AU/ACSC/239/1998-04

AIR COMMAND AND STAFF COLLEGE

AIR UNIVERSITY

DISTINGUISHING SPACE POWER FROM AIR POWER: IMPLICATIONS FOR THE SPACE FORCE DEBATE

by

Alec M. Robinson, Major, USAF

A Research Report Submitted to the Faculty

In Partial Fulfillment of the Graduation Requirements

Advisor: Mr. Budd A. Jones, Jr.

Maxwell Air Force Base, Alabama

April 1998

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

Public reporting burder for this collection of information is estibated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burder to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (FROM - TO)
01-04-1998	Thesis	xx-xx-1998 to xx-xx-1998

4. TITLE AND SUBTITLE Distinguishing Space Power from Air Power: Implications for the Space Force Debate Unclassified	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Robinson, Alec M. ;	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME AND ADDRESS Air Command and Staff College Maxwell AFB, AL36112	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS ,	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Air Force General Charles ?Chuck? Horner, former commander of U.S. Space Command, advocates the creation of an independent Space Force, separate from the Air Force. Justifications for such a change depend in large measure on whether space power can provide a way of fighting and winning wars distinct from that provided by the other services. An important aspect of this issue is whether differences between air power and space power suggest a rationale for a separate and independent Space Force. It has been said that space is at a crossroads.2 We cannot afford to wait for the next war to show us if space power will, as air power did, revolutionize the conduct of warfare. We cannot make such a decision based on vague allegories to the air power debate. A more rigorous approach is required. This paper sheds light on this question from the perspective of doctrine and theory and seeks to suggest the next steps in keeping the U.S. approach to space ?from being too badly wrong.?3 This research project critically compares air and space power in order to discern whether the differences between air and space power suggest a paradigm shift in the way wars will be fought. As a foundation for comparison, air and space power are exposed in terms of features of the mediums, characteristics of the forces, and tenets of employing forces in each medium. The resulting expositions of air and space power are compared, extracting and evaluating the key differences. These differences are then explored to determine if a new paradigm of warfighting is emerging. Finally, the differences between air and space power and their implications for warfighting are examined with respect to the need for a separate and independent Space Force. The finding of this project was that air and space power are indeed different, but not so fundamentally so that the creation of a separate Space Force is mandated. Further development of space capabilities, operational concepts, and doctrine is necessary before the need for a Space Force can be determined based on the natures of air and space power. However, General Horner?s concern that the cost of concurrently developing space forces and modernizing air forces is too large for the Air Force?s budget is an unresolved question.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
			Public Release	64	Fenster, Lynn lfenster@dtic.mil
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39.18

Disclaimer

The views expressed in this academic research paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense. In accordance with Air Force Instruction 51-303, it is not copyrighted, but is the property of the United States government.

Contents

Page

DISCLAIMER ii

LIST OF TABLES v

PREFACE vi

ABSTRACT vii

WHITHER SPACE? 1
- Dissenting Views 2
- Historical Precedent 4
- The Assumption 5
- Potential Implications 6
- The Research Question 7

THE ELEMENTS OF MILITARY POWER 10
- JV 2010 Style Warfare 10
- Features of the Medium 13
- Characteristics of the Forces 13
- Tenets of Force Employment 14

THE ELEMENTS OF AIR POWER 16
- JV 2010 Air Warfare 17
- Features of the Air Medium 17
- Characteristics of Air Forces 18
- Tenets of Employing Air Forces 20

THE ELEMENTS OF SPACE POWER 23
- JV 2010 Space Warfare 24
- Features of the Space Medium 24
- Characteristics of Space Forces 25
- Tenets of Employing Space Forces 27

A COMPARISON OF AIR AND SPACE POWER 31
- Differences Between the Mediums 31
- Differences Between the Forces 33
- Differences in Employment 40

SPACE POWER: VERTICAL DIMENSION OR OUTER SHELL? 43
Space is a Place 43
Space Forces are Ubiquitous 44
Space Tactics and Techniques Will Be Different 45
Space: The Outer Shell 46
Implications 47

GLOSSARY 50

BIBLIOGRAPHY 52

Tables

Page

Table 1. Features of the Air Medium 18

Table 2. Characteristics of Air Forces..... 19

Table 3. Tenets of Air Power..... 21

Table 4. Features of the Space Medium 25

Table 5. Characteristics of Space Forces..... 26

Table 6. Tenets of Space Power 28

Table 7. Comparison of Features of the Air and Space Mediums 32

Table 8. Summary of Differences in the Features of the Air and Space Mediums 33

Table 9. Comparison of the Characteristics of Air and Space Forces 34

Table 10. Summary of Differences in the Characteristics of Air and Space Forces 39

Table 11. Comparison of the Tenets of Air and Space Power 41

Table 12. Summary of Differences in the Tenets of Air and Space Power 41

Preface

I undertook this project in order to settle in my own mind whether the Air Force is going in the right direction with respect to the future of space. The Air Force argues that it has the preponderance of space expertise and can best shepherd the development of space. I was inclined to accept this argument, but wanted to convince myself that there were no conceptual problems with airmen developing space. The Air Force also argues that if it did not accept the mandate to develop space, it would be failing to step up to the plate.[1] In examining this argument, I wanted to determine whether the Air Force leadership is navigating toward a correct vision or is just trying to keep the space Mafia under its thumb. In researching this issue and crafting my argument, I reached my own conclusion. It is my sincere hope that this paper is useful to others who are deciding whether to support the Air Force's evolutionary path or a more revolutionary path such as the creation of a separate and independent Space Force.

I would like to thank Mr. Budd Jones for his guidance and assistance in developing and presenting the argument in this paper. Of course, any errors are my own. The sacrifices my wife, Lori, and daughters, Jessica and Krista, have made in supporting me in this effort are especially appreciated. They are my *raison d'être* and without their love and support I could never have accomplished this project.

Abstract

Air Force General Charles "Chuck" Horner, former commander of U.S. Space Command, advocates the creation of an independent Space Force, separate from the Air Force. Justifications for such a change depend in large measure on whether space power can provide a way of fighting and winning wars distinct from that provided by the other services. An important aspect of this issue is whether differences between air power and space power suggest a rationale for a separate and independent Space Force.

It has been said that space is at a crossroads.[2] We cannot afford to wait for the next war to show us if space power will, as air power did, revolutionize the conduct of warfare. We cannot make such a decision based on vague allegories to the air power debate. A more rigorous approach is required. This paper sheds light on this question from the perspective of doctrine and theory and seeks to suggest the next steps in keeping the U.S. approach to space "from being too badly wrong."[3]

This research project critically compares air and space power in order to discern whether the differences between air and space power suggest a paradigm shift in the way wars will be fought. As a foundation for comparison, air and space power are exposed in terms of features of the mediums, characteristics of the forces, and tenets of employing forces in each medium. The resulting expositions of air and space power are compared, extracting and evaluating the key differences. These differences are then explored to determine if a new paradigm of warfighting is emerging. Finally, the differences between

air and space power and their implications for warfighting are examined with respect to the need for a separate and independent Space Force.

The finding of this project was that air and space power are indeed different, but not so fundamentally so that the creation of a separate Space Force is mandated. Further development of space capabilities, operational concepts, and doctrine is necessary before the need for a Space Force can be determined based on the natures of air and space power. However, General Horner's concern that the cost of concurrently developing space forces and modernizing air forces is too large for the Air Force's budget is an unresolved question.

Notes

[1] Estes, Gen. Howell M. III, Commander in chief, US Space Command, "The Air Force at a Crossroad," Address, Air Force Association National Symposium, Los Angeles, Calif., 14 November 1997;on-line, Internet, 19 November 1997, available from http://www.spacecom.af.mil/usspace/speech6.htm.

[2] Estes, "The Air Force at a Crossroad."

[3] Howard, Michael E., "Military Science in an Age of Peace," RUSI Journal 119, No. 1 (March 1974), 7.

Chapter 1

Whither Space?

> *We say we are evolving toward becoming a Space and Air Force because spacepower (sic) and airpower are inextricably linked as components of the vertical dimension of warfare.*[1]
>
> —General Howell M. Estes III

After World War I, air power theorists suggested that the air weapon provided a new way to wage and win wars. The effect air power had in shaping the course of World War II justified the formation of a separate Air Force. The decisive effects achieved by U.S. aircraft and missiles in DESERT STORM dramatically proved that air power had brought a revolution in the way in which wars are fought and won. DESERT STORM was also the first war in which space systems played a militarily significant role. As a result, the force enhancement capabilities of space forces are now accepted as an vital part of the American arsenal. The question of a separate Space Force has now been raised, similar to the call for a separate U.S. Air Force in the inter-war period following World War I.

Currently the Air Force claims space as its domain and has taken on the task of developing space forces and doctrine while continuing to develop and field traditional air forces. As the Army did with the Air Corps between the wars, the Air Force has taken a stand against a separate Space Force. And, like the Army's position that the function of aviation is to support land warfare, the Air Force believes that space's function is to support terrestrial (the air, land and sea) warfare. There is a significant parallel in the

logic between the Army view of aircraft as mobile artillery and the Air Force's plans for space.

The Air Force approach to the development of space power is stated in its vision for the 21st century, *Global Engagement*, as a transition "from an air force into an air and space force on an evolutionary path to a space and air force."[2] The first element of this transition, from an air force to an air and space force, is the normalization of space operations and the integration of space forces and functions into the mainstream Air Force. This "aerospace force" will serve as the foundation for the evolution to a space and air force. This foundation is necessary to limit changes in operational concepts and organizations to the weapons systems which implement functions migrated to space. The transition to a space and air force will then optimize the air-space mix by selectively migrating air functions into the space medium when that change provides an advantage. This process will begin with non-combat functions such as theater missile warning, surveillance, and target tracking.[3] The process will be gradual because the capabilities of air and space forces must at all times fulfil the assigned roles of the Air Force.[4] Economics and technology will also limit the pace of evolution.[5]

Dissenting Views

Arguments against the evolutionary approach focus on the creation of a separate Space Force, independent of the Air Force. Justifications for such a change in the structure of the Department of Defense include: potential cost efficiency of the independent use of space power in achieving national objectives, the risk of retarded growth of space power under the control of airmen, the risk of incorrect use of space

power under airmen, and the risk of insufficient modernization of air forces during the building up of space power.

The first three justifications are linked in that each bases creating a separate Space Force on the notion that space power provides a new way of fighting and winning wars that is substantially different from what air power provides. Air Force Major Bruce DeBlois supports this view, arguing that the air and space mediums and their forces are characteristically different, requiring independently developed space power theory and doctrine, and that space power cannot develop within the "confines of Air Force culture and doctrine."[6] Proponents of this view draw a parallel to the development of airpower which was spurred by the air power theories of Douhet, Mitchell, and Trenchard.

What is missing, and what this argument requires, is a clear vision of how space power provides a new and different means of winning wars. Mahan advanced the idea that sea power could be used to win wars by threatening the life blood of an industrial nation, the trade that supplied the resources critical to its industry, its means of generating wealth. The air power theorists extended this idea to suggest that air power could win wars by directly attacking a nation's vital population and industrial centers without first defeating the adversary's sea and land forces.[7] *Joint Vision 2010* describes a future in which the information centers and flow of an enemy's military are attacked in order to more quickly and decisively achieve military victory.[8] Visions of space power, such as *Space Power 2010*, discuss functions such as space control and space strike, but stop short of envisioning a new way in which nations, not just their forces, can be defeated.[9]

The final justification is avidly argued by Air Force General Charles "Chuck" Horner, former commander of U.S. Space Command. General Horner argues that the

investment required to develop space forces should not come solely at the expense of the modernization of air forces.[10] The evolutionary approach restricts the budgetary choice to one made by the Air Force between air and space implementations of a given function. General Horner argues that the decision is more properly made between the development of a new space capability and the modernization of any military force; that always trading off air power for space power will be sub-optimum. A clear vision of the contribution of space power to a new way of winning wars that distinguishes it from the other forms of military power is necessary to enable the budgetary debate General Horner advocates.

The validity of these justifications depends, in large part, on the existence of unique properties of space power that distinguish it from air power. Today's advocates lack a clear vision of how the Space Force would provide a new way of fighting and winning wars. It is therefore instructive to examine the differences between air and space power in order to apply the results to the rationale for a separate and independent Space Force.

Historical Precedent

Space Force advocates compare the development to the development of air power as an example of revolutionary change. After World War I, in which air power had first shown significant value in war, the Army viewed the development of aviation as an evolution. "It is the role of the Air Service, as well as the other arms, to aid the chief combatant, the Infantry."[11] Air power theorists did not agree and, in the inter-war years, advanced the theory of strategic bombing as a new and independent means of victory. Air power, as part of the revolution in military affairs surrounding World War II, was a fundamental change in warfare. The combination of mobile armored warfare, strategic bombing, carrier aviation, and amphibious warfare dramatically changed the way wars

were fought.[12] However, it was the theory of strategic bombing, a new way that wars could be won, that set air power apart.

The revolution provided by air power affected the Army and the Navy in distinctly different ways. Both land- and sea-based aviation were revolutions in military affairs.[13] The key difference between the changes in the Army and those in the Navy was the nature of the operational concepts that emerged. Land-based aviation provided a means of fighting wars in addition to fighting war on the land. Carrier-based aviation, along with submarine warfare, became the new means of fighting war at sea. If the military value of space power is sufficiently similar to that of air power, then space will go the route of carrier aviation. If war in space is so different from war in the air that separate air and space operations are conducted in parallel seeking different means of victory, then space power will go the route of land-based aviation.

The Assumption

The fundamental assumption inherent in the Air Force's vision of an evolution from an Air Force to a Space and Air Force is that the development of space power should be aimed at complementing and, in some cases, replacing air forces in the execution of "vertical dimension" operational concepts. Clearly, the Air Force has accepted what Major DeBlois called the aerospace power conjecture.[14] If the development of space forces can provide nothing more than the current and emerging "vertical dimension" operational concepts, then this assumption is valid and the development of space forces will fit the evolutionary path. However, if what space forces can achieve goes beyond these operational concepts then the assumption is not valid and new operational concepts and corresponding organizational changes will be required to best develop space power.

Potential Implications

If air and space power are indivisible in the vertical dimension of warfare, the future will consist of a mix of air and space forces executing vertical dimension operational concepts. Which functions will be executed by space forces will depend on technological developments. How rapidly space forces should evolve to perform vertical dimension operational concepts will depend on the strategic environment. It is the capabilities of potential adversaries that determine when a space implementation of a particular function is needed. Unfortunately, the time to develop a new space system is fairly long compared to the time required by an adversary to develop a low technology asymmetric threat to U.S. forces. Whether space capabilities will advance fast enough to provide sufficient military advantage in future conflicts will be decided both by technology and funding.[15] The critical funding challenge in the transition of functions to space will be the need to continue to modernize air forces to maintain dominance in those functions which space forces will not perform. It is this concern which motivates some to advocate creating a separate Space Force.[16] With lengthy development cycles and the pace of threat development in the adversary's hands, it is possible that motivation for funding a new space capability will not be strong enough when that development needs to be initiated.

If air and space power provide sufficiently different means of waging and winning wars, then the future holds a fundamental shift in the way wars are fought. Space forces will develop to execute vertical dimension operational concepts as well as new concepts. These new concepts will shape a new relationship between the air, land, sea, and space forces, requiring new doctrine for the new approach to warfare. One critical question in this future is whether such development of space power can and will occur under airmen.

This path, clearly at odds with the current Air Force approach, can only worsen the competition for funds between the modernization of air forces, evolutionary development of space forces to implement vertical dimension operational concepts, and revolutionary development of space forces to implement new operational concepts. The other critical question is whether "air-bound" thinking will prevent development of space power to implement new operational concepts.

If answering these questions leads to the conclusion that a separate Space Force is necessary, then it is the basis for this conclusion that will decide the correct short term actions. If experience with the employment of air and space forces call for a separate force, the only remaining question is when separation should occur. Rational self-examination by the Air Force should result in a solid separation plan. Alternatively, if the divergent development of space power is based on theory, the future role of space power will be determined by the further maturation of space power. The near-term need for a separate Space Force should then be determined by deciding whether the maturation of space power will be obstructed by air-bound thinking and competition for funds. The funding decisions will be between the speculative development of space power and the needs for modernization of air forces and "vertical dimension" space functions.

The Research Question

The first question to be answered is whether there are substantial differences between air and space power. To answer this question, clear and succinct expositions of air power and space power must be formulated. Doctrine will be a key source in this, augmented by theory and, failing informed military thought, policy. Based on these expositions, the differences between air and space power must be identified.

The second question to be answered is whether the differences between air and space power indicate that the divergent development of space power would result in a new approach to warfare. Major DeBlois' essay showed that space and air power are characteristically different, but did not support the assertion that those differences must result in a space power doctrine inconsistent with Air Force culture and doctrine.[17] The conjecture in this investigation is that a separate Space Force is required only if the differences between air and space power require that the divergent development of space power will fundamentally change the way wars are fought and won.

The third question to be answered is what the implications are for the future development of space power. In answering this question it is necessary to examine whether there is a theoretical or experience-derived basis for the differences between air and space power and for their implication to whether or not space power promises a new means of warfighting. A theoretical basis for a new means of war winning implies a more speculative development of space power while an empirical basis implies a more defined course of action.

Notes

[1] Estes, Gen. Howell M. III, Commander in chief, US Space Command, "The Air Force at a Crossroad," Address, Air Force Association National Symposium, Los Angeles, Calif., 14 November 1997;on-line, Internet, 19 November 1997, available from http://www.spacecom.af.mil/usspace/speech6.htm.

[2] *Global Engagement: A Vision for the 21st Century Air Force*, (Washington, D.C.: Department of the Air Force, 1997), 7.

[3] For a discussion on the migration of theater missile warning functions to space, see Ferster, Warren, "Missile Tracking Tops Military Space Plan," *Space News* (15-21 Sep 97), 8-14. The Space Based Infrared System (SBIRS) will system will provide not only strategic missile warning aimed at determining where the missile will strike, but also theater ballistic warning aimed at determining where the missile will strike and from where it was launched. More information is available via the internet at http://www.laafb.af.mil/SMC/MT/. See *Defense Daily*, 19 Feb 98, for a discussion of the Space Based Radar IPT effort aimed at migrating the Airborne Warning and Control

System (AWACS) and the Joint Surveillance and Target Attack Radar System (JSTARS) capabilities into space.

[4] There are arguments against such an approach. See, for instance, Krepinevich, Andrew F. Jr., "The Air Force of 2016," (Washington, D.C.: Center for Strategic and Budgetary Assessments, October 1996), 31.

[5] Estes, "The Air Force at a Crossroad."

[6] DeBlois, Maj. Bruce M., "Ascendant Realms: Characteristics of Airpower and Space Power," in The School of Advanced Airpower Studies, *The Paths of Heaven: The Evolution of Airpower Theory,* Edited by Col Phillip S. Meilinger, (Maxwell AFB, Ala.: Air University Press, 1997), 563-566.

[7] Howard, Michael E., "The Concept of Air Power: An Historical Appraisal," *Air Power History* (Winter 1995), 5-11.

[8] *Joint Vision 2010* (Washington, D.C.: Joint Chiefs of Staff, 1996), 10-11.

[9] Hyatt, Major James L., III, Major Ronald R. Ricchi, Major Paul L. Laugesen, Major Joseph H. Schwarz, and Major Michael A. Rampino, "Space Power 2010," (Research Report no. 95-010e. Maxwell AFB, Ala.: Air Command and Staff College, May 1995).

[10] Horner, Gen. Charles, reported in "Air Force Space System Control Questioned," Space News (8-14 Sep 97), 2. General Horner's views were elaborated on more fully in Watkins, Steven, "Is the space mission too big to handle?" Air Force Times (7 Oct 96): 32.

[11] "Notes on the Characteristics, Limitations, and Employment of the Air Service," Air Service Information Circular 1, no. 72 (12 June 1920), in Futrell, Robert Frank, *Ideas, Concepts, Doctrine: Basic Thinking in the United States Air Force 1907-1960*, (Maxwell AFB, Ala.: Air University Press, December 1989), 29.

[12] Keaney, Thomas A. and Eliot A. Cohen, *Revolution in Warfare? Air Power in the Persian Gulf* (Annapolis, Md.: Naval Institute Press, 1995), 200.

[13] Krepinevich, "The Air Force of 2016," 10-11. The technological innovation of powered flight provided the aircraft as a new tool for solving military problems. New operational concepts, aerial bombing of strategic targets and fleets engaging each other from the air, were developed. Organizational changes, the separation of the Army and Air Force and the reorganization of fleets around carrier battle groups, were made to execute the new operational concepts.

[14] DeBlois, "Ascendant Realms: Characteristics of Airpower and Space Power," 530.

[15] The argument that funding is the only limit because technology will limit both our capabilities and our adversaries is weak. The future is an uncertain world in which we will undoubtedly face asymmetric threats to our air and space forces.

[16] Horner, Gen. Charles quoted in Watkins, Steven, "Is the space mission too big to handle?" Air Force Times (7 Oct 96): 32.

[17] DeBlois, "Ascendant Realms: Characteristics of Airpower and Space Power," 531.

Chapter 2

The Elements of Military Power

> *[R]evolution implies rapid, violent, and, above all, unpredictable change. Clio has a number of lessons to teach Mars, but perhaps none is more important than that.*[1]
>
> —Eliot Cohen

In order to determine the differences between air and space power, it is necessary to provide a clear and concise exposition of each form of military power. Traditional approaches discuss the nature and principles of war, the strategic environment at the time, the feature of the medium, the characteristics of the forces, and the tenets of employing the power.[2] That approach will be followed here. The enduring nature and principles of war are adequately treated elsewhere. That discussion will not be repeated here.[3] The strategic environment during the period of interest will be addressed in this chapter. The features of the air and space mediums, characteristics of air and space forces, and the tenets of air and space force employment will be addressed in following chapters.

JV 2010 Style Warfare

The focus of this investigation is on the development of space power to meet the threats of the early 21st century. The report of the Quadrennial Defense Review (QDR) describes the global security environment that the United States anticipates facing in the early 21st century.[4] The National Military Strategy outlines the strategy that the military

instrument of power will employ in meeting the challenges posed by this environment.[5] The chairman's *Joint Vision 2010* identifies the operational concepts to be employed in carrying out this strategy.[6] These documents identify the salient characteristics of the environment, strategy, and style of warfare that air and space forces will have to respond to in carrying out their assigned tasks. A brief discussion of each is in order.

While a peer competitor is unlikely to emerge by 2010, the United States will be confronted by a number of dangers.[7] Regional powers whose interests run counter to those of the U.S. pose a considerable challenge. Failing and failed states will tend to destabilize their region and threaten U.S. interests. Transnational threats, such as terrorism, the illegal drug trade, organized crime, and uncontrolled migration, will pose an even greater threat than they do today. The non-trinitarian nature of these threats will make them especially difficult to counter.[8] Aided by the accelerating diffusion of information and advanced technology, potential adversaries will have a far greater choice of means to use against the U.S. Of great concern will be advanced weaponry; nuclear, biological and chemical weapons and delivery means; low observable and unmanned atmospheric vehicle capabilities; and information warfare and space denial capabilities. Not only will these means be used against U.S. interests abroad, there will be a real danger that they will be used against the homeland. No matter where or by whom, there will be motivation for adversaries to employ these means in asymmetric ways. U.S. strengths in space and information systems may become weak links vulnerable to attack. This already complicated picture is further confused by unpredictable changes such as technological advances, loss of critical overseas facilities, and hostile takeover of friendly nations. In all, the environment of the 21st century is uncertain and dangerous.[9]

It is in this environment that the United States will seek to promote peace and stability and, when necessary, to defeat its adversaries. This challenge will be met by a threefold strategy. The use of diplomacy and military operations will seek to shape the environment through deterrence based on both nuclear and, increasingly, conventional military capabilities. Those capabilities will be called on to respond to crises across the spectrum of conflict, from major theater wars to humanitarian assistance operations. The military will be called upon to use strategic agility, based on forward presence and power projection, to employ decisive force when and where required. In order to continue to shape the environment and respond to the full range of crises, the military will have to prepare now to meet the uncertain environment of the 21st century.[10]

In order to enact such a strategy, the military will be required to achieve what JV2010 calls full spectrum dominance, the ability to dominate the full range of military operations. This will require the transformation of current forces to implement four new operational concepts. The first, dominant maneuver, is "the application of information, engagement, and mobility capabilities to position and employ widely dispersed (forces) to … compel an adversary to either react from a position of disadvantage or quit."[11] The second, precision engagement, is "a system of systems that enables our forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess our level of success, and retain the flexibility to reengage with precision when required."[12] The third, full dimensional protection, is "control of the battlespace to ensure our forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses for our forces and facilities at all levels."[13] The last, focused logistics, is "the fusion of information, logistics, and

transportation technologies to provide rapid crisis response, to track, and shift assets even while enroute, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical level of operations."[14] The synergy of these concepts produces full spectrum dominance and provides the requirements for operational forces in the 21st century.

Features of the Medium

In defining a form of military power, such as space power, it is necessary to define the features of the medium in which it operates. These features, or basic properties, are the foundation for understanding how the medium will affect the forces of the medium and how those forces may be employed. The features of the medium result from a number of factors. The physical nature of the environment establishes the fundamental laws of operation in the medium. Political and legal factors often provide limits on the use of the medium.[15] Non-military use of the medium provides some of the environment in which the military uses of the medium must operate. The resulting features form the basis for distinguishing the opportunities and challenges presented by the medium for generating and applying military power.

Characteristics of the Forces

It is also necessary to determine the characteristics of the forces to be employed in the medium. These characteristics help build an understanding of how a form of military power can be employed in the medium.[16] The characteristics result from a number of factors. Non-military use of the medium determines what emphasis has been and will be placed on developing capabilities in the medium. The resulting technical capabilities

determine to what extent the potential of the medium may be exploited. Political and legal factors often provide limits on the nature or employment of the forces.[17] The resulting characteristics form the basis for determining how military power will be employed in the medium.

Tenets of Force Employment

Tenets are basic principles which, in environmental doctrine, augment the principles of war by providing the basic truths of how to conduct warfare within a medium.[18] Thus, the tenets of air power and those of space power serve as guides for employment of air power and space power. They describe how to best take advantage of the opportunities provided by the medium, as well as how best to confront the challenges imposed by the medium during operations. Tenets also describe approaches to extract the maximum combat power from the forces at hand given their unique characteristics.

Notes

[1] Cohen, Eliot A., "A Revolution in Warfare," (*Foreign Affairs 75*, no. 2), 54.

[2] This is most directly seen in Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine*, September 1997, 14-27 and Field Manual (FM) 100-5, *Operations*, June 1993, 1-3 to 2-24. For slightly different approaches see Fleet Marine Field Manual (FMFM) 1, *Warfighting*, March 1989, 1-37 and Naval Doctrine Publication (NDP) 1, *Naval Warfare*, March 1994, 3-50. A different approach was sought, but no suitable alternative was found.

[3] In the author's opinion, the best brief treatment of the nature of war is found in chapter one of FMFM 1, *Warfighting*, 1-15. The treatment of the principles of war in AFDD 1 is the most applicable to the current work.

[4] Cohen, William S., *Report of the Quadrennial Defense Review*, (Washington, D.C.: Office of the Secretary of Defense, May 1997).

[5] *National Military Strategy* (Washington, D.C.: Joint Chiefs of Staff, 1997).

[6] *Joint Vision 2010* (Washington, D.C.: Joint Chiefs of Staff, 1996), 13-18.

[7] Cohen, *Report of the Quadrennial Defense Review*, 5. Both the QDR and a monograph by Andrew Krepinevich point out that a peer competitor may arise not long after 2010. See Krepinevich, Andrew F. Jr., "The Air Force of 2016," (Washington, D.C.: Center for Strategic and Budgetary Assessments, October 1996), 31.

Notes

[8] Creveld, Martin van, *The Transformation of War*, (New York, N.Y.: The Free Press, 1991), 50. Clausewitz's original treatment of the trinity of the government, people, and army is found in Clausewitz, Carl von, *On War*, (Michael Howard and Peter Paret, eds., Princeton, N.J.: Princeton University Press, 1976), 89.

[9] Cohen, *Report of the Quadrennial Defense Review*, 3-5.

[10] *National Military Strategy*, 11-20

[11] *Joint Vision 2010*, 13.

[12] Ibid, 14.

[13] Ibid, 15.

[14] Ibid, 16.

[15] Lupton, *On Space Warfare: A Space Power Doctrine*, 18.

[16] Here the author disagrees with Major Newberry's statement that characteristics based on current technology or force structure are inappropriate as a basis for doctrine because the doctrine would have to change as technology or force structure changed. Quite the opposite. Doctrine must adapt to what is possible with current technology and forces. Otherwise, naval doctrine would not have advanced from battleship based operational concepts to carrier battle group based concepts. What Newberry describes as doctrine risks becoming hidebound dogma in the ever-changing nature of war. For Newberry's comments, see Newberry, Major Robert D., "Space Doctrine for the 21st Century," (Research Report no. 97-0427. Maxwell AFB, Ala.: Air Command and Staff College, March 1997), 25.

[17] Lupton, *On Space Warfare: A Space Power Doctrine*, 18.

[18] Air Force Manual (AFM) 1-1, Volume II, *Basic Aerospace Doctrine of the United States Air Force*, March 1992, 113.

Chapter 3

The Elements of Air Power

> *The Gulf War supports the fact that air strikes can, by themselves, form the basis for victory. In Operation Desert Storm, air power was responsible for victory because air superiority altered the complexion of the war from the very outset.*[1]
>
> —Soviet Army Major General Vladimir Slipchenko

The air medium is the atmosphere, the realm above the surface of the earth in which the laws of aerodynamics rule the motion of objects.[2] This definition recognizes that the air medium has an upper boundary above which aerial flight is not possible. This investigation will restrict itself to military air power, not air power in the broader sense which includes civil and commercial aviation. Air power is the use of or denial of the use of the air medium for military value. Likewise, air forces will be defined as forces that use or deny the use of the air medium for military value. This broad definition includes such forces as air defense artillery, carrier aircraft, and surface-to-surface missiles. The intent is neither to lay claim to these forces as the province of the Air Force, nor to claim the air assets of the Marine Air Ground Task Force for the Joint Forces Air Component Commander, but to indicate that all air forces must be employed jointly to meet the nation's defense needs.

JV 2010 Air Warfare

In order to implement the operational concepts laid down in JV 2010, air forces will need to provide a number of capabilities to the joint team. Those capabilities are well described by the core competencies in the Air Force vision for the 21st century, *Global Engagement*.[3] Air superiority, the ability to control what moves through air, provides freedom from attack and freedom to attack and is necessary for dominant maneuver and full-dimensional protection. Global attack, the ability to attack rapidly anywhere on the globe, is key to providing power projection and is an exercise of dominant maneuver. Rapid global mobility, the ability to move rapidly to any spot on the globe, directly supports the joint force's capability to project power and achieve dominant maneuver. Precision engagement, identically defined by the Air Force and JV 2010, is a key capability of and a top priority for air power in the 21st century. Information superiority, including a common view and understanding of the battlespace, is a foundation of JV 2010 and will be a necessary component of all forces. Finally, agile combat support, both in providing support and in reducing the footprint of forces and systems, directly supports focused logistics. Air forces which implement these core competencies will support the joint vision and provide decisive force on demand.

Features of the Air Medium[4]

The physical features that the air medium provides are elevation above the surface of the earth, three-dimensional motion within the air, freedom from natural barriers, and close proximity to the surface of the Earth. The air medium limits air power because it is prone to weather and because aerodynamics do not support continuous presence.[5] The proximity of the air to the surface combined with the mobility of air forces provides

access to the entire surface of the Earth. The main political and legal feature of the air medium is that states claim sovereignty over the airspace above their territory. Non-military uses of the air medium are concentrated in air transportation and aerial photography. Thus the economic value of the use of the air medium is due to the transport of people and materials through the air. The features listed in table 1 provide the basis for the characteristics of air forces.

Table 1. Features of the Air Medium

Elevation
3 Dimensional Motion
Lack of Barriers
Weather
Proximity to Earth/Access
Lack of Constant Presence
Sovereign Airspace
Economic Value from Platforms Moving Through Air

Characteristics of Air Forces[6]

Elevation provides air forces the ability to view a large area of the Earth at one time. Because their forces can view a large part of a theater, airmen have a theater perspective.[7] The physical nature of the air medium allows three-dimensional motion in the air, providing maneuverability, the ability to move in and engage targets from any direction. The lack of natural barriers in the air and elevation above the surface provide freedom of movement over the surface of the Earth unrestrained by terrain or surface forces. Mobility is the freedom to appear at a time and place of one's own choosing. This freedom can be limited by the ability of surface-based forces, such as surface-to-air missiles, to project air power from the surface.

Table 2. Characteristics of Air Forces

View
Theater Perspective
Maneuverability
Freedom of Movement/Mobility
Range
Speed
Responsiveness
Versatility
Flexibility
Autonomy
Precision
Lethality
Stealth
Permissive Overflight and Basing
Transitory Operations

The technical capability of air platforms and their munitions provide many of the capabilities of air forces that are critical to military air power. The range and speed available to air forces are superior to those of the surface forces. These combine to provide a responsiveness to the needs of the joint force commander that is unmatched by surface forces. Responsiveness combined with the broad access of air forces provides the versatility to strike targets with effects at all levels of war. This is unique to the mediums above the surface in providing the commander with the ability to apply combat power towards achieving operational and strategic effects without first prevailing at the tactical level of war. The ability to mount a variety of munitions on general purpose platforms gives air forces the flexibility to fulfil one function, rapidly reconfigure, and provide a very different function with the same platform. Manned air platforms provide autonomy to make tactical decisions and execute operations based on first hand knowledge. Unmanned air forces such as cruise missiles provide an equivalent benefit by receiving command and control from an operator immediately prior to launch. Precision effects are

achieved by air forces by employing modern munitions. The precision and effect of modern munitions combine to provide devastating lethality. Technology also provides stealth, resulting in the ability to build into air forces a degree of air superiority.

The exercise of sovereignty over airspace places a limit on the freedom of motion of air forces. This gives the use of a state's airspace a permissive character. Because the air medium does not allow air platforms to be constantly present, civil and military operations in the air have, except for balloons and aerostats, been of a transitory nature. This characteristic of air power leads to the need for basing of air platforms on the surface of the Earth. Basing requirements extend the limitation of permissiveness on air operations beyond overflight to the land bases from which they are launched and to which they will recover. Sea-based air power does not suffer this limitation.

Tenets of Employing Air Forces

Unlike the characteristics, the tenets of air power are defined in AFDD 1.[8] The discussion that follows is condensed from that text, with some alteration. Flexibility and Versatility are treated in this paper as characteristics of air power, not tenets of its application. The tenets of centralized control, decentralized execution, and achieving synergistic effects are aimed at maximizing the benefits derived from the flexibility and versatility of air power. While this varies from official thought, the author believes this departure to be logically consistent and correct.

The tenets of employing air forces derive from the experiences gained in employing air power. Air power resources have always been limited in number. Centralized control by an airman who maintains a broad perspective in prioritizing their use is necessary to maximize the effect achieved by air forces. Decentralized execution in response to this

control ensures effective spans of control, initiative, responsiveness to changing situations, and tactical flexibility. Synergistic effects, whose value is far beyond the effort expended in their achievement, are achieved by the optimum use of the flexibility and versatility of air power. Air superiority is necessary to achieve successfully apply air power.[9] Superiority may be local or theater-wide, but it must be present to ensure freedom of action in the air and on the surface of the Earth.

Table 3. Tenets of Air Power

Centralized Control
Decentralized Execution
Synergistic Effects
Air Superiority
Persistence
Concentration
Priority
Balance
Initiative

Air power achieves lasting effects on targets and areas by persistence, achieving an initial effect and revisiting as necessary to maintain that effect. The versatility and flexibility of air power make its application attractive for a multitude of uses in modern warfare. In order to achieve massed and persistent effects, it is necessary to concentrate the application of air power towards achieving significant objectives. In addition, the objectives to which air power will be applied must be prioritized so that they make the greatest contribution to the joint force. In applying air forces, the commander should balance combat opportunity, necessity, effectiveness, efficiency, and the impact on accomplishing assigned objectives against the associated risk to friendly air forces. Air forces are inherently offensive in nature.[10] Their ability to strike anywhere in the theater

with effects at all levels of war makes them the ultimate weapon for gaining and keeping the initiative.

Notes

[1] Lambeth, Benjamin S., "Bounding the Air Power Debate," (*Strategic Review 25*, no. 4), 54.

[2] Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine*, September 1997, 21.

[3] *Global Engagement: A Vision for the 21st Century Air Force*, (Washington, D.C.: Department of the Air Force, 1997), 8-17.

[4] There is no official set of features of the air medium. The 1992 version of AFM 1-1, volume II, essay H discusses the air medium. Essay J describes elevation and its benefits, but without recognizing that speed, range, and maneuverability are potential capabilities of air forces but are only realized through technology. The author's attempt here is to synthesize a list of features that will suffice for the purposes of this paper. The list has been kept general, but is intended to be fairly comprehensive.

[5] Air Force Manual (AFM) 1-1, Volume II, *Basic Aerospace Doctrine of the United States Air Force*, March 1992, 79-80.

[6] The characteristics of air forces presented here are a synthesis from a number of sources. AFM 1-1, volume II, essay J and AFDD 1 are the main sources. Two other sources, DeBlois, Maj. Bruce M., "Ascendant Realms: Characteristics of Airpower and Space Power," in The School of Advanced Airpower Studies, *The Paths of Heaven: The Evolution of Airpower Theory,* Edited by Col Phillip S. Meilinger, (Maxwell AFB, Ala.: Air University Press, 1997) and Newberry, Major Robert D., "Space Doctrine for the 21st Century," (Research Report no. 97-0427. Maxwell AFB, Ala.: Air Command and Staff College, March 1997) supplemented the official doctrine.

[7] AFDD 1, 22-23.

[8] AFDD 1, 21-27.

[9] While AFDD 1 does not call our air superiority as a tenet, it is necessary to call it out as a key employment principle.

[10] AFDD 1, 14.

Chapter 4

The Elements of Space Power

> *To begin with, it must be made clear that space is becoming, or some would say, space has become the 4th medium in which the military operates in the protection of our national security interests.*[1]
>
> —General Howell M. Estes III

As in exposing air power, some definitions are necessary. The space medium is the vast extent beyond the atmosphere where the laws of astrodynamics rule the motion of objects.[2] This definition does not recognize an upper boundary above the space medium. This investigation will restrict itself to military space power, not space power in the broader sense which includes civil and commercial space efforts and assets. Space power is the use of or denial of the use of the space medium for military value. Likewise, space forces are those forces that use or deny the use of the space medium for military value. This broad definition includes forces such as civilian communications satellites carrying military traffic, anti-satellite weapons, and tactical satellites supporting land operations. The intent is not to lay claim to these forces as the province of the Air (or Space) Force, but to indicate that all forces must be employed jointly to meet the nation's defense needs and must be considered in determining the differences between air and space power.

JV 2010 Space Warfare

Space forces that implement *Joint Vision 2010* will have two components. The first, more traditional, component will be space functions, that are directly integrated with terrestrial operations, such as navigation, communication, and ICBM early warning,. This component will continue to grow as functions that are today implemented by air and surface forces migrate into space, as is likely with the airborne warning and control system (AWACS) and the joint surveillance target attack radar system (JSTARS).[3] The second component will be space forces which conduct operations to control space and affect strategic centers of gravity in space. Space is becoming an economic center of gravity for the United States and may well become such for other nations.[4] Given the known value of space capabilities to air and surface military operations and the likelihood of economic centers of gravity in space, the placement of weapons systems in space seems likely. When developed, such systems will be used against other military space systems as well as to hold at risk the economic power civil and commercial space systems will represent. The core competencies necessary to implement JV 2010 style warfare include control of space, global engagement, full force integration, and global partnerships.[5]

Features of the Space Medium[6]

The physical features that the space medium provides are elevation above the surface and atmosphere of the Earth, three-dimensional motion within the expanse of space, and the lack of natural barriers. The space medium is hostile to human beings, materials, and electrical circuits. Space provides direct access to the air medium as well indirect access to the surface through the air. Unlike aerodynamics, astrodynamics provide space forces

the continuous orbital presence. The space medium provides the political and legal feature of the sovereignty of space vehicles. Non-military uses of space are communications, earth observation, and navigation.[7] Thus the permanent basing of platforms in space and their capabilities provide the economic benefit of the use of space. The features listed in table 4 give rise to the characteristics of space forces.

Table 4. Features of the Space Medium

Elevation
3 Dimensional Motion
Lack of Barriers
Hostile Environment
Access to and Through the Air
Orbital Presence
Vehicular Sovereignty
Economic Value from Platforms Based in Space

Characteristics of Space Forces[8]

Elevation above the atmosphere gives space forces a view of the entire atmosphere and surface of the Earth. This view gives spacemen a global perspective unmatched by forces of the other mediums. The energy required to change orbit significantly limits the maneuverability of space forces. However, three-dimensional motion and the lack of barriers gove space forces freedom of movement. Elevation above the Earth and orbital motion give space forces a global range, allowing a small number of space forces to provide their capabilities to or against the entire surface and atmosphere. Presence in orbit and the technical capabilities of the payloads, communications, and command and control of space forces allows them to achieve rapid, often instantaneous, response.

Table 5. Characteristics of Space Forces

View
Global Perspective
Limited Maneuverability
Freedom of Movement
Global Range
Speed of Response
Slow to Deploy
Versatility
Limited Flexibility
Timely Control
Difficult Physical Access
Limited Weapon Effects
Observability
Vulnerability
Legal Overflight
Positional Operations

Technology provides significant capabilities to and limitations on U.S. space forces. The lack of rapid and assured launch capability makes space forces slow to deploy. Their global range and speed of response make space forces highly versatile, able to support or engage targets in geographically separated areas of operations and to rapidly shift focus between areas of operations. Restricted launch capabilities result in space payloads that are capable in a narrow range of functions, limiting the flexibility of space forces.

The orbital nature of most space force operations results in a variety of control paradigms. Geosynchronous space forces are in constant view of ground terminals, providing real-time control and autonomy. Lower altitude space forces gain and lose contact with control stations, receiving "command loads" of planned operations for some future period, resulting in decreased timeliness of command and control for some forces. Technological limits on launch access, maneuver, and propulsion significantly restrict physical access to and from space. Restricted physical access to the surface of the Earth combines with technological shortfalls to limit the weapons effects available to space

forces. Weight and technical capability limitations combine with the lack of terrain and masking opportunities to make space forces extremely observable from the air, land, and sea. An additional effect of the difficulty and expense of launching space forces into orbit is that they must be made light and are thus rather fragile. This, combined with the observability of space forces, results in the relative vulnerability of space forces.

The vehicular sovereignty of space provides a political and legal environment which assures legal overflight is afforded to space forces.[9] Both military and civil space systems require continuous presence and operations in space, which combines with the nature of orbital motion to give the operation of space forces a positional nature.

Tenets of Employing Space Forces[10]

Space forces are limited in number, costly, and provide significant capability to theater commanders. This will require centralized control of space operations on a global scale. A knowledgeable theater commander will identify the focus of space forces efforts and prioritize those efforts. The requests of theater commanders will then be deconflicted based on strategic priorities by a commander with global perspective and a sound understanding of the tradeoffs involved in applying space power. Decentralized execution by space operators will maximize effects applying specialized knowledge and situational awareness.[11] Space forces will require protection to achieve freedom of action and will need to limit the enemy's freedom of action in order to produce success in warfare. This will require achievement of space superiority.

Table 6. Tenets of Space Power

Centralized Control
Decentralized Execution
Space Superiority
Synergistic Effects
Persistence
Concentration
Priority
Balance
Redundancy
Initiative

Optimum use of the global presence and versatility of space power is achieved when it is employed to produce synergistic effects. Space power differs from the surface forms of military power in that it cannot directly occupy and control territory on the surface. Instead, lasting effect upon targets and areas will be achieved by persistence, the continual vigilance of space information systems combined with combat power applied from all four mediums of military power. For geosynchronous space forces, this will require constant access to the area of interest. For space forces at other altitudes and non-orbital space forces, this will require revisit of the area of interest without an unacceptably long gap in coverage.

The global presence and versatility of space power make its application attractive for a multitude of uses in modern warfare, but to achieve massed and persistent effects, concentration of space forces towards achieving significant objectives is necessary. In addition, the objectives to which space forces will be directed must be prioritized so that they make the greatest contribution to the joint force. In applying space forces, the commander must balance opportunities, necessity, effectiveness, efficiency, and impact on accomplishing theater objectives against the associated risks. Use of space forces may incite enemy action against them, so the risk to space forces and the global capability

they provide must be balanced against the benefit of their use, as space forces will be the most difficult to rapidly replace and whose loss is most difficult to work around.

Space is hostile to both human and machine, making redundancy necessary for successful use of space power. Success will require space systems whose forces have redundant subsystems or that employ a redundancy of platforms to ensure robustness of a space provided function. The hostility of the space will also include enemy threats to space forces. Due to the vulnerability and observability of space forces, acting to counter or eliminate such threats before they can be used will be critical to maintaining space control as well as information dominance. This requires the application of the tenet of initiative in space operations, especially those aimed at attaining space and information superiority.

Notes

[1] Estes, Gen. Howell M. III, Commander in chief, US Space Command, "Space: Fourth Medium of Military Operations," Address, Air Force Association National Symposium, Los Angeles, Calif., 18 October 1996; on-line, Internet, 19 November 1997, available from http://www.spacecom.af.mil/usspace/speech1.htm.

[2] While AFDD 1 uses the term orbital dynamics, the author has chosen astrodynamics to avoid the implication that all space forces are in orbit. Space forces such as fractional orbital bombardment systems and military space planes will not always, or even usually, be in orbit.

[3] The recent agreement on the funding and management of the STARLITE technology demonstration of space-based moving target indication radar capabilities is an indication that this may happen in the early 21st century. See *Inside the Air Force*, 30 Jan 98.

[4] Estes, Gen. Howell M. III, Commander in chief, US Space Command, "The Promise of Space," Address, National Space Symposium, Colorado Springs, Colo., 3 April 1997; on-line, Internet, 21 January 1998, available from http://www.spacecom.af.mil/usspace/speech3.htm.

[5] "United States Space Command Vision for 2020," on-line, Internet, 28 January 1998, available from http://www.spacecom.af.mil/usspace/visionbk.htm, page 8.

[6] The author's attempt here is to synthesize a list of features that will suffice for the purposes of this paper. The list has been kept general, but is intended to be fairly comprehensive. It is based on a draft of what was to be AFDD 4, and other sources, including Lupton, Lt Col David E., *On Space Warfare: A Space Power Doctrine*.

(Maxwell AFB, Ala.: Air University Press, June 1988), Kwast, Major Steven L., "Convergence or Divergence: The Relationship Between Space Doctrine and Air Force Doctrine," Research Report no. 97-0604F, (Maxwell AFB, Ala.: Air Command and Staff College, March 1997), and Newberry, Major Robert D., "Space Doctrine for the 21st Century," Research Report no. 97-0427, (Maxwell AFB, Ala.: Air Command and Staff College, March 1997).

[7] While the space shuttle provides transportation to and from space for a limited number of satellites and personnel, no significant growth of this capability is expected in the JV 2010 timeframe. The international space station is likely to be the main consumer of civil and commercial space plane traffic.

[8] The characteristics presented are a synthesis of the draft of AFDD 4, Lupton, *On Space Warfare: A Space Power Doctrine*, Kwast, "Convergence or Divergence: The Relationship Between Space Doctrine and Air Force Doctrine," and Newberry, "Space Doctrine for the 21st Century."

[9] This may change as weapons are placed in space.

[10] The tenets presented are based on Newberry, "Space Doctrine for the 21st Century."

[11] Here the author disagrees with Major DeBlois' concept of space force decentralized execution. The execution of space force taskings by a satellite control squadron is decentralized execution. It is at the command and control center that situational awareness exists and that actions by the space force can be initiated. For a manned space force platform, the autonomous decision making will be done in the platform, rather than remotely. However, this does not change the decentralized nature of unmanned space operations. Space operations are similar to UAV operations with respect to decentralized execution. See DeBlois, Maj. Bruce M., "Ascendant Realms: Characteristics of Airpower and Space Power," in The School of Advanced Airpower Studies, *The Paths of Heaven: The Evolution of Airpower Theory,* Edited by Col Phillip S. Meilinger, (Maxwell AFB, Ala.: Air University Press, 1997), 545-546.

Chapter 5

A Comparison of Air and Space Power

The tables below provide a comparison of air and space power grouped according to the features of the medium, the characteristics of the forces, and the tenets of employing the power. The first table in each section identifies the attributes of and the resulting differences between air and space power. The text expands on the tables, discussing the nature of each difference, whether it is temporary or permanent, and whether it is based on experience or on theory. The second table in each section summarizes the examination of the differences. This comparison forms the basis for the discussion of whether air and space power should evolve together or separately.

Differences Between the Mediums

The first difference between the air and space mediums is the nature of force presence in the medium. Air forces fly through their medium, taking off and returning to bases on the surface. Space forces also fly through their medium, but can maintain their flight path without spending energy. This difference between the air and space mediums is permanent, growing from the different physical laws by which air and space are governed, and based on experience.

Table 7. Comparison of Features of the Air and Space Mediums

Air Medium	Space Medium	Differences
Elevation 3 Dimensional Motion Lack of Barriers Weather Proximity to Earth/Access Lack of Constant Presence Sovereign Airspace Economic Value from Platforms Moving Through Air	Elevation 3 Dimensional Motion Lack of Barriers Hostile Environment Access to and Through the Air Orbital Presence Vehicular Sovereignty Economic Value from Platforms Based in Space	Presence in the Medium Ease of Access to/from the Medium Sovereignty of the Medium Source of Economic Value through use of Medium

The second difference between air and space is the relative ease of access to and from the medium. Since the first flight of the Wright brothers, the ability to operate an airplane has become widespread and economical. Space vehicles did not follow a similar course after Goddard's rocket. Space launch continues to be expensive and technically challenging. Commercial ventures, such as the Iridium™ program, may provide greater investment in reducing the difficulty of achieving access to space. The Space Shuttle and *Soyuz* programs demonstrated that return and reuse of space vehicles is feasible and practical. However, the region of space which is accessible by such systems is very limited. While this difference is likely to persist beyond the JV 2010 timeframe, it is probably temporary and based on experience.

The third difference between air and space is the nature of sovereignty in the medium. The airspace above a sovereign state is viewed as its sovereign domain, just as territorial waters are viewed. Platforms moving through the air are under the sovereignty of the nation that owns them, like ships at sea. Conversely, the region of space directly above a sovereign state is and not under any state's sovereignty, similar to the concept of international waters. Platforms moving through space, like ships at sea and planes in the

air, are the sovereign property of the state which launched them. While this difference is based on political and legal convention, the freedom of the seas have been respected for centuries, hence this difference is considered to be permanent and based on experience.

Table 8. Summary of Differences in the Features of the Air and Space Mediums

Difference	Duration of the Difference	Nature of the Difference
Presence in the Medium	Permanent	Experience
Ease of Access to/from the Medium	Temporary	Experience
Sovereignty of the Medium	Permanent	Experience
Source of Economic Value through use of Medium	Permanent	Experience

The final difference between air and space is the source of economic value of the use of the medium. Economic value derived from the use of the air is due to airline travel and air cargo, with a smaller source coming from aerial photography and surveying. There do not appear to be any emerging uses of the air medium that will change this. Economic value in space is derived from systems operating in space and from the launch services necessary to station them in space. So, while the use of the air medium provides economic value, its occupation does not. Conversely, it is the occupation of the space medium with useful systems that provides economic value. Communications and earth observation systems represent both economic and informational centers of gravity in space.[1] This difference appears to be permanent and is based on experience.

Differences Between the Forces

The first difference between air and space forces lies in the scope of the perspective that they provide. Airmen, due to the speed, range, and view of air forces, have a theater-

wide perspective.[2] The efficient employment of air forces requires that their use be prioritized within the theater. This belief is rooted in the air operations in North Africa during World War II.[3] The capabilities of space forces provide a global capability, thus the effective and efficient employment of space forces requires a global perspective. One demonstration of this is the arrangement by which command and control of satellite intelligence, surveillance, and reconnaissance resources is handled in wartime. Tasking requests are submitted by the theater commander and then prioritized by a central tasking authority. This difference is permanent and based on experience.

Table 9. Comparison of the Characteristics of Air and Space Forces

Air Forces	Space Forces	Differences
View	View	Scope of Perspective
Theater Perspective	Global Perspective	Choice of Time, Place and Approach
Maneuverability	Limited Maneuverability	Range
Freedom of Movement/Mobility	Freedom of Movement	Response
Range	Global Range	Versatility
Speed	Speed of Response	Flexibility
Responsiveness	Slow to Deploy	Autonomy and Control
Versatility	Versatility	Vulnerability
Flexibility	Limited Flexibility	Power Projection from Medium
Autonomy	Timely Control	Overflight
Precision	Difficult Physical Access	Basing
Lethality	Limited Weapon Effects	Operations
Stealth	Observability	
Permissive Overflight and Basing	Vulnerability	
Transitory Operations	Legal Overflight	
	Positional Operations	

The second difference between air and space forces is in their ability to maneuver, and hence to choose the time, place, and approach of their engagements. Air forces are maneuverable in the third dimension and unrestrained by natural barriers, allowing them to choose the time and place they will attack, their route, and the direction from which

they will attack. Space forces must expend energy to maneuver and cannot make large changes in their flight path and simultaneously achieve precision of thrust control, nor does it provide the capability to carry enough fuel to make frequent maneuvers practical. This limits space forces to attacking their targets at the times and along the approaches allowed by their flight path with only small changes. Thus, space forces enjoy only some of the benefits of the third dimension. Advances in technology may overcome this limitation, although air forces will always be able to achieve such freedom at a lower cost in energy than space forces. This difference is temporary and based on experience.

The ranges of air and space forces differ. While air forces can travel globally with aerial refueling, their current practical range for sustained combat operations is much shorter, requiring in-theater basing. Space forces are not limited in this way in fulfilling current operational concepts. Future operational concepts for space forces, especially maneuvering forces such as a military space plane or weaponized platform designed for rapid re-targeting, may be more dependent on fuel and other consumables. However, the advantage space forces have of being able to stay in orbit will not change. This difference is permanent and based on experience.

Another difference is in the speed and nature of the ability of air and space forces to respond to new tasking and requests for support. Air forces can respond instantaneously in close air support roles when nearby the requesting unit, but when not in the area, they must be generated, taking minutes to hours to do so. Space forces are on-orbit and ready to respond immediately, if the area of interest is in view. Space forces are limited by their orbital motion, to a response time varying from immediate to hours. However, if the requested space asset is not in orbit, it must be generated and launched, requiring days to

months. In the future, space launch my become much more responsive. This difference is temporary and based on experience.

Air and space forces differ in their versatility. Air forces are able to engage targets throughout a theater and to produce effects at all levels of war. Space forces can engage targets all over the globe but are limited in their effects, especially at the tactical level of war. This is due to the limited nature of weapons effects likely to be available from space, which is temporary, and the nature of their orbital motion. Weaponized space forces are most likely to be placed in low orbits in order to minimize their range to targets on the earth. This results in periodic opportunities to revisit targets. The frequency with which air forces can re-engage targets depends on the distance between their base and the target. Space forces can only re-engage when their orbit (or flight path) provides an opportunity for them to do so. Limited weapon effects and strike opportunities reduce the effect of space forces at the tactical level of war. This difference is temporary and theoretical, as there is no experience with space weapons engaging targets on the surface of the Earth.

The flexibility of air and space power is another difference. Today, air forces can execute a close air support mission, return to base, rearm and execute an interdiction or strategic attack mission. This flexibility is derived from ability of the air vehicle to deliver various munitions. The difficulty and expense of space lift cause most space payloads to be single purpose, reducing the flexibility of space forces. This facet of the limited flexibility of space forces is based on experience, but is temporary. Another limiting factor is the that space forces do not yet carry weapons. When they do they will initially be limited to a single type of effect or munitions. Only after space forces gain

easy access to space and maneuverability will they enjoy the same degree of flexibility as air forces. This facet of the difference is theoretical and temporary.

The next difference between air and space forces is the means by which they achieve autonomy and control. Today, air forces are predominantly manned, giving the individual platform the autonomy that comes from an intelligent operator. Unmanned atmospheric vehicles (UAVs) are coming into use, where similar autonomy is gained by an intelligent operator remotely receiving situational awareness information from and sending control signals to the platform. Fire-and-leave munitions are not autonomous, but this shortfall only occurs in the terminal phase of an air mission. The earliest space forces were limited to periodic commanding opportunities as they flew by a ground control station. During these "contacts" the satellite would receive a set of commands to be stored and executed over a period of time and would transmit a set of telemetry to the ground station. Satellites and manned space vehicles have advanced to provide control and situational awareness similar to that of UAVs. This difference is mainly limited to the difference in reaction time due to the communications delay to the space platform, a permanent difference, based on experience.

Air and space forces also differ in their vulnerability. Air forces are able to use terrain, weather, and other limitations to avoid detection and observation. The maneuverability of air forces provides additional opportunities for air forces to evade or complicate efforts to detect and track them. Air forces can exercise built-in air superiority through stealth. Space forces have few options to avoid observation from air, surface, and other space forces and the predictability of their motion further aids forces attempting to detect and track them. Building stealth features into space platforms has not been

attempted. Observability is affected by the advance of technology, but the lack of natural opportunities for space forces evading observation is permanent and based on experience.

The next difference between air and space forces is that of their ability to project power into the surface mediums. Air munitions provide substantial lethality through precision and a variety of weapons effects. Space forces do not yet provide the capability to apply combat power, especially from space to the air or the surface. Weapons exist and are being developed which will probably be adapted to space forces. However, space-borne weapons are likely to lag air delivered munitions in lethality and precision. Delivery from space must overcome the re-entry into the atmosphere which also limits what weapons can be employed from space. There will always be an advantage to air forces in this area, but the gap between air and space is expected to gradually close as new technologies are developed. Based on this assumption, this difference is temporary, but given the lack of effort in fielding weapons in space, this difference is theoretical.

Air and space differ as areas of operations in the nature of overflight restrictions on their respective forces. Air forces are limited in peacetime by the sovereignty states hold over their own airspace, while space forces are free to overfly all states. The legal overflight of other states by space platforms is predicated on the peaceful use of space. That this may change with the development of highly maneuverable space forces or their weaponization makes this a theoretical and temporary difference.

Air and space forces also differ in their basing requirements. Air forces are limited in their effective combat range by their requirement for basing. Airplanes may eventually overcome this limitation, but such a vehicle of the future is likely to be a space plane. Cruise missiles and other long range precision strike capabilities partially overcome this

limitation today and are likely to overcome it completely in the future. Space forces, because of their persistence in orbit and the legal overflight currently accorded to platforms in orbit, may be able to take on part of the forward presence role, sharing with naval forces the lack of restriction by basing and overflight considerations. This theoretical difference temporoary.

Table 10. Summary of Differences in the Characteristics of Air and Space Forces

Difference	Duration of the Difference	Nature of the Difference
Scope of Perspective	Permanent	Experience
Choice of Time, Place and Approach	Temporary	Experience
Range	Permanent	Experience
Response	Temporary	Experience
Versatility	Temporary	Theory
Flexibility	Temporary	Experience/Theory
Autonomy and Control	Permanent	Experience
Vulnerability	Permanent	Experience
Power Projection from Medium	Temporary	Theory
Overflight	Temporary	Theory
Basing	Temporary	Theory
Nature of Military Operations	Permanent	Theory

The final difference between air and space forces is the nature of military operations in each medium. Air operations are aimed at achieving effects on the surface. This is not to say that they are tied to surface forces, but that the centers of gravity air operations seek to affect are either other air forces or surface targets. Space forces, in addition to operating against surface targets and air and space forces, will also operate against the economically vital civil and commercial space systems of other states. The presence of economic and informational centers of gravity in space raises it from an area in which

forces operate to support and affect air and surface operations to one containing valuable targets and objectives in its own right. This difference is theoretical, but permanent.

Differences in Employment

One difference between the employment of air and space power is the scope considered in prioritizing and balancing their use in operations. The theater focus of airmen and the ability of air forces to influence events across a theater requires the allocation of air forces to a theater commander. This commander then can prioritize the use of these air assets as well as balancing their use and the risk to them. The global perspective of space power and the ability of most space forces to influence events in multiple regions of the world within a single day will require a means of achieving global prioritization and balance. One area in which this difference is not broadly applicable is that of strategic airlift. It is possible that the mechanisms used in prioritizing and balancing the use of airlift assets may be adapted to the challenge of prioritizing and balancing the use of space forces. However, the pace of events for space forces will be much faster than that for airlift. This difference can already be seen in the procedures for use of tactical ISR assets and national space assets. Experience has been that theater ISR assets are best employed and directed by the theater commander while national space assets operate with central requirements and tasking organizations. This difference is permanent and based on experience.

Table 11. Comparison of the Tenets of Air and Space Power

Air Power	Space Power	Differences
Centralized Control Decentralized Execution Synergistic Effects Air Superiority Persistence Concentration Priority Balance Initiative	Centralized Control Decentralized Execution Space Superiority Synergistic Effects Persistence Concentration Priority Balance Redundancy Initiative	Scope of Prioritization and Balance Robustness

The other difference in the employment of air and space power is their robustness. Air forces are fairly survivable, when enemy air defenses are suppressed and anti-radiation missiles, fighter sweeps and escorts are employed. Additionally, individual air platforms have advanced from their spit and bailing wire heritage to become fairly reliable and maintainable. Space forces are fairly fragile, at risk to attacks by enemy capabilities as well as to the natural space environment. Redundancy is employed to enhance the robustness of space forces, but at significant cost in additional components of space platforms and payloads as well as additional space forces. This difference is temporary and based on experience.

Table 12. Summary of Differences in the Tenets of Air and Space Power

Difference	Duration of the Difference	Nature of the Difference
Scope of Prioritization and Balance	Permanent	Experience
Robustness	Temporary	Experience

Notes

[1] Estes, Gen. Howell M. III, Commander in chief, US Space Command, "The Promise of Space," Address, National Space Symposium, Colorado Springs, Colo., 3

Notes

April 1997; on-line, Internet, 21 January 1998, available from http://www.spacecom.af.mil/usspace/speech3.htm.

[2] Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine*, September 1997, 23.

[3] McNamara, Lt. Col. Stephen J., *Air Power's Gordian Knot: Centralized versus Organic Control*, (Maxwell AFB, Ala.: Air University Press, August 1994), 21.

Chapter 6

Space Power: Vertical Dimension or Outer Shell?

The preceding comparison reveals three significant areas of divergence between air and space power. First, the space medium is a place where operations will be conducted to achieve operational and strategic objectives. Space will no longer be a medium where forces are employed solely to support terrestrial operations. Second, space forces are ubiquitous, with constant presence above the earth's surface and atmosphere and rapid response to tasking by national decision makers and theater commanders. Third, the tactics and techniques used to employ space forces will be different from those used in the air. These differences between air and space power constitute the governing factors in this investigation. The specifics of each divergence will be now be examined.

Space is a Place

Space platforms are positional; they can be placed in and maintain orbit almost indefinitely. They provide a constant presence in the high ground of space.[1] Sovereignty in space is extended to the forces, not the areas above states on the surface, allowing space forces to be placed where they are needed and moved when necessary without political restrictions. Military, civil, and commercial space systems derive their value from their constant presence in space. Their value comes, not from transporting people or cargo through space, but from gathering, transferring, and using information. Future

space forces will also provide force application.[2] Space forces, whether they provide weapons or information functions, must be placed advantageously relative to the surface features of the earth in order to be of value. The lack of political encumbrances allows freedom of action to place and move space forces. Thus, constant presence in useful and valuable orbits is important in the use of space power.

Space operations will fulfil three roles: support of terrestrial operations, power projection into terrestrial areas of operations, and combat operations in space. Space, as an area of operations, will be physically remote from the terrestrial theater where the enemy decision-maker resides. This remoteness, combined with the presence of centers of gravity in space, will make space operations important to consider in achieving the objectives of the theater campaign. Major operations in space may, in some cases, be the only measures taken to affect an enemy decision maker. However, while such operations may be independent of the forces in the terrestrial theater, they will never be completely divorced from the terrestrial theater commander's campaign plan. Thus, space operations will seek to achieve objectives in space, not just on the surface.

Space Forces are Ubiquitous

The global perspective and range of space forces allow them to exert a global presence, and to act anywhere they are needed. The positional nature of space forces and the overflight allowed them by the lack of territorial sovereignty in space give space forces unfettered access. The near-instantaneous response of orbital space forces to tasking requests combines with the global presence of space forces makes them a near-immediate global response capability. The ubiquity of space forces is enhanced by the continuous nature of space operations. Space forces operate continuously, uninterrupted

by returns to base for refueling, rearming, or crew rest. Thus, space forces can be present everywhere above the earth and will operate constantly.

Space Tactics and Techniques Will Be Different

The rapid world-wide response of space forces gives the national command authority and theater commanders a powerful tool to shape the strategic and theater environments. However, this tool is limited by two factors. Space forces are not currently able to move easily between space and the air or surface. This technological shortfall prevents re-supply of space forces and denies them the flexibility that air forces achieve through tailoring their munitions to their mission on each sortie. Current policy also limits space weapons effects, preventing large-scale power projection from space to the air and surface. In the near future, force application from space to the surface will be limited.

Space forces are and will continue to be slow to deploy until easy launch access to space is achieved. They are also limited in their ability to choose their approach and the time and place of their attacks. These factors combine with limited force application capabilities to make it difficult for space forces to seize the initiative from and dominate the actions of terrestrial forces in the same way that air forces can dominate the operations of surface forces. Thus, space forces will have to be used in conjunction with air or surface forces to achieve decisive effects against surface forces. However, space forces provide a significant information umbrella to air and surface forces which significantly enhances the capability of terrestrial forces to gain and exploit the initiative. Thus, the role of space forces in gaining and exploiting the initiative in the terrestrial mediums will be limited to supporting the terrestrial forces.

Space capabilities are valuable, which will require both offensive capabilities to deny them to an adversary as well as defensive capabilities to preserve them. Position in space is also valuable, resulting in the need for the ability to deny areas of space to the enemy and to protect friendly space forces in high value areas. Offensive operations will hold at risk enemy economic, informational, and military centers of gravity while defensive operations will safeguard friendly centers of gravity. The effects achieved by or against space forces may be tactical, eliminating or degrading enemy space forces; operational, achieving an information gap via a space operation in support of the terrestrial campaign; or strategic, damaging the capability to gain economic value or to conduct the war in order to convince the enemy that further hostilities can only worsen its position. In some cases, the same effects may be able to be achieved by attacking the terrestrial elements of the enemy space and information infrastructures. Thus, space operations will include contests for the control and use of space, not just the enhancement of terrestrial forces.

Space: The Outer Shell

Together, these differences indicate that warfare in space will be fought for different operational objectives and using different tactics than warfare in the air. Air power derives its military value from its use of the third dimension. Air operations exploit the vertical dimension by gaining air superiority and then exploiting it in two principal ways. The first is employing air power to achieve strategic and operational objectives through direct attack on enemy centers of gravity. The second is employing air power to deny freedom of action to enemy surface forces and thus dictate the terms of combat on the surface. The picture that emerges of space power is that it derives its military value from operating as if space were an outer shell that surrounds the atmosphere of the earth.[3] The

transition from the shell to the terrestrial mediums is somewhat restricted. Space power will be used to dominate the outer shell, through space control, and to provide support, including limited force application, to operations in the terrestrial mediums. Space control, whether it be superiority or dominance, is not likely to provide, by itself, the same degree of control of the terrestrial mediums that air superiority provides in controlling activity on the surface of the earth. Achieving decisive effects will require more than space control and its exercise. Thus, war in space will be different from war in the air, but their use will continue to be linked in the 2010 timeframe.

Implications

What this research has suggested is that there are important differences between air and space power. Space is a place which will contain centers of gravity and in which major operations will take place. This assertion is supported by recent experience, such as the fielding of systems such as the Iridium™ system, as well as discussions at many levels regarding the future of space control. Space forces are ubiquitous in providing nearly immediate world-wide response. This assertion has some basis in experience, but the scale of LEO space force constellations necessary to achieve constant presence in many functions is still in the future. The expense of such constellations is a significant factor in determining when such constellations will exist. Space tactics and techniques will be different from those employed in air warfare. This assertion is theoretical in nature. Development of operational concepts, space forces, and tactics, techniques, and procedures (TT&P) for space control and force application is necessary in order to assess the value of such capabilities and to validate the operational concepts and TT&P.

The preceding discussions show that there are differences between air and space power, in the mediums, the forces, and their employment. These differences have been shown to result in differences in the ways operations will be prosecuted in space and in the air, indicating that the development of space power may not completely and conveniently fit within the emerging vertical dimension operational concepts. However, strong ties between the use of space power and air power are suggested. Further, the use of space power to win wars independent of air power or the other forms of military power has not been shown to be supportable. This research has not identified a clear vision of how space provides different means of fighting and winning wars. This indicates that it is not clear that the development of space power does not fit within the emerging vertical dimension operational concepts.

Together, these findings provide a direction for the future. The evidence neither rejects outright nor mandates the creation of a separate and independent Space Force. Given the Air Force's track record in accepting and meeting the challenge of significant expansions in its role, such as the ICBM and satellite forces it has today, it is advisable to err, if one must, on the side of keeping space within the Air Force. The answer to General Horner's concern that there simply is not enough money in the Air Force budget to continue to develop both air and space capabilities has not been found.[4]

Further development of space capabilities must be pursued in two directions. The first, the one to which the Air Force appears to be committed, is the evolutionary development of space capabilities to implement portions of vertical dimension operational concepts. The second, which may not be within the Air Force's plans, is the exploration of what truly can be achieved by space forces. Both must be pursued in order

to fully develop operational concepts and doctrine for space operations. Only through development of space capabilities along both paths can the true value of space power be discovered. Once that value has been clearly envisioned and explored the Space Force debate will come to an end.

There is the hint of a vision of the true value of space forces in *Joint Vision 2010*. As stated in the first chapter, *Joint Vision 2010* describes a future in which the information centers and flow of an enemy's military are attacked in order to more quickly and decisively achieve military victory. But this vision stopped short of envisioning a new way in which nations, not just their forces, can be defeated. If information is becoming the principal source of wealth in the future, then warfare which threatens that source of wealth may be able to achieve victory. Space capabilities are vital to the U.S. information web, and will become vital to other nations as well. Victory in war through attack of an enemy state's informational web is one area of air and space operations and doctrine which requires further effort.

Notes

[1] Geosynchronous space forces provide constant presence by their very nature. A good example is the Defense Support Program (DSP) which has provided continuous missile launch warning since 1970. Low and medium earth orbiting (LEO and MEO) space forces achieve constant presence by operating as a constellation of spacecraft. This is how the Iridium™ system will provide continuous world-wide communications services. Some airmen claim that space forces, especially those in LEO, lack persistence. This view ignores the realities of both air and space power. Air forces achieve persistence either by re-striking targets or by loitering in an "orbit" (as tankers do) and replacing one aircraft with another when it must return to base.

[2] This is the author's opinion and should not be taken as a policy statement.

[3] A shell may not be a perfect analog, as the space medium has a significant depth, from LEO out past GEO.

[4] The congress, in questioning General Ryan, chief of staff of the Air Force, recently challenged whether the Air Force was aggressively pursuing the development of space forces, citing that the budget for space had, if anything, gotten tighter.

Glossary

Acronyms

AFDD	Air Force Doctrine Document
ATACMS	Army Tactical Missile System
AWACS	Airborne Warning and Control System
DOD	Department of Defense
FM	Field Manual
FMFM	Fleet Marine Field Manual
GEO	Geosynchronous Orbit
HEO	Highly Inclined Earth Orbit
ICBM	Intercontinental Ballistic Missile
JFACC	Joint Force Air Component Commander
JSTARS	Joint Surveillance Target Attack Radar System
JV 2010	Joint Vision 2010
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
NDP	Naval Doctrine Publication
NMS	National Military Strategy
QDR	Quadrennial Defense Review
SBIRS	Space-Based Infrared System
TT&P	Tactics, Techniques, and Procedures
UAV	Unmanned Atmospheric Vehicle
USAF	United States Air Force

Definitions

air. The air medium is the atmosphere, the realm above the surface of the Earth in which the laws of aerodynamics rule the motion of objects. This definition recognizes that the air medium has an upper boundary above which aerial flight is not possible.

air forces. Forces that use or deny the use of the air medium for military value.

air power. The use of or denial of the use of the air medium for military value.

characteristic. A quality of a force which is used to describe its military value.

feature. A quality of a realm of military operations which is used to describe its military value.

medium. A realm of military operations. The four recognized in this work are the air, land, sea and space.

space. The space medium is the realm above the atmosphere of the Earth in which the laws of astrodynamics rule the motion of objects.

space forces. Forces that use or deny the use of the space medium for military value.

space power. The use or denial of the use of the space medium for military value.

tenet. A basic principle to be applied in employing a form of military power.

terrestrial. Of the air, land and sea.

Bibliography

Air Force Doctrine Document (AFDD) 1. *Air Force Basic Doctrine*, September 1997.

Air Force Doctrine Document (AFDD) 2. *Global Engagement: Air and Space Power Organization and Employment, Draft version 7*, 10 October 1997.

Air Force Doctrine Document (AFDD) 2-2. *Space Operations, draft*, February 1997.

Air Force Manual (AFM) 1-1. *Basic Aerospace Doctrine of the United States Air Force. 2 vols.*, March 1992.

Athens, Major Arthur J. "Theory on the Battlefield: Nuissance or Necessity." In *War Theory*. Edited by Glover, Sybill and Gwen Story. Maxwell AFB, Ala.: Air Command and Staff College, 1997.

Barlow, Maj Jason B. "Strategic Paralysis: An Airpower Theory for the Present." Research Report. Maxwell AFB, Ala.: Air University Press, February 1994.

Bell, Lt Col Thomas D. "Command and Employment of Space Power: Doctrine for the Asymmetric Technology of the 21st Century." Research Report no. 97-011. Maxwell AFB, Ala.: Air War College, April 1997. On-line. Internet, 9 September 1997. Available from http://www.au.af.mil/au/database/projects/ay1997/awc/97-011.pdf.

Builder, Carl H. *The Icarus Syndrome*. New Brunswick, NJ: Transaction Publishers, 1994.

Cichowski, Lt Col Kurt A. "Doctrine Matures Through a Storm: An Analysis of the New Air Force Manual 1-1." Research Report. Maxwell AFB, Ala.: Air University, June 1993.

Clark, Lt Col D. Tom. "The Transition to a Space and Air Force: Proposed Solutions to the Dilemma." Research Report no. 97-030. Maxwell AFB, Ala.: Air War College, April 1997. On-line. Internet, 9 September 1997. Available from http://www.au.af.mil/au/database/projects/ay1997/awc/97-030.pdf.

Clausewitz, Carl von. *On War*. Michael Howard and Peter Paret, eds. Princeton, N.J.: Princeton University Press, 1976.

Cohen, Eliot A. "A Revolution in Warfare." *Foreign Affairs 75*, no. 2 (March/April 1996): 37-54.

Cohen, William S. *Report of the Quadrennial Defense Review*. Washington, D.C.: Office of the Secretary of Defense, May 1997.

Creveld, Martin van. *The Transformation of War*. New York, N.Y.: The Free Press, 1991.

Day, Dwayne A. "The Air Force in Space: Past, Present and Future." *Space Times*, March-April 1996: 15-21.

DeBlois, Maj. Bruce M. "Ascendant Realms: Characteristics of Airpower and Space Power." in The School of Advanced Airpower Studies. *The Paths of Heaven: The Evolution of Airpower Theory*. Edited by Col Phillip S. Meilinger. Maxwell AFB, Ala.: Air University Press, 1997: 529-578.

Defense Daily, 19 Feb 98.

Drew, Dennis M. "Inventing a Doctrine Process." *Airpower Journal 9*, no. 4 (Winter 1995): 42-51.

Drew, Col Dennis M. and Donald M. Snow. *Making Strategy: An Introduction to National Security Processes and Problems*. Maxwell AFB, Ala.: Air University Press, August 1988.

Estes, Gen. Howell M. III, Commander in chief, US Space Command. "Space: Fourth Medium of Military Operations." Address, Air Force Association National Symposium, Los Angeles, Calif., 18 October 1996. on-line, Internet, 19 November 1997, available from http://www.spacecom.af.mil/usspace/speech1.htm.

Estes, Gen. Howell M. III, Commander in chief, US Space Command. "The Air Force at a Crossroad." Address, Air Force Association National Symposium, Los Angeles, Calif., 14 November 1997. on-line, Internet, 19 November 1997, available from http://www.spacecom.af.mil/usspace/speech6.htm.

Estes, Gen. Howell M. III, Commander in chief, US Space Command. "The Promise of Space." Address, National Space Symposium, Colorado Springs, Colo., 3 April 1997. on-line, Internet, 21 January 1998, available from http://www.spacecom. af.mil/usspace/speech3.htm.

Fadok, Maj David S. "John Boyd and John Warden: Air Power's Quest for Strategic Paralysis." Research Report. Maxwell AFB, Ala.: Air University Press, February 1995.

Ferster, Warren. "Missile Tracking Tops Military Space Plan." *Space News* (15-21 Sep 97): 8-14.

Field Manual (FM) 100-5. *Operations*, June 1993.

Fleet Marine Field Manual (FMFM) 1. *Warfighting*, March 1989.

Futrell, Robert Frank. *Ideas, Concepts, Doctrine*. 2 vols. Maxwell AFB, Ala.: Air University Press, December 1989.

Global Engagement: A Vision for the 21st Century Air Force. Washington, D.C.: Department of the Air Force, 1997.

Gray, Collin S. "Space Power Survivability." *Airpower Journal 7*, no. 4 (Winter 1993): 27-42.

Holley, I. B., Jr. *Ideas and Weapons*. Reprint, Washington, D.C.: Air Force Office of History, 1983.

Holley, I. B., Jr. "An Enduring Challenge: The Problem of Air Force Doctrine." Harmon Memorial Lecture 16. U.S. Air Force Academy, Colo., 11 March 1974.

Holley, I. B., Jr. "The Doctrinal Process: Some Suggested Steps." *Military Review LIX*, no. 4 (April 1979): 2-13.

Horner, Gen. Charles, reported in "Air Force Space System Control Questioned." Space News (8-14 Sep 97): 2.

Howard, Michael E. "The Concept of Air Power: An Historical Appraisal." *Air Power History* (Winter 1995): 5-11.

Howard, Michael E. "Military Science in an Age of Peace." *RUSI Journal 119*, no. 1 (March 1974): 3-11.

Hyatt, Major James L., III, Major Ronald R. Ricchi, Major Paul L. Laugesen, Major Joseph H. Schwarz, Major Michael A. Rampino. "Space Power 2010." Research Report no. 95-010e. Maxwell AFB, Ala.: Air Command and Staff College, May 1995.On-line.Internet, 9 September 1997. Available from http://www.au.af.mil/au/database/projects/ay1995/acsc/95-010e.pdf.

Inside the Air Force, 30 Jan 98.

Joint Vision 2010. Washington, D.C.: Joint Chiefs of Staff, 1996.

Jones, Lt Col Johnny R., ed. *Development of Air Force Basic Doctrine 1947-1992*. Maxwell AFB, Ala.: Air University Press, April 1997.

Keaney, Thomas A. and Eliot A. Cohen. *Revolution in Warfare? Air Power in the Persian Gulf*. Annapolis, Md.: Naval Institute Press, 1995.

Krepinevich, Andrew F. Jr. "The Air Force of 2016." Washington, D.C.: Center for Strategic and Budgetary Assessments, October 1996.

Kwast, Major Steven L. "Convergence or Divergence: The Relationship Between Space Doctrine and Air Force Doctrine." Research Report no. 97-0604F. Maxwell AFB, Ala.: Air Command and Staff College, March 1997.

Lambeth, Benjamin S. "Bounding the Air Power Debate." *Strategic Review 25*, no. 4 (Fall 1997): 42-55.

Lee, Maj James G. "Counterspace Operations for Information Dominance." Research Report. Maxwell AFB, Ala.: Air University Press, October 1994.

Lupton, Lt Col David E. *On Space Warfare: A Space Power Doctrine*. Maxwell AFB, Ala.: Air University Press, June 1988.

Mann, Col Edward C., III. *Thunder and Lightning: Desert Storm and the Airpower Debates*. Maxwell AFB, Ala.: Air University Press, April 1995.

Mantz, Lt Col Michael R. "The New Sword: A Theory of Space Combat Power." Research Report No. AU-ARI-94-6. Maxwell AFB, Ala.: Air University Press, May 1995.

Martin, Lt Col Jerome V. "Victory from Above: Air Power Theory and the Conduct of Operations Desert Shield and Desert Storm." Research Report No. AU-ARI-92-8. Maxwell AFB, Ala.: Air University Press, June 1994.

McNamara, Lt. Col. Stephen J. *Air Power's Gordian Knot: Centralized versus Organic Control*. Maxwell AFB, Ala.: Air University Press, August 1994.

Myers, Major Grover E. *Aerospace Power: The case for Indivisible Application*. Maxwell AFB, Ala.: Air University Press, September 1986.

National Military Strategy. Washington, D.C.: Joint Chiefs of Staff, 1997.

Naval Doctrine Publication (NDP) 1. *Naval Warfare*, March 1994.

Newberry, Major Robert D. "Space Doctrine for the 21st Century." Research Report no. 97-0427. Maxwell AFB, Ala.: Air Command and Staff College, March 1997.

Overy, R. J. "Air Power and the Origins of Deterrence Theory before 1939." *The Journal of Strategic Studies 15*, no. 1 (March 1992): 73-101.

Owen, Col Robert C. "The Balkans Air Campaign Study: Part 1." *Airpower Journal 11*, no. 2 (Summer 1997): 4-24.

Pape, Robert A, Jr. "Coercion and Military Strategy: Why Denial Works and Punishment Doesn't." *The Journal of Strategic Studies 15*, no. 4 (December 1992): 423-475.

Pelligrini, Lt Col Robert P. "The Links between Science, Philosophy, and Military Theory: Understanding the Past, Implications for the Future." Research Report. Maxwell AFB, Ala.: Air University Press, August 1997.

Petersen, Maj Steven R. "Space Control and the Role of Antisatellite Weapons." Research Report No. AU-ARI-90-7. Maxwell AFB, Ala.: Air University Press, May 1991.

Posen, Barry R. *The Sources of Military Doctrine*. Ithaca: Cornell University Press, 1984.

Reynolds, Col Richard T. *Heart of the Storm: The Genesis of the Air Campaign against Iraq*. Maxwell AFB, Ala.: Air University Press, January, 1995.

Ritcheson, Phillip L. "The Future of 'Military Affairs': Revolution or Evolution." *Strategic Review 24*, no. 2 (Spring 1996): 31-40.

Shultz, Richard H., Jr. and Robert L. Pfaltzgraff, Jr., eds. *The Future of Air Power in the Aftermath of the Gulf War*. Maxwell AFB, Ala.: Air University Press, July 1992.

Sietzen, Frank, Jr. "The Re-Inventing of DOD Space." *Space Times*, September-October 1997: 15-18.

Slaven, CAPT George E., Jr. "What the Warfighter Should Know About Space: A Report on U.S. Space Command Joint Space Support Teams." Research Report no. 97-179. Maxwell AFB, Ala.: Air War College, April 1997. On-line. Internet, 9 September 1997. Available from http://www.au.af.mil/au/database/projects/ay1997/awc/97-179.pdf.

The School of Advanced Airpower Studies. *The Paths of Heaven: The Evolution of Airpower Theory*. Edited by Col Phillip S. Meilinger. Maxwell AFB, Ala.: Air University Press, 1997.

The United States Strategic Bombing Surveys. Reprint, Maxwell AFB, Ala.: Air University Press, October 1987.

"United States Space Command Vision for 2020." on-line, Internet, 28 January 1998, available from http://www.spacecom.af.mil/usspace/visionbk.htm.

Walker, Maj Scott. "A Unified Field Theory of Coercive Airpower." *Airpower Journal 11*, no. 2 (Summer 1997): 70-79.

Watkins, Steven. "Is the space mission too big to handle?" *Air Force Times* (7 Oct 96): 32-33.

Watts, Lt Col Barry D. *The Foundations of U.S. Air Doctrine: The Problem of Friction in War*. Maxwell AFB, Ala.: Air University Press, December 1984.

Winton, Harold R. "A Black Hole in the Wild Blue Yonder: The Need for a Comprehensive Theory of Airpower." In *War Theory*. Edited by Glover, Sybill and Gwen Story. Maxwell AFB, Ala.: Air Command and Staff College, 1997.

DISTRIBUTION A:

Approved for public release; distribution is unlimited.

Air Command and Staff College
Maxwell AFB, Al 36112