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BACK TO THE FUTURE: SPACE POWER THEORY AND A.T. MAHAN

MARTIN E.B. FRANCE, LT COL, USAF/CLASS OF 2000

FACULTY ADVISOR:
JACK LEONARD, COL, USAF

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More than four decades since our first steps into space, no definitive work on space power theory, comparable to the writings of Clausewitz, Mahan, or Mitchell (among others in their respective fields), is recognized by military theorists. This lack is magnified by the billions of dollars already invested in military, civil and commercial space systems and a global population increasingly dependent upon space. Though most preliminary space power writing in the United States centered on space as a logical extension of air power theory (if for no reason than the organizational location of most space forces within the U.S. Air Force), such treatment is akin to early Army characterizations of aircraft as a tool of the artillery or signal corps, restricted to supporting ground operations. While space is certainly a unique operational setting that has yet to be fully exploited, it shares many characteristics with the sea as an arena for commerce, transport, observation and conflict. In fact, because of the distances involved, the importance of constantly safeguarding the free flow of global commerce in both peace and war, and the more or less permanent basing of key civil and military assets in orbit, space power, missions and responsibilities have many analogs to those of the sea. Therefore, one would do well to consider the earlier work of sea power theorists, specifically A.T. Mahan, when attempting to develop a theory of space power and to develop strategies for space control.

Any discussion of space power must begin with a short description of the characteristics of space and both the advantages afforded those who choose to operate there and the restrictions and hazards they face. Several excellent texts (e.g. Jerry Sellers' **Understanding Space: An Introduction to Astronautics**)[1] describe the physics of space, the hurdles one faces in placing satellites in sustainable orbit, how to maneuver and/or recover them, and how individual satellites and constellations are designed for various missions. The common operational features of space include vast distances in three dimensions (from altitudes of about 100 kilometers to beyond lunar distances), a harsh environment, very high speeds, generally predictable paths (orbits) dictated by mission requirements, and (currently) limited access points from which to deploy space assets, i.e. launch bases. Spacecraft are very expensive to design, build and deploy, often costing hundreds of millions or billions of dollars, and have useful lives ranging from months to a decade or more. Deployments (launches) are infrequent, complex events that are scheduled months or years in advance.

Though now cliché, space is indeed the ultimate high ground. The global perspective afforded those able to operate in space remains its primary advantage. No point in the Earth's atmosphere or on the surface, (and, to an ever-increasing degree, below the surface), is completely immune from the view of satellites. Satellites launched into low Earth orbit (LEO) can pass over any point on the globe in less than 90 minutes and satellite constellations can provide continuous line-of-sight coverage of any point on the globe depending on their altitude and number. Satellites in geosynchronous Earth orbit (GEO) remain fixed relative to a specific longitude on the Earth's equator at an altitude of about 22,400 miles, able to stare or survey. The intelligence advantage space assets provide, coupled with the opportunity to project power swiftly when needed, increase the importance of dominating space in peace and war.

If extended from two dimensions to three, Mahan's opening paragraph from Chapter I of **The Influence of Sea Power Upon History, 1660-1782**[2] applies equally today and may be rewritten by the space power theorist as follows [changes in boldface]:

> *The first and most obvious light in which* ***space*** *presents itself from the political and social point of view is that of a great* ***network of*** *highway**s**; or better, perhaps, of a wide* ***and deep ocean, through*** *which information, men* ***and their machines*** *may pass in all directions, but on which some well-worn paths show that controlling reasons have led them to choose certain lines of travel rather that others. These lines of travel are called* ***orbits****; and the reasons which have determined them are sought* ***not only in Newtonian physics but by the current global social and political structure****.*

Just as shipping lanes are designed to minimize transit time and shipping cost, orbits are chosen to maximize operational effectiveness while minimizing launch costs. GEO satellites, mentioned earlier, allow broad coverage for observation and signal reception and transmission. Polar orbiting satellites in LEO can survey the entire globe once per day, while medium Earth orbit (MEO, 12 hour orbital period) offers the best compromise between coverage and constellation size for Global Positioning System (GPS) satellites. High latitude communications are supplied by a constellation of two or more satellites in inclined, highly elliptical “Molniya” orbits named for their discoverer. Given a satellite’s mission, one can easily surmise its orbit and in some cases its actual location, much as a commerce raider can be reasonably sure of finding targets in specific shipping lanes given the point of origin and destination ports.

If a satellite’s orbit is its “well-worn path,” then two or more space analogs to seaports also exist. First, satellites are generally deployed from expendable boosters launched from fixed, well-known bases.[i] In many cases, launch bases are on seacoasts for safety reasons. Second, sites from which information is transmitted to satellites for command and control or retransmission and those that gather data transmitted from the same satellites (often the same site) constitute ports of origin and destination. Finally,

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[i] The only two current exceptions to this are Orbital Science’s Pegasus booster (air-launched from a converted jetliner) and the Boeing Sea Launch system that uses a mobile, floating platform to launch rockets from mid-ocean.

satellites themselves might be considered ports of origin, if their primary role is to gather terrestrial or spatial information.

Space is also quite similar to the seas in that it is recognized by international law as available for use by all nations. Nations have the right to control access to their airspace much as they have the right to restrict access to their territorial waters, but this right only extends upward to the practical limits of the atmosphere—a point not specifically defined by law or treaty. The resulting internationally accepted policy is that satellites may over fly sovereign nations whereas aircraft cannot.[i] Nations may place satellites on orbit for commercial, research and national security purposes, with the exception for the weapons of mass destruction, forbidden by the Outer Space Law of 1967.[3] Assignment of specific orbits—most importantly GEO longitudes—are, in turn, regulated by the International Telecommunications Union (ITU) to minimize radio frequency interference between satellites and ground control sites, reduce the possibility of collision and to assure adequate access to space for all nations. Satellite operators and United States Space Command (USSPACECOM), the latter publishing a catalog of all detectable man-made and natural satellites in Earth orbit, monitor compliance with regulations. No direct (on-orbit) enforcement of ITU regulations is possible, though, leaving only terrestrial means (diplomatic action, economic sanctions, military action, etc.) to resolve any potential conflict today.[4]

Unlike the high seas, where an abandoned ship may be claimed for salvage by whomever takes control of it, jurisdiction over and control of abandoned objects remain

[i] The question of freedom of over flight for spacecraft may be contested at such as single-stage-to-orbit boosters or “spaceplanes” capable of significant powered maneuvering in space are used to over fly nations at very low orbital altitudes.

with the launching state, according to Article VIII of the Outer Space Treaty of 1967. However, a landmark event similar to the concept of sea salvage occurred in 1998 after the AsiaSat-3 commercial communications satellite was left in a seemingly useless orbit following failure of its final stage. Once the AsiaSat consortium settled their insurance claim for the failure and was reimbursed, the Hughes Corporation (builders of the satellite) worked out an agreement with the underwriters to attempt to salvage the satellite. Hughes engineers proposed an innovative way to maneuver the satellite into a useful orbit by firing its on-board control rockets at specific times, causing it to actually loop around the Moon twice, finally settling into GEO. Though this greatly reduced its useful on-orbit life, Hughes paid for all maneuver costs (about $1M) and now shares all satellite revenues with the underwriters[5]—potentially tens of millions of dollars per year.

Large proportions of the raw materials and finished products of the Industrial Age were (and still are) borne by ships at sea. Similarly, much of the raw and processed data of the Information Age traverse space and are therefore dependent on satellites in orbit to gather, process and/or relay this data to the end user. Current commercial and national security space activities generally fall into four general categories: communications; navigation and timing; remote Earth sensing, surveillance and reconnaissance; and scientific research. Multibillion-dollar military communications systems such as MilStar, DSCS (Defense Satellite Communications System) and UFO (UHF Follow-On) provide secure, nuclear-hardened communications for American forces worldwide. GPS provides extremely accurate position, velocity and timing information for a myriad of applications. Precision guided munitions employed in Kosovo and Iraq, civilian transportation networks such as trucking and aircraft, cellular phone networks, shipping, search and rescue workers and even growing numbers of individual hikers and automobilists depend on an accurate, secure and accessible GPS signal. Spaceborne sensors provide missile warning and tracking, while multispectral and optical Earth imaging systems make available critical environmental and intelligence information to farmers, conservationists and military commanders at nearly all levels. Meteorological satellites in LEO and GEO have revolutionized weather forecasting over the last 40 years. Where shipping enabled global commerce, information flow and conflict in earlier centuries, space power has much the same effect during the present day.

Seapower, as defined by Mahan, is not a single property, but a combination of factors that figured prominently in a nation's security, prosperity and influence in the world. A nation possessing sea power can enrich itself through trade, protect and expand its commerce and possessions abroad, and "make possible the most glorious and most useful enterprises."[6] Mahan elaborated six conditions that define a nation's seapower: geographical position; physical conformation; extent of territory; number of population; character of the people; and character of the government.[7] Even though the primary focus of Mahan's work was to guide the education of future commanders, not to define naval theory,[8] these elements seem generally applicable to space power at the beginning of the 21st Century as well, and may serve as a guide to developing a better understanding of the elements of space power.

Though all nations have some access to space, unlike a landlocked nation's inability to reach the sea directly, the first three of Mahan's conditions still play an extremely important role in defining a nation's space power. The fact that the Earth rotates from west to east, imparting a "boost" to any eastwardly launched satellite (directly related to the latitude of the launch site), grants an advantage to nations with territory or possessions near the equator. Since all current boosters are staged vehicles that drop expended stages downrange from launch, physical conformation and extent of territory favor spacefaring nations able to place their spaceports either on the seacoast, where an uninhabited corridor exists into which debris may fall (e.g. Cape Canaveral) or centrally located in a great land mass as was the case with the former Soviet Union's Baikonur Launch Complex, now located in Kazakhstan. Extent of territory also has serious security implications, allowing large nations to place other ground-based space assets such as command and control centers hundreds or even thousands of miles from any external borders.

In the case of the United States, launch bases are conveniently located on each coast. Cape Canaveral is used for eastward launches to LEO, MEO and GEO because of its relatively low latitude (28.5^{o} N), while polar-orbiting satellites are launched southward from Vandenberg AFB, California, a coastal promontory. Other launch options abound, including a newly complete (albeit austere) polar launch site on Kodiak Island, Alaska, the possibility of launching from Hawaii in any direction, or even launches of proposed reusable, single-stage-to-orbit (SSTO) launch vehicles (no falling debris) from one of several landlocked western states. By contrast, Israel's budding space program is restricted by the sensitivity of its Arab neighbors to falling missile parts if it launches in any direction except due west across a well-populated Mediterranean Sea, while its territorial security has always been problematic due to its small size and proximity to enemies. India, too, has sensitive neighbors but can launch across the Indian Sea, while France and other European nations have banded together to overcome their geographical disadvantage by launching from Kourou (5^{o} N), French Guiana. Geographically speaking, two potential future space powers might be Australia and Brazil, where plans already exist for the construction of commercial spaceports. Finally, just as Russia has historically struggled for warm water seaports from which to exert her power, she is now faced with a unique situation whereby her primary spaceport is located on foreign soil and many of her production facilities are now part of the Ukraine following the breakup of the Soviet Union. While agreements between Russia and Kazakstan over Baikonur appear stable, the possibility of future complications cannot be fully discounted.

Whereas number of population is probably not a limiting factor for space power as it might have been at one time for sea power, the national character and character of government are certainly important parts of space power. Mahan stated, “If sea power be really based upon a peaceful and extensive commerce, aptitude for commercial pursuits must be a distinguishing feature of the nations that have at one time or another been great upon the sea.”[9] Extended to the current day, then, Mahan would grant the space power advantage to those nations whose people share an aptitude for commercial pursuits, for they will be the first to exploit space for commercial purposes. A modern component of a population’s “commercial character” is also its willingness to embrace technology in everyday life. Perhaps no other element of sea power so directly translates to space power today as national character, especially since the end of the Cold War (during which space power had a less significant commercial sector).

Mahan would not be surprised that the two largest market economies in the world are also the two most robust space powers. The European launch industry and its Ariane boosters respond almost entirely to commercial needs for communications and sensing/imaging satellites. The U.S space market is exploding with direct broadcast television, hand-held GPS units, internet access and a wide variety of global communications systems.

Other nations are also participating in space, joining commercial ventures with leading space powers to overcome the expense of booster and satellite development which prohibits many smaller economies from participating directly in space. The cost of buying a satellite and having it launched by one of the primary space powers is well within the means of many nations. In fact, 35 nations have payloads in orbit and many more are expected to join them in the coming years. The open market in space tends to strengthen the economies of all involved and enhance the stature of the primary space powers.

Russia again provides an excellent counterexample. Prior to the collapse of the Soviet Union, some would argue that Russia was the world's preeminent space power. They had launched and operated space stations, communications, intelligence and warning satellites, a navigation constellation, and had a vigorous scientific program in place. However, the Russians built their space program almost entirely for national security purposes--without any basis in the commercial factors that make a nation a full space power. With the end of the Cold War and resultant diminution of threat to national security, coupled with an economy in ruins, the Russian space program collapsed. That the Russians, as well as the Ukrainians, have maintained any capability at all is largely due to massive infusions of capital from free-market governments (e.g. International Space Station "partnership" with NASA and other nations), and corporations such as

Boeing and Lockheed-Martin who have bought and commercialized tremendous portions of the Russian space infrastructure and knowledge base at “fire sale” prices.

Mahan also finds favor in governments that actively stimulated shipping, markets and commerce, citing the British as an example for creating, equipping and maintaining her navy and its bases of operation.[10] No better example of such stewardship can be found than the U.S. government’s development of GPS, around which a multibillion-dollar per year industry now exists. A more recent example is the Evolved Expendable Launch Vehicle (EELV) with which the Department of Defense intends to reduce launch costs by first underwriting the development costs of two new families of low-cost boosters for both military and commercial launches, then purchasing launch services from the prime contractors to reduce the cost of operating a separate military launch infrastructure. The European Space Agency used a similar approach to develop their Ariane boosters. NASA is also spurring work in revolutionary launch technologies by funding a series of “X” vehicles that will ultimately lead to fully reusable SSTO launchers that operate not unlike commercial aircraft.

Following his elements of sea power, Mahan proceeded to discuss the importance of naval power. In his view, naval power consists of three elements: position; bases; and the fleet itself. He defined naval power as “the possession of that overpowering power on the sea which drives the enemy’s flag from it, or allows it to appear only as a fugitive; and which by controlling the great common, closes the highway by which commerce moves to and from the enemy’s shores.”[11] The current space analog to naval power is space control, defined by USSPACECOM 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, if required."[12] The similarities in the definitions are obvious. Mahan's purpose for a naval force was ultimately to strangle the enemy, to compel one's adversary to discontinue resistance and bend to one's will by destroying its commerce, denying its ability to trade on world markets and ultimately causing its economy to crash. With information playing such a critical current role in any current or future conflict, the primary role of a space force then could be to deprive an enemy of the information necessary to function effectively in the global economy and to mount effective resistance against terrestrial or spaceborne forces, while fully protecting one's space assets.

The difference in the two definitions may seem to be only in tone, but it implies a vulnerability as well as strategic direction. USSPACECOM does not speak of "overpowering power in space" largely because no such capability exists today. Not only does the United States possess no comprehensive means of directly attacking an adversary's space forces on orbit, it also lacks any ability to actively defend its assets already on orbit from a surface-based or orbital attack. The result is an unprecedented amount of wealth representing overwhelming strategic value left undefended in space today, with the target date for fielding systems capable of protection and negation in space no sooner than 2020 by even the most optimistic forecast.[13] While the distances and speeds involved make directly attacking our assets admittedly difficult, the possibility of a successful, limited attack using technology available to any spacefaring nation or even some limited to intermediate range ballistic missiles is real.[14] The result is an assumed sense of space superiority that exists if for no other reason than no successful, documented attacks on U.S. systems have yet occurred.

Beginning with the Persian Gulf War, each contingency during this decade has relied increasingly on space control to achieve its goals. There is no reason to think this trend will not continue, if not accelerate. Recent events in Kosovo not only highlighted this point, they evidently triggered some sensitivity to our growing vulnerability. On 19 October 1999, testifying before the House Armed Services Committee on the lessons of Kosovo, Lieutenant General Marvin Esmond, the Air Force's Deputy Chief of Staff for Air and Space Operations stated that:

> "*Space superiority was assumed from the start of hostilities. In this operation space was a neutral sanctuary that both the United States and Serbia used to their own advantage. Serbia did not threaten the United States' space capabilities. However, the heavy US reliance upon space today reflects a dependence that is expected to grow in the future. It is important that future operations characterize the space threat as is currently done for land, sea, and air and assess actions needed to gain and maintain space superiority.*"

By Mahan's definition, the United States did not adequately exert space control in the Balkans, nor did it achieve space control as defined by USSPACECOM.

The importance of space power and control is today a primary concern of both our civilian and military leaders. The huge investment in space and our pervasive dependence on assets in space argues convincingly for the development of a workable theory of space power as well as strategies to establish and maintain space control in the near future. It follows, therefore, because of the striking current and historical similarities between sea power and space power, that we should begin this journey by first looking to the past, taking a lesson from the author who defined sea power, Alfred Thayer Mahan.

ENDNOTES

[1] Jerry Jon Sellers, Understanding Space: An Introduction to Astronautics (New York: McGraw-Hill, 1994)

[2] "The first and most obvious light in which the sea presents itself from the political and social point of view is that of a great highway; or better, perhaps, of a wide common, over which men may pass in all directions, but on which some well-worn paths show that controlling reasons have led them to choose certain lines of travel rather than others. These lines of travel are called trade routes; and the reasons which have determined them are to be sought in the history of the world." A.T. Mahan, The Influence of Sea Power on History, (New York: Dover Publications, 1890), p. 25.

[3] William B. Winn, "Chapter 21, Limits on Mission Design," Space Mission Analysis and Design, ed. J.R. Wertz and W.L. Larson, (Dordrecht: Kluwer Academic Publishers, 1991), pp. 683-687.

[4] Winn, pp. 688-689.

[5] Bruce A. Smith, "Commercial Satellite Complete Lunar Flyby," Aviation Week and Space Technology, 18 May 1998, pp. 74-75.

[6] John Gooch, "Maritime Command: Mahan and Corbett," Seapower and Strategy, ed. C.S. Gray and R.W. Barnett (London: Tri-Service Press, 1989) p.32.

[7] Mahan, p. 28-29.

[8] Jon Tetsuro Sumida, Inventing Grand Strategy and Teaching Command: The Classic Works of Alfred Thayer Mahan, (Baltimore: Johns Hopkins University Press, 1997), p. 24.

[9] Mahan, p. 50.

[10] Gooch, p. 33.

[11] Gooch, p. 33.

[12] "Long Range Plan: Implementing USSPACECOM Vision for 2020," March 1998, pp. 19-20.

[13] Long Range Plan, pp. 36-44.

[14] Major Martin E.B. France, "Antipodal Points: Implications for the Future of Space Surveillance and Control," Air Power Journal, Spring 1996.