendations that are informed by these theories range from the

\textsuperscript{51} J.F.C. Fuller, Armament & History: The Influence of Armament on History from the Dawn of Classical Warfare to the End of the Second World War, Da Capo Press (1945), 33.
bizarre to the downright dangerous. These theories are fundamentally flawed because they are based on linear deterministic conditions, among other reasons.

Models developed by these theorists are too far removed from reality to be of particular use to practitioners of security. Some extol nuclear weapons as having a stabilizing effect on international security. In the early 1990s, John Mearsheimer recommended that the United States should encourage nuclear proliferation in Europe, specifically Germany.\textsuperscript{54} Setting aside the strong feelings a nuclear-armed Germany would likely arouse in many European countries, a theory that argues in favor of proliferation is not going to be useful to practitioners of security that are working hard at counter-proliferation. As stated by J.D. Williams in a 1954 paper for the RAND Corporation, “If two men armed with grenades are locked in a room together, adding more grenadiers does nothing to improve the stability of the situation.”\textsuperscript{55}

Mearsheimer is joined by Kenneth Waltz and G. John Ikenberry as unabashed fans of nuclear weapons under the assumption that nuclear deterrence removes the threat of war.\textsuperscript{56} Such assumptions should remind the reader of a remark by Hedley Bull that it is the freedom of the model maker from the discipline of looking at the world that “makes him dangerous.”\textsuperscript{57} Assuming that because nuclear weapons have not been used since 1945 they will not be used again is dangerous. If anything, the utility of nuclear weapons, especially tactical nuclear weapons, has increased in recent years as anti-satellite weapons, as an asymmetric response to

conventional superiority of the United States and its NATO allies, and for their electromagnetic pulse effects that would disrupt microelectronics of modern warfare beyond the range of the nuclear explosion itself. A last point against the argument that nuclear proliferation leads to stability is that it is a mathematical certainty that the more states that possess nuclear weapons and the means to deliver them necessarily increases the probability of their use.

There is potential for long term damage from such theories because other countries may adopt the ideas espoused by theorists as intellectual justification for opposing the United States, or they may be adopted within the United States itself. For example, Waltz argues that the military buildup, beginning with the Carter administration and running through most of Reagan’s was “worse than irrelevant” because it burned up resources that could have safely been put to constructive uses. Such a statement could be used by pacifists to advocate drastic reductions in defense spending and undermine the United State’s lead in cutting edge military technology and platforms that enable force projection on a global scale.

Waltz’s statement that the Carter-Reagan military buildup was irrelevant is also dangerous because it ignores historical reality. Historian Walter Laqueur recounts the numerous factors that led to the Soviet Union’s downfall in his book *The Dream that Failed*, and one of them was the increasing difficulty Soviet leadership had in shifting limited resources to its military in order to keep up with Carter-Reagan build-up.

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Part of the Carter-Reagan military build-up was driven by the development of stealth, strategic missile defense, as well as the “Offset Strategy,” a concept based on synergistic application of technologies for standoff precision strike to counter second-echelon Soviet armored forces.\textsuperscript{60} The Offset Strategy was demonstrated by the DARPA-funded Assault Breaker program, see Figure 2. Assault Breaker was begun in 1977 and successfully test-demonstrated in 1982. It used multiple ideas for attacking Soviet armor deep in enemy territory using airborne reconnaissance, guided-long range missiles, terminally guided sub-munitions, synthetic apertures, moving target radars, and ground-based sensor fusion to locate, track, and classify vehicles beyond ground line-of-sight, and could operate day or night under most weather conditions.

Notra Trulock reported in 1988 that Assault Breaker stirred anxiety among Soviet military observers. The trends exemplified by Assault Breaker pointed toward across-the-board improvements in conventional weapons, particularly in the development of long-range, highly accurate, and remotely guided combat systems with qualitatively new electronic control. The Soviets described these as “Reconnaissance Strike Complexes,” and the technologies of greatest value to their development were those associated with microelectronics, automated systems, and telecommunications.\textsuperscript{61} Ominously, the Soviet economy and industrial base lacked the necessary level of sophistication to keep up in these areas. It is not surprising that development of such advanced technology was cited by Mikhail Gorbachev as a national priority in 1989,\textsuperscript{62} but the Soviet system was fundamentally, philosophically at odds with the creative destruction necessary

\textsuperscript{62} Mikhail Gorbachev, Address to the Council of Europe – Parliamentary Assembly (July 6, 1989), 11.
for such an economy. This was one of many factors that drove Gorbachev’s policies of glasnost and perestroika, and these policies helped undermine the Soviet Communist system itself. Thus, Waltz’s assertion that the United States’ military buildup from the late 1970s through the 1980s was “irrelevant” is wrong in its interpretation of the history of the complex interactions between cold war superpowers, and it is dangerous for the future in that his statements, informed by his theories, may be used as an intellectual justification by those who may advocate steep cuts in defense spending.

Figure 2

Figure 2

For international relations theory to advance it should adopt analytical methods from contemporary science that look at nonlinear dynamics because the linear reductionist approach to theorizing about social science is insufficient by itself for understanding complex phenomena like war and politics. Jack Levy laments that “we are more explicitly theoretical in our general

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orientation, more rigorous in theory construction, more sophisticated in the use of statistical methods, and more methodologically self-conscious in the use of qualitative methods, yet there are few law-like propositions, limited predictive capacities, and enormous divisions in the field.\textsuperscript{64} Even John Mearsheimer admits there is a problem; he notes that the study of international relations does not yet resemble the hard sciences; political phenomena are highly complex and the study of social sciences rests on a shakier theoretical foundation than that of the natural sciences.\textsuperscript{65} James Roche and Barry Watts reinforce the point in their observation that analysts today have access to a large array of measures and models, but if such tools are routinely pulled off the shelf and applied without due consideration of their appropriateness, then analysis runs the danger of becoming more and more divorced from reality.\textsuperscript{67} Stephen Peter Rosen echoes this in noting that problems arise when models are used without regard for their limitations.\textsuperscript{68} Alan Beyerchen reminds readers that Clausewitz underscored the feedback effect on complex systems in that the relationship between policy and war cannot be that of discreet independent and dependent variables. Simplicity achieved by idealized isolation of systems and of variables within systems, deterministic laws, clearly delineated bounds, causal trains, and other tools have become the hallmarks of good theory, but in doing so we have trained our imaginations to be

fundamentally linear, and we are wearing analytical blinders as a result. Thus, theorists should augment linear deterministic conditions with a more dynamic and complex approach when studying military and political matters. For theory to be useful to practitioners it must supplement the current approach.

What is the Solution to the Problem?

The previous section criticized some of the contemporary theories found in international relations literature. However, it is not enough to criticize; one must be able to offer a scientific alternative. In short, this essay has identified the problem: the field of security studies relies too heavily on the universality of linear determinism for theoretical models to understand and explain war and international politics. While this approach does have applicability to practitioners under certain conditions, the changes in global conditions following the end of the cold war have made the world more complex, and the traditional theoretical models have less applicability today than they did in the twentieth century. Since bizarre and dangerous policy recommendations flow from these theories, the problem appears to be getting worse, and is exacerbated by a lack of grand vision for the United States. None of the theories have helped inform a grand vision for the United States in the twenty-first century. The obvious question now: what is the solution? The solution is to augment traditional deterministic modeling with a dynamic complex approach.

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The dynamic approach is rooted in a scientific paradigm that, for lack of a better term, may be referred to as the complexity paradigm. The Newtonian approach is based on a linear way of thinking. In contrast, complexity is nonlinear, nondeterministic, and is understood through interactions and coactions instead of action-reaction. The understanding and application of this paradigm has been growing in the hard sciences since the early twentieth century, but it has not yet adequately filtered down to the social sciences. There has been progress in the security field to acknowledge and make better use of this paradigm. The work being done at the Santa Fe Institute, the Argonne National Laboratory, and Sandia National Laboratories have added tremendously to the debate, and, in 1997, National Defense University and the RAND Corporation sponsored a symposium on complexity, global politics, and national security that attracted a wide range of speakers, including Zbigniew Brzezinski, Robert Jervis, and Murray Gell-Mann, and also featured the participation of, among others, Lt. General Paul K. Van Riper and the late Arthur K. Cebrowski.\textsuperscript{70} Moreover, complexity in security studies has a successful but lesser known tradition that may be traced to Carl von Clausewitz. Thus, the security studies field is on the cusp of a major leap forward in its theoretical approach.

Complexity is embodied, for the purposes of war and international politics, in Clausewitz’s concept of \textit{zweikampf}, literally “two-struggle.” Clausewitz explains: “War is nothing but a duel on a larger scale. Countless duels go to make up war, but a picture of it as a whole can be formed by imagining a pair of wrestlers.”\textsuperscript{71} Alan Bayerchen elaborates that in \textit{zweikampf} the two wrestlers struggle against one another, and as they interact they generate


positions and shapes that neither could possibly create alone.\textsuperscript{72} Clausewitz explains: "War... is not the action of a living a force upon a lifeless mass... but always the collision of two living forces.... there is interaction."\textsuperscript{73} Robert Jervis agrees with this conception. He notes that further complexities are introduced when one looks at the interaction between strategies when actors consciously react to others and anticipate what they think they will do.\textsuperscript{74} \textit{Zweikampf} is the foundation of an alternative scientific paradigm for theorizing about war and politics.

Understanding the concept of \textit{zweikampf} is the key to understanding complex systems. An example of how this may be applied in practice was the development and implementation of the Office of Net Assessment in the Office of the Secretary at the United States Department of Defense. Stephen Peter Rosen explains that the focus of net assessments was on the interactions of opposed establishments, and he cites Clausewitz’s emphasis on war as a human activity that necessitates going beyond static evaluations of the strengths and weaknesses of each side in order to consider the dynamic interactions of belligerents.\textsuperscript{75} By analogy, in examining a \textit{zweikampf} of wrestlers, one must look at more than basic characteristics such as height, weight, and bench pressing strength to get a sense of the competition. Theorizing that "if" wrestler A is taller, stronger, and possesses an advantage of one or more other variables "then" wrestler B will lose is a weak theory. It does not necessarily follow that wrestler B will lose; he may have better training in wrestling techniques and may better know how to leverage his body relative to his

opponent. History is full of examples where the seemingly weaker opponent prevails over an adversary, time and again examples may be found from the plain of Marathon to forests of Bastogne. Instead of static variables and linear diagrams, one must examine how a zweikampf interacts as each side struggles against the other, trying to find maximum leverage against the opponent while the opponent does the same. It is this notion of zweikampf – how two sides interact with each other and co-act in the environment – that helps one understand nonlinear competitions.

The resultant interaction of a zweikampf is ill-suited to linear determinism alone because it is very complex and chaotic. Prediction is impractical and one must accept, if not embrace, a degree of uncertainty as the interactions lack the regularity and predictability of Newton’s laws of motion and gravitation.76 Chaos was first encountered in the 1960s when applied mathematician Edward Lorenz used computer models of weather development to assist in meteorology. The models proved so sensitive to the initial conditions that it was estimated a butterfly flapping its wings in one part of the world would be sufficient to cause a major storm to emerge elsewhere.77 Put another way, small and seemingly insignificant initial conditions can have inordinate outcomes. For example, chaos can be illustrated by a nonlinear pendulum. If the bob of a pendulum is released in a chosen position with a chosen velocity and its motion recorded, it is virtually impossible to exactly imitate the previous initial position of the bob, and the subsequent motion will not match the first time as a result.78 Thus, a wrestler who appears to be out of his weight class could prevail against a larger opponent through chance as much as

through superior skill. This occurs regularly on the battlefield when a smaller force triumphs over a larger opponent through a combination of factors, including chance. An example is when Alexander defeated Darius III at Gaugamela despite being numerically disadvantaged and deep in enemy territory. Although the Macedonian phalanx was superior to its Persian counterparts, historian Victor Davis Hanson notes that the battle was determined primarily by cavalry, and by chance the Persian cavalry was more intent on stealing booty from the Macedonian’s rear camp than with defeating the enemy at a critical moment when they may have pressed their advantage.\textsuperscript{79} The \textit{zweikampf}’s complex and chaotic nature makes it unpredictable and undetermined by initial conditions alone.

The complexity paradigm should not be thought of only as a two-struggle. Clausewitz complements the notion of \textit{zweikampf} with the observation that “War is a paradoxical trinity.”\textsuperscript{80} Alan Beyerchen explains that the trinity is made up of the passionate irrationality of the people, rational policies of the state, and combination of incidents in battle. Theory, he says, should be treated as if it were an object suspended among these three points of attraction: rationality, irrationality, and chance. Each state must contend with these forces as it interacts with one or more other states that also must contend with them. The result will be complex and chaotic as a seemingly small chance occurrence may produce disproportionate global affects, such as in June 1914 when Gavrilo Princip shot dead Archduke Franz Ferdinand and his wife Sophie. The deaths of these individuals set off a wave of interactions and coactions that eventually climaxed with the onset of the First World War, and then its sequel twenty years later, the Second World War.

\textsuperscript{79} Victor Davis Hanson, Carnage and Culture, Anchor Books, New York (2001), 60-98.
The complexity paradigm, as a distinct scientific way of interpreting phenomena may be traced to the late 1940s and early 1950s. Brian Castellani, of Kent State University, chartered a map of the history of Complexity science, see Figure 3. It began with pivotal early thinkers like Ludwig von Bertalanffy, one of the founders of general systems theory, along with mathematical psychologist Anatol Rapoport, economist Kenneth Boulding, mathematician and cyberneticist Norbert Wiener, and psychiatrist and cyberneticist W. Ross Ashby, among others. The three fields pioneered by these thinkers – systems theory, cybernetics, and artificial intelligence – are the foundations of “Complexity Science.” Complexity represents an altogether different paradigm than the mechanistic approach.\(^{81}\) There are a number of related approaches and offshoots such as chaos theory, fuzzy logic, data mining, and computational modeling, but the central aspect that defines the paradigm is the concept of complexity.

\[\text{Figure 3}\] \(^{82}\)


Complexity is interdisciplinary in that it draws on a large numbers of fields and identifies unifying elements among disparate approaches to studying phenomena. Hiroki Sayama provides a visual representation of contemporary complexity that illustrates its interdisciplinary approach incorporating systems theory, pattern formation, evolution and adaption, networks, collective behavior, game theory, and nonlinear dynamics, along with all of the sub-fields that make up these areas of study, see Figure 4. The interdisciplinary aspect of complexity is a hallmark of Andrew Marshall’s approach to understanding military competitions through interdisciplinary study of political, economic, historical, and technological factors. Clausewitz also brought an interdisciplinary approach to On War by incorporating his experiences in the Napoleonic Wars with philosophy, aesthetics, as well as mathematics and science. Thus, complexity is interdisciplinary in nature and can be used both to inform and be informed by social science, making the paradigm complementary to linear modeling.

Figure 4

If nonlinear thinking is to be used, if it is to augment linear-based Newtonian thinking, then it must be scientific. Specifically, one must understand more precisely what the complexity paradigm is beyond its interdisciplinary nature to understand why it may be useful to security studies – it has to be more than a metaphor. This means it has to be operationalized.

The first place to find scientific definitions of terms is to look at contemporary science. There are three institutions that stand out in regards to studying complexity. The first is the Santa Fe Institute (SFI). Founded in 1984, SFI is private nonprofit research and education center that focuses on multi- and interdisciplinary research and collaborations in the physical, biological, computational, and social sciences in the hope of gaining a better understanding of key environmental, technological, biological, economic, and political challenges. John Miller, an economics professor from Carnegie Mellon University, and Scott Page, an economics and political science professor from the University of Michigan, describe their time at SFI as “a wonderful coincidence of people, ideas, tools, and scientific entrepreneurship… [in which] the central problems and approaches in fields such as biology, chemistry, computer science, economics, and physics made it clear that there was a common set of questions that would require a willingness to transcend the usual disciplinary boundaries if answers were to be forthcoming.” SFI is one of the pioneer institutions studying complexity.

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84 http://www.sandia.gov/CasosEngineering/images/Sayama_Complex_systems_organizational_map.png
86 http://www.santafe.edu/about/
Second, the Argonne National Laboratory (ANL), a federally funded research and development center, is one of the U.S. Department of Energy’s oldest and largest national laboratories for science and engineering research, with a mission to apply a unique mix of “world-class science” and engineering facilities to deliver innovative research and technologies.\(^{88}\) ANL’s Decision and Information Sciences division has been studying complexity by researching and developing agent-based modeling and simulation (ABMS) and other computational techniques to apply them to problems of interest in biology, ecology, electric power grids, and social systems. Their progress is being applied to security issues. For example, ANL scientists like John Christiansen have developed complex simulations of stability operations and irregular warfare in Afghanistan for the U.S. Army Training and Doctrine Command (TRADOC).\(^ {89}\) ANL is one of leading institutions illustrating how complexity may be applied to security issues.

Third, since 1949, Sandia National Laboratories (SNL), a government-owned/contractor operated facility, has developed science-based technologies that support U.S. national security in five key areas of nuclear weapons, energy and infrastructure assurance, nonproliferation, defense systems and assessments, and homeland security.\(^ {90}\) SNL, through the work of Robert Glass, Walter Beyeler, Stephen Conrad, and others has established itself as one of the foremost authorities on complexity and how it may be practically operationalized and applied to a wide range of fields and disciplines, including security studies. The study of complexity is not limited to these three institutions, but given the breadth of their resources and employment of first-rate


scientists, they are good places to look for operationalization of terms such as complex, system, self-organized criticality, feedback, adaptive, and phase transition.

First, “complex,” is defined as interactions between agents and coactions of agents in an environment that are nonlinear and generally unpredictable.

Second, “system” is the observable macro behavior that aggregates from numerous complex agents. The trouble with systems, writes Duncan Watts, is that they are built up of many components whose individual behavior is reasonably well understood, but whose collective behavior can sometimes be orderly and sometimes be chaotic, confusing, or even destructive.\textsuperscript{91} Anatol Rapaport has stated that a whole which functions as such by virtue of the interdependence of its parts is called a “system,” and the method that aims at discovering how this is brought about is general systems theory.\textsuperscript{92} Miller and Page trace the concept back to Adam Smith’s \textit{Wealth of Nations} in 1776. They note that Smith’s concept of an “invisible hand” leads collections of self-interested agents into well-formed structures that are not part of any agent’s intention.\textsuperscript{93} Thus, it describes how an order is spontaneously formed from the self-interested acts and interactions of individual units. At the same time, however, the system’s micro level dynamics also generate increasing disorder. Whether the result is order or disorder, macro level behavior is coupled to micro dynamics.\textsuperscript{94} Sometimes it can produce ordered structures, and sometimes it destroys such structures. Put more simply by SNL scientists, a

“system” is composed of many interacting parts that often yield behavior that is not intuitively obvious at the outset – the whole is greater than the sum of the parts. Agents in the system interact, and when one agent changes its state, it influences the state of its neighbors. Thus, “complex” describes the micro interactions of agents and “system” characterizes the macro result of their interactions.

Third, “self-organized criticality,” according to SNL, is a system that self-organizes into a critical state where events of all sizes can occur at any time and thus are, in some cases, unpredictable. This is how micro level agents can disrupt or destroy macro structures of aggregate behavior. In general, the details do not matter, what matters is the ultimate behavior of an agent that influences the state of its neighbors. Thus, a “system” organizes itself from “complex” interactions of individual agents. The key driving force behind self-organized criticality is that micro-level agent behavior tends to cause the system to self-organize and converge to critical points in which small events can have big global impacts. For example, the outbreak of WWI shows how a seemingly small perturbation on a self-organized system, like early twentieth century Europe, can have massive global effects that brought about the dissolution of the German, Russian, Austro-Hungarian, and Ottoman Empires and witnessed the emergence of the United States and Japan as great powers, among many other massive global changes. Put another way, one of the hallmarks of complex systems is the aggregation of local

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actions into well-defined global patterns. It has a generic pattern known as a “power law,” whereby the system is characterized by many small events and a few, rare big ones. These big, albeit rare, events of power laws are at the root of self-organized criticality.

Fourth, “feedback” has been identified as impacting social systems for some time. Feedback is not an outside force acting on the system; it is the result of complex interactions and coactions by agents in the system. Feedback is a pervasive characteristic of practically all open systems, and is nonlinear by definition. There are two types of feedback: negative and positive. In a system with negative feedback, changes get quickly absorbed and the system gains stability. Negative feedback reinforces the system. With positive feedback, changes get amplified leading to instability. There are many examples of “large-events” that arise in social systems: stock market crashes, riots, outbreaks of war, and so on. These events are driven by positive feedback. Thus, negative feedback reinforces the system while positive feedback disrupts it. Vulnerability to positive feedback is why complex systems may suffer from criticality, punctuations in equilibrium and tumultuous phase transitions caused by small,

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98 A system is subject to a power law when \( \text{Prob}(X = x) \sim x^{-k} \). If \( x \) is the number of occurrences of some event of a particular size, then a power law would imply that the likelihood of this event is proportional to the size of the event raised to the \(-k\)th power. Thus, if \( k = 1 \), events of size 100 are one-hundredth as likely events of size 1, cited from John Miller and Scott Page, *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*, Princeton University Press, Princeton (2007), 165.


seemingly minor events that give rise to large outcomes, or “butterfly effects.” Feedback is an integral concept to complexity.

Fifth, “adaptive” is a result of feedback and criticality. It is the means by which the system’s behavior changes over time due to interactions or conditions. The changes may be within entities or their interactions, within sub-systems or their interaction, and may result in a change in the overall system’s behavior relative to its environment. Systems may adapt gradually over time due to feedback, or suddenly all at once when positive feedback introduced to the system causes critical disruption. In time, the system will adapt to the perturbation, but it may look completely different as a result.

Sixth, “emergence,” is a key concept that comes from biology. It means that in a structured system new properties emerge at higher levels of integration which could not have been predicted from knowledge of the lower-level components. Thus, a “system” “emerges” as a result of the “negative feedback” of “complex” interactions of agents. Emergence is the process by which systems become apparent and distinct from its predecessor.

For example, hunting-gathering had been an effective adaptation to the wilderness, permitting man to spread from the African woodlands and savannas where he arose, and to find living space on all continents in all climates. Striving for control in a world of uncontrolled

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growth, however, resulted when man embraced a sedentary life in the riverine areas of Egypt and Mesopotamia. There are basic connections between population pressures and “emerging” elites and hierarchies—a need for schedules, quotas, overseers, and punishment for slacking off. The emergence of civilization was distinct from the hunter-gatherer system that preceded it.

Another example is the polis. It “emerged” from the Dark Age of households and alliances of aristocratic clans partly through the growth of a new class of men: those of the middle class, neither aristocratic bigmen nor serfs dependent on the powerful landowners. Probably they were small farmers who cultivated vines, grains, and olives on marginal lands, earned enough of a surplus to create disposable income, and most likely developed the hoplite style of fighting. The Greek manner of fighting must be explained as an evolving idea, a perception in the minds of small farmers that their ancestral lands should remain at all costs inviolate, land whose integrity all citizens of the polis were willing to fight over at a moment’s notice. The system emerged from bottom-up interactions of middle class farmers that was distinct from the system that characterized the Greek dark ages.

Another example of emergence is the state system itself. Medieval kings did not exert effective political control over semi-sovereign walled cities, duchies, and feudal lords within their domains and did not possess full independence of authority from the Pope and the Holy Roman Emperor. The post-1648 system “emerged” with the centralization of political power within a given territory, independent from any higher secular authority and interacting in an

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independent fashion with similar agents in a system of states. The post-Westphalian system was distinct from the medieval one.

Another example is the gradual “emergence” of total war. There was an increasing rationalization of military power under the state, beginning in the late fifteenth century and intensifying after the legal codification of the Westphalian system. Reinforcing this was the increasing centralization of power within the state as feudal interests were gradually subordinated to centralized state authority in the early sixteenth century, a process that intensified in the late seventeenth century with the development of an administrative and financial system capable of supporting a military establishment and providing the logistical base. The commercialization of war followed as the relationship between these two systems within the state became increasingly symbiotic under mercantilism, and finally the popularization of war was made possible through the rise of nationalism, conscripted manpower, “nation in arms,” and professionalization of military power. In each example, the system emerged through bottom-up interactions; it evolved on its own rather than through top-down planning, and it was distinct from the system that preceded it.

Seventh, “phase transition” relates to how systems adapt to self-organized criticality. As noted above, positive feedback may result in perturbations to the system with global affects, and though equilibrium may be restored, the system could look completely different as a result. A phase transition marks the change of a system from one state of relative equilibrium to another.

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and though equilibrium is restored the system is fundamentally different than it was before the criticality of an event brought about the phase transition.

Lastly, from all of the above, the definitions may be combined to form one unifying concept of a Complex Adaptive System (CAS). SFI defines complex systems research as an attempt to uncover and understand the deep commonalities that link artificial, human, and natural systems. By their very nature, these problems transcend any particular field. If we understand the fundamental principles of organization, we will gain insight into the functioning of cells in biology, firms in economics, and magnets in physics. This research relies on theories and tools from across the sciences.\textsuperscript{112} Again, the Complexity paradigm is necessarily multidisciplinary and seeks to understand theoretical similarities in what appear to be very different phenomena, but these different phenomena are all CAS in one form or another.

ANL defines a CAS as fluidly changing collections of distributed interacting components that react to both their environments and to one another. Examples of CAS include the Internet, biological systems, ecological systems, social groups, and even human society itself.\textsuperscript{113} Robert Maxfield echoes ANL by defining a CAS as an open-ended system of many heterogeneous agents that interact nonlinearly over time with each other and their environment and that are capable of adapting their behavior based on experience.\textsuperscript{114} Similarly, SNL defines CAS as vastly complex physical-socio-technical systems that include people, organizations, cities, infrastructure, government, ecosystems, the Planet – in short nearly everything that involves

\textsuperscript{112} http://www.santafe.edu/about/faq/.
\textsuperscript{113} Argonne National Laboratory, http://dis.anl.gov/exp/cas/index.html.
biological and social systems. These definitions are complementary and illustrate that the paradigm may be used to study and understand any system that is nonlinear and made up of heterogeneous agents capable of adapting to changing circumstances. Thus, the science of complexity attempts to discover laws governing such systems by bringing together people and ideas from many disciplines. The unifying principle notion of these disciplines is that they all deal with CAS.

All of these definitions are consistent with observable phenomena in war and international politics and that is why complexity warrants consideration to supplement — not supplant — the traditional linear approach to social science. To be fair, the strides that complexity scientists have made are still a long way off from amounting to a science that can be relied upon for precision in charting the course of human affairs that lies ahead. Nevertheless, enough groundwork has been done in this field for Steven Mann to conclude that complexity is more than mere metaphor. Complexity is a unifying science that draws on a large and diverse number of disciplines and finds commonalities among them that may be described as Complex Adaptive Systems (CAS). A zweikampf is an example of a CAS, as is a state, an organization within a state, an individual within an organization, and even the brain within an individual. Examining war and international politics through a paradigm of complexity may reveal more about these phenomena than through Newtonian mechanics alone.

115 http://www.sandia.gov/CaseEngineering/
So What?

One final question to ask is: So What? Specifically, what is the significance and relevancy of complexity to the current state of international relations moving from theory to practice? What are the implications of complexity to United States interests? These are excellent questions that need to be answered.

First, in regards to the implications of dynamic analysis to the current state of international relations, there are numerous applications for moving from theory to practice. For example, al Qaeda and the global war on Islamic extremism are best understood in terms of a zweikampf. The zweikampf between the United States and Islamic extremism should not be visualized as two wrestlers in the same weight class. The United States is large and powerful but tires relatively easily; the enemy is scrawny, squirmy, incredibly flexible, and dangerously tenacious. Clausewitz explains that if “you want to overcome your enemy you must match your effort against his power of resistance… the product of two inseparable factors, viz. the total means at his disposal and the strength of his will.”\(^{119}\) In short, one must understand one’s adversary in order to defeat them.

To understand Islamic extremist networks, one must approach the adversary by understanding it as a complex adaptive system (CAS), that is, as a fluidly changing collection of distributed interacting components that react to both the environment and one another.\(^{120}\) Russ Marion and Mary Uhl-Bien apply complexity theory to al-Qaeda in noting that its structure is based on bottom-up coordination of individuals who come together based on common interest.


\(^{120}\) [http://www.dis.anl.gov/exp/cas/](http://www.dis.anl.gov/exp/cas/).
rather than recruited and directed through top-down control.\textsuperscript{121} The authors go on to describe the concept of "coupling strength," whereby weak coupling permits units to innovate and adapt more readily to the environment due to the weak structure. Tight coupling, on the other hand, results in a highly interdependent system. Al-Qaeda currently displays weak coupling strength because there is limited contact between, or direction from, the inner core to affiliate groups. However, the East Africa bombings of 1998 illustrate tighter coupling strength through greater direction and coordination, and the 9/11 attacks arguably illustrate moderate coupling. Coupling strength is an indication of danger because tighter coupling probably increases the damage the movement is capable of inflicting. However, Marion and Uhl-Bien also point out that maximum damage can be inflicted on a system if it is tightly coupled by targeting its communications centers, or nodes.\textsuperscript{122} Michael Beech elaborates that loosely coupled networks can absorb assaults on the network due to lower interdependence, while tightly coupled networks enhance cooperation and coordination but also have greater vulnerability.\textsuperscript{123}

By way of analogy, Mao Tse-tung breaks revolutionary war into three phases. Phase 1 is organization of political cadres in rural areas. Phase 2 is progressive expansion of Phase 1 combined with guerrilla tactics against government forces. Phase 3 is the destruction of government forces conventionally.\textsuperscript{124} Mao's strategy was a linear progression, but in Vietnam the enemy alternated between Phases 2 and 3 depending on circumstances and sometimes used

\textsuperscript{121} Russ Marion and Mary Uhl-Bien, "Complexity Theory and Al Qaeda: Examining Complex Leadership," \textit{Emergence}, Vol. 5, Issue 1, Management Department Faculty Publications, University of Nebraska, Lincoln (2003), 54.

\textsuperscript{122} Russ Marion and Mary Uhl-Bien, "Complexity Theory and Al Qaeda: Examining Complex Leadership," \textit{Emergence}, Vol. 5, Issue 1, Management Department Faculty Publications, University of Nebraska, Lincoln (2003), 64-65.

\textsuperscript{123} Michael Beech, "Observing Al Qaeda Through the Lens of Complex Theory: Recommendations for the National Strategy to Defeat Terrorism," Student Issue Paper, Center for Leadership, US Army War College (July 2004).

both simultaneously. Phase 3 is more tightly coupled than Phase 2. Islamic extremists illustrate a similar pattern of alternating between loose and tight coupling. Tight coupling allows for more sophisticated – and more deadly – operations, but it also leaves the network more vulnerable. When Western governments retaliate and crack-down on extremists, the network adapts by moving toward a looser coupling structure. Because the underlying forces driving Islamic militancy remain, the ideology survives; as more people join the movement a bottom-up idea may percolate upward and receive seed money or other forms of support as the network’s coupling strength increases, even if only moderately so, to perpetrate another attack.

Another example of the relevance of complex dynamic analysis is in the realm of conventional military operations. In 2000, several authors contributed to a study at the Strategic Assessment Center at Science Applications International Corporation (SAIC) entitled “Defeat Mechanisms: Military Organizations as Complex, Adaptive, Nonlinear Systems.” The study analyzed the disintegration of the 106th Infantry Division during the 1944 Battle of the Bulge. The authors found that “defeat is the result of a process internal to the military force under consideration... [and their analysis is rooted in the] belief that military organizations are best understood not as simple conglomerates of people, or as ‘well-oiled machines,’ but rather as biological or organic systems.”¹²⁵ This kind of analysis may yield key insights for fighting a conventional military force, as opposed to the previous example of fighting terrorist networks.

Lastly, complex dynamic analysis may also be applied to geopolitics, or what Michael Delurey refers to as “Geocomplexity.” Delurey explains that the traditional (i.e., reductionist)

approaches and ways of thinking have “hit a glass ceiling.”\textsuperscript{126} To understand contemporary global politics one must view the world itself as a complex adaptive system.

To put it all succinctly: an organism that cannot adapt goes extinct; a military organization or terrorist network that cannot adapt is defeated; a country or nation-state that cannot adapt is conquered. This is the relevancy of complexity theory to the practice of national security, and is precisely why it deserves greater attention by the security studies field.

The second question is what are the implications of all this to United States interests in the twenty-first century? The answer is in the need for a grand vision for the United States something the United States has not had since the vision of containment became defunct following the collapse of the Soviet Union. A distinction needs to be made between grand strategy and grand vision. Strategy is problem solving, and is more appropriately suited to the linear deterministic approach. For example, Chess is a strategy game that involves a series of linear moves within a given set of parameters. Thus, according the Miller and Page, Chess is fundamentally no different than tic-tac-toe in that it has a well-defined game tree that, in theory, one could work through and develop an optimal strategy with enough cognitive ability.\textsuperscript{127}

Grand vision, as a term, should be understood on its own merits. For example, Richard Rumelt once recalled a discussion he had with a graduate student: He explained to her that there are tools in every field, but in strategy, the tools are the frameworks designed to trigger and guide insight. The student’s response was that she did not have time for philosophizing: “What I


need is a simple roadmap, a plan."\textsuperscript{128} In essence, the student was asking for a simple, linear solution. Such an approach does not work in a complex world. Vision, on the other hand, puts one on a path toward a grand goal, but leaves the details blank so that strategists have the flexibility to adapt to changing circumstances as they unfold.

For example, cold war containment should be thought of more as a grand vision than a grand "strategy." Through the cold war, each administration took its own approach to containment, with a wide range of strategies between administrations, and strategies sometimes differed even within the same administration. For all the variety in approaches they still adhered consistently to the basic grand vision of containment. For example, the Kennedy administration abandoned massive nuclear retaliation for a strategy called "flexible response." The Nixon-Ford administration was characterized by "Détente," and, the Carter administration changed strategic approach from one initially focused on human rights to one focused on a buildup in defense spending. John Lewis Gaddis and Paul Nitze characterized the evolving short term strategies within the long term grand vision of containment as varying between symmetric and asymmetric responses to the Soviet threat. Symmetry is reactive policy, where the response is to enemy action at the time and place of his choosing – it lacks initiative. Asymmetry retains the initiative by acting in time and place of one's choosing.\textsuperscript{129} The strategies varied, but the vision remained constant to the end of the cold war. It is important to note that the grand vision had the political salience to be accepted by both political parties.

A grand vision is what is needed for the United States today. If the United States is to have a grand vision in the twenty-first century it should have one devised from complex analysis;

not because the world complex — obviously it is — but because the world is becoming more complex. Complexity results from interactions, and complexity is increasing with the unprecedented growth in population, combined with their increased interactions due to greater connectivity from advances in communications technology and more, faster modes of transportation. This is an example of the importance of dynamic analysis in the contemporary security environment, and why it should be used to supplement linear analytical methods used in security studies.

Conclusion

The field of security studies is arguably one of the most interesting and most important areas of study because it deals with issues of war and international politics, matters of life and death. These are highly complex phenomena, and there is still much about them we do not fully understand.

The hypothesis of this examination was that the linear deterministic conditions used to theorize about war and international politics are falling short of expectations to understand these phenomena. This is a problem, and it appears to be getting worse since the end of the cold war because the policy prescriptions that flow from linear theories are often impractical. Linear models do have application under certain conditions, and during the cold war they proved useful by simplifying matters under the umbrella of bipolarity. They were also instrumental in developing a grand vision of containment for practitioners of security to guide policy choices.

The comfortable simplicity of bipolarity no longer exists, and debating the merits of unipolarity versus multipolarity obscures the broader issue: what is the grand vision for the United States in
the twenty-first century? Linear reductionist analytical methods are insufficient alone to answer this question; they must be supplemented with complex nonlinear methods.

This paper is not arguing for a choice between linear and nonlinear analysis anymore than scientists argue for a choice between Newtonian and quantum mechanics. Traditional approaches are important and have an appropriate role to play under certain conditions, but greater advancements in knowledge can be achieved through the adoption and integration of new ways of thinking to complement traditional approaches. Social scientists, especially those in the field of strategic studies, are on the verge of incorporating complexity into their analyses. Great strides have been made in this area and applied to current conflicts in Iraq and Afghanistan. The sooner this approach is embraced by the security studies community the better; its adoption will result in a dramatic leap forward in our understanding of war and politics. It is not a matter of choosing between linear and nonlinear methods, but understanding how the two complement each other and recognizing where each is most appropriate for analysis.

The biggest issue facing the United States in the twenty-first century is the lack of a grand vision with the political salience to be accepted by the majority of the voting public. A grand vision is not deterministic in nature, and it is impossible for linear reductionism to inform a grand vision by itself. The problem is a complex one, and will require nonlinear thinking to foster such a vision. Containment was a vision, and although it adhered to a linear “if/then” approach on its surface, it was supplemented by Kennan and others’ complex analyses of Russian history, culture, and institutions compared broadly with those of the United States. Containment is the quintessential example of the complementary nature of linear and nonlinear thinking. Both methods are important, and both will be necessary if the post-cold war generation is to confront the unique and uncertain challenges facing the United States and its allies in the
twenty-first century. The challenge for security studies is to start teaching complexity to students who will go on to be practitioners, and who ultimately bear responsibility for securing United States interests in the years ahead.
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