Airlift 2025:
The First with the Most

A Research Paper
Presented To

Air Force ***2025***

by

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Disclaimer

2025 is a study designed to comply with a directive from the chief of staff of the Air Force to examine the concepts, capabilities, and technologies the United States will require to remain the dominant air and space force in the future. Presented on 17 June 1996, this report was produced in the Department of Defense school environment of academic freedom and in the interest of advancing concepts related to national defense. The views expressed in this report are those of the authors and do not reflect the official policy or position of the United States Air Force, Department of Defense, or the United States government.

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Executive Summary

Power projection is critically dependent on mobility forces. The air mobility system should be capable of supporting national objectives from humanitarian, nonhostile operations through armed conflict. Because of operational constraints that include evolving threats and reduced external infrastructure, the airlift system in the year ***2025*** should be independent of theater-basing structure. International political changes will likely necessitate the basing of most, if not all, US military forces in the continental United States (CONUS). However, this will not end the requirement for a global US presence. Although the probability of direct foreign military threats to our interests may be slight, Air Mobility Command (AMC), the air transportation arm of US Transportation Command, must be prepared to conduct global air mobility on a daily basis. In addition, AMC must continue to support humanitarian and peacekeeping missions in both benign and hostile environments. These expanding requirements demand attention. This paper proposes technologically feasible concepts to meet the air mobility requirements posed by probable US national objectives in the year ***2025***. The employment and integration of technologies that exist today, along with those that will develop by the year ***2025***, will allow the concepts proposed in this paper to meet future needs.

A number of assumptions were made to narrow the focus of this paper. First, the recommendations herein assume no traditional intratheater airlift capability. This assumption addresses a worst case scenario and drives our requirement of direct delivery

from CONUS to the war fighter. A corollary to this assumption is the belief that the availability of overseas basing will continue to decline, thus necessitating long unrefueled ranges, limited materiel on ground, and the decreased utility of Civil Reserve Air Fleet (CRAF) assets. Secondly, this paper assumes that any lift capability extraneous to traditional air-breathing platforms is the purview of other Air Force ***2025*** projects. Therefore, our primary concern with other lift assets is the intermodality and interoperability between systems in an overarching logistics framework.

Considering technologies that should be available in the year ***2025***, several possible systems are evaluated for their applicability and usefulness to the airlift mission. Of these, a combination of large airships and both powered and unpowered unmanned aerial vehicle (UAV) delivery platforms appear to provide the greatest utility.[1] This system, operating in conjunction with existing airframes, will use a greatly improved command, control, communications, computers and intelligence (C^4I) system to provide clear and continuous command and control as well as direct communication with the customer. In-transit visibility will provide the user/war fighter invaluable insight and enhance his operational capability. Communication with the user/war fighter will also provide for the delivery of personnel and equipment directly where needed within 10 meters of the target. System costs will adversely affect the development of any new system, therefore, the Air Force will be required to depend on research, development, and production in the civil sector.

Notes

[1] Throughout this paper the term “unmanned” will be used vice “uninhabited.” For our purposes, vehicles are unmanned.

Chapter 1

Introduction

No matter how good the armed forces are, they are of no value if they cannot be in the right place at the right time and in the right numbers to get results.

—Adm James R. Hogg, USN
“Reinforcing Crisis Areas”

The single biggest deficiency in the Department of Defense is lift.

—Gen Ronald R. Fogleman, CSAF
Address to Air Force ***2025*** Participants

With the successful end of the cold war and the achievements of Operation Desert Storm, the United States armed forces find themselves firmly established as the world’s preeminent military force. These successes have led to an increased willingness by the national command authorities (NCA) to deploy forces throughout the world to meet national objectives. Plausible future scenarios indicate an increase in this tendency for involvement.[1] A dilemma exists, however, and threatens to undermine America’s military strength even while the evidence of that strength is undeniable. That dilemma is air mobility. The current air mobility system will not support the air logistics requirements we are likely to face in ***2025***.

This paper addresses this dilemma. Through an analysis of the capabilities required by the air mobility customer in the year ***2025***, the required attributes of the air mobility system are identified. A system and concept of operations are then proposed that will best meet customer needs while employing systems and technologies currently in development and those that will be available by the year ***2025***. Our thesis is that the air mobility concepts proposed in this paper, in conjunction with the employment and integration of innovative technologies and systems, will allow the United States to adequately meet future national objectives.

Notes

[1] Lt Col Robert L. Bivins et al., "2025 Alternate Futures," unpublished white paper, Air University, n.d. This paper outlines possible future scenarios for the 2025 project.

Chapter 2

Required Capabilities

The United States requires an air mobility capability to deploy robust and flexible military forces that can accomplish a variety of tasks. These tasks include deterring and defeating aggression, providing a credible overseas presence, countering weapons of mass destruction, contributing to peace operations (multilateral and unilateral), and supporting counterterrorism efforts. This capability will still be necessary in ***2025***, but the air mobility system must be carefully developed and nurtured.

In the past, the US military failed to maintain the airlift capability required to meet identified requirements.[1] Even today, concerns remain as to whether our airlift capability can meet the increasing number of requirements. "Military officials admit that even if they can buy as many C-17s as the Air Force wants, there will still be a need for more airlift as the US withdraws from bases overseas."[2] The pending retirement of the C-5, C-141, and much of the C-130 fleets, the aging of remaining air mobility assets, and the requirement to replace the aforementioned in what are likely to be austere economic conditions, are among the challenges facing the air mobility system. To meet these challenges, an analysis of the customers, their needs, and the attributes required of the air mobility system of ***2025*** is necessary and serves as the foundation upon which any future airlift system should be built.

Customer

The military airlift system supports attaining national objectives continuously through all levels of conflict. "The primary responsibility [sic] of America's military is to deter potential adversaries or fight and win wars decisively."[3] To meet these responsibilities, the airlift system supports the following: US military and civilian agencies, allies, friendly and other foreign governments, multinational organizations, nongovernmental organizations, private volunteer organizations, and other entities deemed necessary to support national objectives. Due to the unique air mobility capabilities of the United States, it is often the only option for meeting these customers' air mobility needs.[4]

In meeting the needs of the customer, the airlift system must address two primary problems. The first is the horizontal problem of getting personnel and materiel from their locations to the theater of operations in a timely fashion. The second is the vertical problem of transferring personnel and materiel between the airlift platform and surface mediums. It will be imperative for war fighters to access an efficient system to have materiel delivered directly to the battle area in a time-sensitive manner.

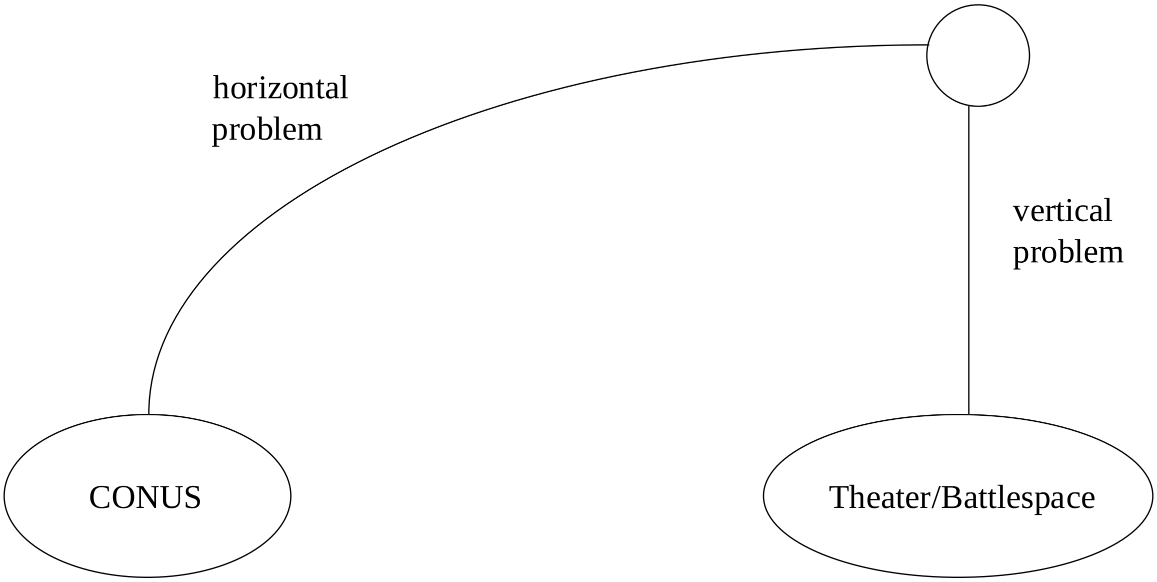


Figure 2-1 Horizontal and Vertical Problem.

The airlift system is composed of internal systems including airlift platforms, infrastructure, and payload operations control. These systems must merge with both commercial and military land, sea, and space lift systems to provide continuous mobility support. In providing this support, airlift operations will employ a variety of platforms. To best serve the airlift customer, it is imperative that these platforms be part of a seamless mobility system capable of operating throughout the spectrum of conflict.

History has frequently shown the need for deploying forces in a timely fashion over great distances and in sufficient numbers to achieve a credible numerical advantage. Currently, personnel and materiel are not only deployed to theater staging bases but are also transshipped to the employment location. In the past, the US has been able to create a "safe" theater transshipment infrastructure. However, it is a slow, labor-intensive process to move personnel and materiel from the strategic to tactical cargo movement mediums for delivery to final destination. Even today, we cannot meet the battlespace demands of immediate and direct delivery of personnel and materiel.[5]

By ***2025***, due to the proliferation of weapons of mass destruction as well as the high potential for a worldwide revolution in military affairs, there will be a drastic increase in the speed, efficiency, and lethality of battle.[6] Concomitant with these increases is the need for rapid support to the war fighter. Modern conflict has complicated this problem by creating a rear battle area that is much more vulnerable, thereby denying the assurance of a safe transshipment infrastructure. According to Dr. Eliot A. Cohen, rear area security may no longer be possible in as few as 20 years due to the "precision revolution," the emergence of alternative forms of air power (such as UAVs, cruise missiles, etc.), and the changing nature of platforms resulting from the increased use of stealth, range, and information power.[7] These wartime challenges are compounded by the need to respond to natural and man-made disasters, nation assistance, and additional operations other than war. Meeting our nation's complex air mobility needs in time of both conflict and peace requires a flexible and responsive system designed to enhance the abilities of the user.

Recognizing the evolving battlefield requirements and mobility constraints, the US Army is adapting to improve its capabilities while reducing the impact of mobility constraints. "Force XXI will be a more resource-efficient Army, with capabilities enhanced through information age technologies. It will allow us to project power into any area of the world more quickly, more effectively, and with greater efficiency as part of a joint effort."[8] However, Army modernization cannot overcome many inevitable constraints. "The Army of 2010 will be based primarily in the continental United States. While we will continue to maintain a minimal forward presence in some parts of the world, we will depend on a combination of airlift and sealift to execute the Nation's strategy."[9] If the war fighter is to succeed, the airlift system must address the customers' needs and not expect the customers to sacrifice their capabilities for the sake of eliminating air mobility constraints.

Required Attributes

The air mobility system of ***2025*** will provide three basic functions: personnel delivery, cargo delivery, and aeromedical evacuation (AE). To accomplish its mission, the following air mobility system capabilities are proposed.

Table 1

Measures of Capability

Capability	**Measures**
Point of Use Delivery	within 10 meters of designated target
Long Range	12,500 miles unrefueled[a]
Total Resource Visibility	Near-real-time information
Interoperability	Standardized containers
Survivability	Standoff range of 150 miles[b]
	Threat detection/defeat within 150 miles
Infrastructure	Less is better

Notes: a. Based on no in-theater basing and multiple delivery points.
b. 150 miles provides over-the-horizon protection up to 20,000 feet.

Point of Use Delivery and Extraction

"The giant airbases of today will become the bomber cemeteries of a future war."[10] Although the world envisioned in 1958 by General P. F. Zhigarev has altered dramatically, the projected lack of established bases for transshipment and the vulnerability of forward bases to diverse threats will require the capability for airlift systems that can provide direct delivery from CONUS to the point of intended use, and direct extraction from those operational sites without the availability of an established support infrastructure.

"Precision airdrop is a critical Air Force capability."[11] Personnel and equipment must be delivered with essentially pinpoint accuracy. Aircraft security can be greatly enhanced if the airlifter can perform its delivery mission while remaining at "standoff" range from the hostile battlespace. To best serve the war fighter, delivery accuracy of 10 meters from the intended target is required. The delivery system can be either powered or unpowered, such as a parasail or rigid-winged glider/container (a smart box that directs itself to a specific destination). Current systems continue to be highly inaccurate, are susceptible to wind and altitude variances, and require the cargo aircraft to fly through or above the threat airspace, increasing the aircraft's vulnerability to hostile fire. Although grossly exaggerated, a Pentagon source highlighted the need for increased precision by stating that when "Dropped from altitudes of 10,000 ft, to stay above anti-aircraft fire, the parachuted supplies would be lucky to hit Yugoslavia."[12] In fact, accuracies achieved during Operation Provide Promise were significantly better than this estimate and showed improvement throughout the operation. These improvements however, were more in line with the 350 yards from target (when dropped from 1,100 feet) required by Air Force air-drop standards.[13] These standards will not be sufficient for operations in ***2025***.

Like delivery, extraction of cargo and personnel could occur in hostile and austere environments with no runways available. Proposed extraction systems will allow the airlift platform to recover personnel and materiel without landing. Because most operations dictate retrograde at a lower rate than the actual deployment, not every mobility platform would be required to accomplish direct extraction.

Long Unrefueled Range

Due to projected CONUS force basing in ***2025***, the United States may lack established airfields in-theater for transshipment points. To project power globally, strategic lift platforms will need an unrefueled round-trip range of at least 12,000 miles.[14] This will allow deployment from CONUS bases directly to the theater of operations and return without refueling. Air refueling will still be a requirement to increase the flexibility of the air mobility system and allow changes to occur en route.

Total Resource Visibility

Total resource visibility (TRV) will provide visibility of all resources from acquisition through employment to all command and control elements. Additionally, it will allow cognizant authorities to redirect in-transit cargo and troops as needs dictate. Although several improvements are underway, current in-transit visibility (ITV) systems can identify in-transit payloads only by specific aircraft and mission number, and are limited in their ability to adapt to rapidly changing situations.[15] During Operation Desert Shield, the time-phased force and deployment data (TPFDD) could not identify the impact of altering the sequence of deployment on military operations and led to detrimental decisions without comprehensive analysis.[16] The TPFDD and other Joint Operation Planning and Execution System databases are projected to be incorporated into systems such as the Global Command and Control System (GCCS) which will merge it with other databases.[17] Although the GCCS as currently designed will greatly enhance existing capabilities, it will be insufficient for future TRV needs.

Survivability

Air mobility planners have not adequately considered the first principle of logistics of the former Soviet Union, "The organization of the rear must reflect the character of the war and the nature of the fighting."[18] Along with this concept, current air doctrine states that "Logistics capabilities must be designed to survive and operate under attack; that is, they must be designed for combat effectiveness, not peacetime efficiency."[19] Through the year 2020, the notional strategic cargo airlift capability calculations to support national objectives rely exclusively on large, conventional airlift platforms. These platforms incur substantial constraints resulting from weapon system vulnerability, infrastructure requirements, material handling equipment (MHE) needs, and other limitations. In addition, the projections do not account for unanticipated platform attrition, airframe gentrification, or significant forward-basing restrictions.

Increased reliance on the civil reserve air fleet (CRAF) for mobilization and expanded commercial transport support could result in the costs of CRAF mobilization exceeding those that are acceptable and in preventing the projection of US military power.[20] In addition, over-reliance on CRAF could hinder effective response by military forces, resulting in interests vital to the United States being compromised. Although this may be a very stressful scenario, it must be considered.

In an effort to address the above limitations, the airlift system must be able to project forces into the forward battlespace. "Our vital interests—those interests for which the United States is willing to fight—are at the endpoint of 'highways of the seas' or lines of strategic approach that stretch from the United States to the farthest point on the globe."[21] Lacking secure rear areas of operation, the airlift platforms must be survivable under potentially hostile circumstances.

Depending on the sophistication of the threat, the hostile environment could extend a considerable distance from the actual battlespace.[22] The size and importance of airlift platforms present a very lucrative target to both ground and air threats. To be effective, they must be able to detect and counter these threats either by direct active measures or by avoidance. Also, support systems and equipment must be able to survive in hostile environments to include those contaminated by nuclear, biological, and chemical agents.

In order to help counter the above threats, airlift platforms, direct delivery systems, and unmanned combat aerial vehicles (UCAV) must incorporate technologies such as "low observables," multispectral sensors, and directed energy weapons.[23] According to the Advanced Research Projects Agency (ARPA), advances in coatings, materials, and design will lead manufacturers away from radical designs like the F-117 and B-2 shapes. The future will see smaller, more subtle changes and aircraft designers will be able to treat less different airframes and get equivalent performance (to today's stealth shapes). It will be a healthy competition between materials and coatings, at least among US competitors.[24]

Intermodality

Intermodality is a basic requirement for airlift systems. Cargo must be configured for direct transfer between air, land, sea, and space lift systems and operational use at delivery destination. Because we anticipate the requirement to transport military cargo on commercial carriers of all mediums when possible, military payload configuration must comply with national and international standards. Through cooperative international development, these configurations also allow direct synergistic support among operational allied, coalition, and US forces.

Modularity

The platform payload interface will allow selected payloads to provide diverse mission capabilities to the airlift platform. The airlift platform will be capable of passenger, cargo, and aeromedical evacuation configurations. Additional payloads, such as power generation, information support, or maintenance systems will primarily enhance the airlift platform. Other payloads may include special mission configurations, such as reconnaissance, or auxiliary capabilities such as offensive and defensive weapon systems. Also, many special purpose operations such as psychological operations, aerial spraying, fire fighting, and developmental test and evaluation can be supported through modular configuration of airlift platforms. Since the airlift platform will be supporting these types of users, it must be equipped with very robust power, oxygen, and communication systems in the event of simultaneous taskings.

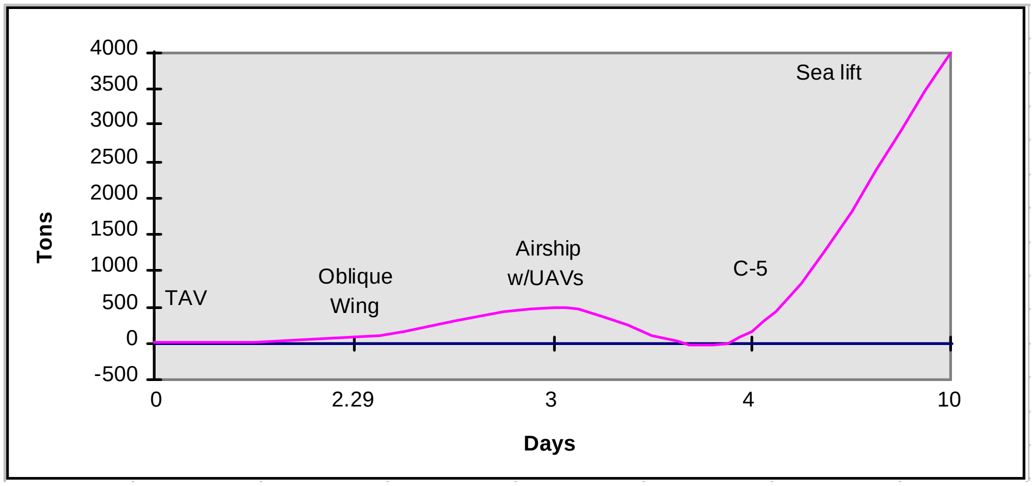
Interoperability

Interoperability is the capacity to seamlessly interact with all airlift system customers and operational partners. The US mobility system will operate with commercial systems globally and conduct multinational operations. The airlift system components will be designed to maximize compatibility with airlift system components and payload configurations of other government and private organizations. The development of universal standards and compatible equipment by international transportation organizations should eliminate most interoperability problems due to equipment and payload.

Responsiveness

> *At the outset of war, time is the supreme factor. Do not let us forget that the aggressor is also concerned with the time factor; he is ready, otherwise he would not have provoked armed conflict; he inevitably hopes and plans for a quick decision, since no one would wish for a long war if it could be avoided; moreover he wants a decision before his opponent has had time to turn his capacity into the new activities which war calls for.*
>
> — Lord Tedder

Responsiveness alludes to timeliness. It is the ability to deliver personnel and materiel exactly when and where the user requires them. Although speed from point A to point B is important, it is of little use if arrival time at the battlefield is delayed by repackaging or transshipment. In light of this, airlift needs a faster shipment “system” as much or more than faster aircraft (Fig. 2-2). Other enhancements such as the ability to change the place of delivery while the personnel or materiel are en route will also improve responsiveness.



Notes: Responsiveness - time for cargo to move from point of origin to point of use in days.
Except for airships with UAVs, all cargo must be moved from point of origin to airfield (approximately 24 hours).
C-5s and airships with UAVs deliver to point of use; cargo moved via other systems must be transshipped in theater (approximately 24 hours).
Times do not include airlift platform preparation times.
In-flight times based on 6,000 miles one way.

Figure 2-2. Responsiveness

Cost

To be effective in ***2025***, the airlift system must meet airlift requirements throughout the airlift operational spectrum. These missions have vastly different operational requirements such as responsiveness, volume, and defensive capabilities. Given a finite supply of labor, energy, and materiel, the United States should field an airlift system that considers cost factors in determining the mix of airlift platforms and support systems. Also, cost factors should be considered when determining policy, particularly when vital interests are not at stake.[25] These costs, while primarily monetary, also involve the expense of political capital as it relates to the mobilization of reserve and CRAF assets.

Therefore, the airlift system will be composed of both technologically evolutionary and revolutionary systems that optimize capability and costs within the constraints of the timeframe considered.

Other Considerations

Airlift platforms will most likely be required to employ systems that comply with international environmental restrictions and eliminate existing negative effects. Propulsion systems should reduce to acceptable limits or eliminate negative environmental effects from hypersonic systems. The capability will exist to engineer systems to eliminate noise pollution. These include managing boundary effects to eliminate sonic booms. Materials technology will be able to produce structures composed of compositions that eliminate the requirement for scarce resources. Airlift direct transfer and short takeoff and landing/vertical takeoff and landing (STOL/VTOL) systems can eliminate requirements for extensive concentrated terminal facilities and materials handling and storage infrastructure, thus reducing resources demand, urban development congestion, and air traffic congestion.

The need for airlift support can also be reduced significantly through other efforts. System designs should incorporate the capability to perform multiple functions and use electronic transfer to allow these systems to repair and update capabilities. These options will eliminate extensive logistics support and airlift requirements. In addition, active search methods will identify alternate sources of materiel in the theater of operations, determine acquisition options, determine support operations, and eliminate many airlift requirements. At the operations-other-than-war end of the airlift spectrum, air mobility's ability to "show the flag" will continue to demonstrate government-to-government and military-to-military relations. These can be much more visible to a population and usually much less threatening to a populace than the naval presence of a carrier battle group.[26]

The required capabilities of the air mobility system in ***2025*** have been identified as follows: point of use delivery and extraction, long unrefueled range, total resource visibility, survivability, intermodality, modularity, interoperability, responsiveness, and cost. Each serves an integral purpose in a synergistic whole. If the air mobility tasks required to meet national objectives in ***2025*** are to be accomplished, each of these capabilities must be present in the air mobility system.

Notes

[1] Lt Col Duane C. Johnson, "Strategic Airlift and Sealift: Both Have Long Suffered from a Capabilities Versus Requirements Disconnect. What Is the Prognosis?" (Maxwell AFB, Ala.: Air War College, 1990), 8–9.

[2] "Close the U.S. Strategic Airlift Gap," *Aviation Week & Space Technology* 141, no. 17 (24 October 1994): 66.

[3] Sheila E. Widnall, Secretary of the Air Force and Gen Ronald R. Fogleman, *Global Presence, 1995* (Washington, D.C.: Department of the Air Force, 1995): 3.

[4] Lt Col Marcel Duval, Canadian Armed Forces, "How To Improve the Response Time and Reduce the Costs of UN Operations Through A Better Use of the World's Air Assets," (Maxwell AFB, Ala.: Air War College, April 1995), 12.

[5] Lt Gen William G. Pagonis, *Moving Mountains: Lessons in Leadership and Logistics from the Gulf War* (Boston: Harvard Business School Press, 1992). This book outlines the six-month logistics build-up phase required to prepare personnel and materiel for Operation Desert Storm.

[6] Togo D. West, Jr., Secretary of the Army and Gen Gordon R. Sullivan, *Force XXI: America's Army of the 21st Century* (Fort Monroe, Va.,: Office of the Chief of Staff, Army, 15 January 1995): 8–18.

[7] Dr Eliot A. Cohen, "Long Range Air Power and US Military Strategy," address to Congressional staffers, Washington, D.C., 7 March 1996.

[8] West, 9.

[9] Ibid., 31.

[10] Charles M. Westenhoff, *Military Air Power, The CADRE Digest of Air Power Opinions and Thoughts* (Maxwell AFB, Ala.: Air University Press, 1990), 126.

[11] Sheila E. Widnall, Secretary of the Air Force and Gen Ronald R. Fogleman, *Air Force Executive Guidance, December 1995 Update* (Washington D.C.: Department of the Air Force, 1995): 15.

[12] Frederick Painton, "High-Altitude Help," *Time* 141, no. 10 (8 March 1993): 37.

[13] MCI 10-202, *Aircrew Training Programs: Policies, Organization, and Administration*, vol. 1, 15 October 1995, 49.

[14] USAF Scientific Advisory Board, *New World Vistas: Air and Space Power for the 21st Century,* summary volume (Washington, D.C.: USAF Scientific Advisory Board, 15 December 1995), 10.

[15] John L. Cirafici, *Airhead Operations--Where AMC Delivers: The Linchpin of Rapid Force Projection* (Maxwell AFB, Ala.: Air University Press, 1995), 80–81.

[16] Pagonis, 89–93.

[17] *User's Guide for JOPES (Joint Operation Planning and Execution System)*, 1 May 1995, 14–19.

[18] Maj Gen Julian Thompson, *The Lifeblood of War: Logistics in Armed Conflict*, (London: Brassey's, 1991), 302.

[19] Air Force Manual 1-1, *Basic Aerospace Doctrine of the United States Air Force*, vol. I, March 1992, 15.

[20] Not only would it cost the US a great deal to provide incentives to Civil Reserve Air Fleet (CRAF) carriers, but modifications to civil aircraft are not cost effective in all cases. Some CRAF carriers have elected to not renew their CRAF contract agreements after Operations Desert Shield/Desert Storm due to the loss of routes, traffic, and market share. It may not be possible for the US government to pay the costs of an effective CRAF fleet in 2025.

[21] John H. Dalton, Secretary of the Navy, Adm J. M. Boorda, and Gen Carl E. Mundy, Jr., *Forward...From The Sea* (Washington, D.C.: Department of the Navy, 1994), 2.

[22] Cohen.

[23] *New World Vistas,* summary volume, 9, 12.

[24] David A. Fulghum, "International Market Eyes Endurance UAVs," *Aviation Week & Space Technology* 143, no. 2 (10 July 1995): 40.

[25] Lt Col Ronald L. Bean, "Air Mobility--Pivotal Non-Lethal Capability: Where are we going with Peacekeeping?," (Maxwell AFB, Ala.: Air War College, April 1995): 1.

[26] Currently, airlift aircraft show the flag worldwide on a daily basis.

Chapter 3

System Description

The following platform options were evaluated in light of required capabilities to determine their place in the Air Mobility system of ***2025***. They include transatmospheric, hypersonic, and supersonic vehicles, airships, in-ground-effect wings, very large aircraft, and unpowered and powered delivery systems using both manned and unmanned technologies. In addition to platform options, additional equipment such as standardized cargo containers and on-board materiel handling equipment required to operate these platforms are described below and the technologies required are indicated. The required capabilities identified in Chapter 2 will determine the best mix of options.

Transatmospheric (TAVs) and Hypersonic Vehicles

There have been two noteworthy attempts to develop a transatmospheric vehicle (TAV) to provide an airlift platform that meets the rapid in-transit response criteria for high-priority payloads.[1] The advantages of TAV systems include decreased vulnerability due to the lack of en route infrastructure and support facilities. It is intended that the TAV incorporate the environmental support systems to meet crew, system, and payload needs while employed in exoatmospheric operations, including the capabilities for crew transshipment infrastructure or platform replenishment support. The TAV allows transport of cargo to any location globally within one hour from departure.

Unfortunately, the projected TAV technological requirements and operating parameters make this aircraft infeasible for most military payload requirements. Although TAV sorties could reach any location on earth in one hour, payload size would be limited to 10,000-to 30,000-pound capacity. In addition, typical TAV requirements include conventional runways of at least 11,500 feet and extensive specialized support infrastructure as well as an extensive turnaround time to prepare the vehicle for another mission (anticipated to be approximately five days).[2] TAVs should have the capability however, to deliver limited payloads quickly once the vehicle is prepared and the cargo loaded. While certainly suited for small, notional six-man team delivery, this vehicle is unlikely to be used for movement of moderate to large payloads.

Supersonic Transport

Force projection depends on delivering personnel and/or materiel where they are needed in the shortest time possible. The best military strategies and tactics are of little value if the right soldiers, weapons, and supplies cannot be in the right place at the right time. Consequently, the movement of personnel and equipment at supersonic speeds is alluring. Two possible options for supersonic airframes are the “standard” Concorde SST (supersonic transport) design and the unique oblique flying wing design.

While Europe’s Concorde has logged more than 100,000 supersonic flight hours (more than all the military services combined) in its 20 years of commercial service, its 100-passenger capacity is much too small for military transport use.[3] However, in addition to the US, both Europe and Japan are spending significant time and money researching supersonic transport vehicles that will carry up to 300 passengers, a size that could have military applications. In addition, market research for supersonic travel has shown that if the price of a ticket could be brought to within 10-to 20 percent of current subsonic fares, there would be a substantial market. "Studies show a potential high speed aircraft market of 315,000 passengers per day by the year 2000, and 600,000 per day by 2020. To meet this demand, 500-1,000 high speed civil transports would be needed."[4] This current civil attention is advantageous since the cost of research and development for aircraft design is prohibitive for the Air Force. At an "estimated cost of $15-20 billion to bring a new supersonic transport to market," it is imperative that the Air Force depend on the civil sector for overall design.[5]

Unfortunately, even civil sector attention is no guarantee. Large leaps in technology are required to build an environmentally safe supersonic airlifter at a price the struggling airlines could afford. Although some scientists are confident that environmental barriers can be overcome and noise reduction ideas for takeoff and landing will work, there is much work to do in the development of advanced materials. "Needed are ceramic matrix composites that can withstand the prolonged high temperatures in the new engine combustors, and lightweight, durable composites and super alloys for the airframe and engine components to hold down the airframe's weight and fuel consumption."[6] Even the application of military sensor technology replacing windows with computer displays to reduce weight is still in its infancy. Though new designs will have longer ranges than the Concorde, they still come far short of the desired 12,000 mile unrefueled range. "Current SST designs have a range of 5,500-6,000 nautical miles and require 4,000 meter (13,000 feet) long runways."[7] This obviously places a restriction upon how far it could go and where a military SST would be able to operate. The need for a truly long-unrefueled-range aircraft is unlikely to be met by a supersonic transport by the year ***2025***.

Oblique wings may provide more efficient supersonic flight. "Preliminary studies indicate in direct comparison with the Boeing 747, that the oblique wing may be 16-30% cheaper to fly."[8] Like the "standard" Concorde design, for an oblique wing to be practical there must be a need to carry a large number of passengers. "A passenger or cargo carrying wing would have to be about 7 feet thick to allow people to stand, and this in turn dictates a 50 foot chord and 500 foot wing span. Such an aircraft would be able to carry more than 500 passengers."[9] The vehicle would fly about a 60-degree angle at top speed of between Mach 1.6 and 2.0 but rotate to about 30 degrees for takeoff and landing. While the oblique wing concept is slightly slower than other designs, its advantage is that it is very efficient. "Initial wind tunnel tests indicate that the oblique wing would have a very good lift to drag ratio (as high as 30:1), and subsequently low thrust requirements even for takeoff and acceleration."[10] The low power requirement advantage is obvious when considering the continually stiffening noise restrictions surrounding US airports.

There are two impediments to the development and use of an oblique wing design. First, though feasible, the technology to produce and fly such a design may not develop because of a lack of interest at the civilian level. Even though a flying scale model has been developed, research shows little interest in pursuing further development has been demonstrated by civil aviation manufacturers.[11] Unless the public sector decides such a unique design is safe and passenger friendly, there is little hope such a craft will be developed regardless of its advantages.

Secondly, significant support problems hinder the development. Not the least of these is the extensive and costly renovation of existing infrastructure to accommodate an aircraft nearly twice as large as any currently in existence. Individually, these impediments might be overcome. Together, they represent a commitment of resources inconceivable, given the projected availability of future funding. For these reasons, we believe the costs outweigh the benefits of such vehicles.

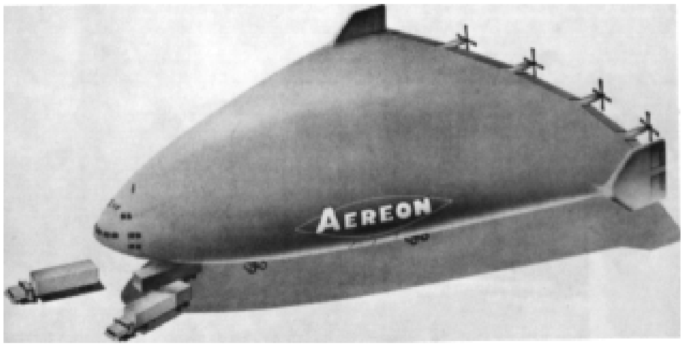
Airships

Since the Hindenburg catastrophe in 1937, airship development has taken a backseat to aircraft development. Because of this, opportunities exist for tremendous advancements in design and capability with the application of technologies that are common in the aircraft industry. The application of probable ***2025*** technologies to airship design could yield tremendous increases in overall capabilities with substantially decreased delivery times at a fraction of current per-mile costs for air cargo movement.

Current airship development efforts have concentrated on the application of materials technologies to the airship structure. These efforts include the introduction of composite framing and high strength-to-weight fabrics. Additionally, developments in engine technology have increased speed and controllability while decreasing the manpower-intensive nature of previous airship operations. These developments have reinvigorated inquiry into the future role of airships. They have not, however, expanded the capabilities of the airship beyond those achieved before World War II.[12]

Air mobility requirements in ***2025*** will demand a substantial increase from existing airship capabilities. These include a 500-ton useful lift capability, maximum airspeed of 250 knots, maximum range at maximum gross weight of 12,500 miles, and a defensive/stealth capability. Although substantially slower, the airlift capacity of this notional airship would be nearly six times that of our largest airlift platform, the C-5B.[13] Even with the difference in delivery time (approximately a 2-to-1 advantage over the C-5) the airship would still have three times the effective ability of the C-5B (Fig. 2-2). Cost of airship production is also low since cost per unit produced could be approximately one-third that of the C-5B.[14] In addition, with the integration of UAVs and airships, the capability exists to deliver personnel and equipment directly to the user (point of use delivery), thereby, eliminating transshipment time and reducing infrastructure requirements and costs.

Technologies that will have a great impact on the development of Airship ***2025*** include: future composite materials, advanced computer modeling capabilities from which structural analysis and inexpensive test "flights" can be conducted, and nanotechnology innovations that will decrease the weight and size of onboard systems. Additional developments in stealth/low observables technologies will make what is already a low-signature target (due to its composite structure) more survivable. The development of stand-off delivery vehicles (UAVs) will also increase the



Source: William J. White, *Airships for the Future* (New York: Sterling Publishing Co., 1978): 127.

Figure 3-1. Large Cargo Airship

airship's survivability by allowing the airship to loiter well outside the battlespace threat area while the UAVs provide point of use delivery to forward deployed units.

The possible commercial applications of airships are numerous. Commercial air carriers are currently pursuing larger-capacity aircraft to increase the efficiency of air transport. The substantially cheaper per-unit cost of airships, combined with their superior capacity, hold great promise for long-range passenger and package delivery. Additionally, civilian adoption of airship operations similar to those proposed in this paper could usher in a new era of innovation in the commercial air freight industry where direct delivery of goods is the baseline product.

In-Ground Effect Wings

Wing-in-ground effect vehicles (or wingships) are another type of platform design that could provide the size, weight, and volume of lift required in ***2025***. Wingships are hybrid sea/air vehicles capable of very heavy lift over extremely long ranges. They do so by taking advantage of the ground effect phenomena to provide a significant increase in lift capability over what conventional aircraft are currently capable. Because of these phenomena, it is technologically feasible to build vehicles that are at least three times larger and 10 times heavier than the largest airplane currently built.[15] Developed initially by the Russians in the 1960s, the first wingship (named the "Caspian Sea Monster") was capable of lifting 540 tons and cruised at 310 miles per hour.[16] This vehicle took off and landed on the sea and held a steady altitude of 10 feet above the surface. Current wingships have the capability of flying between 20 and 90 feet above the surface of the sea and can cruise at 400 knots. Higher altitudes are possible when necessary to transit small land masses or avoid shipping or other obstacles, but these altitudes cause a significant decrease in fuel efficiency. Because of their shallow draft, these vehicles are able to load and unload in shallow and/or undeveloped ports where deep-draft vessels are unable to go.

Developments in lightweight structures and materials have made it technologically feasible to construct a wingship capable of lifting 5,000 tons, although the engines required to power it are still a long way off. The Advanced Research Projects Agency (ARPA) of the Department of Defense (DOD) recently analyzed a wingship that was able to transport 1,500 tons over an unrefueled range of 10,000 nautical miles at a cruising speed of 400 knots.[17] Even with this kind of lift and the potential ability to attain altitudes of almost 10,000 feet, the most significant challenge is designing engines that can produce the enormous power to break free of the water and maintain the required power levels for an extended period of time at low altitudes where temperatures are relatively higher than those experienced by conventional aircraft. Other technological problems include stability problems as well as the difficulty of flying over turbulent seas.[18] These problems could potentially be solved by using enhanced computer processing to assist in wingship control.

In addition to these technological drawbacks, the wingship cannot provide the direct delivery and extraction required in ***2025*** since they are confined to waterways only and are susceptible to interdiction in narrow passageways such as

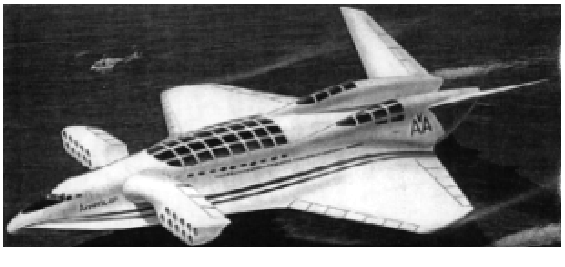


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Figure 3-2. Conceptual Wingship

the Suez and Panama Canals. They also require an infrastructure outside of the continental United States, even though that infrastructure does not have to be extensive or large. While the wingship could conceivably deploy and recover UAVs, the UAVs would all have to be powered, driving up the cost of the air mobility system. Ultimately, the wingship is unable to provide a seamless point of use delivery capability to the war fighter without another form of transportation (rail, truck, etc.) to get the cargo and equipment to the battlefield. Because of this, we believe it is not a good platform for the air mobility system of ***2025***.

Very Large Aircraft

Commercial aircraft manufacturers, in concert with governmental agencies, are currently showing a great deal of interest in the development of very large aircraft (VLA). Shelby J. Morris, head of a NASA/Langley engineering group brainstorming the concept, states that "largeness is a virtue up to a point, but we're not sure of how large is large enough and how large is too large."[19] These developments are reliant on the extensive existing infrastructure of the United States and other developed First World countries and are pertinent to operations in these areas.

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Figure 3-3. Very Large Aircraft

Current VLA concepts include expanded conventional transports, blended wing bodies, and a variety of other designs. These concepts propose maximum payloads ranging from 300,000 to 1,000,000 pounds with wingspans as large as 330 feet.[20] Such designs are problematic, as their sheer size vastly increases the infrastructure required to support them. Possible solutions to this problem include the creation of landing piers along lakeshores.[21] Cost and environmental problems associated with this idea greatly undermine its feasibility and serve to highlight similar problems associated with the renovation of existing structures.

These infrastructure problems are even more daunting when one considers the lack of infrastructure available to military forces deployed abroad. Future VLAs are likely to face the same problem inherent with our current very large aircraft, the venerable C-5B. This problem is the requirement for an extensive supporting infrastructure unavailable in a high-threat, forward deployed military operation.

The VLA exhibits a high profile during operations. Even if the adversary lacks sufficient capabilities to directly contest air superiority with the United States, the VLA's conventional operating procedures induce reliance on a fixed infrastructure. This infrastructure represents an extremely vulnerable center of gravity, as it can be targeted by a variety of standoff air-to-surface and surface-to-surface weapon systems to ensure airbase denial.[22] In addition, man-portable antiair weapon systems enhance the capability to infiltrate and target US theater insertion capability. The VLA's most significant advantage is its increased lift capability. However, the operational and infrastructure requirements to service this increased capacity present two key vulnerabilities: the need to fly into the battlespace thus presenting a high-value target and the need to offload/transship its cargo at a suitable in-theater airfield, itself a center of gravity in the highly lethal and fluid environment of ***2025***.

In the final analysis, the main problem with VLAs is that they remain an evolutionary change in airlift capability and have failed to adequately evolve to meet mission requirements to survive and support operational needs in a threat environment. In other words, VLAs are doing the same old thing, the same old way, with new/larger equipment. The VLA has utility in supporting nonthreat operations such as humanitarian assistance, but it is a system that complements airlift operations, without providing the necessary capabilities to support potentially hostile operations in ***2025***.

Delivery Vehicles

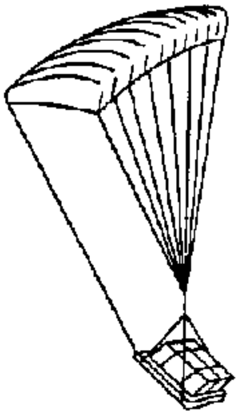
Since the air mobility system of the future may not have operationally supportable access to airfields (large or small) or transshipment infrastructure outside of the continental United States due to political, environmental, threat, and/or infrastructure considerations, there must be a method to deliver personnel and equipment directly from the large airlifter to the precise location requested by the war-fighting commander. The current airdrop capability of the US Air Force raises some tricky problems, most notably hitting small targets from high altitudes (above 10,000 feet), the requirement for large drop zones, and the necessity of having personnel on the ground to monitor weather conditions during the actual drop. As mentioned previously, during the recent humanitarian airdrop into Bosnia, there was significant concern over the ability to find and hit small, obscure drop zones while at night and/or in poor weather.[23] The war fighters of the future will need to place equipment and personnel within 10 meters of the intended target during all weather conditions and in any type of terrain as well as during potentially hostile situations. This precision capability will be required not only during the initial insertion of forces but also during the following resupply and sustainment efforts. Several unpowered vehicles currently in development show promise in this respect.

Unpowered Delivery Systems

One of the most promising unpowered delivery vehicles is an autonomous system that can deliver heavy payloads to within about 30 feet of the intended target. This system, called the Guided Parafoil Aerial Delivery System (GPADS), uses a parafoil that is 49 feet long, 8 feet deep, spans 150 feet, and weighs 1,600 pounds. The guidance package utilizes a global positioning system (GPS) receiver, compass, pressure altimeter, air speed indicator, and a computer to sense and correct in real time for changes in wind speed and direction and compensates for movement of the payload and canopy. Designed to guide a total load of 42,000 pounds from an altitude of 25,000 feet and 12 miles away from a target, an airborne division would require a mix of 450 heavyweight and medium-weight parafoils in addition to 450 parafoils that could deliver 1,200 pound loads.[24] Even if the war fighter of ***2025*** requires less overall weight to deploy, parafoils of the future would need to carry significantly heavier loads and be capable of delivering them from farther away.

Another system that is complementary to the GPADS is being developed by NASA as a method for returning cargo and crews from space in an autonomous mode. Termed the Spacewedge, it allows cargo to be deployed from an aircraft up to 20 miles away from the intended landing zone and potentially brought within 100 feet of the target. To fly at about 20 miles per hour with a sink rate of 10 feet per second, this system uses a parachute and a guidance package composed of a GPS receiver and antenna, an uplink receiver, an altimeter, and electronic compass as well as a 80196-based flight control computer. It is not as accurate as the GPADS. The objective of this program is to be able to deliver a full-scale space vehicle to a soft landing at a sink rate of about 2.5 feet per second.[25]

A parafoil system that combined the best characteristics of these two systems would provide precise delivery of personnel and equipment to the war fighter. The ability to drop heavyweight loads would allow the war fighter to insert most, if not all, of his heavy equipment within 10 meters of the intended target. This ability would allow the advantage of surprise and also would be very difficult to defend against since the choice of landing site increases significantly. The ability to drop the load from approximately 150 miles away also enhances surprise (not to mention aircraft survivability) by not announcing the location of the drop zone. In addition, several loads could be dropped simultaneously in opposite directions, allowing the greatest amount of coverage if required by the situation. Finally, personnel could be dropped in containers, reducing the parachute training required for individuals and allowing more concentration of troops in a particular area. If the psychological aspects of lack of control warrant adjustments, a man-in-the-loop option for control of the container can be developed for dealing with emergency contingencies.



Source: Robert W. Rodier, et al., *Master Plan for Airdrop Future Systems* Natick TR-91/037L (Natick, Mass,: US Army Research, Development & Engineering Center, June 1991): 35.

Figure 3-4. Parafoil Delivery System

A disadvantage of this parafoil delivery system is that it relies on a GPS link that could be either disrupted by the enemy or used by the enemy to locate the delivery system and either shoot it down or otherwise compromise the attack. Use of an internal guidance package (such as a micro-internal navigation system device) that did not need external links to determine its location would take care of this problem. The package would still need to receive data about wind direction and speed but as long as it did not send out signals it could retain its stealthy characteristics. Another disadvantage of a parafoil system (or any unpowered system) is that the large parafoils and containers could potentially become excess material on the battlefield. While soldiers traditionally use most available materials in combat, any excess material could be difficult to dispose of, becoming an environmental issue once the war or conflict was terminated. In a special-operations-type scenario, this debris could indicate the presence of troops that were attempting to operate in a covert mode. Advances in materials technology might be able to produce materials that rapidly degrade or reconfigure for alternative uses. Finally, the main disadvantage to an unpowered parafoil system is that while it can deliver cargo and personnel very accurately from high altitudes and significant distances, it cannot extract the troops once the mission is complete (or during a fighting withdrawal). Also, these systems are vulnerable to severe local weather conditions that may degrade performance significantly.

Powered Delivery Systems

Powered unmanned aerial vehicles show enormous potential for direct delivery and extraction of cargo and personnel to and from the customers' desired location. The use of UAVs in this role would minimize the risk to humans by removing the transport pilot from the battlefield and would also maximize the payload of the UAV by not having to lift additional crew members. UAVs showed recent success in Operation Desert Storm and are currently being used in the operations in Bosnia, although in exclusively reconnaissance-type missions. Currently these aircraft are small and are able to carry only small sensor/communications payloads. Future technological advances (such as more powerful propulsion units, more versatile airframe designs, lightweight but strong materials, etc.) may allow the development of a UAV that will be able to lift and maneuver a standard cargo container carrying personnel and/or equipment. To accomplish these tasks, a UAV must have the capability for full or near full autonomous flight to make round trips from the airlifter to an unimproved location and back while surviving in a potentially hostile environment.

The requirement to deliver cargo and personnel wherever the user needs it demands that a UAV be capable of taking off and landing vertically or at the very least in a very short distance, allowing the combatant commander maximum flexibility in placing troops and equipment. Four powered vehicle designs could potentially fill this requirement: a helicopter-type vehicle, an x-wing design, a "jump jet," and an ornithographic vehicle. A helicopter-type vehicle already exists that is capable of fully autonomous vertical takeoff and landing and can land on slopes of up to 15 degrees, with indications that landings on greater slopes are possible.[26] Also, in the late 1980s, a Canadian firm built a remotely piloted helicopter capable of horizontal speeds up to 80 miles per hour, altitudes up to 10,000 feet, and hovering maneuvers.[27] The vertical takeoff and landing capability of these types of vehicles reduces the space required for cargo unloading (and loading during extraction operations) and allows landing at unimproved sites, which gives much more flexibility to the war fighter in placing troops and equipment. Because of this almost unlimited capability to place troops where and when required, the US can retain or achieve the advantage of surprise, at least until the UAVs are deployed from the mother ship and potentially until they are making their final approach at the landing site.

Among the drawbacks to the use of helicopters are that they generally require more power than equivalent fixed wing aircraft and are adversely affected by high altitudes and hot temperatures. Significant advances in propulsion design and fuels would be required to solve or at least minimize this problem. Helicopter UAVs are also more complex but the use of adaptive neural networks could eventually be used to control these types of vehicles.[28] Also, although helicopter UAVs currently have limited maneuverability, genetic algorithm could be useful in increasing their maneuverability enough for effective use in an airlift role in a hostile environment.

The final disadvantage of unmanned helicopter vehicles in the airlift role is that their in-flight performance is significantly less than conventional fixed-wing aircraft. A solution to this is the development of an x-wing or “stopped-rotor” type of aircraft. This design combines the vertical takeoff and landing characteristics of a helicopter-type vehicle with the forward speed of a conventional fixed-wing aircraft. A rotor would be used to enable vertical takeoffs and landings and then would be stopped in flight to serve as wings for forward flight at speeds in the high subsonic region.[29]

As mentioned, x-wings retain the vertical takeoff and landing characteristics that are necessary for maximum flexibility in the direct delivery and extraction of cargo and personnel to and from the battlefield. The capability to transition to forward flight would allow greater forward speed, potentially into the high-subsonic range, which would enhance the survivability of the aircraft in a hostile environment since it is harder to hit a fast moving target.[30] Also, this capability to transition to forward flight would increase the vehicle's range and would enable the mother ship to remain farther from the battlefield without delaying the time required to deploy a unit to the field. Like the helicopter UAV, the x-wing design would incorporate fully autonomous flight control and navigation using an internal miniature inertial navigation device preprogrammed by the airlifter flight crew, and would be capable of landing and taking off from an unimproved site. Among the disadvantages of x-wing UAVs are the difficulties in overcoming the transition from rotors to fixed wings and the development of an appropriate powerplant that could provide power to the rotor as well as supply thrust for fixed-winged flight. While these challenges were being addressed as early as the late 1980s, technological advances in propulsion, as well as in circulation control for the critical transition phase between rotor-powered flight and fixed-wing flight, should enable the use of an x-wing unmanned vehicle by the year ***2025***.[31]

A similar and perhaps more promising aircraft is another vertical takeoff and landing vehicle capable of forward flight, the so-called "jump jet" or hoverjet being developed by the National Aerospace Laboratory (NAL) in Tokyo. The design of this transport helps ensure stability in the low, forward-speed range and during vertical flight and is powered by three aft-mounted turbine engines that power a unique system of lift fans and cruise fans. During forward flight, the air trapped from the compressors would be routed to two cruise fans. For vertical flight, this same high-

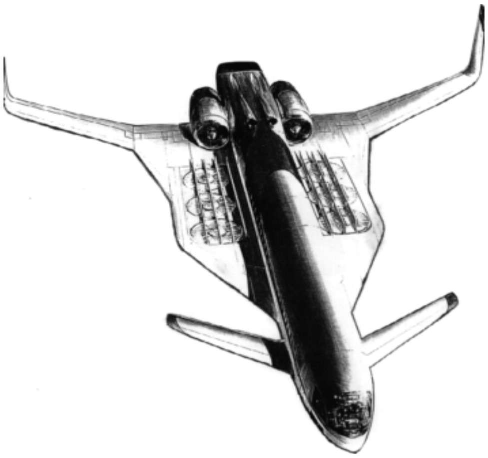


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Figure 3-5. NAL Jump Jet

pressure bleed air would be routed to six rotors, made of single piece carbon fiber composites, encased in the wings and shielded by louvers on both the upper and lower sides. The transition from vertical to horizontal flight is accomplished by gradually redirecting the air from the rotors to the cruise fans.[32]

Although this particular vehicle is designed to transport more than 100 passengers at 0.8 Mach with a range of 1,600 miles, the basic technology could be converted into an unmanned aircraft that could be launched and recovered from a much larger mother ship as discussed in the preceding paragraphs. One of the biggest design challenges for NAL has been the development of a powerful and reliable lift fan. In addition to advances in power plant design, the success of aircraft of this type also depends on advances in composite materials and manufacturing processes. Even more than the previously mentioned UAV designs, this hoverjet would require significant progress in adaptive neural networks and genetic algorithms to achieve autonomous control of the vehicle. Finally, since cargo containers would be carried inside the aircraft instead of being slung beneath it like the helicopter and x-wing UAVs, this type aircraft would require some type of material handling equipment to off-load or on-load equipment.

The "jump jet" design, however, offers some advantages that the helicopter and x-wing UAVs do not. Like them, this aircraft takes advantage of both vertical and horizontal flight. Its size and design would be attractive to the commercial market where it could be used in the short-range passenger market as well as short-haul cargo routes. Major disadvantages, in addition to the requirement for on-board cargo handling equipment, are the increased infrared signatures resulting from the high heat and pressure generated from the engine compressors and the fact that this type of design would probably be much more expensive than the previous two, resulting in fewer overall numbers and a greater reluctance to send it into a hostile fire zone.

A potentially less expensive airlift UAV would be an ornithographic vehicle—an engine-powered aircraft that flies by flapping its wings. The world's first successful engine-driven ornithopter flew in September 1991 for a grand total of two minutes and 46 seconds.[33] While this vehicle was not large (only four kilograms and a three meter wingspan), it did achieve flight and demonstrated this method of propulsion does work. The creators of this modern-day Icarus believed they could build an ornithopter that could carry a single person by 1996.[34] With advances in propulsion systems and lightweight but strong materials, a UAV could be designed that would be no more than a frame with a power plant and wings with a generic attachment for a cargo container. The powered wings would allow for a controlled glide to the unimproved landing zone, adjusting for winds and avoiding detected threats. The wings would also enable a "soft" landing in a small area by rotating into the wind just above the ground in the same manner as birds alighting on a nest or a tree limb. A design of this type would provide an additional measure of stealth since the use of flapping wings would be significantly quieter than a rotor-equipped vehicle. Also, if the wing materials were inexpensive enough and the power plant and control package were small, the UAV could be virtually disposable on the battlefield. (Containers would also have to be disposable or useable by the war fighter.) Additional technologies such as very short-term (within days), biodegradable materials would enhance the disposability and help prevent discovery of personnel operating in a covert mode. This capability would be greatly beneficial to special operations personnel or any other unit operating in a covert mode in hostile territory and not wanting their operations revealed by the presence of a delivery vehicle.

An obvious disadvantage of an ornithopter UAV would be the inability to lift large, heavy containers without revolutionary breakthroughs in propulsion, materials, and aeronautical design. Without the capability of lifting large, heavy containers, another vehicle would be necessary to provide the direct extraction of cargo and personnel. These powered vehicles, however, would be more expensive to develop and operate than ornithopters. Since retrograde often occurs at a much lower rate than deployment, ornithopters (or other unpowered vehicles) and powered lifting vehicles could be used in conjunction (at a ratio of 3 unpowered UAVs per powered UAV) for less cost. Another disadvantage is that this type of flapping wing design would be relatively slow moving, exposing the vehicle to enemy fire longer and allowing for an easier targeting solution for the enemy. This disadvantage however, could be overcome by employing other stealth technologies in the design (i.e., stealthy materials, a cloaking mechanism, etc.).

A more feasible delivery vehicle would be based on the "Angel's Wings" concept developed for the Army by Dr. Lowell Wood. The original concept would be implemented as a helicopter-type personal lift device individuals would be able to strap on. With auto-folding and unfolding composite rotating wings, a GPS-updated microprocessor, and a 50-horsepower internal combustion engine, this device would be able to deliver the twenty-first century warrior to the battlefield in an unpowered mode, using flywheel energy to provide last-minute braking. Liftoff would be provided either from the energy stored in the flywheel (modern flywheels have the capability to store enough energy to lift their own mass up to 10,000 kilometers) or from the 15,000 revolutions per minute engine. Although designed for only one person, increasing the swept-circle diameter of the rotating wings as well as increasing the engine thrust would provide capability to lift much heavier payloads.[35]

Delivery vehicles of this type are relatively simple, allow rapid retrograde, and provide significant mobility across the terrain for ground forces. With the engine shrouded and using ducted fan-cooling design, the vehicle and payload would have minimal signatures across the spectrum. Disadvantages include the size of the rotating wings to lift heavy payloads and the resulting increase in platform signatures. It is doubtful the useful payloads could be increased to provide enough lift capability without having to use a significant number of vehicles or increase the platform signatures beyond acceptable levels. If used as an individual lift device, the soldier would need some sort of protection from the elements particularly if deployed from a mother ship located 100-to 200 miles from the battlefield. Finally, the speed of these vehicles would be relatively slow, which would increase their exposure to hostile fire. The concept in its current form is available using commercial off-the-shelf components and technologies. However, to decrease weight and reduce detection signatures while increasing range and lift capacity, advances in structural composites, engine design (to include minimizing noise output), as well as in microminiaturization of communications, sensors, and navigation packages are required.

Other potential delivery vehicles are ballistic and cruise missiles. Ballistic missiles have the capability to provide the most rapid in-transit delivery vehicle for small, high-priority payloads, can be configured to ensure payload survivability and extreme accuracy, and are technologically feasible. However, there are many negative aspects to consider. First, the delivery system resembles the delivery characteristics of weapons of mass destruction. Since ballistic missile designers are developing capabilities to alter in-transit flight profiles to counter antiballistic missile systems, any flight profile that vaguely threatens potential enemies could provoke a preemptive strike against what is in reality a cargo transfer. Not only could this system destabilize a developing crisis, it would also result in the loss of a high-priority payload that was important enough to get to the user extremely quickly. Also, ballistic missiles have high profiles that could eliminate the element of surprise for most payloads. In addition, the cost of expendable launch vehicles is extremely high and few payloads, except for highly critical ones, would warrant such costs. The system would also require the retention of a complete weapon system support infrastructure to support a small quantity of payloads. Furthermore, the infrastructure for ballistic missile launch does not coincide with the logistics support infrastructure, requiring payloads to be delivered to remote launch facilities, incurring additional time for transit from point of origin to point of embarkation.

Cruise missiles can transfer 500 pound payloads over 1,500 miles while maintaining a low-observable profile, autonomous control, and precise point of delivery. With development of containers for supporting diverse cargoes, cruise missiles can be developed to rapidly deliver payloads to users without reliance on infrastructure between points of origin and delivery. Evolutionary changes such as improvements in composites to strengthen airframes while reducing weight, increasing engine efficiencies and output, and using low observables technology to decrease probability of detection, can improve range, payload, and mission effectiveness. With development of the capability to recover cruise missiles used for cargo delivery in a mission-capable condition and to ensure proper en route identification, cruise missiles can provide direct delivery and extraction support for cargoes meeting weight and volume constraints. This capability is significant in high threat environments and operations in niche theaters such as support of forces ashore by naval units in littoral areas. Operating as an autonomous UAV, the cruise missile provides a lower cost, less vulnerable platform than most airlift vehicles. The main problems with cruise missiles are significant volume and weight constraints, differentiation between strike and airlift cruise missile operations by friendly, neutral, and hostile forces, and constraints on making changes to cargo while en route. Due to its capabilities, the cruise missile provides a possible component of the overall airlift system, but its limitations constrain its useable mission profiles and the amount of cargo that could be delivered.

Additional Equipment

Equipment that is not platform specific but which is required for the mobility system of ***2025*** includes cargo containers and onboard materiel-handling equipment. Additional equipment/subsystems such as robust communications, targeting computing, stealth/low observables, and so forth, are not airlift specific and should be the same systems that are used on other aerospace platforms.

Cargo Containers

Containers will be standardized between US military and commercial aircraft and will also comply with international standards to improve compatibility with potential allies and coalition partners. Modular units, such as those used for medical evacuation units, will use these standard-size cargo containers without modification in size and/or dimensions to enable transport via the most effective means, regardless of whether it is by aircraft, ship, railroad car, or truck. Use of these standardized containers, miniaturization of many components and weapons, and the possible transition from projectiles to directed energy weapons will result in less weight and volume to be transported to the theater and will eliminate most, if not all, of the current air cargo categories such as oversize and outsize.

In addition to ease of handling during transshipment, standardized containers will provide protection during climatic extremes, allow information about the internal contents to be transmitted to the user, allow for quick download at destination (in minutes), all while not generating disposal problems in either a peacetime or wartime environment.[36] If made of strong lightweight materials that are fire retardant, vermin-resistant, and waterproof, the containers will be able to provide the protection required without adding significant weight to the payload carried by the delivery vehicles and the mother ship. The containers must also allow extremely rapid unloading (within a minute or less) if delivery into a hostile zone is required. Finally, the containers must be built to allow the attachment of delivery vehicles (either powered or unpowered) to form an integral unit and eliminate the problems of slung loads.

Onboard Materiel-Handling Equipment

The cargo bay of the “mother ship” must have some robotics-based, materiel-handling equipment capable of shifting the cargo containers and other equipment while in flight to ensure the center of gravity is maintained within flight limits, as well as optimizing personnel and equipment for rapid offload at the destination. This robotic system will be controlled by the flight crew through the onboard computer systems and will act semi-autonomously. Payload configuration systems will analyze payload and mission profiles to configure the payload to maximize volume and mass, minimize airlift system operational requirements, and facilitate cargo upload and download needs.

Recommendations

The Scientific Advisory Board has recommended five primary areas for airlift system improvement: mobility information dominance, global range transports, precision guided airdrop, directed energy defensive systems, and virtual reality military applications.[37] However, as discussed earlier, additional considerations are necessary and include the need for direct delivery and extraction and the ability to operate in hostile, infrastructure-deficient environments.

Table 2

Summary of System Options

	Point of Use Delivery	**Direct Extract**	**Range**	**Speed**	**Required Infrastructure**	**Required Tech**	**Capacity**
TAVs	Low[a]	Low[a]	Global	Very High	Very High	Very High	Low
Supersonic Transport	Low[a]	Low[a]	Moderate	Very High	Very High	High	Moderate to High
Airship	High	High	Very High	Low	Low	Low	High
Wing-in-Ground Effect	Very Low[b]	Very Low[b]	High	Moderate	Moderate	Very high	Very high
Very Large Aircraft	Moderate	Moderate	Global	Moderate	High	High	Very High
Parafoils	High	None	Low	Low	None	Low	Moderate
Helicopters	High	High	Moderate	Moderate	None	Low	Moderate
X-wing	High	High	Moderate	Moderate	None	High	Moderate
Jump Jet	High	High	Moderate	Moderate	None	High	Moderate
Ornithopter	High	High	Low	Low	None	Very High	Low
Ballistic Missiles	High	None[c]	High	High	Moderate[c]	Low	Very Low
Cruise Missiles	High	None[c]	High	High	Low[c]	Low	Very Low
Angels Wings	High	Moderate[d]	Low	Low	None	Low	Moderate to Low

Notes: a. Deployment/recovery of containers from/to extremely high speed aircraft is improbable.
b. Only if point of use is port or beachhead.
c. Would require launch structure in field and additional recovery apparatus on mother ship.
d. Powered altitude capability unknown.

Each of the systems described above were evaluated for their ability to provide the capabilities required in ***2025*** that were discussed earlier in this paper. Since one of the major assumptions of this paper is that the air mobility system will not have access to airfields outside of the CONUS, the system chosen must have an extremely long range and be capable of direct delivery and extraction. The system must also be survivable in a hostile environment and be responsive to the customer's needs by getting all the user's personnel and equipment to the required location in time to accomplish the war fighter's mission. Because some of the alternate futures postulate significant to severe budget restrictions, the platform must not be cost prohibitive. Other capabilities required in ***2025*** such as Total Resource Visibility, intermodality, modularity, and interoperability, are not platform dependent but must be included in whatever platform is selected. A review of the evaluated systems and their contributions to the air mobility system of ***2025*** is shown in table 2.

When the described systems are compared against the capabilities required by the air mobility system of ***2025***, airships, used in conjunction with unpowered and powered UAV delivery platforms (primarily vertical takeoff and landing or VTOL vehicles), are the best matches for the air mobility system of ***2025***. Although the airship is not as fast as modern jet aircraft, its high-cargo capacity (both in weight and volume) allows the delivery of more materiel to the battlefield sooner than a much larger and more expensive fleet of jet aircraft, ultimately supporting the war fighter sooner than today's air mobility system. Additionally, the standoff capability of the airship/UAV system provides much greater survivability than existing and proposed systems. A fleet of C-17s will still be in the Air Force inventory and will be able to provide the same precision delivery capability for small, light forces using the described delivery systems. If transshipment bases are available in or near the theater of operations, the C-17 can also be used to support intratheater lift. Direct extraction capability will be provided by the combination of the VTOL UAV and the airship. Chapter 4 describes how these futuristic air mobility systems will operate.

[1] Douglas A. Fulmer, “Sanger: Germany’s Black Bullet,” *Ad Astra* 4, no. 2 (March 1992): 14–16.

[2] Gilbert G. Kuperman, *Information Requirements Analyses for Transatmospheric Vehicles*, AL-TR-1992-0082 (Wright-Patterson AFB, Ohio: Armstrong Laboratory, Crew Systems Directorate, Human Engineering Division, June 1992): 24–31.

[3] Johan Benson, “Conversations,” *Aerospace America* 3, no. 2 (February 1995): 16.

[4] William B. Scott, “NASA Aeronautics Budget Fuels High-Speed, Subsonic Research,” *Aviation Week & Space Technology* 138, no. 19 (10 May 1993): 61.

[5] Benson, 16.

[6] Pamela S. Zuner, “NASA Cultivating Basic Technology For Supersonic Passenger Aircraft,” *Chemical & Engineering News* 73, no. 17 (24 April 1995): 11.

[7] Tokyo, “JAL Business Routes Require Longer Range Than Offered by Current SST Plans,” *Aviation Week & Space Technology* 137, no. 7 (17 August, 1992): 57.

[8] Breck W. Henderson, “NASA Ames Resumes Effort to Develop Supersonic, Oblique Wing Aircraft,” *Aviation Week & Space Technology* 136, no. 3 (20 January 1992): 54.

[9] Ibid.

[10] John D. Busick and Bill Siuru, *Future Flight: The Next Generation of Aircraft Technology*, 2d ed. (Blue Ridge Summit, P.a.: Tab Books, 1994), 157.

[11] “Oblique Flying Wing Is Airborne,” *Aviation Week & Space Technology* 141, no. 15 (10 October 1991): 19.

[12] The maximum gross weight of the Hindenburg was 242.5 tons with a range of 6,250 miles.

[13] Air Mobility Command, *1996 Air Mobility Master Plan* (Scott AFB, Ill.: Air Mobility Command, 1995). C-5B maximum gross weight ranges from 70 to 120 tons depending on range requirements. A 100-ton average was used for comparison.

[14] Lt Col Donald E. Ryan, *The Airship’s Potential for Intertheater and Intratheater Airlift* (Maxwell AFB, Ala.: Air University Press, 1993), 44.

[15] Bradley Lohrbauer Olds, *The Impact of Wingships on Strategic Lift* (Monterey, Calif.: Naval Postgraduate School, September 1993), 17.

[16] Craig Mellow, “When Ships Have Wings,” *Air and Space Magazine* 10, no. 5 (December 1995/January 1996): 53.

[17] Olds, 2.

[18] Stacey Evers, “US Wingship Pursuit Keyed to ARPA Study,” *Aviation Week & Space Technology* 141, no. 8 (22 August 1994): 55.

[19] Gregory T. Pope, “Titans of Transport,” *Popular Mechanics* 172, no. 3 (March 1995): 54.

[20] Ibid., 55.

[21] Ibid.

[22] Dr Eliot A. Cohen, “Long Range Air Power And US Military Strategy,” address to Congressional staffers, Washington, D.C., 7 March 1996.

[23] Frederick Painton, “High-Altitude Help.” *Time* 141, no. 10 (8 March 1993): 36–37.

[24] James T. McKenna, “Team Tests Parafoil for Heavy Payloads,” *Aviation Week & Space Technology* 142, no. 25 (19 June 1995): 57.

[25] James R. Asker, “Space Autoland System Shows GPS’ Wide Uses,” *Aviation Week & Space Technology* 139, no. 16 (18 October 1993): 54.

[26] J. P. Bott and D. W. Murphy, “On the Lookout: The Air Mobile Ground Security and Surveillance System (AMGSSS) Has Arrived,” Internet, Fall 1995, available from http://www.nosc.mil/robots/air/amgsss/amgssssi.html.

[27] Busick and Siuru, 140.

[28] Stanley W. Kandebo, “Waverider to Test Neural Net Control,” *Aviation Week & Space Technology* 142, no. 14 (3 April 1995): 79.

[29] Busick and Siuru, 126.

[30] Ibid.

[31] Ibid., 129.

[32] Ibid.

[33] Jonathan Beard, “Magnificent Flight with Flapping Wings,” *New Scientist* 134, no. 1826 (20 June 1992): 21.

[34] Ibid.

[35] Dr Lowell Wood, Visiting Fellow, Hoover Institution, Stanford University, telephone interview with author, 1 Mar 96.

[36] Judy L. Edgell et al., “Logistics in ***2025***: Consider It Done,” unpublished white paper, Air University. Standardized containers and the associated communications equipment are integral to the logistics “system of systems.”

[37] Air Mobility Command, 1-33–1-34.

Chapter 4

Concept Of Operations

No matter how futuristic or innovative weapon systems may be, they will be of little or no use if they adhere to yesterday's operational concepts. The following concept of operations using the systems mix recommended in Chapter 3 represents what we believe to be a revolution in systems use and operations that will exponentially increase the efficiency of the war fighters in ***2025***.

The basic mission, goals, and objectives of air mobility will likely remain as they are today. The airlift operational tasks of cargo airlift, passenger airlift, aeromedical evacuation, and special operations airlift will continue. The core support processes of information resources management, C^4I systems, information warfare, intelligence, logistics, training, security, operations support, medical, cargo and passenger handling, and base operating support will be crucial.[1] However, new technical and operational parameters will change the look of airlift platforms. Air cargo in ***2025*** will no longer be categorized as bulk, oversize, outsize, rolling stock, and special, as standardized cargo containers are integrated into the airlift system.

The future air mobility system will utilize both commercial and military resources to execute the missions of ***2025***. Future worldwide commercial infrastructure may be able to handle a large portion of the routine airlift requirements but will be unable to provide military unique requirements. The military airlift system will be able to overlay on the commercial system to provide direct delivery and extraction from unimproved and remote areas, the capability to operate in hostile environments, and the extreme range required to operate around the world solely from bases located in the continental United States. This overlay will be seamless, using standardized cargo containers as well as a total resource visibility (TRV) system to provide interoperability between commercial and military airlift platforms. As previously described, the air mobility system will include both the C-17 and long-range airships as strategic lift platforms, and both unpowered UAVs (primarily parafoils attached to cargo containers) and small powered UAVs as delivery vehicles. The civil reserve air fleet (CRAF) will still be used in ***2025*** to complement organic passenger and cargo capabilities.

The described TRV system, part of the DOD-wide logistic system, will identify and track cargo and personnel from origin to final destination and return. This system will have the capability to notify simultaneously the transportation system and the supported unit. The required transportation assets will be automatically generated by the same system once timing and flow decisions have been directed by the NCA. The large airlifter will deploy with sufficient parafoil delivery systems and powered UAVs to accomplish the assigned mission. Since any type of retrograde will occur at a slower rate than deployment, there will normally be one powered UAV for every four parafoil delivery systems. (If the capability exists to manufacture biodegradable materials, the vast majority of the parafoils will be unpowered with just enough powered UAVs to support aeromedical evacuation and retrograde operations to include noncombatant evacuation operations.)

In CONUS

When a unit has been notified of an impending deployment, it will load cargo and/or personnel into standard cargo containers. These containers, in addition to those few self-powered vehicles that can not be loaded into containers, will be moved via land to the nearest airfield (most likely a commercial airport) and loaded onto strategic lift platforms. For those forces with less than 48 hours from departure to required delivery time, C-17s will be the platform of choice. Airships will be used to directly deliver the remaining required equipment and personnel and the majority of self-powered equipment. Since the cargo containers are wheeled they will require minimal handling. Equipment no more sophisticated than that currently used (trucks, C-17 MHE) will handle remaining requirements. Self-powered equipment that is not loaded in a cargo container will have standard attachment points to enable easy loading and securing of cargo in the cargo bay of the airship.

If deployment time constraints require, the airship also will be able to embark a unit and its equipment directly from the unit’s point of origin. The mother ship with UAVs (both parafoils and powered UAVs) would be flown from its home base to the pickup location where the powered UAVs would pick up the cargo containers. Once within range of the user’s location, the powered UAVs would be deployed from the airship and flown to the pickup location where the containers (or self-powered equipment) will be attached to the powered UAVs by the users. Once the container or piece of equipment is attached, it will fly back to the mother ship for recovery. The cargo will be detached by the aircrew and the UAV will repeat the process for as many trips as required. If space exists on the mother ship, other units will be loaded either sequentially or simultaneously. Robotic material-handling equipment in the cargo bay of the mother ship will be able to move containers around as required to ensure the proper center of gravity is maintained and to facilitate quick offload at the various drop zones.

En Route

Throughout the en route phase of operations, users will maintain communication with their command and control components. To facilitate communication, the user’s command modules will be linked to the mother ship’s power and communications systems using standard connections. If a change to the final destination, payload configuration, or force package is required, the data will be passed to both the crew of the mother ship and the users on board by the appropriate command and control facilities. These updates will be entered into the system and will reflect the changes in near real time. Users will be able to interconnect with the aircraft cargo computers to input desired offload sequencing of their cargo containers and the target locations. This will enable the cargo bay robotics, as directed by the flight crew, to move containers and/or other equipment within the cargo bay to optimize offload sequencing while maintaining the required center of gravity. These robotics will also marry up the appropriate UAVs (either the parafoil assemblies or powered UAVs) to the cargo containers for offload.

Due to extended en route times, aircrew management and composition will be significantly different from those that are currently practiced. Increases in crew size (i.e., using two or more crews in sequence) and use of performance-enhancing substances are possible solutions. Personnel will also be required to assist the robotics and provide necessary maintenance. Crew work/rest cycles will require sleep facilities on board the aircraft for the entire crew.

In-Theater

Once in the theater of operations, two options exist for delivering personnel and equipment. If intratheater bases are available (as well as in-theater transportation), the airship or other aircraft (e.g., C-17, CRAF vehicles, etc.) can land and offload. If the intratheater bases are not available or the cargo must be delivered quickly to the battlefield, the personnel and equipment can be delivered directly to the desired location using the guided parafoil delivery systems. Immediately before to their release, the airlifter cargo crew will ensure the guidance packages are programmed with the desired drop zone locations, known winds, and threat areas to be avoided, and other data necessary to ensure they arrive at the target location.

The parafoils (and other powered UAVs) will be released/deployed once the airlifter is within range of the drop zone. Once released, the UAVs will guide themselves to within 10 meters of the target. The containers, which have been configured by the users to enable expeditious unpacking at the drop zone, will be unloaded by the users. If the parafoils or cargo containers were not biodegradable or for other reasons required return to the airlifter, the powered UAVs will be used. Once en route to the airship, the UAVs will request and receive a burst transmission from the airlifter giving it return instructions and locations. The powered UAV would fly back to the airship and directly into the cargo area. Due to the high-operational risk, particularly when recovering personnel, the process will incorporate some degree of human intervention either via remote control of the UAV by an aircrew member or through positive control of the UAV/robotic recovery system. Once aboard, the contents of the containers will be unloaded by the cargo bay crew who, with the help of the robotic system, will recycle systems as required for future use. The airship would either remain in place to continue delivery and reception operations or proceed to the next drop zone as required. Since the C-17 will be able to deliver a significantly smaller amount of cargo, it will usually service a single location and then either return to CONUS or recover at an intratheater base if available.

Special operations requires airlift support for insertion and extraction of operational forces and equipment. The airlift system components are capable of supporting special operations requirements. However, the VTOL airlift vehicle must incorporate sufficient low-observable profiles to both active and passive detection to lower the probability of detection and interception to levels sufficient to allow mission effectiveness. The standard VTOL airlift vehicle will incorporate low-observables technology within resource constraints. In addition to these technologies, the special operations VTOL airlifter will incorporate active and passive offensive and defensive systems to support mission needs. It is important to note that these systems will not require development of a unique airframe or substantial infrastructure to support special operations needs.

Once all personnel and equipment have been delivered, the airship will remain in an orbit area to recover casualties and/or remove the inserted forces. If the duration of the operation were to exceed 48 hours, the airship would begin the return trip to CONUS only after being replaced by another airship with aeromedical evacuation capability.

Aeromedical Evacuation

Medical evacuation in the year ***2025*** will use the same airship platform that is used for transporting cargo and personnel. Before departure from its CONUS base, one or more portable, modular medical units will be loaded into the airlifter's cargo space. These units will contain medical supplies and life support equipment as needed to care for expected casualties for the duration of the flight to and from home station. The appropriate types and number of medical technicians deemed necessary will accompany the medical units and remain with the airlifter. These medics will be in addition to any field medics that may be deploying with the ground units. In addition, a small number of cargo containers will be designated solely for the evacuation of battlefield casualties. These vehicles will be equipped with either autonomous life-support systems much like the neonatal units in use today (although significantly larger) or will provide seating for one or more medical technicians to care for the evacuees.[2]

Launch and recovery of these medical units would be in the same manner as delivering or extracting cargo and personnel, and would provide relatively quick transportation of casualties from the battlefield to a place where long-term care is available. No special medical equipment other than the autonomous life-support systems and medical supplies would be required for these units since transport time should be relatively brief. Most care could take place on board the mother ship (in the modular units) with the medical technicians using communications links with CONUS to consult appropriate experts. On return to home base, patients would be offloaded either by stretcher or within the modular units themselves. While this concept of operations increases the turn time at home station and decreases the amount of cargo and personnel deployed to and from the battlefield, it deletes the requirement for an additional airlifter and uses all of the same components of the cargo and personnel delivery system. It also removes casualties from the battlefield as soon as they can be placed into the dedicated medical UAVs and airlifted directly to the modular medical units on board the airlifter, reducing complications and resulting in decreased morbidity and mortality rates.

Survivability

Because commercial airlift operations do not incorporate the offensive and defensive systems necessary to survive in a high-threat environment, airlift operations will require military aircraft to support requirements in hostile areas. Expected threats include ground, sea, and air launched missiles as well as enemy attack aircraft. To counter these, military airlift platforms should be configured with directed energy weapons coupled to multi-spectral sensor packages enhanced with state of the art computational capability. With the proliferation of threat technology, these platforms could provide an offensive capability to employ weapon systems for operations ranging from rear area sustainment in a low-threat environment to operational power projection in high-threat environments. Possible offensive capabilities include standoff aerial bombardment and the employment of combat UAVs in support of ground operations.

Many missions, such as diplomatic and humanitarian assistance, may require airlift platform configurations lacking active offensive and defensive weapon systems. Therefore, the airlift platform must be configurable to support these missions as well. Modular weapon system packages will provide this system flexibility and will enable the employment of the airlift platform throughout the spectrum of conflict.

Presence

Military airlift platforms directly support power projection and presence.

> When this nation responds, mobility forces are no longer merely support forces. We use these aircraft to project influence. When those aircraft are sitting on a ramp in some far away country with that American flag on the tail they are not representing the United States of America, they are the United States of America.[3]

When the government wishes to de-emphasize involvement, commercial carriers are acceptable unless payload prohibits their use. Because official United States aircraft reflect national commitment and power, military airlift platforms provide political dividends that can exceed the benefits of cost savings achieved through commercial carriers. The media does not turn out to highlight commercial cargo but even one military transport can gain global attention when properly managed. "Media coverage of any future wars will by necessity weigh heavily in determining the level of national resolve, the degree of commitment, and the complexion of the response. . . . As the old adage goes, 'pictures don't lie,' and quite literally they speak louder than words."[4]

Special Handling Requirements

The military airlift network also transports payloads requiring special security and/or special-handling requirements. These payloads include: high-profile dignitaries, weapons of mass destruction, research, developmental test and evaluation materiel, hazardous materiel, equipment supporting compartmentalized operations, and international assistance programs. These operations support the military, other governmental agencies, and foreign governments. Additionally, oversized payloads, security, hazardous material, environmental control cargo requirements, and special-handling needs may also arise. Although many of these activities may be supported by commercial carriers if proper measures are implemented, the potential loss of control, conflicts of interest, security aspects, and political effects will make retention of military airlift support preferable.

The melding of airships and UAVs with the concept of operations recommended above will enhance the entire spectrum of air mobility operations. Most importantly, the revolutionary point of use delivery and extraction capabilities will enable the war fighter to aggressively and decisively prosecute the field of battle. Additionally, this concept shows potential for use by the commercial sector to enhance the cost effectiveness of cargo movement.

Notes

[1] Air Mobility Command *1996 Air Mobility Master Plan*. Scott AFB, Ill.: Air Mobility Command, 1995, 1–11 to 1–22.

[2] Maj Barbara Jefts, USAF, NC, interviewed by author, Maxwell AFB, Ala., 2 February 1996.

[3] Widnall and Fogleman, *Air Force Executive Guidance*, *December 1995 Update*. Washington D.C.: Department of the Air Force, 1995, 12.

[4] Marc D. Felman, "The Military/Media Clash and the New Principle of War: Media Spin," Maxwell AFB, Ala.: Air University Press, June 1993: 24–25.

Chapter 5

Conclusion

The realization of an air mobility system as extensive as that recommended in this paper demands the development and integration of a wide range of technologies (table 3). With the exception of low visibility enhancement and directed energy, each of the above technologies is currently being developed and validated in the commercial sector. Because of this, and given the continued paucity of defense research and development funding, we believe it is necessary that any new air mobility system evolve from the application of civilian technologies to the problem of airlift. Conversely, any system conceived and implemented by the military would ideally have some commercial applicability. If the military could demonstrate the technological feasibility of a concept and the civilian sector could demonstrate the feasibility of commercial applications of that technology, both sectors would benefit from the operation of common systems and any complementary infrastructure. This close cooperation would also enhance air mobility operations by providing sufficient resources to the commercial market for inclusion in a future version of the CRAF.

Table 3

Required Technologies

System	Technology	Advantage
Airframe	*Lightweight Materials	Lighter Weight, Higher Useable Lift Stronger Structures
	*Composites	Lighter Weight, Higher Useable Lift Stronger Structures
	Nanotechnology	Self Repair Expanded Environmental Operating Parameters Light Weight/Small Components
	Boundary Layer Control	Higher Speed Greater Fuel Efficiency
	Articulating Design	Allows Use In High Wind Gusts
Power Plants	*Ceramics/Metallurgy	Allow Higher Temperatures At Lighter Weights Greater Thrust
	*Advanced Fuels	Greater Efficiency
Aircraft Control	*Computer Processing	Maintenance Of Weight And Balance During On- and Off-load Operations Wind Gust Control *Enhanced Semi Autonomous Control
	Nanotechnology	Self Repair
	*Microinertial Navigation Systems	Reduction Of Weight And Space
	Lift Gas Processing	Pressure Stabilization Throughout Flight Regime
Materiel Handling Equipment	Robotics	Reduced Crew Workload
	Composites/Metallurgy	Lighter, Stronger Structures
Survivability	*Multispectral Sensors (w/enhanced computer processing)	early identification of threats *All Weather Operations
	Directed Energy (w/enhanced computer processing)	Defense Against Threats
Total Resource Visibility	Computer Processing	Allow Near Real Time Updates To Command And Control Elements
	Communications Across Known Electromagnetic Spectrum	Communications Security Simultaneous Access For Multiple Users

Note: * - applicable to UAVs

The physical aspects of the air mobility system recommended in this paper are evolutionary. It proposes systems that, with a modicum of technological development, could be in service by ***2025***. The concept of operations proposed for the air mobility system of ***2025*** is, however, revolutionary. It represents the application of technology to the capabilities we believe will be required to meet the logistics needs of our military at that time. These capabilities include responsiveness, point-of-use delivery, direct extraction from point of use, interoperability, intermodality, survivability, and long unrefueled range. While some of these activities are possible today, they are not performed at the level and with the consistency that must exist in ***2025***.

For the concepts proposed in this paper to become a reality, two events must occur. First, the ever widening gap between airlift requirements and airlift capability must be acknowledged. Advanced war-fighting systems are of little utility if the warrior is unable to sustain, or even join, the fight. Second, emphasis must be placed on those systems that best solve the problems future conflicts present. Adherence to the adaptation of archaic systems and ideas to the problems of the future (as the French did before World War II) only serve to delay the inevitable: the catastrophic failure of a system in the face of requirements it was never capable of addressing.

The systems presented in this paper address our future air mobility concerns. It is our hope that what we propose will stimulate a debate that will lead to the development of innovative solutions to the air mobility problems before us.

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