Space Power and the Revolution in Military Affairs

A Glass Half Full?

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CONCEPTUALLY, SPACE power has scored more success in the last five years than in the previous 50. At least as an idea, space power has come of age in the second half of the 1990s. So much for the good news. The less than good news is that the distance between a powerful idea and idea-as-capability can be measured in decades rather than years.[1] It is important that the control of space is recognized today as a truly vital requirement of the US armed forces. Yet, the United States to date has deployed no—repeat—*no* forces to effect many elements of the space-control mission.

Essentially irrelevant, but potent, controversies frequently impede the writing of innovative strategic theory with clear policy relevance. The understanding of space power has been hindered over the past 15 years by two great debates: first by the controversy about President Ronald Reagan's Strategic Defense Initiative (SDI) and more recently by the lively discussion about a revolution in military

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We should be mindful of, and honest about, current technological limitations but not be overwhelmed by them. On the right is a photograph taken in April 1999 showing a B-2 refueling over the Atlantic during Operation Allied Force. On the left, a Martin MB-1 flies over Washington, D.C., some 80 years previously. The MB-1 cruised at less than 100 MPH and had a range of under four hundred miles. Its maximum gross weight was a little over a quarter of the B-2's payload.

affairs (RMA) keyed to advances in information technologies. To clarify, space power *essentially* is about neither an SDI nor an RMA. The reason why this point can matter is that attitudes towards the military exploitation of an entire geographical environment should be driven neither by policy judgments on specific defense issues nor by such metastrategic preferences as presented in the RMA debate. In other words, too many people are commenting on space power when their real subjects are cold-war-era missile defenses or the wonder of technology writ large.

It is no criticism of US Space Command (USSPACECOM) to note that the command's *Long-Range Plan: Implementing USSPACECOM Vision for 2020* (hereinafter *LRP)* expresses two views of space power—one bold, the other less so. The "Summary" to the *LRP* claims only an enabling role for space capabilities: "The combined effects of the current strategic pause, the evolving space and information age, and the possibility of a Revolution in Military Affairs . . . *enabled by space capabilities*, indicate that the time is right to have an integrated LRP for space" (emphasis added).[2]

The "Introduction" to the *LRP*, however, stakes out a much stronger claim when it refers to "the potential for space capabilities to become a 'Revolution in Military Affairs'"[3] —that is to say, space power is an RMA, not merely an enabler of an RMA. There is something to be said for both views of space power, but—with reservations—we endorse the latter, bolder view. It is regrettable, however, that the *LRP* repeats the popular error that "this type of revolution [RMA] is a fundamental change in the nature of warfare that doesn't depend solely on exploiting technology."[4] The *LRP* is right to emphasize "operational capabilities, Concepts of Operations (CONOPS), and organization" as contrasted with technology alone.[5] But the *LRP* is unwise to endorse the proposition that RMAs can effect "a fundamental change in the nature of warfare." War and strategy are eternal in their nature, regardless of geographies, technologies, and adversaries.[6] Indeed, the *LRP*'s support for the fallacy that a space-enabled, *or* a space power, RMA could effect such a change in the nature of warfare tends to subvert its own sound, general argument that "early in the 21st Century, space will become another medium of warfare."[7]

In this article we build upon the excellent prognosis for space power presented in the *LRP* by consolidating bridgeheads of intellectual and policy advances, slaying some of the dragons of misunderstanding that have crept into the debate about space. The US space community would be ill advised to hitch a ride with some protagonists in the contemporary RMA debate. The concept, and the capa-

bilities, of space power are far too important to be hostage to the fate of a controversy over a possible RMA keyed to the exploitation of information technologies. It was unfortunate that the 1980s discussion of space power was dominated by attitudes towards a particular character of ballistic missile defense (BMD) in the SDI. It is scarcely less unfortunate that in the 1990s the debate over RMA largely has sidelined proper discussion of space power *as space power* (as contrasted with space power as provider of information). Space power needs protection from lobbyists for BMD and for information-led warfare.

This article puts forward the argument that what has traditionally been perceived as space power is, in fact, only the beginning of how we will use space strategically. It challenges contemporary thinking on what many have regarded the present RMA to be—namely, it is proposed that space power will be the RMA. In order for space power to reach its full potential, however, space must be recognized as a geographical environment for conflict that is, in a strategic sense, no different from the land, sea, air, and the electromagnetic spectrum (EMS). Using historical case studies of the emergence of sea power and airpower as unique and separate forms of military power, as well as stressing the eternal nature of strategy, it will show that space power is on the threshold of something much more prominent, indeed will be a form of military power analogous to land power, sea power, and airpower. It is this emergence of space power that will mark it out as an RMA.

Space Power: The Idea and the Great Tradition of Strategic Thought

Strategically, though not quite geographically, space is just another environment for conflict. The caveat with respect to geographical parallels is the evident difference in scale—the "quantity that becomes quality"—between the Earth and its atmosphere and *the remainder of the universe* (i.e., space).[8] Notwithstanding the vast asymmetry between the terrestrial geographical environments and space, it is not entirely obvious that "the stars" or "the heavens" have strategic significance for contemporary defense planners. Threats originating from far beyond the Earth-Moon system may appear from beyond our solar system or even from beyond our galaxy. If they do, we will be fortunate if we are able even to note the approach of such threats, let alone be equipped to see them at launch. In the long run, the very long run indeed, the security of the human race most likely will depend upon its space power. The dinosaurs faced a grim prospect between emigration and extinction and were condemned technologically to the latter. Fortunately for us, the random menace from fast-moving alien objects in space would appear to pose far more severe a threat to life on Earth than does purposeful menace from alien civilizations that would be unschooled in the niceties of the Geneva Convention. An asteroid may just terminate the human experience and settle religious arguments, but at least in principle it is detectable, trackable, and possibly divertable. By way of caveat, any animate, purposeful, alien menace that could reach Earth from another solar system, let alone from another galaxy, can be assumed to be likely to enjoy a decisive technological edge for superior strategic effect.

We raise these unusual, even extravagant-sounding, matters—asteroids and aliens—to demonstrate that we recognize fully that there is a key geographical sense in which space is unlike the bounded and more or less familiar terrestrial environments of land, sea, and air. Were this article charged with the mission of discussing "space and the human race," then our eyes would focus on the heavens rather than on Earth. It so happens, though, that our mission is to consider space power and the RMA, with particular reference to USSPACECOM's *LRP*.

The challenge today is to foster a prudent, strategically reliable understanding of space power. Scientists and poets are right to insist that we approach "the stars" with proper awe and respect. However, that awe and respect is

not particularly helpful when it comes to thinking and planning practicably for, say, the first 25 years of the next century. Also unhelpful in understanding space power is the opinion that space is distant (which low earth orbit is *not)* and is exotically different from the familiar terrestrial environments, hence strategically distinctive.

Regardless of its potential to provide an infinity of unimaginable wonders, space also happens to *be just another environment of human conflict*. Of course, that strategic orientation is not the whole of the space story, but then neither does such an orientation suffice to frame discussion of land, sea, air, and cyberspace (or the "infosphere"). Despite the notable conceptual advance secured in USSPACECOM's 1998 *LRP*, space power, especially in relation to policy and strategy, will probably need missionary assistance for educational purposes for many years to come. Let us identify some of our key assumptions and claims.

1. In all strategic essentials for now, space power is akin to land power, sea power, and airpower.
2. The strategic history of space power is likely to follow the pattern already traced clearly by sea power and airpower.
3. Geographically and geophysically, space is distinctive but then so is the land, the sea, the air, and even cyberspace.
4. People have only one natural environment, the land.[9] To function at all in any other environment, people require technological support. The vacuum of space admittedly is exceptionally hostile to human life, but it does not differ in basic character from the sea and the air; all these environments can tolerate human presence only when that presence is supported by machines.
5. Because people live only on the land and belong to security communities that are organized politically with territorial domains, all military behavior, no matter what its tactical forms, ultimately can have strategic meaning only for the course of events on land. It follows that sea power, airpower, and now space power can function strategically strictly as enabling factors. The outcome of a war may be decided by action at sea, in the air, or in space, but the war must be concluded on land and with reference to the land.
6. The logic of strategy is both geographically universal and temporally eternal. Different strategic cultures may "do it their way," consistent with the laws of physics, at least (willpower is only hot air if the engineering is unsound), but strategy and war have natures and dimensions that are timeless and ubiquitous.[10]
7. The unique geography of space must find expression in unique technology, operations, and tactics. That unique geography does not, however, point the way to some unique logic of strategy, let alone a unique irrelevance of strategy.

Political, legal, technological, operational, and tactical judgments continue to impede sound understanding of space power. Even when such judgments are approximately correct for today, still they can hinder clarity of strategic comprehension. For a recent example, consider the confusion that is encouraged by a strong statement by Prof. Lawrence Freedman: "The conviction that, in the future, the US will 'fight in space, from space, and into space' still has its adherents, but there is no reason to suppose that it is any more credible now than it was when first proclaimed 40 years ago."[11]

The confusion lies with the level, or levels, of analysis merrily conflated and obscured here. In fact, Freedman stealthily piggybacks theoretical, policy, and strategic judgments onto a tactical assessment. It is one thing to notice, as does USSPACECOM's *LRP* in painless detail, that space warfare (broadly conceived) capabilities are modest today; it is quite another to pour scorn on the whole idea.[12] There are several major reasons why the era of space warfare—including fighting "in space, from space, and into space"—may

be slow to arrive, but being slow to arrive is a light-year removed from being impracticable.

Freedman's scornful rejection of space warfare is undisciplined by temporal qualification. Of antisatellite weapons, he says that "these systems are unlikely to be employable on such a scale that they become much more than nuisances."[13] It is perhaps unfair to single out Professor Freedman for particular criticism here, especially since the study in which his unfriendly treatment of space warfare options is embedded is otherwise truly excellent. His brief analysis of the space dimension to the revolution in strategic affairs illustrates all but perfectly the structure of the problem that underpins this paper: That problem is the inability or unwillingness of people to approach space as just another geographical environment for conflict.

There is nothing about the space environment that renders it effectively beyond strategy. A problem, or perhaps opportunity, is that space forces today are technically immature. Historical parallels beckon from the maritime and air realms. In the galley era, fleets had to hug the shore, both because the oarsmen had to be watered frequently and because the stink of human waste became unbearable. In addition, the naval architecture for galley design could not overcome even a moderately turbulent sea.[14] In the age of "fighting sail," wind power (as contrasted with the muscle power of the galley) liberated the fleets operationally. However, until the second half of the eighteenth century, this freedom was massively offset by the need for anti-scorbutics in the naval diet to combat scurvy and by the need for hulls protected in tropical waters against the teredo worm.[15] Speculation about the efficacy of sea power in the seventeenth or early eighteenth century could have pointed to problems entirely comparable to those that Professor Freedman cites to suggest that spacecraft will enjoy a continuing sanctuary status in orbit.

The problems that ships had to overcome to free themselves from immediate dependence upon the land have been mirrored in this century by the difficulties in the development of airpower. People today who are easily impressed with the apparent difficulty a US adversary would face in seeking to take down the NAVSTAR Global Positioning System (GPS) satellite constellation should be exposed to the history of airpower.[16] There is nothing geotactically unique about outer space that renders it immune to the authority of general strategic logic.[17] How could there be? The geographical, geophysical, and therefore technological *and tactical* details of combat must be unique to each environment. Nonetheless, there is a pattern common to the development of military technology in all geographies: vision, experimentation, exploration, and correction.

Consider the military effectiveness of the B-17 in Europe and the B-29 in the Pacific. The fundamental challenge to the B-17 and to its crews in the Eighth Air Force in Britain was that its design was based on an unsound theory of air warfare. The US Army Air Forces (USAAF) believed that B-17 *formations*, not individual aircraft, would be flying "fortresses"; that they could bomb accurately from altitudes above 30,000 feet (altitudes beyond the range of German antiaircraft artillery); and that their modest bomb loads, imposed by heavy self-defense systems and the fuel needed to climb to such altitude, would be offset by the anticipated marvelous performance of the Norden bombsight. Alas, the wonderful machinery of the Norden bombsight was not weather-independent in its performance. So, bombardiers who could put it into the pickle barrel when training over Texas had considerable trouble finding the right neighborhood in Europe.[18] USAAF's B-29s ultimately wrought a war-winning level of devastation upon Imperial Japan, even prior to the two atomic strikes. But the B-29 could prove itself only after near-catastrophic developmental problems were overcome (very expensively) and after Curtis LeMay recognized that bombing at an altitude so high that flyers had to aim through the newly discovered jet stream was tactical nonsense.[19]

The technical-tactical challenges that limit the operational and strategic effect of a kind of military power—sea power, airpower, space power—eventually are overcome. This is not

to say that geographical environments are created equal; they are not. The land matters most because that is where we live. Space is geographically unique and therefore is distinctive in its technological, tactical, and operational aspects. However, that uniqueness and distinctiveness are of the character of the difference between the sea and the air, between ships and aircraft. In short, it is not obvious that the space environment is technically or tactically any more different from the sea or the air than they are from each other.

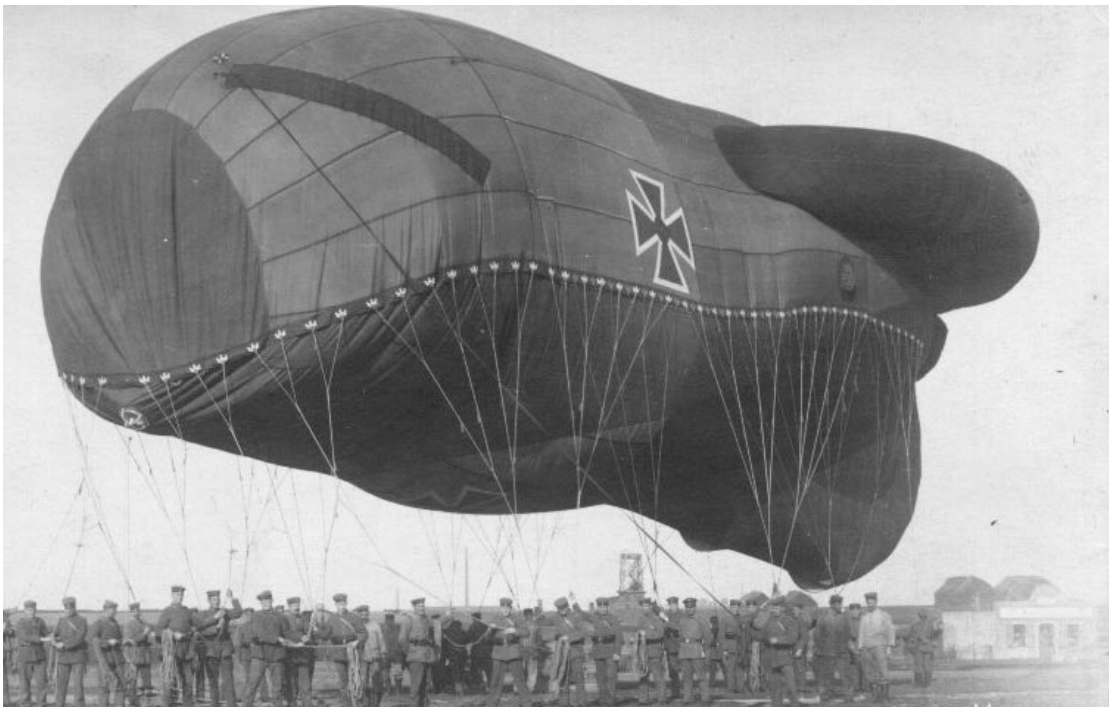
Space power, space warfare, and the geography of space are not beyond strategy. There is what one can call a "great tradition" of strategic thought that makes sense of military space behavior just as it does of military behavior in the other environments. From Sun Tzu and Thucydides, through Machiavelli, Clausewitz, and Jomini, to John Boyd and Edward Luttwak today, there is a great tradition of strategic speculation that achieves a universal and immortal relevance.[20] Strategic theorists cannot help being the product of their time and place—their culture, if you will—but the theorists just cited have each discerned essential features about the nature, not merely the ever-ephemeral character, of war and strategy.

It is useful to approach the space environment for conflict in these distinctive yet complementary ways. First, space needs to be approached as *just another* generator of strategic effectiveness. In this quintessentially strategic perspective, the name of the game is to influence the course and outcome of a conflict. Land power, sea power, airpower, and space power, independently and in various interpenetrating combinations, all perform the same service: They provide strategic effect.

Second, space can be viewed as the latecomer on our block whom we will try to interpret and mold according to the ideas and systems with which we are familiar already. Much as the builders of early horseless carriages—automobiles—constructed vehicles that looked like horse-drawn carriages, only with an engine in place of the horse, so some of the pioneers of military doctrine for space have plundered the more familiar military environments of land, sea, and air in quest of inspiration. We are friendly to such plundering—up to a point, at least. Unique though the geographies are, there is a set of military ideas that can be applied across environments, albeit taking different forms. The point should not be to look for similarities between, say, sea or air warfare and warfare in space. Rather, it is valuable to test important ideas developed for land, sea, or air war against the novel and unique challenge posed by war in space.

This is not to draw a distinction without a difference. We have just advised that it is useful and forward-looking to consider, for instance, what convoy, choke points, blockade control, and special operations might mean for space warfare. In contrast, we believe that it is not forward-looking to become preoccupied by how space warfare might *resemble* significant features of sea or air warfare. Such an unwillingness to approach space warfare uniquely *as space warfare* is encouraged by views such as that expressed recently in a study published by the US Army War College. In a generally first-rate analysis, William T. Johnsen advises that "while [outer space and cyberspace] are important, they are not yet ready to be considered components of military power in their own right."[21] Colonel Johnsen might be correct; an approach to space power that declines to view it *jointly*, instead of regarding it hierarchically as substantially subordinate, impedes progress.

The third way to view space is as a wholly unique geographical environment that requires total respect on its own geostrategic terms. In this third perspective, we point neither to the common coin of strategic effectiveness that unites the military "output" from each geographical environment, nor to the ways in which military space may borrow from operations in other climes. Instead, we advise that, in addition to the first and second views just outlined, there needs to be space-derived tactical and operational thinking. It is possible that there literally is a geographically universal set of tactical and operational ideas for the conduct of threat and of war itself. Just possibly, every idea that the space warrior will



The changing face of battlefield air reconnaissance: a World War I observation balloon, a World War II spotter airplane, and the E-8C JSTARS. The authors note that development for military technologies in all environments has followed a similar progression of vision followed by experimentation, exploration, and correction.

need is lurking, in different guise, somewhere in the writings of Baron Antoine Henri de Jomini, Adm Alfred Thayer Mahan, Sir Julian Corbett, or perhaps Albert Wohlstetter. We elect not to pass judgment on that possibility. Instead, we recommend that—in addition to historical education in actual military experience, to inspiration from the classics of strategic theory, and to more mundane borrowing from extant manuals of doctrine for terrestrial combat—ideas for the practice of space power should develop from the geographically unique context of space itself.

The Logic of Space Power

Continuing resistance to the strategic logic of space power today is vastly more remarkable than is that logic itself. After all, the logic of

space power is identical to the logic of military sea power and military airpower. Space power, after the fashion of BMD, suffers generically from a history of premature claims for operational maturity. If it is any consolation, the history of airpower is scarred even more noticeably with exaggerated and foolish claims.[22] We would remind those of a historical turn of mind that gunpowder artillery was the coming force in land warfare for one hundred to 150 years before it finally came, definitively, in the 1490s in Italy.[23] Contemporary critics of space power have too little sense of history. Whatever wonders "the stars" hold for our future, there is a vastly nearer-term strategic logic of space power that is all but entirely comprehensible in principle today. Polities will fight for access to, to maintain vehicles in, and to operate from space for precisely the same reasons that they extended their conflicts from the land to the sea and then the air. The technological, tactical, and operational details of space warfare must be distinctive to their no-less-unique environments. The strategic logic, however, is entirely common to all geographies of combat.

Our problem with much of the current literature on space power is that it confuses tactics and strategy, as well as politics and vision. Let's look at a small but telling "historical hypothetical" parallel. In 1938, a careful, honest, but strictly nearsighted analyst could have examined the leading air forces of the world with respect to their probable efficacy in a major conflict and dismissed them as no more than supporting players. Had a great war erupted in 1938, not an entirely absurd proposition, bombers lacked navigational competence, range, and payload, while fighters lacked the ability to find bombers.[24] To consider effective air warfare from the standpoint of the mid- to late 1930s, one needed to postulate some new miracle ingredient. That which was glimpsed dimly at the time but which shines like a beacon in long retrospect, the missing element was competent and practical exploitation of the EMS so as to permit air interception of bombers and accurate bombing. Radio and radar transformed air warfare.

The operational freedom accorded by the wind to sailing ships was noticeably at a strategic discount until the antiscorbutic benefits of citrus fruits were recognized and systematically applied as an answer to scurvy among ships' crews. The point is that it is foolish to rest an argument about space power—or sea power, or airpower—upon undoubted, *but only contemporary*, technical and tactical (hence operational) difficulties. Provided a forward-looking argument about space power, one is not required to deny the laws of physics. It is entirely appropriate to be less than impressed by critics who cite the imperfections of current technology and tactics. Physics textbooks have a way of dating rapidly; both heavier-than-air flight and the atomic bomb were proclaimed by distinguished experts to be impossible.

If anything, space power has suffered from too much vision of the wrong kind. In the inspired words of a recent commentator, "Nothing becomes so dated as yesterday's tomorrow."[25] Space warfare is thus tainted with the aura of overpredicted futures. In common with airpower and BMD, space warfare has a credibility problem created by past overprediction and, inevitably, apparent underperformance. What is needed most urgently today is not so much some grand vision of space power or even some vision of America's future in space, *useful though those would be*. Instead, what we need is a relatively mundane understanding of the space environment as yet another environment for conflict. Our comprehension of space power is entirely compatible with the view advanced in USSPACECOM's *LRP*. We are open to new science, and we expect new technology, but we do not require the invention of time machines, the reliable harnessing of antimatter, or the discovery of a new physics to thwart the force of gravity. If or when such advances are made, we will be more than delighted to accommodate them strategically.

The strategic logic of space power says that the greater our motivation to use space for military purposes, the greater must be the

motivation of our foes to deny us the ability to use space. Parallels with the maritime and air environments could hardly be clearer. Germany and the "Grand Alliance" placed different requirements upon their sea power in World War II. The Allies needed reliable use of the seas almost at will, both to bind themselves together logistically and to take the war to the continental foe. Nazi Germany had little need to use the sea—beyond the Baltic and, to a lesser degree, the Mediterranean—but she had a survival-level interest in being able to deny use of the sea to her maritime enemies.[26] The strategic logic of space power—following the maritime case just cited—is not a matter merely of abstract principle. That strategic logic has been created by the practice of space-system dependence by the US armed forces (and indeed by the US economy). Modern, professional fighting navies developed primarily because national economic interests had to be defended at and from the sea. By extension, as the US armed forces depend upon space systems for essential support functions (communications, navigation, reconnaissance, meteorology, and so forth), so the enemies of America's armed forces have to explore the military possibility of denying them that support.

The strategic logic is altogether inexorable. With respect to politics, technology, tactics, costs, and organization, just about everything pertaining to space warfare is eminently debatable. What is *not* debatable is a strategic logic that requires an irreversible trend towards military space exploitation to trigger programs to try to deny effectiveness to that exploitation. We are utterly unimpressed by (largely) accurate caveats that point to the *contemporary* high costs of access to orbit, the slowness of orbital transfer, and the distinctive political-ethical-(quasi)-legal regime that renders outer space different as the last "wide common" of mankind.[27] Space power and space warfare are coming. The only issues are how and when. This uncompromising prediction could be upset only in the unlikely circumstance that a truly political peace broke out and was sustained, on Earth. Even in that improbable event, still one might be anxious about the kind of futures signaled in the scenarios of the movies *Independence Day* and *Starship Troopers*. Far-fetched, even comic such movies may well be, but they can act as a reminder that we may be at peace with ourselves. But would the universe be at peace with us?

Geography and sea power. The battleship USS Oregon *made an epic voyage around South America during the Spanish-American War. She reached Cuba in time to participate in the battle of Santiago. The year was 1898, and the Panama Canal did not exist.*

RMAs and All That

It is distinctively American to approach interpretation of the present, the future, and then retrospectively the past by means of pretentious doctrine, even ideology. The US defense community has long been vulnerable to capture by the power of big ideas and not necessarily sensible big ideas—"high concept," as they say in Hollywood. The trouble with a fashionable big idea is that it is certain to be superceded by another big idea, and so on, and so on. Although space power can be regarded as an RMA, certainly as a military-technical revolution (MTR), it is much, much more than that. Space power is an evolving physical reality; RMAs and MTRs are mere intellectual inventions that comprise only con-

structed realities. If, as Dennis Showalter suggests engagingly, "RMA has replaced TQM [total quality management] as the acronym of choice" among the US armed forces, there may, for a while, be some political value in hitching "space power" to the conceptual wagon of an RMA.[28] Overall, though, we advise that the enduring reality of space power would be well advised to ditch an RMA connection as rapidly as is decently possible.

One might argue either that space power is vital to an information-led RMA or that space power itself is the RMA (or MTR). Putting aside for a moment the politics of public debate, it can be unimportant how we label what is happening in the military space realm. Over the better part of 10 years, space power has changed its status in the US armed forces from one of typically "useful and important adjunct" to terrestrial forces to, at the least, "indispensable adjunct."[29] Putting theory, labels, and public relations entirely to one side, the contemporary reality is that the US armed forces could not prevail, even against a modestly competent foe, without the support of space systems. We could be tempted to advocate preservation, even rediscovery, of non-space-dependent options for navigation/targeting, communications, surveillance-reconnaissance, but we decline to sign on to a lost cause. For good and ill, the era of space-system dependency has arrived. It is for this reason that we insist that the United States take seriously the idea of space warfare. Early modern Imperial Japan rejected the promise in gunpowder weapons in favor of the virtue of the sword: The United States will not eschew space systems in favor of terrestrial alternatives.

The space age of conflict irrevocably has arrived. This fact would be easier to highlight were it not extant amidst a hugely confusing "noise" created by the surrounding and accompanying RMA debate. Lest we be judged "space cadets," insufficiently sensitive to what else is happening today in the strategic realm, let us advance the proposition that the maturing of space power is the real RMA.

It is not our position that space activity is the only revolutionary zone in the field of modern conflict. But we do believe that military space is witnessing the most systemically radical and irreversible changes in military affairs of any areas plausibly relevant to this article. The great RMA debate, very largely in the United States, from 1991–98, has yielded a wide range of candidate alternatives, or complementary, "revolutions." At least eight distinctive possible "revolutions" vie for consideration. There is something to be said in favor of each of them. Some of these eight plainly are not so much alternatives as they are arguably useful distinctive lenses for viewing the same phenomena in different ways.

1. *Military Revolutions (MR).* In the words of Williamson Murray, "We might compare them in geological terms to earthquakes. . . . Such 'military revolutions' [e.g., for Murray's examples, the creation of disciplined military power in service of newly developed nation-states in the seventeenth century, the French and industrial revolutions, and World War I] recast the nature of society and the state as well as of military organizations."[30] Some theorists believe that contemporary information technologies are effecting just such an MR, while others are skeptical, suggesting that "cyberspace has been oversold as a realm unduly independent of geography and institutions."[31]
2. *Revolution in Military Affairs I.* Also according to Murray, RMAs can be likened to the pre- and aftershocks that may help trigger and exploit MRs. A deep and sweeping military revolution may be encouraged by the social, cultural, and institutional innovations required to execute RMAs.[32] The concept of a "system of systems" envisages,[33] in the words of *Joint Vision 2010*, achievement of a "dominant battlespace awareness."[34] The fog of war will not be dispelled totally, but "the combination of technology trends will provide an order of magnitude improvement in lethality."[35] What we label here as RMA I is the "bombs and bullets" version of informa-

tion-led warfare. The idea is that superior operational intelligence, communications, and navigation can enable the (US) armed forces to use precise bombardment to effect strategically decisive systemic shock. The practical relevance of this vision of RMA depends upon political, social, and even cultural factors that far transcend discussion of technology. Whether or not one is skeptical of the promise in the concept of a "system of systems" delivering relatively cheap, swift, and decisive military success, there can be no argument with the proposition that space systems will play a vital enabling role in this type of RMA.

3. *Revolution in Military Affairs II: Information (or Cyber) War*. The world of cyberspace breeds anticipation of virtual conflict in the form of information warfare. Information warriors will wage cybercombat—provided, that is, that they are so permitted.[36] It is well to ponder the implications of the following caveat suggested by Lawrence Freedman: "Even if a successful strategic information campaign could be designed and mounted, there could be no guarantee that a victim would respond in kind, rather than with whatever means happened to be available."[37] Such caveats aside, the growing importance of computers for almost all military activities guarantees that cyberspace must be a field for (electronic) warfare, while the machines and operations for information warfare are also bound to attract some crude, old-fashioned, physical assaults.
4. *Revolution in Military Affairs III: Airpower Is the Revolution*. Whether or not one chooses to judge the military effectiveness of (US) airpower in the 1990s so great an improvement over past performance—in World War II, Korea, and Vietnam, for example—as to warrant the label of "revolution" is a matter of taste. Benjamin Lambeth notes that "air-power proponents . . . have grown more and more inclined to argue that the ability of modern air-power to affect land warfare has crossed a threshold in which its effects are fundamentally greater than ever before. This development, in their view, has given rise to a paradigm shift in the relationship between air and surface forces."[38]

   Strong stuff, but not wholly implausible. At last airpower has demonstrated the all but independent ability to decide which side will win conflicts waged in open terrain in permissively symmetrical, conventional ways. Nonetheless, impressive though (US) airpower has become since the days of Linebacker I and II (1972), let alone Rolling Thunder (1965–68), airpower is a candidate RMA that has been "coming" at least since 1918. This is not to demean the potency of airpower in some contexts, but its maturing is a story that has been running for so long that it cannot compete for attention as novelty with other candidate RMAs.
5. *Revolution in Military Affairs IV: Space Power Is the Revolution*. The arrival of space power in strategic history is revolutionary in rather commonsense ways in which some other contemporary trends are not. Although it is important to emphasize the broad complementarity among all the ideas itemized here, we would perform a disservice if we understated the innovation that is space power. We agree with Freedman when he writes that "there is a danger in exaggerating both the novelty of the information revolution in military affairs, and in particular the difference that information can make on its own. By itself, it does not energize, destroy, shelter or move forces, though it can provide vital support to all these functions."[39]

   Information always has been more or less available and more or less important in warfare. Armies can fight in ignorance, but they tend to perform better when reliable information—especially

when it translates as knowledge and can be used with judgment and wisdom—is at hand. The emphasis in *Joint Vision 2010* on "dominant battlespace awareness" would have appealed strongly to Sun Tzu.[40] The great Chinese military philosopher and the US military establishment today have in common an unwise faith in the attainments and value of "intelligence" in all its forms.

Unlike the systematic exploitation of space, information is a permanent dimension of war. Effective airpower also is new, but it is nowhere nearly as new as space power. Of the four RMAs that we have discussed briefly, space power is the most revolutionary. Perhaps too much "cyberexcitement," too many debating "sidebars" about BMD, overinterpretation of "magic-bullet" airpower against Iraq, and an overload of fanciful tomorrows from the realm of science fiction have combined to dull strategic senses. Certainly, in 1971 one visionary commentator had already recognized space power as an enabler of an information-led warfare RMA. Francis X. Kane saw that space systems provided "responsiveness to decisions based on real-time data from sensors located in space; integrated operation of theater forces using a common grid; intimate awareness of changes in the physical environment; direct access to events occurring around the globe on a real-time basis; and improved effectiveness in weapons delivery resulting from our increased geodetic knowledge."[41]

We recognize that space power, in common with the other three candidate RMAs, has the characteristics of an MTR about it. However, following most willingly in the steps of other scholars who have emphasized how limited can be the efficacy of technological change per se, we note—in their good company[42]—that technology is not itself an effective weapon. For the relevant technologies to fuel something worth calling space power, there have to be military-cultural, institutional, and doctrinal changes. The true glory of USSPACECOM's *Long Range Plan* is that it does not equate space power simply with technical developments.

6. *A Revolution in Strategic Affairs*. This somewhat imperial concept, advanced by Lawrence Freedman,[43] may yet achieve leading-edge status as the idea of choice among commentators. This concept has the obvious virtue of reminding us all that armed force and war are about much more than technology alone. Indeed, Freedman advises that "the revolution in strategic affairs is driven less by the pace of technological change than by uncertainties in political conditions."[44] Strategy is the bridge that should cement military power of all kinds with political purpose.
7. *A Revolution in Security Affairs*. There are those among us who believe that although traditionally strategic matters, which is to say matters bearing upon the threat or use of force, certainly persist, menaces to security are taking less and less traditionally strategic forms.[45] It so happens that space power regarded totally is exceedingly relevant to problems of environmental security (e.g., information gathering in the earth sciences, as well—one day—as serious "asteroid watch" activity), but there is a popular view among scholars to the effect that military topics are of sharply declining significance for security. Large-scale interstate warfare happily is at present an endangered species of conflict, but the use of military power is anything but in decline.
8. *A Revolution in Political Affairs*. Our final candidate revolution is one that would preempt arguments advising about extant or imminent RMAs. Instead, this eighth "revolution" points to the radical shift in the international political context for the threat or use of military power. Some theorists fear that in our enthusiasm for the military value of

electronics, excitement about the apparent operational triumph of the heirs of Gen William "Billy" Mitchell, and in *our* conviction that space power is the trend that really sets these years apart, we may be missing the trends that matter most. The demise of the unlovely USSR and, as a consequence, the temporary absence of a great balance-of-power, or ideological, struggle do rather put Pentium processors, stealthy materials, and GPS satellites in the strategic shade.

Conclusions

We are in danger of being taken prisoner by our own concepts. The idea of RMAs is useful in alerting us to the probability of occasional nonlinear change. The idea becomes less useful, however, when it is allowed to transcend the category of helpful and suggestive insight and instead is employed as a grand theory to organize understanding of all of strategic history. An RMA inherently tends to bias interpretation in favor of discounting continuities; in addition, it spawns a rather incestuous debate about labels and theory. In short, scholars, especially scholars from the social sciences, are never happier than when they can debate eloquent conceptual distinctions. As a result, instead of empirical exploration guided by RMA insight, we are apt to slide into arid discussion of "What is an RMA? When is an RMA actually an MTR, or an MR, or something else?" Theorists are not inventing the influences of new information technologies and space systems; what they are inventing are ways to gift wrap those realities conceptually. Capabilities for information-led warfare down the road, pioneered conceptually by Adm William Owens,[46] among others, are a physical reality. By way of sharp contrast, an RMA is an intellectually constructed reality; it can be neither true nor false but just more or less useful. High concepts like the RMA, MR, and MTR are the playthings of intellectuals. You may find them helpful, but do not confuse them with empirical realities.

Because space is a relatively simple geographical environment compared with the sea—but especially when compared with the complexities of the land—technological advantage is at a premium.[47] Technology always matters in conflicts of all kinds in all geographies, but nowhere does it matter more than for space. Even for space, technology is only one of the many dimensions of strategy and war. Without suitable space technology we cannot operate tactically to, in, and from orbit; hence operational and strategic matters would be moot. Indeed, the quest for a financially tolerable logistics for space power remains key to the more ambitious elements of USSPACECOM's *LRP*. That granted, it is a persisting fact that war, even space war, cannot become simply a robotic fixture. Even with superior mechanics for the conduct of space warfare, everything we learn from strategic history tells us that better tools of war cannot deliver victory. Organization, doctrine, training, numbers (recall that both Clausewitz and Jomini agreed about the need to bring superior force to bear at the decisive point),[48] good statecraft, and wise generalship will all be needed if superior technology is not to be wasted. The idea of the human element in space warfare should certainly not be dismissed because of current technological and political obstacles. Nathan Goldman states that "the debate whether human presence in space is required or more cost-effective than a robotic presence is arcane, the decision has a simple conclusion: the dream of spaceflight is a human craving that an armchair presence will not fulfill."[49] We emphasize this point not out of some misguided romantic notion of a human presence in space, although to many people such notions are justification enough, but as an acknowledgement that space warfare, like war in all other environments, is a human affair. Naturally, the advantages and disadvantages of humans versus technology in space will have to be carefully considered.

Much as the nuclear era cannot be repealed by policy fiat,[50] so the emerging physical realities of space are beyond basic policy choice. We cannot choose whether or not

space power should be required. We cannot elect to reverse the technological and commercial surge of information technologies. The relevant questions are all at a lower level: who will have how much space power, of what kinds, and when? With respect to new information technology, the technical frontier is expanding more because of technological opportunity and the commercial opportunism of those who invent and refine the hardware and software than because of customer demand. The US armed forces are surfing the ever-higher waves of information power more than they are in any practical sense controlling the heights or frequency of those waves. Similarly, space is exploited for vital military and commercial functions simply because it is efficient to do so. We should worry about new vulnerabilities as we come to depend more and more upon orbiting platforms, just as we are right to be anxious about our burgeoning cyberdependence. But we have made a pact with the devil that we could not avoid. Because space power is a reality, so space warfare is an impending reality whose prospect is endorsed by all of history, as well as by the logic of strategy.

If space power is defined as *the ability in peace, crisis, and war to exert prompt and sustained influence in or from space*,[51] then the key enabler for space power has to be space control. The *LRP* is exactly right when it defines space control as "the ability to assure access to space, freedom of operations within the space medium, and an ability to deny others the use of space."[52] In World Wars I and II, the inability of Germany to challenge for sea control left her with the strategy of the weak, stealthy guerrilla war at sea by surface and subsurface raiders. In both wars, Allied sea control was a vital enabling factor for victory in war as a whole. In World War II, the Allied Combined Bomber Offensive attempted in 1942–44 to win the war by strategic air bombardment without first securing control of the air (i.e., without first defeating the Luftwaffe). The gods of strategy were not to be mocked; in 1943 both the USAAF by day and the RAF Bomber Command by night were defeated by Germany's well-integrated air defense system.[53]

Space control is not an avoidable issue. It is not an optional extra. If the US armed forces cannot secure and maintain space control, then they will be unable to exploit space reliably or reliably deny such exploitation to others. The US ability to prevail in conflict would be severely harmed as a consequence. If you fail to achieve a healthy measure of space control in the larger of the possible wars of the next century, you will lose.

Finally, the glass of US space power is half full. USSPACECOM's *LRP* is more than adequate as an official document that attempts to meld vision, plans, and hopes. Both generally and with specific reference to particular space missions, a huge advance in understanding has been secured. At least, it is a huge advance in understanding on the part of those responsible for the *LRP*.[54] The half of the space power glass that remains empty, alas, is represented by most of the equipment, the *space forces*, needed to make space power a reliable strategic factor in future conflict. Leaving aside the controversial question of possible deployment in orbit of weapons for force application against terrestrial targets, it is not controversial to claim that the United States has an almost hollow policy on space control. The excellent discussion in chapter 5 of the *LRP* puts the best spin that it can on the subject of aspirations, intentions, and actualities, but it comprises more a statement of the problem or challenge than it does a firm commitment to secure the necessary military grip on this most essential enabler of space power.

Contrary to appearances, perhaps, this is not intended as criticism of the *LRP*. We understand that that document proceeds as far as it can, given its nature and purpose. Nonetheless, space control cannot be achieved strictly with conventional terrestrial forces, by electronic means, or by hopes and prayers. Space control, indeed space power, requires the deployment of dedicated space forces. □

Notes

1. "Policy" comprises capabilities, declarations, and action. Policy documents, vision statements, long-range plans, and the like are all useful, indeed essential, milestones on the journey to comprehensive, full-service (i.e., including weaponized) space forces for space power. Documents, vu-graphs, speeches, and so forth, however, are not synonymous with policy properly understood. To write or speak of space power is not necessarily to make it so.

2. US Space Command, *Long-Range Plan: Implementing USSPACECOM Vision for 2020* (Peterson AFB, Colo.: US Space Command, March 1998), 141. Hereinafter *LRP*.

3. Ibid., viii.

4. Ibid.

5. Ibid.

6. See Colin S. Gray, "RMAs and the Dimensions of Strategy," *Joint Force Quarterly,* no. 17 (Autumn/Winter 1997–1998): 50–54; and idem, *Modern Strategy* (Oxford: Oxford University Press, forthcoming 1999).

7. *LRP,* 7.

8. Useful introductions to space "basics" are Lyn Dutton et al., *Military Space* (London: Brassey's [UK], 1990), chapter 2; and John M. Collins, *Military Geography for Professionals and the Public* (Washington, D.C.: National Defense University Press, 1998), chapter 7.

9. Julian S. Corbett, *Some Principles of Maritime Strategy,* ed. Eric J. Grove (1911; new imprint, Annapolis: Naval Institute Press, 1988), 16.

10. Carl von Clausewitz, *On War,* ed. and trans: Michael Howard and Peter Paret (Princeton, N.J.: Princeton University Press, 1976), 183; Michael Howard, "The Forgotten Dimensions of Strategy," in Michael Howard, *The Causes of Wars and Other Essays* (London: Temple Smith, 1983), 101–15; and Gray, *Modern Strategy,* chapter 1.

11. Lawrence Freedman, *The Revolution in Strategic Affairs,* Adelphi Paper 318 (London: International Institute of Strategic Studies, April 1998), 52–53.

12. Freedman is especially critical of Steven Lambakis, "Exploiting Space Control," *Armed Forces Journal International,* June 1997, 42–46. Also see Lambakis, "Space Control in Desert Storm and Beyond," *Orbis* 39, no. 3 (Summer 1995): 417–33; and "The United States in Lilliput: The Tragedy of Fleeting Space Power," *Strategic Review* 24, no. 1 (Winter 1996): 31–42.

13. Freedman, 52.

14. John Francis Guilmartin Jr., *Gunpowder and Galleys: Changing Technology and Mediterranean Warfare at Sea in the Sixteenth Century* (New York: Cambridge University Press, 1974); and John H. Pryor, *Geography, Technology, and War: Studies in the Maritime History* of *the Mediterranean* (Cambridge: Cambridge University Press, 1988), 649–57, are useful on the realities of galley warfare. In an older classic study, William Ledyard Rodgers wrote that "the odor of a galley could be perceived a mile or more to leeward," *Naval Warfare under Oars, 4th to 16th Centuries: A Study of Strategy, Tactics, and Ship Design* (Annapolis: Naval Institute Press, 1967), 234.

15. See G. J. Marcus, *A Naval History of England,* vol. 1, *The Formative Centuries* (Boston: Little, Brown, 1961), chapter 11; and N. A. M. Rodger, *The Wooden World: An Anatomy of the Georgian Navy* (Annapolis: Naval Institute Press, 1986), chapter 3.

16. Happily, NAVSTAR GPS poses, indeed quite properly was designed to pose, truly formidable tactical challenges even to a competent spacefaring foe. (The 24-satellite constellation is deployed with four vehicles to each of six orbital planes, each inclined at 55 degrees to the equator in circular orbits at an altitude of 20,233 kilometers.) A formidable technical-tactical challenge though it may pose to those who would seek to degrade it via action against any or all of its three segments, it remains only that—a formidable technical-tactical challenge. Even though it is designed to degrade under attack relatively gracefully, GPS has become so critically important to US military performance that US enemies must be extraordinarily strongly motivated to try to meet the challenge.

17. On the paradoxical nature of strategic logic, see Edward N. Luttwak, *Strategy: The Logic of War and Peace* (Cambridge, Mass.: Harvard University Press, 1987).

18. Stephen L. McFarland, *America's Pursuit of Precision Bombing, 1910–1945* (Washington, D.C.: Smithsonian Institution Press, 1995).

19. Michael S. Sherry, *The Rise of American Air Power: The Creation of Armageddon* (New Haven, Conn.: Yale University Press, 1987); and Kenneth P. Werrell, *Blankets of Fire: U.S. Bombers over Japan during World War II* (Washington, D.C.: Smithsonian Institution Press, 1996).

20. Sun Tzu, *The Art of War,* ed. Ralph D. Sawyer (Boulder, Colo.: Westview, 1994); Thucydides, *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War,* ed. Robert B. Strassler (New York: Free Press, 1996); Niccolo Machiavelli, *The Art of War,* ed. Neal Wood (Indianapolis, Ind.: Bobbs-Merrill, 1965); Clausewitz, *On War;* Baron Antoine Henri de Jomini, *The Art of War* (1862; new imprint, Novato, Calif.: Presidio, 1992); John R. Boyd, "A Discourse on Winning and Losing," unpublished manuscript, August 1987; and Luttwak.

21. William T. Johnsen, *Redefining Land Power for the 21st Century* (Carlisle Barracks, Pa.: US Army War College, Strategic Studies Institute, 7 May 1998), 4.

22. Colin S. Gray, *Explorations in Strategy* (Westport, Conn.: Praeger, 1998), part 2.

23. Bert S. Hall, *Weapons and Warfare in Renaissance Italy: Gunpowder, Technology, and Tactics* (Baltimore: Johns Hopkins University Press, 1997).

24. Uri Bialer, *The Shadow of the Bomber: The Fear of Air Attack and British Politics, 1932–1939* (London: Royal Historical Society, 1980); Williamson Murray, *The Change in the European Balance of Power, 1938–1939: The Path to Russia* (Princeton, N.J.: Princeton University Press, 1984); and James S. Corum, *The Luftwaffe: Creating the Operational Air War, 1918–1940* (Lawrence, Kans.: University Press of Kansas, 1997).

25. Philip E. Agre, "Yesterday's Tomorrow: The Advance of Law and Order into the Utopian Wilderness of Cyberspace," *The Times Literary Supplement,* 3 July 1998, 3.

26. This strategic logic is developed in Colin S. Gray, *The Leverage of Sea Power: The Strategic Advantages of Navies in War* (New York: Free Press, 1992).

27. Alfred Thayer Mahan, *The Influence of Sea Power upon History, 1660–1783* (1890; new imprint, Boston: Little, Brown, 1918), 25.

28. Quoted in Williamson Murray, "Thinking about Revolutions in Military Affairs," *Joint Force Quarterly,* no. 16 (Summer 1997): 69–76.

29. Gray, *Explorations in Strategy,* 102.

30. Murray, "Thinking about Revolutions in Military Affairs," 71.

31. See Agre.

32. Murray, "Thinking about Revolutions in Military Affairs."

33. Adm William A. Owens, "The Emerging System of Systems," US Naval Institute *Proceedings* 121, no. 5 (May 1995): 35–39.

34. US Joint Chiefs of Staff, "Joint Vision 2010," *Joint Force Quarterly,* no. 12 (Summer 1996): 39.

35. Ibid., 40.

36. The outstanding skeptical analysis is Andrew Rathmell, "Cyber-Terrorism: The Shape of Future Conflict," *RUSI [Royal United Services Institute] Journal* 142, no. 5 (October 1997): 40–45.

37. Freedman, 57.

38. Benjamin S. Lambeth, "The Technology Revolution in Air Warfare," *Survival* 39, no. 1 (Spring 1997): 65–66.

39. Freedman, 50.

40. "Joint Vision 2010," 39.

41. Francis X. Kane, "Space Age Geopolitics," *Orbis* 14, no. 4 (Winter 1971): 913.

42. In particular, see the case studies in A. J. Bacevich and Brian Sullivan, eds., *The Limits of Technology in Modern Warfare*, forthcoming.

43. Freedman.

44. Ibid., 76.

45. See David A. Baldwin, "Security Studies and the End of the Cold War," *World Politics* 48, no. 1 (October 1995): 117–41; and Barry Buzan, Ole Weaver, and Jaap de Wilde, *Security: A New Framework for Analysis* (Boulder, Colo.: Lynne Rienner, 1998).

46. Owens, 35–39; and Stuart E. Johnson and Martin C. Libicki, eds., *Dominant Battlespace Knowledge*, rev. ed. (Washington, D.C.: National Defense University, Institute for National Strategic Studies, April 1996), 1–14.

47. "Other things being equal, the simpler the environment in which war is waged the greater the advantages offered by high technology." Martin van Creveld, *Technology and War: From 2000 B.C. to the Present* (New York: Free Press, 1989), 272.

48. Clausewitz, 204; and Jomini, 70.

49. Nathan C. Goldman, *Space Policy: An Introduction* (Ames, Iowa: Iowa State University Press, 1992), 146.

50. Whatever our policy choices over nuclear weapons, we cannot abolish knowledge of the fact that we have made these weapons work.

51. This is a direct adaptation of the definition of *land power* provided in Johnsen, 6. We judge this somewhat "borrowed" definition to be good enough for now, though not so good as to foreclose on useful redefinition in the future.

52. *LRP*, 19–20.

53. See Stephen L. McFarland and Wesley Phillips Newton, *To Command the Sky: The Battle for Air Superiority over Germany, 1942–1944* (Washington, D.C.: Smithsonian Institution Press, 1991).

54. USSPACECOM's *Long-Range Plan* would be more persuasive still were it written with explicit reference to some well-respected text or texts on the subject of space power. As of today, there is literally no extant major book or study of strategic theory that seeks to explain how space power "works." The military space literature on hand tends to be narrowly focused on matters of arms control, BMD, antisatellite (ASAT), or other particular issues. Some years ago, one of us wrote, "Where is the theory of space power?" Colin S. Gray, "The Influence of Space Power upon History," *Comparative Strategy* 15, no. 4 (October–December 1996): 307. Even a weak theoretical work on space power could serve a really useful purpose.

What our sword has won in half a year, our sword must guard for half a century.

—Helmuth von Moltke