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SPACE POWER THEORY

A RISING STAR

by

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Preface

There is an excitement about military activities in space today and the future. It's as if a whole new door of opportunity has opened in recent years. Hollywood is not short on films that dramatize the potential importance of space forces. There is even serious debate within the US military regarding the advantages and disadvantages of a separate branch of service—the US Space Force. And yet, amid all this enthusiasm, we as a nation have failed to establish the foundational, theoretical ideas regarding the significance and use of space power that would serve as a basis for such enthusiasm and justification for reorganizing America's space forces. It seems that the body of military thought on space power lacks a Douhet, Trenchard, Mitchell, Boyd or Warden to articulate the importance, nature and best use of space power.

While studying at Air Command and Staff College, I was aghast when we reached our lesson on space power theory. As a space operations officer, I wondered if the scant material presented in our lesson that day adequately represented the body of military thought on space power. I began asking myself the questions that sparked the writing of this paper: What is space power theory? Does it exist? Where? Who is writing it? How far along are we in developing a conception of space power? The simple fact that I had to ask these questions indicated that the literature on space power is either not abundant or not well known. I now believe that both aspects are true, but I suspected enough of the latter was factual that a paper assessing current space power theory would

add something worthwhile to the body of military thought. I thus chose to research this topic in order to help future students of space power theory identify what's out there and help future authors determine where the body of space power theory needs to go.

In 1992, Dr. Harold Winton, then Professor of Military History and Theory at the School of Advanced Airpower Studies (SAAS), wrote an article entitled, *A Black Hole in the Wild Blue Yonder: The Need for a Comprehensive Theory of Air Power.*[1] Winton's insightful article painted a fairly pessimistic picture regarding the existence of air power theory. Winton argued that a single comprehensive air power theory does not exist; yet he goes on to refer to a few of the writings that contributed to air power theory.[2] In like manner, I propose that we lack a single comprehensive space power theory. To make this claim, I researched some of our best thinking on space power—writings most often identified by authors as "in the ball park" of space power theory—as well as lesser known works I felt were worthy of this examination.

As I peeled back the layers of thought on space power, I discovered the basic concepts presented thus far and the current state of space power theory. It gave me a picture of what ideas have been advanced and which ideas are especially prominent or lasting. It allowed me to establish a baseline for where we are in developing space power theory, identify where the holes are in our current thinking, and recommend what we need to do to fill those holes.

There are two things that this paper is *not*. This paper is not a new theory of space power. In no way did I intend this paper to be an attempt at a new comprehensive space power theory. Indeed, the short length of this paper alone would prevent such a thorough work. Instead, the value of this paper is that it brings together some of our best thinking

on space power providing its reader a single resting stop on the road to space power theory. From this rest stop, you have a "scenic overlook" to the prominent ideas shaping space power today and possibly years to come. Additionally, this paper is in no way intended to be exhaustive. It is a review of a sizable cross section of space power theory sufficient enough to allow us to draw some general conclusions. Furthermore, my review is purposefully limited to unclassified, non-fiction writings or briefings. I've also attempted to weed out material based on the criteria set forth in Chapter One. One notable exception, however, is that I found doctrine to be the most difficult aspect of space power thinking to separate from theory and have, therefore, purposely included some material labeled "doctrine" because of its close tie to this subject.

Several people were instrumental in writing this paper. I want to acknowledge the guidance and assistance I received from my research advisor, Maj Lantz Balthazar. Additionally, I received invaluable insight from Col (Ret) Dennis Drew, Associate Dean of School of Advanced Airpower Studies and Maj Roy Houchin, Space Chair at School of Advanced Airpower Studies. Finally, I wish to thank my wife, Maggie, and my three children, Emily, Jason and Jonathan for putting up with this research effort. I can't thank them enough for their prayers and the sacrifices they made.

Abstract

Is there a single comprehensive theory that could shape future space and air forces? This essay examines the current state of space power theory. The method of research was a literature review of books, periodicals, government and private reports, and conference proceedings via Air University Library and the Internet, as well as personal contact with faculty members from several military schools. This effort identified basic elements of military theory—definitions, explanations and predictions—which then became a qualification as well as a framework for this paper.

The major findings of this paper are that 1) Space power theory is emerging: it exists and is growing in the form of definitions, explanations and predictions of the nature, significance and functioning of systems in space; 2) A single comprehensive space power theory does not exist; and 3) Space power theory has much room for improvement in its definitions, explanations and predictions of space power.

Finally, this paper recommends that future theorists 1) Expand all areas of space power theory to create a more robust body of literature; 2) Thoroughly examine the contributions of early space theorists (see Chapter 3, Note 1); 3) Address, in detail, the two "hot topics" in space power theory today—space control and space force organization; and 4) Seek a single comprehensive space power theory to bring together the lasting ideas of space power for the purpose of shaping future space forces.

Notes

[1] Harold R. Winton, "A Black Hole in the Wild Blue Yonder: The Need for a Comprehensive Theory of Air Power," *Air Power History* (Winter 1992), 32-42.

Chapter 1

Introduction

We are now transitioning from an air force into an air and space force on an evolutionary path to a space and air force.

—1996 Air Force White Paper, Global Engagement:
A Vision for the 21st Century Air Force

The above declaration is arguably the US Air Force's boldest statement ever about the future role of space power in the Air Force. This statement suggests a significant shift in focus for the Air Force. Yet, some military thinkers believe that significant changes in focus for military services should be preceded by a change in military theory. Carl Builder, for example, convincingly argued in *The Icarus Syndrome* that air power theory was the catalyst for the establishment of the US Air Force as an independent branch of service.[1] Builder's analysis suggests that space power theory is also important for developing a "space and air force." What is the status of space power theory?

The thesis of this paper is that space power theory is emerging, but lacks a single comprehensive form and has much room for improvement in its ability to define, explain and predict the nature, significance and functioning of space power. This paper will first build a framework in which to discuss the basic elements of space power theory. It will then use this framework to identify the content of space power theory. It will next analyze the current state of space power theory by comparing and contrasting its various

parts. Finally, this paper recommends subjects for more thorough development in order to decisively shape the future of US space and air forces.

Notes

[1] Carl H. Builder, *The Icarus Syndrome*. (New Brunswick, NJ: Transaction Publishers), 1994, xiii.

Chapter 2

Military Theory

Theory will have fulfilled its main task when it is used to analyze the constituent elements of war, to distinguish precisely what at first sight seems fused...

—Carl von Clausewitz

Despite its usefulness, [1] military theory is difficult to define. Classic assertions, such as Clausewitz' words above, are scholarly, but do not pinpoint a precise definition useful for research. Yet, in order to determine the contents of current space power theory, one must first answer the question, "What is military theory?" To this end, this paper synthesizes definitions of military theory in order to create a framework for identifying and understanding space power theory.

What is theory? The *American Heritage Dictionary* states that theory is a "system of assumptions, accepted principles, and rules of procedure devised to analyze, predict, or otherwise explain the nature or behavior of a specified set of phenomena."[2] In other words, there are three aspects of theory: *method*—system of assumptions, accepted principles, and rules of procedure; *purpose*—to analyze, predict, or otherwise explain; and *focus*—the nature or behavior of a specified set of phenomena. Adding in a military perspective for each aspect will now bring a military theory framework to life.

Methods used to present military theory are as varied as the authors presenting them are. These methods include propositions, observations, analyses, treatises and syntheses

of military models.[3] In light of the multitude of methods for presenting military theory, this paper proposes a simplified version. Military theory will be identified as any systematic body of knowledge with the appropriate purposes and focus.

The purposes for presenting military theory are also numerous. However, in a manner particularly useful for developing a framework, Winton proposes that theory "has five purposes: to define; to categorize; to explain; to connect; and ideally, to anticipate."[4] Winton's purposes are broad enough in scope to incorporate other purposes.[5] However, Winton's purposes can be further simplified. It can be argued that categorizing and connecting are covered in defining and explaining respectively. That is, a thorough definition is one that both limits the discussion and provides categories of the concept at hand. Likewise, an effective explanation will explain the relationship between categories as well as connect the overall concept to other concepts. By way of simplification, then, the purposes of theory are to define, explain, and predict. With the method and purposes of theory established, attention must be given to the focus of theory.

The focus of theory is straightforward. The *American Heritage* definition states that theory presents information on the nature and behavior (or functioning) of some phenomenon.[6] Carl Builder adds that theory not only "explains why things should work in a particular way" but also "why anyone should care."[7] In other words, theory addresses the nature, functioning and *importance* of a phenomenon. Synthesizing all of the above information leads to the following framework: *military theory is a systematic body of knowledge that defines, explains or predicts the nature, importance and functioning of military power.*

This paper will now focus on space power theory.[8] This focus will be on theory as opposed to history or doctrine.[9] This paper will hold an appreciation for descriptive as well as prescriptive military theory.[10] And it will avoid limiting this thinking based on temporary fiscal, political, technological and policy limitations.[11]

Notes

[1] Military people value military theory for numerous reasons. In "Theory on the Battlefield: Nuisance or Necessity?," Arthur Athens states that military theory provides a basis for historical study, a method for training the commander's mind, and a means to clarify the "normal" pattern of war (Athens, 33-34). Thus, theory helps today's warrior gain insight to avoid repeating past mistakes. Theory also gives planners a framework with which to define doctrine and strategy for future military operations (Caffrey, slide 7). Moreover, military theory captures the language that best articulates what the military professional affirms and advances as true about military power (I am indebted to Dr. Donald Chipman, Education Advisor, Squadron Officer School, who first made me aware of the importance of military theory when he articulated the idea that, "A true professional has something to profess.") And more recently, Carl Builder, in his book, *The Icarus Syndrome,* skillfully argues that military theory is vitally linked to the way militaries organize, train, and equip to operate (Builder, xiii).

[2] William Morris, *The American Heritage Dictionary of the English Language,* (Boston: Houghton Mifflin Company, 1980), 1335.

[3] Dr. Harold Winton states that theory is a "systematic body of propositions related to a particular phenomenon or field of study." (Winton, 33) Thus, the method for Winton is a systematic formulation of "propositions." In *Theory on the Battlefield: Nuisance or Necessity?*, Arthur Athens states that "theory comes from the Greek words *theoros*, *theasthai*, and *thea*, meaning 'spectator,' 'to observe,' and 'a viewing' respectively." Therefore, recording observations is the method of choice for Athens. (Athens, 33) In *The Art of War in the Western World*, Archer Jones refers to "an analytical approach to military operations" thus inferring that the best method of presenting military theory is in the form of an analysis. (Jones, 1) In his book *Masters of War*, Michael Handel states that military theories are presented as "treatises." (Handel, 1) In yet another opinion, Azar Gat, in his book, *The Origins of Military Thought*, claims that military theory is presented as "a synthesis of the best military models." (Gat, 1)

[4] According to Winton, to define means "to specify what exists within the area under investigation and what, by definition, remains outside it." To categorize means "to divide the field into subordinate parts." To explain means to clarify "the relationships among the parts...usually in the form of 'if...then...' propositions that explicate cause and effect." To connect means to relate "the field to other related phenomena" (i.e. air, land and sea power or war and politics). To predict means "to assimilate new information and...anticipate what the new relationships will be." (Winton, 34)

[5] According to Athens, military theory has three main purposes: "first, theory serves as a basis for historical study; second, theory as Clausewitz stated, trains the mind of the

commander; and third, theory clarifies the 'normal' pattern of war." (Athens, 33-34) Handel, on the other hand, argues that the purpose of theory is to "provide an insightful point of departure and help to define an area of study" as well as "a standard for evaluation of all other studies in the field." (Handel, 1)

[6] Morris, 1335.

[7] Carl H. Builder, "On the Future of Air Power," Lecture, *USAF Air & Space Doctrine Symposium*, Maxwell AFB, AL, 7 April 1993, slide 15.

[8] It should be noted that military theory could be divided into four categories: land, sea, air, and space power theory as well as various combinations of these categories (i.e. AirLand). This paper will focus solely on space power theory.

[9] One of the more difficult tasks in identifying military theory is to distinguish it from doctrine. One model that helps to focus on military theory is the Air Command and Staff College (ACSC) Five Rectangle Model (see Figure 3 in Appendix A). This model proposes that theory is less broad than the history it seeks to explain, yet more broad than the doctrine which is to be derived from the theory. Furthermore, it can be said that theory claims, "This is the way it works," while doctrine asserts, "This is the best way it works." I.B. Holley says that doctrine is "the one best way to the job which has been hammered out by trial and error, officially recognized as such, and then taught as the best way to achieve optimum results." (Kimminau, 4) Dennis Drew offers that "military doctrine is what we believe about the best way to conduct military affairs." (Drew, 163) A more cynical approach states that doctrine is the "general's favorite theory." Another viewpoint is that theory tends to answer the question, "Why?" and doctrine tends to answer the question, "How?" This close tie between theory and doctrine allows room for the inclusion of some doctrinal works into this review of space power theory.

[10] There are two schools of thought on military theory: descriptive and prescriptive. Proponents of the descriptive theory would argue that theory must describe history. Carl von Clausewitz modeled this view in his work *On War*. Proponents of the prescriptive school would argue that theory should prescribe principles for what to do on the battlefield. Antoine Jomini's book, *The Art of War,* is such a work. Since then other classic works that have been labeled "Jominian" include Alfred Thayer Mahan's *The Influence of Sea Power upon History:1660-1783*, the writings of Julian Corbett, Giulio Douhet's visionary work *Command of the Air*, and John Warden's systems theory of air power, which have all been called prescriptive.

[11] A further point about military theory may help the reader to distinguish what is military theory from its counterfeits. For the purposes of this paper, the following realities (while constituting valid considerations for building a theory) are *not* considered military theory on their own and are thus not the focus of this work: 1) Purely historical accounts of space power; 2) Information on current military operations; 3) Ideas limited by current budgetary constraints; 4) Ideas limited by current political constraints; 5) Ideas limited by current technology; 6) Ideas limited by policy; 7) Ideas limited by doctrine; and 8) Ideas limited by current threat situations.

Chapter 3

Current Space Power Theory[1]

The influence of space power upon history is already substantial and growing, and has the potential to yield decisive advantage. Where is the theory of space power? Where is the Mahan for the final frontier?

—Colin S. Gray

Definitions of Space Power

The term space power is found in writing as early as 1964, but appears without a definition.[2] Concerted efforts to define space power did not occur until much later. In 1988, Lt Col David Lupton, in his publication, *On Space Warfare, A Space Power Doctrine*, presented the first formal definition. Lupton suggested that respected definitions of land, sea and air power offered by Mahan, Mitchell, Arnold and others included three characteristics: 1) elements of national power, 2) purposes that are military and non-military, and 3) systems that are military and civilian.[3] With this in mind, Lupton offered this definition:

> Space power is the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation.[4]

Lupton adds that a nation with such capabilities is also called a *space power.*[5]

Col Robert Larned, former Deputy Director for Operations, AFSPACECOM, presented the following definition at the 1994 Air & Space Doctrine Symposium:

> Spacepower is the ability to exploit the civil, commercial and national security space systems and associated infrastructure in support of national security strategy.[6]

He further defined space systems as, "distributed systems consisting of three elements: a space element, a terrestrial element, and a link element."[7]

In 1995, the authors of Space Power 2010 offered another definition of space power. Their idea was to define the individual terms space and power, and then marry them together to form the full concept. They defined space as "the area above the Earth's atmosphere extending out to infinity in all directions, beginning approximately 62 miles (or 100 kilometers) above the Earth's surface."[8] They defined power as "the ability of a state or non-state actor to achieve its goals and objectives in the presence of other actors on the world stage."[9] Their overall definition then looked like this:

> Space power is the ability of a state or non-state actor to achieve its goals and objectives in the presence of other actors on the world stage through control and exploitation of the space environment.[10]

More recently, Colin Gray offered yet another definition in his 1996 article, "The Influence of Space Power upon History." Gray said,

> Space power may be defined as the ability to use space while denying reliable use to any foe.[11]

Finally, the authors of the February 1997 draft of *AFDD 2-2, Space Operations*, defined space power as:

> The capability to exploit space forces to support national security strategy and achieve national security objectives.[12]

The authors also provide categories of space power. First, they suggest that the subparts to space power can be seen as national, DOD, civil and commercial space systems and their associated infrastructures.[13] Secondly, these parts can be further subdivided as follows: space-based systems, ground-based systems, and launch systems.[14]

Explanations of Space Power

Explanations of space power include discussions on the nature, importance, and functioning of space power. Many authors explain the nature of space power in terms of various attributes of the space environment and space forces. Lupton used three categories of attributes: 1) *Environmentally Influenced Characteristics* such as global presence, the positional nature of motion in space (as opposed to maneuver-oriented operations in the air), and long-range electromagnetic weapon effects; 2) *Logistically Influenced Characteristics* such as long and difficult lines of communication and few inhabited assets in space; and 3) *Politically/Legally Influenced Characteristics* such as legal overflight (over sovereign territories) and vehicular sovereignty.[15]

Other authors added to the list of space power attributes. Colin Gray offered the following *Defining Characteristics* of space power: 1) Space is the "high ground" of all combat arenas; 2) Space is both global and of all but infinite military depth; and 3) astrodynamics translates to satellites globally available as a regularly repeating, overhead presence.[16] Gray balanced these potential advantages of space power by identifying the following *Limitations*: 1) Cost of transportation into orbit; 2) Laws of motion limiting maneuver in space; and 3) Long distances from terrestrial events.[17] In contrast, Larned argued that the three key attributes of space power are *Continuity, Dispersion and Timeliness*.[18] Finally, in a rare integration of air and space power, Maj Bruce DeBlois brought air and space power attributes together in his article, "Ascendant Realms: Characteristics of Airpower and Space Power," where he discussed the characteristic advantages of air and space power in terms of politics, deployment and employment,

realm access, realm environment, and realm-afforded capability.[19] Detailed lists of these and other space power attributes are listed in Appendix B.

A second aspect of space power that military thinkers explain is its importance. A common method for this purpose is the use of analogies; especially analogies of land, sea, and air power. Several authors used Carl von Clausewitz' theory of land warfare and applied it to space power. For example, in his paper "Clausewitz on Space War," Lt Col Donald Baucom projected Clausewitzian concepts onto space operations.[20] Baucom translated the unpredictability of war into space and argued that danger, uncertainty, chance, fog, and friction will influence space wars.[21] He also discussed how moral factors such as courage, intuition, battlefield experience and genius will effect space wars.[22] Baucom causes the reader to wonder what unmanned, computer-controlled systems battling in space would do to the predictability and moral factors of space wars. To that end, he made the following supposition:

> ...in a space war, human beings would be removed a minimum of 100 miles from the location of actual combat. "Death" may now become the destruction of a space system, and this sterile, unemotional event may only be "sensed" through electronic data that are translated into a command post display. Under these circumstances, what becomes of Clausewitz's dictum that "war is the realm of danger; therefore courage is the soldier's first requirement?"
>
> For one thing, in a space battle, the fear and stress traditionally associated with combat may be replaced by something akin to the excitement of play experienced in a video game.[23]

Another analogy from land warfare used to capture the significance of space power is the high ground theory. The high ground theory states that by commanding the hill you will control the surrounding country and can influence the battle in your favor—thereby winning the war.[24] One unique version of the high ground theory applied to space involves the *gravity well theory*. While, Appendix X has an explanation of the gravity

wells (gravitational forces) that shape the Earth and Moon, G. Harry Stine captured the military significance of the gravity well theory in two axioms:

> a) Control of the Moon means control of the Earth, and
>
> b) Control of the L-4 and L-5 libration points [see Figure 1] means control of the entire Earth-Moon system.[25]

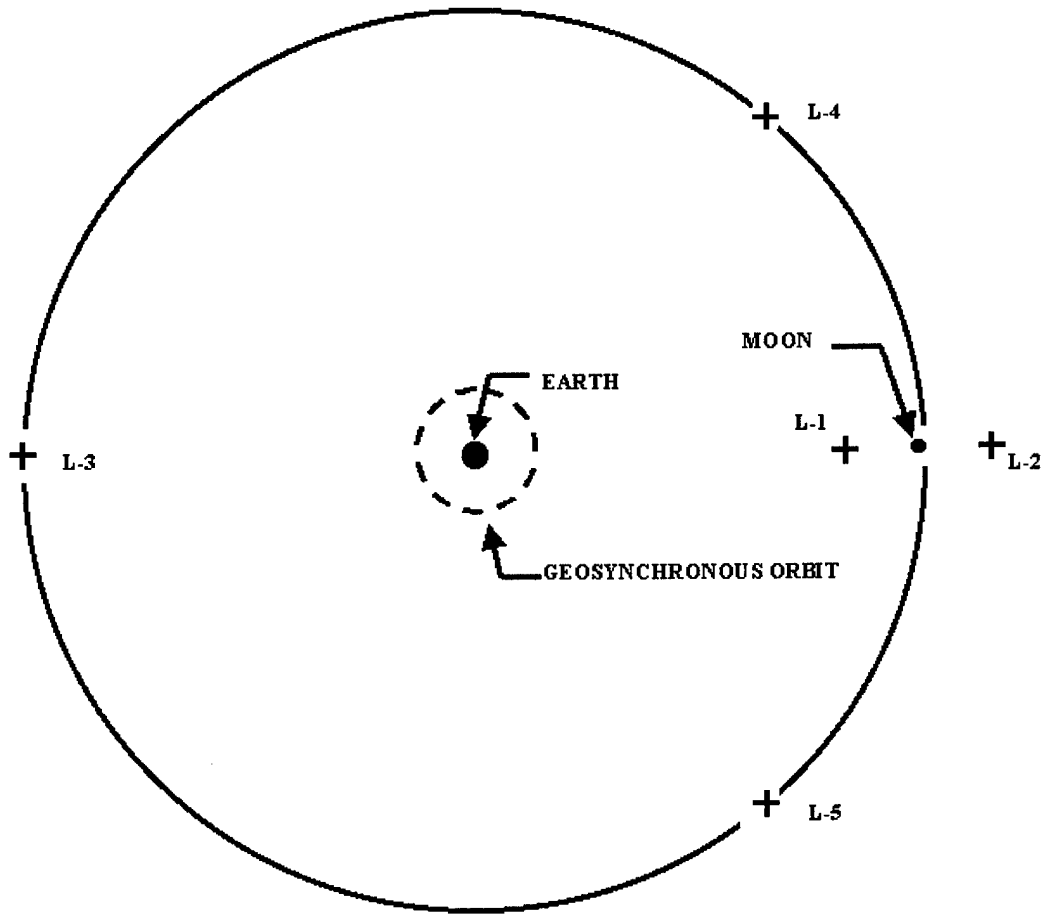

Figure 1. Lagrangian Points in the Earth Moon System

From here, Stine stated that a military commander has

> the ability to permit or deny passage of space traffic, to deny the use of other military or commercial orbital areas to others, to launch strikes against *any* target on Earth, on the Moon, or in Earth-Moon space, or detect and take action against any threat originating anywhere in the Earth-Moon system.[26]

Another land warfare approach that Stine took was to divide space into military operational zones. He claimed each zone has a different "terrain" (physical properties). Stine's Earth-Moon operational zones and their significance on space weapons are presented in Appendix C. Overall, the gravity well theory is an extension of high ground theory into space. However, proponents of the gravity well theory believe that control of the high ground in space means not only control of space, but land, sea and air as well.

In addition to land power analogies, the significance of space power is often explained using sea power analogies. An early attempt was in 1960, when Capt Brent Brentnall, wrote in his SOS paper "Military Strategy in Space: A Theory of Choke Points." Since 1960, such papers as Maj Douglas Kohlhepp's, "A Mahanian View of Space Control," and Maj Richard Davenport's Naval War College paper "Strategies for Space: Past, Present, and Future" also added to the sea power analogies for space power. Perhaps better known, is Dandridge Cole's Panama Theory presented to the American Astronautical Society in 1961. Cole offered that, "the exploitation of space will follow the general historical pattern almost invariably repeated during the pretwentieth-century [sic] expansions on Earth [through sea power], at least to the extent that some competitive advantage will accrue to the nation or nations that control the most valuable extraterrestrial real estate."[27] All of these authors applied sea power terms like choke points to space power. Cole suggested that choke points in space would be like the Panama Canal—a single strategic point where lines of communication converge.[28] Such choke points in space might be space stations, asteroids or planets.[29] Cole argued that lines of communication in space would be critical for future interplanetary missions (exploration, mining and other economic and military purposes). Therefore, there are

military, political and economic advantages (and disadvantages) to defending and controlling these "stepping stones" in space.[30]

In a Mahanian fashion, Gen Howell Estes, USCINCSPACE, explained the significance of space power in terms of the economic strength of the US. Estes said, "A tremendous amount of our economic strength is migrating to space."[31] Within a decade, government and commercial concerns are "going to put 1,800 satellites into orbit."[32] Estes claims that dependence on satellites will be akin to dependence on foreign oil and our potential enemies will find these satellites too tempting as a target.[33] Estes concluded, "we as a nation are going to protect the investment. One of the main reasons for having a military is to make damn sure that economic investment survives."[34] For a list of other sea power analogies and a comparison of sea and space operations with land and air operations by George and Meredith Friedman, refer to Appendix D.

Explanations of the significance of space power are also replete with analogies from air power. Some analogies compare air power missions with space power missions. Traditional missions such as communications, surveillance and reconnaissance are frequently discussed. Some writings referred to space launch as spacelift thus, by inference, drawing an analogy to airlift.[35] More overtly, Gen Estes talked of space missions such as on-orbit refueling, and space transport which smacks of air refueling and air transport.[36] Maj Gregory Billman also used an air power analogy to explain the significance of space power. He compared air and space power's early employment, organizational development, new and environmentally hostile environments, requirement for a technological knowledge base, conceptual thought required to develop theory, need for doctrinal push, the way each power's resources were first employed (observation and

reconnaissance), and evolution and relationship of each power's technologies to new roles.[37] Billman asserted that remarkably similar circumstances exist for space power today that also led to the importance of air power.

Other authors added to the air power analogy for space power. Maj Edward Lorenzini suggested the following parallels between air and space power: control of the sky (i.e., air and space superiority), development of strategic theory prior to the wide use of air or space power, similarities between satellites and observation balloons, and strategic paralysis as a common objective.[38] Colin Gray drew another parallel between the strategic utility of air and space power. He suggested that both have progressed from 1) experimental/marginal adjunct to terrestrial forces to 2) useful and important adjunct to 3) indispensable adjunct and on the possible road to 4) independent war winner.[39] Gray concluded, "there is a possible analogy between 1918 vintage air power as a harbinger of air power in 1939-45, and 1991 vintage space power in Desert Storm and the use of space power in deterrence and war in the future."[40] Another interesting analogy comes from Erik Bergaust, when he quoted I. A. Getting of the Aerospace Corporation in 1962:

> Almost five years before the first successful flight by the Wright Brothers, The Hague Peace Conference solemnly promulgated a declaration that prohibited assignment of aircraft, present or projected, to combatant use in war. The discharge of projectiles or explosives from the air was banned, and by agreement the role of air vehicles was limited to reconnaissance and similarly passive employment.[41]

The analogy is clear—airpower began with certain peaceful standards, which air warfare later made obsolete. Bergaust suggested that similar standards for the strictly peaceful use of space (reflected in many international treaties) are likewise facing the inevitability of war in space.[42] While the nature of space power is often explained by attributes, and

the significance of space power is often explained using analogies, the methods for explaining how space power functions are more varied.

Authors use schools of thought, historical examples of space power, traditional military roles, the concept of space control, and debate regarding the best way to organize space power to explain the functioning of space power. The seminal work on schools of thought is Lupton's *On Space Warfare*. Referred to by many other authors, Lupton focused on the uses of space. Lupton explained four schools of thought for the military value of space forces. These schools of thought range from the absolute condemnation of weapons in space to the total and dominating weaponization of space.[43] For a more detailed account of these schools of thought, see Appendix E.

Authors also used historical examples to explain how space forces function. Early examples of the use of space power in Vietnam, Libya, Haiti, Grenada, Somalia, Bosnia and the Cold War are virtually unavailable in unclassified form. Likewise, the military significance of events like the Challenger disaster and the fixing of the Hubble telescope were also rarely discussed. However, numerous authors discussed examples of space power during the Persian Gulf War.[44] Janushkowsky's summarized his analysis with six lessons learned about space power from the Gulf War. David Spires and Maj Frank Gallegos, offered historical accounts of space power in the Gulf War from military analysts. The conclusions of Janushkowsky, Spires, and Gallegos on the importance of space power in the Gulf War are found in Appendix F.

Colin Gray also examined the Gulf War, but came to a different conclusion. In his paper, "The Influence of Space Power upon History," Gray explained that

> The future of space power and its actual meaning for particular conflicts are, of course, beyond precise prediction. What matters is to put a finger

> on a clearly identifiable trend (i.e., a trend toward information based war critically dependent on space systems).[45]

Gray's thesis is that "a maturing space power is on—indeed is—the leading edge of a transformation of war."[46] Gray expanded on Alvin and Heidi Toffler's idea that information age (or "third wave") warfare (dominated by space power) represents a possible revolution in military affairs.[47] Gray saw space power as the cutting edge (but not the entire sword) of information age military prowess. Appendix G captures some of Gray's definitive statements concerning the military use of space power.

In addition to schools of thought and historical examples, some authors have tried to explain space power through its incorporation into traditional military roles. For example, in "Space—A New Dimension to AirLand Battle Doctrine," Army Maj Herbert Carr stated, "the basic character and spirit of AirLand Battle (ALB) doctrine will not change."[48] However, Carr acknowledged that "ALB needs to change in order to accommodate the increased firepower of DEW [directed-energy weapons] and KEW [kinetic-energy weapons]."[49] Carr then went on to develop the argument for the "synergistic effect of a combined arms approach to maneuver warfare."[50] Similarly, Army Col Arthur Estrada, asserted that while "'Star Trek' images...may indeed predict the future battlefield of soldiers yet unborn, they presume to take us beyond the battlefield where space forces are most likely to be employed: planet Earth."[51] Estrada and Carr gave place to the idea of space control, but their focus remained on an integrated terrestrial battle. In contrast, other authors focused their thinking on space control.

Space control is a topic of great concern among many individuals today. Many authors explained space power by explaining space control. Michael Mantz had such a focus in his 1987 ACSC paper, "On Space Warfare: Space Rules of Engagement," where

he introduced the idea of rules of engagement for counterspace operations.[52] In 1990, Lt Col Stephen Dunning cited US Space Command Pamphlet 2-1 as a "starting point for developing a US military space doctrine for the employment of space forces."[53] Dunning then suggests a four-phased approach to space control. His phases included: Force Readiness, Endurance, Denial and Post-conflict.[54] The specific steps of these four phases and Dunning's main doctrinal tenets for space control are listed in Appendix H.

Other authors used the idea of space control to explain how space power functions. In 1990, Capt John Power addressed, "Space Control in the Post-Cold War Era." Power focused on assuring access to space first; then denying access to potential enemies.[55] Some authors narrowed their focus on space control to discussions about ASATs. In "Space Control and the Role of Antisatellite Weapons," Maj Steve Peterson argued that the functions of space control should include monitoring, assessing, informing, negating and protecting, and that ASAT capabilities are critical to performing these functions.[56] In 1993, Lt Col Brian Carron broadened this discussion to address the question of whether it's even possible to achieve "total space control."[57] He defined space control borrowing from AFM 1-6, which stated that "the purpose of aerospace control is to assure the friendly use of the environment while denying its use to an enemy."[58]

Of special note is Steve Lambakis' article, "Space Control in Desert Storm and Beyond." Lambakis combined historical examples from the Gulf War and an explanation of space control. He examined space control efforts during the war and argued that without space power, a coalition victory would have been much more grueling.[59] Lambakis spoke of current armed forces as "space-dependent military capabilities," and argued that "in the future, space control will be as important as sea control or command

of the air is today."[60] He concluded that the "Persian Gulf War demonstrated in no uncertain terms the life and death importance of modern C^3I networks to current military doctrine."[61] Lambakis then predicted "a future dominated by information technologies dependent on space systems," and suggested "a formal institutional separation of space power from air, land, and sea power seems to be in order."[62]

Debate regarding the best way to organize space assets has been used to explain how space power best functions. The 1997 "Space Day" panel held at Maxwell AFB, Alabama, focused on this issue. While a transcript of this event is not yet available, the panel members presented numerous opposing views. Various individuals have argued for or against an independent US Space Force. Appendix I sums up many arguments for and against the centralization of space power as a separate branch of service.

Predictions of Space Power

A final element of space power theory is predictions of space power. While some explanations of space power enjoy a strong predictive power as a side benefit, other thinking is predominantly focused on space power's future nature, significance and functioning. These stand-alone products are the focus of this section. Two notable methods for expressing these predictions are discussions about the weaponization of space and Air Force studies designed to envision the future.

Theory concerning the weaponization of space can express powerful predictions of the future of space power.[63] Lt Col Mike Mantz wrote one of the most thorough theories on the use of weapons in space. In his study "Space Combat Theory, A New Sword," Mantz discussed the possibilities of space combat. Mantz saw the use of space for the following hostile missions: space denial, space strike, and space protection.[64] Mantz also

discussed three categories of targets: ground-based systems, space-based systems and the medium(s) between the two types of systems. Mantz' defining axioms and types of missions are listed in Appendix J.

Many predictive approaches incorporate possible scenarios about the future. Some writings, such as James Snead's "United States Aerospace Forces Circa 2020" and "Pearl Harbor II", and Michael Baum's "Defiling the Alter; The Weaponization of Space," were purely scenarios that used fictitious (but realistic) examples of space power to send powerful messages of the possible importance and uses of space power in the future. These scenarios highlight the importance of space-based information and weapon systems by discussing what might happen if a nation that did not have them fought an adversary that did. The message of such writers is that space weapons are inevitable, space weapons are essential to the survival of third wave nations, and to wait to develop space weapons until after an adversary takes hostile action would be disastrous.

Finally, there was a recent wave of Air Force studies that explored future possibilities. These efforts include *Spacecast 2020*, *Air Force 2025*, and *New World Vistas—Air and Space Power for the 21st Century*. Janushkowsky also captured future-oriented themes in his predictions on future space requirements. Janushkowsky's eight predictions, supplemented with matching comments from the three Air Force studies, are listed in Appendix K.

Notes

[1] In the interest of brevity, four groups of space theorists were intentionally left out of this paper. The first group is the early theorists such as Aristotle and Nicolaus Copernicus. While these visionaries generated interest in the nature, significance and functioning of heavenly bodies, many of their ideas were not accurate as scientists have discovered: this paper will not include their "visions" as theory. A second group includes theorists such as Johannes Kepler and Sir Isaac Newton, whose laws of motion for bodies

in space were instrumental in the fields of orbital mechanics and astronautics. They were excluded because of their technically specific application to science: this paper will not include their "laws" of motion as theory. The third set of early theorists was individuals like Konstantin Tiolkovsky, Robert Goddard, Hermann Oberth and Arthur C. Clarke. While these individuals accurately predicted interplanetary travel, sending rockets to the moon, orbiting artificial satellites around the Earth and global communications using satellites, their predictions are no longer "theories." This paper will not include what is now reality in this discussion of current theory. The fourth group of theorists that was intentionally left out of this paper includes individuals like Wernher von Braun, Gen Bernard Schriever and President Dwight D. Eisenhower. These individuals were integrally involved in the founding of certain space programs. It could be strongly argued that the reasoning and policy guidance of these leaders constitute space power theory. However, unlike the previous three groups, it is difficult to find publications by these individuals that were designed to articulate space power theory. The task of understanding their logic and translating their often concise statements into space power theory is better left to a more exhaustive study. This paper will focus on published works that were obviously intended to add to the body of current space power theory. For more information on the first three group of space theorists, see *U.S. Army Space Reference Text* by the US Army Command and General Staff College, Fort Leavenworth, KS, January, 1995. I'm indebted to Maj Roy Houchin, Space Chair, SAAS, for his insights regarding the last group of space power theorists.

[2] Klaus Knorr, "On The International Implications Of Outer Space," presented at *Reflections On Space: Its Implications for Domestic and International Affairs*, (United States Air Force Academy, CO, 1964), 247.

[3] David E. Lupton, *On Space Warfare, A Pace Power Doctrine,* (Maxwell AFB, AL: Air University Press, June 1988), 6.

[4] Ibid., 7.

[5] Ibid.

[6] Robert E. Larned, *1994 Air and Space Doctrine Symposium,* Maxwell AFB, Ala.: Air University Press, December 1994, 4.

[7] Ibid., 4.

[8] James L. Hyatt et al., *Space Power 2010,* (Maxwell AFB, AL: Air Command and Staff College, May 1995), 5.

[9] Ibid., 4-5.

[10] Ibid., 6.

[11] Colin S. Gray, "The Influence of Space Power upon History," *Comparative Strategy,* October-December, 1996: 293.

[12] Air Force Doctrine Center. *AFDD 2-2, Space Operations (Draft)*. Maxwell AFB, AL: Air Force Doctrine Center, February, 1998, 1.

[13] Ibid., 1.

[14] Ibid.

[15] Lupton, 18.

[16] Gray, 300.

[17] Gray, 301-302.

Notes

[18] Larned, 9.

[19] Bruce M. DeBlois, "Ascendant Realms: Characteristics of Air Power and Space Power," In *The Paths of Heaven: The Evolution of Airpower Theory,* Ed. Phillip Meilinger, (Maxwell AFB, AL: Air University Press, August 1997), 540-555.

[20] Baucom, Donald R. *Clausewitz on Space War: An Essay on the Strategic Aspects of Military Operations in Space,* Maxwell AFB, AL: Air University Press, June 1992, 3.

[21] Ibid.

[22] Ibid.

[23] Ibid., 9.

[24] Erik Bergaust, *The Next Fifty Years in Space,* (NY: The Macmillan Co., 1964), 101. Bergaust mentioned that important military functions are best conducted on high ground (e.g. observation, communication, navigation, defending, and even attacking).

[25] G. Harry Stine, *Confrontation In Space,* (Englewood Cliffs, NJ: Prentice-Hall, Inc. 1981), 58.

[26] Ibid.

[27] Dandridge Cole, "Report on the Panama Theory," American Astronautical Society (August, 1961), 229.

[28] Dandridge M. Cole and Donald W. Cox, *Islands In Space,* (Philadelphia: Chilton Company, 1964), 113.

[29] Ibid. According to Stine, these choke points include L-4, L-5 and the Moon. (Stine, 55, 61)

[30] Ibid.

[31] John A. Tirpak, "The Rise of Space," *Air Force Magazine* (August, 1997), 53.

[32] Ibid.

[33] Ibid.

[34] Ibid.

[35] Air Force Doctrine Center, *AFDD-1, Air Force Basic Doctrine,* Maxwell AFB, AL: Air Force Doctrine Center, September, 1997, 56.

[36] Tirpak, 54.

[37] Gregory Billman, *The Inherent Limitations of Spacepower: Fact or Fiction?* Maxwell AFB, AL: School of Advanced Airpower Studies, 1995, 4.

[38] Edward V Lorenzini, *Foundations For Space Warfare Theory,* Maxwell AFB, AL: Air Command and Staff College, March 1997, 26-27.

[39] Gray, 295.

[40] Gray, 300.

[41] Bergaust, 101.

[42] Ibid.

[43] Lupton, 35-37.

[44] I appreciate Maj Roy Houchin's insight into the difference between military space power before and after Desert Storm: prior to 1990, space power was support to the NCA (usually reconnaissance or communications), whereas during and after Desert Storm space power meant support to the warfighter.

[45] Gray, 293.

[46] Ibid.

Notes

[47] Alvin Toffler, and Heidi Toffler, *War and Anti-War,* (Canada: Little, Brown and Company, 1993), 29-32.

[48] Herbert M. Carr, III, *Space—A New Dimension To Airland Battle Doctrine.* Maxwell AFB, AL: Air Command and Staff College, 1987, vi.

[49] Ibid.

[50] Ibid., 2.

[51] Arthur T. Estrada, *Space Support for Airland Battle-Future.* Carlisle Barracks, PA: US Army War College, 1991, 1.

[52] Michael R. Mantz, *On Space Warfare: Space Rules Of Engagement,* Maxwell AFB, AL: Air Command and Staff College, 1987, 2.

[53] Stephen J. Dunning, *US Military Space Strategy,* Newport, RI: Naval War College, 14 May 1990, 13.

[54] Ibid., 16-17.

[55] John W. Power, "Space Control in the Post-Cold War Era," *Air Power Journal* (Winter, 1990), 26.

[56] Steven R. Petersen, *Space Control and The Role of Antisatellite Weapons,* Maxwell AFB, AL: Air University Press, May 1991, 62-68.

[57] Brian, E. Carron, *The Value Of Space Control And How We Can Achieve It,* Maxwell AFB, AL: Air War College, April 1993, iii.

[58] Ibid., 3.

[59] Steven Lambakis, "Space Control in Desert Storm and Beyond," *Orbis: A Journal of World Affairs* (Summer, 1995), 417.

[60] Ibid., 427.

[61] Ibid., 430.

[62] Ibid., 432.

[63] The notion of weaponizing space carries a particularly future orientation, for although the FSU has deployed operational ASAT weapons, the widespread use of weapons in space has not yet occurred.

[64] Michael R. Mantz, *The New Sword, A Theory of Space Combat Power* Maxwell AFB, AL: Air University Press, May 1995, 2.

Chapter 4

Analysis of Current Space Power Theory

If Desert Storm has taught us anything, it is that only when space is recognized as a strategic environment central to the American way of war will the security and power of the United States attain its highest measure. The alternative is to await another shock—a Pearl Harbor in space—by which time it may be too late.

—Steve Lambakis

Definitions of Space Power

A complete definition of space power is still emerging. While different definitions emphasize different aspects, no definition covers all aspects of the actors, capabilities, functions and purposes of space power. Additionally, definitions are notably different.[1] Nonetheless, the definitions offered provide a meaningful addition to space power theory.

Lupton's definition proved insightful, yet incomplete. Lupton's definition allows non-military systems such as the space shuttle, which has made a valuable contribution to US space power, to be considered part of a nation's space power. It also allows the inclusion of non-military purposes, such as enhancing economic well being through the sale of space technology to other countries. Furthermore, Lupton was among the first to recognize that a nation with space capabilities is also called a *space power.* Lupton's insightful definition is a sound starting point,[2] and yet, it is incomplete. Lupton failed to acknowledge the non-state actor. Yet, it is plausible for a non-state actor (MNC, NGO,

or terrorist group) to buy, rent, borrow or use its influence to gain space capabilities in a Post-Cold War, multipolar world.[3] Furthermore, Lupton does not address the function of space control in his definition. Moreover, Lupton was not precise when defining the "entire astronautical capabilities" of a nation, like Larned does in his definition.

Larned's definition gives categories to Lupton's "entire astronautical capabilities" by identifying "national security, civil, and commercial space systems" as the types of capabilities. One subtle difference, however, is that Larned spoke of exploiting "space systems," whereas Lupton speaks of exploiting the space environment. Larned's terminology raises some interesting questions. If a space system such as a missile or space plane is given a flight path that does not reach into space, does that mean that these are still space power missions since they use space systems? It is the author's opinion that the actual ability to operate in the space *environment* is a better dividing line to differentiate what is space power and what is not. Defining space power by its systems runs the same problem as trying to define an air power mission based on the air platform.[4] Larned's definition is subject to further criticism in that it limits space power to national security purposes with the apparent exclusion of economic and political purposes. Moreover, like Lupton, Larned did not allow for a non-state actor in his definition of space power.

The authors of *Space Power 2010* picked up where Lupton and Larned left off. In their efforts to redefine space power, they address the possibility of non-state actors. Additionally, the authors' proposed altitude at which space begins, provides a picture of the "geography" and vastness of this unique environment. Furthermore, among the definitions covered in this paper, the Space Power 2010 version is the first to include the

idea of control. The idea of space control may be an important missing ingredient from previous definitions. Since exploitation may be dependent on control, it seems a worthwhile to include both of these basic space power functions in a thorough definition.

Unfortunately, the authors' overall approach to defining space power invites criticism in two ways. First, the very approach of defining space and power to arrive at space power is insufficient. The end result is a sterile definition. One part of their definition that is alive is the idea of "control and exploitation," yet it is unclear where these concepts came from as the authors did not address these ideas in their definitions of space or power. Regardless, even if foolproof definitions of space and power existed, the overall definition of space power is more than just the sum of its sub-definitions. It is an entirely new concept.

A second problem with the *2010* definition is the difficulty of defining boundaries for space. The definition of space is not consistent across the body of space power literature. Writers have proposed different upper and lower limits to space.[5] The authors of *Space Power 2010* even acknowledge the difficulty in defining the limits of space. They summarized Capt Carol Laymance's definitions of space from her article "Science of Space."

> If trying to define where space begins for biological reasons, one might choose 9 miles above the Earth since above this point a pressure suit is required. If concerned with propulsion, 28 miles is important since this is the limit of air-breathing engines. For administrative purposes, one might find it important that US astronaut wings may be earned above 50 miles. An aeronautical engineer might define space as starting at 62 miles above the Earth's surface since this is where aerodynamic controls become ineffective. Conventional and customary law defines the lower boundary of space as the lowest perigee of orbiting space vehicles, about 93 miles.[6]

Unfortunately, the authors of *Space Power 2010* did not explain why they chose 62 miles as the best boundary. They also offered no upper border to limit their discussion of space

operations. Furthermore, they failed to even make use of boundaries in their definition of space power. Despite the obvious difficulty in defining where space begins (or ends), one common theme did emerge—militarily useful space is "where satellites orbit."

Colin Gray included the idea of space control in his definition. His unique approach offers no specific actors, capabilities, functions, or purposes. Instead, he focuses purely on the desired end result—one can either use space or not; deny its use to an enemy or not. Is Gray's approach refreshingly straightforward or deceivingly oversimplified? On the one hand, Gray's bottom line tactic seems helpful. On the other hand, if we do not address the categories (of actors, purposes, functions and capabilities) in our definition, the usefulness of this approach is in question. As Winton expresses in chapter two above, categories help us to understand a theory. Gray himself modified his own definition in a later chapter to include categories of capabilities. Gray then lightly touched on some of the other categories. It is the author's opinion, however, that a more complete definition offers greater potential to concisely articulate the full essence of space power.

Finally, the authors of *AFDD 2-2, Space Operations*, chose to focus their definition on national security strategy and objectives. This approach highlights the importance of national security in guiding the use of space power. More importantly, the authors offered categories of capabilities immediately following their definition. Their categories of "national, DOD, civil and commercial space systems" are the first to distinguish between national and military systems. Additionally, categorizing system capabilities as either space-based, ground-based, or launch may prove helpful in understanding the mechanics of space power. Unfortunately, this most recent definition of space power is

relatively incomplete. It fails to acknowledge the use of space power by non-state actors and does not include the important function of space control.

A complete definition of space power still eludes space power theorists. However, significant headway has been made in reaching this goal. The promising definitions bring forth the following fundamental aspects:

1) the ability to exploit the space environment
2) the ability to control the space environment
3) space is a separate environment
4) the pursuit of an actor's goals (security, economic and political)
5) an actor's entire astronautical capability
6) categories of space capability include national, military, civilian, and commercial (each can be subdivided into space-based, ground-based and launch systems)
7) the actor can be a state or non-state actor

Explanations of Space Power

Explanations of space power are nearly as varied as the authors and speakers that present them. Although not exhaustive, the plethora of methods helps explain the nature, significance and functioning of space power. The nature of systems operating in the space environment is revealed using the attributes of space power. These attributes help the reader to see the peculiar nature of space power. Unfortunately, while there are many attempts to identify "key" attributes that make space power truly unique from other forms of military operations, there is virtually no consensus on which are those key attributes. Furthermore, the preponderance of thought claiming that space is a unique environment may be out of balance. While the authors successfully paint a picture of space as a separate and unique environment demanding a unique set of operational considerations, this picture fails to clarify how air and space power form an integrated team. Few writers discussed the similarities of air and space power. One notable exception is Maj (now Lt

Col) Bruce DeBlois' article, *Ascendant Realms: Characteristics of Airpower and Space Power*. DeBlois took a major step forward in this area; however, the prevailing focus on unique characteristics may still be hindering the development of an integrated theory of air and space power. It is the author's opinion that a new focus on common attributes of air and space power is needed in the foundational thinking necessary for an "air and space force" as advocated in *Global Engagement*. At some point, military theorists must preserve space power's uniqueness while also establishing a clear explanation for the Air Force controlling and exploiting the entirety of the third dimension.

Analogies for space power provide powerful illustrations of the nature and significance of space power. Comparing and contrasting aspects of land, sea and air power with aspects of space power helps one to imagine what space power is like. The character of space power becomes tangible when viewed in light of the military powers that went before it.[7] Additionally, land, sea and air power become a type of standard with which to gage space power. It is natural to compare space power with its big brothers, but this type of comparison has the same advantages and disadvantages as brothers in high school. People immediately recognize the "family name," but they also tend to hold high expectations of the younger sibling—leaving the younger sibling living in the shadow of his older siblings until he independently establishes his own merit. Thus the message is twofold: 1) since land, sea and air power are significant and decisive, space power holds equal potential; however, 2) space power has yet to fully prove itself.

Also somewhat lacking amongst the many military analogies, is a comparison of undersea power to space power. The three-dimensional operations in the vastness of the dark undersea may actually provide an even better comparison to space power.

Moreover, despite the more obvious boundary between the mediums, sea surface and subsurface operations integrated into one service may be a critical, yet overlooked, analogy for an air and space force of the future. Furthermore, one must wonder if another more original analogy (like Clausewitz comparing land warfare to two wrestlers)[8] exists, which can further explain space power. If an effective, original, non-military example does exist, it is not prominent in space power literature.

Historical examples also add to the body of space power theory. Gray and Lambakis' analyses of space power in the Gulf War conveyed meaningful interpretations of space power's contribution to information warfare. In essence, Gray and Lambakis picked up where Lupton left off and Mantz intentionally avoided. The historical examples of space power used in the desert war clearly communicate the growing significance of space power. Conversely, historical examples of space power are limited, thus their power to convey the full significance and use of space power is notably limited. Many articles attempted to explain without historical examples. Conversely, David Spires provided a very factual and thorough account of space power history, but without much interpretation or explanation of the significance of these events. Spires' *Beyond Horizons* is history, not theory. Furthermore, while historical examples usually serve as the meat of land, sea and air power theory, many writers have complained that there simply are not enough examples of space power in action to make lasting explanations of its use in the battlespace. There are even fewer examples of actual violence in space leaving one to "theorize" what such chaos might be like by extrapolating land, sea and air war into space or by exploring science fiction.

Explaining space power using traditional combat roles can help one's comprehension of space power. This approach incorporates the functions of space power smoothly into the theories of surface warfare. It meets space power where it is developmentally today—as a joint force multiplier. It also fosters the joint flavor emphasized in US military doctrine today. Unfortunately, this approach has flaws as well. The flip side of the coin is that this method does not advance the potential significance that space power may take beyond the force enhancement role. It fails to address the arguable potential of information or combat power from space as a decisive war winner.

Space control is a hot topic in space power theory today and an essential concept for understanding space power. Colin Gray argued, "All theories of space power must include treatment of space control. Unless theorists, including an official defense planner, can explain why and how their country will be at strategic liberty to derive military advantage from the use of space, their theory or defense plans must invite skepticism."[9] Space superiority, now a core competency of the Air Force, requires space control. The new *AFDD 1* and the draft *AFDD 2-2* both declare the importance of space control. The common understanding of space control is that it assures friendly and denies enemy access to space. But the subject begs further discussion.

Another hot topic is the organizing of space capabilities. Not much of current literature explains the heated debate, but numerous researchers have proposals to address the subject. The question many seek to answer is, "What is the best way to organize space capabilities and why?" This question takes the form of two separate debates: centralization versus decentralization, and an independent Space Force versus a single service of integrated air and space forces. The merits and shortcomings of each position

need to be further explored. Coherent explanations of space control and space force organization may be the next significant addition to space power theory.

Predictions of Space Power

Predictions of space power are a valid part of space power theory. Some predictions are derived from explanations of space power like those discussed above. Many of these explanations carry with them an ability to predict "more of the same" (or a variation of it) in the future. Yet some predictions are stand-alone and do not enjoy an accompanying explanation. These stand-alone predictions of space power cause us to look (and hopefully plan) ahead in the same way that Giulio Douhet's *Command of the Air* assisted air power. Nevertheless, the major predictive theories have strengths and weaknesses.

Mantz' theory looked at firepower in space. His publication predicted space power to progress in much the same manner that air power has—to the point of being a decisive force by applying long range, strategic firepower (including bombardment) through the sky. Mantz' respectful discussion of space strike operations gives amplification to the idea of decisive space power as a potential war winner. It also gives specific details to accomplish space control in a weaponized space environment. Disappointingly, Mantz intentionally chose to limit his theory to fire power and thus makes no statement on the significance of information systems to the future of warfighting. Nor does he address but scant information on joint operations. Thus, Mantz' theory is not a space power theory; it is a space *combat* theory. Nevertheless, with the exception of his omission of force enhancement roles from space, Mantz' theory remains one of the most scholarly works on space power that actually claims to be a theory.

Other discussions about the weaponization of space add to space power theory. Predictions that use scenarios help to create a believable picture of the future with (or without) appropriate space capabilities. These "what if" scenarios raise awareness of the importance of space-based information and weapon systems. If there is value in fiction literature to the body of space power theory, this may be an area of possible contribution.

There are, however, some concerns with the idea of space weaponization. First, authors discussing space weaponization generally assume that space weaponization is inevitable and thus focus on weapons in space giving little attention to the use of ground-based or air weapons to target space-based assets. Additionally, given the lack of history to describe, some of these theories take on a how-to flavor thus departing conservative descriptive theory. Without thorough explanations, prescriptive approaches run the risk of being less than theory (probably strategy or doctrine regarding the functions of space weapons). A complete theory of why weapons in space are important (as opposed to "how-to") may be more valuable at this point in history.

Several other predictive theories exist. The Air Force studies cause the reader to imagine more future details than one might envision on his or her own. On the other hand, it is possible that the Air Force studies are simply not free enough from political "guidance" to "sell" to a wide audience of space "high ground" enthusiasts, "info-warriors" and advocates of joint operations. Furthermore, like explanations of space power, a coherent prediction of integrated air and space power is missing from Air Force libraries. This theoretical foundation must be laid in order to pave the way for future Air Force operations.

Lack of Comprehensive Theories of Space Power

The body of space power literature currently lacks a single comprehensive theory.[10] No one theory thoroughly defines, explains and predicts the nature, significance and functioning of space power. Space power theory lacks the exhaustive treatment of military theory comparable to Clausewitz' work. Nevertheless, an examination of the closest candidates to a comprehensive theory is illuminating.

The closest candidates to a comprehensive theory were trailblazing efforts, but lacked the scope and sense of thoroughness associated with comprehensive theories. These three works were: 1) the gravity well theory; 2) Lupton's *On Space Warfare*; and 3) Mantz' space combat theory. Writers referred to these three theories more often than any other space power theory. Each of these theories (compared in Appendix K) served as a baseline or starting point for other theories.

Each theory made a unique and significant contribution. The gravity well theory raised the importance of space power to that of other types of military power. Through a respectable scientific discussion of space as the high ground of modern war, Stine and others placed space power on an equal level with air, land and sea power. Stine's "geographic"[11] approach to space power established it as a member to the joint warfighting team as well as a potentially decisive war winner. Likewise, Lupton's theory helped to advance a solid definition of space power. Also, Lupton's four philosophical schools of thought concerning the military use of space is referenced more than any other work in the body of space power theory. His explanation of the space control school was not only illuminating, it has heightened awareness of this important subject. Finally, Mantz' theory represented a first in space power theory. Mantz is the first to capture a

theory of the nature, importance and uses of firepower from space. He is one of the first theorists to formally explain why space combat power may require an independent branch of service to organize, train and equip armed forces for a separate combat arena.

As beneficial as three theories were to space power theory, each one fell short of a comprehensive theory. The gravity well theory lacked a single author, which made it difficult to capture its full explanation in a single document.[12] The theory, however, was embraced in 1958 when Air Force Gen Homer A. Boushey, Director of Space Flight Research and Development proposed putting missiles on the moon; the idea, however, met political and economic resistance.[13] This theory's time has simply not arrived. Additionally, this theory did not define space power, and it lacked sufficient discussion on space power used in a force enhancement or treaty verification role. Likewise, Mantz' theory offered no explanation of current space operations; it was fundamentally a prediction. More importantly, all three theories lacked historical examples of space power from the Persian Gulf War and, therefore, failed to draw conclusions about the importance of space power to information warfare. Each theory ultimately lacked a sense of thoroughness found in those theories recognized as complete and comprehensive works. Furthermore, none of these theories claimed to be a comprehensive theory. Proponents of the gravity well theory did not claim they have a complete theory. Lupton described his work as "doctrine" not theory. And Mantz' theory was not a space power theory, but a theory of space *combat* power. Even in his excellent article "The Influence of Space Power upon History," (which sounds remarkably like an attempt at a Mahanian-type space theory), Colin Gray stated that "Despite its growing importance, no comprehensive theory of space power has been formulated."

Recommendations

In view of the above analysis of space power definitions, explanations and predictions, this paper proposes the following recommendations for future space power theorists. Future approaches should discuss definitions, explanations and predictions of space power more thoroughly. Serious theorists should aspire to pen a single comprehensive theory of space power. In addition, this paper submits the following list of topics for more complete exploration:

1) The contributions of the four groups of space power theorists intentionally omitted from this paper (see Chapter 3, note 1)
2) A thorough descriptive approach to space power (using space power in the Gulf War which can be further assessed and reassessed as further historical examples of space power become available)
3) An updated and complete definition of space power
4) The influence of the space environment on space strategy
5) What makes space power unique from other forms of military operations
6) Hot topic one: space control
7) Space superiority (Why? What is it? How?)
8) Hot topic two: space power organization (Douhet, Mitchell, and Trenchard all said a nation needs centralized control of air power—how does this apply to space power?)
9) Limitations of space power
10) The integration of space power theory with air power theory to clearly shape the future of US air and space forces (integration of air and space environments, common attributes, superiority, common roles, operations such as using a spaceplane, and common themes such as exploiting the third dimension)
11) The operational use of space to enhance terrestrial operations in a comprehensive understanding of war as a total phenomena
12) The independent use of space power to win wars
13) Force application from and through space
14) The need for, nature, significance and uses of human beings in space (why a manned space program)
15) Training space crews (ground and space-based)
16) Space power as an extension of policy
17) Probable courses of action in response to friendly use of space power (making use of Clausewitz' idea that an enemy is someone you wrestle with, not someone you do something to)
18) Fog and friction (war on paper vs. war in reality: real world problems/space debris) in space operations (expanding on Baucom's work)

19) Space power's tie to technology and need to keep up with technology (short vignettes would help)
20) Asteroids and space power (the use of orbiting asteroids, the threat of natural or man-made disasters)
21) The contribution of science fiction (H. G. Wells, Buck Rogers, Star Wars, Star Trek, Battlestar Galactica, Babylon 5) to space power theory
22) Overcoming enormous distances in space
23) Undersea power as an analogy for space power
24) Currents and winds as an analogy for gravity
25) Unforeseen technology that may "revolutionize" warfare (like the steam engine, or nuclear weapons)
26) Defense of space launch facilities
27) Enemy use of our information systems (such as GPS)
28) Space weaponization (realistic discussion of the important of weapons in space)
29) Transitioning from space as functional support for terrestrial regions to space as an Area of Responsibility
30) Centers of Gravity in space power (satellites = COGs?)
31) Protection vs. prevention (treaties)
32) Denying space to an adversary
33) Access to space
34) Investments, interests and dependence on space power (a la Space Day panel)
35) Protecting the space lines of communication (SPLOCs)

A comprehensive theory would cover a majority, and ideally all of the above topics. In the interim, a separate and deeper treatment of each subject is needed.

Notes

[1] Authors even lack a consensus on whether to use one word (spacepower) to represent this single concept or two words (space power) emphasizing the unique space combat arena.

[2] Many authors have used the insight found in Lupton's definition when trying to define or redefine space power.

[3] Countries like France and Russia have already advertised imagery from space.

[4] One may, for example, want to identify a B-52 mission as a strategic strike mission, yet B-52s are also used for other missions such as combat air support (CAS).

[5] In his 1989 work, *Military Space Forces: The Next 50 Years*, John Collins suggested that space begins at "about 60" miles above the earth. Collins offered an upper limit of 50,000 miles to what he calls the *circumterrestrial* region of space, but admitted the upper limit is "arbitrary." (Collins, 2) He then saw a separate operating arena from 50,000 miles out to the moon. (Collins, 2) In contrast, the yet unpublished 1992 draft of Joint Pub 3-14, defined this *near-earth* region of space as extending from 93 miles above the earth to 22,300 miles (the approximate) altitude of a geosynchronous orbit. (Joint Pub 3-14, II-22) While the 93 mile limit was said to correspond to the altitude that satellites normally operate at or above, no rational is given (as is often the case in doctrine or

"how-to" manuals) for the 22,300-mile boundary, which excludes satellites operating beyond this altitude. Furthermore, Allen Sexton, Senior Space Systems Analyst, Betac Corp (supporting space education at Air University for the Space Warfare Center, Falcon AFB), said that short-lived, non-powered orbits have been achieved at 69 miles above the Earth, and technology (including powered orbits) could reduce this further. (from conversation with Lt Col (Ret) Sexton on 22 January 98)

[6] Carol Laymance, "Science of Space," in the *Space and Missile Orientation Course* (Vandenberg Air Force Base California: 30th Operations Support Squadron, 1993), in Hyatt, 97.

[7] Since space power is the fifth type of military power to exploit a new medium, land, sea, undersea and air power are often used to explain the significance of space power.

[8] Carl von Clausewitz, *On War,* ed. and trans. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1976), 357.

[9] Gray, 306.

[10] US Space Command has recently hired Dr. Brian R. Sullivan, Senior Member of the Technical Staff with OAO Corporation, Defense Systems Group, Colorado Springs, to write a strategic theory of space power. His final draft was not available for the writing of this article.

[11] Along this "geographic" vain, one could argue that USSPACECOM is not only a functional combatant command, but may some day be a geographic one as well.

[12] Stine, 56. Dr. Robert Richardson first published his article on the gravity well in a science fiction magazine in 1943 because other magazines refused to consider this a part of serious science. Since then, other authors have articulated the military significance to the theory.

[13] Brentnall, 6-7.

Chapter 5

Conclusion

This paper defined a framework in which to assess space power theory. Within this framework, it identified and analyzed a sizable cross section of current space power theory. The analysis revealed three observations about space power theory—it is emerging, it is not comprehensive in form, and it is immature. First, space power theory is emerging. By *emerging* this paper means that it exists and is growing. Space power theory exists in the form of definitions, explanations and predictions. The definitions of space power help to set limits on the concept while providing categories of space power's actors, capabilities, functions and purposes. Explanations of space power generally address space power's nature, importance and functioning. The nature of space power is discussed in terms of attributes unique to the space environment or space systems. The importance of space power is often related—by way of analogy—to the importance of land, sea and air power. The functioning of space power is explained using schools of thought, historical examples, traditional military roles, the idea of space control, and suggested ways to organize space power. Predictions of space power are frequently expressed in ideas for the weaponization of space (often dramatized with fictional scenarios) and Air Force studies that envision the future. These two approaches tend to see the future significance of space power as either a potentially independent war-winner

or the leading edge of joint information warfare. Taken as a whole, this body of literature makes significant strides in developing an understanding of space power.

Space power theory is also growing. Compared to the works of authors such as Clausewitz, Mahan, and Douhet, space power theory is relatively embryonic. The earliest published works date back to just 1960. However, most of the meaningful writing on space power occurred in the last decade (not surprisingly after the Gulf War). In fact, half of the sources deemed appropriate for this paper were written in the last five years. While space power theory is emerging, its elements are disjointed.

A single comprehensive work bringing together all the elements of space power theory does not exist. The closest candidates to a comprehensive theory are the gravity well theory, David Lupton's *On Space Warfare*, and Michael Mantz' space combat theory. These works are trailblazing efforts, but lack the scope and sense of thoroughness associated with comprehensive theories. Additionally, these and other works of space power theory have notable room for improvement.

Space power theory is immature in its development of definitions, explanations and predictions of the nature, significance and functioning of space power. Despite the significant headway made in defining space power; a single, complete definition still eludes space power theory. Likewise, explanations of space power lack full development. For example, much disagreement exists as to which are the key attributes of space power. Furthermore, these discussions generally fail to integrate air and space power attributes—foundational thinking for shaping a future "space and air force." Additionally, analogies to land, sea and air power sometimes lack originality in capturing the unique significance of space power. Moreover, discussions of historical examples on

space power are limited, discussions on traditional military roles neglect space power's independent use, and the concepts of space control and space force organization are underdeveloped. Finally, predictions of space power are heavily prescriptive and lack complementary descriptive explanations. Interestingly, company or field grade officers wrote just over half of the sources used in this paper. Might there be a void in senior officers with space experience to put together mature space power theory? To overcome some of these shortcomings in space power theory, this paper recommended space power theory development be aimed at improving the rigor of the definition, explanations and predictions of space power as well as creating a single comprehensive space power theory. The shape of America's 21st century air and space power may well depend on it.

Appendix A

ACSC Five Rectangle Model

This model, used in the War Theory Course at Air Command and Staff College,[1] helps to put theory into perspective (a subset of history, yet a foundation for doctrine).

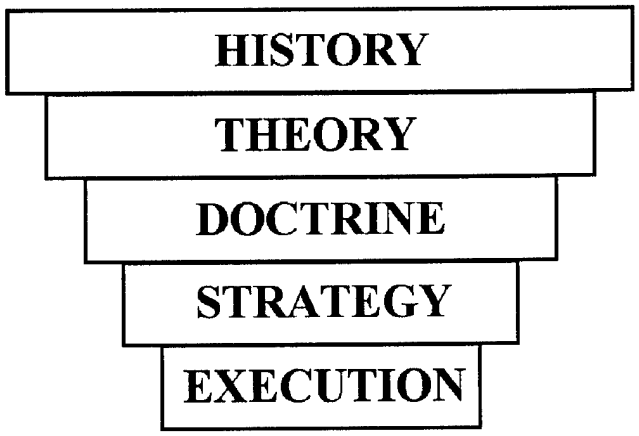

Figure 2. ACSC Five Rectangle Model

Notes

[1] Matt Caffrey, *ACSC Lesson TH-503: Revolution in Military Affairs.* lecture, Air Command and Staff College, Maxwell AFB, AL, 9 September 1997, slide 7.

Appendix B

Attributes of Space Power

Table 1. Unique Attributes of Space Power

Lupton [1]
Environmentally Influenced Characteristics:
Global Presence
Quasi-positional Siting (the nature of motion in space is more positional than maneuver-oriented)
Congregational Tendency (concentration of satellites in certain locations in certain orbits)
Long-Range Electromagnetic Weapon Effects
Hypervelocity Kill (easier in space due to the lack of atmosphere)
Infinite Operating Area
Logistically Influenced Characteristics:
Logistical Handicap (limits space missions to those not performed by forces in other environments which have more feasible logistics capabilities)
Inaccessibility (to satellites once deployed; now being overcome at low orbits with shuttle)
Lack of Manning (space forces are primarily unmanned)
Altitude/Security Tradeoff (the lower the orbital altitude, the greater the threat from ground forces)
Politically/Legally Influences Characteristics:
Legal Overflight (over sovereign territories)
Vehicular sovereignty
Political Insensitivity (space forces are out of sight and out of mind if used in military operations, but this insensitivity yields vulnerabilities: 1) would nuclear weapons more likely be used in the remote, uninhabited space environment? and 2) would the destruction of an unmanned satellite protected only by vehicular sovereignty be cause for retaliatory action?)
Gray [2]
Defining Characteristics
Space is the "high ground" of all combat arenas
Space is both global and of all but infinite military depth
Keplerian astrodynamics translates to satellites globally available as a regularly repeating, overhead presence
Limitations
Cost of transportation into orbit
Laws of motion in space
Distance from terrestrial events

Joint Pub 3-14 (1992 draft) [3]

Characteristics of the Space Operating Medium:

Extent (50 billion times greater than the air-combat arena)
Vantage (commanding view)
Gravity (the key determinant for maneuver)
Composition (less matter in this medium, considered a vacuum, but man-made debris a problem)
Radiation (ultraviolet, X-rays, Van Allen radiation belts)
Temperature (extremes dependent on position in or out of Earth's shadow)
Propagation (energy passes freely through space)

Operational Considerations for Space Forces:

Difficult Access
Placement (must use precise orbits that maximize a satellite's mission capabilities; also, satellite orbits are highly predictable—predictability means vulnerability to detection and targeting)
Long-Duration Flight (lack of drag yields longevity of space missions)
Maneuver (requires tremendous energy and on-board fuel)
Global Coverage
Decisive Orbits (Orbital altitudes are determined by satellite function)
Weapons Range (unattenuated transmission/directed energy fire)

Middleton [4]

Characteristics	Air/Aircraft	Space/Spacecraft
Speed:		
Values	1000 mph	17,000-25,000 mph
Propulsion mechanism	Aerodynamic lift/ Atmospheric Combustion	Chemical, nuclear, and solar propulsion
Range:		
Altitude	0-60 miles	Above 60 miles
Distance	Global (with refuel)	Global (90 minutes)
Flexibility:		
Loiter	Hours	Minutes-Years
Redirect path	360 degrees in seconds	Limited in days/weeks
Takeoff/land	Runway length, grnd/air conditions	Support infrastructure, air conditions
Factors		
Locations	Thousands	Two
Sortie rate	Several per day	One every 3-6 months
Generation	Within hours	Months/Years
Precision: Weapon	System dependent	None (by treaty)
Lethality:		
Weapon type	Conventional, NBC	None (by treaty)
Delivery Mode	Gravity, missile, RPV, manned, laser	Same as air, but add directed & kinetic energy

Larned [5]

Airpower Employment	Spacepower Employment
Aerodynamics	Astrodynamics
Attenuation	No Attenuation
Limited Mission Duration	[Greater] Persistence
Political Boundaries	Limitless Operations

Airpower Attributes	Spacepower Attributes
Speed Range Flexibility/Versatility	Continuity Dispersion Timeliness

DeBlois [6]

Characteristics Advantages of Airpower and Space Power

	Airpower	Space Power
Politics	Political access to the realm	Sovereignty Likelihood of reduced casualties
Deployment/ Employment	Centralized C^2 Decentralized execution	
Realm Access	Access to the realm	
Realm Environment	Composition of the realm	Size of the realm Position of the realm
Realm-Afforded Capability	Autonomy Maneuver Flexibility Precision Firepower Stealth	Surveillance and reconnaissance Duration Range Speed of response

Notes

[1] Lupton, 18.

[2] Gray, 300.

[3] Office of the Chairman Joint Chiefs of Staff. *Joint Pub 3-14, Joint Doctrine; Tactics, Techniques, and Procedures (TTP) for Space Operations (draft).* Washington D.C.: Office of the Chairman Joint Chiefs of Staff, 15 April 1992, II-3 through II-12.

[4] Gordon R. Middleton, *Space is a Different Place.* Maxwell AFB, AL: Air War College, 1992, 5-6.

[5] Larned, 8-9.

[6] DeBlois, 564.

Appendix C

The Gravity Well Theory

In 1943, astronomer Dr. Robert Richardson wrote an article explaining the Earth's gravity field.[1] He explained gravitational forces by using an analogy of a well with gradually sloping sides (see Figure 3). He said that gravitational forces around the Earth are like a well that gets steeper as it gets deeper. At the bottom of the well (the Earth's

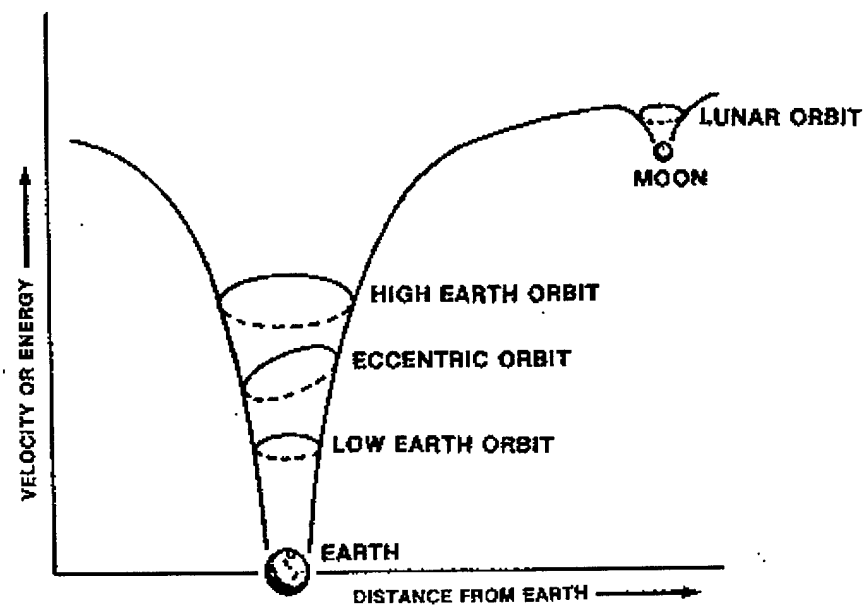

Figure 23. Gravity Wells

surface), the greatest amount of energy is required to escape the well. As one moves up, the well is less "steep," and less energy is required to continue up the well. At the top of

the well, there is theoretically a place where no (or negligible) energy is required to resist gravitational forces because the gravity well has transitioned into level ground. The moon, planets and stars all have gravity wells.[2]

Since Richardson's 1943 article, other authors have added to the gravity well concept. While it is difficult to trace this theory to one person, G. Harry Stine captures the military significance of the gravity well theory. Stine explains how shots fired down the gravity well will travel faster than shots fired up the well. Thus, the higher person has an *energy advantage* (he will not have to fire his shot as fast in order to maintain the same speed as one shooting up the well).[3] The higher person also has a *maneuvering advantage* (all things being equal, the higher person will have more time to observe the attack and dodge the shot than his opponent will).[4] Therefore, to maintain a military advantage in space, one must remain higher up the gravity well than his adversary must.[5]

Stine goes on to discuss exactly where the "highest" ground is in space. According to Stine, a libration point (also called Lagrangian point after Joseph Louis Lagrange, the French astronomer who suggested the existence of these points around 1800) is a location where gravitational forces are theoretically in perfect balance.[6] Three of the five libration points are considered unstable because the Moon's non-circular orbit and the Sun's gravitational pull adversely affect these points.[7] The last two libration points (L-4 and L-5), also known as Trojan libration points, are not affected by these phenomena and are thus considered stable.[8] At these two locations (see Figure 2) a body in space would theoretically require little to no energy to sustain its position in the Earth-Moon system. Therefore, L-4 and L-5 are the highest ground in the Earth-Moon system.[9] Stine then articulated these axioms for the gravity well theory:

a) Control of the Moon means control of the Earth, and

b) Control of the L-4 and L-5 libration points means control of the entire Earth-Moon system.[10]

From here, Stine stated that a military commander has

> the ability to permit or deny passage of space traffic, to deny the use of other military or commercial orbital areas to others, to launch strikes against *any* target on Earth, on the Moon, or in Earth-Moon space, or detect and take action against any threat originating anywhere in the Earth-Moon system.[11]

Table 2. Significance of Earth-Moon Operational Zones on Weapon Systems[12]

Operational Zones	Military Significance
Earth Atmosphere (EA): 0-100 km	Atmospheric gases in sufficient quantities to govern the movement and propulsion of military vehicles/ weapons.
Low-Earth Orbit (LEO): 100-500 km	Technically easy to reach via several launch vehicles (surveillance, reconnaissance, meteorological or communications satellites), but low altitude makes these satellites vulnerable to attack from Earth.
High-Earth Orbit (HEO): 500-40,000 km	Offers greater protection due to ability of space vehicles to maneuver here and time it takes to climb the gravity well. Includes GEO (geosynchronous) locations where satellites appear to remain stationary in the sky as seen from Earth. GEO is a prime location for communications/other satellites, but GEO getting crowded; several equatorial nations have laid claim to these preferred positions. At GEO, more velocity is required to change orbital planes, but it's hard to reach this altitude with an anti-satellite (ASAT) weapon.
Cislunar space (CLS): 40,000-390,000 km	Perhaps the most important zone; it includes L-4 and L-5; little energy required to maneuver in CLS; lots of volume to maneuver; relatively immune to Earth-launched ASATs; will become highly significant with the development of deep space, manned transportation.
Lunar Orbit/Surface (LOS): lunar surface-100 km	Has the Moon as stable platform for a military base, which offers protection by burrowing deep within it; of secondary importance to L-4 and L-5 because of Moon's gravity well.
Translunar Space (TLS): lunar+100-1 million km	Place to maneuver/rendezvous; copious space to maneuver; a staging area; too far for surveillance and reconnaissance activities, but equally out of view of Earth radars and other sensors; contains L-2 libration point, which lies on the opposite side of the Moon. This is an "unstable point," but a satellite would stay there for years before it begins to wander away. Activities here cannot be seen from Earth, but can be seen from the backside of the Moon or L-4/L-5.

Notes

[1] Stine, 56

Notes

[2] Ibid.
[3] Ibid., 58.
[4] Ibid.
[5] Ibid.
[6] Ibid., 59.
[7] Ibid.
[8] Ibid.
[9] Ibid., 60-61.
[10] Ibid., 58.
[11] Ibid.
[12] Ibid., 64-73.

Appendix D

Sea Power Analogies for Space Power

Brentnall, Kohlhepp, Davenport, Cole and others offered several sea power analogies to explain space power. The following is a partial list of some of those analogies:

1) Observations that the United States had become dependent on sea power (and now space power) for national growth, prosperity and security
2) The need for a space battleship to control the "narrows" of the celestial seas
3) The concepts of sea (space) control and sea (space) supremacy
4) Global coverage (the ability to project power around the world)
5) Free passage
6) Vehicular rather than positional sovereignty
7) The commercial possibilities
8) A force in being.

Table 3. Friedmans' Comparison of Land/Air Operations with Sea/Space Operations[1]

	Land/Air Operations	Sea/Space Operations
Dependency on Basing	Forces tied to ground bases	Operate away from land bases for months
Cost/Numbers	Tanks/Planes relatively cheap/numerous	Naval vessels/Spacecraft relatively costly/few
Type of Geography	Ground war: geography topography Air war: Freedom from topographical restrictions	Sea/Space: unseen physical and economic "geography" shapes operational patterns
Use of Concealment For Protection	Concealment: topography, vegetation, clouds	No concealment. Protection is vastness of medium and own defensive means
Communication Between HQ and Operational CCs	Can be in person	Must use the electromagnetic spectrum (radio, light)

Notes

[1] George Friedman, and Meredith Friedman, *The Future Of War: Power, Technology, and American World Dominance In The 21st Century,* (NY: Crown Publishers, Inc., 1996), 370-371.

Appendix E

Lupton's Four Schools of Thought

The Sanctuary School:

A fundamental tenet of this school is that the primary value of space forces is their capability to "see" within the boundaries of sovereign states. This value stems from the space vehicle's legal overflight characteristic. Proponents of sanctuary doctrine argue that past arms limitations treaties could not have been consummated without space systems that serve as a "national technical means of treaty verification."

Moreover, the prospects for any future treaties would be extremely dim without the ability of space systems to fulfill President Eisenhower's dream of verification through open skies. Thus, space systems have had a tremendous stabilizing influence on relations between the two superpowers [Lupton wrote prior to the fall of the Berlin Wall. Had he written today, he could have just easily said, "between nations."] Finally, these advocates caution that overflight is a granted right that nations have not attempted to deny and that any proposed military use of space must be weighed against the possible loss of peaceful overflight. This train of thought leads to the conclusion that the only way to maintain the legal overflight characteristic is to designate space as a war-free sanctuary.[1]

The Survivability School:

The basic tenet of this school is that space systems are inherently less survivable than terrestrial forces. Several factors undergird this belief. First are the long-range weapon effects in the space environment, coupled with a belief that nuclear weapons are more likely to be used in the remoteness of space. Second, the quasi-positional nature of space forces and their vehicular sovereignty imply that space forces cannot rely on maneuverability or terrestrial barriers to increase survivability. Finally, the negative aspect of space forces' political insensitivity creates uncertainty about the political implications of an attack on space forces (e.g., would we go to war if a satellite were destroyed?). Advocates of the survivability school have serious reservations as to the military value of space forces. They agree that military forces can do certain military

functions (e.g., communication and weather data gathering) more economically and efficiently in peacetime than other forces. They believe, however, that space forces must not be depended on for these functions in wartime because they will not survive.[2]

The High Ground School:

A third school harkens back to the old military axiom that domination of the high ground ensures domination of the lower lying areas. Disciples of this "high-ground" school advocate a space-based ballistic missile defense (BMD). They argue that the global presence characteristic of space forces combined with either directed-energy or high-velocity-impact space weapons provide opportunities for radical new national strategies. In their view, space-based defensive forces can reverse the current stalemate caused by the preeminence of the offense and create either an offensive-defensive balance or a preferred defensive stalemate. This rebalancing would allow replacement of the flawed strategy of assured destruction with one of assured survival. The high-ground school believes space forces will have a dominant influence.[3]

The Control School:

A fourth doctrine, the control school, declines to place an exact value on space forces and only suggests their value by using air power and sea power analogies. For example, according to Gen Thomas A. White, "Whoever has the capacity to control space will likewise possess the capacity to exert control over the surface of the earth." Others argue that there are space lanes of communications like sea lanes of communications that must be controlled if a war is to be won in the terrestrial theaters. Control school advocates argue that the capability to deter war is enhanced by the ability to control space and that, in future wars, space control will be coequal with air and sea control.[4]

Notes

[1] Lupton, 35.
[2] Ibid., 36.
[3] Ibid., 36-37.
[4] Ibid., 37.

Appendix F

Lessons Learned from the Use of Space Power in the Gulf War

Janushkowsky[1]

1) Good Warning but poor defense against ballistic missiles
1. Shortage and vulnerability of communication channels
2. Important of "information dominance" was recognized
3. No single organization responsible to coordinate space support
4. Weather data was critical to operations and bomb damage assessment
5. Navigation equipment was critical to fighting forces

Spires[2]

1) Overall space power contributed to victory in the political battle, ensured effective command and control, and helped make the war a short conflict, which saved lives.
2) The most impressive element was the ability of space personnel to adapt their systems from Cold War, strategic requirements to the tactical warfighter.
3) Deficiencies included space power systems not designed for tactical use, and ground personnel often lacking necessary equipment and training to fully exploit space capabilities.
4) Challenges include modernizing the space infrastructure, continued technical improvements, and extending space awareness throughout the Air Force.
5) Space control efforts included hardening satellites, increasing the number of satellites, better tactics, and deploying mobile ground segments. Also Desert Storm aroused renewed interest in developing an ASAT capability.
6) Force application from space was theoretical only, but again, the Gulf War heightened interest in a ballistic missile defense (BMD)—an idea that often included weapons in space.
7) Force enhancement included surveillance and reconnaissance, environmental monitoring, navigation, tactical warning and attack assessment and communications from space.
8) The National Reconnaissance Office (NRO) ran space surveillance and reconnaissance. The national intelligence community continued to operate largely independent of the broader military space sector, which furthered Air

Force worries about coordination of space requirements with the warfighter. National systems provided superb spatial resolution, but little overall view of the battle area. Additionally, they lacked sufficient multi-spectral imaging (MSI) capability and many products were awkward to handle due because of their classification.

9) Environmental monitoring included weather and earth-sensing satellites. DMSP weather satellites and mobile terminals, including a prototype that operated in the rear of a Humvee, exceeded expectations. However, data needed to be made more widely available. MSI capability did not always provide timely or accurate data for mission planning, bomb damage assessment, or use with precision guided weapons.
10) GPS navigation satellites reaped little criticism. Its primary shortcoming was a shortage of mobile receivers (especially Selective Availability receivers). Managers of the GPS program worried that Iraqi forces might take advantage of the "open" signals.
11) Tactical warning and attack assessment saw the integration of Defense Support Program (DSP) warning missile satellites and the Patriot anti-tactical ballistic missile capability. DSP successfully provided timely warning of Scud launch sites and impact point identification. However, Desert Storm clearly demonstrated the need for improved tactical ballistic missile warning and assessment and midcourse tracking capability.
12) The Gulf War highlighted both the importance and shortcomings of military satellite communications (SATCOM). SATCOM provided the necessary support to the warfighter through a variety of systems not designed for intra-theater communications. These assets were stretched to the limit, highly exposed to jamming, and far less mobile than ground forces desired.
13) Space support (for space forces) was the Achilles heel of the space program. Only satellites scheduled well in advance of Desert Shield were launched during Desert Storm. The US space launch system continued to reflect a policy of launching on schedule, not on demand.

Gallegos [3]

The common post Gulf War theme was "normalizing space support for the warfighters." The following lessons learned come from the USSPACECOM After Action Report (1992):

1) More preplanning required—may not have six months to build-up for next war.
2) Supported CINC OPLANs need work.
3) Include communication requirements in OPLANs.
4) Normalize all space support.
5) Operational control of military SATCOM systems remains fragmented.
6) Maintain the US MSI capability.

Notes

[1] Victor Janushkowsky, "Developing Space Assets," *Challenge and Response* (August, 1994), 399-401.

[2] David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership,* (Peterson AFB, CO: Air Force Space Command, USAF, 1997), 259-269.

[3] Frank Gallegos, *After the Gulf War: Balancing Spacepower's Development,* Maxwell AFB, AL: School of Advanced Airpower Studies, 1995, 8.

Appendix G

Colin Gray's Propositions Regarding Space Power[1]

1) States prepare for and wage war according to their distinct natures.
2) Post-industrial societies are information led from economics to leisure activity.
3) Warfare always has been led by information.
4) The new age is being propelled most directly by the quantity and quality of reliable, timely information of military value provided by space systems.
5) Space systems are far from the only means available for information warfare.
6) Space systems are at least the key coagent for information warfare.
7) The future of space power is not exclusively hitched to information warfare.
8) The case for the transformation of war by the application of information age technologies can slide into the zone of snake oil salesmanship, unless enthusiastic advertisers exercise self-criticism.
9) Space power must always be useful, but its precise set of roles and its actual strategic utility will be distinctive to each class and case of conflict
10) Because of the distinctive strengths and limitations of each element of the armed forces, success or failure in deterrence and war itself must be a joint endeavor.
11) Thought the outcome of a future war may, in some vital sense, plausibly be decided by space power, the fighting will be conducted largely on Earth.
12) Space power, in common with sensible approaches to sea and air power, can and should aspire to make the critical strategic difference in war.
13) It would not be sensible to aspire to the ability to wage and win wars independently by space oriented action.
14) Long-standing military principles decree the general superiority of joint over single military element solutions to strategic problems.
15) "Leading edge" space power will depend on US decisions with respect to the development of its space power for joint warfare and on the potency of those other armed forces that must exploit the advantages granted by space systems.
16) Space power may be exploited more readily in the open conditions of desert warfare or in war at sea than, for example, in heavily urban combat.

Notes

[1] Gray, 293-308.

Appendix H

Dunning's Tenets and Phases of Space Control

Doctrinal Tenets for Space Control [1]

1) Seize the initiative by disabling the enemy's critical warfighting satellites before they provide the enemy a tactical advantage on the terrestrial battlefield.
2) Retain the initiative by disabling the enemy's on-orbit spares, denying the enemy the ability to launch additional satellites to reconstitute, and attacking and destroying the enemy's anti-satellite capabilities.
3) Control the "cone of vulnerability" over the terrestrial theater(s) of operation.
4) Control launch regions before the enemy begins surge or reconstitution launches. Protect friendly launch regions to prevent their use by the enemy.
5) Concentrate antisatellite combat power in time, i.e., disable the maximum number of war-supporting enemy satellites in the minimum time at the optimum hour of the campaign.
6) Space operations require centralized control and decentralized execution in a coordinated space campaign to ensure maximum damage at the right time.
7) Use concealment, defensive countermeasures, space-based reconstitution, and ground-based reconstitution to assure mission support to terrestrial forces.
8) Provide combat support satellites with sufficient maneuver capability to respond to emergent requirements for supporting terrestrial operations and avoid enemy attacks.

Phases of Space Control [2]

1) Force Readiness:
   a) Launch preparation of augmentation and surge assets.
   b) Increased surveillance of enemy space forces
2) Endurance:
   a) Passive defense through satellite hardening, maneuver and other countermeasures.
   b) Control of friendly and enemy launch antipodal areas in anticipation of further escalation.
   c) Active defense to destroy any orbital ASATs attacking US space forces.
   d) Activate on-orbit spares or launch necessary reconstitution satellites.

e) Proportional response to Soviet [enemy] attack on US space forces. This may be the destruction of an enemy satellite in response to the destruction of a US satellite.

3) Denial:
   a) Control the space above the terrestrial theater(s) and destroy enemy satellites before they enter the "cone of vulnerability."
   b) Defeat the enemy reconstitution effort by destroying enemy satellites in the launch antipodal area.
   c) At a critical time in the campaign, concentrate combat power to destroy as many enemy combat-support satellites as possible in as short a time as possible.
   d) Attack enemy ASAT facilities (EW sites, directed energy weapon sites, co-orbital ASAT launch sites, etc.)
   e) Attack remaining enemy space launch and support facilities.
4) Post-conflict:
   f) Launch space force strategic reserve to augment remaining force enhancement and reconnaissance assets (to ensure conflict termination agreements are adhered to).

Notes

[1] Dunning, 13.
[2] Ibid., 16-17.

Appendix I

Pros and Cons of an Independent Space Force

Table 4. Pros and Cons of an Independent Space Force

Arguments For	Arguments Against
Lupton[1] - The Air Force organizational imperative, which focuses on "air force" things (bombers, fighters, etc.) will never allow exploitation of the space medium	Lupton[2] - Threatens the sanctuary of space - Tit-for-tat survivability measures can be orchestrated by a unified or specified command - Technology may never match "high ground" theorists' expectations
Space Day Panel[3] - Could save US tax dollars - Redundancy of organizations (NRO, DARPA, labs, BMDO, NASA, USSPACECOM, commercial industry, international partners)	Space Day Panel[4] - Aerospace is a continuous operating arena (focus should be: dominating vertical dimension through seamless integrated air and space power) - Air and space forces work best when closely integrated - AF not ready for the evolutionary step
Lambakis[5] - Can better lobby for acquisition of tools needed for space missions - Permits rational expansion for growing space forces	Space Power 2010[6] - Possibly a Joint Force Space Component Commander (JFSCC) would solve some problems
Mantz[7] - Soviet Strategic Rocket Force proved space/missile ops could be centralized - Air and space are operationally different - Space forces currently isolated (organizationally) from air forces - Space power is potentially as decisive as air power	Butterworth[8] - Gains in space support to the warfighter would be lost under current centralization schemes
DeBlois[9] - Lack of centralized control results in service infighting, inefficiency, and duplication. The Air Force can regain sight of the unique capabilities of airpower.	Builder[10] – The radical surgery of space and missile systems from the Air Force ignores the historical circumstances and bureaucracy, which make it impractical at the moment.

Notes

[1] Lupton, 45.
[2] Ibid., 44-45.
[3] Space Day Panel, various speakers.
[4] Ibid.
[5] Lambakis, 432.
[6] Hyatt et al., 89.
[7] Mantz, 79-81.
[8] Butterworth, 41.
[9] DeBlois,
[10] Builder, 225. One might wonder if Builder would also argue that coherent space power theory (which has not yet arrived) must precede an independent space force, therefore, a new branch of service is not yet in order.

Appendix J

Mantz' Theory of Space Combat

Defining Axioms [1]

1) Space strike systems can be employed decisively by striking earth forces, both independently and jointly.
2) Space strike systems can be employed decisively in war when the enemy's essential means for waging war (industry, transportation, and communications) are vulnerable to attack from space.
3) Space strike systems can be employed decisively by striking at the decision-making structure (leadership and command and control) of the enemy.
4) Space strike systems can deter hostile actions by holding forces, decision making (leadership and command and control), infrastructure (industry, transportation, and communications) at risk.
5) Space denial systems can be employed decisively by denying enemy access to space-derived data.
6) Space denial systems can be employed decisively by physically denying enemy access to space.
7) Space protection systems can be employed to assure friendly access and use of space.
8) Total space control (the combination of space denial, space protection, and passive space defense measures) is neither achievable nor necessary.
9) Space combat power must be centrally and independently controlled.
10) Space power is not intrinsically linked to air power.

Types of Space Combat Missions [2]

- Space Denial Operations
  - Earth-to-Earth Attacks
  - Earth-to-Space Attacks
  - Space-to-Space Attacks
  - Space-to-Earth Attacks
- Space Strike Operations
  - Space-to-Land/Subterranean Attacks
  - Space-to-Sea/Undersea Attacks

    - Space-to-Air Attacks
- Space Protection Operations
    - Protecting against Earth-to-Earth Attacks
    - Protecting against Earth-to-Space Attacks
    - Protecting against Space-to-Space Attacks
    - Protecting against Space-to-Earth Attacks

Notes

[1] Mantz, *Sword*, 74.
[2] Ibid., 36-56.

Appendix K

Predictions for Future Space Requirements

The following is a list of predictions common to most thorough predictive works of space power theory. Janushkowsky's eight predictions[1] form the basis for this list, but common ideas from Spacecast 2020, Air Force 2025, and New World Vista—Air and Space Power for the 21st Century, are supplemented in parentheses:

1) Better support to the warfighter (information dominance, knowledge on demand, global awareness)
2) Continued search for better technology (launch vehicle, satellite bus, sensor, communications, data fusion, weapon, propellant, materials, maneuvering, and power generation technologies)
3) Deployment of trans-atmospheric vehicle (space transportation)
4) Manned space presence (space stations)
5) Standardized, multipurpose, dual-use launch infrastructure (launch on demand)
6) More international agreements/cooperation (IGOs to control space traffic)
7) Need for space surge capability (including a space equivalent to the CRAF for satellites)
8) Weapons in space (space control, force application)

Notes

[1] Janushkowsky, 403-408.

Appendix L

Comparison of the Three Most Prominent Theories of Space Power

Table 5. Prominent Theories Compared

Aspect of Theory	Lupton	Gravity Well	Mantz
Definitions	Space power: the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation[1]	Offers no definition of space power. Instead it defines space in "geographic" terms.	Space Combat: the hostile application of destructive or disruptive force into, through, within, or from space.[2]
Methods of Explanation	Attributes and schools of thought	Expansion of high ground analogy to space	Scenarios and suggested organization for weaponizing space
Analysis of Space Power in Desert Storm	No	No	No
Claims to be Comprehensive Theory	No	No	No
Unique Limitations	Incomplete definition, Confusing identity as "doctrine."	Offers no definition of space power. Futuristic and costly. Fairly focused on one (high ground) idea: lacks balance.	Does not properly address role of space power in information warfare.

Notes

[1] Lupton, 7.
[2] Mantz, *Sword,* 64.

Glossary

ACGSC	Army Command and General Staff College
ACSC	Air Command and Staff College
AFB	Air Force Base
AFDD	Air Force Doctrine Document
AFSPACECOM	Air Force Space Command
AOR	Area of Interest
ASAT	Anti-Satellite
AU	Air University
AWC	Air War College
CADRE	College of Aerospace Doctrine, Research, and Education
COG	Center of Gravity
DEW	Directed-energy Weapon
DOD	Department of Defense
FSU	Former Soviet Union
GEO	Geosynchronous Earth Orbit
GPS	Global Positioning System
KEW	Kinetic-energy Weapon
MNC	Multi-national Corporation
NGO	Non-governmental Organization
NWC	Naval War College
SAAS	School of Advanced Airpower Studies
SOS	Squadron Officer School
SPLOCs	Space Lines of Communication[1]
USAF	United States Air Force
USCINCSPACE	Command-in-Chief US Space Command

astronautics. The science of operating space vehicles. (US Army Space Reference Text)

ASAT. Anti-satellite weapon. Any weapon designed to destroy satellites. (from US Army Space Reference Text)

descriptive theory. Theory that describes history. Carl von Clausewitz modeled this view in his work *On War*.

directed energy. Concentrated energy that is transmitted in tight beam form. (from US Army Space Reference Text)

doctrine. What we believe about the best way to conduct military affairs. (from Col Drew's *Making Strategy*)

gravity well. An analogy for the gravitational field around a celestial body. The well has gradually sloping sides (see Figure 1) that get steeper as it gets deeper. At the bottom of the well (e.g., the Earth's surface), the greatest amount of energy is required to escape the well. As one moves up the well, the well is less "steep" (gravity is less strong) and less energy is required to continue further up the well. At the top to the well, there theoretically exists a place where no (or negligible) energy is required to resist gravitational forces because the gravity well has transitioned into level ground. The moon, planets and stars all have gravity wells

libration point. A location where gravitational forces are theoretically in perfect balance (see Figure 2 for the Earth-Moon system's libration points).

lagrangian point. Another name for a libration point named after Joseph Louis Lagrange, the French astronomer who first suggested the existence of these points around 1800.

orbital mechanics. The physics discipline that describes the motions of bodies in orbit. (from US Army Space Reference Text)

prescriptive theory. Theory that prescribes principles for what to do on the battlefield. Antoine Jomini's book, *The Art of War,* Alfred Thayer Mahan's *The Influence of Sea Power upon History:1660-1783*, the writings of Julian Corbett, Giulio Douhet's *Command of the Air*, and John Warden's systems theory of air power have all been called prescriptive.

satellite. An object in space that is in orbit around another, more massive object. (from US Army Space Reference Text)

space power (or Spacepower). The ability of a state or non-state actor to control and exploit the unique and separate space environment in pursuit of an actor's goals (security, economic and political) using an actor's entire astronautical capability (national, military, civilian, and commercial which can be further subdivided into space-based, ground-based and launch systems). Lupton was among the first to recognize that a nation with space capabilities is also called a *space power.*

space control. The assurance of friendly use of the space environment while denying its use to an enemy (from AFM 1-6).

theory. A systematic body of knowledge that defines, explains or predicts the nature, functioning and importance of a phenomenon.

Notes

[1] Hyatt, et al., 101. According to Hyatt, et al., this term was first documented by Maj Henry G. Franke III, in *Evolving Joint Space Campaign and the Army's Role,* (Leavenworth: School of Advanced Military Studies, US Army Command and General Staff College, 1992), 21.

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