Overview

Bruce M. DeBlois

Major issues have plagued the US military space community for years. Foremost among these issues is the relationship between air and space. At a recent airpower conference, military leaders from the western powers presented discussions of airpower and space issues with a pervasive underlying assumption: that the next logical step from the exploitation of airpower and space capabilities was the merging of the two environments toward the exploitation of "aerospace" power.[1] The current distinction between air and space rests on the fiscal and technical inability to merge them—an inability that is soon to be overcome. Conferees dismissed environmental distinctions between the two on the grounds that there is no absolute boundary between air and space.[2] In *Paths of Heaven*, the chapter titled "Ascendant Realms: Characteristics of Air and Space Power," I examine this assumption from the perspective of 21 different military characteristics and conclude it to be invalid. The reasons extend well beyond an inability—fiscally and technically—to merge the two realms.

Similarities based upon functions and the lack of a distinct boundary are offset by distinctions in the physical environments. The physical laws of air and space are profoundly different. A vehicle flying on a cushion of air is not equivalent to a vehicle in free-fall orbit. Aside from the issue of access due to huge differences in energy requirements, the airborne vehicle is maneuverable and allows for flexible operations while the space-borne platform is fixed to a high-velocity orbital path. The latter expends little energy to stay in a fixed orbital position, allowing it a duration capability well beyond airborne vehicles. The issue is not whether the two environments can be merged technically, but given that they can be merged, should they be merged. An analogy is useful to illustrate the argument.

Land and sea forces maintain a two-dimensional perspective and relatively slow pace of operations. The amphibious mission certainly illustrates the fact that there is no absolute boundary between land and sea for military purposes. Fiscal and technical capability to merge the two environments in an attempt to exploit surface power exists. In spite of these similarities, land power and sea power have not been merged as surface power because of environmental differences. The question is not whether to make a land/sea capable vehicle or system, but whether they should be the mainstay of a military surface capability. The answer is a resounding no. Given limited fiscal resources, the choice between making either 1,000 land/sea vehicles or making 490 land vehicles, 490 sea vehicles, and 20 land/sea vehicles is trivial. A land vehicle will out-perform a land/sea vehicle on land, and a sea vehicle will out-perform a land/sea vehicle at sea. Most missions are either at land or at sea; only a few cross the hazy boundaries. It makes sense to invest in the best capability for the environment in which the mission will be performed. Doctrine, organization, and strategies flow from the environments and the systems employed to exploit those environments. Hence land power is distinct from sea power. Surface power would be a less optimal approach.

The same argument holds true for air and space power. Air and space forces maintain a three-dimensional perspective and relatively fast pace of operations. The similarities end there. Although there is no absolute boundary between air and space, no physicist would refute the fact that once the fuzzy boundary is transcended, the nature of the environment changes radically. Fiscal and technical capability to merge the two environments in an attempt to exploit aerospace power is emerging, but should it be pursued? Again, environmental differences drive the answer. The question is not whether to make an aerospace capable vehicle/system, but whether we should make many as the mainstay of a military aerospace capability. The answer, again, is a resounding no. A space vehicle will out-perform an aerospace vehicle in space: A typical aerospace vehicle will carry the baggage of air capability, such as wings, into space. An air vehicle will out-perform an aerospace vehicle in the air: A typical

aerospace vehicle will carry the baggage of space capability, such as radiation shielding, in the air. Most missions are either in the air or in space, and only a few missions are performed at the boundary. As was the case with land and sea, it makes sense to invest in the best capability for the environment in which the mission will be performed. Hence, airpower is distinct from space power. Aerospace power, like surface power, would be less than an optimal approach. The crux of the argument rests on the distinction in physical environments, which may not be obvious to a society raised with science fiction presenting maneuverable, flying space fighters. The fact that the environments and related physics are drastically different is above reproach. The chapters in this book embody independent graduate research on space-related issues, and all assume the distinction between air and space.

Many of the chapters are products of one of several schools of space power thought. From a theoretical perspective, the seminal work by David Lupton sorts the "how-to-approach-space" controversy into four categories.[3] The *sanctuary school* views space as a realm free of military weapons, but allows for military-related systems providing such functions as treaty verification and intelligence activities. Advocates maintain the only way to ensure the legal overflight aspect of current space treaties is to declare space as a war-free zone or sanctuary. This school calls for virtually no funding of military space programs involving weapons in space. The sanctuary school has a substantial following in the domestic and international populace, though many in the military see it as a "head-in-the-sand" approach to national security. This military perspective is unfortunate, since the strong case in favor of the military advantages of a space sanctuary posture warrants objective consideration.[4]

The *survivability school* argues that military forces should deemphasize space access, but for less idealistic reasons—the assumption that space forces are inherently exposed and vulnerable. Survivability adherents assert that the probability of using nuclear weapons in the remoteness of space is higher. This, the fact that weapons effects have longer ranges outside of an inhibiting atmosphere, and the vulnerability

associated with predictable orbit locations support the survivability position. Remoteness also allows for plausible deniability, thus making the decision to attack more likely. The survivability school calls for the recognition that space forces are not dependable in crisis situations. They are critical systems openly exposed and make for likely targets. Military space missions should thus be limited to communications, surveillance, reconnaissance, and weather reporting. From this perspective, investment strategies ought to fund those missions, along with redundant space-terrestrial programs, and perhaps ground-based antisatellite (ASAT) systems.

The *space control school* recognizes the importance of space as coequal with air, land, and sea power. The result is that military space policy must balance investments in space, air, sea, and land power to meet the anticipated threat. Of the four schools, space control is the face worn by the Department of Defense (DOD) and the Air Force since the 1980s. Current political emphasis on jointness prompts a space control approach as evidenced in Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force;* Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine*; AFDD-4, *Space Operations Doctrine;* Field Manual (FM) 100-5, *Operations;* and Joint Doctrine, Tactics, Techniques, and Procedures (JDTTP) 3-14, *Space Operations*.[5]

The *high-ground school* advocates space as the location from which future wars will be won or lost. The view of using space-based ballistic missile defense (BMD) to convert the current offensive stalemate of mutually assured destruction to mutually assured survival has some appeal. The growing number of supporters of this school advocate expanded militarization of space and the adoption of a corresponding policy. In their view, investments ought to focus on both offensive and defensive space systems at the expense of air, land, and sea systems. Funding would include space-based ASAT systems, directed-energy warfare (DEW), and BMD with maneuverable, space-to-space, space-to-air, and space-to-ground capability. Air-to-space (airborne laser or kinetic miniature homing vehicle ASAT) and ground-to-space (direct ascent ASAT) systems would also warrant investment.[6]

These schools of thought often extend beyond the military perspective into the policy arena. Each school has support from a variety of constituencies, and each plays a role in the way the military has approached space as a potential war-fighting realm. Beyond the theoretical controversies, the fundamental problem within the military space community stems from a violation of military principle: unity of command/effort. Former commander in chief for space (CINCSPACE), retired Air Force Gen Charles A. Horner, when asked by the chairman of the Senate Armed Services Committee, Senator Sam Nunn, if he was in charge of space, replied that—it depends because he is the one commander in chief (CINC) that exercises little control over his own command. The National Aeronautics and Space Administration (NASA), the Defense Information Systems Agency (DISA), the Ballistic Missile Defense Office (BMDO), the Central Intelligence Agency (CIA), the Central Imagery Office (CIO), the National Reconnaissance Office (NRO), the National Oceanographic and Atmospheric Administration (NOAA), the departments of Commerce, Transportation and Interior, the National Science Foundation, and the White House Office of Science and Technology Policy all intrude upon CINCSPACE's budget, while many of the same organizations intrude upon his launch, on-orbit control, research and development (R&D), and acquisition authority.[7] In addition to the governmental intrusion into his joint command, CINCSPACE must also deal with service infighting over who should have the dominant role in space.

Military space lift vehicle requirements, space architectures, and ground support infrastructure are more major issues. Graduate students at the School of Advanced Airpower Studies (SAAS) researched and discussed a variety of these issues and their efforts are brought together here as a collection of master's degree research theses. The significance of this book lies in the synergism of the contributions. Although each of the following articles reflects varying, well-documented, independent perspectives with both strengths and weaknesses, in total, the articles give a mature summary of the best available military thought regarding space power. A summary of each thesis follows. The first three

papers examine space organization, doctrine, and architecture. The remaining are loosely grouped as predominantly sanctuary/survivability, space control, or high-ground perspectives.

Space Organization, Doctrine, and Architecture

"An Aerospace Strategy for an Aerospace Nation" analyzes the need for a national aerospace strategy that encompasses the linkage of the aerospace industry and military aerospace. Stephen E. Wright's assessment of the US aerospace industry reveals that it provides the kind of high-technology and high-wage jobs necessary to improve the nation's standard of living. Likewise, a vibrant military aerospace is essential to national security. The writer evaluates current military strategies against a set of political imperatives and the reliance each strategy has upon aerospace power. The results of this process show that each military service relies on aerospace power for the success of its strategy. By coupling these facts with the serious problems that exist in the aerospace industry and in military aerospace, the author shows the need for the United States to develop a national aerospace strategy. The final section of the study proposes this goals and objectives of such a strategy and recommends the formation of a national aerospace council to develop and implement a national aerospace strategy.

The strengths of Wright's work lie in his presentation. The critical issue is not how to get to space or what to do when we get there. The issue is, and has always been, support of a flourishing economy and a national security policy that protects it. The commercial and/or military use of space is pertinent only as it supports national interests. Wright recognizes this and establishes that the health of the US aerospace community is in the US national interest. The breadth at which the author examines the issue is evidenced by his nonparochial approach examining the criticality of aerospace from Navy, Marine, Army, and Air Force perspectives. Broaching the topic from this vantage shows several limitations. Although he examines future conflict broadly, he addresses current and emerging political

imperatives as they direct current and near-term employment of aerospace forces. This limitation is somewhat excusable, as it would require an extensive futures study to establish future political imperatives, and even then, those future political imperatives would be, at best, educated guesses. As for the emerging political imperatives, each of the services' strategies conveniently supports the imperatives. While the services have produced effective, satisfying strategies for nurturing and employing aerospace power, it is hard to believe that they have produced efficient, optimum strategies. The fact that the services claim that a joint, national strategy for aerospace is a necessity suggests that there must be some redundancy between the separate services' strategies. Further research into how such a joint, national strategy would impact each service is necessary, but was beyond the scope of Wright's work. Finally, lumping of air and space together makes it difficult to cull which of Wright's main points apply to space power. The argument can be made that even if the environments and systems are radically different, air and space capabilities both emerge from the same technical community—the aerospace community. Thus the claim that the United States needs a coherent, national aerospace strategy has merit.

Such a national strategy would, no doubt, have a significant impact on doctrine. The lack of a national aerospace strategy may in part be responsible for the many doctrinal shortcomings cited in this book.

Frank Gallegos' purpose in writing, "After the Gulf War: Balancing Space Power's Development" is to expose such doctrinal shortcomings which caused significant problems in the employment of space power during the Persian Gulf War. Comments like "the Gulf War was the first space war" wreak of revisionist history and seem to indicate that the United States entered the war with a well-thought-out strategy for employing space power. Nothing could be further from the truth. Space technology was certainly exploited, but its effectiveness against a lack-luster adversary tends to overshadow the inefficiency in its employment during Desert Shield/Desert Storm. Ironically, the success of space

technology in that war may be the biggest obstacle in correcting significant doctrinal shortcomings.

Gallegos presents many perspectives on the role space played in the Gulf War. Each results in different points of view on space shortfalls, which once brought together, produces a rich pool of recommendations. While United States Space Command (USSPACECOM) recognized the lack of capability (normalized operations and theater missile defense), the war fighter, that is United States Central Command (USCENTCOM), accented a lack of doctrine, training, and support. *The Gulf War Airpower Survey (GWAPS)* emphasized a different set of issues exemplified by a fundamental flaw in space architecture: a cold war mentality which focuses on supporting strategic levels of war and overlooking operational and tactical support. The *Conduct of the Persian Gulf War: Final Report to Congress*, unlike other sources, emphasized technology's shortcomings, particularly space launch and communication satellite vulnerabilities. Gallegos' summation of these shortcomings provides a comprehensive summary of the many limitations space presented to the war fighter in the Persian Gulf War.

The strength of Gallegos' work lies in his clear summation of lessons from the war, many of which boil down to poor doctrinal development, a problem which he claims continues today. One weakness of his analysis is the assumption that lack of doctrine is a problem. A valid counterposition is that the lack of doctrine aimed at weaponizing battlefield space is a well-thought-out, military sanctuary strategy. Gallegos recognizes that the newly formed Fourteenth Air Force, Space Warfare Center, and Space Support Team have all attempted to fill the experience and doctrinal gap, but for a variety of reasons, have fallen short. Recognizing a problem is a beginning toward a solution, but the lack of a clear method for correcting the doctrinal shortfall is a weakness of the work. Stating that we need more doctrinal development falls short of stating who is to do it, on what sort of continuing cycle it is to be done, and in what forum it is to be developed—Air Force, joint, and/or combined. Furthermore, the contention that

> the inclination to be on the leading edge of technology often comes with a mutually strong penchant to disregard the teachings of the past

offers a false dilemma of either technological development or doctrinal development. The fact that space technological development leads its complementing doctrinal development does not mean that the former comes at the expense of the latter. Beyond these obvious limitations, Gallegos provides a useful summary of the major space lessons of the Gulf War. His articulation of the cold war space paradigm as a highly classified, strategic approach to space, which emphasizes technological research and development over doctrinal development and operational integration is accurate, and offers the next generation of space strategists an objective perspective. As emphasized in the *GWAPS* , space architectural development is one possibility such doctrinal development may support, a subject examined by the next author.

In "Blueprints for the Future: Comparing National Security Space Architectures," Christian C. Daehnick makes a credible argument that US posture toward developing a space architecture in support of national security is strongly biased by an historical inertia of organizational development, as opposed to a rational decision to produce the most efficient and effective architectures.[8] He defines the current approach to space architecture as a command-oriented approach and offers an alternative: demand-oriented space architecture. Command and demand architectures vary on three counts.

Physically, the current command-oriented architecture focuses on heavy lift for specialized cargos and requires big investments for a few large systems with extensive ground-based infrastructures. A demand-oriented architecture would involve lighter lift requirements not tailored to any specific cargo and would require dispersed investments in many systems with smaller ground-based infrastructures.

Temporally, the development cycle that supports the command-oriented architecture is restricted to incremental improvements in design, manufacture, and deployment, as the sunk costs in current systems compel future investments to support them. Once deployed, the paradigm is long-loiter,

on-orbit capability with long-lasting mission-specific capability. The demand-oriented approach allows for radical change, as huge sunk costs in particular systems do not exist. Additionally, the paradigm can shift, allowing ground-to-space missions to meet situational requirements on demand, as opposed to maintaining predetermined capabilities on orbit.

The third difference between command-oriented and demand-oriented architectures is probably the most profound. Philosophically, the command-oriented approach grew out of a high-performance, 100-percent reliability aircraft manufacturing community. It was politically motivated by a controlled response to the USSR during the cold war. The demand-oriented architecture is a rational approach without zero-fault tolerance or cold war biases. It emphasizes responsiveness, flexibility, ease of operations, and cost attributes over high performance and reliability (most spacecraft, unlike most aircraft, are unmanned). While the command-orientation prescribes centralized command, control, and execution directed by specific group interests, demand-orientation allows for flexibility in command, control, and execution. Military use may require centralized command and control and decentralized execution analogous to the traditional method of allocating scarce air assets. Depending on the military situation, a demand-oriented architecture would allow for a more distributed network of space assets which would reduce each asset's vulnerability. Corporations, on the other hand, may see the low-cost communication space asset as a capability that is readily decentralized in command, control, and execution.

The strength of Daehnick's research rests in his presentation of a different approach, one that has not been previously considered and seems superior to the old way of doing business. By framing US current posture as a command-oriented paradigm, and offering an alternative, Daehnick sheds new light on long-held beliefs. For instance, duration is often seen as a characteristic advantage of space power. But on-orbit capability equates to spending limited monies on specific capabilities before the situation that generates the demand exists. By comparison, the demand-oriented alternative of an earth-to-space, tailored

response diminishes the worth of durable, on-orbit capability. Daehnick discusses many strengths and weaknesses of space, and further recognizes that many of those weaknesses (life-cycle costs, inflexibility, timelines) are not a result inherent to the environment, but more a result of a prechosen architecture.

The weakness of Daehnick's work is that he presents the current command-oriented architecture in a negative light. He describes that architecture as a flawed approach to highlight the strengths of the demand-oriented approach rather than as a credible alternative. Ironically, had a strong case for command-oriented space architecture been made, the argument against it would have been more credible. To be fair, the author does not simply advocate a demand-only oriented space architecture. In his conclusion, he recognizes that a hybrid command/demand-oriented space architecture is possible and may be the optimum solution. The value of this work does not reside in the debate over command or demand orientation but lies in the recognition that alternative space architectures exist, which in turn frees future space planners from the command-orientation paradigm. This broad examination of space strategy, doctrine, and architecture provides an objective backdrop for the remaining papers.

Sanctuary/Survivability Perspectives

The SAAS is a professional military education facility. Not surprisingly, students interested in space-related research are apt to be space enthusiasts. Upon initially consolidating this volume, an overall weakness became apparent: No contributing author had made the case against pursuing space for military purposes beyond intelligence, surveillance, and reconnaissance (ISR). Although each research paper is balanced in its analysis, the balance is between command or demand architecture, or between one concept of operations for reusable launch vehicles or another. None of the papers questioned whether the US's pursuit of weaponizing space at this time in a sound military strategy. I challenged David W. Ziegler, a space enthusiast, to do just that.

In “Safe Heavens: Military Strategy and Space Sanctuary Thought,” Ziegler outlines the historical development of US space policy, and the lessons of that review reflect a tradition of American restraint. From that context, he makes the point that US interests in space are currently limited to surveillance, reconnaissance, intelligence (SRI), and signal relaying. Ziegler lays out the logic that currently and for the foreseeable future, we don’t live in space, there are no natural resources which can be cost effectively developed in space, nor is space a travel medium. Furthermore, the cost of accessing space is currently enormous—and that alone may be good reason for waiting until commercial exploitation of the medium drastically reduces the cost of getting there. The enormous-cost-now/cheaper-cost-later argument is further strengthened as the author takes a serious look at requirements and opportunity costs. Aside from competing social programs outside the DOD, the opportunity cost to other military programs, which could satisfy the same need or other significant need is staggering.

Ziegler then presents a line of reasoning that even the staunchest space enthusiast would agree to be novel. There is a lot of interest in emerging technologies that facilitate access to space. But what if equivalent investment was aimed at different, surface- or air-based solutions to meet the same requirements? In spite of unequal funding, advances in surface-based, fiber-linked telecommunications threatens high-cost/highly vulnerable space-based counterparts. Long-loiter unmanned aerial vehicles (UAV) are also beginning to fill ISR requirements in a more cost-effective, flexible, and responsive manner than equivalent space-based assets.

Beyond the lack of interest, huge opportunity costs, and substitute technologies, Ziegler has tapped the best available intelligence sources which estimate that the United States faces virtually no peer threat in space for at least 10 to 15 years. The author defines *peer threat* as a competitor that seeks to dominate space to the same level as the United States. Hence the author recognizes little utility in furthering the militarization. The author did find *challenging threats*, threats weaker than peer threats that seek to deny or destroy US capabilities but lack an ability to field similar capabilities.

Surface-based, directed-energy ASATs stand out as a potential weapon that a challenging threat could employ even if it lacks the technology to field space-based ASATs. This discussion serves to articulate the survivability viewpoint, and the author expounds upon significant limitations of space-based systems. Additionally, any attempt at this time to weaponize space threatens a renewed arms race in a realm that offers significant advantages over the air realm. There is no logic in escalating the armaments game.

Based on this analysis of historical precedents, US interests in space, the cost of access, the potential of substitute technologies, the lack of a peer threat, and the presence of challenging threats, Ziegler concludes by defining space as a credible *military sanctuary,* as a place where forces can be posited and trained, but an attack on that sanctuary changes the political nature of the conflict. Such a definition dominates US current posture in space. It distinguishes between the US current militarization of space and suggested weaponization of space. The author presents a credible argument that a sanctuary strategy in space has significant merits. The work also highlights the danger of blindly proceeding beyond the militarization threshold and plunging the United States into an era of space weaponization.

Ziegler effectively articulates the argument that favors a military sanctuary strategy regarding US use of space. The argument balances the remainder of the papers which, by-in-large, assumes a natural escalation to space weaponization.

Space Control Perspectives

James Lee, in “Counterspace Operations for Information Dominance,” examines space strategy from the traditional perspective that space control is a military requirement, but he adds a nontraditional twist by emphasizing that control does not necessarily require the use of antisatellite weapons. The work shows space control in a new light that defines it in terms of information rather than the physical environment. Tracking the development of US space power, Lee highlights the fact that the US notion of space control grew out of the cold war paradigm, a path which led the United States to

anticipate a peer competitor in space. Hence, space control developed as a notion of physically controlling the space medium. Making that notion stronger was its compatibility with previous experience. The development of sea power and airpower demonstrated that once access to those domains became common, it was necessary to physically dominate them during conflict.

A strength of Lee's work resides in his excellent summary of unclassified US and foreign satellite reconnaissance capability. He supports the argument that access to space surveillance and reconnaissance capabilities are essential to the employment of US military power and that those capabilities are spreading around the globe. Given these developments, Lee recognizes that the United States requires a space control strategy which can be tailored to particular threats and situations, and has the practical aim of controlling information traffic from space. He offers a three-dimensional model that considers the capability of the threat (extensive space access, limited space access, or purchased space information); the situation (peace, crisis, or war); and the space system to be manipulated or targeted (ground, up/down link, or orbital elements). While the paper makes sense in terms of giving the commander flexible options in the control of space information, the model seems to be over-simplified, particularly in its categorization of such human events as peace, crisis, or war. This is perhaps not so much a weakness of the work, as it is an opportunity for further research and thought. Clearly, the issue of space control in the information age is complex—a function of threat, capability, circumstance, domestic and international relations, and international law. With the advent of proliferating access, the space medium may be beyond the ability of any one nation to control, and perhaps Lee's notion of space control as a matter of controlling information is more practical. In any event, the United States will have to develop its space doctrine under the assumption that the adversary will have some space information access, or in the words of the next author, we will have to proceed under the assumption that "the enemy has our eyes."

"When the Enemy Has Our Eyes" by Cynthia A. S. McKinley is primarily intended for space operations personnel who are tasked with the challenge of becoming space strategists. It is also of value to individuals who seek unclassified information about reconnaissance satellites, an understanding of changes within the military space community, or an analysis of the space control mission. In reviewing the historical foundations of America's space-based strategic intelligence assets, McKinley identifies the visionaries who gave the United States its strategic eyes and the revolutionary technology that unnerved the US's closest competitor. Further, she discusses the use of strategic intelligence in theater warfare. The author offers a unique perspective for looking at the context in which national and international actors may prosecute warfare, which leads to illumination of the space control challenge facing the United States. To take positive steps toward meeting that challenge, McKinley offers an analytical approach for space control and applies the results to a commercial reconnaissance system. The author concludes that the space control mission is more challenging in today's multipolar world than it was during the cold war.

The strengths of McKinley's work include a practical analysis of space control and the military role in space for the next five to 10 years. The author compares a survey of the historical inertia which drives current space policy, capabilities, and force structure to the future context of warfare including a realistic estimate of future spaced-based capabilities. The merger leads the author to examine the significant role of imagery in future warfare and to recommend a space control strategy (access and denial). The most significant limitation of the study rests on the assumption that the enemy will have the same information as the United States. This is clearly pessimisstic.

Further, limitations of McKinley's effort are primarily a matter of scope. The thrust is limited to strategic intelligence and the role of space-based imagery with a primary focus on force enhancement. Additionally, the author's theory of warfare is well thought out, but may unnecessarily constrain the vision of the future role of space in military affairs. Finally, the potential of extensive space-based weapons with the

primary function of force application is briefly mentioned, but not seriously considered.

High-Ground Perspectives

In "National Security Implications of Inexpensive Space Access," William W. Bruner III recognizes that the government of the United States is about to embark on an ambitious enterprise. As per Presidential Decision Directive/National Science and Technology Council (NSTC)-4, *National Space Transportation Policy,* 5 August 1994, the United States is planning to make a significant leap forward in repeatable and economical access to space. While routine access to orbit will give the United States a clear advantage in the ability to use near- earth space to serve national political, economic, and military interests, those responsible for making national space policy and writing military space doctrine are fallaciously doing so based upon the old assumption of infrequent and expensive space access. The author explains that the difficult and expensive access assumption is primarily a result of an expectations gap where early promises of space exploration, as well as recent promises of routine space access via the shuttle, have left the public somewhat disillusioned. He also cites (1) the erroneous notion that the United States will necessarily lead the way into space; (2) perceived treaty, policy, and legal limitations; (3) the *Challenger* accident; and (4) the lack of a coherent national space policy are reasons this country is dragging its feet in the space access effort. Bruner asserts that these impediments will wane due to new political, economic, and technological realities. His analysis is balanced, as it addresses the cases for and against standing down, the status-quo, pursuing expendable launch vehicles (ELV), and pursuing reusable launch vehicles (RLV). The cost-benefit analysis seems to favor the latter. The author emphasizes that life-cycle costs make the RLV more attractive than the ELV, while at the same time RLVs allow for the expansion of military capabilities.

The most significant strength of the paper lies in the author's ability to recognize military possibilities for an RLV concept beyond the limitations of expectations and policy,

which are for the most part, self-imposed. His concept of using RLVs for on-orbit refueling shatters the old paradigm of orbital mechanics dictating inflexibility. The concept allows on-orbit upgrades, repairs, replacements, access to higher orbits, and capability for orbital maneuvers—traditionally assumed to be cost prohibitive.

Several inconsistencies appear. On the one hand, the author is optimistic regarding technology's ability to provide space access and assumes this access readily allows for military space-to-earth precision capabilities. On the other hand, the author is pessimistic regarding technology's ability to provide remote control to spacecraft, insisting that onboard human judgment is often a necessity. This is somewhat ironic in that progress in the technologies of remote control and virtual environments is to a large extent already proven, whereas the technological pursuit of ready access to space has been disappointing. Bruner's basic contention, that space offers an inherent energy advantage, is also optimistic from the spacelift perspective and, at the same time, ignores the possibility of other technologies. While his contention is true from a potential and kinetic energy standpoint, he does not address, for instance, the advent of directed energy technologies, which could very well turn the advantage of altitude/elevation into the disadvantage of exposure. Finally, toward the closing sections, the work takes somewhat of an Air Force parochial turn, degenerating into a discussion of which service should take the lead in space, the Navy or the Air Force. Although the discussion regarding the applicability of Navy and Air Force cultures to space is interesting, it is an aside from the main theme. Further, the analysis offers a false dilemma: Should the Navy take the lead from the environmental perspective of living and working in a stationary but hostile environment, or should the Air Force take the head from the functional perspective of employing military power from the third dimension? A separate space force is just one of many alternatives to the dilemma.

A primary limitation of the work is that while Bruner accurately recognizes what international laws and treaties do allow, he overlooks what domestic policy won't allow. Space as a sanctuary may not be part of international law, but that

may be irrelevant, if domestic expectation demands it. Bruner reaches out 20 or 30 years and assumes the militarization of what he calls "decisive orbits" to be an accepted practice, without considering the broader context of domestic and international politics or nongovernmental commercial interests. Although this is a recognizable limitation of the work, it is also excusable. As part of his professional obligation as a military planner/strategist, Bruner is expected to plan contingencies that might warrant military action. In this regard, he has provided some of the best military vision of what space power could be in the future.

In "Concepts of Operations for a Reusable Launch Space Vehicle," Michael A. Rampino also pursues military concepts of operations (CONOPS) without answering fundamental questions regarding who is the threat and what are the requirements to negate that threat. As with Bruner's work, this is a justifiable planning approach from the military perspective. Militaries don't necessarily need to arm for contingencies, but they ought to plan to arm for contingencies. When that plan recognizes a need for long-term investment to arm appropriately, the issue of preparedness in the absence of a clear and present adversary has merit. Rampino's thesis emphasizes that the US military must be prepared to take advantage of reusable launch vehicles should the NASA-led effort to develop an RLV demonstrator prove successful.

The strengths of the work are many, the most obvious being the structured methodology. The author develops two different concepts of operations from a detailed investigation of military requirements and current paths to produce the capability to meet those requirements. The first concept attempts to make the fullest military use of a roughly half-scale notional RLV to accomplish not only traditional spacelift missions but also the additional missions of returning payloads from orbit, transspace operations, reconnaissance, and strike (in and from space). The second concept is based on the full-scale vehicles currently being proposed under the RLV program. It too attempts to make expanded use of RLVs, but military application is inhibited by design attributes and a focus on completely commercial operation. Both of these CONOPS are comprehensively described via their mission, the systems they

require, the operational environment, the command and control links, the support they require, and the means by which they are employed in civil and military situations. Subsequent to the detailed descriptions, a comparative analysis of the two concepts proceeds with criteria which include capability, cost, operations efficiency and effectiveness, and political considerations.

Major conclusions are drawn from that analysis. RLVs are recognized to have military potential, yet the design choices for any operational RLV must be measured in terms of risk, cost, capability, and operations efficiency and effectiveness. Given this preliminary analysis, the choice of a larger vehicle is found to be accompanied by more risk. Beyond the RLV itself, supporting science and technology development is the crucial issue. Particularly, increased investment in propulsion technology is warranted. The final conclusion gives the entire space community a clear focus: The top priority for the RLV program, even from the DOD perspective, should remain cheap and responsive access to space.

Based on the conclusions, Rampino puts forth three recommendations. The US military should become a more active participant in the RLV program, the United States should not pursue development of operational RLVs before the technology is ready, and finally, it is not too early for the US military to think deeply about the implications of operational RLVs for war-fighting strategy, force structure planning, training, and doctrine.

As with any other research, this work has limitations of scope. While the author effectively extrapolates space capability to the 2012 time frame, he assumes a command and control structure dictated by current Air Force doctrine. This assumption places his 2012 space capabilities in a 1996 context. From a broader perspective, the requirements for a military RLV were garnished from the military environment. Asking the military to produce military requirements does not necessarily mean there is a genuine need. Of course, this ties back to the initial point of the military planner's role of developing courses of action in the event of military need.

The final paper, by Gregory Billman, also makes similar assumptions. "The Inherent Limitations of Spacepower: Fact

or Fiction?" Billman squarely addresses the US approach to space. He finds it odd that many of the self-imposed limitations to exploiting space stand in light of twentieth century US airpower experience. The analogy seems strong: The first employment of airpower concerned a primary focus on observation and reconnaissance; it rapidly evolved into an offensive form of military power due to advantages of response, speed, and reach; and finally, doctrinal and organizational development followed the new capabilities. Billman compares space power with the forms of terrestrial powers by examining each across a set of military force characteristics that he generalizes into five distinct categories: strategic agility, commitment and credibility, economic considerations, military considerations, and political considerations. [9] While the latter three initially appear unclear and unfocused, Billman delineates them as a reasonable means of categorization. A weakness of the work is the lumping together of all terrestrial military powers (air, land, and sea), on the grounds that they all have gravitational limitations while space power uses gravity to its advantage. The grouping of terrestrial forces comes across more as a matter of analytical convenience rather than a technically justifiable assertion. It may have been beyond the scope of the work, but a similar analysis comparing space, air, land, sea, and perhaps even information power would be enlightening.

A strength of the analysis is Billman's recognition that as these five categories of characteristics apply to terrestrial and space forces, they must be measured at different phases of employment. Each military force characteristic will vary as the instruments of that force are home based, deployed, or engaged.

Billman's analysis strongly favors the advantages of space power under all five military force characteristics. Assuming space power to be predominantly in a deployed, or even engaged state, he supports the argument that it has strategic agility and commitment and credibility advantages without the economic, military, and political risks of terrestrial forces. This, coupled with the airpower/space power developmental analogy, leads the author to conclude that space power should develop as a separate capability which exploits the medium in all military

roles, including the force application role. He asserts that space power must no longer be merely a supporting force.

While the air and space power analogy is useful on certain specific points, extrapolating the analogy into sweeping recommendations on the US's future approach to space is a fundamental breech of logic. On one count, the similarities between airpower and space power development were emphasized, without any serious effort to examine distinctions between the two. On a second count, numerous examples of using gross historical analogies in major policy decisions have been documented with a single resounding outcome: The decision they lead to is most often wrong.[10] The most significant weakness of the work is not a limitation of historical inference, though, but one of omission. The author establishes that the only limitations of US space power are self-imposed. He makes a strong case for the advantages afforded by a future space force unencumbered by those limitations. The shortcoming is that he never articulates why those self-imposed limitations exist. He loosely attributes their existence to policy, but policy is often made for good reasons. Those good reasons in this case include international law, domestic and international opinion, significant technical limitations, opportunity costs, and even military advantages of a sanctuary approach. While the author summarizes with three requirements to overcome the self-imposed limitations: a change of military perspective, space as a separate military area of operations (AOR), and military/ civilian cooperative efforts, these recommendations are hollow in the absence of a detailed examination of why those self-imposed limitations exist.

Conclusion

There are perhaps two weaknesses that remain in spite of the synergy of this consolidated volume. First, although many of the works begin with a historical survey, the total leaves the impression of lacking context.[11] For example, some authors assume the space community to be distinct from the air community, yet to date those technical communities are one in the same, made up of such aerospace giants as Lockheed-Martin and McDonnell-Douglas. Exploring the

contextual development of the space community reveals many current space trends, such as the preoccupation with zero-fault tolerance. Such trends may seem irrelevant for the space architect planning efficient unmanned operations, but it is a reality, as it is ingrained in an air community that for almost a century has had human cargo.

The second weakness, evident in several of the works, is the idea that advocating one position or another on space power must be done in the context of a zero-sum game. That is, it must be to the benefit or detriment of another form of military power. In some ways, the zero-sum game of economic funding forces this issue. This tends to overshadow the fact that new forms of military power have historically complemented one another, allowing missions that were unachievable from a single environment. Sea power did not supplant land power, airpower did not supplant land and sea power, nor will space power supplant air, land, and sea power.[12] The enlightened joint approach to the employment of military power recognizes that different environments require different forces, and all must work in harmony. It seems shortsighted to advocate a distinct military force for a new environment at the expense of other forces. It is the situation at hand, and not the physics or position of a particular environment, that dictates the dominance of one force over another. In advocating different aspects of the US role in space, it is not the intent of this editor or this learned group of air and space professionals for our material to be taken without an appreciation of the air, land, and sea roles in putting forth the most effective joint force in support of national security. The intent is a comprehensive examination of space power: the Ziegler and Billman works being extremes which illustrate the value of this collection of papers. While each may overlook the perspectives and assumptions of the other, collectively they comprehensively address the subject. What Bruner, Rampino, and Billman overlook or assume away is addressed in Ziegler, Mckinley, and Lee's work. The reverse is also true. Additionally, these sanctuary, survivability, control, and high-ground perspectives are balanced against a background of the most significant issues: space organization (Wright), doctrine (Gallegos), and architecture (Daehnick). As the collection of

strengths addresses most of the weaknesses, this collection reflects a mature, documented consolidation of military thought on space power.

Notes

1. *Air Power & Space—Future Perspectives 1996,* Queen Elizabeth Conference Centre, Broad Sanctuary Westminster, United Kingdom, Airpower Conference, 12-13 September 1996.

2. Professor and Air Vice-Marshal R. A. Mason, "Characteristics of Aerospace Power," panel 1 presentation, *Air Power & Space*, 12 September 1996.

3. David E. Lupton, *On Space Warfare: A Space Power Doctrine* (Maxwell AFB, Ala.: Air University Press, 1988).

4. A broad definition of military *sanctuary* is a place where aggressive forces can be postured, but attacks in that sanctuary would change the nature of the conflict. Under this definition, China was a sanctuary for communist forces during the Korean War and more recently, Argentina was a sanctuary during the Falklands War. Space is considered to be such a sanctuary today as evidenced by the number of militarized space-borne systems and lack of weapons on these systems. To assume the sanctuary notion of space is now obsolete at least requires justification. What is lacking among the space enthusiast arguments is a discussion of opportunity costs—that is, not the fact that space access is affordable, but what other capabilities are not pursued at the expense of space access (such as airpower, research and development, or education). Given a study of opportunity costs, the space sanctuary concept may be a very valid military strategy. See Professor Lawrence Freedman, "Sanctuary or Combat Zone? Military Space in the 21st Century," *Air Power & Space*, 12 September 1996. The counter to Freedman's argument was given by US Air Force Vice Chief of Staff Gen Thomas S. Moorman: Violation of the space sanctuary will not be one of choice, but of a response to a projected threat.

5. AFM 1-1, *Basic Aerospace Doctrine of the United States Air Force,* 5 March 1992; AFDD-1, *Air Force Basic Doctrine*, draft, 1 September 1997; AFDD-4, *Space Operations Doctrine,* 22 May 1996; JDTTP 3-14, *Space Operations*, April 1992; FM 100-5, *Operations,* 14 June 1993, 2–16 through 2–18. It is worth noting that although capabilities-based planning has merit, threat-based and objective-based planning are other options worth consideration.

6. Paul B. Stares, *The Militarization of Space: US Policy 1945–1984* (Ithaca, N.Y.: Cornell University Press, 1985), 206–7. As early as 1978 miniature homing vehicles were successfully launched from F-15 platforms, using first stage boost via a modified Boeing short-range attack missile (SRAM) and second stage boost via a Vought Altair III.

7. Air Force Association, "*Special Report: Facing Up to the Space Problem,*" 1 November 1994.

8. The seminal work of Graham T. Allison, *Essence of Decision* (New York: HarperCollins Publishers, 1971), clearly distinguishes rational,

organizational, and bureaucratic decision making, and further discusses the benefits and shortcomings of each.

9. Gregory Billman takes a unique perspective on commitment and credibility. While standard deterrence theories assume commitment to be a function of an actor putting himself at risk, and credibility a function of demonstrated capability, Billman hypothesizes that the lack of risk and ease of use of space-based assets engender commitment and credibility. The lack of risk Billman focuses on is risk to the operator, and while that is reduced for an unmanned space asset, the risk in deterrence theory is risk of reprisal to the operators or any other form of political, economic, and military fall-out (pun intended). Much of that risk is retained when using a strategic weapon, manned or not.

10. Yuen Foong Khong, *Analogies at War: Korea, Munich, Dien Bien Phu, and the Vietnam Decision of 1965* (Princeton, N.J.: Princeton University Press, 1992).

11. Cynthia A. S. McKinley's article is the notable exception, being well grounded in historical development.

12. Maj Bruce M. DeBlois, "Ascendant Realms-Characteristics of Air and Space Power," in *Paths of Heaven: The Evolution of Airpower Theory* (Maxwell AFB, Ala.: Air University Press, 1997).