"Complex" Targeting:

A COMPLEXITY-BASED THEORY OF TARGETING AND ITS APPLICATION TO RADICAL ISLAMIC TERRORISM

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ABSTRACT

This thesis attempts to answer the following research questions: "What are the concepts and principles of a targeting theory based on Complexity theory?" "What are the principles and concepts of Complexity theory?" "What insights does Complexity theory provide for the military strategist?" Finally it asks, "What are the targeting implications for the war on terrorism using a Complexity-based targeting theory?"

To answer these questions the study reviewed the literature of Systems, Chaos and Complexity theory that traces the broad historical sequence of systems theoretical thought and development. Information gained in this review was used to describe and explain each theory's main terms, concepts and principles and to establish a foundation for the targeting theory and its application to radical Islamic terrorism. This information was also used to explore the impact of nonlinear system theory as applied to conceptual thinking about warfare.

The study concludes that Complexity is a helpful analytical paradigm that highlights certain aspects of an issue that are not emphasized in reductionist methodologies. In addition, it shows that the USAF's understanding of a "system" is badly outdated and that an update to its formal targeting publications is warranted. Finally, the study concluded (along with many others) that nonlinearity is a fact of warfare. Nonlinearity is incorporated into Chaos and Complexity theory and, all together, have major import for our thinking across a whole range of subjects to include the war on terrorism.

Several targeting implications resulted from the Complexity-based analysis of radical Islamic terrorism. The most significant leveraged off the concept that *strategy* is based on what has worked in the past and evolves, and in a more general sense, it means strategies are learned behaviors. Thus, from a targeting perspective, the real focus should be on defeating the behavior of radical Islamic terrorism rather than targeting radical Islamic terrorist organizations.

CONTENTS

Illustrations

Table

Figure

Chapter 1

Introduction

Americans are asking: Who attacked our country? The evidence we have gathered all points to a collection of loosely affiliated terrorist organizations known as al-Qaida…This group and its leader -- a person named Osama bin Laden -- are linked to many other organizations in different countries, including the Egyptian Islamic Jihad and the Islamic Movement of Uzbekistan. There are thousands of these terrorists in more than 60 countries. They are recruited from their own nations and neighborhoods and brought to camps in places like Afghanistan, where they are trained in the tactics of terror. They are sent back to their homes or sent to hide in countries around the world to plot evil and destruction.

—President George W. Bush

Address to a Joint Session of Congress and the American People, September 20, 2001

This thesis was written in direct response to the author's personal experiences and observations after the terrorist acts of September 11, 2001. Like much of the world's population who had access to television that day, I was stunned at the extent of destruction at the World Trade Towers. After the initial shock wore off, the military professional within began to ponder the significance and meaning of the events that had transpired. First of all, one couldn't help but give grudging respect to the imagination and innovativeness of those who planned and executed the most damaging foreign attack to ever occur on American soil. Thus, a desire to learn more about terrorism and how terrorists operate was born. The more I looked into the issue the more I began to understand that terrorism is

an immensely complicated issue. Second, I was astounded when arguably the single most important financial target in the world was destroyed and there was nigh a serious hiccup in the financial markets after a week's time had elapsed. Accordingly, as a former targets officer I began to ponder how it was that the damaging effects of a strike of this magnitude could be overcome so rapidly, and, how one could ever hope to be successful in attacking something so adaptive in the future. Lastly, as an airman and SAAS student I began to wonder if current targeting theory was suited to the situation we are in now. In short, a search for answers to questions arising from this tragic day began.

This thesis, then, is an attempt to bring some very disparate topics and questions into some kind of synthesis. Through the research effort undertaken in search of answers to the above questions, I concluded that Complexity Theory could be a useful analytical paradigm for examining the phenomenon noted above (e.g. terrorism and adaptive target systems). Complexity Theory is an emerging body of theory that attempts to explain the characteristics and behavior of complex adaptive systems. Complex adaptive systems are complex in that they are composed of many different system elements and there are many different relationships in and among system elements. The more elements there are and the greater the density is in relationships, the more complex a system is. Complex adaptive systems are adaptive in the sense that they don't just react to externalities, they adjust to and exploit change for the system's benefit.

Accordingly, this thesis attempts to answer the following primary research question: What are the concepts and principles of a targeting theory based on

Complexity Theory? Secondary questions include: "What are the principles and concepts of Complexity Theory? What insights does Complexity Theory provide for the military strategist?" and "What are the targeting implications for the war on terrorism using a Complexity-based targeting theory?" In attempting to accomplish this task, the thesis proceeds in the order noted below.

Chapter two discusses the principles and concepts of Complexity Theory. However, a discussion of its predecessors, Systems and Chaos Theory, must also be included because it is difficult to fully understand Complexity Theory without it. Complexity Theory is very much an extension of Systems and Chaos Theory and draws heavily from their conceptual foundations and lexicon. The approach taken in this chapter was to review the literature of Systems, Chaos and Complexity Theory which traces the broad historical sequence of systems theoretical development. Chapter two will show how this body of thought developed and will explain each theory's main terms, concepts and principles.

Chapter three looks for insights that Complexity Theory provides the military strategist. Chapter three discusses Chaos and Complexity Theory's recent impact on military thought, theory and doctrinal development that has culminated in some changes to service doctrine. The chapter then develops some lessons from nonlinearity, Chaos, and Complexity Theory that may be helpful to the military strategist or doctrine writer.

Chapter four develops the concepts and principles of a targeting theory based on Complexity Theory. Such a theory may be beneficial for two reasons. First, it is assumed that human societies and military forces *are* complex and

adaptive entities. Thus, a targeting theory that incorporates concepts and principles similar to a theory attempting to capture the dynamics of living, adaptive systems may provide a more nuanced and less mechanistic targeting theory than is currently available. Second, it is believed a targeting theory based on Complexity Theory principles can be developed that is more universally applicable than those in use today. Such a theory would not advocate specific "panacea" targets for attack (e.g. industry, populace, leadership, fielded forces etc.) or stipulate weapon systems to be used. Thus, the theory to be introduced is a generalized theory that may provide some value across a spectrum of target systems and circumstances rather than a theory that is tailored to specific weapon systems and force structures.

In form, this targeting theory is patterned along the lines of Sir Julian Corbett's naval theory found in *Some Principles of Maritime Strategy* in that it will address the object, methods and means for attacking complex adaptive systems.[1] The theory also draws heavily on an adaptation of the "variation" and "interaction" concepts found in Robert Axelrod and Michael D. Cohen's

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[1] Julian S. Corbett, *Some Principles of Maritime Strategy*, with an introduction and notes by Eric J. Grove, (London: Longmans, Green and Co., 1911; reprint, Annapolis MD: United States Naval Institute, 1988). (Page citations are to the reprint edition.)

Harnessing Complexity: Organizational Implications of a Scientific Frontier.[2] I have attempted to "reverse engineer" these concepts while at the same time trying to remain accurate in their description, inverted as they are.

Chapter five addresses the question "What are the targeting implications for the war on terrorism using a Complexity-based targeting theory?" Chapter five applies the targeting theory developed in chapter four to the war on terrorism using a theme developed throughout the thesis: Complexity Theory provides an alternative method from the normal Newtonian model of thinking that can assist us in understanding terrorism and how to defeat it. Of course it would be presumptuous to claim a better analysis is based on Complexity Theory, but it is certainly a different one than that normally found and can be used to provide illumination on aspects of the problem we might not contemplate otherwise.

Finally, the thesis finishes by summarizing the main points of the previous chapters and by discussing the strengths and limitations of using Complexity Theory as a basis for a targeting theory. This study will also make some general observations about the current war on terrorism as viewed through the lens of Complexity Theory.

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[2] Robert Axelrod and Michael D. Cohen, *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, (New York: The Free Press, 1999).

Chapter 2

Systems, Chaos and Complexity Theory

The whole is more than the sum of its parts.

—Aristotle

Introduction: Newtonian and Complexity-based Analytical Approaches

It is generally agreed that British scientist Sir Issac Newton's approach to scientific enquiry (i.e. the scientific method) has over time become the "way" most Westerners think in many respects. His approach was to observe scientific phenomenon and try to deconstruct them into the smallest elements possible. After deconstruction, further analysis and observation was used to determine cause and affect relationships, which assist in building descriptive and predictive models. However, over time, some scientists began to believe that the Newtonian approach had its limitations as a helpful analytical paradigm.

This chapter will provide a rough historical trace of the rise of Systems Theory and its successors (Chaos and Complexity Theory) to show an evolution of thought in reaction to Newtonian thinking. As will be shown below, Systems, Chaos and Complexity Theory take a more holistic view of issues. Systems Theory focuses more on interrelationships between elements and

whether or not a model is validated by the observed behavior of the whole, rather than the sum of its parts. Meanwhile, Chaos adds that even when a system is fairly well understood minor changes in conditions can lead to radically different results. Finally, Complexity adds the concept that elements and relationships change due to continuous adaptations of disparate parts, which on their own, produce certain system-wide behaviors in order to cope. Such a system is known as a complex adaptive system.

In analyzing terrorism using the concepts to be discussed, the analysis will not "prove" terrorism is a complex adaptive system. One can only choose to *view* terrorism through the analytical prism of Complexity as opposed to the normal analytic or Newtonian prism. Accordingly, the benefit of Complexity is that it provides an alternative method from the normal Newtonian model to assist in understanding a phenomenon. This does not necessarily mean Complexity is a better model, but it is a different one that can be used to provide illumination on aspects of the problem we might not contemplate otherwise. In short, its main value is to help describe and explain things.

In addition, before beginning this chapter, it should be noted that the literature covering Systems, Cybernetic, Chaos and Complexity Theory is immense and often highly mathematical in nature. Some significant works in this area are virtually unintelligible to those without a graduate degree in a quantitative field. Scientists and theorists working in these fields search for fundamental laws, principles and theorems that hold true in a cross-disciplinary fashion and tend to communicate in mathematical terms. Fortunately, many

works have been written for the layman by authors who feel these fields offer some fundamental concepts that are widely applicable to other non-scientific issues and disciplines. However, one of the main criticisms of the theoretical constructs that follow is that they have been grossly over extended and misapplied beyond that to which they apply.[3]

Even though a significant body of the literature is geared toward specific technical or theoretical issues, when looking for information that may apply to a targeting theory, one is not particularly interested in the mathematics necessary for building a control device, but one is interested in how to "control" an enemy. Thus, certain higher level concepts may be of help from a metaphorical or analogical standpoint in the descriptive and explanatory tasks that lie ahead. However, one would be hard pressed to claim even a modicum of "scientific" substantiation for them in the way they will be applied here.

The purpose of this chapter is two fold. First, it serves to define and explain the basic terms associated with Systems, Cybernetic, Chaos and Complexity Theory. Of course, defining and explaining terms provides a foundation for the rest of this paper, but it also provides an update to the Air Force's understanding of a system. If one compares an article on targeting and target systems in the very first issue of what airmen now know as the *Aerospace*

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[3] Robert Lilienfeld, *The Rise of Systems Theory: An Ideological Analysis* (New York: John Wiley & Sons, Inc., 1978), 247-280.

Power Journal[4] with the current official Air Force manual on targeting, the *USAF Intelligence Targeting Guide*, it becomes apparent the Air Force has not kept abreast of the developments that have occurred in over fifty years of Systems Theory development. Indeed, if one compares page 75 of Col deRussy's 1947 article "Selecting Target Systems and Targets" in *Air University Quarterly Review* with pages 47-51 of the latest Air Force targeting manual published in 1998, he will notice virtually no change in how an enemy target system's essential elements for analysis are described (e.g. the concepts of depth, cushioning, vulnerability, etc.). Page 41 in the USAF targeting manual goes on to note "if targeteers don't provide full targeting service, then other well meaning but under trained and ill-experienced groups will step in and attempt to provide that which is perceived to be missing."[5] If USAF targeteers are going to lay claim to the previous comment, then one might suggest updating their theoretical knowledge base on systems in order to provide a more contemporary view of our concept of a target system.

The second purpose of this chapter is to highlight theoretical concepts which may provide some unique insights into strategy and targeting theory than those normally resulting from a Newtonian approach. To facilitate identifying

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[4] Colonel John H. deRussy, "Selecting Target Systems and Targets," *Air University Quarterly Review*, vol. 1, no. 1, (Spring 1947): 69-78.

[5] Air Force Pamphlet 14-210, *USAF Intelligence Targeting Guide*, 1 February 1998, 41.

important items in a barrage of definitions and concepts, key terminology and concepts will be ***bolded and italicized***.

A Different Way of Viewing the World

> *System: An assemblage of things adjusted into a regular whole or a whole plan or scheme consisting of many parts connected in such a manner as to create a chain of mutual interdependencies.*
>
> —Noah Webster
> *An American Dictionary of the English Language, 1845*

At the dawn of the 21st century it is difficult to fathom the fundamentally different theoretical paradigm that "systems thinking" has brought to us. It is also hard to imagine that the concept of a "system," as we now know it is even younger than the airplane. While scattered elements of systems concepts were developed in various disciplines as early as the 19th century, Systems Theory or the "systems paradigm" began to emerge as a significant construct in the 1930s and 1940s. "Systems thinking" has its main roots in several different disciplines to include biological, social, and computer sciences.[6] Since the 30s and 40s, Systems Theory has developed two main threads, which are clearly distinguishable, but at the same time are tightly interwoven and highly dependent upon one another.

The first thread is known as General Systems Theory (GST). The most well known proponent of GST was the theoretical biologist Ludwig von Bertalanffy (1901-1972) who formulated the concept of an open system. Bertalanffy was troubled by his observations indicating that many of the laws of

[6] Lilienfeld, 1.

physics could not explain certain biological phenomenon. Specifically, Bertalanffy observed that the Second Law of Thermodynamics did not seem to apply to living matter.[7] The Second Law of Thermodynamics states that, over time, energy will be transformed in a manner such that it will no longer be available for future use in a closed system. As this occurs, disorder and randomness increases. Bertalanffy's observation is easily seen in the formation of an egg from strands of DNA, which then eventually grows into a human being. Throughout this process energy is taken in from the environment and transformed into greater organization and more complexity. In short, living organisms exhibited properties that were the exact opposite suggested by the Second Law.[8]

Another problem noted by biologists was that the normal "reductionist" approach to science didn't work very well for some biological problems. Reductionism in science is simply the process by which something is broken down into ever smaller and simpler elements so as to understand its fundamental properties. Reductionism is also closely associated with "cause and effect" wherein basic elements are sought after in order to understand how they may initiate or change something. This approach has paid huge dividends in the physical sciences and is the basis of much of man's more recent knowledge. However, reductionism doesn't do well when encountering the multi-variable,

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[7] Ibid., 16-17.

[8] Ludwig von Bertalanffy, *General Systems Theory: Foundations, Development, Applications* (New York: George Braziller, Inc., 1968), 39-41.

interrelated problems often found in biology.[9] It became apparent to the biologists that a new model was required, one that tended to look at things as a whole rather than as a "conglomeration of parts…in narrowly defined contexts."[10] From this beginning the general systems theorists eventually came to assert that "there exist models, principles and laws that apply to generalized systems regardless of class, components and relations between components [and that these principles] could be transferred between fields safeguarding against the transfer of vague theories which mar progress."[11]

Starting at about the same time, another group of scientists began to find that they were working on problems that also required a "systems approach." The lead figure in establishing this second thread of Systems Theory, known as "Cybernetics" (a shorter name for control and communications theory), was Norbert Wiener (1894-1964).[12] Cybernetics was born out of the research scientists were doing to develop guided anti-aircraft guns and missile systems, and methods for controlling computer computations. This group of scientists faced the practical problem of figuring out how the controlling element of a weapon system or computer could gather information, process it, and then give instructions to other elements of the weapon or computer to accomplish the

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[9] Ibid., 10.

[10] Ibid., 9.

[11] Ibid., 32-34.

[12] Lilienfeld, 35.

desired action.[13] The above efforts were heavily dependent on understanding the essential elements of communication and information and how they related to control. Feedback is a central concept of Cybernetics—a concept we take for granted today. Accordingly, Cybernetics is important to GST because it helps to explain how internal system elements work and communicate with one another. In addition, Cybernetics also helps to explain system behaviors in response to environmental data and, of course, the principles behind control.

In short, GST and Cybernetics have brought an additional theoretical approach to use when trying to assess and understand an object of study. The approach places emphasis on integrated and organized wholes rather than isolated elements.[14] The systems approach, at the time it was initially conceived, represented a fundamentally different view of the world. Since then, it has been adopted by many fields of study and the language and terminology of systems thinking has entered the common vernacular.[15] While specific system concepts are explained below, it is helpful at this point to contrast analytic and systemic thinking so as to highlight their differences before addressing the particulars of Systems and Cybernetic theory.

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[13] J. Daniel Cougar and Robert W. Knapp eds., *Systems Analysis Techniques* (New York: John Wiley & Sons, 1974), 15.

[14] Robert M. Krone, *Systems Analysis and Policy Science: Theory and Practice* (New York: John Wiley & Sons, 1980), 14.

[15] Lilienfeld, 2.

Table 1: Comparing Analytic and Systemic Approaches

Analytic Approach	Systemic Approach
Isolates, then concentrates on the elements	Concentrates on the interaction between elements
Studies the nature of interaction	Studies the effects of interactions
Emphasizes the precision of details	Emphasizes global perception
Modifies one variable at a time	Modifies groups of variables simultaneously
Validates facts by means of experimental proof within the body of a theory	Validates facts through comparison of the behavior of the model with reality
Is an efficient approach when interactions are linear and weak	Is an efficient approach when interactions are nonlinear and strong

Source: J. deRosnay (1997): *Analytic vs. Systemic Approaches*, in: F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web*[16]

System Definition and Characteristics

The first essential concept to understand about a system is its definition. While there are numerous definitions of a system, perhaps the clearest is that set forth by George J. Klir. Klir notes that "a system is a set of things with

[16] Adapted from: J. deRosnay (1997): *Analytic vs. Systemic Approaches*, in: F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web* (Principia Cybernetica, Brussels), available from http://pespmc1.vub.ac.be/analyst.html; Internet; accessed 3 February 2002. This information is copyrighted and may be used for personal or educational purposes only (to include publication) with proper citation.

a relationship between them, S=(R, T)."[17] However, it is important to note that while "things" are usually some type of concrete entity, "relationships" are in the eye of the beholder. Where a system begins and where a system ends is defined by the analyst. For example, a piston can by part of an engine system, which can be part of a car system, which could be part of the highway system. Thus, systems "can be defined by restricting things to certain kinds of things or restricting relations between things."[18] In short, ***systems are "what people define them to be*** and what nature has bequeathed."[19]

From the above definition arise important system characteristics to include:

1) Goal Seeking: Systems form or are designed to accomplish an objective.
2) Hierarchy: Systems have an established arrangement composed of subsystems.
3) Interdependence: Synergistic interrelationships exist amongst system elements.
4) Entropy: All nonliving systems eventually fall into disorder and randomness. Living systems are able to postpone this process by importing energy.
5) Gestalt Phenomena/Holism: Systems display behaviors and can accomplish activities as a system that a system's individual elements can not. To borrow Aristotle's words again, "the whole is more than the sum of its parts."[20]

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[17] George J. Klir, *Facets of Systems Science* (New York: Plenum Press, 1991), 4.

[18] Klir, 14.

[19] Krone, 17.

[20] Vincent P. Luchsinger and V. Thomas Dock, *The Systems Approach: A Primer* (Dubuque Iowa: Kendal/Hunt Publishing Company, 1975), 1.

6) Equifinality: A closed system will always arrive at the same end point if initial conditions are the same (i.e. direct, repeatable cause and effect). However, open systems may reach the same end state from different initial conditions.[21] Said another way, there are different ways to achieve the same end by rearranging system elements or processes.

System Types

While systems are what people define them to be, generally systems are described in three general ways. The first way is whether or not a system is a closed or open system. A ***closed system*** does not exchange energy, materials or information with the environment or other systems and, as noted above, is subject to the basic laws of thermodynamics. An ***open system*** exchanges inputs and outputs with the environment and until system destruction/death is able to avoid the laws of thermodynamics.[22] Another way systems are described is by determining if they change over time in response to some type of energy, force or action. If they do, then they are ***dynamic systems***. A *conservative* dynamical system has no friction; it does not lose energy over time, whereas a *dissipative* system looses energy and will eventually approach some limiting condition or state. Finally, dynamic systems can be linear or nonlinear in nature. A ***linear system*** is one in which inputs and outputs are generally, though not always, proportional. Because variables are generally proportional, a linear system is predictable and relatively easy to understand. Linear behavior is smooth and regular over time, and accordingly, cause and

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[21] Bertalanffy, 40.

[22] Luchsinger, 6-8.

effect is easily determined. In ***nonlinear systems***, outputs are not proportional to inputs, change is erratic, behavior is difficult or impossible to predict and cause and effect may be indeterminate.[23]

A Generic System Model

As noted earlier, specific systems are defined by the analyst who decides "what's in and what's out." However, over time a generic system model has been created which captures the essential elements of a system. The generic system elements include inputs, outputs, process, boundary, environment and feedback. ***Inputs*** are those things taken into a system from the environment (e.g. information, energy, resources). ***Outputs*** are those things a system produces that have value to the environment. ***Process*** is the inner workings of a system that transform inputs to outputs. ***Boundary*** is the real or conceptual line dividing the system from its environment. ***Environment*** is anything (e.g. space, time, conceptual framework, etc.) external to the system that cannot be changed by the system and influences the system.[24] ***Feedback*** is the return of some of the output of a system as input (usually information).[25] Because feedback is so critical to a

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[23] Garnett P. Williams, *Chaos Theory Tamed* (Washington D.C.: Joseph Henry Press, 1997), 10-11.

[24] Luchsinger, 4-6.

[25] Peter P. Schoderbeck, Charles G. Schoderbeck and Asterios G. Kefalas, *Management Systems: Conceptual Considerations*, 3d ed. (Plano Texas: Business Publications, Inc., 1985), 371.

system's operation, it is perhaps the element of a system that has received the most in-depth study and is the subject of the next section.

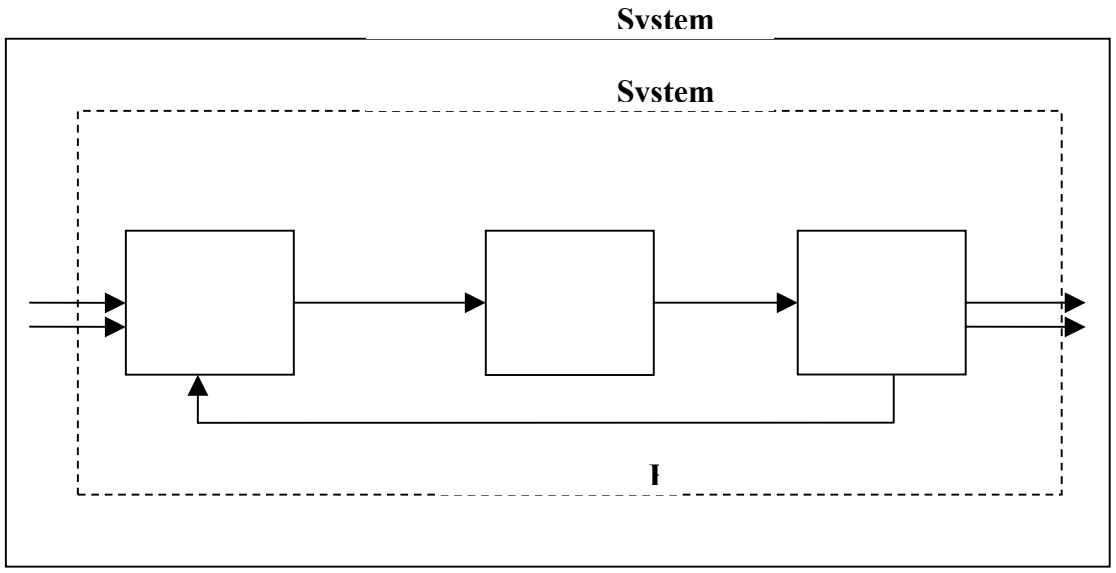

Figure 1: Generic System Model

Cybernetics

Cybernetics focuses on system coordination, regulation and control.[26] As such, cybernetics explores the nature of information and communication within a system. If one were to study the "cybernetics" of our body, they would examine the brain, the central nervous system and how it interacts with our body, sensory organs and the environment. Thus, Cybernetics provides several important concepts relating to systems, many of which are

[26] Klir, 37.

explained in what is considered to be the classic of Cybernetic literature, W. Ross Asbhy's *An Introduction to Cybernetics*.[27]

One major concept of Cybernetics is a system's "state." According to Ashby, "the most fundamental concept in Cybernetics is that of "'difference', either that two things are recognizably different or that one thing has changed with time."[28] A change of system state has occurred if the system at T+1 is different than at T. If a system has a well-defined condition or property that can be recognized if it occurs again in the future, it is one of the system's states and a system can have many different states.[29] A system is generally considered to be ***stable*** when it will return to its original state when disturbed. A system is ***instable*** when it shows increasing divergence from its original state when disturbed.[30]

Another significant Cybernetic concept discussed by Ashby is ***feedback***. Feedback is present when two systems are coupled in such away that the action(s) of one affects the other. Feedback can be one-way or two-way. Feedback can also be negative or positive. *Negative feedback* exists "when an initial disturbance travels through the feedback system and arrives back at its

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[27] W. Ross Ashby, *An Introduction to Cybernetics* (New York: John Wiley & Sons, 1956).

[28] Ibid., 9.

[29] Ibid., 25.

[30] Ibid., 85.

origin in such a way that it is diminished and is a sign of a stable system."[31] In other words, negative feedback dampens the effects of a disturbance causing the system to return to its original state. *Positive feedback* is exactly the opposite. Positive feedback will magnify the disturbance causing greater instability as it loops through the feedback system. Given the above feedback descriptions, it becomes apparent that negative feedback is associated with being able to control or regulate a system, while positive feedback can cause a system to go out of control. However, it should be noted that both negative and positive feedback can be good or bad depending on what is desired. For example, negative feedback (control) prevents change, whereas positive feedback promotes change which is necessary for growth and adaptation to a new state.[32]

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[31] Ibid., 80.

[32] Felix Geyer, "Challenges to Sociological Knowledge", (paper prepared for Symposium VI: Session 04: "Challenges from Other Disciplines", 13th World Congress of Sociology, Bielefeld, Germany, July 18-24, 1994) available from http://construct.haifa.ac.il/~dkalekin/cyber1.htm; Internet; accessed 03 February 2002.

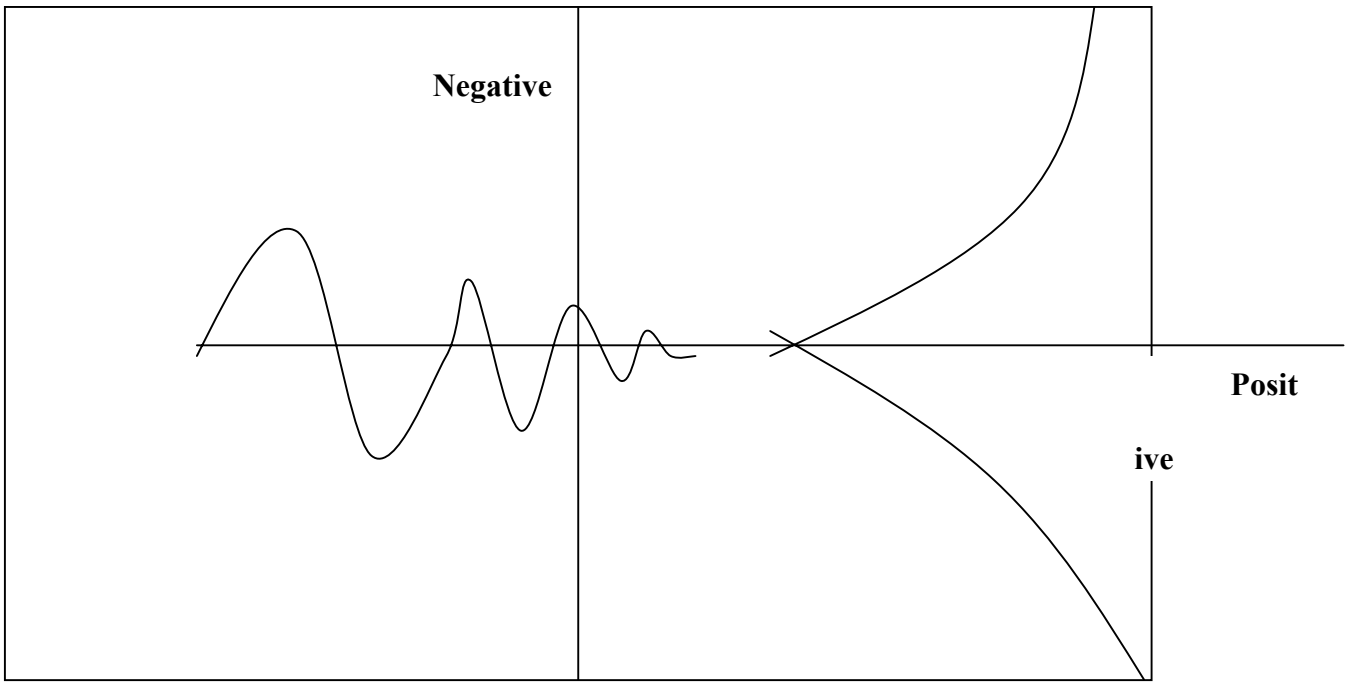

Figure 2: Example of Negative and Positive Feedback

A third notion put forth by Ashby is the concept of variety. Ashby defines ***variety*** "as a set with distinct elements."[33] The greater the number of sets and elements the greater variety a system has, and importantly, the greater the number of states a system can achieve. Variety is an extremely valuable commodity for a system to possess because a system is "constrained" if it does not have sufficient elements and arrangements of elements to deal with variety imposed upon the system by the environment or other systems. Ashby notes that "the severity of constraint is shown by the reduction it causes in the number of arrangements a system can take to counteract opposing elements" and "that when

[33] Ashby, 125.

a constraint exists, a system can be taken advantage of because it is predictable."[34] Theoretically, systems are unpredictable if they are unconstrained. The above may seem confusing, but actually it is quite simple and can be summed up another way: More options are better than fewer options, particularly if one does not know what they will be encountering in the future. Or, the fewer options someone has, the easier it is to figure out what it is they might do. In Ashby's book all of the above finally concludes in a mathematical proof known as the Law of Requisite Variety (today also known as Ashby's Law) which states: "***Only variety can destroy variety***."[35] In short, systems with more variety can, in Ashby's words, "regulate and control other systems."[36]

Starting in the early 1970s, some "cyberneticists" began to focus on the subject of modeling systems and the fundamental differences between modeling machines and modeling living entities in what became known as second-order Cybernetics. First-order Cybernetics dealt with machines, in which the builder knows all of their internal and external interfaces and knows exactly how he expects the machine and the interfaces to behave. Therefore, a builder's models of a machine are likely to be highly accurate and any differences between the model and the actual machine are probably well understood and/or the model was developed intentionally to restrict the information to something more

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[34] Ibid., 127-131.

[35] Ibid., 207.

[36] Ibid., 195.

manageable, or to focus only on certain system elements and relationships. Meanwhile, second-order Cybernetics deals with living entities that are not built by the observers. When someone is modeling a living entity the situation is very different. First, due to the inherent subjectivity of observation and model making (i.e. you observe and model that which you choose to observe and model) any model built is, at best, only going to reflect a partial reality. Lastly, and more critically, ***the simple act of observing something forms a new system wherein the observer and the observed begin to influence each other***. Thus, the observer and the observed are connected and may become more so over time.[37]

One example of second-order Cybernetics in operation is the frequently cited "CNN effect." CNN effect occurs when U.S. foreign policy-makers are forced to react to sensational news reporting in situations they might not have otherwise acted on. In second-order Cybernetics terms, there was no model before the reporting, or at least a model that represented the reality soon to be created with the arrival of sensationalistic reports. However, after arrival on the world's television screens, observation began, a system was formed whether desired or not, and in some cases events and public opinion compelled action. In

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[37] F. Heylighen and C. Joslyn (2001): *Second-Order Cybernetics*, in: F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web* (Principia Cybernetica, Brussels), available from http://pespmc1.vub.ac.be/SECORCYB.html; Internet; accessed 14 April 2002

short, the observed and observer began influencing each other in a larger system encompassing both of them.

A Different Way of Viewing the System

Historically, systems theoretical development and its application to actual problems were in full swing starting in the early 1950s and continuing well into the 1970s. The Rand Corporation was an early proponent of systems analysis and the Department of Defense's Planning, Programming and Budgeting System (PPBS) is a direct outcome of systems thinking.[38] However, beginning in the mid 1960s an outpouring of scholarly effort was directed at the limitations which were readily apparent in the existing Systems Theory due to the problem of nonlinearity and its attendant challenges. If Systems Theory was a new way of looking at the world, this later body of work was a new way of looking at the system.

One group to take up the study of nonlinearity in dynamical systems was the Chaos scientists whose efforts were greatly facilitated by the advent of ever increasing, cheap computer power.[39] The main finding of the Chaos theorists was that some dynamic systems which appeared to be random were, in fact,

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[38] E.S. Quade, *Systems Analysis and Policy Planning: Applications in Defence*, eds. E.S. Quade and W.I. Boucher (New York: Elsevier North-Holland, Inc., 1977), 1-3.

[39] Williams, 18-19.

predictable over the short term. According to James Gleick, Chaos Theory began with the realization that quite simple nonlinear mathematical formulas could model what had been thought to be random systems.[40] Thus, computers allowed predictable patterns to be detected, observed and modeled where only apparent chaos had been seen before.

Meanwhile, another group of scientists began to study the nonlinear behaviors observed in nature. According to Waldrop, "Chaos theory told you a lot about how certain simple rules of behavior could give rise to astonishingly complicated dynamics," but had little to say about living systems or evolution in a world that is definitely nonlinear.[41] Scientists had long noticed that living systems demonstrated special properties enabling them to "adapt" to ever changing nonlinear situations and bring apparent order to disorderly situations and circumstances. These scientists wanted to know if there were general principles governing this phenomenon. An interdisciplinary body of study got underway in the mid 1980s to study adaptive systems and became known as the study of Complexity.[42]

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[40] James Geick, *Chaos: Making a New Science.* (New York: Viking Penguin Inc., 1987; New York: Penguin Books, 1988), 8.

[41] M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos*. (New York: Simon & Schuster, 1992; New York: Touchstone, 1993), Waldrop, 287.

[42] Ibid., 12.

Chaos Theory

> *Chaos can be important because its presence means that long-term predictions are worthless and futile.*
>
> —Garnett P. William
> *Chaos Theory Tamed*

As a way of understanding what Chaos is, let us first begin with what it is not. "Chaos is not social disorder, anarchy or general confusion."[43] Chaos is actually a class of dynamical behavior that occurs in deterministic nonlinear systems (i.e. the system is semi-stable and predictable).[44] In addition, Chaos happens in feedback systems in which yesterday's events impact today's events and today's events will affect tomorrow's. In short, "chaos" was probably not the best choice of words to name this class of phenomena.[45] Chaos is actually a semi-orderly system in a state, which despite an apparent disorderly appearance, in fact has some predictability and order in its structure and process.[46]

Essentially, Chaos boils down to the observation that some systems which appear random in their behavior, will gravitate toward ***phase spaces*** of stability

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[43] Major Glenn E. James, *Chaos Theory: The Essentials of Military Applications*, Paper (Newport RI.: Naval War College, 21 February 1995) [DTIC AD-A293-163].

[44] Williams, 9-11.

[45] Steven R. Mann, "Chaos Theory and Strategic Thought," *Parameters*, vol. 22, no. 3, (Autumn 1992): 58.

[46] Williams, 209-210.

over time. These spaces of stability are known as ***attractors*** and, if the system is understood well enough, the attractor space can be predicted but only over the short term. However, one shouldn't think of an attractor as something like a magnet that a system is physically drawn to. Attractors are more like watching a top spin on a table. Initially the top will gyrate rapidly and wobble around all over the table, but eventually the top will stabilize in its vertical axis and more or less confine its motion to a small area of the table. The small area of the table the top settles into is the attractor. Attractors are sometimes described as bowls or basins because they better connote a system settling into something. Thus, if our table had a depression in it, the top would tend to settle there. Finally, if the top hits a bump on the table or runs out of energy, the top may bifurcate and fly off the table uncontrollably or begin a more exaggerated wobble ending in collapse. ***Bifurcation*** is an abrupt change in the system's state due to a changed parameter(s).[47] When a system bifurcates, it may do so into disorder, or simply move to another settled state. To conclude the top analogy, if one was to again spin the top on the kitchen floor a similar picture would be repeated, only this time in an entirely different location with entirely different environmental circumstances. Thus, a "top" scientist might see Chaotic properties in a top in that its behavior is sometimes stable and predictable. However, the top's behavior varies widely depending on starting conditions and occasionally the top will even fly off into instability/collapse.

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[47] Ibid., 448.

Garnett P. Williams in his book *Chaos Theory Tamed* lists 16 different characteristics of Chaos.[48] Several of these characteristics have already been discussed, and some are related to the mathematical aspects of Chaos modeling, and as such, will not be discussed here. Of the remaining conceptual characteristics, some have been carried over into Complexity and are listed below rather than in the next section on Complexity.

1) Chaotic systems are ***hyper-sensitive to initial conditions*** (i.e. the same elements together as a system may exhibit drastically different behavior depending on starting conditions).

2) ***Long-term predictions are meaningless*** due to sensitivity to initial conditions and the impossibility of measuring variables to infinite accuracy. Short-term predictions, however, can be relatively accurate.

Complexity Theory

> *I shall proceed from the simple to the complex. But in war more than any other subject we must begin by looking at the nature of the whole; for here more than elsewhere the part and the whole must always be thought of together.*
>
> —Carl von Clausewitz
> *On War*

Before examining Complexity in detail, it is first important to understand what exactly is meant by the term "complex" when referring to a system. In one sense of the term, complex refers to the difficulty involved in describing a system.

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[48] Ibid., 209-210.

In the descriptive sense, complex refers to the amount of information required to describe a system or the level of uncertainty involved in a system's description. Obviously, the more information that is required to describe a system, the more complex the system is. However, one can also choose to describe a system in more abstract terms to "lessen its complexity." Thus, a given system may be physically exactly the same, but be seen as more or less complex, depending on how it is described. It should also be apparent that there is an inverse relationship between descriptive complexity and descriptive uncertainty. In general, good models are descriptively simple and, yet, avoid unnecessary uncertainty which would damage the model's credibility.[49]

The second sense of the term, which is the one that will be used for the rest of this thesis, refers to the distinct number of system elements, interrelationships between elements and number of states a system can take.[50] The more of each, the more complex a system is, and, the more difficult it is to model. In this sense, complexity can be decomposed into three essential elements: scale, differentiation, and integration.[51] Scale refers to complexity in scale or time and

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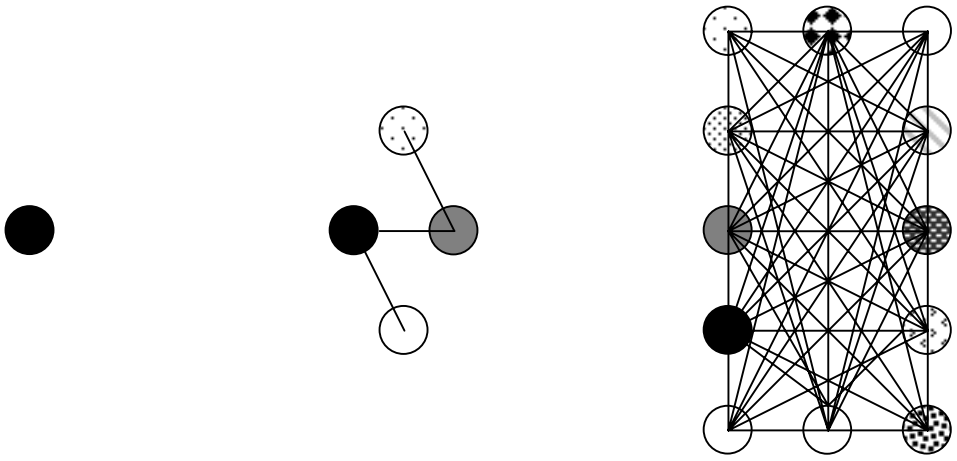
[49] Klir, 115-119.

[50] Lilienfeld, 38.

[51] F. Heylighen (1996): *What is Complexity?*, in: F. Heylighen, C. Joslyn and V. Turchin (editors): *Principia Cybernetica Web* (Principia Cybernetica, Brussels), available from http://pespmc1.vub.ac.be/complexi.html; Internet; accessed 11 February 2002.

is analogous to saying the world is more complex than a farm town, or that the long history of the Balkans makes the situation more complex. Differentiation refers to increased variety of elements. A system may have a billion elements, but if they are all the same, it is not as complex as one with hundreds of distinctly different elements all acting according to different rules. Finally, integration refers to increased connections between elements. A billion elements unconnected, is a billion simple systems, whereas a billion elements with myriad connections is an inordinately complex system. Thus, "complexity is actually in the organization—the myriad ways that the components of a system can interact."[52] In sum, a highly complex system is big and has lots of different parts with numerous interconnections

[52] Waldrop, 86.



Slig **More**

Figure 3: An Illustration of Increasing Complexity

In view of the above second meaning of complexity, it is important to note that Complexity emphasizes a subtle, but critical, distinction in the study of systems. The sciences of Complexity study how ***the actions of micro-level actors can add up to macro-level effects***. Thus, the emphasis is on the actions and interrelationships between system elements rather than the individual parts of a system themselves.[53] To use a simple example, a Complexity scientist studying a four-ship engagement, while being interested in the specific aircraft, air-to-air missiles and pilots involved, would be even more interested in how the actions, relationships and coordinating actions between lead and wingmen lead to shooting

[53] Michael J. Mazarr, *Global Trends 2005: An Owner's Manual*. (New York: St. Martin's Press, 1999), 93.

down an aircraft. Thus, we come to one key difference between Complexity and Newtonian thinking as it impacts target system analysis and strategy. ***Complexity focuses primarily on system interrelationships instead of system elements***. In the above example, both elements and interrelationships are important, but with Complexity, the focus is different.

While Complexity has many concepts which shall be discussed in a moment, the theory's centerpiece is the ***complex adaptive system*** composed of agents. An ***agent*** is anything that has the ability to interact with its environment and other agents.[54] Sometimes agents will share similar common features or behaviors and when this occurs, this group of agents is known as a ***type*** of agent.[55] A system is complex due to scale, differentiation, and integration factors noted above. A system becomes complex *and* adaptive when the previous factors are present and there is "the ability of a system to modify itself or its environment when either has changed to the system's disadvantage so as to regain at least some of its lost efficiency."[56] However, in a complex adaptive system, adaptability comes in a unique way described next.

There are two requirements for an agent to be adaptive in order to survive and prosper: prediction and feedback. Agents constantly make predictions concerning the correct action to take in the future based on past

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[54] Axelrod, 4.

[55] Ibid.

[56] Cougar, 35.

experience. Experience provides models (sometime termed "schemata") upon which future decisions are based. Responses are triggered when certain actions occur for which a historically-derived model is available. After a response, feedback is obtained when the response's results are obtained and compared with the model to determine if the model will be kept, deleted, or refined to become the new model for similar events in the future. The model which an agent uses as a response to an event is known as a ***strategy***.[57] Note here that in Complexity terms, strategy does not mean how means will be used to obtain ends.[58] Rather,

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[57] Axelrod, 4.

[58] Note: There are numerous definitions of strategy and the term strategy has evolved in meaning from a purely military one to something more general in nature. However, most modern definitions can be boiled down to the rather simple "the use of means to obtain ends." This definition of strategy has three basic components: What to use, how to use it, and toward what purpose. Definitions beyond that just described usually take on qualifying contextual factors applicable to a specific issue being discussed. Meanwhile, Complexity theorists have added a slightly different twist to the term which implies some previous experience that influences what to use, how to use it, and toward what end. In my view, it is hard to argue Complexity theorists don't have a valid point in that strategies usually have at least some experiential precedent upon which they are based in one form or another. Their slightly different take on the term simply recognizes that living entities use past experience as a rough guide in

strategy means taking initial response actions based on past successful actions which are then updated as the situation progresses. In other words, ***strategy is based on what has worked in the past and evolves*** and, in a more general sense, it means strategies are learned behaviors.

Interestingly, all these individual adaptive agents oftentimes organize to create systems that are also adaptive and one of the ways agents adapt is through ***self-organization***. Self-organization occurs through a process whereby system agents form combinations and recombinations with other system agents to gain a competitive advantage. In this process there are a great many agents and types interacting constantly with each other via defined interrelationships with other agents and types.[59] Self-organization occurs inevitably and spontaneously in

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choosing an option and that truly successful adaptive entities are able to recognize differences between the past and the present in their choices and adjust accordingly. In light of this discussion, the term "strategy" as used here will be a synthesis of both ideas. Essentially it will mean "the use of means to obtain ends" but it will also imply that strategic choices involve some historical or experiential influence in the "what to use, how to use it, and toward what purpose" aspects of any strategic decision. Any deviation from that noted here will be explicitly qualified in the discussion.

[59] James N. Rosenau, "Many Damn Things Simultaneously," in *Complexity, Global Politics and National Security*, eds. David S Alberts and

response to ongoing feedback in order to optimize for current conditions. At the point agents self-organize, a complex adaptive system is born. However, a key principle behind self-organization is that it is done in response to *each agent's perception* of the situation rather than through some central controlling mechanism. A good example of this is the current state-centered international system where states form or break alliances and coalitions according to their independent assessments of national interest. Coherence in the system arises from the dynamics of cooperation and competition among the countries themselves according to local prerogatives rather than universal rules. Accordingly, ***control of a complex adaptive system is highly dispersed and not dependent on any single system element***. It should be apparent then, that lack of a central controlling element portends serious theoretical problems for targeting theories emphasizing command and control decapitation if one accepts the notion of a complex adaptive system.

When a system self-organizes and begins to have particular characteristics or behaviors it can take on emergent properties. ***Emergence*** occurs when numerous agents take on a property that none of them have alone. An example of emergence is when two parts hydrogen combine with one part oxygen to form a water molecule. Emergence can occur repeatedly as a complex adaptive system gains new levels of organizational complexity and, accordingly,

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Thomas J. Czerwinski (Washington D.C.: National Defense University, 1997), 82-83.

different properties are observed at each new level.[60] Another example of an emergent property due to self-organization and decentralized control in response to self-interest is the economist Adam Smith's "invisible hand" theory of economics. Indeed, emergence and the invisible hand are very similar ideas developed over two hundred years apart.

Sometimes the organizational response and structure designed by the complex adaptive system is so successful that it becomes autopoietic. ***Autopoiesis*** is the process by which systems utilize elements from their environment to reproduce and repair themselves.[61] Autopoietic systems have strong internal models of themselves that allow them to recreate past successful actions or copies of themselves, oftentimes without regard to newly acquired information. Thus, autopoiesis is based on highly successful strategy as it was defined above. According to Complexity, this concept of self allows complex adaptive systems to maintain their identity in complex situations. It is also a behavior that can be exploited to a system's detriment if a system's concept of self becomes overly divorced from reality.[62] An example of military autopoiesis might be the Prussian-German staff system designed in the early 1800s in response to Prussia's defeats by Napoleon. The Prussian staff system is seen as

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[60] Waldrop, 82.

[61] Geyer, Section 4.

[62] Arthur Battram, *Navigating Complexity*. (Sterling, VA.: Stylus Publishing Inc., 1998), 225.

very successful and has been widely replicated throughout the world and, if a specific staff was destroyed in combat, "new agents" would likely adopt the same staff system. In terms of potential theoretical application, autopoiesis means that ***highly successful past strategies are oft repeated and are hard to kill off.*** It also means there is tendency to use past successful strategies in situations that might not be appropriate.

Another complex adaptive system property is ***co-evolution***. Complex adaptive systems exploit niches in the environment. However, the very act of filling a niche may create other niches, so new opportunities are continuously opening up for exploitation. Thus, complex adaptive systems are in a constant cooperative-competitive environment and may evolve and specialize in some manner symbiotically interrelated to another complex adaptive system. At any given point in time, a complex adaptive system may be at some advantage or disadvantage which it (and other complex adaptive systems) are continuously trying to expand or overcome.[63] As such, co-evolution suggests that ***one side's strategy and operations are interactive with the other sides in a process that is not totally controllable by either party***. This is an uncomfortable proposition for western-oriented Newtonian thinkers, but one that reflects the reality of

[63] Williams, 14.

nonlinearity. An example here is the perennial tug-of-war observed between offensive and defensive weapon systems and Clausewitz's concept of chance.[64]

To further expand the concept of co-evolution, some Complexity theorists have added artifacts to the co-evolution equation. ***Artifacts*** are objects used by agents in a complex adaptive system. Artifacts also co-evolve with the agent and changes in the environment and sometimes it can be difficult to decide whether the agent or the artifact is the driving evolutionary force.[65] Indeed, the history of the USAF and airpower theory could be seen as a process of growing and evolving as its aircraft "artifacts" evolved and improved technologically.

Complex adaptive systems and their artifacts can form densely interconnected webs that are highly dynamic and unstable. Over time, they can establish technologies that are subject to bursts of creativity and massive extinction. Sometimes artifacts and systems will experience ***increasing returns and/or lock-in***.[66] Increasing returns is a positive feedback loop or snowballing of success that gives an agent a sustained competitive advantage and may "lock-in" the entire system to the artifact.[67] An example of this is Microsoft's DOS and Windows computer operating systems. Another example of lock-in may be the

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[64] Carl von Clausewitz. *On War*, Edited and translated by Michael Howard and Peter Paret. (Princeton, New Jersey: Princeton University Press, 1989), 85-86.

[65] Axelrod, 6.

[66] Waldrop, 119.

[67] Battram, 155-156.

World War I choice of single-seat fighters as the preferred type of air superiority vehicle. When lock-in occurs, it may become an attractor for several systems or agents.

On the downside, when a new agent or artifact is developed or environmental conditions change substantially, punctuated equilibrium may occur. ***Punctuated equilibrium*** is a marked surge in new artifacts, agents and complex adaptive systems and/or extinction of existing ones rather than gradual change. A complex adaptive system that does not adapt to punctuated equilibrium events will disappear.[68] An example here is the demise of horse cavalry and the line abreast charge with the advent of the tank and machine gun.

Closely associated with punctuated equilibrium is power law behavior. ***Power law behavior*** states that the average frequency of a given event is inversely proportional to some power of its size.[69] An example of power law behavior often cited is the frequency of earthquakes. Small earthquakes happen quite frequently, cause little damage, and release small amounts of energy that may prevent large earthquakes. However, if pressures build up in the earth's crust for an extended period of time, infrequent, but massive, quakes occur that can cause widespread damage.

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[68] Walter C. Clemens Jr., *The Baltic Transformed: Complexity Theory and European Security*, with a forward by Ambassador Jack F. Matlock Jr. (Lanham MD: Rowan & Littlefield Publishers Inc., 2001), 14.

[69] Waldrop, 305.

Like chaotic systems, complex adaptive systems may also reach periods of relative equilibrium, but they never reach a permanent state of equilibrium because the environment is constantly changing. Thus, complex adaptive systems are said to be characterized by ***perpetual novelty.*** Whereas Chaos noted that small differences in initial conditions can lead to vastly different end states, Complexity extends the concept to say that every day is different and can lead to vastly different end states. In short, punctuated equilibrium, power law behavior and perpetual novelty imply ***each situation is different and even small differences can lead to dramatically different results.***

Finally we come to one of Complexity's more exotic sounding highly metaphorical concepts, fitness. "***Fitness*** is a biological concept which describes the relative 'success' of a species in relation to others in its environment…and can be seen as a measure of how well an 'actor' is adapted to its niche in the landscape."[70] Keeping in mind the continual change endemic in complex adaptive systems, "competition can be said to occur on a ***fitness terrain*** [landscape]. That terrain is not fixed, but changes by 'deformation' in response to the effects of the actions of all other actors."[71] A fitness landscape's "surface" is like soft rubber. An agent (or complex adaptive system) moves around trying to optimize its fitness by getting on a peak, with the peak signifying relative competitive advantage. However, the longer the agent remains stationary on the

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[70] Battram, 210.

[71] Ibid., 210.

peak, the more the peak begins to subside. Eventually, if the agent does not evolve and improve, the peak can sink into a depression which connotes relative competitive disadvantage. In addition, existing peaks and depressions can be destroyed and formed as the environment changes.

Fitness is an amorphous concept that emphasizes ***a constantly changing environment in which a system's suitability to the current and future circumstances it finds itself in can change in both subtle and dramatic ways***. Fitness is extremely difficult to measure and, in actuality, is probably composed of hundreds of variables which are also changing over time. If systems could measure their relative fitness with ease, they would take measures to become more fit. In fact, one author describes fitness terrain as a hike through the mountains by blind men. However, there are some macro measures of fitness that can be observed. For example, a country can measure its fitness in the international system by "its ability to cope with complex challenges and opportunities at home and abroad: to defend [its] society and values against internal and external threats; and to provide conditions in which its members can choose how to fulfill human potential."[72] Meanwhile, a military might assess its weapons and training standards against other militaries in peacetime, while in war battle provides about as clear an indication of relative fitness as possible.

[72] Clemens, 15.

Systems Summary

This chapter reviewed the evolution of "systems thinking" and the concepts related to it. It was noted that General Systems Theory began in response to the observation that deconstructing variables into ever simpler elements and the analytical approach were not always sufficient for some problems. One of System Theory's threads emphasized a holistic view of phenomenon, while the other thread sought knowledge in order to control systems. Chaos and Complexity extended Systems Theory taking into taking account the fact that system behavior is not always linear. Chaos helps to explain and capture apparently random phenomenon, which are in fact predictable, but not linearly so. Chaos also explains how systems can jump from one state to another or take on different properties due to changed initial conditions. Finally, Complexity theorists used some of Chaos' concepts as a departure point for their research on how complex adaptive systems evolve and succeed or fail in an ever changing environment. Thus, there is a continuum of systems-related theory that describes systems in various states of stability and linearity describing system behavior ranging from order to randomness. With order comes stability and predictability, while further down the scale the ability to predict and identify cause and effect becomes ever more limited to nonexistent. Some authors used to categorize dynamic system behavior as orderly or random. However, now it is categorized into order, complexity, chaos and randomness.[73] The relationship

[73] Williams, 233-234.

between the various systems theories and order, stability and predictability is illustrated in Figure 4, while a summary of key systems terms categorized by theory can be found in Table 2 on the next page.

This chapter also attempted to highlight some of the important theoretical implications of Chaos and Complexity that might be useful beyond these fields. Since Chaos and Complexity first became more widely known in the early 1990s, many other groups have picked up on and explored the implications of nonlinearity and associated Chaos and Complexity paradigms for their areas of expertise to include; social and political scientists, business and organizational writers, military historians, and theorists and professionals. Indeed, many military writers believe nonlinearity and the concepts developed in Chaos and Complexity have important lessons that should be incorporated into our thinking on war and military matters.

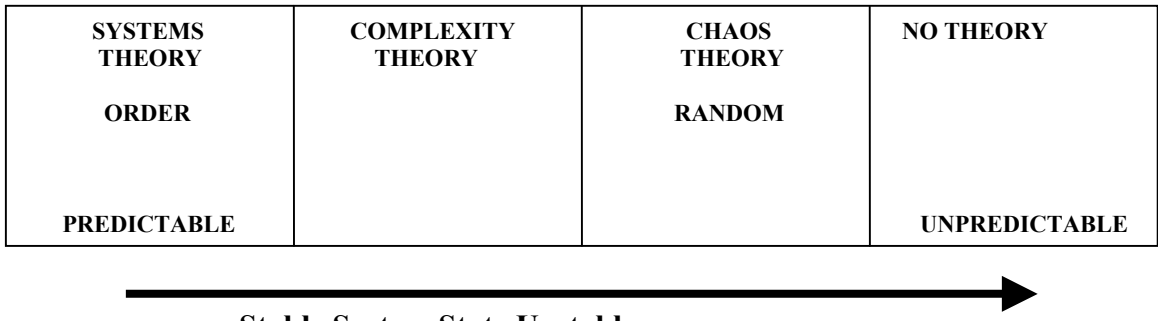

Figure 4: Theoretical Comparison

Table 2: Summary of Key Terms and Concepts

Systems Theory	Chaos Theory	Complexity Theory
Goal Seeking	Phase Space	Complex Adaptive System
Hierarchy	Attractors	Agents and Types
Interdependence	Bifurcation	Strategy
Entropy	Sensitivity to Initial Conditions	Self-organization
Holism	Futility of Long Term Prediction	Dispersed Control (Local rules)
Equifinality		Emergence
Closed vs. Open		Autopoiesis
Static vs. Dynamic		Co-evolution
Liner vs. Nonlinear		Artifacts
Input – Process - Output		Increasing Returns (Lock-in)
Boundary - Environment		Punctuated Equilibrium
Feedback		Power Law Behavior
Stable - Instable		Perpetual Novelty
Positive vs. Negative Feedback		Fitness – Fitness Terrain
Variety/Law of Requisite Variety		

Chapter 3

Nonlinear Systems Theory and Military Theory and Doctrine

What is a strategy? Once upon a time, everybody knew the answer to this question. A strategy specified a pre-commitment to a particular course of action. Moreover, choosing a strategy meant optimizing among a set of specified alternatives, on the basis of an evaluation of the value and the probability of their possible consequences. Optimizing pre-commitment makes sense when a firm knows enough about the world to specify alternative courses of actions and to foresee the consequences that will likely follow from each of them. When the foresight horizon is clear, it may be possible to anticipate all the consequences of any possible course of action, including the responses of all other relevant agents, and to chart out a best course that takes account of all possible contingencies. As foresight horizons become more complicated, the strategist can no longer foresee enough to map out courses of action that guarantee desired outcomes. Strategy then must include provisions for actively monitoring the world to discover unexpected consequences, as well as mechanisms for adjusting projected action plans in response to what turns up.

—Arthur Battram
Navigating Complexity

Nonlinearity Branches Out

Shortly after Chaos and Complexity theorists began to publish books and articles for the general public in the mid 80s to early 90s, military officers, theorists, and historians began to speculate upon and incorporate nonlinearity and Chaos and Complexity concepts into their books and articles. Perhaps the earliest military theorist to be influenced by nonlinearity and early Chaos and Complexity concepts was USAF Colonel John Boyd of the Observe-Orient-Decide-Act (OODA) Loop fame. One of Boyd's briefings specifically lists theoretical influences upon his thought which included three famous Chaos/Complexity scientists and their work on nonlinear system irregularity and

unpredictability.[74] While nonlinearity-related concepts were not the only influence on the eclectic Boyd, they were a significant influence. In addition to original theoretical development, the historian Alan Beyerchen argued in a 1992 article entitled *Clausewitz, Nonlinearity, and the Unpredictability of War* that Clausewitz was profoundly aware of the nonlinear nature of war and this fact influenced his tome *On War.*[75] As justification for his views, Beyerchen links several of Clausewitz's dictums to nonlinear systems and Chaos principles.

During the remainder of the 1990s military professional interest in nonlinearity and Chaos and Complexity theoretical implications remained strong. The National Defense University published several books and articles exploring nonlinearity and Chaos and Complexity implications for warfare culminating in an extensive work on Network-Centric Warfare.[76] As nonlinearity and Chaos and Complexity Theory became better known in the various war and staff colleges, numerous papers, theses, and briefings were published, and continue to be

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[74] Colonel John R. Boyd, "Conceptual Spiral" copy of unpublished briefings, October 1991, Special Collections, Air University Library, Maxwell Air Force Base, Alabama, slide 11.

[75] Alan Beyerchen,. "Clausewitz, Nonlinearity, and the Unpredictability of War," *International Security,* vol. 17, no. 3, (Winter 1992-93): 59-90.

[76] David S. Alberts, John J. Garstka, and Frederick P. Stein, *Network Centric Warfare : Developing and Leveraging Information Superiority*, revised 2d ed. (Washington D.C.: National Defense University, 2000).

published describing Chaos and Complexity concepts and their potential military applications. As an interesting aside, at about this time USAF Colonel John Warden was developing his "Five Rings" theory, which harkened back to the earlier Systems and Cybernetic theories.[77] Perhaps the pinnacle of the military's acceptance of these theories was their explicit incorporation into U.S. Marine Corps doctrine.[78] In summary, nonlinearity and Chaos and Complexity have made significant inroads into military educational institutions, military/strategic journals, theory, and even service doctrine.

Unfortunately, many military-oriented writings on nonlinearity, Chaos and Complexity fell into an all too familiar rut, nicely summed up by two reviewers of business-related writings on Complexity. Their comments, which equally apply to the military genre, were as follows: "The trade books have a more or less standard content, presenting a common argument with a structure as follows:

"Managers now find themselves in a qualitatively different world. It is more "uncertain," "turbulent," "complex," "nonlinear," unpredictable," "fast-

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[77] Colonel John A. Warden, "The Enemy as a System," *Airpower Journal.* Vol.9, no. 1, (Spring 1995), 40-55.

[78] Nonlinear and Complexity concepts are explicitly referred to in Marine Corps Doctrine Publication (MCDP) 1, *Warfighting* on page 12, MCDP 1-3, *Tactics*, pages 10-12 and MCDP 6, *Command and Control*, pages 44-47.

paced," "dynamic"… [The military writer would add "due to the end of the Cold War" here.]

The "old" or "traditional" models employed by managers, founded on Newtonian science are not (or will not be) adequate in this new world… [The military writer would substitute doctrine, tactics or strategy here.]

Fortunately, science has developed something new and improved…

From New Science can be derived a new set of managerial tools, models, principles or even entire philosophies that, if applied, will bring organizational success… [The military writer would substitute warfighting for managerial and organizational here.]

Finally, most books provide illustrations of the applications of these tools, models, concepts, and principles…"[79]

The reviewers end their article by noting that unless Complexity concepts become more concrete and usable to the manager, they stand a serious chance of being just the latest management fad to be superseded by the next management fad. Indeed, it is possible this same critique may befall military applications as well.

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[79] Steve Maguire and Bill McKelvey, "Complexity and Management: Moving From Fad To Firm Foundations," *Emergence*, vol. 1, no. 2, (1999): 7.

Nonlinear Systems Theory and Military Theory

The above introduction serves to highlight two issues. First, it is apparent that nonlinearity and Chaos and Complexity provide concepts that resonate with a wide audience on a variety of subjects. I agree with Beyerchen's view that if Clausewitz had the vernacular of nonlinearity available in his time, he would have used it. Complexity, with its Darwinesque concepts, is particularly seductive to military writers who can easily find resonance and parallels with its concepts and their trade. Thus, in light of what has been written by other military-oriented writers, this thesis does not further the tradition of extolling the virtues of Complexity and its relevance for us. As noted in the previous chapter, I take the position that Complexity provides an interesting alternative analytical framework for examining issues. I also assert that if the USAF is going to continue to think in terms of target systems, it ought to catch up with systems theoretical thinking. Second, like the reviewers noted above, concepts related to nonlinearity (Chaos, Complexity etc.) could easily fall by the wayside without more concrete applications and demonstrations of their practical use. To meet this challenge for a military audience, this thesis attempts to provide a concrete example of the application of nonlinear principles as articulated by Complexity by applying them at the macro-level of military strategy and theory and at a more micro-level in targeting.

A Nonlinear Perspective on Military Strategy and Theory

Looking at strategy and theory through the "systemic lens" of Complexity Theory offers several potential insights for the military strategist and

theorist. Some insights are relatively innovative, others clarify or expound upon existing warfare concepts, and yet other insights affirm existing warfare principles via a different theoretical base. This section will attempt to outline some major insights applicable to military strategy.

Nonlinearity is a fact of warfare, not an abstract concept.

Recalling chapter two, nonlinearity describes a system where outputs are not proportional to inputs, change is erratic, behavior is difficult or impossible to predict, and cause and effect may be indeterminate. Nonlinearity in warfare is caused by several different aspects of war. One cause is acting and misacting on good and bad feedback information, or as Clausewitz would phrase it, the challenge of making decisions in the "fog of war." War is not perfectly controllable because information is not perfect, nor do humans always interpret what they receive correctly. Another fundamental cause of nonlinearity in war is the nature of some warfare actions. Timeless principles of warfare like surprise, maneuver, and deception create disproportional effects. A good example is when an infantry unit breaks and runs even though it may still be numerically superior to its opponent. Clausewitz's friction concept is a third cause of nonlinearity in war. Small mistakes in execution can frustrate the best of plans.[80] Returning yet again to Clausewitz, chance events inject themselves into war thereby frustrating

[80] Majors David Nicholls and Todor Tagarev, "What Does Chaos Theory Mean for Warfare," *Airpower Journal* Vol.8, no. 3, (Fall 1994), 48-57.

those who expect smooth and predictable operations.[81] Finally, human emotion is also a causal factor of nonlinearity. War breeds hate, fear, greed, and a host of other intense emotions, thus pushing humans out of a completely rational decision making process. To cite on oft repeated observation on grand strategy that demonstrates the ultimate reality of war's nonlinearity we can ask: "Would anyone start a war if they thought they were going to lose?"

No strategy survives contact with itself.

Co-evolution suggests that as soon as a strategy is put into execution everything changes. Actions combine to become the new operating environment and the new operating environment, in turn, changes the actions antagonists are likely to take.[82] Opposing militaries will suddenly find their preconceptions and pre-war strategies validated or destroyed and will act on the new situation, not the old. This concept has critical implications for strategy and plan development. The first is that strategy development and planning is a constantly moving target. Accordingly, strategists should be thinking of and fully developing branches and sequels before the initial plan is ever executed, or in systems language, looking

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[81] Alan D. Beyerchen, "Clausewitz, Nonlinearity, and the Importance of Imagery," *Complexity, Global Politics and National Security*, eds. David S Alberts and Thomas J. Czerwinski (Washington D.C.: National Defense University, 1997), 160.

[82] Robert Jervis, *System Effects*. (Princeton NJ: Princeton University Press, 1997), 57-58.

and planning for bifurcation points that lead to the desired end state. Thus, in a Complex world, wargamming should be a staple of staff planning. In addition, when wargamming Complexity would suggest that an attempt made to plan multiple successive steps is probably beyond the pale. Rather, one should focus on the next couple of steps and be vigilant for, and flexible in meeting unforeseen changes. The second implication is that the "monitoring gear" should be on before the plan is ever executed and "full-up" during battle to detect enemy adaptation to the plan in order to adapt yours as needed. Thus, as noted earlier, strategy and planning is an interactive evolutionary process necessitating adaptive procedures. Indeed, the ability to monitor and execute faster and more accurately than an opponent is the conceptual underpinning of both OODA loop and Network-Centric Warfare strategies. Finally, it is important to note that strategy choices can shape the character of the war, future strategies, and the strategist himself due to the feedback process. As an example, Beyerchen notes how Prussian military reforms, in response to Napoleonic defeats, ended up changing the Prussian state and its approach to future politics and strategy over time.[83]

Greater variety destroys lesser variety.

A system or organization's complexity is a close approximation to the variety and frequency of strategic, operational or tactical tools, actions and/or responses that it possesses and can attempt. Remembering back to the Law of

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[83] Beyerchen, *Clausewitz, Nonlinearity, and the Importance of Imagery*, 162.

Requisite Variety, small organizations have fewer parts and interconnections and therefore are incapable of adapting to certain interactions imposed by larger, more complex organizations. This is another way of saying asymmetric attacks have definite theoretical merit from a systems standpoint and that a sound strategy is to often use something the other side does not have or cannot defeat. The United States' recent and frequent use of airpower seems to indicate that we have intuitively grasped the advantage of using superior variety to engage in actions that less complex adversaries can not successfully oppose. There also appears to be some proof for this assertion by observing that U.S. airpower has been able to conduct actions virtually unopposed since the Gulf War. Thus, while airpower has its inherent doctrinally-touted advantages of speed, range and flexibility, what it really provides to the United States is a unique moment in time where it can use a type of force with no real counter. In short, there is currently a major variety mismatch which provides the U.S. significant strategic advantage.

The Law of Requisite Variety also argues for multi-faceted joint operations and developing technologies not easily replicated by others. In a strategy context, requisite variety would also suggest multi-faceted strategies are superior to simplistic strategies. Multi-faceted approaches are superior because they may have an element the opposing system cannot effectively engage and they present the opponent with a much more difficult strategic problem to counter and defend against. Simplistic strategies do just the opposite. They provide the opponent a single axis upon which to focus multiple capabilities, whereas against a "complex" strategy, resources must be spread across the gamut of our

capabilities. Given the complexity of modern terrorism, the above would also suggest a multi-faceted national strategy involving all the nation's instruments of power is probably required.

While variety may provide significant advantages, it can come at a price. The more internally interconnected a large organization is in order to coordinate agents, artifacts and actions, the more conservative it may become in its potential responses, as any new change may cause harmful side effects to system sub-elements.[84] One wonders if this principal is not at work in the joint doctrine process, wherein joint doctrine is often captive to the least common denominator of service agreement. Certainly, joint doctrine fosters the advantages listed in the previous paragraph; however it is also possible that truly transformational ideas and concepts will not be approved if they overly encroach on service turf.

The ability to control is integrally connected to the ability to understand (i.e. Boyd was right).

Humans are limited in their ability to accurately perceive things, and thus, almost always operate in a suboptimal mode.[85] This is due to many reasons, but the one we are most concerned with is complexity. According to Complexity theorists, complexity is at its root an information issue as the more complex something is the more information it takes to describe it. Herein lies the rub as it

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[84] Eric D. Beinhocker, "Strategy at the Edge of Chaos," *The McKinsley Quarterly*, no. 1 (1997): 118.

[85] Waldrop, 151.

relates to influence and control.[86] While variety and complexity can provide strategic advantages, they also impose information costs associated with them because one must understand the various components, relationships and interactions going on in a complex adaptive system in order exert any kind of control, or if not control, influence over them. Indeed, understanding "adaptive interactions are, in fact, a major reason for the information revolution [whose] improvements in processing, storage, transmission and sensing make it possible to know the state of a system with greater precision. We want this knowledge because it allows us to be more adaptive, and that in turn can vastly increase performance."[87] Thus, Complexity seconds the theoretical assertions made by John Boyd with some slight variations on the same theme.

Complexity shares Boyd's emphasis on the ability to be more adaptive than your opponent, but with a few differences and some additional insights. Like Boyd, Complexity theorists note that "measures of size and material assets do not reveal the intangibles that help people convert their assets into influence and fitness,"[88] However, one difference is while Boyd emphasized speed, the Complexity theorist would probably emphasize advantages accruing due to observation accuracy, as noted above. In addition, a second Complexity insight comes from relating the ability to "OODA" with a system's stability. In a stable

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[86] Maguire, 28-29.

[87] Axelrod, 27.

[88] Clemens, 229-230.

situation, learning is fast and adaptation happens faster, while in unstable situations the reverse is true.[89] Boyd assumed that inflicting disorientation is almost always beneficial in order to fold a system back in on itself thus leading to a collapse in activity.[90] However, Complexity theorists would point out two additional issues. First, disorientation can produce positive feedback in a system, which causes a system to jump to another state or go totally out of control. If the intent of a given strategy is to move an opponent to a particular desired end state, thoroughly disorienting an opponent, in fact, can lead to many other end states than the one desired. Thus, if precision effects are desired and the approach is to manipulate leadership or some other controlling functions, a Boyd-style OODA strategy is not wise. Second, in confusing, unstable situations, autopoietic behavior will tend to make a complex adaptive system collapse in to its internal guidance mechanisms which may be helpful rather than harmful. As noted in chapter two, if these mechanisms are suited to the true nature of the environment, confusing information can be ignored and the response may be totally appropriate, thus potentially defeating a Boyd-style strategy.[91] For example, military organizations have long exploited autopoietic behavior by emphasizing standard

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[89] Waldrop, 251.

[90] Boyd, Colonel John R. "Organic Design for Command and Control." May 1987, copy of unpublished briefings, Special Collections, Air University Library, Maxwell Air Force Base, Alabama, slide 23.

[91] Battram, 233.

operating procedures and intense drill which are designed to enable successful "non-thinking" response in confused situations.[92] Meanwhile, hierarchy is also a common organizational response to complexity and confusion. Hierarchy allows senior leadership to filter information and maintain some "distance" from the situation in order to make key decisions correctly under less time constraints. Thus, Complexity suggests disorientation is a necessary condition for successfully executing an OODA loop strategy, but not a sufficient one. According to Complexity, the sufficient condition is an actual mismatch of response to true environmental conditions.

Every war is different.

Chaos points out that even if the mix of starting variables is ever so slightly different, major differences in outcome can be the result.[93] Thus, one should not assume that even if a previous situation is quite similar to the current one the end results will be similar. Meanwhile, Complexity asserts that the more elements and interconnections there are, the *less likely* it is that any system state or situation will be repeated.[94] Together these theories strongly suggest to the strategist that it is imperative he does his intelligence preparation of the battlespace in order to understand what is different in the current situation from

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[92] Waldrop, 178.

[93] Philip Anderson, "Complexity Theory and Organization Science," *Organization Science*, vol. 10, no. 3 (May-June 1999): 217-218.

[94] Geyer, Section 6.

past experience.[95] They would also caution the strategist to not be overconfident in his plans. There is a strong tendency in living entities to recall and repeat what has been successfully done in the past, but these two principles emphasize the fact that the dynamics of the new situation will proceed on a trajectory of their own. In short, history never exactly repeats itself.

Stability is neither good nor bad.

Stability can be a bad, neutral, or good state. It simply depends on whether or not change is desired. On the positive side, stability is a system state that is often sought after because it offers system agents apparent equilibrium, prediction and control over events.[96] In other words, it's comfortable. In international politics, structural stability is a near universal goal sought by most nations. However, one author claims that "we are deluding ourselves" if we believe "long-term stability can be a defining feature in the world. [He suggests] a system in criticality [i.e. the world] offers no neutral ground, no hope of permanent stability."[97] Stability serves a purpose, but by definition, it also means no change. Thus, the real question is whether or not the status quo is acceptable.

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[95] Major Michael R. Weeks, "Chaos, Complexity and Conflict"; available from http://www.airpower.maxwell.af.mil/airchronicles/cc/weeks.html; Internet; accessed 13 February 2002.

[96] Beyerchen, *Clausewitz, Nonlinearity, and the Importance of Imagery*, 162.

[97] Mann, 62-63.

If it is not, a strategist can take deliberate actions designed to induce instability to use to his advantage. In addition to stability perhaps being a chimera, it can also be dangerous. Our concept of punctuated equilibrium suggests that system agent skills finely honed during stable periods can become obsolete and counterproductive when the situation changes dramatically. Thus, the challenge is to be both competitive now and capable of rapid change and flexibility.[98] No doubt the French Army lived and died according to the above principle in 1940.

Rethinking centralized control and decentralized execution.

Not only is stability a strategically neutral term, but so is control. "In Anglo-American intellectual traditions [and in the United States Air Force], decentralization is normally assumed to be an advantage. It is typical to expect the adaptive capacity of the system…to be increased when events can be [acted on] locally and flexibly rather than globally and rigidly. But it is essential to point out that adaptive capacity is *two-edged*….Adaptivity can speed extinction as well as increase viability."[99] Thus, military strategists (and doctrine writers) should understand that *control is fundamentally concerned with limiting outcomes, rather than maximizing efficiency*. Systems Theory and Complexity strongly suggest that if one wants to be efficient decentralization is the preferred method of operations. However, if one wants to ensure a specific outcome, or perhaps more importantly, eliminate potential undesired outcomes, close control provides a

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[98] Beinhocker, 114-115.

[99] Axelrod, 70-71.

valuable function. Indeed, while we often lambaste close civilian control of military operations, military professionals have themselves long used the controlling mechanisms of standardization and synchronization to limit the shape of operations. Standardization ensures consistency of response and capabilities and of course provides the glue of knowing what military units can do and how they will do it. Without this knowledge, planning would be impossible.[100] Meanwhile, synchronization of multiple unit operations and designating supported and supporting relationships has the systemic effect of limiting what can occur and the number of states possible.[101] In addition, the military is known in the civilian world for its tight chains of command designed to exert maximum control over subordinate units.

"Centralized control and decentralized execution" is about the closest thing the USAF has to a mantra. However, it is instructive to look at Vietnam and Kosovo targeting controversies in the light of close control's actual purpose. Both conflicts were examples of close civilian control over target selection and are held by the military to be perfect examples of "how not to do it." It should be noted, however, that in neither case was military efficiency in the forefront of

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[100] Beinhocker, 117.

[101] Linda P. Beckerman, "The Non-Linear Dynamics of War," (Science Applications International Corporation, 1999); available from http://www.belisarius.com/modern_business_strategy/beckerman/non_linear.htm; Internet; accessed 12 February 2002.

civilian leadership concerns. In the Vietnam example President Johnson's goal was to prevent the communist overthrow of South Vietnam without initiating war with China or the Soviet Union, all the while keeping the war small enough to pursue his domestic agenda. Meanwhile in Kosovo, the goal was to stop the ethnic killing in Kosovo and force a Serbian withdrawal while at the same time keeping the NATO alliance together and minimizing allied casualties. In both cases civilian leadership desired a positive outcome—but only within certain parameters. Both cases are also examples where civilian leadership trumped military efficiency in order to control or eliminate certain outcomes. Thus, in reality control, like stability, is a strategy neutral concept.

The more important strategic question concerning control is: "Which is more important, military efficiency or limiting potential outcomes?" One can argue either side, and the real answer will depend on the specifics of each individual case. The preferred option may change as operations change or a mixture of both close control and decentralization could be used depending on target type or special circumstance. However, given the above discussion what should be clear is that the issue should not be approached dogmatically. A carefully weighing of the necessity to limit the possibility of some outcomes from occurring with the requirement to use forces in the best possible manner should be accomplished.

Assess potential strategies in light of how their consequences may spread.

As noted in chapter two, strategies are repeated because they have been successful. When strategies are successful, they are also often copied[102] and, worse yet, may be used against their employer. For example, perhaps one of the great ironies of the current war on terrorism is that some of the Mujahideen forces now arrayed against us received U.S., Pakistani and Saudi Arabian support during the Jihad in Afghanistan against the former Soviet Union. Another example is NATO's support for and build-up of the Kosovo Liberation Army (KLA) during Operation Allied Force to help in the war against Serbia. In the 1990s the KLA had been a small group heavily involved in the European drug trade whose membership and leadership was widely known to consist primarily of criminals, thugs, and drug trafficers.[103] Toward the end of the decade as tensions in Kosovo mounted, the KLA conducted low-level terrorist campaign against Serbian police and civilians. Once the war started however, the KLA was seen as one of the few groups in Kosovo that had a dedicated cadre that could be expanded by U.S. aid and support to further NATO's goal of ejecting Serbian forces from the area. Unfortunately, since then, the KLA has become a major force in Kosovo and has been involved in efforts to destabilize Macedonia and several attacks against

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[102] Axelrod, 38-41.

[103] Philip Smucker and Tim Butcher, "Shifting stance over KLA has betrayed' Albanians", *Daily Telegraph*, London, 6 April 1999.

NATO personnel stationed in Kosovo.[104] In addition, there are also reports that Kosovo is being used as a staging ground for terrorist attacks into other parts of Europe.[105] Thus, it is important to note that temporary support for some radical Islamic groups done as a tactical exigency has backfired in many respects and, perhaps, helped those groups to become stronger than they may have otherwise. In part, this may have also led to a widespread perception that dedicated, radical Islamic elements could successfully defeat a superpower or thwart its policies.[106] It also suggests one should think about the long-term potentialities of what else might occur in choosing a strategy rather than just a short-term focus on gaining the immediate objective.[107]

Beware overly simplistic theories.

Perhaps the most important lesson of all that comes from Chaos and Complexity (and one that just about sums up most of the above lessons) is a warning to strategists to be extremely skeptical of overly simplistic theory.

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[104] Anatoly Verbin, "U.S. Troops Open Fire in Clash Near Macedonia", *Washington Post,* 08 March 2001, 15.

[105] "U.S. Gave Green Light to Terrorists in Bosnia," *WorldNetDaily*, 24 April 2002; available from http://www.worldnetdaily.net/news/article.asp?ARTICLE_ID=27367; Internet: accessed 24 May 2002.

[106] "'Blowback'," *Jane's Intelligence Review,* August 2001, 42-45.

[107] Axelrod., 157.

Westerners are ingrained with cause and effect and "if-then" thinking and analytical processes. However, if one accepts the premise that human societies and military forces are complex adaptive systems, Complexity reminds us that there are limits to how well we can fully comprehend complex issues. It also challenges simplistic cause and effect analysis by reminding us of the perpetual novelty of every situation and the fact that multi-variable situations are rarely linear equations in the real world.[108] It seconds Clausewitz's notion that war is more like a wrestling match than a Jominian geometrical equation by highlighting the fact that there is constant interaction in and among system agents, different systems, and agents and systems, and their environments. When this occurs, unique dynamics can take on a life of their own which may repeat the past, or go in a totally new and unique direction.

Newton is still relevant.

While an extensive discussion on how nonlinear concepts might be applied to military strategy, theory and doctrine has just been completed, it should still be pointed out that many elements of warfare can show cause and effect and are amenable to rough-order predictive rules and methods.[109] A problem with many military and civilian writers on nonlinear-related theory is that they overdo the "unpredictability" issue. Indeed, much of mankind's progress is due to linear prediction and approximation. In warfare there are a few possible basic states to

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[108] Rosenau, 90-92.

[109] Maguire, 17.

include defeat, defense, stalemate, offense, and victory. In addition, terrain or environmental effects often provide fixed variables that impact strategy, operations and weapon systems, which in turn, channelizes and reduces options. Technology and political factors also circumscribe options, thereby reducing the variety of potential outcomes. Finally, in historical experience greater mass and numbers usually win battles and wars. In summary, while war is chaotic and complex, it isn't an entirely random event.

Chapter 4

A "Complex" Theory of Targeting

When blows are planned, whoever contrives them with the greatest appreciation of their consequences will have a great advantage.
—Frederick the Great

Airpower theory has been criticized in many quarters as being overly simplistic or fundamentally flawed. Indeed, the history of airpower theory and operations might be summarized as one continual debate over what are the best targets and whether or not striking these targets had the desired effect. Queuing off this historical trend, Lt Col Pete Faber in a 1996 address to the Air and Space Power Doctrine Symposium held at Maxwell Air Force Base, Alabama, noted that airpower theory has suffered from three "pathologies." The first pathology was developing "hoary maxims that would apply to all wars regardless of time and circumstance." The second was a fetish for quantification and prediction in war, while the third was an over reliance on metaphors to "buttress the logic" of their arguments. He also noted that airpower theory has predominately focused on strategic bombardment to the detriment of other airpower missions and functions.[110] Interestingly, in Faber's concluding briefing

[110] Lt Col Peter Faber, "Competing Theories of Airpower: A Language for Analysis" (Paper presented to the Air and Space Power Doctrine symposium, at Maxwell Air Force Base, Alabama, April 30 to 1 May 1996); available from;

slide he also suggested that perhaps Chaos and Complexity might provide a good basis from which to develop an improved theory of airpower.[111]

In this chapter I will accept Lt Col Faber's challenge and try to articulate a targeting theory based on the principles of Complexity. Such a theory may be beneficial for two reasons. First, it is assumed that human societies and military forces *are* complex and adaptive entities. Thus, a targeting theory that incorporates concepts and principles similar to a theory attempting to capture the dynamics of living, adaptive systems may provide a more nuanced and less mechanistic targeting theory than is currently available. Second, it is likely that a targeting theory based on Complexity principles can be developed that is more universally applicable than those in use today. Such a theory would not advocate specific "panacea" targets for air attack (e.g. industry, populace, leadership, fielded forces etc.), and accordingly, is not a theory of airpower. Thus, the theory discussed here is a generalized theory similar to what the general systems

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http://www.airpower.maxwell.af.mil/airchronicles/presentation/faber.html; Internet; accessed 21 February 2002.

[111] Lt Col Peter Faber, "Competing Theories of Airpower: A Language for Analysis" (PowerPoint Briefing presented at Air and Space Power Doctrine symposium, at Maxwell Air Force Base, Alabama, April 30 to 1 May 1996); available from; http://www.airpower.maxwell.af.mil/airchronicles/presentation/index.html; Internet; accessed 21 February 2002, slide 18.

theorists attempted, and hopefully, one that will provide some value across a spectrum of target systems and circumstances rather than a theory tailored to specific weapon systems and force structures. Finally, the targeting theory below does not attempt to link specific means to specific ends. Quite the contrary, my theory lays out a generalized construct for altering a complex adaptive system's state, usually to a state of disorder, collapse or lesser complexity/capability. In order to apply the theory in the real world one needs specific information on the target system to be attacked, means available, and to what strategic, operational or tactical end.

In form, the proposed targeting theory will be patterned along the lines of Sir Julian Corbett's naval theory found in *Some Principles of Maritime Strategy* in that it will address the object, methods, and means for attacking complex adaptive systems.[112] However, because the intent here is to develop a targeting theory, most of the study will focus on method vice object and means. As the focus is to provide a targeting theory devoid of weapon or force structure constraints, the means section will address only a single method particularly critical to targeting a complex adaptive system.

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[112] Julian S. Corbett, *Some Principles of Maritime Strategy*, with an introduction and notes by Eric J. Grove, (London: Longmans, Green and Co., 1911; reprint, Annapolis MD: United States Naval Institute, 1988). (Page citations are to the reprint edition, if needed)

The "Systemic" Object

From a purely theoretical, systems-based point of view, a system has only two basic strategic choices. It can choose to maintain system stability (e.g. status quo) or move the system toward instability in order to institute change. However, the system under consideration must be the larger system formed by itself and the opposing system at a minimum, but could certainly include other agents and systems. At the macro-system level, one can attack to maintain or change the system's state which the attacker is a part of. However, below the macro-level where one system is opposing another, at a minimum, the objective is to change the opposing system's state to one that has less variety or cohesion in order to control it. More aggressive goals might include driving the system into a chaotic state, disorder, or complete dissolution. During any attack, a system must also maintain its own internal system integrity. In summary, Systems Theory suggests that general strategic options are few in number and conceptually quite simple. Yet, the above does not mean in the real world strategic choice is simple. As a practical matter, the above paragraph would get one about as far as making the basic decision to attack or not.

Targeting Methods for Changing a System's State

According to Corbett, "methods" are how something may be accomplished.[113] Accordingly, this section of the thesis discusses how or by what methods a system can be altered through targeting. Joint Publication 1-02

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[113] Corbett, 128.

Department of Defense Dictionary of Military and Associated Terms defines targeting as:

1. The process of selecting and prioritizing targets and matching the appropriate response to them, taking account of operational requirements and capabilities. 2. The analysis of enemy situations relative to the commander's mission, objectives and capabilities at the commander's disposal to identify and nominate specific vulnerabilities that, if exploited, will accomplish the commander's purpose through delaying, disrupting, disabling, or destroying enemy forces or resources critical to the enemy.[114]

In the above definitions one is operationally focused, while the other is more analytical in nature. For this thesis, targeting will be defined using the second definition as it focuses on target system analysis and disrupting or destroying an opposing system. To accomplish system disruption or destruction there are four primary methods by which an opposing complex adaptive system may be altered through the use of military force. These methods are:

Decrease system variety

Decrease system interactions

Decrease energy available to the system

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[114] Joint Publication 1-02 *Department of Defense Dictionary of Military and Associated Terms*, s.v. targeting, 423.

Alter system feedback and control

The above methods focus on the primary elements of a complex adaptive system (e.g. system agents, artifacts, and interactions between agents, artifacts and the environment), how systems and agents gain and sustain themselves using energy from the external environment or transferred and shared within the system, and finally, how the system and its agents are able to adapt to the complex environment via system feedback mechanisms. When action is taken to decrease system variety and system interactions beyond a certain point, or feedback and/or control is rendered ineffective, it will have the systemic effects of either; A) driving the opposing system into full entropy which will cause the system to collapse or, B) driving the opposing system into a lesser state of entropy that will make the system unable to overcome an opposing course of action with the requisite counteracting responses, resources, organizational structure, or ability to control and coordinate resources and responses.

Within each of the four basic methods, there are also specific techniques that may be attempted to affect the system according to the method being employed. These techniques will be discussed in greater detail below and are summarized in the following table.

Table 3: Summary of Complex Targeting Methods and Techniques

Decrease System Variety	Decrease System Interactions	Decrease Energy Available to the System	Alter System Feedback and Control
- Destroy Agents and/or artifacts	- Erect Barriers	- Erect Barriers	- Destroy controlling agents/mechanisms
- Destroy agent Strategies	- Restructure physical or conceptual space	- Attack adaptive tension areas	- Manipulate feedback (Boyd's tactics)
	- Attack tightly coupled systems in a way not anticipated by the system		
	Destroy successful agents		
	- Attack attractive signals		
	Collapse decision- making time scales		
	- Parallel attack		

Decreasing System Variety

As noted in chapter two, variety is related to the distinct differences between system agents, artifacts and the unique capabilities they bring to the system and/or the distinctly different system responses or strategies a system may employ to counteract or take advantage of environmental conditions using various agents and artifacts.[115] Thus, system variety equates to both capability and

[115] In addition to reducing an opposing complex adaptive system's variety through the methods that will be discussed in this section, it is also interesting to note that increasing variety, or using variety the opposing complex adaptive

options and the more of each, the more formidable a system is. Complexity authors note complex adaptive system behavior can be changed by increasing or decreasing the variety of agents in the system's population or their artifacts.[116]

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system does not have, are equally important potential military strategies. For example, more variety in terms of a mix of force types, multi-axis attacks or other means of complicating the amount of variety an opposing system will have to deal with increases its strategic, operational and tactical problems. Joint doctrine often makes this very same point when it rightly points out that joint forces synergistically employed are more powerful than single services alone. In addition, asymmetric warfare strategies are conceptual similar to Ashby's Law of Requisite Variety. As history has often demonstrated, new weapon systems, tactics and organizational constructs can be very effective if a corresponding counter is not available. However, Complexity also suggests that such advantages will be fleeting as other systems adapt to the new element employed.

[116] Axelrod, 33. This section of the thesis (decreasing variety) and the following section (decreasing interaction) are adaptations of two of Axelrod and Cohen's concepts (variation and interaction). In their book, Axelrod and Cohen discuss how these concepts can be used to harness Complexity to help businesses adapt their organizations for and design strategies to succeed in the business environment. Generally, Axelrod and Cohen seek to increase their organization's capabilities, while our goal here is to suggest how to do just the opposite. I have attempted to "reverse engineer" these concepts while at the same time remaining

However, because the intent is to decrease another system's ability to oppose us, one is primarily interested in decreasing the other system's variety, which has the effect of limiting that system's options. This makes sense because if various capabilities and their attendant options are eliminated, associated behaviors are as well.

Destroy agents and artifacts. Variety can be reduced in one of two ways: destroying complex adaptive system agents or artifacts, or agent strategies.[117] Destroying complex adaptive agents and artifacts has two effects. The first technique simply destroys a system capability. Military operations have been conducted to accomplish this effect since time immemorial and it is one we are very familiar with and usually employ—one can kill the solider or destroy his weaponry. To use a current example, if Saddam Hussein no longer has weapons of mass destruction (WMD), he is no longer as capable of threatening his regional neighbors.

Destroy agent strategies. The second method, strategy destruction, is a more direct means to "teach" an opposing complex adaptive system that its response is not or will not be successful. When employing this method, actions are taken to demonstrate to the opposing system that what it is attempting will

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accurate in their description, inverted as they are. Any errors in the reverse engineering are mine alone.

[117] Axelrod, 117.

simply not work, thereby defeating the anticipated strategy. One might use agent and artifact destruction to "teach" the opposing complex adaptive system that the agents or artifacts employed are not the proper elements for a successful response to certain conditions, and, according to the theory, they would not be employed again in the future. Hence, the strategy itself has been destroyed.[118] A rather simplistic military example of strategy destruction through agent and artifact destruction is when military organizations abandon a major force type due to its defeat and obsolescence on the battlefield (e.g. horse cavalry). However, in a military context, destruction of soldiers and weaponry is not always required to destroy strategy. Other military methods of destroying strategy might include shows of force, flexible deterrence options, or selective attacks designed to demonstrate superior power before an opposing strategy is used. Sometimes just broadcasting the fact that one knows an opposing system's strategy will defeat it. This method is often used to defeat potential terrorist attacks via warnings to the greater public, which has the dual effect of producing a better defense and letting

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[118] Complexity theorists have an expanded definition of strategy from that normally used in military circles. In their definition, strategy is simply how an agent chooses to respond to its surroundings in order to achieve its goals. (Axelrod, 4.) Thus, "strategy" could be completely reactive relying only upon past successful responses as a guide to the correct response in the current situation. In a military context, organizational tactics, techniques and procedures would be considered a strategy for response.

the terrorist know his plans have been compromised. Of course such an approach must also be weighed against future advantages lost when the terrorist learns his internal security has been compromised.

Advantages and disadvantages to agent/artifact and strategy destruction. Both approaches have advantages and disadvantages. Agent/artifact destruction is often more resource intensive because the opposing system may not immediately perceive its agents or artifacts will no longer be successful over the longer term. It will then continue to use those agents and artifacts until decisively demonstrated otherwise. Alternatively, the opposing system may adapt and acquire the same agents or artifacts you used to disrupt him, thus increasing the initiating system's problem in the future. This is known as strategy copying and is a common complex adaptive system response to unfavorable conditions. On the other hand, if agent/artifact destruction is successfully accomplished, that capability and the response options it provides are no longer available to the opposing system. In addition, unanticipated synergistic effects may occur resulting from the concurrent destruction of system interrelationships between the destroyed agents/artifacts and other agents that are not fully understood, but nevertheless exist (i.e. cascading effects).

Meanwhile, strategy destruction tends to be lower in cost and time to achieve, assuming the opposing strategy is correctly perceived and the opposing system is somehow made to understand that ultimately its strategy will not be successful. Of course, perceiving in a timely manner and communicating

convincingly to the enemy are two very big assumptions. However, a weakness of strategy destruction is that correctly identifying the opposing strategy may be more difficult than identifying the agents carrying it out. Thus, such a course of action requires accurate and timely observation and assessment of the opposing system in order to determine its strategy and develop a counter.[119] Military strategists will note that attempting to defeat an enemy's strategy vice the enemy himself is an approach to warfare advocated by Sun Tzu over 2,500 years ago.[120]

In summary, one method to attack a complex adaptive system is to destroy its agents, artifacts and strategies. The methods noted above are those probably most familiar to military professionals in one form or another. However, Complexity suggests other potential methods that are more oriented on the relationship between things, rather than the things themselves and are discussed next.

Decreasing System Interaction

Interactions in and amongst system agents and between the system and its environment are the primary mechanism by which a system is able to employ its inherent capabilities. Recognition that interaction and improving the ability to interact among multiple system agents (units, people, companies, etc.) provides competitive advantages is a major conceptual driver behind networking and the

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[119] Axelrod, 128-134.

[120] Sun, Tzu. *Art of War*. Translated, with a historical introduction by Ralph D. Sawyer. Boulder CO.: Westview Press Inc., 1994, 79.

building of networks.[121] Interaction patterns shape the responses available to a complex adaptive system and help determine what is more successful for the agents themselves and the system as a whole. Successful interactions, in turn, shape the dynamics of future interaction patterns and system responses.[122] An example of how interaction and patterns of interaction works can be found in the development of carrier aviation. Ships have been around for thousands of years while powered aircraft have only been around for 100 years or so. Naval officers were quick to use aircraft as a supplement to traditional naval activities, particularly scouting and gunfire adjustment. Eventually the two were combined in a more intensive interactive pattern and the aircraft carrier was designed to exploit the advantages of its younger sibling. The United States Navy's World War II experience further reinforced this co-evolutionary relationship to the point the carrier battle group is now the centerpiece of U.S. naval power and its deployment and employment has become a standard response to many international crises. In short, successful interaction patterns are a source of power, which are continuously repeated until proven ineffective.

Proximity and interaction. Before addressing how interaction can be reduced or destroyed, it is first essential to discuss the determinants of interaction. The first determinant is proximity. *Proximity* roughly equates to space and

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[121] Axelrod, 65-66.

[122] Ibid., 62-63.

captures those factors that increase the likelihood that interaction will occur. The closer the proximity, the more likely it is interaction will occur. Proximity factors include physical space as well as conceptual spaces such as organizational hierarchy and group affiliations.[123] For example, members in and outside of a clan, religion or ethnic group will mutually define themselves conceptually by referencing their relation to the group in question.

The second determinant is *activation.* Activation factors roughly equate to those things that are related to the temporal dimension. Activation factors influence or determine the sequencing of interaction and can be externally or internally driven. An example of an externally driven activation factor in military operations is seasonal change. In general, military operations are reduced in tempo or not conducted during unfavorable seasons such as the monsoon season or extreme winter weather. An internally driven factor for American air forces is the air tasking order (ATO) or a carrier's launch and recovery cycle. In a complex situation, how a strategy plays out is directly related to the patterns, and density of interaction (i.e. continuous action-reaction-action) between opponents.[124]

Proximity and activation are key concepts to understand when targeting because manipulating them can influence how and at what pace effects will

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[123] Ibid., 68-69.

[124] Ibid., 26.

occur.[125] Manipulating proximity factors is roughly akin to a using a throttle on effects. This "throttling" of effects occurs because the movement of system agents in space and time affects the density and intensity of interaction by determining how likely it is opposing system agents will come into contact with each other. By removing system elements from proximity space, effects achievement may be slowed or halted, while closer proximity intensifies and speeds up effects accomplishment.

In the case of two opposing systems, the closer agents are, the more likely they are to interact, and the more likely conflict is. For example, if there were not a U.S. presence in the Persian Gulf region it would be less likely that the war on terrorism would have started, or at a minimum, it would be more difficult for Islamic extremists to claim the U.S. was desecrating Muslim holy lands. Siege, blockade, and diplomatic isolation are tools that have long been used to expand proximity in hopes of causing collapse via terminating interconnections. It should also be noted that proximity is not just a physical concept, it is also conceptual. An example of conceptual space conflict is when cultures and ideologies collide over ideas. However, while proximity and activation may act as a throttle and timing mechanism for effects, Complexity does not guarantee specific results. Over time the summation of interactions and events will begin to take on a life of its own. Actors will adjust over the short-term with certain behaviors that may then morph into very different behaviors based on adaptation to the multiplicity of

[125] Ibid., 75.

previous interactions.[126] With an understanding of proximity and activation's relationship to system interaction, a framework has been established for discussing techniques to manipulate system interactions and interrelationships. The discussion will begin with techniques related to proximity and conclude with those related to activation.

Erect barriers. Conceptually, the simplest way to reduce or destroy system interactions via proximity is by raising barriers. Barriers are those things that inhibit movement in time and space.[127] Barriers cut off the ability to interact and prevent a complex adaptive system from using its components in the way intended or prevents individual system agents from coordinating action in a mutually beneficial way. In addition, barriers can cut a system off from its energy sources in the environment or prohibit transfer of energy within the system to smaller subsystems or agents.

Erecting external barriers is an old technique in warfare and finds its most direction expression in sieges and naval blockades. Military forces have also often tried to erect internal barriers to achieve success via ground envelopments, interdicting lines of communication and isolating leadership or other force elements from their higher and lower commands, support or lateral partners. As noted earlier, closeness facilitates interaction and by placing an opposing system

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[126] Jervis, 32.

[127] Axelrod, 78-79.

"A" in closer proximity to another system "B," we can disrupt B's internal interactions. All offensive operations work on this principle with the goal of closing attacking forces to the enemy's forces in order to disrupt and destroy the enemy. However, the ground commander's intent is usually not only killing the enemy, but also breaking down the opposing unit's cohesiveness. In short, he is conducting an attack on the opposing unit's interrelationships and interactive capability. However, Complexity asserts that all things being equal, as the intensity of interaction raises so does the unpredictability of the outcome. Thus, as is the case with offensive operations, one should try to stack the odds in their favor as much as possible.

Restructure physical and conceptual space. In addition to simply cutting interaction, another method to exploit proximity in an attack on a system is by restructuring physical and conceptual space. As noted earlier, this has the effect of either decreasing or increasing interactions depending on the effect desired. If, as is the case with targeting, the intent is to decrease system interaction, then increasing physical space will accomplish that. Usually, increasing physical space is accomplished through maneuver (retreat) in order to extend the enemy into more territory than he can control while simultaneously concentrating forces for a counterattack. From a Complexity viewpoint, this has the systemic effect of reducing the amount of interaction that can occur between enemy elements and it is also likely to increase the time delay between interactions. From an air perspective, targeting can be used to decrease the

density of agents in a given space, thereby, accomplishing the same effect as withdrawal even though physical space remains constant.

Restructuring conceptual space is obviously in the realm of Information Operations more than kinetic targeting. However, the intent is the same. One wants to either increase or decrease the likelihood that interactions will occur. The history of the Cold War provides an example of reconstructing conceptual spaces to manipulate interaction. In the early years of the Cold War both sides maneuvered to draw and promote clear ideological distinctions in order to buttress their positions. This had the effect of drawing various countries and peoples into one camp or another depending upon what each perceived to be in its own interests…when given an opportunity to choose. However, from a Complexity standpoint, the Cold War ended in the exact reverse of how it started. Over time, communist authorities were unable or unwilling to continue blocking interactions between their citizens and the West. Eventually, these citizens began to be increasingly exposed to Western ideas and affluence through modern communications or physical proximity. This, in turn, led them to demand the benefits they perceived were available through capitalism and democracy, and with that came the demise of communist ideology in Europe.

Attack tightly coupled systems in an unexpected way. Another way to take advantage of an opposing system via proximity is by exploiting the tightly coupled nature of some complex adaptive systems. In this case, one targets the internal structure of interrelationships. Complex adaptive systems, through their

numerous agents and complex relationships between agents, are normally able to effectively redistribute stresses throughout the system under most circumstances. Numerous linkages provide for many alternative paths to dissipate energy and work around and repair damage. However, this same strength is also a weakness that operates according to power law behavior wherein the average frequency of a given event is inversely proportional to some power of its size. For example, a study of casualties in warfare by Lewis Richardson provides an illustration of how power law behavior works. Lewis found that from 1820 to 1945 that battle casualties in wars where there were over 300 total deaths had the following distribution:

Table 4: Deaths and the Frequency of War

Size of War	Number of Wars
~ 1,000 deaths	188
~ 10,000 deaths	63
~ 100,000 deaths	24
~ 1,000,000 deaths	5
~ 10,000,000 deaths	2

Source: Lewis Richardson, *Statistics of Deadly Quarrels*[128]

In Richardson's study the power law operated at roughly a tenfold increase in casualties for a threefold increase in frequency. While the above table provides an interesting data point for consideration in the current debate on US Army transformation (i.e. should the army organize around heavy ground combat forces for a worst case scenario of infrequent occurrence or emphasize light forces for more flexibility to meet more likely events), its main purpose here is to illustrate how power laws operate. In targeting terms, power law behavior suggests complex adaptive systems are quite resilient under most circumstances because they are able to redistribute stress as noted above. However, when they fail, they tend to fail catastrophically because of the dense coupling of agent interrelationships.

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[128] Lewis Richardson, *Statistics of Deadly Quarrels*, (Pittsburgh: Boxwood Press, 1960) as cited in Axelrod, 105.

Systems can be, and sometimes are, developed to try to counteract power law events and lower the risk of catastrophic failure. This can be accomplished by building the system in such a way that stress is not automatically passed on to other elements, partitioning the system to isolate the stress to just a few elements and/or building in additional system slack and redundancy.[129] From a targeting perspective, it is critical to know how the system is constructed in order to attack it effectively. Tightly coupled systems are more susceptible to power law behavior, while loosely coupled systems are less so. A particularly helpful piece of information is what the system's designers or clusters of agents have anticipated would stress the system. If one attacks that which was anticipated by the system, the system is likely to be more resilient. However, if one can attack the system in a way not anticipated, then the potential for taking advantage of power law behavior exists. Thus, surprise is a good approach in both linear and non-linear warfare.

In summary, one can target system interactions by simply cutting them, increasing the space between them and thereby weakening them, or exploiting the internal structure of them. The above three techniques take advantage of interaction proximity and focus directly on linkages and interrelationships between system agents. However, targeting techniques exploiting activation, which is discussed next, are more indirect in nature in that they impact how linkages are formed, maintained, and sustained in a complex

[129] Axelrod, 110.

adaptive system. But before addressing activation techniques in detail, it is helpful to review the essential nature of a complex adaptive system. Briefly, complex adaptive systems are composed of numerous agents who have self-organized into a system according to what they *individually* perceive are successful strategies and relationships suited to current conditions. Thus, targeting by manipulating activation factors involves affecting a myriad of linkages and agents rather than some central controlling agent.

Attack Successful Agents. Complex adaptive systems often have an agent(s) that provides a successful model of behavior or strategy that other agents will copy. Indeed, the behavior may be so successful that a "neighborhood" of agents clusters with the successful agent combining resources to become even more successful. However, when the leading agent is destroyed other agents may abandon the behavior as it may then be seen as unsuccessful.[130] The important issue here, however, is the *perception* of unsuccessful behavior by other agents, not just the destruction of the lead agent. It would seem that international terrorism is a good example of this phenomenon. As shall be seen in the next chapter on targeting radical Islamic terrorism, numerous terrorists, supporting entities, and terrorist groups have formed around the al-Qaida organization and Iran to form a potent radical Islamic terrorist network.

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[130] Ibid., 86-92.

Alter Attractive System Signals. Altering signals that attract system agents (which then leads to complex systems formation and maintenance) is directly related to the concept of fitness landscapes discussed in chapter two. A signal is anything that attracts an agent to move to a certain location and act in a certain way that the agent believes will lead to obtaining its objective.[131] If the signal can be altered to indicate a different path or be destroyed to cut off the signal, then the agent will no longer pursue the associated objective using that form of interaction. Terrorism provides an example of how signals work. Radical Islamic clerics and terrorist organizations exploit young Islamic men's mostly religious beliefs in order carry out their political objectives through the means of suicide bombings. In this case, the signal for the individual is martyrdom wherein they exchange their lives for benefits to their families left behind and themselves in the afterlife to come. Martyrdom is an unusual signal to Western understanding, but the recent events in Israel indicate, it is a powerful one to certain Muslims. However, it has been noted that suicide bombings increase and decrease when the sponsoring terrorist organizations believe them to be more or less politically effective.[132] This observation suggests that signal strength does change with conditions. As it relates to the current war on terrorism, it would appear that the only way such bombings could be reduced or

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[131] Ibid., 93.

[132] Walter Laquer, *The New Terrorism*, (New York: Oxford University Press, 1999), 141-143.

eliminated is somehow to alter or replace the religious message being taught to these young recruits by radical Islamic organizations about martyrdom. Another alternative is to convince the sponsoring terrorist organizations that the tactic is counterproductive. However, both methods are probably remote possibilities. Nonetheless, the example demonstrates how signals can be manipulated to obtain individual or system objectives.

Collapse Decision-Making Time Scales. Collapsing a system's decision-making time scales can provide another technique for disrupting or destroying system interactions. One of the reasons systems develop hierarchical organizations is to expand the time available for decision-making. Herbert Simon noted that the upper levels of hierarchical organizations "typically involve processes that span longer time intervals." This arrangement of "time scales" supports more effective control. Simon goes on to argue that the slower activity at the upper level helps to establish a stable context for faster processes running below. This context "allows subordinates to act in concert" toward a greater purpose.[133] In a military context we can see this principle in action as the decisions and length of time and deliberation that can be devoted to decisions compresses as one moves down the spectrum from strategic policy making through the operational level to individual tactical decisions. In addition, in the

[133] Axelrod, 103.

military decision making process it is axiomatic that subordinate levels act in support of the higher headquarters plan.

The above concept provides an interesting and distinctly different approach to targeting than Col John Boyd's OODA loop theory. Boyd proposed that actions taken to deceive, confuse and elongate an opponent's decision-making cycle would cause a situation that would fold adversaries "back inside themselves, morally, mentally, and physically, so that they can neither appreciate nor cope with what is happening."[134] Alternatively, Complexity suggests forcing higher levels to make more and quicker decisions leads to a greater likelihood that poor strategic choices will be made. Thus, if one accepts the notion of numerous agents acting according to individual prerogatives in a complex adaptive system, it is manifestly more important that the proper context is established for these agents rather than specific agent decisions be accurately made all the time. In short, Complexity would argue that one correct decision at the strategic level makes up for a host of poor ones at the tactical level. Complexity would also posit that a correct higher level decision goes a long way toward ensuring lower level decisions are made correctly. Accordingly, targeting facilities and locations that could potentially draw senior officials into the realm of tactical decisions is an excellent way to compress their time scales. Possible historical anecdotes suggestive of the above might include Hitler's fixation on Stalingrad during World War II, and the Johnson administration's hands-on approach to targeting

[134] Hammand, 160.

during the Vietnam War. In sum, the effect desired by this targeting technique is to develop a situation ripe for poor decision making.

Parallel Attack. Another way to disrupt interaction is to attack in parallel. Destroying a system in parallel is a concept that has grown in familiarity to military audiences since the end of the Gulf War. Col John Warden has been a key advocate of such an approach in USAF circles. Warden believes parallel attack is desirable because an enemy system subject to it will not be able to overcome the degree of damage imposed in such a short time.[135] At this point it is assumed the system will collapse or no longer be capable of effective response. However, Warden doesn't provide any insight into why or how the mechanics of such an effect might occur. Interestingly, Complexity does.

Destruction in parallel can be devastating because it takes advantage of the element of time in system interaction.[136] When a system is attacked in sequence, its recovery time is determined by the longest time involved to repair an individual system element. However, when a system is attacked in parallel, full recovery occurs only when the longest element in time of the entire system is repaired. Thus, a longer time delta accrues to the attacker in which he can take additional advantage. Another way of looking at the effects of parallel attack is that when an entire system is attacked in parallel, the level of effect is, in a certain

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[135] Warden, 54-55.

[136] Axelrod, 85.

sense, shifted up to the interface of the system with its external environment rather than within the system itself. In other words, the effect is system wide, rather than local. One last possible advantage to parallel attack is that it may have the effect of compressing decision making time scales as well. System wide damage causes a situation where numerous decisions might have to be made near simultaneously. Taking advantage of power law effects may be a distinct possibility as well. Even with all of parallel attack's potential advantages, it is less likely to be successful against highly complex adaptive systems as there are more counter responses possible. Thus, a highly complex system may be able to absorb and localize the damage anyway due to numerous redundant or alternative measures available, without major disruption to the system's ability to interact with its external environment.

Like Warden, Complexity theorists also advocate parallel operations. However, they highlight a key challenge that was not explored by Warden and they also point out some significant advantages to sequential operations. Complexity theorists note that to conduct parallel operations successfully, expert information and anticipatory actions are required on the part of the user. In addition, they suggest that such an approach can fall well short of expectations if the requisite system understanding is not gained. Complexity theorists also point out that some key advantages of sequential operations are that execution, mistake correction, and understanding relationships between cause and effect is generally

easier than with parallel operations.[137] In short, sequential options offer a greater likelihood of success because it is relatively easier to ascertain the correct action to take, while parallel options can be risky if there is insufficient information.

In summarizing this section on decreasing system interactions, it is important to note that while organization is implicit in much of what has been discussed, the real focus is not on organizational structure per se, but upon how organizational structures form, change and disappear via interaction. From a Complexity approach, what one seeks to understand is not necessarily a system's organization, but how a system interacts to build, maintain and use the capabilities it has or can form. This approach to targeting doesn't necessarily give control over specific events or organizations, but it will disrupt how a complex adaptive system *currently* does something if the system is understood properly. However, implicit in the Complexity concept is the ability of the complex adaptive system to evolve to meet new circumstances. Thus, what works today, might not work tomorrow, and any knowledge one has about the current complex adaptive system is fleeting. Most of the targeting options delineated above disrupt organizations based on their activity vice their components. This is a distinctly different tack taken from most airpower targeting theories, and, as such, will hopefully provide a helpful approach to analyzing target systems in the future.

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[137] Ibid., 84-86

Decreasing Energy Available to the System

Erect barriers. As noted in chapter two, all open systems must import energy from their surrounding environment in order to stave off the Second Law of Thermodynamics. If an open system is unable to do this, it follows the course of closed systems and will eventually reach entropy. The conceptually simplest (though not always easy) way to eliminate energy from a system is to cut off the system from its environment. This is also accomplished by erecting barriers. Conceptually, the main difference between what was discussed earlier, and now here, is the focus (barrier building) is extended beyond the internal into the system's external environment. Another way to decrease energy is to destroy those agents and/or cut interactions that bring energy into or transport it within the system. Conceptually, there is no difference between agent and interaction targeting techniques discussed above. However, a practical difference is that one would specifically target energy related agents and interactions. From a systems viewpoint air, sea, and land interdiction efforts are nothing more than an attempt to disrupt energy importation and transportation. Interestingly, Complexity suggests another way to decrease system energy that will be discussed next. This technique is somewhat unique and roughly analogous to attacking centers of gravity.

Identify and Attack Adaptive Tension Areas. As discussed earlier, systems build ever more complex structures and processes to allow them temporarily to escape entropy. Oftentimes, the more complex a system is, the

longer it can evade the Second Law. However, Complexity theorists note that these same structures usually become areas where energy is applied and dissipated. These structures form the energy delta between the system's current state and a higher or lower state.[138] The energy delta is referred to as an *adaptive tension area* and is a function of those factors that are associated with a system's superior fitness.[139] In the case of military organizations and operations, these factors might include such things as superior technology, tactics, intelligence, logistics, and mobility. If a system can be attacked in an area of significant adaptive tension (usually a defining strength), there will be an accompanying and possibly severe reduction in system energy and fitness. Given the recent history of U.S. military operations and their reliance on airpower, Complexity would suggest successful attacks on the USAF might go a long way toward reducing the "energy level" of our military and its fitness/superiority. Indeed, analyzing a military in this fashion may suggest various centers of gravity as they may be a hub of power.[140]

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[138] Maguire, 16.

[139] Ibid., 18.

[140] Pat Pentland "Center of Gravity Analysis and Chaos Theory", as cited in *Coping with the Bounds*, by Thomas J. Czerwinski (Washington D.C.: National Defense University, 1998), 287-303.

Altering System Feedback and Control

Altering system feedback and control is one of the most frequently written about subjects in recent military theory. Boyd and Warden's work, Network Centric Warfare and Information Operations are all attempts aimed at altering or taking advantage of system feedback and control methods and mechanisms. In keeping with the attempt made here to develop a more generalized theory of targeting, the study shall not dwell on any of the above theories in any great detail. In the context of the theory being developed here, the above theories are techniques for accomplishing the main objective of reducing system control or manipulating feedback and controlling mechanisms to cause deleterious effects on the system.

Destroy control mechanisms. As described above, negative feedback is used to keep a system in a constant steady state by dampening system disturbances, while positive feedback can be used to drive a system to another state or shove it into instability. Accordingly, one can target to take advantage of both types of feedback. J.F.C. Fuller, B.H. Liddel Hart and John Warden's theories all concentrated on affecting negative feedback mechanisms. All three basically posit that destroying an enemy's ability to control its forces will lead to outright destruction of or severe degradation in the enemy system. While certainly the specific approaches they advocated were different, the systemic effect was the same: An enemy would no longer be able to control the activities of his forces to dampen externally imposed perturbations and the system would

disintegrate or collapse. At this point, the adversary is also no longer able to control the future state of his forces. For most military systems, which are hierarchal, their theories have definite merit. However, if the system is believed to be a complex adaptive system, then attacking a central controlling element is likely to meet with less success. A complex adaptive system, using local rules, will simply revert to those processes or mechanisms used in a lesser state of organization or recombine agents and processes to overcome the event. In sum, control is decentralized and command and control attacks are less likely to be effective on a complex adaptive system than on a linear, hierarchical system.

Manipulating feedback. However, Boyd's theory, being influenced by nonlinearity concepts, is more attuned to disrupting both types of feedback and complex adaptive systems. Boyd understood the problems that would befall any system if it were unable to observe and accurately assess its environment when he noted that such systems would increasingly choose the wrong adaptive responses as they became more divorced from reality.[141] With regard to negative feedback, inaccurate information leads to inappropriate control responses, which simply degrades or negates the controlling function altogether and all that it provides. Meanwhile, inaccurate information can warp or amplify positive feedback control hastening the system to an undesired new state or driving it completely out of

[141] Hammond, 159.

control. In other words, due to bad information or bad interpretation of information, the system will decide and act incorrectly given actual conditions.

To target the feedback and control process, Boyd suggested different methods in addition to destroying the controlling mechanism advocated by Fuller, Liddel Hart, and Warden. Boyd noted that one could attack the observation function and associated sensors, deceive the controlling mechanism through manipulation of his orienting and decision-making processes and/or simply "out control" the opposing system by cycling through one's own OODA loop before an enemy could cycle through his.[142] Several different techniques can be used to attempt what Boyd suggests including; attempting to alter what the opponent views as success through action or deception (i.e. do things to try and dissuade him from pursuing his original objectives),[143] being unpredictable in order to preempt any learning by the opponent (remembering that learning is based on pattern recognition),[144] bombarding the opponent's information system with data to cause system lock,[145] manufacturing as much ambiguity as possible through deceptive means, constantly changing communications or confusing actions,[146]

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[142] Ibid., 160-170.

[143] Axelrod, 120-123.

[144] Michael J. Mazart, *Global Trends 2005: An Owner's Manual for the Next Decade*, (New York: St. Martin's Press, 1999), 95.

[145] Battram, 220-221.

[146] Maguire, 33.

and executing multiple simultaneous attacks on system components or agents.[147] The subtle difference between parallel attacks done here and those noted earlier is that the intent is to cause information overload vice destruction. The main thing that must be remembered when using Boyd's theory against a complex adaptive system is that one must aim at numerous system agents rather then a few individuals or system command and control nodes. Thus, the tactics listed above must be aimed at a broad audience.

In sum, the above are several different "tactics" that are designed to alter the control and feedback processes or information going into a system. These tactics are equally applicable to both linear, hierarchical systems and complex adaptive systems. However, applying them to a complex adaptive system demands an approach that will affect the mass of agents vice a few central control nodes.

The Means Required for Disrupting Complex Adaptive Systems—

Continuous and Effective OODA

The nature of complex adaptive systems is such that they will adapt, improvise and overcome to the best of their abilities. A fight between complex adaptive systems, then, is a fight for relative fitness. If one assumes two competitive complex adaptive systems opposing one another, the ability to more

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[147] Ibid., 23. In this case parallel attacks would be designed to confuse rather than to paralyze by destruction ala Warden. Such attacks would be another way to bombard the enemy system with information.

accurately observe, analyze and anticipate a targeted system's likely responses, becomes a significant advantage. In conflict, this advantage will enable its possessor to counter, and possibly, preempt follow-on adaptations by its adversary. In pre-conflict, it leads to better selection of agents, artifacts and strategies suited to meet the future crisis.

Boyd's OODA loop theory has been critiqued as not being suitable for anything above the tactical level.[148] However, it is important to understand that observing, orienting, deciding, and acting occur simultaneously, on multiple time scales. While it is probably true that OODA speed is an imperative at the tactical level, the earlier discussion on collapsing decision-making time scales suggests that getting it right might be more important at the operational and strategic levels. In any event, OODA plays a critical role in all adaptive processes and as such must occupy center stage in any theory relating to complex adaptive systems. One author summarizes the relationship between OODA and Complexity as follows: "In a complex world, strategy is a set of processes for monitoring the behaviors of both the world and the agents of the organization…. Command and control is impossible (at least in the absolute and in the aggregate), but the [commander] does retain the ability to influence."[149] Meanwhile, another notes that the connection between Complexity and policy means that "you

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[148] Thomas Hughes, "The Cult of the Quick," *Aerospace Power Journal,* Vol 15, no. 5, (Winter 2001), 57-68.

[149] Battram, 213.

observe, observe, observe…you see reality for what it is and realize that the game you are in keeps changing, so that it's up to you to figure out the current rules of the game as its being played."[150]

"Complex" Combat Assessment

Defeating a complex adaptive system is challenging, but certain system characteristics can be observed when one is beginning to have an effect and when one has totally defeated the system. First of all, attacks will trigger adaptive responses. However, if the attacks are successful, one would expect to see in the targeted organization/system a splintering into smaller groups (e.g. breaking down into less complex systems), the emergence of newer less effective systems, an inability to control system agents and responses leading to an overall decrease in effectiveness, and oscillations between individual dominated groups and attempts at setting up different networks.[151] If an effective adaptation were not forthcoming, the system would disintegrate or be defeated.

While the above are indicators of some targeting success, one of the results of a true "complexity" defeat is that the defeated system's strategy will be eliminated as the defeated system itself no longer views the previous strategy as an advantageous approach for the future. When attacks are successful to the point that the opposing system is defeated, the result will be displacement of the previous system and the emergence of a newer system more "fit" for the changed

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[150] Waldrop, 331.

[151] Battram, 50.

environment. Being "fit" could be something as simple as being acceptable to the victor with minor changes in actual structure and composition or the emergence of something completely different. However, it is important to note that the opposing system's behavior will have definitely changed. If this is not the case, the system has not yet been defeated. Thus, more "education activities" will be required. Finally, it should also be mentioned that when a system collapses punctuated equilibrium and sensitivity to conditions imply that many different future states are possible. The victorious system should make full use of the opportunity to influence the newly emerging system by developing new lead agents and signals that will be seen as a better strategy to be copied by other agents. Thus, shaping the post-war environment and ensuring that the peace is not lost remain critical concerns under this theory.

Comparing "Complex" Targeting with other Targeting Theories

This chapter began with a critique of airpower theory by Lt Col Pete Faber in which he stated airpower theory suffers from several pathologies. These pathologies included: developing "hoary maxims that would apply to all wars regardless of time and circumstance, a fetish for quantification and prediction in war, over reliance on metaphors to "buttress the logic" of the theory and, theory that has predominately focused on strategic bombardment to the detriment of other airpower missions and functions.[152]

[152] Faber, paper.

The "Complex" targeting theory developed above addresses three of these concerns. "Complex" targeting has no "hoary maxims." Several different targeting approaches with different mechanisms are suggested. However, because the theory is a generalized approach, in that it seeks to drive any system into entropy, or put it in a position where it cannot respond effectively, it is assumed that it can be applied in any attack on a complex adaptive system. Accordingly, the above theory provides a descriptive vice prescriptive framework for thinking about complex adaptive systems (e.g. agents, interactions, energy and feedback and control) and some elucidation on operative principles underlying them.

While, the Complexity principle of perpetual novelty precludes any a priori identification of "most important" targets in this theory, the theory does suggest that one can target agents, interactions, energy importation and transportation or attempt to alter a system's control and feedback processes. The theory also points out that because agents tend to repeat successful behaviors, one should seek to determine those leading agents, processes, subsystems, or feedback and control processes that are most significant to the particular system in operating the way it does in order to have the greatest effect or take advantage of power law behaviors. "Complex" targeting also posits that parallel attacks and superior OODA loops provide some significant advantages that should be exploited if possible. Thus, flexibility in approach is an inherent quality of the theory. Finally, the concepts described above can be applied to any complex adaptive system. Accordingly, there is no association with strategic bombing or

any of the "counter" missions (e.g. counterair, land, sea, etc.) nor is there any association with any weapon or service.

The above theory incorporates the Complexity-based concept that long-term prediction is impossible and that accurate short-term observation, assessment and adaptation to ever evolving circumstances is a key to strategic, operational and tactical success. Therefore, the theory intrinsically has no "fetish for quantification and prediction" and Boyd's OODA loop concept is a key component of "Complex" targeting. It should be noted, however, that while there isn't a fetish for prediction in the theory, there probably is one for accurate observation and appropriate response. In fact, the one prediction the theory does make is that assuming the requisite variety and resources are available, whichever system is the most adaptive will probably win.

Using Faber's comparative framework, the table on the next page provides a quick summary of "Complex" targeting's main points and indicates how the theory compares to other airpower theories developed since 1960.

Table 5: "Complex" Targeting and Faber's Representative Air Strategies Since 1960

	Timing	**Target Sets**	**Mechanism**	**Political Outcome**
Mayo	Incremental	Political leadership	Exploit factions	Change leaders or policies
Janis	Irregular	Leadership	Near miss	Change policies
Warden	Hyperwar	Leadership + 4 rings	Decapitation/ Strategic paralysis	Change leaders
Schelling	Incremental	Population	Future costs and risks calculations	Change policies
Boyd	Fast Tempo	Communications	Deny strategy/Battlefield success	Yield territory; change policies
Pape	Incremental	Military forces	Thwart military strategy	Yield territory; change policies
Complex Targeting	***Parallel preferred***	***Agents/artifacts, interactions, energy, control/feedback***	***System collapse/ ineffective response***	***System replacement/ change policies***

Adapted from: Lt Col Peter Faber, "Competing Theories of Airpower: A Language for Analysis" (PowerPoint Briefing presented at Air and Space Power Doctrine symposium, at Maxwell Air Force Base, Alabama, April 30 to 1 May 1996)

The one theoretical criticism posited by Faber that has yet to be addressed is his assertion that airpower theory suffers from an "over reliance on metaphor to buttress its logic." To address this criticism for the theory developed here, the next two chapters will analyzes the "radical Islamic terrorism system" using Complexity concepts and "Complex" targeting to demonstrate the utility of these concepts in describing, explaining and targeting terrorism. From this "target analysis," potential weaknesses will be identified that may prove susceptible to "Complex" targeting.

Chapter 5

Targeting Radical Islamic Terrorism

The tragic embassy bombings in Nairobi and Dar es Salaam underscore with particular force that terrorism is among the most fluid and dynamic of political phenomena: one constantly evolving into new and ever more dangerous forms in order to evade existing security procedures and surmount defensive barriers placed in its path...government responses must accordingly be both innovative and multi-faceted if they are to achieve any demonstrable effects.

—Bruce Hoffman
Inside Terrorism

Terrorism as a Complex Adaptive System

As noted earlier, Complexity is used in this thesis as an analytical framework. What follows will not "prove" terrorism is a complex adaptive system but, in the author's mind, profitably describes and explains radical Islamic terrorism's elements and behaviors in a useful way. Thus, the benefit of Complexity is that it provides an alternative method from the normal Newtonian model to assist us in understanding terrorism and terrorists and it also provides illumination on aspects of the problem that might not be contemplated otherwise. Indeed, the analytical, deconstructionist literature on terrorism is vast and, with recent events, exploding in volume. In order to accomplish the analytical task, the initial analysis will concentrate on terrorism's characteristics and evolution using a systems and Complexity-based analytical framework. Thereafter, a narrower analysis focuses on radical Islamic terrorism. Once radical Islamic terrorism has been analyzed, the chapter concludes with a targeting analysis of radical Islamic terrorism using the "Complex" targeting theory developed in the previous chapter.

Terrorism Defined

Complexity suggests focusing on analyzing a system's agents, its artifacts, and the strategies agents employ as they seek greater fitness. It also seeks to determine how systems measure their own fitness, how systems stay at a certain fitness level or lose and gain fitness, and what makes the system evolve or stay the same over time.[153] In order to perform this analysis on the larger phenomena of terrorism this thesis proceeds in a top-down fashion. First, the study defines terrorism and develops a general systems Input-Process-Output-Feedback-Control model in order to describe terrorism's essential elements. Second, there is a brief discussion on how terrorism has evolved over the past century in four distinct phases that highlights terrorism's adaptive nature. Thereafter, it focuses on radical Islamic terrorism's basic objectives and strategy as well as radical Islamic terrorist's own concept of fitness, worldview, and general operational and organizational characteristics. In addition, key system agents, linkages and the nature of these linkages are explored to provide a general understanding of the "system" for targeting purposes.

According to the Department of Defense terrorism is: "The calculated use of unlawful violence to inculcate fear; intended to coerce or to intimidate governments or societies in pursuit of goals that are generally political,

[153] Clemens, 228.

religious, or ideological."[154] Thus, in every sense of the word, terrorism is a form of warfare as defined by Clausewitz in that it is a political act using force to compel.[155] More specifically, terrorism is a strategy of the weak to compel the strong using terrorist tactics and methods, such as hijacking, murder, kidnapping, etc.[156] Even the word "terrorist" is a politically charged word which is indicative of terrorism's political nature and is a term that is often used to delegitimize political groups using violence to achieve their goals. Terrorist activities are "illegal, and [often] explicitly anti-legal."[157] While the tactics (kidnapping for ransom, assassination, hostage taking, civilian bombings, etc.) are often the same, terrorism is different than crime and guerrilla warfare. Terrorism is aimed at political change, while crime is perpetrated for personal gain. Meanwhile, terrorists usually do not openly act as military units, engage in sustained combat actions or attempt to hold territory like guerrillas do.[158]

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[154] Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Term*, 12 April 2001, s.v. "Terrorism."

[155] Clausewitz, 75.

[156] Christopher C. Harmon, *Terrorism Today*, (Portland, OR: Frank Cass Publishers, 2000), 44.

[157] Harmon, 44.

[158] Bruce Hoffman, *Inside Terrorism*, (New York: Columbia University Press, 1998), 44-42.

A Basic Model of Terrorism

The Input-Process-Output-Feedback-Control model introduced in chapter two can be used to describe and understand the basic elements and functioning of terrorism. The primary inputs to and artifacts of terrorism are ideology, people, financing, weapons, and training. Terrorists need an ideology and political goals that are sufficiently attractive to garner recruits and motivate and sustain terrorist group members in their actions. The ideology and goals also must be sufficiently attractive to gain at least some support among the outside population. The durability of terrorist groups is often directly related to the extent the group and its ideology are supported by others.[159] In the twentieth century anarchism, communism, fascism, neofascism, ethnic separatism, religion and pro-state causes have been key motivating factors for terrorism.[160] As noted, ideology provides the second major input: people dedicated to the cause. Supporters can range the gamut from actual operational terrorists, to active supporters providing intelligence, technical advice, shelter and other items to passive supporters who are sympathetic, yet not involved. A third major input required is financial resources needed to acquire weapons and support the terrorist group's operations. Money can be garnered via legitimate businesses and charity organizations, crime (theft, illegal drug sales/production, extortion, kidnapping etc.), and supportive

[159] Hoffman, 171.

[160] Harmon, 1-33.

governments and individuals.[161] Money or other outside support entities provides the fourth major input, weapons. Financing also provides other terrorist tools and support equipment. Finally, terrorists require training. Terrorism is an extremely risky activity that often results in capture or death to those found wanting in the necessary skills. Terrorist training usually comes in two forms, basic and advanced. Basic training usually includes political indoctrination and training in weapons use, close combat skills, physical conditioning, bomb-making and surveillance, counter-surveillance techniques and interrogation resistance methods. Advanced training may include such things as computer skills, forgery, weapons of mass destruction use and surface-to-air missile operations.[162]

With the above inputs, terrorist organizations plan and carry out terrorist acts designed to achieve their political objectives. It is important to note that there are, in fact, two levels of process and output going on—the tactics of terrorism and the strategy of terrorism. At the lower level, all inputs are used by *terrorist organizations* to plan and organize (process) and execute terrorist acts (output). These outputs come in the form of the various tactics and operations used by terrorists. However, at the strategy level of *terrorism*, terrorist acts (process) are designed to produce political change (output). Thus, terrorism is a

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[161] Wayman C. Mullins, *A Sourcebook on Domestic and International Terrorism*, with a forward by Michael J. McMains, (Springfield, IL: Charles C. Thomas Publishers Ltd., 1997, 156-158.

[162] Mullins, 158-163.

warfare strategy. As a strategy, terrorists seek to destroy or build political power by acts of terrorism directed at political, economic, civilian and military targets.[163] "Through the publicity generated by their violence, terrorists seek to obtain the leverage, influence and power they otherwise lack to effect political change on either a local or international scale."[164] The dual levels of terrorism have important target strategy implications that are discussed in the target analysis section of this chapter.

Governing or controlling virtually all terrorist actions is the perceived public and political effect. In keeping with the dual level process of terrorism, there are two different feedback mechanisms that are critical to terrorist groups. At the lower level, there is a critical requirement for operational intelligence. Operational intelligence helps in identifying targets, developing tactics and strategies and achieving surprise. Meanwhile, counter-intelligence is essential for survival.[165] Several experts argue that intelligence is probably the single greatest requirement for successful terrorist and counterterrorist operations. Another way terrorists obtain feedback and adjust their operations is by assessing the media's interest in their actions. Terrorists need the media to get their political message out and carefully craft their operations to gain maximum

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[163] Harmon, 53.

[164] Hoffman, 44.

[165] Harmon, 101-111.

exposure.[166] Terrorists will also change tactics if current acts lose media attention.[167] At the strategic level of terrorism, the primary feedback mechanism is observing and adjusting to actual political conditions. Terrorist groups seek and use information on the target's will and political resolve and, critically, the target's perception of the effectiveness and impact of the terrorist's operations, on the target's political situation.

While feedback comes through assessing public, media and political reaction to terrorist acts, control in terrorist groups is usually exerted in the same way virtually any organization is controlled, through its leadership. This is certainly the case with many terrorist groups who tend to be tightly controlled and dominated by strong charismatic leaders.[168] However, in the case of the "new" terrorism, control of the multitude of loosely associated groups is more in line with that found in the "self-organizing" principle of Complexity as will be demonstrated by analyzing radical Islamic terrorism.

Perhaps the best modern example of carefully calibrating and controlling violence in accordance with the current political situation can be found in the form of the Irish Republican Army (IRA) and its political arm Sinn Féin. Over a period of thirty years these two organizations gained notoriety for

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[166] Hoffman, 134.

[167] Walter Laquer, *The New Terrorism: Fanaticism and the Arms of Mass Destruction*, (New York: Oxford University Press, 1999), 43-45.

[168] Mullins, 137-138.

their cause through a sustained and bloody campaign of terrorism supplemented by political dialogue. As Sinn Fein gained a measure of political recognition and influence, the IRA's attacks were reduced substantially and eventually halted in order for Sinn Féin to remain in the 1998-1999 peace talks between Great Britain, Northern Irish Protestants and Sinn Féin.[169]

The fact that terrorists observe and adjust operations according to the perceived public exposure and political benefits or losses indicates that terrorism "is a learned behavior, and as such subject to the forces that control all our behavior….If this is correct, we know that the most powerful forces that control terrorist behavior will, in some sense, relate to its positive consequences [for the terrorists]".[170] At this point it is critical to refer to a major tenet from Complexity in order to understand the importance of the above statement. Complex adaptive systems execute strategies based on a historically-derived model. Results are obtained and compared with the model to determine if the model will be kept, deleted, or modified. The important message here is—*terrorism occurs because it works*.[171] It is also highly unlikely to be dropped as a

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[169] *The Terrorism Reader*, ed. David J. Whittaker (New York: Routledge, 2001), 89-107.

[170] Maxwell Taylor and Ethel Quayle, *Terrorist Lives*, (London: Brassey's Ltd., 1994) 199.

[171] Harmon, xviii.

model of behavior/form of warfare unless "taught" otherwise by those who oppose it.

The Attractor of Terrorism: Ideology

Terrorism is an ancient form of warfare, but most scholars writing on the historical evolution of modern terrorism begin the chronology in the late 1800s. Over the period of 120 years, modern terrorism has come in four waves which are analogous to Complexity's "attractors" wherein the system stabilizes for a while before jumping to another state. Each of the first three phases lasted approximately thirty to forty years each, while the fourth phase is ongoing.[172] The first phase space began in Tsarist Russia in the 1880s and was focused on anarchist revolution or national separatism. The primary tactic was the assassination of high-level officials. This type of terrorism started in Russia and spread to the Balkans, the Ottoman Empire, Europe and the United States. Occasionally, terrorists at this time were also supported by foreign governments.[173] World War I ended the first phase and the second phase started shortly thereafter. The second phase was inspired by unfulfilled Wilsonian post-war idealism and centered on national liberation from colonial powers. Terrorist numbers grew substantially over the previous phase and operations became more aggressive in nature. Indiscriminate attacks on civilians were much more

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[172] *Encyclopedia of Violence, Peace & Conflict*, vol 3., s.v. "Terrorism," by David C. Rapoport

[173] Ibid.

prevalent and the police and military also became targets. International support was more pronounced and the United Nations frequently passed resolutions encouraging these movements.[174] The third phase, which began in the late 1960s, gave rise to the term "international terrorism." The political orientation of terrorist groups reverted back to something similar to the first phase (revolution/separatism), but usually had active support from communist states. Operations frequently transcended international boarders with several states actively using terrorism as an instrument of foreign policy. Worldwide publicity was sought via hijackings, audacious acts and large scale murders. Television became the terrorist communications device of choice. Large scale left-wing terrorism gave birth to right-wing terrorists groups as well, who saw their governments as ineffective against the leftist threat. The third phase began to ebb somewhat in the 1980s as the Soviet Union and its system collapsed. The current phase we are in today was marked by two important events: the Soviet Union's defeat in Afghanistan and the overthrow of the Shah of Iran. "Both "demonstrated" that religion provided more hope and motivational power than did the prevailing revolutionary ethos."[175] This latest phase of terrorism is often called the "new" terrorism because it is religiously oriented, often extremely brutal, and murderous on an even larger scale than before. The "new" terrorist groups are incredibly complex, well funded, and marked by the initial use of

[174] Ibid.

[175] Ibid.

weapons of mass destruction (WMD) by the Japanese religious cult *Aum Shinrikyo* and arguably, al-Qaida in the World Trade Towers attack.

While the previous paragraph provided a summary of the broad evolution of contemporary terrorism, it should be noted that in reality the picture is more complex. For example, nationalistic-ethnic terrorism remains strong in several countries. In addition, while communist ideology is not the large-scale attractor for terrorist groups that it was before the fall of the Soviet Union (particularly in the advanced industrial nations), it remains a potent ideology for insurgent organizations and terrorist groups operating in the Third World as evidenced by their continued presence in South and Central America and, most recently, Nepal. Indeed, one can easily make the argument that the third phase rages on unabated in some areas of the world.

The short history above is reminiscent of a complex adaptive system. One can see a slow evolution to ever greater "variety" in the system translating into increased capabilities inherent in many terrorist groups. Modern terrorism started out with very small numbers of terrorists using guns, knives and small bombs to assassinate. It has evolved to worldwide conglomerates with thousands of supporters capable of employing WMD. In addition, this growth in variety has been marked by terrorist "co-evolution" with the "artifacts" of terrorism. As technology has advanced, terrorist tactics have evolved to take advantage of it. This is evidenced by terrorists using airplanes, mass media and

advanced weapons to promote their causes.[176] Most alarmingly, the weapons of terrorism have gotten progressively more dangerous

Terrorism also seems to be related to a complex adaptive system because it appears to be correlated with the rise and fall of strong ideological and political movements. During the rise and fall of strong political movements in the 20th century there was also a corresponding shift in terrorist organization types, motivating ideology and tactical behavior.[177] In the cases above, the system state shifts came at the end of World Wars I and II and with the gradual fall of the Soviet Union. Indeed, it appears terrorism adapts and enters a new system state shortly after changes in the world political system. Finally, terrorism seems to be highly adaptive in that terrorist groups tend to gravitate to or take up for popular support those ideologies that they believe provide a good model of success and then are discarded when they are no longer popular or useful. Thus, the "attractor" or basin that terrorism activity settles into comes and goes with political and ideological change. If this assessment is correct, it may also have portent for developing a strategy against the strategy of terrorism discussed previously.

In summary, the way terrorism functions demonstrates that it can be viewed as a system with inputs, processes, outputs and feedback and control mechanisms. However, one should differentiate between the tactics and

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[176] Harmon, 160.

[177] Hoffman, 157-183.

organizations of terrorism and terrorism as a military-political strategy. The evolution of terrorism in the 20th century suggests terrorism can also be viewed as an adaptive system as defined in chapter two given that many of Complexity's adaptation-related properties are evident. Of particular note, is how terrorism has evolved with and settled into forms correlated with dominant ideologies of the time.

Radical Islamic Terrorism

> *Its goal is remaking the world -- and imposing its radical beliefs on people everywhere.*
>
> —President George W. Bush

The Radical Islamic Objective and Fitness

A system analysis almost always starts with an attempt to understand the objective or purpose of the system under study so as to place the system in proper context. This section begins with the basic objective of radical Islamists and describes how it relates to their concept of fitness. Radical Islamists view the West and modernity as "being the source of all crises and trouble afflicting the Muslim world."[178] The physical and intellectual penetration of Islamic areas by Western and modern ideas and entities is seen as the primary impediment to Islam's expansion throughout the world. More pointedly, radical Islamists believe this penetration prevents them from practicing a pure form of Islamic law (Sharia—the law governing mankind) wherein church and state

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[178] Yosseff Bodansky, *Bin Laden: The Man Who Declared War on America*, (Roseville, CA: Prima Publishing, 2001), ix-x.

government is one and the same. If this situation could be rectified, it is believed that Islamic society would advance in the world and many of society's problems (Western and Muslim) would be solved. Thus, the objective originating from the ideology of radical Islamists is to establish fundamentalist governments based on Sharia.[179]

In addition, radical Islamists believe their ideology makes them more "fit" (with Allah's help) in this deadly competition with the West and the world. As noted in chapter two, countries and societies can roughly measure their relative fitness by evaluating how well they are able to respond to international challenges that threaten their society and belief systems. Radical Islamists point toward the overthrow of the Shah in Iran and defeat of the Soviets in Afghanistan as examples where Muslims were successful in accomplishing their objective of establishing Sharia and eliminating Western-oriented governments and influences.[180]

Iran's Success: An Example of Emergence

Emergence and self-organization is one of the unique perspectives brought to an analysis of a problem by Complexity. Emergence is a bottom up phenomenon wherein multiple independent agents take on similar properties according to individual conditions, perceptions and needs (i.e. local rules). In a complex adaptive system there is no "central controlling" agent that governs the

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[179] Bodansky, ix-xviii; Hoffman, 95.

[180] Bodansky, 28.

system.[181] However, agents will self-organize in mutually beneficial relationships to achieve common goals.

The history of radical Islamic terrorism since World War II suggests it is a complex adaptive system that has emerged in response to strong local political, social and economic conditions.[182] Politically oriented radical Islamic terrorist movements have developed in virtually every country with a significant Muslim population and some of the world's most violent and long-running conflicts are sustained by these groups to include; Algeria, Israel/Palestine, India/Pakistan and Sudan.[183] These groups predominately consist of native residents, however, their "emergent" terrorist behavior is inspired by the common radical Islamic ideology they share and the Iranian example of Islamic success against a Western-oriented government.

One of the watershed events in radical Islamic history was the successful revolution that deposed the secular and westward leaning Shah of Iran. Many radical Islamic groups, including radical Islamic terrorist groups, saw the Iranian success as a model to be emulated (strategy copying) or proof that radical

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[181] Clemens, 228.

[182] Richard H. Schultz Jr., "Iranian Covert Aggression: Support of Radical Political Islamists Conducting Internal Subversion Against States in the Middle East/Southwest Asia Region," *Terrorism and Political Violence 6*, no. 3 (1994): 291.

[183] Laquer, 127-155.

Islamic ideology could be successful.[184] Indeed, the Shah's overthrow could probably be classified as a "bifurcation" or "punctuated equilibrium" event wherein many previously nationalistic or separatist Arabic terrorist groups were transformed into radical Islamic groups (or at a minimum began espousing their ideology to gain popular support).[185] In addition, Iran has made it a principal domestic and foreign policy objective to consolidate and expand the institutionalization of Islamic states even to the point where this objective is enshrined in the Iranian constitution.[186] To achieve this objective, Iran is one of the world's leading sponsors of radical Islamic terrorist groups. The successful Iranian example and the support Iran lends to affiliated groups has probably lead to "increasing returns" in the overall success of these groups and "lock-in" of the radical Islamic terrorist model around the Arab world and increasingly in parts of the world with significant Muslim populations. As a result of Iran's support, today there is a situation where numerous radical Islamic groups (system agents) are inextricably linked in a complex network of relationships.

Agent-Based Systems and the Greater Web of Radical Islamic Groups

Radical Islamic terrorism in its totality is an immensely complex system with myriad linkages between various system agents that extends beyond

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[184] Hala Jaber, *Hezbollah: Born With a Vengeance*, (New York: Columbia University Press, 1997), 48.

[185] Harmon, 28.

[186] Schultz, 284.

Iranian affiliated groups. The main factor that ties them together is not a centralized hierarchy directing worldwide terrorist operations (though there is a degree of hierarchy within agent groups to facilitate organizational activities), but rather a loose affiliation based on their common ideology and its political aims. Even terrorist groups that are more nationalist or separatist in nature, but share a common enemy (e.g. some Palestinian groups), have links to this web of relationships and affiliations.[187] Executive Order 13224 lists over a hundred terrorists groups, people, banks, companies and charities affiliated with Islamic terrorism and these are just the system agents clearly identified as having links to Islamic terrorism.[188] However, writing a detailed exposé on the many links and groups that form the network is well beyond the scope of this thesis. Accordingly, this study paints a more generalized picture that describes the main features of radical Islamic terrorism in sufficient detail to apply the targeting theory developed earlier. Fortunately, while the specific details in the discussion

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[187] Maria Do Ceu Pinto, "Some Concerns Regarding Islamist and Middle Easter Terrorism," *Terrorism and Political Violence 11*, no. 3 (1999): 72.

[188] U.S. Department of State, *Comprehensive List of Terrorists and Groups Identified Under Executive Order 13224,* Office of the Coordinator for Counterterrorism, available from http://www.state.gov/s/ct/rls/fs/2000/6531pf.htm; Internet; accessed 27 February 2002.

are likely to be dated and of lesser fidelity than required for an actual operation, it is sufficient for the objective of this thesis.[189]

The Main Links and System Agents: Iran and al-Qaida.

While Iran was emphasized as an example of emergence, the radical Islamic victory in Afghanistan was also a powerful and successful example of radical Islamic success. The Afghan experience gave rise to another major web of terrorists organizations captured under the al-Qaida organizational structure. Accordingly, most recent literature on Islamic terrorism points toward two main networks; one affiliated with Iran and the other with Osama Bin Laden's al-Qaida. The common feature of all is a dedication to their ideology. This is the overarching signal which shapes the two interconnected networks

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[189] Due to the continuous evolution of these groups and their relationships according to past and recent events, the groups and linkages described here will undoubtedly be outdated and incorrect to a degree. In addition, it is doubtful that purely open sources will be able to paint the most complete picture possible given classified source material. Even then, these groups and associated individuals deliberately generate multiple aliases and false organization names to confuse intelligence organizations and obfuscate their activities. Finally, several sources that have been used for this thesis were published in different years compounding the problem. Thus, the discussion here should be seen as primarily illustrative in nature in order to identify potential targeting options.

agents' OODA loops and guides their actions. However, the strength of linkages that bind them (network to network and agent to agent) is highly varied.

With regard to Iran specifically, one author describes the links between Iran and Islamic terrorist organizations in terms of five degrees of separation.[190] The first level is complete control and includes such organizations as the Iranian Revolutionary Guard Corps (IRGC) and the Ministry of Intelligence and Security (MOIS).[191] The second level is the "recruit and training of operatives specifically for an overseas mission."[192] Iran has often used this type of link for specific assassinations in foreign countries. The third level is close, though not total, control of terrorist groups and direction of their actions. The Iranians have this type of relationship with a few Palestinian groups.[193] The fourth level, and the one most common, "is when a government provides training, financing, and safe haven for an autonomous terrorist group" (e.g. Hamas).[194] The fifth level is when a state simply finances an organization that directly serves its purposes (e.g. Libyan support to the Irish Republican Army as a way "to

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[190] Louise Richardson, "Terrorists as Transnational Actors," *Terrorism and Political Violence 11*, no. 4 (1999): 212-214.

[191] This is an example of state sponsored terrorism by an Islamic state.

[192] Richardson, 213.

[193] Ibid.

[194] Ibid.

punish Britain for its collaboration in the U.S. bombing of Tripoli").[195] The key point is that most Iranian affiliated groups fall in category four which means they are not centrally controlled, though they may possibly be heavily reliant on Iran.

Meanwhile, al-Qaida is probably an even better example of a complex adaptive system. Al-Qaida "is a prime example of an alarming trend in terrorism…loosely knit networks with fewer direct ties to government. Their organization is very flat [and] less hierarchical."[196] Al-Qaida is also a network with global reach that has a presence in at least 35 countries,[197] and whose key leadership hails from at least nine different countries.[198] In addition, an interesting facet of the al-Qaida network is that most of its affiliated groups have a common core of "Afghans." Afghans are a relatively small group of hardened terrorists from many countries who got their start as Mujahideen fighting the

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[195] Ibid., 214.

[196] Congress, Senate, Committee on Foreign Relations, *Extremist Movements and Their Threat to the United States: Hearing before the Subcommittee on Near Eastern and South Asian Affairs*, 106th Cong., 1st sess., 2 November 1999, 5.

[197] "'Blowback'," *Jane's Intelligence Review,* August 2001, 42.

[198] "Who's Who in the Enemy Alliance," *Time,* 12 November 2001, 48.

Soviets in Afghanistan and have personal ties with Osama Bin Laden.[199] Together they constitute "a global unifying factor" among the al-Qaida groups.[200] As such, they serve in key leadership roles responsible for terrorist selection, training, financing and operational planning.[201] In Complexity terms, the Afghans can be seen as "autopoietic" entities who, drawing from their experiences gained in Afghanistan, have become key system agents who promulgate a terrorism strategy that they believe works. Indeed, the autopoietic quality of the Afghans is so strong that several countries have noted that with whatever success they may achieve against radical Islamic terrorism, the terrorism "regenerates itself continuously."[202]

Networks provide terrorist organizations with several operational and organizational advantages. They assist in information gathering, coordination and execution by providing a wide range of nodes to accomplish these functions. The dispersed nature of a networked organization also increases flexibility and

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[199] Bodansky, 52-53. Note: The term is also used to describe numerous other terrorists who fought in Afghanistan or received training in Pakistan or Afghanistan and who now populate terrorist organizations in many countries.

[200] Bodansky, 52.

[201] Pinto, 77-78.

[202] "Convictions Mark First Step in Breaking Up Al-Qaeda Network," *Jane's Intelligence Review,* August 2001, 50.

responsiveness.[203] The practical effect of these advantages is that al-Qaida is able to rapidly transfer and employ personnel, funds, equipment and information and intelligence to conduct operations and spread a coordinated message and propaganda throughout the world.[204] Finally, the complexity of this network, and the use of multiple fronts and names allows its various agents (terrorists, terrorist groups, state sponsors and private individuals and non-government organizations) to conduct or support radical Islamic terrorism while maintaining their deniability and anonymity.[205] In summary, radical Islamic ideology, the "Afghans", and al-Qaida's networked organizational structure has all the hallmarks of a highly dispersed controlling mechanism characteristic of complex adaptive systems.

Lesser Links and Agents

An analysis of the U.S. State Department's Appendix B in its annual *Patterns of Global Terrorism (Patterns)*, while somewhat incomplete, can provide some insights into the large web that composes radical Islamic

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[203] *Networks and Netwars: The Future of Terror, Crime, and Militancy*, eds. John Arquilla and David Ronfeldt, (Santa Moncia, CA: RAND, MR-1382-OSD, 2001), 35-39.

[204] "Terrorist Threats Target Asia," *Jane's Intelligence Review,* July 2000, 41 and Shultz, 292.

[205] Shultz, 282.

terrorism.[206] In this analysis several key elements can be discerned. First, it becomes obvious that the system is complex in that it has numerous agents and interrelationship between agents. Second, a quasi-geographical orientation can be observed that is strongly correlated with most of the world's problem areas. One author notes that currently eighty percent of the world's current conflicts involve Islamic movements.[207] Second, these trouble spots tend to be system "attractors" for the birth and subsequent operations of multiple, similarly oriented radical Islamic terrorist organizations, with Iran having a pronounced relationship with several Palestinian groups. Third, the major agent types (i.e. groups of agents that can be generically categorized at a higher level of abstraction due to shared similarities) in the web include; terrorist organizations, nation-states, non-governmental organizations including Islamic charities and banks, and unnamed private individuals. Because *Patterns* is itself a highly political document that

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[206] U.S. Department of State, *Patterns of Global Terrorism – 2000, Appendix B: Background Information on Terrorist Groups,* Office of the Coordinator for Counterterrorism, Washington D.C., April, 2001, 53-81.

[207] Laquer, 129.

changes with the diplomacy and policies of the U.S. government at the time of its writing, it understates and ignores many links and organizations that less constrained terrorist experts believe exist. Undoubtedly, many links remain unpublished in *Patterns* for security reasons. This web, limited as it is, is illustrated in Figure 5 on the next page.

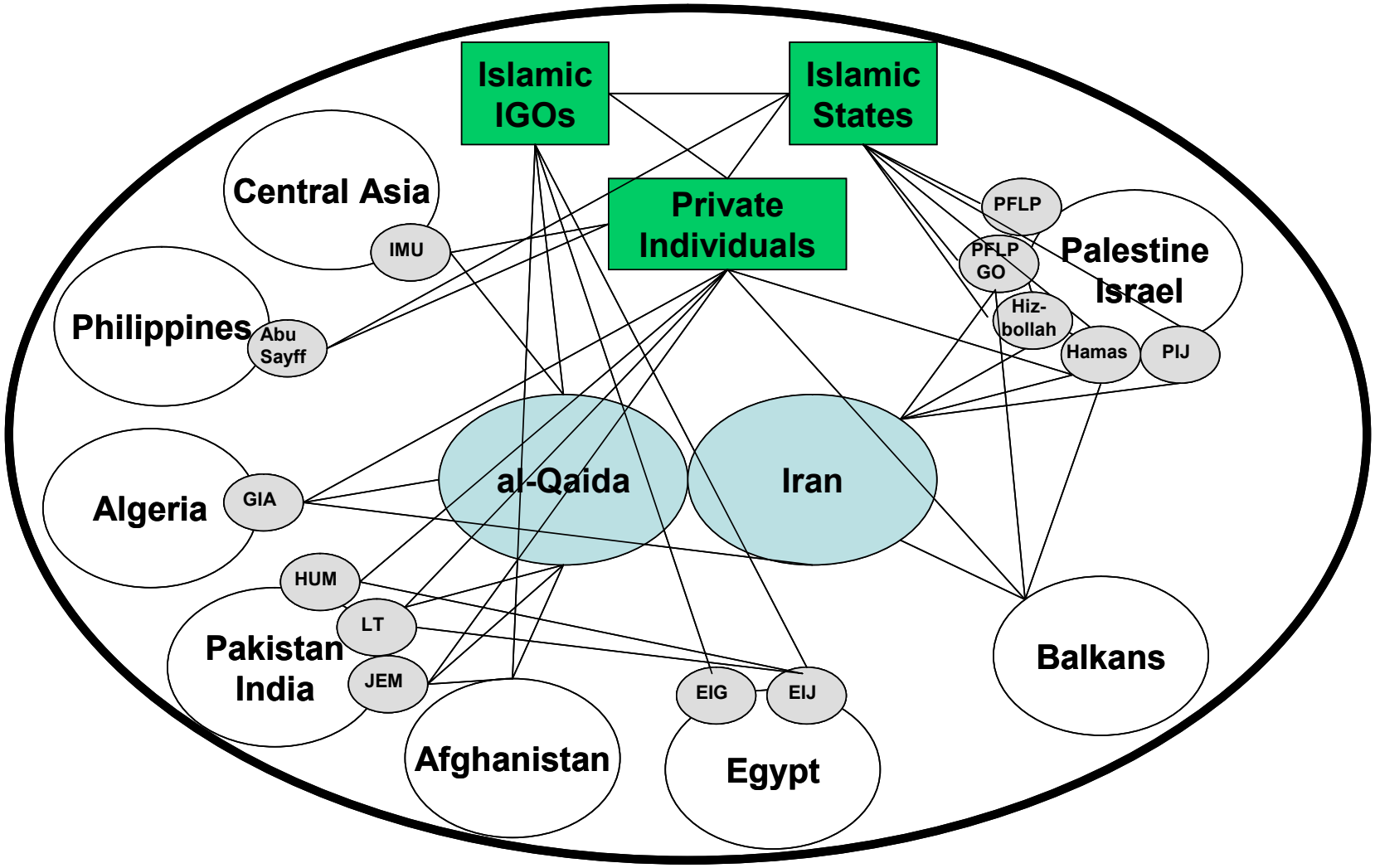

Figure 5: The Web of Radical Islamic Terrorism

Adapted from: U.S. Department of State, *Patterns of Global Terrorism – 2000, Appendix B: Background Information on Terrorist Groups*

A Strategy for Targeting Radical Islamic Terrorism

> *The world is open to experience on many levels, and we would be acting unrealistically if we claimed primacy for any one scientific paradigm over all others as a foundation for strategic thought. Each framework offers unique insights. And the art of strategy is choosing the most enlightening one for a given situation. Strategy has traditionally been described as the iron linkage of ends and means. The complexity of national security today suggests that such an Iron Age has passed, and we must develop a more encompassing definition of strategy: not simply a match of means to ends but a match of paradigm to the particular strategic challenge. It makes little sense to define ends and select our means until we have achieved an accurate representation of the reality we encounter.*
>
> —Steven R. Mann
>
> *Chaos Theory and Strategic Thought*
> *(Parameters, Autumn 1992)*

Targeting the Tactics of Terrorism and Terrorist Organizations

Previously it was posited that one could look at the process and outputs of terrorism on two levels; terrorism as a tactic and terrorism as a strategy. It was noted that this duality had important implications for targeting terrorism. One implication is that counterterrorism literature has tended to focus on defeating the tactics of terrorism rather than the strategy of terrorism. Indeed, much of the literature seems to have surrendered to the notion that terrorism is an inevitable fact of life that must be suffered through. Usually the literature also tries to downplay the threat of terrorism by comparing deaths caused by terrorists with some common malady, the message being to "keep things in perspective."[208]

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[208] Bruce Hoffman, "Re-Thinking Terrorism in Light of a War on Terrorism, (Testimony before the Subcommittee on Terrorism and Homeland Security, House Permanent Select Committee on Intelligence, Washington D.C.,

As a result of this paradigm, the literature tends to focus on methods to defend against terrorist attacks or ways to attack terrorist organizations instead of attempting a comprehensive examination with the aim of defeating the strategy of terrorism.

With regard to Complexity and the targeting theory developed in the previous chapter, there is little that either theory can add to counterterrorist literature discussing how to defend against terrorism or attack terrorist organizations. However, it is worthwhile to correlate these methods with the general approaches found in "Complex" targeting. This correlation provides an example of "Complex" targeting by applying the more generic targeting theory devoid of force, combat medium and weapon system peculiarities to a specific problem. Hopefully, this cross correlation example between specific counterterrorist measures and the theory's four general methods will make the theory less conceptual and more easily understood (See correlation in Table 6 on the following page). In addition, one can match tactical methods found in Table 6 with the web of radical Islamic terrorism found in Figure 5 to flesh out some basic targeting possibilities for radical Islamic terrorism.

Table 6 highlights several observations. First, system variety is usually attacked using military and police actions. Military actions are focused on

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26 September 2001), available from http://www.rand.org/publications/CT/CT182/CT182.pdf; Internet; accessed 19 April 2002, 1-2.

attacking and defeating individual terrorists and organizations through the use of deadly force, whereas police actions accomplish the same effect by arresting and incarcerating terrorists. Second, sanctions of various sorts are the countertactic most often used to decrease system interactions and cut terrorist organizations off from their support. Military, legal, economic and diplomatic activities assist in this area but are aimed more at severing the relationships between the terrorists and their supporting infrastructure than the terrorists themselves. Other methods in this area are aimed at preventing and isolating terrorists and their supporters from targeted countries and the international community. Finally, terrorist leadership can be attacked to eliminate their controlling influence on terrorist organizations or Information Operations can be directed at altering the terrorists' and public's perception of and support for terrorist causes.

Table 6: Counterterrorism Measures

Decrease System Variety	Military Operations – Strikes and raids Law Enforcement Activities - Arrests
Decrease System Interactions	Military Operations – Strikes, raids, and blockades against support entities Law Enforcement Activities – Arrests, legal sanctions against support entities Economic Sanctions – State supported terrorism Diplomatic Sanctions – State supported terrorism Moral Isolation Defensive Measures – Target hardening
Decrease Energy Available to the System	Law Enforcement Activities – Arrests, legal sanctions against support entities Economic Sanctions – State supported terrorism Diplomatic Sanctions – State supported terrorism Consistent Policy Propaganda/Counter propaganda

Alter System Feedback and Control	Military Operations – Leadership attacks Information Operations

Adapted from: Christopher C. Harmon, *Terrorism Today*; Jeffrey D. Simon, *The Terrorist Trap: America's Experience with Terrorism*; John B. Wolf, *Antiterrorist Initiatives*. [209]

Targeting the Strategy of Terrorism

Unfortunately, the events of September 11th, 2002 brought to the forefront a call for "rethinking terrorism" in light of the massive casualties caused that day.[210] In terms of foreign policy, rethinking terrorism lead to promulgation of the "Bush Doctrine" wherein it is U.S. policy to regard any nation that aided or abetted terrorists as a potential enemy and target for military action. Strong pressure has been brought on countries to "choose sides" in the current war and the U.S is attempting to change the international political environment to reduce or eliminate global terrorism. Thus, the time may have arrived for a strategy to defeat the strategy of terrorism.

U.S. Objectives in the War on Terrorism. Before beginning the strategy making or targeting process it is the usual practice to begin with the objectives.

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[209] Christopher C. Harmon, *Terrorism Today.* (Portland, OR: Frank Cass Publishers, 2000); Jeffrey D. Simon, *The Terrorist Trap: America's Experience with Terrorism.* (Indianapolis, IN: Indiana University Press, 1994); John B. Wolf, *Antiterrorist Initiatives.* NY: Plenum Press, 1989.

[210] Hoffman, "Re-Thinking Terrorism," 1-2.

On January 29th of this year in his State of the Union Address to Congress, President Bush gave a clear enunciation of U.S. goals in the war on terrorism. "First, we will shut down terrorist camps, disrupt terrorist plans, and bring terrorists to justice….And, second, we must prevent the terrorists and regimes who seek chemical, biological or nuclear weapons from threatening the United States and the world. Our second goal is to prevent regimes that sponsor terror from threatening America or our friends and allies with weapons of mass destruction."[211] From President Bush's statement it is clear that the United States intends to go after both terrorist organizations and supporting countries. The statement also helps us determine what the overall system is to be altered and what things are "in or out."

As noted earlier, defining what is in the system to be altered is a critical question in systems analysis. In the current war on terrorism what is in and out of the system to be changed is also a question of major strategic importance. If the object were simply to eliminate the al-Qaida system then a likely objective would be to seek out and destroy the al-Qaida system using the normal tactics approach. If, however, the system to be changed is international or radical Islamic terrorism, the strategic problem is an order of magnitude larger and will require an approach

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[211] George W. Bush, "State of the Union Address" (Presidential address to Congress, 29 January 2002), available from http://www.whitehouse.gov/news/releases/2001/09/20010920-8.html; Internet; accessed 15 April 2002.

that will defeat the strategy of terrorism. Given the breadth of President Bush's objectives, it seems clear that the United States must target the strategy of terrorism before even more tragic events occur. This thesis is an attempt to provide insights into some potential approaches to targeting the strategy of such a large and complex system.

Attacking and Destroying the Motivating Ideology. The phenomena of terrorism ebbs and flows according to ideological attractors. The attractor most common today is based on radical Islamic doctrine. From a "Complex" targeting perspective, the radical Islamist doctrine and worldview presents significant advantages and disadvantages. On the positive side, the religious nature of this worldview provides an ideology that has great appeal to many Muslims. As a result, the last two decades demonstrate that there is an abundance of young Muslim men who are willing to become Islamic terrorists and fight to advance the cause. At an individual level, the Muslim faith, supplemented by heavy radical religious indoctrination builds a sustained and deep personal commitment to the cause. In terms of the targeting theory already laid out, this ideology provides a strong signal that attracts many disparate agents to act in a certain way. Over time, the ideology has produced several charismatic and capable leaders that provide attractive model agents (e.g. Osama Bin Laden and Ayatollah Ruhollah Khomeini) for other would be Islamic terrorists.

It is clear that with if one is trying to target radical Islamic objectives the focus should be on their ideology. Of the four basic targeting approaches developed in chapter four, decreasing a system's internal interactions

is the one that provides options most applicable to affecting radical Islamists in pursuit of their objective. One possible approach is to target key radical Islamic leaders (successful agents) who are influential in the movement, are a model of behavior and as such draw adherents to them. By all accounts Osama Bin Laden is such a leader.[212] Theoretically, killing or capturing Osama Bin Laden would disrupt internal interactions and be a disincentive for others to follow in his footsteps. In fact, this seems to be the initial approach taken by the Bush Administration in its initial focus on killing or capturing Osama Bin Laden.[213] A significant agent "type" to focus on is the worldwide distribution of Afghans as they form the hardcore of al-Qaida and are usually responsible for starting or reenergizing radical Islamic groups in many countries. However, one problem with targeting agents is the ideology that motivates radical Islamists is compelling enough that it is likely other charismatic leaders might simply fill their places.

In addition to attacking Osama Bin Laden and the Afghans, two other potential targeting options aimed at defeating the internal interactions of radical Islamic terrorism exist. The first is attempting to alter the signal of radical Islamic ideology that attracts Muslim recruits and support throughout the Islamic world, while the second is making a deliberate attempt to alter the conceptual space in which this radical ideology operates. In both cases the target is the

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[212] Bodansky, 28-57.

[213] Bob Woodward, Dan Balz and Washington Post Staff Writers, "We Will Rally the World," *Washington Post*, 28 January 2002, p. 1.

Muslim mind. A direct approach would be altering the signal via information or possibly kinetic operations undertaken to replace the message with something else and/or eliminate signal broadcasters. From a political and ethical standpoint, dispatching radical Islamic clerics is not likely a viable option for U.S. forces. However, a place of focus that is probably critical to long-term success is altering or providing a more benign alternative to the radical Islamic religious schools (madrassas) so prevalent in the Muslim world. Some of these schools play a key role in radicalizing young Muslim men.[214] While it is unlikely that anyone could eliminate an educational system that has existed for centuries, one could target the most radical educators and promote and support more modern alternatives. Another signal to be targeted is Iran. It is generally recognized that after the Shah's overthrow in 1979, Iran has been the leading country in supporting and

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[214] U.S. Department of State, *Pattern of Global Terrorism – 2000, Asia Overview,* Office of the Coordinator for Counterterrorism, Washington D.C., April, 2001, 9.

Since 9/11 the newspapers have been filled with stories on the impact of madrassas in radicalizing young Muslims in Saudi Arabia, Egypt, Pakistan and many other countries in Asia. While these schools are strongly supported by the majority of Muslims, it is now being recognized that more secular education is required if these schools are to prepare young people to be successful and productive citizens in the modern world.

propagating radical Islamic ideology.[215] The U.S. may want to give consideration to overthrowing the government unless Iran's support for radical Islamic groups is halted. The idea here is to halt the behavior through signal destruction or extend an opportunity to Iran to cease transmission before being taken off the air anyway.

A more indirect approach is to attempt to restructure Muslim conceptual space by increasing the amount of interaction between Westerners and Western ideas with Muslims and Islamic ideas in hopes that a more mutually acceptable worldview will emerge. At a time when the United States may be inclined to withdraw from the Middle East, the exact opposite might be called for. One author captures this idea as follows: "Conflict energy reflects the goals, perceptions, and values of individual actors—in sum, the ideological software with which each of us is programmed….To change the conflict energy of peoples—we need to change the software."[216] If the Cold War example cited earlier provides any lesson for the current war on terrorism, it might indicate that at one level, the war will eventually be decided upon whether or not radical Islamic groups are successful in blocking Western interactions with the Islamic world or whether the West is successful in maintaining and expanding them. However, one of the challenges to increasing interaction between Muslims and

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[215] Kenneth Katzman, "Terrorism: Near Eastern Groups and State Sponsors, 2001," *Congressional Research Service Report for Congress*, 10 September 2001, 25-26.

[216] Mann, 65.

the West is that the results can not be predicted and in some cases may be negative. On one hand, increased Western penetration of the Middle East has resulted in many Muslims having more Western ideas and a favorable opinion of the West. On the other hand, it is a well know fact that many radical terrorists are middle or upper class Muslim men who have had extensive exposure to the West.

While the above options targeted internal interactions, one can also take actions to affect radical Islamic ideology by targeting the external interactions of those associated with it. One option is for the United States and interested allies to tie political and economic relations to a country's support for radical variations of Islam similar to what was done, and is still being done, with regard to a country's support of communism. Moderate countries such as Turkey, Malaysia and Morocco should be treated favorably and actively supported in their attempt to build modern, prosperous economies and political institutions. Meanwhile, countries affiliated with more virulent strains of Islam should be assessed for continued political and economic support. The intent here is to reinforce the idea that moderation and accommodation in Islamic ideology has tangible benefits and is therefore a better strategy.

Where are the targets? The discussion of targeting the strategy of radical Islamic terrorism has little to offer in the way of military options. Indeed, that is one of the main findings of this analysis. As noted several times in this work, defining where system boundaries should be drawn is one of the most critical analytical and target analysis decisions that can be made. Given stated

U.S. goals for the war on terrorism, America has circumscribed a very large system indeed. It is a system that, for the most part, is driven by a determined and deeply felt dedication to radical religious principle possibly fostered by a reaction to unacceptable local political, social or economic conditions. If one is to adhere to Carl von Clausewitz's dictum that "the supreme, the most far-reaching act of judgment that the statesman and the commander have to make is to establish by that test [of motives and situations] the kind of war on which they are embarking; neither mistaking it for, nor trying to turn it into, something that is alien to its nature,"[217] then radical Islamic terrorism must be seen for what it—a highly compelling form of ideology that is in direct opposition to Western values.

There were two great ideological battles in the 20th century, and perhaps the first one of the 21st century has just been entered. When confronting the two major ideological challenges in the 20th century, fascism and communism, the victory was secured only when the ideology was destroyed. In the case of World War II, the physical threat was so great that world war ensued and the offending ideology was purged by war and occupation of the offending countries. In the case of communism, war was mainly avoided due to mutual constraint imposed by the fear of nuclear weapons. In the end, a long-term commitment to containment, internal economic failure, and subsequent collapse of the ideology itself led to its defeat. However, as Complexity emphasizes every situation is different and has its own dynamics. In the current war a powerful-networked

[217] Clausewitz, 88.

organization is faced that has only elements beholden to the prerogatives of a nation-state, yet has the potential to acquire and use weapons of mass destruction (if they already haven't). As a result of the peculiarities of this situation, it appears the United States does not have a good historical model to bring forth for use and comparison, but perhaps the enemy has an even harder time finding supporting historical analogies. Thus, if one looks at the epic ideological battles of the last century, and if the Complexity-oriented analysis has any merit, it is important to remember that the primary target in this fight is against radical Islamic ideology and not the terrorist trappings thereof.

Analytical MIAs.[218] Radical Islamic terrorism, for the most part, is driven by a determined and deeply felt dedication to radical religious principle possibly fostered by a reaction to unacceptable local political, social or economic conditions. However, "for the most part" and "unacceptable local political, social or economic conditions" amount to large gaping holes in the analysis. What this Complexity-based analytical framework suggested was terrorism in its various forms evolves with emerging ideologies and that ideology is an attractor that shapes the current form of terrorist organization, tactics, and strategy. It also points out that ideology serves as a measure of relative fitness by its practitioners and a signal to its current adherents and potential followers. This signal is manifest in leading agents who also are an attracting element for the ideology's

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[218] MIA: A reference to soldiers who are missing as a result of combat actions.

followers. All of this helps to establish and maintain a system whose common efforts are oriented toward achieving the ideology's goals. The targeting implication, then, is that *the ideology is the real target*. In coming up with the above analysis the critical question that remains unanswered is: "Why is this particular ideology popular?" This fundamental question leads to many other sub-questions which would help one to get at the roots of the problem. Is there an economic problem such as poverty or, perhaps, a political problem such as wide-spread corruption? How about social problems such as repression, class or ethnic tensions? Then of course one could go into the specifics of why certain individuals are joining terrorist groups related to the ideology. In short, reductionism would fill in the picture and help to answer, "Why?" Indeed, it may be that "Why?" is the most important question of all.

Chapter 6

Conclusions and Implications

The exertions which a nation is prepared to make to protect its individual representatives or citizens from outrage is one of the truest measures of its greatness as an organized state.

—Sir Winston Churchill

Memorandum to the Government, September 3, 1918

Review

This thesis set out to develop a targeting theory based on the principles of Complexity. The reason for this method was that Complexity seemed to be a theoretical model that fit the subject of radical Islamic terrorism. Preparatory to developing the targeting theory, Systems, Chaos, and Complexity terminology and key concepts were examined and several concepts noted to highlight the unique insights that are part of these analytical paradigms. Among the most basic are that systems are human constructs and that oftentimes the mere fact of one system observing another forms yet a larger system (e.g. CNN effect). Chapter three discussed how concepts regarding nonlinearity, Chaos and Complexity have found their way into many disciplines, to include the military. I then developed some of my own ideas along these lines. Chapter four is the heart of the thesis and laid out a targeting theory that is patterned after Sir Julian Corbett's naval theory found in *Some Principles of Maritime Strategy* and also heavily influenced by Robert Axelrod and Michael Cohen's *Harnessing*

Complexity. I reversed engineered two concepts in Axelrod and Cohen's book, *variation* and *interaction,* to come up with a targeting theory that focused on four methods that could be used to affect a system. These methods are: decrease system variety (agents/artifacts), decrease system interactions, decrease energy available to the system and alter system feedback and control. Within each of the four methods several targeting techniques were also discussed to provide additional illumination on various ways a system could be affected to drive it into collapse or reduce its capability to respond. Thereafter, "Complex" targeting was applied to the issue of terrorism, and more specifically, radical Islamic terrorism.

Conclusions

The first major conclusion was noted in the introduction to chapter two and was constantly reinforced throughout the thesis. Simply put, Complexity is a helpful analytical paradigm that highlights certain aspects of an issue that are not emphasized in reductionist methodologies. Accordingly, the benefit of Complexity is that it provides an alternative method from the normal reductionist Newtonian model to assist us in understanding a phenomenon. This does not necessarily mean Complexity is a better model, but it is a different one that can be used to provide illumination of aspects of a problem one might not contemplate otherwise. In short, its main value is to help describe and explain things.

Another conclusion, though not discussed extensively, was the USAF's relative backwardness in understanding systems theoretical developments. Essentially, any official discussion of a target system is based on

concepts having their origins before the Air Force existed as a separate service. It would seem an update incorporating the past fifty years of theoretical development would be helpful in improving the training of USAF personnel engaged in the targeting process and is highly warranted.

A third conclusion is that nonlinearity is a fact of warfare. Many military-oriented writers have emphasized this fact, and as a result, nonlinearity and associated theoretical concepts (i.e. Chaos, Complexity) have found their way into military history, theory and doctrine. The fact of nonlinearity is one that has major import for our thinking across a whole range of subjects and nowhere more so than warfare. Nonlinearity means that long-term prediction is nearly meaningless, that strategy making is an interactive process that constantly evolves, that the ability to control things is probably much weaker than many would like to believe, and that every war is different so one must not over rely on history. It also means that one should beware of simplistic cause and effect thinking in both theory and practice. Finally, nonlinearity means one should not become overly sanguine in their perceived ability to "make things happen." In short, nonlinearity means uncertainty.

Implications

If one accepts Complexity as a valid theoretical construct, then several important targeting implications follow. The first is that the actions of micro-level actors can add up to macro-level effects. Thus, within radical Islamic

terrorism, it was asserted that the system is composed of many different groups who would probably act in the same way regardless of leadership. The system formed as result of a common dedication to radical Islamic theology and its objective of instituting Sharia rather than from some strong central controlling entity. This is not to say terrorist groups do not have leadership or people who control them, because they do. What it does mean is that the effect of destroying command and control is not likely to last very long and that any actions taken to effect feedback and control of the larger system must be aimed at a broad audience.

Another implication is that *strategy* is based on what has worked in the past and evolves, and in a more general sense, it means strategies are learned behaviors. As argued above, conceiving strategy as a learned behavior has major targeting implications. From a targeting perspective the real focus then becomes one of defeating the behavior rather than targeting the system. Usually military strategists are much more attuned to attacking *things* in a system, rarely do we think of attacking *the strategy*…except when reading Sun Tzu. With regard to radical Islamic terrorism, the targeting focus then necessarily becomes one directed toward destroying the perception that radical Islamic ideology is a successful response to conditions in the modern world. Using "Complex" targeting, several possible methods were discussed regarding how this might be accomplished. As ideology is the real target, not surprisingly, the military has only a partial role in defeating the strategy of radical Islamic terrorism vice the tactics of radical Islamic terrorist groups.

It was also noted in chapter two that highly successful past strategies are oft repeated and are hard to kill off. Therefore, somehow the West must overturn the successful examples that inspire radical Islamic terrorists which were engendered by the Shah's overthrow in Iran and the Mujahideen in Afghanistan. The Bush Doctrine is a step toward this goal in that it attempts to change the international playing field of terrorism. However, even as this sentence is being typed, one wonders if the clarity of this doctrine is not being watered down in the administration's approach to the wave of Palestinian homicide bombers and Israel's military response. Terrorism is used because it works. Thus, the question becomes: "Are not we demonstrating that terrorism *does* work when we respond politically to Yasser Arafat?"

Final Thoughts

The opening citation of this chapter was a challenge issued to His Majesty's Government in the closing days of World War I and one that has been accepted by the United States and several allies around the world in the war on terrorism. A review of terrorism's modern history is frightening. It is one of ever increasing horror and lethality with an affinity for compelling political movements and ideologies. Terrorism is a problem that the events of September 11th moved from major irritant to the forefront of national tasks. However, putting on my "complex adaptive system" spectacles from which to view radical Islamic terrorism, I am encouraged by our requisite variety. As we learned, greater variety destroys lesser variety and while not discussed in the thesis'

previous chapter on terrorism, the history of terrorism also points out that determined governments defeat terrorists far more often than the other way around. We certainly have the means to do it, but the deciding factors are our will and the clarity with which we view the problem.

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