The Art of War, Nonlinearity, and Coping with Uncertainty

A Monograph
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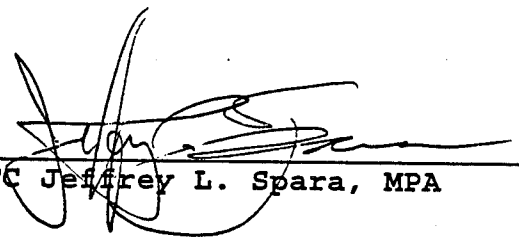

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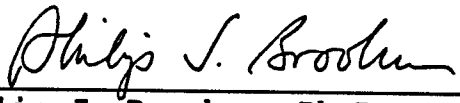

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ABSTRACT

MILITARY ART, NONLINEARITY AND, COPING WITH UNCERTAINTY
by MAJ Gary L. Walters, USA, 46 pages.

This monograph offers a definition of "military art," discusses military art's relationship to the commander's management of battlefield uncertainty, and uncertainty's relationship to nonlinearity. Using the terms of art, uncertainty, and nonlinearity, the monograph builds a model of military art not only linking these terms, but also putting the terms in relation to US Army doctrine through the use of the battlefield operating system (BOS) Command and Control (C^2).

The context for the model of military art is the context of war, specifically Clausewitz's elements of war: danger, exertion, chance and uncertainty. In building the model, and applying Clausewitz, the monograph also offers definitions for the terms, "chance," "fog" and "friction." Additionally considered and incorporated into the model of military art are the terms "intuition," and "vision."

The monograph concludes that military art is the commander's skill as guided by the principles of war in using military means for the attainment of an endstate. Military art begins where military science ends. It is characterized by "synthesis," "judging," and "creativity." As military science is the practice of reducing battlefield uncertainty, military art is the practice of coping with battlefield uncertainty. The military artist's principal virtue is that of intuition, a virtue firmly grounded in experience and education. The principal manifestation of military art is vision, marked by the command's abiltiy to agree upon its endstate and the methods of that endstates acquirement.

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Section 1. Introduction.

> *There are only two sorts of soldiers: old ones and young ones. I've served fourteen years: half of your fellows never smelt powder before. Why, how is it that you've just beaten us? Sheer ignorance of the art of war, nothing else. I never saw anything so unprofessional.*
>
> *George Bernard Shaw, Arms and the Man, Act I (1894).*

These pages begin with the proposition that most military students do not know what they mean when they say "military art." This statement is not intended as revelation, or even much as criticism, but more as a curious assertion. It is curious because our professional language is permeated by the word "art," such as in "operational art," "Professor of Military Art and Science," or, as in FM 100-5, that "command is more an art than science." This imprecision is made more curious by the Army's usually strong desire to be exact in its definitions. [1]

Official sources help little to clarify the term. No definition of either "art," or "science" may be found in FM 100-5, the Army's capstone doctrinal manual, or in FM 101-5-1, the terms and symbols manual, or for that matter anywhere else in doctrinal literature. It seems that by the time the military student puts his mind to the study of military art, the terms "art" and "science" are presumed sufficiently clear and differentiated to preclude the need of further definition, and that however general those definitions might be, that they are easily translated into military studies. Nevertheless, it is an assumption of these pages that the term "military art" deserves more than a short definition, that we have not properly explored its concept, and that it does matter.

We begin, then, with a short, very general definition of "military art" that can be quibbled with. It is a very slightly modified definition of the word "art" taken from Funk and Wagnall's: *"Practice as guided by correct principles in the use of [military] means for the attainment of a desired ends[tate]."* [2] Not bad, but if the above paragraphs began by stating that we were going to examine the *science* of war and then offered the same definition, how many readers would accept it without much grumbling? If we inserted the word "scientific" in front of "principles," how many readers would object at all? Our profession takes a unique view of itself, not only claiming that rigorous study applies, but at the same time that that study is both art and science. Indeed, we are the only profession that offers a Masters degree of *Art and Science* (MMAS).

Of the two terms "art" and "science," the latter is better understood by our profession. We have formulas for calculating convoy operations, for all manner of engineering, computer programs and state of the art communications systems for worldwide command and control. We have ballistics computers aboard tanks, laser range finders, sattelite-based location finding systems, to name only a few of the highly technical devices that are clearly and directly predicated on science; that is, these are all areas that can be quantified. And with that, we pause long enough to define science: *A methodological activity, discipline, or study based on experience that results in knowledge.*[3]

As a profession we are comfortable with quantification, not only in regard to these more technical examples, but also in less concrete areas as illustrated by our fondness for relative combat power tables and force ratios when comparing

courses of action in the command estimate process. Yet even though we are more comfortable with science and quantification, we recognize that science accounts more for isolated, mostly independent operations within the overall larger scheme of military applications and is limited when it comes to smoothly blending all aspects of the profession into a cohesive whole. We appear to reserve this "higher-order," synthesizing function to the realm of art.

The purpose of this monograph is to assist the military student to better understand what he or she means when they say "military art," even if it is to do no more than formulate an argument against the position in these pages. The thesis of these pages is that in military operations art is the skill with which we manage uncertainty on the battlefield. Uncertainty is prevalent on the battlefield because the nature of war is nonlinear, resulting in a multitude of complex problems. They are complex because battlefield events are the products of an unquantifiable number of variables, infinitely interacting with each other in a dynamic system--war. The solution set for war will not graph to a straight line, but will be nonlinear and in the main unpredictable, and have implications for the profession.[4]

This monograph proposes that the art of war is nonlinear and synthetic, while the science of war is linear and analytic. Some will argue that US military theory and even action already include nonlinear thinking (or put another way that war is unpredictable), and they will be right to a degree. It is by degree that this monograph will differ with current practice. Though we have examples of nonlinear thinking in our theory and doctrine, there is evidence, too, that we have not carried nonlinear ideas as far as we ought to, and certainly not as far as

we can.[5] We can especially broaden our perspective on war by considering the metaphorical aspects of nonlinear thinking. Our view of the world is highly mechanistic, that is, linear, even though we know that reality, including war, are highly nonlinear activities.

In other words, this monograph will seek to show that when the military profession utters the word "art," it does so in a way that directly links the utterance with nonlinear thinking, further, that this is the right approach to the "art and science" of war, but that finally we have not carried this "nonlinear thinking" to its logical conclusions. This monograph will also explore, however briefly, terms related to art, such as "vision," "coups 'd oeil," "fingerspitzengefuehl," "intuition,'" and "genius." This monograph avoids ideas such as "the art of war is ineffable," "that leaders are born, not made," and any other such related concept that suggests a "mystical" quality to art. These terms and ideas will be discussed further in Section 3.

The timing for exploring the nonlinear quality of military art, and for suggesting its emphasis, seems right. Operations other than war, which dominate current US military operations (and areas of study), are obviously less linear than a world formerly divided down the middle of Europe. Our world is rather now beset by a host of smaller conflagrations on quite literally every continent. In a world system that is increasingly more complex, nonlinear thinking and solutions will be increasingly more necessary.

Following this introductory section will be a short section defining the concepts of "linear" and "nonlinear" and especially their relationship to military

operations. Section 3 will then examine some of the terms mentioned earlier in this section, and construct a framework which relates these terms to art, science and US military doctrine. Section 4 will follow showing how our traditional view of many important areas have been linear, and how a shift, large or small, toward a nonlinear viewpoint might be different and better. Finally, the last section concludes with a refined definition of art.

Section 2.. Linear and Nonlinear Defined

A work of art that contains theories is like an object on which the price tag has been left.

Marcel Proust (1871-1922) French novelist[6]

Nonlinear research and thinking has pervaded the sciences in recent years, and while the results of some of this thinking have made their way into the military scientific community (such as in operations research), it is less clear that we have fully explored the modeling and metaphorical aspects of nonlinearity. Our view of war is generally mechanistic (or linear). Newton wrote the laws that we apply to the daily conduct of battle and war, but in many cases these laws apply strictly as metaphors, allowing us to reduce complex concepts to manageable and relatively predictable terms. This is of course more good than bad, and we hope Newton will not be wholly overturned anytime soon. Yet we know that many of the events and activities in battle and war that we apply linear concepts to, really are not linear at all, but highly nonlinear, just as we know theories of relativity and quantum physics have gone beyond classical physics in explaining the complexities of everyday life.

So the crux of the matter is that at one extreme, we shoot a bullet along a line and it hits a target doing essentially predictable damage. We know how the weapon works and we have ideas about how to train a soldier to shoot it straighter and faster. We put larger numbers of these trained soldiers with their weapons on the battlefield and we receive increasingly greater effects. At the other extreme is that war is unpredictable; it is shrouded in chaos, confusion, smoke and general mayhem. We really do not know how it will turn out. So which is it? Obviously, neither view is entirely acceptable, and we must find ways to balance the two extremes. Currently, we are a highly linear thinking organization. We would be well served to introduce more nonlinearity to our thinking toward every aspect of war.

The importance of linearity versus nonlinearity in relation to our conceptual framework may at first seem overstated. When hearing the term "linear," most will initially think of the battlefield framework which is composed principally of close, deep and rear operations, with the mind drifting naturally to the forward *line* of troops (FLOT). But many readers will note that even FM 100-5 states that this is just the "preferred" battlefield architecture, implying that there are others.[7] We usually use linear or nonlinear in this battlefield framework context. But this is only one element, albeit an important one, of the larger issue involving linearity and nonlinearity. What is meant here by linear or nonlinear is bigger than the battlefield framework; it is the borrowing from science and mathematics as a metaphor the concept of linear and nonlinear operations. In mathematics linear operations are mechanistic and determinable. Nonlinear operations are dynamic, involving feedback, and chaotic conditions that resist reduction to mathematical

equation. Nonlinear operations are not deterministic. But here, too, readers might respond that our theory and doctrine are full of nonlinear thinking.

Consider Clausewitz' concepts of fog and friction, they might say, or of how we are fond of saying how war is unpredictable. And what do we mean by simple expressions such as "War is hell"? These are expressions resulting from a nonlinear view of war. Why does FM 100-5 state that war is more art than science? Of course there is more than a grain of truth to the notion that nonlinear paradigms already exist in our thinking. Recent efforts to formalize abbreviations to the command estimate process, and challenges to the traditional battlefield framework are just two. Having vaguely introduced the idea of nonlinear thinking, the following paragraphs are devoted to clarifying the difference between linear and nonlinear thinking, and to the implications of favoring one or the other.

Linear and nonlinear operations can be essentially distinguished from each other by their conformity or not to the two basic rules which constitute a linear operation. In half military, half mathematical terms, as one calculates a series of "events" to reach an endstate, first, any small error in any of the calculations will yield a small difference in the endstate; and second, if one totals the calculations of a series of events, they will add up to the endstate, no more, no less. Formally and respectively, these concepts are known as proportionality and additivity.

The first rule of linear operations, additivity, is simple: the sum of the parts equals the whole. Proportionality is only a little more difficult and a simple illustration will suffice to make it clear. If it takes a truck two hours to travel a route, and it is scheduled to depart at 1000 hours to arrive at 1200 hours, a departure time of 1010 hours will result in the truck being ten minutes late,

arriving at 1210 hours. The affect of beginning ten minutes late has a proportional effect on the result. For a more complex linear example simply consider the calculations that go into a military convoy computation, in which multiple factors are considered such as numbers of serials and vehicles, speed, interval, choke points, grade, halts, and so forth. Changes in one or all of the above, yields varying but determinable changes to the calculations overall. These types of linear computations are useful, and we are generally comfortable in making them.

Nonlinear operations are more complex than linear operations and far less "comfortable." They are dynamic and violate both the laws of proportionality and additivity. A small change in any of the computations can result in large changes in the result, and the sum of the parts may be more or less than the whole. We allude to the concept of nonlinearity when we use language such as, "synergistic effects," and "the simultaneous application of complementary capabilities." In a nonlinear world it is possible for the truck to leave ten minutes late and never be seen or heard from again. In a nonlinear world the convoy is strafed by enemy air, ambushed by guerrillas, makes wrong turns, experiences breakdowns, and arrives a day late with half its payload, and no one did or could have predicted that it would happen quite that way.

A further and slightly more complex example is provided by the military theoretician Hans Delbruck. It was Delbruck's contention that tactics, strategy, and politics were not abstractions that could be independently manipulated, but were inextricably intertwined and a change in one "fed back" into the "system," resulting in changes in the other two as well. Delbruck wrote,

> The recognition of the interrelationship between tactics, strategy, the constitution of the state and policy reflects upon the relationship

> [between military history and] world history and has brought to light much that until now has been hidden in darkness or left without recognition.[8]

"Over the top" tactics in World War I, for example, resulted in shifting attitudes toward losses, serving not only to change strategy and political goals, but in "feeding back" through the system of war, changed the tactics as well.

History is replete with tactical examples that reverberated throughout the levels of war and into other parts of the political system. The atrocities at My Lai during Vietnam is one relatively small tactical example that grew large in the American public's eye, becoming one more symbol of the public's disaffection with the war, and helping to shape future events ranging from when a country should use military force, to applicable rules of engagement the next time a patrol entered a Vietnamese village. A more recent, if less poignant, example is provided by the soldiers in Macedonia and the accompanying scrutiny with which they are watched. The potentially far-reaching effects of a single misstep by just one of those soldiers need not be elaborated. Neither does it take much imagination to discern the difference this scrutiny makes to the methods employed by a soldier at a roadblock somewhere in the mountains of former Yugoslavia. According to Delbruck the whole system is interlinked and dynamic. And while Delbruck was more interested in that the components of tactics, strategy and politics made a system, than in the difficulty of making nonlinear calculations, the implications are, nevertheless, easy to extrapolate. The systems of war in the main are nonlinear, that is, nonproportional and nonadditive. Unfolding events and the consequences of actions are difficult if not impossible for us to calculate. Or in platitudinous terms: "Uncertainty is certain."

In fairness to Karl von Clausewitz, still our premier theoretician of war (since the thrust here is that we are too linear), it should be said that he understood well the nature of nonlinear operations even if he never used quite that expression. Alan Beyerchen discusses just this subject in an article entitled, "Clausewitz, Nonlinearity, and the Unpredictability of War," in which Dr. Beyerchen convincingly demonstrates the nonlinearity (and thus sophistication) of Clausewitz' thought in *On War*.[9] One example of Beyechen's demonstration is that,

> Clausewitz argues, for "the same political object can elicit differing reactions from different peoples, and even from the same people at different times.... Between two peoples and two states there can be such tensions, such a mass of inflammable material, that the slightest quarrel can produce a wholly disproportionate effect--a real explosion." Note the nonlinear image of combustion, and the view that the prevailing political conditions rather than the intended "politic object" constitute the parameters that determine fundamental regimes of behavior in the system. The emphasis on the changeable political context also contrasts sharply with the view held by many theorists (then and in our own time) that the parameters of war must be readily quantifiable military categories such as logistical factors, characteristics of weaponry, etc.[10]

But even if war is more nonlinear than linear, so what? What are the implications for the future, and how should we change the way we presently think about and prepare for war? One of the points of a nonlinear metaphor is the demonstration that calculation and prediction are difficult, and it would seem to the degree that persons adopt a nonlinear view of war, they forego traditional ways of theorizing about war. Yet, it only seems so. This is not a case of throwing the good out with the bad. Most of our mechanistic viewpoints and methods are safe for the moment, and probably rightly so. After all, this writing does not come on the heels of a series of military failures or even just one, and the imminent collapse of the American military machine does not loom on the near horizon.

It was, however, only recently that the director of the Army's School of Advanced Military Studies (SAMS) lectured on the subject of strategic surprise and how such a surprise would more likely result from bad theory or doctrine than a particular military action or inaction.[11] It is in this vein that the nonlinear metaphor is explored; it challenges the more traditional linear approach at a time that seems highly appropriate. World disorder prevails as advances in information systems and technology accelerate us toward international unity, while at the same time the end of the Cold War contributes to fragmentation locally and throughout what we used to call the Third World. It is a nonlinear, complex, unpredictable, and uncertain world. Just the formal consideration of a nonlinear metaphor will expand the commander's view and sharpen his vision.

Section 3. The Terms and a Model of Military Art

> *There is no "science" of war, and there will never will be any. There are many sciences war is concerned with . But war itself is not a science; war is practical art and skill.*
>
> *Leon Trotsky*[12]

Art or Science?

According to Clausewitz war is neither art nor science--it is an act of human intercourse. Though he did tell us that "art of war" is more appropriate than "science of war," he denied war the category of art because of an essential difference:[13]

> [W]ar is not an exercise of the will directed at inanimate matter, as is the case with the mechanical arts, or at matter which is animate but passive and yielding, as is the case with the human mind and emotions in the fine arts. In war, the will is directed at an animate object that reacts. It must be obvious that the intellectual

codification used in the arts and sciences is inappropriate to such an activity.[14]

Clausewitz goes on to say that rather than comparing war to art, we might do better comparing it to commerce. Clausewitz's view aside, the view here is that all human endeavor, beyond the mundane, can be accounted for by either art, or science, or some combination of the two. In the same Book 2, Chapter 3, Clausewitz further makes the distinction between art and science, stating that where perception and premises end (science), is where judgment and art begin. This is a useful approach, corresponding to the differentiations previously made between linear and nonlinear, and analysis and synthesis. Figure 1 shows the relationships of various concepts to art and science.

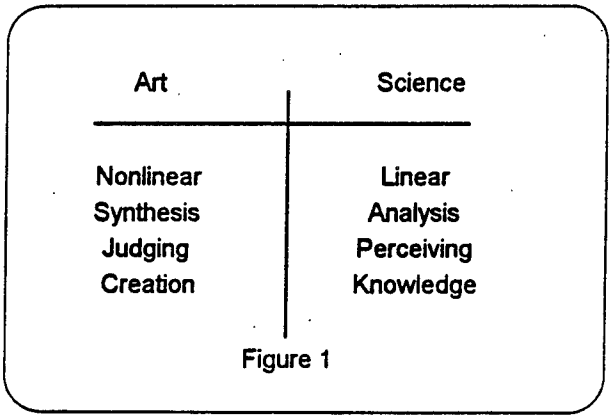

Figure 1

C. P. Snow, the English novelist and physicist, defined "judgment" as the "ability to think of many matters at once, in their interdependence, their related importance, and their consequences."[15] This agrees well with the view of art as management of the nonlinear world, and also well with what the military commander does on the battlefield. War, then, to answer the question that began this subsection, is both an art and a science, with the former being the higher level function. In von Moltke's expression, war is not an exact science, but a

> matter of understanding a constantly changing situation at every moment, and then doing the simplest and most natural thing with energy and determination. This is what makes war an art, an art that is served by many sciences.[16]

The object here, notwithstanding Clausewitz's willingness to live with ambiguity, is to eliminate the intermediate zones created on a continuum of art and war, by making art preeminent in an hierarchical order.

Coup 'd oeil, Fingerspitzengefuehl, Intuition, and Vision

This subsection addresses a few of the more salient terms associated with military art. Their definitions, differences and relationships help to clarify military art as the management of the nonlinear.

We begin with the contentious assertion that the concepts represented by "Coup 'd Oeil," "fingerspitzengefuehl," and "intuition" are the same. "Intuition" properly captures all the meanings that we allude to with the other two terms. There is no difference at all between *coup 'd oeil* and intuition, and, at best, *fingerspitzengefuehl* is but a particular application of intuition. Though there are endless nuances that one might inject into his or her use one of these terms, there is no meaningful universal distinction that others could not just as easily incorporate into their definition of one of the other terms. In short, there is no basis for differentiation between *coup 'd oeil* and intuition, and there is minimal and confusing basis for distinction between intuition and *fingerspitzengefuehl*. First, we consider *coup 'd oeil* and intuition.

Clausewitz put the French term "coup 'd oeil" into our jargon, so perhaps On War is the best place to go for a definition. Coup 'd oeil is "an intellect that, even in the darkest hour, retains some glimmerings of the inner light, which leads to truth."[17] This is highly poetic language as Clausewitz knew. It is also the

definition that some might use to attach virtually any quality they please to *coup 'd oeil*; after all, a term such as "inner light" is vague. Clausewitz did not leave the definition hanging so figuratively. At the end of the next paragraph, he writes,

> [Coup 'd oeil], stripped of metaphor and of restrictions imposed on it by the phrase ["oeil" means "eye"], the concept merely refers to the quick recognition of a truth that the mind would ordinarily miss or would perceive only after long study and reflection.[18]

With this last definition of *coup 'd oeil* in mind, we consider Webster's definition of intuition: "The act of process of coming to direct knowledge or certainty without reasoning or inferring."[19] The "process of coming to direct knowledge" equals Clausewitz's "quick recognition of a truth."

Even if we agree that "intuition" equals "coup 'd oeil," we still have not said what exactly accounts for it. That is, we must explain what one is doing when he is quickly recognizing the truth. The explanation is important. If the skill is innate, then there is nothing to be done but develop methods for identifying who has it and who does not. If the skill is developed, then we must design systems for training it.

As said earlier, this monograph rejects that there are "mystical" qualities involved in military art, and this seems to agree with institutional prejudices, such as leaders are made not born.[20] To completely answer the question of from where does intuition come, we would have to explore theories of brain functions and cognition, of which many exist, and for which there is little time in a paper of this length. We will consider instead one rational explanation of what some would call the irrational function of intuition. The great value in taking a rational approach is that it potentially has practical implications. If one relies on intuition to some

degree in war, and if intuition itself is rationally explainable, then there ought to be ways, as we have said, to develop or improve it. Karl Albrecht, a professor of psychology at the University of California, provides one rational explanation:

> We can consider preconscious thought to be the primary form of the brain's activity, from the point of view of information processing:. Countless preconscious thoughts go on routinely, with very few of them having enough significance to warrant projection on the special "viewing screen" of conscious thought, that is, of being expressed in words, mental pictures, and/or kinesthetic sensations associated with the words and pictures. The innumerable perceptions, associations, decisions, and logical processes involved in routine preconscious problem solving and motor activity do not generally warrant such conscious inspection. But when one of these preconscious thought is important enough, your brain maps out a verbal version of it in the cortex that it can deal with. The conscious thought thus formed is obviously not the same as the preconscious original thought. It is a "translation" of that inexpressible thought into a crude symbolic form, namely a linear sequence of words. By a process which scientists have fairly well traced in the brain, certain electrical thought patterns originating at lower levels--even as low as the cerebellum and portions of the brainstem--get transferred to appropriate regions of the cortex, which reorganizes them into verbal form. This is my proposed model of how preconscious thoughts lead to conscious thoughts. I believe it may also be the mechanism for those thought processes we refer to as "hunches" and Intuitive flashes."[21]

The relationship between art and intuition is central, especially military art and its address of the nonlinear in war. Intuition is one of the more complex mechanisms we have in coping with the problems presented by the innumerable variables rapidly interacting with one another on the battlefield. Intuition is the faculty that associates countless previous experiences and provides the "data" that the commander uses to reach rapid, cogent battlefield decisions, especially when time is not available to use even an abbreviated version of the command estimate process.

Related to intuition and *coup 'd oeil* is *fingerspitzengefuehl*. The German word means "fingertip sensitivity," and as applied to military operations has been used recently in two ways. Lieutenant General (LTG) Funk, in an article on Battle Space, writes about General Abrams' ability to "just know" on the battlefield and that "such maneuvers in the face of enemy opposition call for a special touch, what the Germans call a Fingerspitzengefuehl."[22] So for LTG Funk *fingerspitzengefuehl* is the "touch" with which one makes combat decisions in the heat of battle. A second example of *fingerspitzengefuehl* is offered by Donald Chipman in an article entitled "Clausewitz and the Concept of Command Leadership": "Field Marshal Rommel's biographer said the general possessed fingerspitzengefuhl, an innate sense of what the enemy was about to do."[23] Making decisions in the heat of battle and knowing the enemy's next action are, of course, related ideas. Both are examples of intuition, but just examples of intuition and not special cases requiring special definitions.

Not much is known about intuition in a strictly scientific sense as can be readily inferred from the Albrecht passage presented earlier. Accordingly, we may do ourselves some disservice if we believe there are fine differences between terms such as *coup 'd oeil*, *fingerspitzengefuhl* and intuition. The evidence simply does not support the differentiation. The potential result is that as a profession we appear nonscientific, nonrigorous, or just plain "sloppy" to scholars and academics looking in on us. Defining the art of war consists as much in knowing where we cannot apply a "razor's edge" as where we can. There is an art of war. Intuition plays a role in that art, but we must be realistic in stating what we know about it. *Coup 'd oeil*, and *fingerspitzengefuhl* are evidence that we share the concept of

intuition with other armies and times that are thinking or have thought about the complexities of war. These terms may even have slight differences of meaning, but they will be related to varying cultural approaches to intuition itself or to nuances of language and not to discrete scientific knowledge we have of intuition as a cognitive function. To claim more is to unnecessarily "mystify" our profession.

So if intuition is the "glimmering" of our "inner light," what is vision? There seems to be a relationship between the terms, first, in the way both are aimed at helping us conceptually organize the chaos of the battlefield, and second, through the use of the "eye" as metaphor. If the emphasis of intuition is on "inner," then the emphasis of vision is on the "outer." One might consider intuition as interpolation and vision as extrapolation. Intuition is the way we sub- or preconsciously manipulate and combine previous experience to intuit new experience. Vision is the way we project our thought and ideas forward, represented by terms such as, "goal," "objective," or "endstate."

Senior-level leadership, according to FM 22-103, is "above all ... the art of taking a vision of what must be done, communicating it in a way that the intent is clearly understood, and then being tough enough to ensure its execution."[24] According to the same manual, this vision consists of various attributes and perspectives. Among these are that vision can be an "intuitive sensing," that vision allows senior leaders to make "sense out of the seeming chaos" on the modern battlefield, that vision requires great integrative skills, and that those leaders possessing vision have a "sixth sense about where problems will occur and [are able to] make their presence felt at the critical places and times.[25]

These diverse but connected elements of vision suggest that the commander's art, the forming of his vision, is an exercise in synthesis. He must account for not only an immense number of organizational variables, but also a host of other factors, among which we include fog, friction, and enemy will. He interweaves these variables, emphasizing a few while ignoring the majority, to ultimately mold a coherent view of the organization and its goals that his subordinates can share. His personal view of the organization, the battlefield, and even the world, will influence his vision.

That the commander cannot possibly account for all the variables found in the day-to-day activities of even the smallest unit, much less one as large as a division, brigade or even battalion, is obvious. Even in our individual lives we have to contend with infinitely more detail than we can factor into the thousands of decisions we make each day. The language from FM 22-103 cited in the first paragraph, then, begins to take on additional significance as we define what we mean when we say "vision." The authors include such language as "intuitive sensing," "chaos," and "sixth sense," because whether they state it or not, all know there is a great deal of uncertainty involved in every battlefield decision. If there was not, we could simply plot out in a calculated way from the opening salvo of the first battle to the ends of post-conflict operations, determining in advance our margin of victory or defeat. But of course we cannot, so we learn to cope with the uncertainty.

One of these ways we handle uncertainty is to develop conceptual frameworks that simplify and make manageable the complexities and dynamics of war. In short, the commander's vision is a shared framework that attempts to

provide order and direction to and in what we would otherwise refer to as the fog, friction, and chaos of war.

This vision becomes the framework from which the commander and other organizational leaders determine objectives and upon which they subsequently base decisions. In more familiar language, as one of the Army's senior commander recently wrote in Military Review, "the vision created by the battle space view of warfare eventually becomes the framework from which the commander derives his intent and his concept of the operation."[26] More, there is a larger vision tied to the organization's very being that theoretically drives every decision, every action of the unit as it prepares itself for why it was created. That is, the commander thinks about more than an upcoming battle or operation, whether it be simulated or actual. He thinks about the purpose of his organization, understanding that there is not only a wide variety of ways and means for him to consider, but a wide divergence in possible ends to which his force might be applied. His vision must be both particular to current and near-term events, and at the same time general so that the organization remains tied to the larger context, whether it be a higher commander's intent, or the desires of the National Command Authority and the political realm.

Vision is shorthand for what a nonmilitary looker-on would call a shared conceptual framework. No two visions are ever the same, but in traveling from organization to organization that same nonmilitary observer would notice they have more in common than not. There's a simple reason for this. The foundation for the commander's vision is the Army's vision. Doctrine and theory combine to form an institutional framework whether its ever stated as such or not. Models are

put forth, metaphors presented, and general methods prescribed. As the principal basis for every commander's vision, that institutional framework had better be right, or at least the best it can be.

Vision, then, is the way the commander communicates his solutions for dealing with the complexities of the battlefield, and how he manages his unit's conduct on it. The skills he requires to do it well , are part of his art, and in the theoretical extreme, combine into something called "genius." This is one of the last terms we will consider in relation to the art of war before integrating the terms into a model of art and science..

Clausewitz wrote,

> Any complex activity, if is carried on with any degree of virtuosity, calls for appropriate gifts of intellect and temperament. If they are outstanding and reveal themselves in exceptional achievements, their possessor is called a genius.
>
> We are aware that the word is used in many senses, differing both in degree and in kind. We also know that some of these meanings, make it difficult to establish the essence of genius. But since we claim no special expertise in philosophy or grammar, we may be allowed to use the word in its ordinary meaning, in which "genius" refers to a very highly developed mental aptitude for a particular occupation.[27]

It is in this section on genius that we find Clausewitz's discussion of *coup 'd oeil.* The connection between intuition and genius seems clear for Clausewitz. Less clear are the connections between art, the nonlinear world, and the leader's genius. To help demonstrate their connectivity, we now build a model of the art of war with war being the context.

War, according to Clausewitz, is made up of four elements: danger, exertion, uncertainty, and chance.[28] The relationship to art is distant for the first

two, but direct for the latter. The commander, in order to possess a genius for war, must have qualities that allow him to excel within these four elements of war. Courage and determination are required to deal with danger and exertion. It is not enough to have a brilliant intuition that cuts through the fog of war, for example, if one lacks the stamina and courage required to inspire men to follow his intuition, or the physical qualities necessary to endure on the battlefield. For Clausewitz genius "consist[ed] in a harmonious combination of elements, in which one or the other may predominate, but none may be in conflict with the rest."[29]

One may be, accordingly, a genius of action, the type of commander who possesses such qualities as courage that he can inspire his men to attack when no other could. For Clausewitz this was genius so long as it was not hampered by a lack of skill in another element of war. The commander who led the charge of the light brigade must have possessed great courage and powers of inspiration, but Clausewitz would not have labeled him a military genius. Likewise, it is no genius of war who develops a brilliant plan but cannot motivate his soldiers to execute it. We might say that he has a genius for planning, but because we recognize along with Clausewitz that the word is used in many ways, we do not say he is a military genius. The military genius may or not be, however, a great military artist.

The relationship of war to art rests in third element of war, that of uncertainty and to a lesser extent to the fourth, chance:

> War is the realm of uncertainty; three quarters of the factors on which action in war is based are wrapped in a fog of greater or lesser uncertainty. A sensitive and discriminating judgment is called for; a skilled intelligence to scent out the truth.[30]

But before defining chance, we begin laying the base for the model to come. We have thus far discussed the nature of linear and nonlinear operations, and introduced and discussed briefly some of the more important terms discussed in relation to military art. We now begin to build a model of the art and science of war that connects to US doctrine, and which is constructed around uncertainty.

We start by placing art and science in the context of war using Clausewitz's four elements of war, or better, the climate of war as described above (Figure 2).

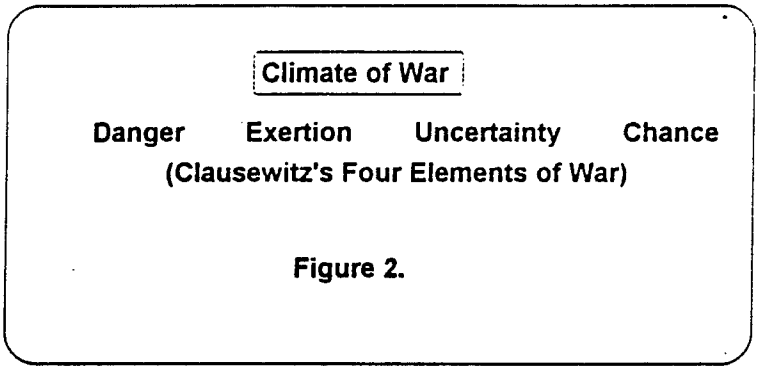

Figure 2.

We next connect the climate of war to US doctrine by introducing the Battlefield Operating System (BOS) of Command and Control to the model with command linked to the art of war and control to the science of war (Figure 3). Command is the purview of the commander, and control that of the staff.

The next step is to apply a correction to Clausewitz's elements of war. This involves better defining the element of chance, something that Beyerchen points out that Clausewitz never gets around to "succinctly" doing.[31] After defining chance, it is then subordinated to uncertainty as one of two principal contributors to uncertainty. The other is friction, but more on that later.

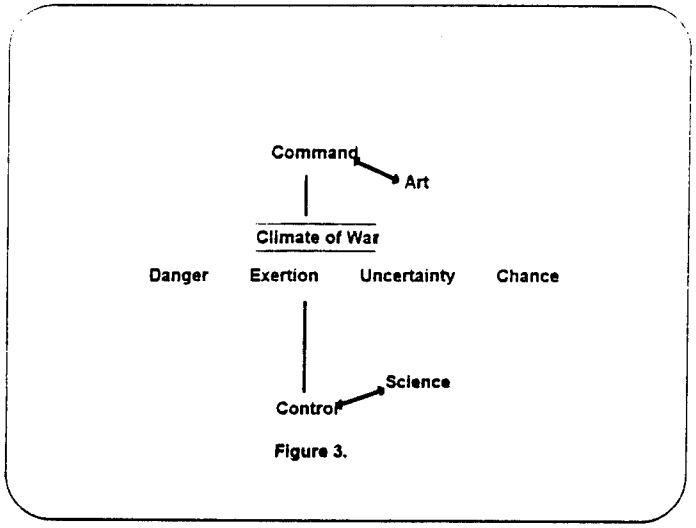

Figure 3.

The definition of chance is provided by the French mathematician Henri Poincaré, as elaborated by Beyerchen. Chance according to Poincaré comes in three forms. First chance is a "statistically random phenomenon."[32]

> This form of chance can be calculated by statistical methods. The very large number of interactions produces a disorganization sufficient to result in a symmetrical (i.e., Gaussian or bell curve) probability distribution. Nothing significant is left of the initial conditions, and the history of the system no longer matters.[33]

The "normal" curve is shown below. A simple set of events that might account for it is the rolling of dice. This is Poincaré's first form of chance and the form that is most commonly associated with the word "chance."[34]

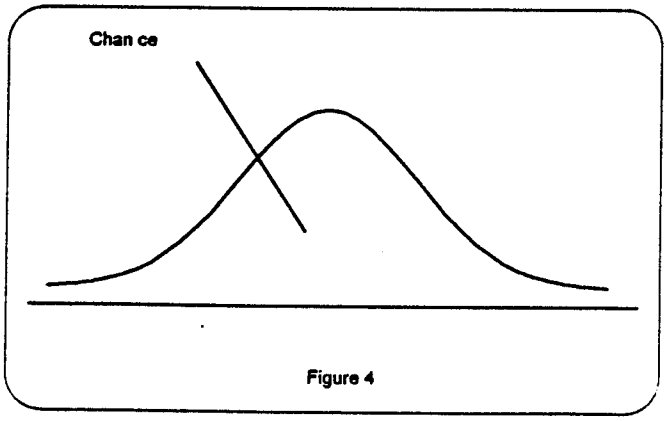

Figure 4

The second form of chance is clearly distinguishable from the first. Whereas the first form of chance leapt past initial starting positions to statistically account for outcomes (the ends of war, battle, etc., under the bell curve), the second form of chance states that initial starting positions are important.[35] In chaos theory this is know as the butterfly effect. That effect says something like, a butterfly beating its wings in Asia today may cause a tornado in Kansas next week. More technically, the phenomenon is referred to as the amplification of a microcause.

> A very slight cause, which escapes us, determines a considerable effect which we can not help seeing, and then we say this effect is due to chance. If we could know exactly the laws of nature and the situation of the universe at the initial instant, we should be able to predict exactly the situation of this universe at a subsequent instant. but even when the natural laws should have no further secrets for us, we could know the initial situation only approximately. If that permits us to foresee the subsequent situation with the same degree of approximation , this is all we require, [and] we say the phenomenon has been predicted, that it is ruled by laws. But this is not always the case; it may happen that slight differences in the initial conditions produce very great differences in the final phenomenon; a slight error in the former would make an enormous error in the latter. Prediction becomes impossible and we have the fortuitous phenomenon.[36]

The third, and related form of chance is that of our failure to see or perhaps consider the interconnectedness of variables relating to our military problem. In our effort to analyze the elements of a problem, we disconnect one portion of it (our central concern whatever it may be), from the whole, and in doing so remove it from important interactions that occur in the fully interconnected reality. The unaccounted for interactions produce results unpredicted and outside our isolated analysis. This yields Poincaré's third form of chance (Figure 5). Arrows indicate actions occurring in the system; the crossing or colliding arrows indicate interactions. The rectangle represents science's efforts to isolate a problem, an

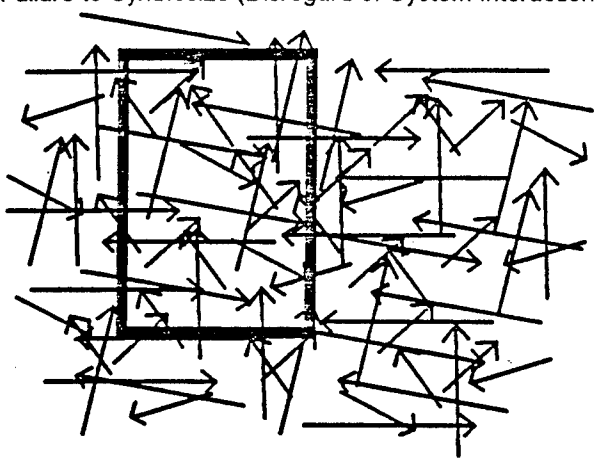

Figure 5.

imperfect process at best. No portion of the system may be isolated without discounting some other portion of the system. In this case the system is the whole of "reality." The rectangle may be a battlefield event, a function, or perhaps war itself.

The other major battlefield contributor to uncertainty is friction. Friction comes in two forms: (1) noise (fog), and (2) dissipation (entropy). Noise also comes in two forms.

The first is miscommunication. This is the garbling of orders, the failure of a radio to work, the misunderstanding of intent, and so forth. The transmission is sent but not properly received. An old example of the phenomenon is the game in which a statement is relayed around a circle of persons with each person changing one word of the message as he or she received it. By the time the message goes full circle the transmission is unrecognizable. This is a minor contributor to noise, or fog.

The major cause of noise is not the confusion of transmission, but comes from trying to determine which statement (or data) to send in the first place.

There is a host of battlefield information, some significant and some not, some accurate and some not. The problem is in drawing an accurate picture of the battlefield based upon the information received or withheld. Determining the proper weight to give particular instances of information before making decisions, and then making decisions knowing that a vast amount of information is still missing or plain wrong, are just two of the significant problems associated with "noise." The result is "informational friction."

The other element of friction is dissipation. This is no more than the Second Law of Thermodynamics, which states that there will energy lost in the numerous interactions on the battlefield. In other words, interactions will never be perfectly elastic and the transfer of energy will result in waste. As interactions themselves occur in a nonlinear fashion, the energy lost cannot be predicted. In everyday jargon dissipation may be described as Murphy's Law--whatever can go wrong will.

Fog and entropy combine, then, to contribute to battlefield friction. Friction combines with chance to create uncertainty. We will now modify the model to subordinate chance to uncertainty and detail the principal ingredients of friction and chance. Furthermore, we will suppress danger and exertion as they are not central to explaining the art and science of war, as will be shown, while leaving them at the margin for the sake of completeness. The model now looks like this, with the uncertainty piece temporarily enlarged (Figure 6).

One more diagram will complete the model. The last diagram now connects science and art to war through the element of uncertainty. Art is the higher level function wielded by the commander with which he copes with the battlefield's uncertainty. Science is the lower function by which the staff controls

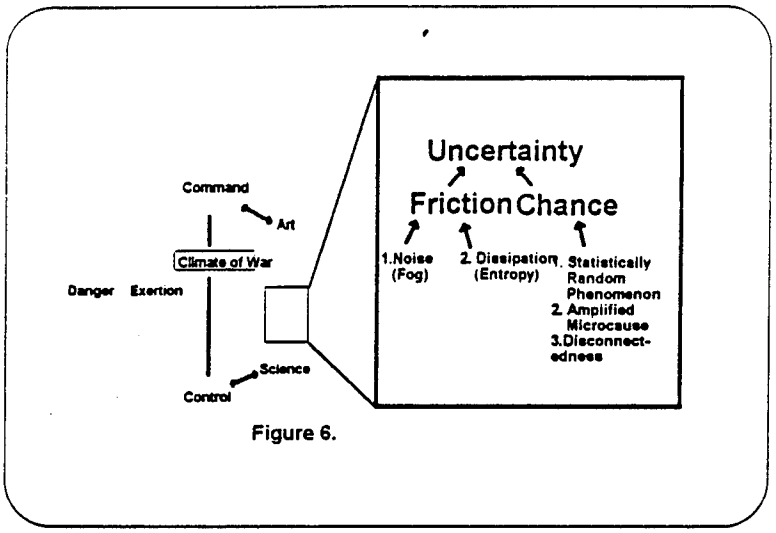

Figure 6.

the battle and with which it attempts to reduce the battlefield's uncertainty. Uncertainty, at the same time, factors back into science ensuring science cannot provide a complete solution. More importantly, nonlinearity works on the battlefield in the sub-elements of friction and chance to further ensure that no purely scientific solution can be found. The commander's art must bridge the gap.

The two terms of intuition and vision are also added to the model. Vision is the manifestation of the commander's art; it is intent as shared in common by the command. Intuition is the principal tool of art. With it the commander connects to his past experiences and when coupled with other cognitive functions such as imagination, it serves to both assess the current situation, as well as provide a solution set. It is hardly an infallible process, but not many believe that art ever is. The final model is depicted in (Figure 7).

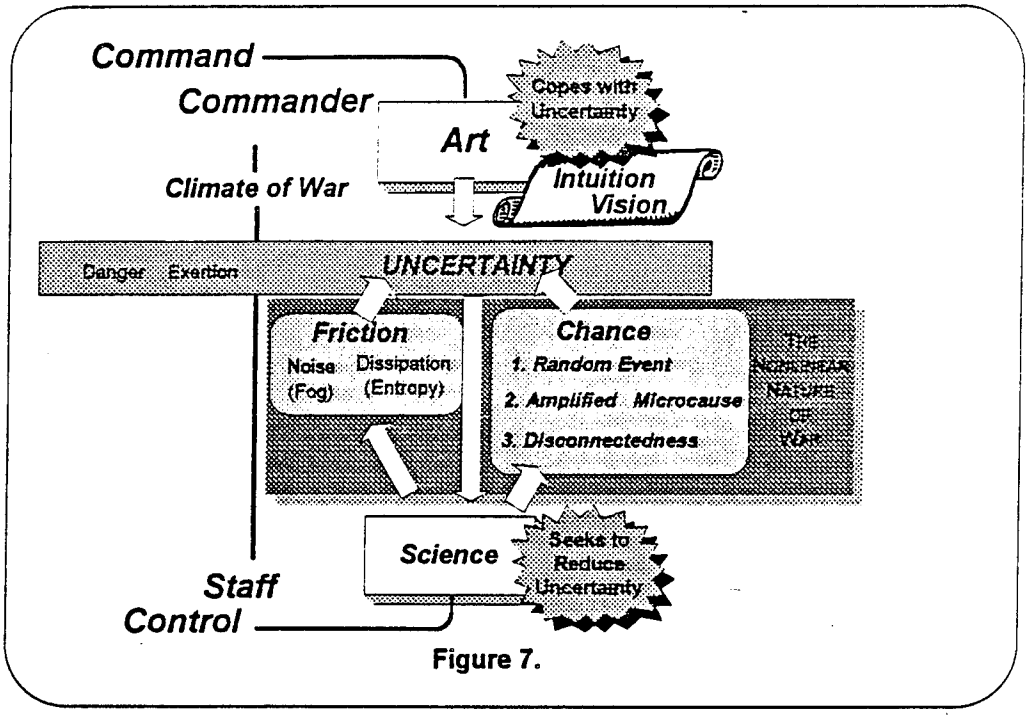

Figure 7.

Section 4. The Nonlinear Perspective

Art is the imposing of a pattern on experience....

Alfred North Whitehead (1861-1947; British Philosopher)[37]

There are more than a few areas of current theory and practice that can be challenged through a nonlinear "lens." First and foremost is the battlefield framework itself, with its close, deep and rear operations, and lines of communications. The principal problem is that the framework is residue from a Soviet-opponent-dominated doctrine in which the battlefield's massiveness and symmetry warranted such a linear approach. Other frameworks which were arguably possible even ten years ago were nevertheless so relatively minor as to not require addressing in the Army's capstone doctrinal manual--FM 100-5. Times have changed. Now the linear framework of close, deep and rear seems less

and less likely, and should give way to a more all-embracing framework that not only accounts for the "preferred" current framework, but also addresses the more likely, and quite literally, nonlinear conditions that will be encountered by a power-projection force in a "third-world" country.[38]

The future opposing army might be linear, nonlinear, or not an army at all. The current framework is too particular, and the capstone doctrinal manual must go beyond just providing examples. The current framework (close, deep and rear) is linear and comprises just one example, even if the preferred example, of the imposed linear parameters on a nonlinear battlefield referred to above. This linear framework must operate inside a larger nonlinear (or at least more nonlinear) framework.[39] And more importantly, a nonlinear framework must be developed and thought through for the majority of cases when the traditional framework does not apply.

Not all nonlinear implications are so objectively physical as a battlefield framework. Consider the concept of "endstate" which seems to be just made for a "linear" versus "nonlinear" debate. The simplistic description of "endstate" as it is currently used not only clearly envisions the stated political objective or goal, with all its attendant conditions for a lasting resolution and ostensibly peace, which the use of military force would achieve, but would presume to know that it was attainable, and even more presumably by what particular ways and means it could be attained. But this says too much the critic argues. If Delbruck is right there is no independent manipulation of tactics, strategy or politics. So, when do we employ military force? We must reconsider if we think the answer is only when the endstate is clear.

The discussion of "endstate" does sharpen the tension between the linear and nonlinear approach. Theoretically, the mechanistic view is as stated above--all must be clear--while the purely dynamic view suggests that no even reasonably accurate prediction of "endstate" is likely. So which is it? What will the commander's vision be? Chaotic or deterministic? Paradoxically, the one seems more accurate, the other more useful. If we construct a continuum (which the good nonlinear thinker would be reluctant to do) with linear at one end and nonlinear at the other, then the answer seems to be somewhere in the middle. Or better, abandoning the continuum, limited linear concepts might be said to operate inside the larger nonlinear model of the world and war. In order to apply the comfortable linear concepts that we are so fond of, we must impose the strictest possible parameters around the "situation." One example might be clearly achieved ends accomplished over a very short period of time, the latter being the strictly imposed parameters, which make the suspicious-sounding "clearly achieve ends" possible. Yet it might be argued that this is not really an "endstate" at all, but something else, call it a "midstate." What then follows, according to the sophisticated military analyst, is something else again--call it "mission creep."

The concept of "mission creep" almost perfectly captures the problem between linear and nonlinear thinking. To date, expert after expert from within and without the services has warned the US military and its civilian leaders about the grave dangers of mission creep, while prescribing for its cure the placebo of "clear endstate." The thesis is that if you clearly know where you are going, you won't get lost along the way. This is a linear view of the cause-and-effects that lead to an endstate; it is often politically expedient, and does help to protect our

fighting force from being deployed inadequately prepared for half-baked purposes.

But US forces have never been deployed toward a clear endstate.[40] Of course rational, if slightly impractical, arguments can be made asserting that "endstate" is never achieved, and yet it is not impractical to consider just that notion for a moment. It helps to further define the problem's boundaries. Clear endstate versus never an endstate. Linear versus nonlinear. Is there a balance to be struck? The following discussion assumes a strategic context.

We do, of course, strike balances in our determination of endstates, but they often get lost in the rhetoric of emotionally and politically charged public debates. And while it is generally a good thing for persons in uniform that politicians do not pass over these issues lightly, the polar nature of the debates (such as might occur between a humanitarian and an isolationist) usually obscures the "ground-zero" truth. That we do strike balances, and the way we conceptually do it within the privacy of our profession, deserves further consideration. Linear versus nonlinear thinking gives us a fresh approach to the problem of "clear endstates" and the attendant problem of military planning.

Of the three components of military strategy, "ways, means and ends," the means will usually be the most clearly focused. We generally know what we have to throw into a conflict, especially from the military side of the house. What is less well focused are the ways and the ends, the latter being the most important and the issue here. We can, in a very general way, either define the endstate that we want, or the ways we will use our means, but as we more clearly define the one, the other falls out of focus.

It is quite easy to state in absolute terms what we want to achieve with an application of force, even in, for example, a place so complex as Bosnia-Herzogovinia. It is when we begin to explore the ways in which we will use available means toward that desired endstate that we run into problems. If the desired endstate is, say, Z, we begin by considering way X with Y means. Most persons will acknowledge that this is the best approach, beginning with the endstate and working backwards.

As we begin the wargaming process (in an informal conceptual sort of way), we announce action A, as one of what will be a long sequence of actions to get us to the desired endstate, and someone asks almost immediately, if we do that what about this? Each wargamer looks at the other nodding, and they agree that "this" is a problem. Perhaps the consequence of A is that the constant Y (means) is exceeded, making the action impossible, or that in doing A the "clear endstate" Z is shifted, however slightly, changing the operation's goal. For whichever of the above, or for some other reason, action A is discarded. Action B is then considered and the process is repeated, including the discarding of the action, because the wargamers are still fresh and intent upon finding the exact solution. But they cannot find it. They learn, or not, that it is easy to define a clear endstate, but it is impossible in a complex world to find just the right ways and means to get there. That is precisely what our experience tells us and is what nonlinear thought processes predict. Yet we still speak in terms of clear endstate. What do we mean? The concept is good, just not very well articulated in all its aspects.

Nonlinear thinking suggests a general approach to the problem. The first, as previously stated, is that some form of strict parameters must be imposed in

which mechanistic, linear-style calculations may be made largely valid. This recognizes that linear calculations are useful, even most useful, on the battlefield, but some effort will be needed to make them viable. For example, the military force can seize an objective, separate opposing forces, or protect a border for some *very short period of time*. Time is just one manipulable parameter. There is more than a hint of incompleteness in this approach. If, after the military force is removed, a return to previous conditions is unacceptable, then little has been achieved. So let's call the short term military objective, referred to just above, condition C. If condition C is not in and of itself a clear endstate, meaning the situation is not simple, then we must go further--and we instantly encounter the complexities associated with nonlinear operations.

One approach to the situation is that the situation must be reevaluated, new parameters imposed, and new linear operations begun. This is a fairly well-known concept among military planners called branching. Branching takes discrete, relatively manipulable ranges of action in an operation and breaks them down into manageable pieces. The action reaches junctures where varying major conditions lead the organization down corresponding branches in the plan accounting for those major conditions. The fact that the concept exists in our planning process is evidence that we are not wholly ignorant of nonlinear operations, meaning that everything does not go just the way we plan it.

Up to now this hardly seems revolutionary, but rather a rehashing of the way we presently do business. What represents a divergence, however, is what this approach really does to the clear endstate concept. First, once these branches we have discussed thus far diverge from the original plan, and they will, it is

unrealistic to expect them to reconverge with the original plan (on the path toward the clear endstate). Second, and perhaps more importantly, it will be exceedingly difficult to determine the real or near real branches of the upcoming operation. Which of these will take us farther from or closer to the original endstate, and won't the odds be against the latter? Third, Delbruck tells us that all this military action is going to reverberate through the political system and feed back into military operations, changing the original planning conditions. Can we rephrase Delbruck by invoking the Heisenberg uncertainty principle, which essentially says that an observer cannot "truly observe" because the very act of observation changes the system? Let us clean up the language a bit, even keeping the term "clear endstate," but defining exactly what that means in relation to a nonlinear reality.

What we really want in a clear endstate is not a crystal-clear vision of what the situation will look like when we redeploy the last soldier, but rather the widest possible terminal parameters that will account for the broad divergences between the plan we left home with and the action actually encountered along the way to an ultimately successful mission. What we really want is not the clearest possible endstate (ideal), but the vaguest. Semantics? Maybe, but confused in enough persons' minds that the point warrants expressing. Then, with nonlinear realities in mind, we not only plan diligently for the largest possible number of branches (systematically and well beyond the current practice), but we also plan for the ideal terminal parameters (clear endstate) to shift, carefully noting and publicizing (informing our leadership and they the public when necessary) where they exceed our ways and means in advance. Perhaps the reader will recognize these shifting

terminal parameters by another term--"mission creep." Yes, they are the same thing, but notice the different approach and attitude implicit in the terms. The central nonlinear suggestion is not to bemoan and forewarn against "mission creep," though that is one option, but rather to determine what to do about it because it is inevitable. But enough about endstate. It is not possible in this limited number of pages to solve the whole of this difficult issue, but rather to illustrate how a linear versus a nonlinear approach to complex problems can dramatically change the perspective, and subsequently the whole attitude toward the solution set.

What is important with regard to these military solutions is that we begin looking for our them in nonlinear operations, that is with a nonlinear view of war and the battlefield, especially at the operational and strategic levels of war. As we simplify and reduce we will naturally slip to mechanistic, simple cause-and-effect solutions, particularly as we power down to the tactical level. But if we begin with linear solutions we run the risk of losing the proper perspective on our complex business, and particularly, the risk of misdefining or over simplifying the larger nature of the problem. A leader's clear vision is very much related to first gaining the larger perspective before applying magnifying lenses. In its larger parts war is highly nonlinear and that is where the leader has to begin. This very unclear situation is why he is an artist and not a scientist.

Nonlinear approaches do more, however, than just better define the nature of the problem, and point the way toward new solution sets. Once embraced, nonlinear thinking can even provide new magnifying lenses to old problems, that is nonlinear, or less linear, techniques for solving the problems. Consider for a

moment the command estimate process: mission analysis, course of action development (COA), COA comparison, decision and implementation.

In the COA development phase, the staff usually plans two or more COAs to solve a particular problem that has been defined by mission analysis of the higher commander's order. Then they set about comparing the COAs by a set of ostensibly objectively derived "states of nature," more commonly called criteria. They assign numerical values to each of the criterion, add them up, and then recommend to the commander the COA that scores the best with which, for the sake of argument, he agrees. Linear or nonlinear, and how well does process mesh with the battlefield's realities of fluidity and compressed planning times?

It is easy to question whether the average military staff has the technical training to objectively and scientifically select and evaluate decisionmaking criteria under battlefield conditions. It is harder to explain why this is not the best approach. Especially as it may still be the best approach "given world enough and time." Yet it is not difficult to see why this is a linear approach, due to the heart of the process being the reduction of the battlefield to the fewest possible critical "states of nature." What does a nonlinear approach suggest and how might a nonlinear approach to the problem look?

First, the battlefield is complex with countless criteria, some identifiable and quantifiable, some identifiable but unquantifiable, and others simply not identifiable. To make matters worse, the battlefield is highly dynamic and even those criteria that we can quantify this minute will as a result of interaction change in the next. In short, the process of selecting and assigning values to a short list of variables is so difficult, slow, and imperfect that we are served virtually as well by

intuitive processes that take a fraction of the time. Suppose that a group of military planners have 12 hours of possible planning time. They can with the commander's direct assistance and an intuitive process, produce a 75% solution to the problem in 6 hours, or, using the full-blown command estimate process, produce an 85% solution in 12 hours.[41] You are the commander. You cross the Line of Departure (LD) in 18 hours. Choose.

This is not to say that intuitive processes are wholly nonlinear, but they are certainly less linear. Intuitive processes are centered on recognition of familiar situations, or taking action to modify current situations to look more like familiar situations. It is more nonlinear because the experienced leader is taking a macro approach to the problem, with the premise that by recognizing the general similarities between situations, his intuition is preconsciously accounting for more of the complex variables and their interactions. It is more holistic, and less sequential. Leaders are still limited in the intuitive process by what cognitive psychologists call "chunking," or the ability to grasp a relatively few blocks of information simultaneously. But by considering the information as a pattern to be recognized or not, the process is more sensitive to the nonlinear aspects of dynamics. There is an important give and take between deliberate and intuitive decisionmaking processes. Gary Klein, president of "Klein Associates Inc.," a research and development firm specializing in applied cognitive psychology, explains,

> Recognitional decision making is more important when experienced personnel are working under time pressure on concrete, contextually dependent tasks in changing environments and have a "satificing" criterion of selecting the first option that looks like it will work.[42] It comes into play when the unit is an individual or a

> cohesive team that does not reach deadlocks over conflicts. Recognitional decisions can ensure that the decision maker is poised to act. Its disadvantages are that it is hard articulate the basis of a decision and it is difficult to reconcile conflicts.... Concurrent option comparison [such as the command estimate process] has the opposite strengths and weaknesses.[43]

If we sense a ring of truth in the intuitive approach, and were to follow the idea down a "nonlinear line" of reasoning, we might see that nonlinear thinking would suggest different ways to develop leaders. Perhaps in the future we would strive to increase the number of situations encountered by a commander whether through actual, or because more could be done, simulated, exercises. If a commander's future success on the battlefield might be determined by his ability to recognize and modify situations (patterns) under relentless time pressure, then maybe "quantity" once again "has a quality all its own." Balance (i.e., the avoidance of superficiality) would be achieved by occasionally working through the more analytical command estimate process, especially as opportunities and time presented themselves through the current deliberate planning processes.

Section 5. Conclusion.

"Art is skill, that is the first meaning of the word."

Eric Gill (1882-1940) British sculptor[44]

The preceding cases are obviously not the only ways that nonlinear thinking might impact on military operations, but are rather a few limited examples applied to current ways of doing business. There are other far more radical implications on the horizon for every aspect of human endeavor, including the military, resulting from pursuits in nonlinear operations. Nonlinear operations have resulted in the formal study chaos, in which complex systems that were seemingly random have been found to have not only an order to their apparent

disorder, but that order is constant from complex, chaotic system to the next.[45] In recent years the study of chaos has raised the science of "complexity," in which remarkable findings are being made daily regarding complex systems, from why the theory of evolution must be reconsidered to questioning tried and tested principles like the law of diminishing returns and entropy[46] The real point here is that much of what we thought we "knew" is being questioned and seriously challenged.

While it is ultimately unclear how far the sciences of chaos and complexity will take us, if anywhere, they do have a simple message for us. The world and war are not linear operations in the main, and we run the risk of distortion each time we rely on reduction and simplification to solve problems. New world complications give us reason to question everything we do, while new world technologies and knowledge give us the ability to consider, and if necessary take, more complex approaches to both old and new problems. We will likely never wholly abandon linear operations. They have simply proven too useful in the course of normal affairs. They run roughshod over most of the problems presented by complexity. For example, we know that much can go wrong each time we launch a convoy, but the convoy usually gets there anyway. The more real danger is when we turn linear operations into metaphors and models to account for the whole of war and its more complex operations without considering the nonlinear world those metaphors and models work in. The fact that we need simplifications at all should serve as a constant reminder that work-a-day living--much more war--are complex affairs. The commander's vision will necessarily need to be both complex and simple for all the same reasons. It is complex and

nonlinear, because that is the way the world really is, and simple and linear, because the commander has to communicate his vision to the organization.

"Art" is the skill with which the commander manages the uncertainty of the battlefield. The battlefield is uncertain because it is the product of nonlinear interactions. The battlefield is uncertain beyond computational abilities; its nature is uncertainty in the same way that the weather is uncertain. Nonlinear calculations cannot be "solved properly," but rather may only be "solved approximately." Art bridges the gap.

Science will seek to reduce uncertainty. It will overlay upon reality or a portion of it, an isolated analytical framework from which it will try to draw some simple linear answers. It will of course be a flawed effort. Not only will the analysis itself be imperfect, but the process will necessarily ignore a host of interactions occurring at the margins of the isolation (see Figure 5). Art will apply correction to the degree that it is good. This is not to say that science does not make a huge contribution to the processes of war. It has, it does, and it will. Science (especially with regard to technology) is an integral part of what many call the "American way of war."

In conclusion, the following proposed definition of art is put forth to replace that found on page 1 of this monograph:

> **Art is the commander's skill as guided by the principles of war in using military means for the attainment of an endstate. Military art begins where military science ends. It is characterized by "synthesis," "judging," and "creativity." As military science is the practice of reducing battlefield uncertainty, military art is the practice of coping with battlefield uncertainty. The military artist's principal virtue is that of intuition, a virtue firmly grounded in experience and education. The principal manifestation of military art is vision, marked by the command's ability to agree upon its endstate and the methods of that endstate's acquirement.**

ENDNOTES

[1] FM 100-5, Operations (Washington D.C.: Department of the Army, 1993) 6-12.

[2] Funk and Wagnall's, New International Dictionary (New York: Funk and Wagnall's, 1959), 189.

[3] American Heritage Electronic Dictionary (New York: Houghton-Mifflan, 1989). This definition is actually a combination of three definitions found in this dictionary.

[4] Linear and nonlinear will be recurring terms in the monograph. Many will be generally familiar with these terms and that is sufficient for this introductory section. Section 2 lays out briefly what is precisely meant by them here and how they apply to military operations. Section 2 can be read first if the reader is unfamiliar with the terms.

[5] Clausewitz offers instances of nonlinear thought when he introduces the concepts of fog and friction. More on this later.

[6] Columbia Concise Dictionary of Quotations (Columbia University Press, 1990), incorporated in The Writer's Toolkit (Systems Compatibility Corporation) (Software).

[7] FM 100-5, 6-13.

[8] Hans Delbruck, "Eine Geschicte der Kriegskunst," Die Neue Zeit, as found in the essay by Gordon A. Craig, "Delbruck: The Military Historian," Makers of Modern Strategy, ed. Peter Paret, (Princeton: Princeton University Press, 1986), 331-332.

[9] This monograph is titled after Beyerchen's article to acknowledge its large influence on these pages.

[10] Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," International Security, Vol. 17, No. 3, 68.

[11] Gregory Fontenot, Colonel, "Strategic Surprise," lecture to Advanced Military Studies Program, March, 1994.

[12] Columbia Concise Dictionary of Quotations.

[13] Karl von Clausewitz, On War , eds. and trans., Michael Howard and Peter Paret (Princeton: Princeton University Press, 1987): 149.

[14] Ibid.

[15] Barbara Tuchman, "Generalship," Parameters, Vol II, No. 2, 1972, 4.

[16] Robert A. Doughty, "The Art and Science of Tactics," Parameters, Vol. VII, No. 3, 1977, 40.

[17] Clausewitz, 102.

[18] Ibid.

[19] Webster's Third International Dictionary (Springfield, MA: Merriam Publishing, 1971), 1187.

[20] A prejudice only because these matters are ultimately (not) settled by metaphysical debate.

[21] Karl Albrecht, Brain Power: Learn to Improve Your Thinking Skills (New York: Prentice Hall Press, 1980), 68.

[22] Paul E. Funk, LTG. "Battle Space: Commander's Tool on the Battlefield," Military Review, December, 1993,38.

[23] Donald Chipman. " Clausewitz and the Concept of Command Leadership. " Military Review, August 1987, 38.

[24] FM 22-103, Leadership and Command at Senior Levels (Washington D.C.: Department of the Army, 1987): 6.

[25] Ibid., 8-10.

[26] Funk, 43.

[27] Clausewitz, 100.

[28] Ibid., 104.

[29] Ibid., 100.

[30] Ibid., 101.

[31] Alan Beyerchen, "Clausewitz, Nonlinearity and the Unpredictability of War," International Security, Vol. 17, No. 3, 77.

[32] Beyerchen, 78.

[33] Ibid.

[34] Ibid., 79.

[35] Ibid.

[36] Ibid., 79-80.

[37] Columbia Concise Dictionary of Quotations.

[38] FM 100-5, Operations, (Washington D.C.: Department of the Army, 1993), 6-12.

[39] Battlespace is a positive step in this direction. Theaters of War and Operations are also useful terms at the highest military levels.

[40] The counter to this assertion that quickly comes to mind is the 90-91 Persian Gulf War. But even here there was tremendous disagreement about how that war should have ended, with books being written after the war with titles such as *Victory Without Triumph*, and *Hollow Victory*.

[41] This is of course an entirely arbitrary depiction of the differences in the two approaches. It is left to the reader whether or not it resembles truth.

[42] In the Army we refer to "satisficing" when we repeat the old saw, "Perfect is the enemy of good enough." "Good enough" is satisficing.

[43] Gary A. Klein, "Strategies of Decision Making," Military Review, May 1989, 61.

[44] Columbia Concise Dictionary of Quotations.

[45] This and the following footnote offer three popular literature texts that deal with the nascent sciences of chaos and complexity:

James Gleick, Chaos: Making a New Science (N.Y.: Penguin Books, 1987).

[46] Roger Lewin, Complexity: Life at the Edge of Chaos (N.Y: Macmillan Books, 1992).

M. Mitchell Waldrop, Complexity: The Emerging Science at the Edge of Order and Chaos (N.Y.: Simon and Schuster, 1993).

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