This report provides operational concepts developed within the Department of Defense for how hybrid airship technology might be employed in future platforms in support of Combatant Commander requirements.

Cost: $46,300

Prepared by the Office of the Assistant Secretary of Defense for Research and Engineering, Rapid Reaction Technology Office
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EXECUTIVE SUMMARY:
The House report 112-78, page 83, accompanying H.R. 1540, the National Defense Authorization Act for Fiscal Year 2012, reiterated the concern expressed in the House report 111-166 that accompanied H.R.2647, the National Defense Authorization Act for Fiscal Year 2010, and requests that the Assistant Secretary of Defense for Research and Engineering develop concepts of operation for how rigid-hull, variable-buoyancy [RAVB] hybrid air vehicle technology might be employed in future platforms. This document fulfills that tasking. Specifically, critical analyses of past reports, airship studies, tabletop exercises and an examination of nascent hybrid air vehicle technologies are detailed in the pages of this report. We made this operational assessment as a result of a COCOM sponsored table top exercise and working with the Services individually. We did not specifically conduct a table top exercise with the Service Acquisition Executives and COCOMs.

Airships have had little influence on modern military strategy due to their operational limitations such as slow speed, extraordinary size, weather and threat vulnerabilities and cumbersome ground handling requirements. Technologies currently being explored address many of these legacy issues and may transform the manner in which airships are considered for practical military and commercial applications.

Hybrid airships (HA) are so named because in addition to aerostatic lift being provided by a lighter-than-air gas, they also utilize hull shape and vectored thrust to establish aerodynamic lift (Fig 1). Like conventional airships, hybrid airships employ three principal hull designs; rigid, semi-rigid and non-rigid. In their current form each of these hull designs can accommodate modest payloads supporting Intelligence, Surveillance, Reconnaissance (ISR) and communications missions. However, in a logistics role, heavy payload demands place a disproportionate burden on the semi-rigid and non-rigid hull designs. This is because transport and offload of heavy payloads generally require a rigid structural design that can support both the payload weight and the weight of an internal buoyancy control system.

This document considers the feasibility of and methodology for using optionally manned, RAVB HA to augment existing logistic systems. This report also considers the operational and logistics considerations such as basing, airspace, and environmental factors. Information from recent intra-DoD collaboration as well as numerous historical studies and analyses is likewise included in the report.

From the outset it must be understood that heavy lift hybrid airships considered in this report are conceptual in nature. In reality, current conventional airships are capable of accommodating payloads of only a few thousand pounds. In order to achieve the massive
payloads envisioned by air-logistic theorists, significant technical advances and resource investments must be made.

This report consists of two parts. The first section outlines the operational considerations that must be addressed when evaluating any airship concept of operations. The second portion highlights an ambitious Point of Need Delivery (POND) experimentation campaign that was conducted in 2009. This multi-phased analysis reflects the work of military professionals and addresses the considerations highlighted in section one in support of a real world operational challenge.

ASD(R&E) gratefully acknowledges the U.S. Transportation Command and the U.S. European Command for their support in preparing this report. Their collective work in
PREFACE:

In the HASC report accompanying the National Defense Authorization Act FY-12, the committee stated its concern “...that airship technology has a history of being hampered by a variety of operational constraints that the military has not adequately dealt with since the last military airships were retired more than 50-years ago. The committee believes the Department should pursue a parallel path that demonstrates robust concepts of operation as the technology is matured and validated. Part of the process of developing concepts of operation should include planning and analysis for addressing operational and logistical constraints of using large airships, such as basing, airspace management, and environmental issues.” The committee requests development of operational concepts for how rigid-hull, variable-buoyancy hybrid air vehicle technology might be employed in future platforms.
PURPOSE:

This document serves as a summary report on the operational considerations and conceptual employment of rigid-hulled, variable-buoyancy hybrid airships.

The purpose of this report is to respond to concerns in committee report (H. Rept. 111-166) accompanying National Defense Authorization Act of Fiscal Year 2012 that airship technology is being hampered by a variety of operational constraints that the military has not adequately dealt with since the last military airships were retired more than 50-years ago. This analysis outlines concepts of operation for hybrid airships; considers operational and logistical constraints of using large air vehicles and evaluates current and forecasted basing, airspace management and environmental issues associated with the employment of large hybrid airships.

METHODOLOGY:

An exhaustive review was completed on open source resources to identify past analyses of potential airship operations. Government and non-government representatives across the air vehicle community were engaged to collect the required data and advance the professional narrative. The data collected was analyzed, organized and used to develop this report.
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INTRODUCTION

Modern Lighter-Than-Air (LTA) craft have a lineage spanning back to the flight of the first hot air balloon by Joseph and Étienne Montgolfier of France in 1783. Since that time, LTA vehicles have seen a variety of military and commercial uses. For example, balloons were used to raise scouts several hundred feet into the air to observe troop movements during the American Civil War. In the late 19th century, Count Ferdinand von Zeppelin developed the first rigid shell airship, the LZ-1, which weighed 13 tons and saw use first for passenger travel and later in the German military. LZ-1s were used in the Zeppelin bombing campaigns of World War I and also as defense assets, surveying harbors and protecting convoys.\(^2\) "Airships were attractive during the early days of military aviation because, with buoyancy provided by hydrogen or helium, the engines needed only enough power to move the aircraft at relatively low speed and airframes needed only enough strength to support their own weight and to withstand the relatively mild stresses associated with low-speed flight. Fixed-wing aircraft, in contrast, required stronger airframe structures and more powerful and reliable engines because their lift is derived from pushing wings through the air at high speed."\(^3\) Military interest in LTA vehicles stems from their ability to support persistence, loitering, weapons delivery and, more recently, potential logistics mission capabilities.

The historical role of LTA vehicles in military engagement varied depending on the technological advancements at the time and the ability of adversaries to mount defenses against the vehicles. The U.S. military has procured, tested, developed and used LTA vehicles since the 1920s. The initial airships, all clad or rigid envelope structures, were used largely for experimental, transport and utility purposes. After several airships were lost, construction transitioned to non-rigid airships. Immediately prior to and during World War II, airship production increased and the vehicles played an important role in efforts such as sweeping for mines, performing search and rescue, escorting convoys and various ISR tasks such as scouting, photographic reconnaissance, and antisubmarine patrols.\(^4\) While airships saw some use in bombing campaigns, after many systems on bombing missions were lost to fighter planes, the airships assumed more defensive roles. Interest in LTA vehicles dropped off after World War II and the U.S. Navy airship program was stopped in 1962.\(^5\)

In the 1980s, LTA vehicles received a new lease on life with the deployment of several tethered aerostats for counter-narcotics and drug interdiction missions on the U.S. border and in the Caribbean.\(^6\) As the U.S. engaged in conflicts where airspace was less contested, such as Iraq and Afghanistan, interest increased in the development and use of LTA vehicles for multiple purposes. For example, tethered aerostat platforms have been highly successful at providing persistent ISR and force protection capabilities at forward-operating bases and even smaller tactical units in Operation Iraqi Freedom (OIF) and
Operation Enduring Freedom (OEF.) Additionally, there is increasing military and commercial interest in developing airships for logistics transport. Heretofore, heavy-lift airships were largely conceptual. The ongoing technical progression in airship technologies suggests that for the first time in history heavy lift airships are viable and could become an actual capability.

SECTION I – OPERATIONAL CONSIDERATIONS

CAPABILITY NEED

The requirement for a point-of-need delivery (POND) capability is widely recognized and articulated in a number of strategic documents and Joint Concepts (Appendix A). Current methods of moving equipment, supplies, and personnel employ legacy delivery systems via truck, rail, ships, and cargo aircraft. Often, these multimodal systems result in long delivery times, excessive cost and an inability to deliver directly to a PON. Moreover, these inefficiencies can be exacerbated in a high threat environment or in an area lacking adequate airfields, seaports or overland infrastructure.

Theater combatant commanders (COCOM) require a capability to rapidly deploy warfighting and sustainment forces from the Continental United States to their theater of operations. Combatant commanders also have intra-theater requirements to deliver within several days a ready-to-employ, task-organized brigade size element to or from a PON, independent of receptive infrastructure. The Point of Need Delivery (POND) Campaign, highlighted in Section II of this report, determined that a hybrid airship with about 200 short tons lift capability, 6,000 mile range and 100 knot air speed offers the greatest potential to close the capability gap and meet COCOM requirements.

OPERATIONAL OVERVIEW

Missions

Military missions that would logically benefit from RAVB HA technology fall into three broad categories:

1. Logistics

2. Persistent Intelligence, Surveillance, and Reconnaissance (ISR)

3. Humanitarian Assistance/ Disaster Relief (HA/DR) and Non-combatant Evacuation Operations (NEO)
Employment Concept

Heavy lift airships could be employed in inter- and intra-theater roles to deliver an operationally significant force in a ready to fight configuration directly to the point of need. They could also serve as a means to deliver humanitarian assistance to locations inaccessible to conventional aircraft or vessels. Moreover, optionally manned hybrid airships, along with similarly equipped conventional airships, could provide much needed persistent ISR in strategically significant parts of the world.

What differentiates HA from the air, sea, and land logistics counterparts is the ability to haul payloads far exceeding that of conventional aircraft at speeds much greater than sealift (Fig 2). HA can bypass intermediate staging areas, point defense zones and natural impediments while avoiding ubiquitous IED and conventional kinetic threats.

![Cost-Speed Comparison for Airlift Vehicles](image)

**Figure 2: Cost-Speed Comparison for Airlift Vehicles**

Operational Constraints
Weather: Weather is a factor in all military operations and plays a particularly unique role in the operation of aircraft. HA will be designed for adverse weather operations. Rain and low visibility will have minimum impact on HA flight schedules.

Wind: The effects of wind merit special attention for at least three reasons:

1. The large size of HA will result in significant wind forces to the airship while on the ground.
2. A heavy lift HA will operate at a low flight ceiling (5,000 to 9,000 ft), which forces it to fly in the dynamic wind patterns of the lower troposphere.
3. A HA's relatively low speed (115 kts or less) make it more influenced by strong headwinds than faster moving aircraft. This will affect flight planning, endurance and navigation.

Storms, gusty winds, wind shear, and rough landings may produce high structural stresses. However, modern structural materials provide improved protection against structural damage from such forces. Also, powerful and reliable engines combined with computer assisted flight systems provide significant 3-axis control authority.

Although HA are more influenced by weather variability than faster, higher flying aircraft, modern real-time weather information systems and cruise airspeeds in excess of 100 knots will aid airship pilots in avoiding severe weather.

Snow and Ice: Primarily due to the added weight on air vehicles, snow and ice accumulation can present a safety hazard to all aircraft. With a large surface area and flight operations at low altitudes where icing conditions are most frequently found, airships are typically at more of a disadvantage to snow and ice accumulation than fixed or rotary wing aircraft. Anti-ice and de-ice protection for hybrid airships would have to be developed prior to receiving certification for flight into known icing conditions. Engine icing is also a concern but techniques used for dealing with this issue on conventional aircraft would logically be applied to HA.

Lightning: Lightning strikes are very rare on airships, but have on occasion caused major damage. Lightning protection on airships usually consists of a single conductor routed lengthwise along the top of the envelope. Such an arrangement offers significant protection for small airships, but not for larger vehicles whose dimensions are longer than the striking distances of some lightning leaders. Research continues on lightning protection for large airships and should be a key technical component of future large airship design.

Hostile Fire: As with conventional cargo aircraft, HA will not typically fly into areas
where they may be subjected to targeting by sophisticated air defense systems. However, low operational altitudes, a large visual signature and military necessity could create a real possibility that the vehicle will come under hostile fire. Studies have shown that an airship's envelope is inherently tear resistance and resilient. It will resist the effects from impact and blast to a large extent. In most cases, high velocity shrapnel impacts from projectiles or exploded warheads will only result in holes (not large tears), about the same size as the impacting bullets or fragments. The presence of holes will allow some helium to leak, but at a slow rate due to minimum pressure differential between the inside and outside of the main envelope (entire gas enclosure).

Technical Constraints

One of the most significant challenges facing heavy lift airships is ballast control. Conventional airships typically maintain zero or positive heaviness. Military airlift flights carrying cargo in one direction only would need to bring aboard ballast at the destination site to compensate for the off-loaded payload and fuel burned in transit. The ballast of choice is water. However, large quantities of water are often unavailable; and, even if attainable, contaminated water used as ballast could present health and environmental issues.

The Control of Static Heaviness (COSH) is a promising solution to control airship heaviness that would eliminate the need for external ballast. COSH uses a series of Helium Pressurization Envelopes (HPE) within the airship's main envelope to store pressurized helium. When the helium within is pressurized by the engine driven compressors and placed in the HPEs, the overall airship buoyancy is significantly reduced. Conversely, when the pressurized lifting gas is released from the HPEs and allowed to expand within the main envelope, airship buoyancy is greatly increased. This buoyancy control will enable air or ground operations including the on- and off-load of cargo without taking on external ballast.

The Assistant Secretary of Defense for Research & Engineering (ASD(R&E)) has invested in a technology demonstrator called Pelican that is expanding our knowledge of COSH and several other key airship technologies. These technologies address some of the most critical technical obstacles that must be overcome if heavy lift HA are to become a reality.

The specific technologies being explored by the Pelican technical demonstrator are:

1. Control of Static Heaviness (COSH) system that allows direct management of the vehicle's buoyancy.
Impact: Would enable Point of Need Delivery (POND) of cargo by allowing a means to compensate for the weight of the offloaded payload.

2. Variable position engines combined with digital software to enable unprecedented slow speed flight control.

Impact: Low speed flight control will be essential for controlling near-ground operations of a cargo airship significantly larger and heavier than any other airship ever produced.

3. Structural design that does not rely on gas pressure to maintain envelope integrity and an aerodynamic shell shape that allows airspeeds substantially higher than what is currently attainable by lighter than air craft.

Impact: Having a skeletal (i.e. rigid) internal design will allow much greater load bearing capacity than a non-rigid alternative. The internal skeletal design will also allow the airship to maintain its shape when the lifting gas is compressed into the HPEs during ground operations.

In addition to the systems being tested in project Pelican, several other critical areas need technical development if operational heavy lift airships are to become practical. These critical areas include:

Buoyancy Control / Mass Management –
- Water Recovery (from engine exhaust)
- Automated Ballast Control

Docking/ Cargo Transfer Techniques
- Air Cushion Landing System
- Floor Leveling System
- Optionally Manned Technology
- Integrated Flight Controls
- High Precision Hover and Drop
- Beyond Line-of-Sight (BLOS) Delivery Assistance

Materials Development:
- Fabric Technology
- Metallurgy
Propulsion
- Aviation Diesel
- Hybrid Engine

Weather Prediction, Avoidance, and Exploitation

If technologies to address these critical areas are mastered and incorporated into future designs, the resulting airship would represent a transformational capability that bridges the long standing gap between high speed, lower capacity fixed wing airlift; and, low speed, higher capacity sealift. The cost per ton/mile to deliver cargo via a large airship is projected to fall between the respective costs of fixed wing and sealift delivery methods.

Operational Restraints

Operational restraints consist of self-imposed limitations that can assist in shaping system requirements. Because no cargo-capable airship has been produced for military utility for quite some time, imposed restraints on developing or operating these systems do not currently exist. Based upon current operations (i.e., OEF) and our change in strategic focus for future operations (i.e. Anti Access/Area Denial and Humanitarian Assistance/Disaster Relief), operational and tactical considerations will be analyzed to determine how the Department of Defense (DoD) will employ airships. For instance, some of our current aircraft inventory is restricted from flying into various threat environments because they do not possess defensive systems to protect against threats. Comparing this philosophy with the conceptual design of hybrid airships, operational limitations will be imposed defining where and how airships shall operate.

Logistics Constraints

Hybrid airships will augment conventional logistics assets and therefore must be operationally compatible with existing DoD inventoried Material Handling Equipment (MHE) (e.g., forklifts, K-loaders, etc). HA must also be supported by current DoD inventoried ground handling equipment (e.g., air carts, power carts, etc). Likewise, heavy lift HA cargo loading/offloading times should be consistent with USAF Airlift aircraft (i.e., 2.25 hours for upload/download only; 3.25 hours for upload/download + fueling). Note that these are standard metrics and that payload bay configuration, such as a roll on/roll off arrangement, could significantly reduce upload/download times.

Disadvantages and Limitations
Although hybrid airships provide an efficient and effective modal option for the transportation distribution system, there are some disadvantages and limitations with their use. Below are examples of these limitations that will be addressed through further analyses and development.

1. Airships have limited ability to attain high altitudes with maximum payloads. At this time, fully-loaded airships have an anticipated maximum altitude of approximately 15,000 feet mean sea level (MSL). Therefore, it becomes a challenge to utilize airships in some mountainous areas.

2. The size of a hybrid airship poses limitations and potential disadvantages for its utility. A 20 ton lift capable airship will have approximate dimensions of 150 feet wide, 250 feet long, and 75 feet high. These dimensions are roughly the equivalent to an Air Force C-5 Galaxy. Larger airships with a commensurate increase in physical dimensions may be limited in landing and parking locations (Fig 3). The 1000 ton versions, for example, would eliminate or jam most landing sites due to their sheer large size. By comparison, airships in the 200-500 ton region seem to provide the best balance between moving a large volume to an austere location and still allowing for ground mobility in and around the PON.

<table>
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<th>185,000</th>
<th>1,000,000</th>
<th>3,000,000</th>
<th>5,000,000</th>
<th>67,000,000</th>
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<tbody>
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<td>Payload (tons)</td>
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<td>15</td>
<td>50</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>Length (ft)</td>
<td>180'</td>
<td>250'</td>
<td>370'</td>
<td>830'</td>
<td>1,000'</td>
</tr>
<tr>
<td>Width (ft)</td>
<td>75'</td>
<td>150'</td>
<td>185'</td>
<td>365'</td>
<td>450'</td>
</tr>
</tbody>
</table>

Figure 3: Size Comparison for Hybrid Airships Required for Various Airlift Applications

3. Although infrastructure is not required for the use of airships at points of need, home basing and locations conducting major maintenance will require hangar storage.
Currently, there are only eleven hangars in the world capable of holding large airships. Many of these large hangars were originally fabricated in the early 20th century and some are in disrepair.

4. A limitation is reached when considering HA categorized as LTA with regard to maintaining buoyancy during cargo offload operations. This issue is of particular interest when considering large airships, as offloading payloads of 500 tons, for example, will require buoyancy management to offset the lift generated from the lifting gas. Industry is pursuing various technical solutions to overcome this challenge.

**Basing**

**Traditional Airfields**

Although hybrid airships will be capable of operating independently of airfields, in order to be effective in the current airlift system, they must be capable of operating at traditional airfields without adversely affecting operations. Factors to consider include:

1. When on the ground, HA must be able to clear runways in a timely manner.
2. The time to conduct ground operations (cargo offload/onload, maintenance, etc.) should be less than or equal to the time it takes current cargo platforms to conduct the same activity.
3. Operate without impacting existing airfield obstructions.
4. Airships must be compatible with current MHE (forklifts, K-loaders, etc...)
5. Airships must be compatible with current ground handling equipment (power carts, air carts, fuel hose connections, etc...)

**Austere Airfield Operations**

Hybrid airships can provide point of need delivery without the traditional infrastructure requirements (runway, parking apron, MHE) of current mobility aircraft. Based on this, hybrid airships are expected to be able to operate at austere airfields worldwide. Although there may be fewer infrastructure and operational issues than at a traditional airfield, the same requirements applying to traditional airfields apply here. Other requirements at austere airfields include:

1. Ability to operate independent of traditional airfield aprons. The landing system must be capable of operating on all types and grades of soil.
2. Ability to load/offload cargo with limited or no on-site MHE. This can be accomplished by several methods that include hand offloading, winch operations, carrying organic MHE (forklift, k-lift, etc.) or an onboard crane system.

**Operations with No Airfield**

One of the unique aspects of hybrid airships is the possibility to operate independently of traditional airfields because they do not require infrastructure (runways, parking ramps, etc.). This unique ability would allow airships to deliver valuable cargo straight from a home base/warehouse directly to the PON. However, this ability brings with it some challenges that must be addressed prior to operations:

1. Ability to perform vertical takeoff and landing (VTOL) operations. Although not required in all situations VTOL is advantageous for operations away from an airfield.
2. Hovering capability allows for possible sling load operations and very accurate airdrop operations.
3. Landing zones (LZ) with acceptable soil composition and large enough to accommodate the airship and cargo load/offload equipment.
4. Accessibility of landing site to ground equipment/traffic/users. The accessibility of landing site by vehicles and personnel should be addressed prior to executing the mission.
5. Options to offload/upload cargo without local MHE

**Seaport Operations**

Hybrid airships may bring the possibility of landing and operating on water. This capability would make HA a viable option for conducting onload/offload operations at a seaport. To be effective in this role, hybrid airships must perform operations with existing seaport equipment. Additionally, the ability to perform VTOL and/or hover may serve to enhance the capability of an airship within a seaport. This capability could allow concurrent onload/offload operations in relatively close proximity to docked vessels.

**Forward Operating Base (FOB) Considerations Include:**

- Daily Ops – Communications
- Berthing/messing
- Electrical power
- Water and sewage
- Lifting gas and aviation fuel storage
- Perimeter security
- Airspace management
- Medical support
- Internet/phone service
- Local transportation
- Overland infrastructure
- Maintenance facility
SECTION II – OPERATIONAL CONCEPTS

POND Experimentation Campaign:
In light of the operational and technical considerations identified thus far, a Point of Need Delivery (POND) Experimentation Campaign was conducted in the spring of 2010. Staff personnel from the U.S. European Command (EUCOM), U.S. African Command (AFRICOM) and U.S. Transportation Command (TRANSCOM) were the principal participants.

The POND Experimentation campaign sought to identify existing and developing capabilities that could enable a Combatant Commander (COCOM) to respond to a crisis within three to five days, anywhere in the COCOM’s Area of Responsibility (AOR), independent of receptive infrastructure or services available at the point of need. The vast distances and austere infrastructure that define the Caucas, Balkan, and African regions drive this requirement.

The campaign consisted of three major events: A Requirements Workshop, a Capability Solutions Workshop, and a Table Top Experiment. The objective of the Requirements Workshop was to develop and validate the COCOM problem statement. Specifically:

EUROC/AFRICOM require a capability to deliver within 3-5 days a ready-to-employ, task-organized element up to brigade or equivalent, to or from a point of need, independent of receptive infrastructure.

In this conference, the participants assessed the characteristics current lift platforms lack, and which combination of assets would best support resolving the problem statement.

The objective of the Capability Solutions Workshop (CSW) was to assess the current deployment process and identify the most relevant solutions.

The Table Top Experiment (TTE) utilized the Joint Flow and Analysis System for Transportation (JFAST) modeling to analyze the capabilities represented by the most promising technologies identified in the CSW to assess the ability of these solutions to resolve the COCOM's capability gaps. Specifically, the TTE modeled existing lift capabilities and notional Joint Future Theater Lift (JFTL) and airship technologies, which were estimated to be available in near (2010–2014), mid (2015–2017), and long term (2018–2025), for their ability to reduce the deployment timeline. The results of the experimentation campaign identified current technologies that can meet the desired deployment timelines while possessing the ability to bypass
traditional infrastructure and delivery barriers to deliver the required capability directly to a location of need. Hybrid airship technology in a platform of about 200 short tons lift capability, with a 6,000 mile range and 100 knot air speed combined with other existing lift platforms offered the greatest potential to close the logistics capability gap. It was also noted during the TTE and further discussed at USAF Global Mobility 2010, that hybrid airship technology offers significant fuel savings over current airlift platforms. Current studies show that hybrid airship technology requires approximately one third the fuel to accomplish the same mission as current cargo aircraft assets. As the fully burdened cost of fuel becomes incorporated into future material solutions, reducing fuel costs while responding to a crisis will be an increasingly significant factor. (Appendix B)

The focus of the table top experiment was to look at solutions that supported the complete Range of Military Operations (ROMO), from deployment of a kinetic force to a needed location to movement of significant supplies and heavy engineering equipment to support Humanitarian/Disaster Relief (HA/DR) missions.

Results, Insights and Validation

Results

The POND Experimentation campaign validated that the current lift platforms available to a COCOM Commander cannot meet the deployment requirements outlined in the requirements statement for the experimentation campaign. Areas of improvement to deployment timeframes were identified within the doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) review. However, these improvements did not result in the ability of a joint force commander to deploy a ready to employ force to a point of need to every location within the COCOM Area of responsibility (AOR) in three to five days without reliance on host nation infrastructure.

The experiment determined that the only platform that had the capability to meet the requirements outlined in the problem statement was a hybrid airship capable of lifting at least 200 short tons. Other air and sea logistics platforms did not have the range, lift capabilities or required host nation support to move a unit to the point of need.

Based on suggestions raised in the TTE, the team considered an alternative concept of employment for the experiment similar to the HA/DR response but on a larger scale; deploying a heavy engineering capability, in the form of a Navy Mobile Construction Battalion to a point of need over 2,500 miles away. The goal of this deployment was to respond to a natural disaster where there was insufficient infrastructure to support
traditional deployment platforms. The team concluded that hybrid airship technology would enable the entire battalion to deploy to the location within four days, without requiring infrastructure support. This contrasts with a similar movement of a Navy Mobile Construction unit, far smaller than a full Battalion, to Haiti which took over thirty days and required the rehabilitation of the port area in order to offload heavy equipment.

Additionally, airship technology significantly reduces the costs of deployment. As the fully burdened cost of fuel becomes a major consideration in developing future platforms, the fuel efficiency of airship technology becomes a key consideration. A study by the RAND Corporation on hybrid technology concluded that a hybrid airship would use approximately 80 percent less fuel than C-17 platforms performing the same mission. The Air Force Global Mobility (GLOMO) Exercise 10 determined that the combination of hybrid airships with C-17's and surface vessels would have resulted in fuel savings in the billions of dollars for a single 30 day deployment period. Applying these principles to OEF, the use of airship technology to support the rotation of assets in Afghanistan results in a 50 percent reduction in deployment time and a 30 percent reduction in fuel costs. One research paper proclaims: “Economic indicators reveal 60% reduction in cost over fixed-wing aircraft in total cost per ton-mile.” In another recent RAND Study, the Cost Per Ton Mile of a hybrid airship was $0.22, while a C-17 performing the same mission was $1.20. This represents an approximately 80% reduction in costs per ton-mile using hybrid technology for the scenarios that were tested against.

Finally, the POND campaign suggests that in addition to logistic support, ISR and communications, other opportunities for hybrid airships could exist such as:

a. Mobile medical facility (Medical team support, aeromedical evacuation, mass casualty support)

b. Mobile command and control (ground or airborne command post)

c. Homeland Security Operations

d. Firefighting.

e. Moving combat forces at tactical or operational distances across the battlefield.

f. Avoiding anti-access defenses.

g. Carrying large radar antennas or high power jamming equipment

h. Carrying air to surface (standoff) weapons

i. Counterdrug/Counter-Narcoterrorism
Insights

While the experiment did not address logistic support, operational maneuver, anti-access, radar/jamming, or gunship scenarios, the effort did provide some insights into the potential for hybrid airships to contribute to these missions

1. One significant finding from the wars in Iraq and Afghanistan has been the cost in lives and resources in maintaining ground lines of communication (LOC). Hybrid airships of between 50 and 200 tons could replace many of these LOCs with greater speed and effectiveness and at a potentially significant saving in lives and resources.

2. The Army has been working on a concept for moving combat forces at operational distances around a modern battlefield. To date the primary focus of this concept has been on large rotary wing aircraft. The potential procurement and operating cost of these aircraft and their relative lack of resilience compared to hybrid aircraft suggest that rotary wing aircraft may not be the best choice for this mission.

3. Many of the scenarios being investigated by DoD force structure analysts involve the challenge of conducting operations in the face of anti-access defenses. Hybrid aircraft offer a potential anti-access solution that could involve the avoidance of anti-access defenses, which are normally located along the coast and around air bases.

4. The large envelope and cargo carrying capability that is characteristic of hybrid aircraft offers the possibility of carrying large radar antennas or high power jamming equipment that could take the place of similar equipment found on fixed wing aircraft.

Validation

In the spring and summer of 2012, personnel from the Office of the Assistant Secretary of Defense for Research and Engineering conducted a series of research inquiries, roundtable discussions and site visit conferences that validated or refreshed the data collected in the POND campaign.
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