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MASTER OF OPERATIONAL STUDIES

NEW AGAIN: INNOVATIVE MISSIONS FOR 21ST CENTURY AMERICAN AIRSHIPS

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EXECUTIVE SUMMARY

TITLE: New Again: Innovative Missions for 21st Century American Airships

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THESIS: Airships have great potential to support 21st Century American military operations in a wide variety of missions. The US should embrace airships and take the necessary steps to ensure its armed forces gain the greatest advantage from these unique platforms.

DISCUSSION: Recent improvements in structural technology, propulsion systems, avionics, and sensors have greatly increased the performance of airships. Airships can be used to perform an expanding list of missions, including: intelligence, surveillance, and reconnaissance (ISR); airlift; communications replay; maritime patrol; theater ballistic missiles defense; and space launch. However, lack of both focus and funding is currently hampering the development, production, and integration of airships into America's 21st Century arsenal.

CONCLUSION: Recent advances in airships performance, in conjunction with ongoing research and development, point to a bright future for airships in support of future US military operations. America must take the necessary steps now to gain the greatest benefits from the unique capabilities of tomorrow's airships.

Future War Scenario

In 2020, as tensions escalate with a Northeast Asian country, the United States (US) postures for possible combat operations. Preparations begin with airships delivering several satellites, held in reserve for contingencies, into low earth orbit to augment American space assets in the area. The US also begins to move an armada of airships from around the globe to converge on the hotspot in four days.

At the beginning of the conflict, small, disposable reconnaissance airships—deployed via cruise missiles, in advance of US forces—provide information to ensure timely and accurate strikes against critical targets. After American air forces seize air superiority, larger airships operating in "near space," the fringes of the upper atmosphere, assume positions to relay communications, providing much greater bandwidth than the on-station satellites in the area; others airships perform intelligence, surveillance, and reconnaissance (ISR) missions.

As the deployment of US forces begins, maritime patrol airships scour the oceans, hunting both submarines and mines to ensure the safety of sea lines of communication (SLOCs). Massive cargo airships lift US ground forces from their home stations directly to the battlefield. Airships augment theater ballistic missile defense (TBMD) capabilities, helping protect arriving US forces from weapons of mass destruction (WMD).

At the tactical level, small, unmanned airships provide a persistent presence above US forces on the battlefield. These airships' sensors transmit real-time intelligence—including live video—to American troops, while also relaying their communications (particularly helpful for those troops involved in urban combat). Some of the orbiting airships serve as flying arsenals, carrying stores of small precision guided munitions (PGM). They release their ordnance in

response to the ground forces' calls for fire, delivering accurate strikes much more economically than either fixed-wing aircraft or helicopters, and without putting any American pilots at risk.

Introduction

Airships were the first military aircraft. They ruled the skies at the beginning of the 20th Century, but were replaced as fixed-wing aircraft eclipsed their speed. Airships are not obsolete relics; rather they are currently undergoing a renaissance. Airships have great potential to support 21st Century American military operations in a wide variety of missions. The US should embrace airships and take the necessary steps to ensure its armed forces gain the greatest advantage from these unique platforms. Lack of both focus and funding currently hamper the development, production, and integration of airships into America's 21st Century arsenal.

The above scenario illustrates the great potential for airships to contribute in a broad spectrum of roles in a future war. Airships' possible utility as ISR platforms and as airlifters is well recognized. After briefly reviewing these areas, this paper will examine other promising 21st Century missions for airships: communications relay, maritime patrol, theater ballistic missile defense (TBMD), and as space launch vehicles to deliver payloads into low earth orbit.

History of Military Use

Before exploring in detail the potential of airships to contribute to future warfare, a brief review of their past contributions highlights the continuing utility of these elderly craft. Like virtually all other types of aircraft, airships have traditionally served in both civilian and military roles. The earliest military use of aircraft was by the French Aerostatic Corps in 1794 at the Battle of Fleurus, where a tethered balloon was used for observation. Prior to World War I, the only other significant use of aircraft was during the US Civil War when both sides used balloons for observation; Union forces even successfully utilized them to direct field artillery fires.[1]

During the First World War, airships become the world's first strategic bombers.[2] German zeppelins attacked the United Kingdom starting in 1915. However, their slow speed and the British development of a comprehensive air defense system—an early warning network, fighter aircraft with sufficient service ceiling (and firing incendiary bullets), searchlights, and antiaircraft guns—forced their retirement from this role in 1917.[3] Airships, however, continued to serve as scouting platforms, mostly for naval forces, and with particular success against submarines.[4] In the interwar years, airships transported both cargo and passengers. They were "luxury liners of the air," providing levels of comfort still unmatched today.[5]

The US made extensive use of airships as maritime patrol aircraft during the Second World War. On the West Coast, they essentially served in an early warning role to provide advanced notice of a Japanese attack.[6] In the Atlantic, the Navy's airships hunted U-boats.[7] Although their efforts are not widely known, airships were extremely effective in this role, accumulating an impressive record escorting convoys.[8] No ship in a convoy protected by a USN airship was lost to enemy force during WWII.[9] Airships' ability to remain overhead, almost indefinitely, allowed them to remain a formidable ASW weapon even after the war.[10]

Current US Military Utilization

The US military retired its last manned airship in 1962.[11] American forces have, however, continued to use them in various—mostly auxiliary—capacities in the intervening 45 years. Since the 1980s, the US has employed tethered airships, aerostats, to monitor the southern border in support of (ISO) counterdrug operations.[12] American forces have recently shown an increased willingness to reexamine airships for current missions. Tethered surveillance airships have served capably in Iraq for two years.[13] The US military is also currently exploring the possible use of airships for ISR, airlift, and communications missions.[14]

Airships: Defined and Compared to Conventional Aircraft

A brief explanation of basic airship terminology is a useful prerequisite for better understanding this topic. Airships, along with fixed and rotary-wing aircraft, are one of three basic types of atmospheric aircraft. "Airship" refers to any aircraft which generates a significant portion of its lift aerostatically, that is through the use of a lighter-than-air gas (virtually always helium).[15] Aerostats are tethered airships; free-flying airships come in rigid (zeppelins), nonrigid (blimps), and semirigid varieties. This paper utilizes the generic term "airship" throughout, unless it is necessary to delineate a specific type of airship for a particular reason.

Much recent literature refers to "lighter than air" (LTA) vehicles. This term is technically a misnomer. Virtually all contemporary airships, when configured for a mission, are heavier than air and consequently require some supplementary source of lift to take-off and gain altitude. This additional lift may be derived either from the aerodynamic configuration of the airship's body or from thrust provided by engines.[16]

Generally speaking, airships, because they obtain their lift aerostatically, can be built to have much longer ranges and greater endurances than conventional aircraft.[17] Their aerostatic lift enables large airships to transport both heavier and larger loads than conventional aircraft, and to fly at very high altitudes.[18] Airships are also more stable and less noisy than conventional aircraft. As a result, they are good platforms from which to hang sensitive electronic packages like sensors or communications suites.[19] The main drawback typically cited for airships is that they are slower than conventional aircraft. While this is true, it is mitigated, at least in part by the fact that airships fly 24 hours a day.[20]

It is difficult to accurately compare the costs of airships to conventional aircrafts. To get an accurate assessment of the price of airships against the costs of conventional aircraft, one

must try to compare roughly equivalent capabilities. For example, massive cargo airships able to carry 500 short tons of outsized cargo are estimated to cost approximately $300 million. This is 50% more than the cost of C-17. However, this airship could carry ten times as much cargo twice as far (unrefueled), but at about a fourth the speed.[21] Airships serving as communications relay platforms would be much less expensive than satellites performing a similar mission.[22] Compared to conventional aircraft, airships are significantly less expensive to operate.[23] This is due in large part to airships consuming much less fuel and being mechanically simpler.[24]

Susceptibility to Enemy Air Defenses

A misconception about airships which must be addressed before further discussing their suitability for future missions is their apparent fragility. In short, airships are much more rugged than commonly perceived.[25] In fact, in some respects, airships are more durable than either fixed-wing aircraft or helicopters. One need not worry about a Hindenburg-type conflagration engulfing a 21st century airship. Since the 1940's, virtually all airships have been filled with inflammable helium.[26] One can, however, still be legitimately concerned about airships' susceptibility to enemy air defenses. This risk encompasses two parts: airships' vulnerability to interception and their survivability, or capacity to withstand damage inflicted upon them.

With respect to vulnerability to interception, one can expect that US forces would gain air superiority, both over enemy airplanes and ground-based air defense systems, before hazarding airships in a theater of operations. For many of the future missions envisaged for airships, they would typically operate high in the stratosphere and would therefore be, "outside the normal range of many aircraft and SAMs."[27] Airships are hard to detect via radar because their fabric skin does not reflect well.[28] They could also be outfitted with infrared suppression system to minimize their heat signature.[29]

A recent Congressional Budget Office (CBO) report on strategic transportation options found that airships have, "unique advantages in terms of survivability," compared to conventional aircraft. The report also acknowledging some potential vulnerabilities of airships, "their large size…and slow speed would make airships very easy to detect, track, and shoot at."[30]

The CBO states that, "Although an airship might be easy to hit, it could operate successfully in a threatening environment for several reasons:

-A large airship could easily carry an extensive set of defensive systems, such as missile countermeasures and even air-to-air missiles to defend against hostile aircraft.

-The cargo compartments could be armored with materials that are too heavy or bulky for use on conventional aircraft.

-The low speed of an airship means that if it was hit, it would not be susceptible to the large dynamic stresses that can cause conventional aircraft to break up in flight when damaged.

-The helium in the compartments of the hull would be at only a slightly higher pressure than the ambient atmosphere, so it would leak very slowly out of any holes shot in the hull. Consequently, if an airship was hit by ground fire, it would not pop like a rubber balloon but rather lose buoyancy slowly like a mylar balloon. [31]

A damage control system, similar to self-sealing fuel tanks, could also be utilized inside airships. The suction created by a hole in the airbag could draw smaller helium-filed bags—already filled and floating in the envelope—to the source of the leak. Even if these devices do

not completely seal a hole, they could at least significantly slow the hemorrhage, providing additional time for the airship to make a safe landing.

An additional margin of safety could possibly be provided by equipping airships with ballistic parachutes. These devices were invented in 1919 and have been used to bring light aircraft to the ground safely.[32] Airships' slow speed and high degree of aerodynamic stability could make them suitable candidates for ballistic parachutes.

Intelligence, Surveillance, and Reconnaissance

Ongoing US military operations highlight a growing demand for persistent ISR coverage.[33] Airships offer the possibility of fulfilling this need by of providing, "an additional resource available at the battlefield command level rather than the national asset level of spy satellites, freeing expensive satellites up for other tasks. Other benefits include improved pictures and easier eavesdropping on low-power communications due to greater proximity, and relative cheapness when compared to advanced satellite programs."[34]

Current projects envision a number of possible uses and configurations for ISR airships, from massive High Altitude Airships (HAA) designed to loiter in the stratosphere for months to small, disposable airships intended to be launched from missiles. All of these projects share one common trait: they are unmanned, so can be employed without risk to human pilots.

Because airships operating even in the upper atmosphere are significantly closer to earth than satellites, their sensors could have 10 to 50 time's higher resolution than those in space.[35] Airships' stability and capability to remain stationary enhance their ability to gain even greater precision from existing sensors. For example, airships using synthetic aperture radars have successfully demonstrated the capacity to find buried land mines and even to detect hand grenades.[36] Because of their great size and lifting capability, airships could carry aloft sensors

too large for either fixed-wing aircraft or satellites.[37] The Integrates Sensor in Structure (ISIS) project seeks to take this concept even further: incorporating surveillance equipment in the skin of the airship. This would allow a dramatic increase in the surface area of sensors like radars, greatly improving their performance over traditional arrays.[38]

A primary criticism of ISR airships is that they are slow to deploy to distant theaters. This is a legitimate concern, but one that can be successfully mitigated. Johns Hopkins University is addressing this issue in an innovative way: designing airships that can be launched from missiles. The Tomahawk is seen as a likely platform to carry these small, disposable, and relatively inexpensive airships. These systems would last about a month and cost approximately $100,000 (excluding the cost of the deploying vehicle).[39] Other small airships, especially aerostats, could be deployed quickly via airlift in standard shipping containers. This means of packaging would also enable airships to be prepositioned in areas of likely future operations.

Additionally, airships should be used to augment, not to replace, other airborne ISR systems. Working in conjunction with existing platforms, later arriving airships would provide enhanced follow-on coverage. USAF LtCol Jason D. Green provides a more complete treatment of contemporary airship ISR issues in a recent paper, "Achieving Persistent Surveillance Through Use of Lighter-Than-Air Vehicles as Theater Intelligence, Surveillance, and Reconnaissance Assets."

Airlift

No matter what form America's future wars take, one can confidently predict a need to transport large quantities of heavy equipment and supplies over great distances. Heavy Lift Airship (HLA) proposals envisage massive hybrid airships—as big as aircraft carriers—combing aspects of traditional airship design with the aerodynamic qualities of conventional aircraft, to

generate enough lift to move 500 short tons intercontinentally.[40] This sort of HLA would represent an intermediate strategic lift capability between conventional airlift and sealift. Faster than ships, and with the ability to lift more than fixed-wing aircraft, HLA could speed the deployment of US forces to far-away conflicts

Unlike both ships and fixed-wing aircraft, HLA would require little or no infrastructure.[41] HLA would be designed so that cargo could be driven on and off. Because they use much less fuel than fixed-wing cargo aircraft, airships would require a smaller logistics footprint. HLA would also not require legions of air-to-air refueling aircraft to support their operations.

A problem which hampered previous attempts to use airships to transport heavy cargo is the need for ballast. Recent developments in "dynamic buoyancy management systems," essentially air cushion-like landing gear, are overcoming this challenge and making ballast unnecessary.[42] Further, this sort of landing gear would, in conjunction with (ICW) thrust vectoring, enable a vertical/short take-off and landing (V/STOL) capability. HLA could deliver combat forces right to overseas landing zones no larger than the size of football fields.[43]

Perhaps the most revolutionary and unique advantage of HLA is their ability to skip intermodal transportation.[44] HLA could lift units from their homestations directly to the battlefield without the need for any intermediate stops.[45] Together these advances are significant steps towards fielding a true vertical envelopment capability at the operational level.

Airships are no panacea for US 21st Century strategic transportation challenges. But, especially ICW other promising technologies like high speed sealift (HSS) and wing in ground (WIG) effect aircraft, HLA could greatly enhance America's ability to rapidly project, and sustain, global power in future conflicts.

Communications Relay

Relaying signals was one of the first missions for airships.[46] Technological advances now make possible the use of airships to relay data at the strategic and operational level in addition to on the tactical battlefield. Airships could use to advantage their high altitude, long endurance, and heavy lifting capabilities to relay communications traffic across the globe.

Stratospheric airships are "designed to fly at very high altitudes (30,000-70,000 feet)."[47] Many of the HAA currently under design aim for even greater altitudes. The USAF sees potential for employing airships up to 350,000 feet where, "they could serve as cheap substitutes for satellites, relaying communications."[48] Operating at such high altitudes puts the airships above both the jet stream and most weather effects. This height advantage would help to give stratospheric airships incredible endurance. One company, Sanswire, projects that its "stratellite" stratospheric airships could stay on station for as long as 18 months.[49]

The potential for stratospheric airships to serve as communications relay platforms has long been recognized. However, it was not until recent advances in solar power and fuel cell technology that this was feasible.[50] As communications platforms, stratospheric airships offer advantages in both performance and cost over satellites.[51] One stratospheric airship could potentially provide digital cellular phone service, broadband internet, voice over Internet Protocol (VOIP), and digital radio and television an area as large as the state of Texas (although heavy usage would require additional stratellites).[52]

Stratospheric airships could supplement, and possibly replace, satellites in low earth orbit. According to Gen Jumper, Chief of Staff, USAF, stratospheric airships, "could alleviate some of the stress and cost associated with fielding spaceborne systems."[53] The Army's chief information officer sees great promise for stratospheric airships as cost-effective alternatives to communications satellites, but believes the military is under-funding research in this area. [54]

Stratospheric airships could also replace terrestrial wireless infrastructure.[55] A constellation of just a few stratospheric airships could supplant scores of wireless towers. Stratospheric airships would also be less expensive to acquire, install, and operate. By flying in a grid of stratospheric airships to a new theater of operations, the US military could, "bring broadband service to a wide area…quickly and with relative ease."[56]

Maritime Patrol

Airships performed valuable service in support of US maritime missions from World War I until the 1960s.[57] The advent of turbojet and turboprop-powered fixed-wing aircraft, coupled with the deployment of helicopters aboard ships, eclipsed maritime patrol airships. However, new technologies may return airships to maritime missions with greater capability than ever before. The USN is currently exploring several options for the possible future use of airships.[58]

Airships' ability to lift heavy cargo means they can accommodate a full complement of sensors and weapons for a wide variety of maritime missions. An unmanned airship outfitted with airborne radar could provide Airborne Early Warning (AEW) to carrier battle groups, potentially replacing the aging E-2C Hawkeye.[59] An unmanned AEW airship would have vastly greater on station time than a fixed-wing aircraft, and without needing aerial refueling. Alternately, a large manned maritime patrol airship could be outfitted with a suite of equipment similar to that on a P-3 Orion. The airship, however, could carry a much greater weight of sensors and weapons and remain aloft for days to months (depending on its size) instead of hours. Maritime patrol airships also offer the ability to perform mine countermeasure (MCM) missions. For MCM operations, airships could be equipped with a towed sled, green laser sensors, and even "wire-guided minisubs."[60]

The capability of maritime patrol airships could be further increased by outfitting them as airborne aircraft carriers for unmanned aerial vehicles (UAVs). The USN successfully experimented with this concept, employing single-engined "parasite" fighter aircraft launched from and recovered by airships in the 1920s and 1930s.[61] An airship equipped with four fighters could visually search a surface area of approximately 129,000 square miles.[62] Today's improved ISR technology should further increase this area substantially.

Critics could argue against airships as maritime patrol aircraft because they are slower than fixed-wing maritime patrol aircraft and helicopters. However, airships are significantly faster than both the ships they would support and the submarines they would hunt. As with other missions, any speed limitations which may limit airships in the maritime realm can be mitigated by employing them in such a way as to maximize their capabilities while simultaneously mitigating their deficiencies. The key to successfully operating airships in a maritime patrol role would be to utilize them as a component of a system, not independently. Airships would need to work closely with other aircraft (fixed and rotary-wing, piloted and unmanned) helicopters, surface ships, submarines, and satellites to gain the best advantage.

Theater Ballistic Missile Defense

In addition to their obvious potential to provide TBM warning and tracking, airships could also help shoot down enemy missiles. The Air Force is currently testing airships outfitted with laser-reflecting mirrors to track objects either in space or in the upper stages of a long-range ballistic trajectory. These tests also demonstrate the feasibility of using airship-mounted mirrors for "kill missions."[63]

Taking this a step further, modified cargo airships would also be capable of carrying lasers aloft.[64] In addition to their potential for use against ballistic missiles, airships mounting

large, high-powered lasers would have utility against low-earth orbit satellites.[65] Laser airships could possibly target satellite ground control and down link stations as well.

The US Air Force is currently experimenting with the YAL-1A Airborne Laser (ABL), a heavily modified Boeing 747 carrying a megawatt class chemical oxygen iodine laser, for use against TBMs.[66] An airship could carry a much heavier (and therefore more powerful) laser and could remain aloft for weeks to months instead of hours, and without aerial refueling.

Against these advantages, a laser airship would not be able to deploy as quickly as fixed-wing aircraft like the YAL-1A. Although a YAL-1A flies approximately five times faster than current projections for future large airships, this disparity is not as operationally significant as it initially appears. Airships fly 24 hours a day. A laser airship could complete a transoceanic trip and arrive in theater fully mission capable, without ever having landed, and without the extensive ground support equipment required for a YAL-1A.[67] A laser airship would also not need extensive aerial refueling either to deploy or to remain on station. However, it is not inconceivable to foresee airships used as aerial refueling platforms for other airships or, possibly, helicopters or slow fixed-wing aircraft.

As with other missions, airships employed for Theater Ballistic Missile Defense (TBMD) should not be viewed as alternatives to fixed-wing aircraft, but rather as a complementary capacity. Fixed-wing aircraft could deploy to a theater quickly and provide an initial TBMD capability. Airships would follow, arriving in a few days, and enabling a sustained TBMD shield. The USAF is currently scheduled to acquire seven YAL-1As.[68] Reducing by half this number, would free significant funding for the development and acquisition of laser airships.

Space Launch

The extensive use of space is an important component of American defense policy.[69] The US recently affirmed its intent not only to ensure its unfettered access to space but also to protect itself from potential competitors.[70] In order to achieve these goals, the US must possess a robust, reliable, and cost–effective capacity to launch payloads into space.

Airships offer a potential capability to serve as launch vehicles for satellites that are both less expense and more reliable than conventional rockets.[71] JP Aerospace's Airship To Orbit (ATO) program envisages a space transportation system which lifts payloads to low earth orbit using a combination of a "booster" airship, a docking station, and a third stage "orbital airship" or "space blimp." The three stage approach is necessary because, "Flying an airship directly from the ground to orbit is not practical. An airship large enough to reach orbit would not survive the winds near the surface of the Earth. Conversely, an airship that could fly from the ground to upper atmosphere would not be light enough to reach space."[72]

Some critics have raised reasonable doubts about the accuracy of the calculation which support this concept. [73] However, even if airships prove unable to place satellites into orbit on their own, they may still be able to play an important role by lifting payloads into the upper atmosphere before other systems—conventional rockets or some sort of Space Shuttle-like aircraft—carry them into space. The benefits of this scheme are the same as the basic concept: reduced cost and increased safety. However, the use of a second stage other than an airship would likely add both additional cost and risk relative to the basic ATO concept.

The employment of a reusable aircraft which gains considerable lift from its shape, instead of only through thrust (like conventional rocket boosters), for the second stage offers two additional benefits. Firstly, it should also be less vulnerable to catastrophic failure.[74] Secondly, a Space Shuttle-like design could have a cargo bay which would enable it to recover satellites

from space and return them to earth for repair or to be recycled. The Space Shuttle is currently the only spacecraft with this capability, and it is scheduled retire in 2010.[75]

Integration

The full potential of airships can only be realized by closely integrating them with other military capabilities. Airships should not be employed separately from other air assets but as part of a system of systems, complementing existing platforms. To better synchronize disparate service efforts, the USAF should serve as execute agent for the development of US military airship technology and doctrine. Because airships represent an intermediate capability between satellites and fixed-wing aircraft, the USAF would likely not need to write new doctrine from scratch. Instead, the USAF could adopt existing operating concepts to integrate airships. When airships reach the operating forces and are deployed in support of contingencies, they should be employed under the cognizance of the Joint Forces Air Combat Commander (JFACC), at least initially. Actual experience employing airships, however, may point to a better arrangement.

Conclusion

Airships are now broadly regarded to have some potential applicability for both ISR and airlift missions, however they also possess the capability to perform a wide range of other roles as well, including: communications relay, maritime patrol, TBMD, and space launch. Past and current utilization of airships, in conjunction with ongoing research and development, point to a bright future for airships ISO future US military operations. There is a place for these "antiques of the air" in America's 21st Century arsenal. The US must take the necessary steps now—conduct more innovative research, increase funding to continue development, overcome cultural biases against their employment, and integrate their use with other systems—to gain the greatest benefits from the unique capabilities of tomorrow's airships.

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