



**WING IN GROUND EFFECT AIRCRAFT:
AN AIRLIFTER OF THE FUTURE**

GRADUATE RESEARCH PROJECT

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Abstract

The genesis of this research was the USAF Scientific Advisory Board's advanced air and space ideas study, New World Vistas, and its mobility volume's analysis of the WIG. This research project was a more in-depth look into the WIG's feasibility and capability. The research looked at how the WIG helps meet the national security strategy of "global engagement," and the resulting growth in expeditionary demands on the DoD. Thus, the research question was: *Should the WIG be the DoD's next mobility platform?*

This research decomposed the basic research question into two: (1) *Does the DoD have a strategic lift shortfall based on National Military Strategy?* and (2) *Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?* First, the analysis focused on the national security strategy, the resulting national military strategy, the USAF Strategy, and rapid global military service requirements, based on these needs, and finally, the culminating mobility shortfalls associated with these strategies, to include the Mobility Requirements Study for 2005. Second, the analysis focused on future airlift requirements, platform alternatives, unique WIG characteristics and the factors that favor the WIG, a Korean scenario using ASCAM and a WIG fleet, the multiple uses and affordability of the WIG, and the technological vision and guidance from the new administration.

Overall, this study establishes the importance, and shortfall, of mobility airlift in meeting the nation's global engagement strategy, and the fact that, because of its unique characteristics, the WIG is the platform of choice to help fulfill this global strategy as the DoD's strategic airlifter of the future.

WING IN GROUND EFFECT AIRCRAFT: AN AIRLIFTER OF THE FUTURE

Chapter I

Introduction

Strategically, time and space are relative, and as the history of war has shown again and again, a handful of men at a certain spot at a certain hour is frequently a far more powerful instrument of war than ten times the number on the same spot twenty-four hours later

-J.F.C. Fuller

Background

The United States national interests dictate national security strategy. The current strategy can best be called “global engagement.” The U.S.’s national interests are global, and projecting its military through “global engagement” is a necessity. The 21st century holds many unknowns for this country and for its military. The national command authority (NCA) may find it necessary to call upon its military to deploy in support of its many national objectives, including conventional deployments, aeromedical evacuations, military operations other than war, foreign humanitarian assistance, noncombatant evacuation operations, and many other engagements that are vital to the U.S.’s national interest (DoD, 1996a:v).

Recent history may be the best litmus test in determining our military deployment future. Since the end of the cold war, there have been 99 major commitments of the U.S. military. The Army’s commitments have increased over 300 percent in the last 10 years, the Navy’s ship deployments have increased 52 percent in the last 6 years, and the

number of Air Force deployments have increased over 400 percent since 1986. While there has been a great increase in commitments, the military has gone through a significant decrease in size. The Army has reduced its personnel by 40 percent, the Navy has reduced its ships by 30 percent, and the Air Force has reduced its personnel by 30 percent (We're, 2000:n.p.). On top of all of this, the U.S. continues to drastically reduce the number of overseas military installations.

What does this mean? As a result of this decrease in force strength and overseas basing, the nation finds its military forces primarily based in the U.S. Yet, the U.S. still has an increase in global interest and “global engagement.” To accomplish the nation’s needs of global presence and engagement, the national military strategy has relied on Rapid Global Mobility (RGM). Using transportation terms, in effect, the U.S. has substituted its overseas “inventory” with rapid and efficient mobility. Military force projection is critically dependent on these mobility forces. This is spelled out quite clearly in AFDD 2-6, Air Mobility Operations:

US national interests drive the national security strategy of “global engagement.” Our dependence on political, economic, and military partners demands a military capable of operating on a global basis. Rapid global mobility is essential to that capability. This is especially true today where smaller, more continental United States (CONUS) based force must be able to rapidly respond to unpredictable threats wherever and whenever they occur. **Quick and decisive response can diffuse crises before they escalate, deter further aggression, or in some cases, defeat an adversary before it can solidify its gains.** Air mobility forces provide joint force commanders (JFCs) with the responsive global reach necessary to achieve US national objectives (DAF, 1999: 1).

RGM is one of the six core competencies of the USAF. In fact, it may be the one core competency that enables the other five. AFDD 1, Air Force Basic Doctrine states,

“global mobility has increased in importance to the point where it is required in virtually every military operation (DAF, 1997:33).”

It is RGM that enables power projection, in-time, where it is needed. Through RGM, the U.S. is able to project influence anywhere in the world, within hours. Again AFDD 2-6 states it appropriately, “The ability to move rapidly to any spot on the globe ensures that tomorrow, just as today, the nation can respond quickly and decisively to unexpected challenges to its interest-air mobility makes this possible (DAF, 1999:8).”

In addition to the national interests and objectives stated above, it is essential to consider global mobility requirements in light of the DoD’s plan for a Major Theater of War (MTW) deployment. For a MTW, the USAF plans to deploy 5 Aerospace Expeditionary Forces (AEFs) in 15 days (about 25,500 tons of cargo and 10,000 passengers), the USA plans to deploy a brigade (13,000 tons of cargo and 4,000 passengers) in 96 hours, two more brigades 24 hours later, and 15 total brigades within 30 days, and the USMC plans to deploy 15,000 passengers within 7 days to meet their 7 prepositioned ships of equipment (Merrill, 2000). Assuming a C-17 load of 100,000 lbs (and Tanker support?) and a commercial Boeing 747 load of 400 passengers, this deployment equates to approximately 1000 C-17 cargo loads and 70 Boeing 747 passenger loads, the first week alone.

Transportation Command (TRANSCOM) is not equipped to handle these requirements, through lack of airlift, tanker support, and speed of sealift. In that light, Congress ordered a study of the DoD’s airlift fleet and for a DoD reexamination of its stationing plans. The study, Titled the Fiscal 2001 National Defense Authorization Act, states that, “[S]trategic lift is the most compelling deficiency theater commanders-in-

chief [CINCs] would face in prosecuting two regional wars simultaneously. At issue is whether the Pentagon could transport sufficient manpower and equipment fast enough by air and sea if, for example, the U.S. were at war with both Korea and the Middle East (Mann, 2000:56).” All of this is in line with the Mobility Requirements Study 2005 (MRS-05) which indicates nearly a 10 million ton miles per day (MTM/D) shortfall for wartime airlift (Wolfe, 2000:1). This strategic, wartime airlift shortfall is important, since this research will try to find a possible answer to meeting this mobility demand.

The use of scarce strategic airlift capability is controversial. The U.S. Army and U.S. Air Force disagree on many aspects of warfare, joint doctrine, and deployment strategy. However, based on the anticipated shortfalls in airlift, both agree on the need for more strategic airlift capability. This mobility awareness comes on the heels of our experiences in Desert Storm and Operation Allied Force. Simply put, the reduction in overall military force size and the CONUS basing of the bulk of this force have left the military with an airlift shortfall. What is debated is just how much more airlift is needed, what systems to acquire, and the acquisition strategy.

One way to solve the shortfall in strategic airlift capability may be with a new, and innovative “global range” transport. With tanker limitations, enroute facility limitations, maximum on ground (MOG) limitations, and many other factors effecting global reach, the standard “T-tail” aircraft platform may not be the answer to the mobility shortfall problem. Maybe the DoD needs a paradigm change in its mobility airlift fleet. The Wing-in-Ground (WIG) effect aircraft may realize a new airlift paradigm. The WIG is not new to the DoD. The Martin P6M SeaMaster, shown in Figure 1, was flown in 1955 and was meant to be the Navy’s nuclear ballistic missile platform. Unfortunately,

the Navy lost a bitter struggle with the Air Force over this leg of the “Nuclear Triad,” and the plane was cancelled. Even with its superior speed and mobility, the plane was passed over in favor of the Air Force’s option, the B-52.



Figure 1. Martin P6M Seamaster (Martin, 2000:n.p.)

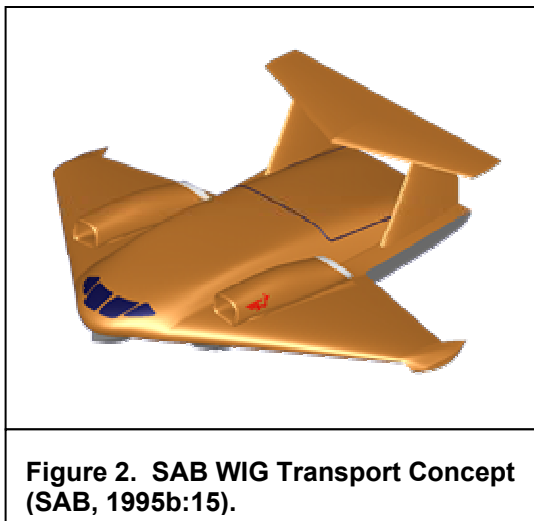
Although the WIG aircraft design may have been shelved by the DoD, it may be time to give this concept new life, just as the DoD did with the B-49 Flying Wing.’s technical rebirth as the B-2. The WIG is an innovative concept that may bridge the gap between the much-needed speed of airlift and the much-needed capacity of sealift.

President George W. Bush embraced innovative concepts when he said, “Our goal is to move beyond marginal improvements to harness new technologies that will support a new [military] strategy (Sanger, 2001:1).” New Secretary of Defense (SecDef) Donald Rumsfeld and his appointed Strategic Review expert, Andrew Marshall have shown favor to new weapon systems that break from the Cold War mold. The new Strategic Review, thought to be approved by both SecDef Rumsfeld and the President, is expected to show radical changes in today’s military. The report hints at “shifting future defense funds away from giant aircraft carriers, tanks and warplanes that now dominate the force toward a new generation of lighter, smaller [airlift mobility requirements], and stealthier weapons . . . for a fundamental change toward a leaner, nimbler military (Moran, 2001b: n.p.).” It appears that the President and SecDef are looking, in their words, “to skip a technology generation.” With this technology vision and a decidedly increased need for

airlift, the WIG could be the airlift platform of the future, and meet the DoD's growing mobility requirements.

Purpose

The purpose of this research is to show that the WIG may be a viable platform when considering the next mobility aircraft to help solve the DoD deployment challenges inherent in "global engagement." The genesis of this research paper is the USAF Scientific Advisory Board's (SAB) 1995 New World Vistas Study. This SAB study was, in the words of General Ronald Fogleman, Chief of Staff of the Air Force, a "search for the most advanced air and space ideas and project them into the future (SAB, 1995b)."



The SAB focused one area of their study on mobility. They looked at 19 mobility concepts, including the WIG, the global range transport (GRT), and many other mobility aircraft concepts. A picture of the SAB WIG concept is seen in Figure 2.

Although the SAB rated the WIG as number 14 in priority, this research will attempt to show that there may be new, or better defined issues that effect the priority listing of the WIG.

This research will examine the viability of the WIG by addressing current issues like MRS-05 mobility shortfalls, combining projected future system concepts such as GRT and fast sealift into one concept (WIG), multiple military uses of WIG such as air defense missile-ships, Recce, SOF/Seal transport, rescue, counter-mine operations, and

finally, the commercial application of WIG. This research is important to AMC, TRANSCOM, and the DoD, due to the fact that it will attempt to address mobility airlift and sealift needs, and the benefits the WIG offers the entire Defense Transportation System, the benefits to other services through multiple applications, and finally to the commercial air carrier market. Overall, the goal is to show that, conceptually, the WIG may now be a very possible and practical answer to the DoD's future mobility needs.

Research Questions

The research theoretical argument is that the WIG may be a practical solution to meet our future mobility needs. The research question is: *Should the WIG be the DoD's next mobility platform?* To answer this research question the following factors are taken into consideration. First, there must be a mobility shortfall, which based on national military strategy, defines the DoD's mobility needs (requirements). Second, the need should be met with the most practical platform in terms of strategic mobility performance, unique capabilities, such as modularity, commercial application, affordability, and one that meets the President's mandate for technological innovation.

Based on these two main factors, this research paper attempts to answer the research question by answering the following two investigative questions:

1. *Does the DoD have a strategic lift shortfall based on National Military Strategy?*
2. *Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?*

Preview

This chapter provides an overview of the research, the background of the problem, the purpose and justification of the research, and finally, the overall research question and the associated investigative questions. Chapter II represents a review of the literature on the WIG. To better understand the results of the investigative questions, Chapter II explains the basic technology of the WIG. Note, this paper assumes technical feasibility of the WIG, and is thus a conceptual study of the WIG's uses and applications. Chapter III represents the methodology of this research used to answer the investigative questions in Chapter IV. Chapter IV is divided into two sections representing the two investigative questions presented above. Finally, Chapter V presents the conclusion of the results and recommendations based on the research.

Chapter II

The whole of science is nothing more than a refinement of everyday thinking.

- Albert Einstein

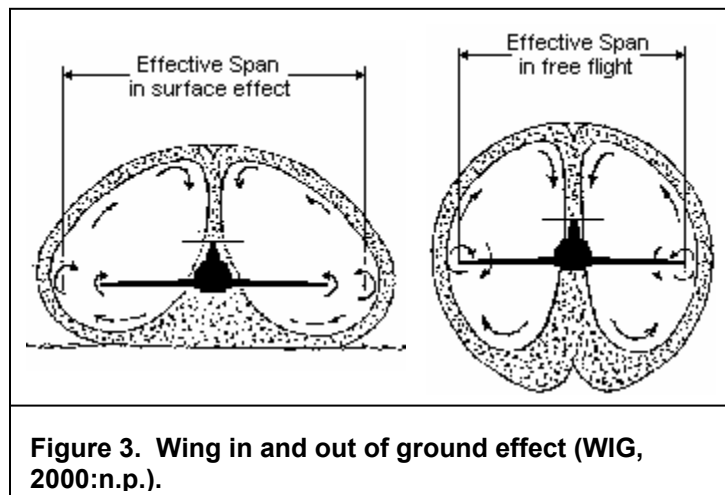
Background

This chapter provides a general review of the fundamentals of WIG flight, a history of the WIG, and a look at the current and projected uses of the WIG and the state of today's WIG technology. This overview is intended to provide a basis of understanding of WIG technology, facilitating the examination of the investigative questions in Chapter IV.

What is the WIG

As covered previously, WIG stands for Wing-in-Ground effect. Other terms used to describe the WIG are wing-in-surface effect ships (WISES), aerodynamic ground effect craft (AGEC), ram-wing surface effect boats, ram-wing vehicles, air cushion vehicles, hoverplanes, wingships, flying boats, and ekranoplanes (Russian for “screen plane” or “low-flying plane”). The generally accepted name is the WIG, so this paper addresses all surface effect aircraft types as WIGs (Wing, 1998:n.p.).

WIG aircraft usually fly close to the surface where ground effect reduces drag and increases lift. Ground effect reflects the wingtip vortex,



much like the winglets on modern airliners do, and in effect, creates an effectively larger wing-span (Wingship, 2000:n.p.). Unlike winglets however, ground effect creates an incredible amount of additional lift, while greatly reducing drag. Figure 3 shows the aerodynamic effects of flying next to the surface. The airflow and associated dynamic cushion of air seen in Figure 3 is created by the WIG's own forward movement (Trottman, 1997:n.p.).

WIGs typically are amphibious and fly close to the water to take advantage of the relatively flat surface. Hovercraft are similar to WIGs as they typically fly over water on a cushion of air. However, hovercraft have fans that continuously blow up a static air cushion which they require to move. WIGs are simply aircraft designed to take advantage of ground effect (Wing, 1998:n.p.). In fact, any aircraft can fly in ground effect if it stays within one-half of its wingspan to the ground. For example, a C-5's ground effect height is 111 feet, half of its 222 foot wingspan. WIGs are made specifically to maximize the efficiencies of flying in ground effect and because of the reduced drag, can efficiently fly on one-fifth the power and one-fifth the fuel of a similar sized aircraft flying at altitude (Dane, 1992a:n.p.).

The WIG aircraft has several key advantages over typical aircraft. Since it can fly on one-fifth the fuel while in ground effect, WIGs can fly further and carry more payload (in place of fuel) than traditional aircraft, and at nearly the same speed. Airspeeds range from 75 knots for the small turbo-prop aircraft to 400 knots for the larger jet aircraft (Donaldson, 2000:n.p.). Another advantage includes safety. Compared to high altitude flight, ground effect flight is safer due to the tremendous stability of the air cushion created by the WIG and the ability for water landings (Wingship, 2000:n.p.).

The WIG also has the flexibility to land anywhere. The WIG can land at airfields, like any other aircraft, and it can land on the water, unlike many other aircraft. The WIG can in fact go many places ships and airplanes cannot go. Any beach, jetty, lake, or river can be an airfield for the WIG (Wing, 1998:n.p.).

WIGs are also inherently stealthy, with a low radar and infrared signature, and are difficult to detect by satellite (Trottman, 1997:n.p.). Low flight profiles increase radar ground clutter, thereby concealing the aircraft.

In all, the WIG may be a perfect military platform for fast troop and equipment movement and as a strike platform both from the land and by sea. Military benefits of the WIG are the main focus of this research and will be covered in detail in Chapter IV.

History of the WIG

Man was not the first to recognize the benefits of surface effect flight. Pelicans and other seabirds have skimmed just above the ocean waters for hours without the need to flap their wings. These birds have learned how to efficiently ride the smooth, naturally occurring air cushion known as ground effect (Wingship, 2000:n.p.). It took man a much longer time to realize the phenomenon of ground effect. In fact, the Wright brothers never got out of ground effect in their first flights, and probably would have never flown if it were not for ground effect. They did not even know that ground effect existed. The first theoretical research on ground effect was done in 1920. This early research introduced pilots to ground effect, and to use it to their advantage.

Aircraft like the flying boat Dornier DO-X could only make it across the Atlantic in ground effect and the HK-1 “Spruce Goose” flew its entire 90-second flight in ground effect. In WWII, pilots knew that when they lost an engine in combat they could make it

back to base by flying a few feet above the water, and taking advantage of ground effect to save power. These are just a few examples of the “informal” use of ground effect.

The “formal” use of ground effect started in 1935, when the Finnish engineer, Kaario, built a ground effect snow sleigh. However, he ran into stability problems and the project died. In 1940, a Scandinavian engineer, Troeng, made the first attempt at a truly, water-borne WIG. However, like Kaario, his WIG faced stability problems and he never finished his project (WIG, 2000:n.p.).

In the 1950s, Martin of the United States worked on the P6M Seamaster, seen in Figure 1 of Chapter 1. The first P6M flew in 1955 and a second flew a year later. Martin earned a contract to build six pre-serial planes. The flight testing resulted in a contract for the production of 24 aircraft. However the P6M lost out to the B-52 as the country’s long range nuclear bomber and the contract was cancelled in 1959. This was a bitter defeat for the Navy since they felt that the Seamaster was superior to the B-52, because of its range and speed, and its unique characteristic of being independent from large air bases that were subject to first strike, a real concern at the time. One final advantage this aircraft had was that it could be refueled anywhere in the world by submarines or ships. Unfortunately, the Navy destroyed all the P6Ms and consequently the US’s interest in WIG type aircraft (Martin, 2000:n.p.).

Between the 1960s and 1990s, the USSR was the steward of WIG research and development. Development took place under ultra-high secrecy, at the Central Hydrofoil Design Bureau, a naval hydrofoil ship design facility. The military potential of the WIG was so great that the program received personal support from Premier Krushchev, and essentially, unlimited funding. The Soviets developed several early versions. In 1966,

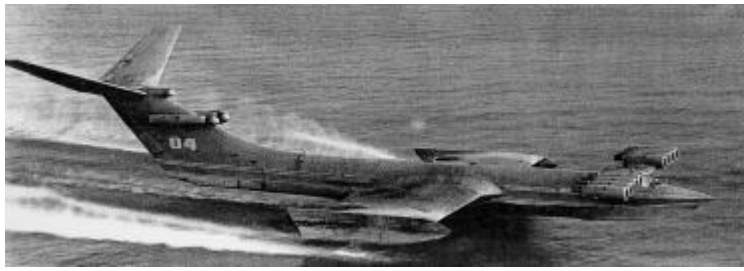


Figure 4. Caspian Sea Monster (WIG, 2000:n.p.).

their research culminated in a historical flight of the 550 ton WIG seen in Figure 4. This aircraft was 100 times heavier than any previously built WIG (WIG,

2000:n.p.). A Defense Intelligence Agency (DIA) analyst studying satellite imagery named the aircraft “Caspian Sea Monster”, as he watched this strange ship flying over the Caspian Sea (Losi, 1995:3). This aircraft was obviously the most advanced WIG yet.

The Soviets envisioned the WIG as an over-the-horizon amphibious transport to move men and weapons from within the USSR into Eastern Europe. The fuselage had a nose ramp for seaborne marine assault. A typical scenario included a mass armada of WIGs deploying across the Black Sea into Turkey. The Soviet’s ultimate plan was to use a fleet of 120 WIGs in lieu of forward basing in some areas (Starr, 1989:195).

The Soviet’s next WIG design was the 125 ton Orlan A90 series, as seen in Figure 5. The Orlan was an improvement over previous Soviet designs, with sprint speeds of 350 miles



Figure 5. Orlan A90 (WIG, 2000:n.p.).

per hour (Starr, 1989:195). The single deck version could carry 150 troops at 240 mph for 1200 miles. A twin deck version could carry 300 troops, and both versions could carry 28 tons of equipment (Dodds, 1991:7). These aircraft were built in the 1970s.



Figure 6. Lun (WIG, 2000:n.p.).

The Soviet's final major WIG design came in 1987 with the Lun, a missile platform with six top-mounted SS-N-22 containers as seen in Figure 6 (Cherikov, 1989:548). Versions of this aircraft were considered for

passenger service and as a rescue vessel.

While the Soviets made great progress with their WIGs, other smaller-scale designs were tested in Japan and the US. The most important of these came from Alexander Lippisch, the father of the delta wing. The X-112 WIG, he designed was just as revolutionary as his WWII Me163 rocket powered delta wing plane. The X-112, seen in Figure 7, proved to be extremely stable. However, Collins Radio Company of the US, where Lippisch worked, sold the patents to the German Company, Rhein Flugzeugbau (RFB). The X-112 would become the model for most all small-scale WIG designs to come (WIG, 2000:n.p.).



Figure 7. Lippisch' X-112 (WIG, 2000:n.p.).

Since the WIG is ideally suited for heavy airlift, anti-submarine warfare (ASW), and maritime patrol, many western aerospace firms put forth WIG designs during the 1960s and 1970s. Studies and designs included a 100 ton WIG developed under a contract by the US Maritime Administration (WIG, 1993:n.p.). The US looked at the

WIG to meet its need for a large transport aircraft, but opted instead for the Lockheed C-5 (WIG, 2000:n.p.). In 1977, Lockheed proposed a 700 ton ASW and cargo WIG as part of a US Navy Advanced Naval Vehicle Concepts Evaluation (WIG, 1993:n.p.).

Unfortunately, none of these designs were built. Other than the small-scale design concepts such as Lippisch's, the only real WIG design progress was made by the Soviets.

In all, the USSR pursued the most advanced large WIG concepts. In 1984, Steven Hooker, an aeronautical engineer and DIA analyst, believed so strongly in the Soviet's efforts, that he left the DIA to pursue the full-scale development of a practical WIG transporter. Hooker's company focused on a WIG design that was over 12 times the weight of a B-747, but could carry over 30 times the payload. It could fly with 44 percent fuel savings, at a speed of 400+ knots. Hooker envisioned a commercial and military vehicle that could deliver a large payload of 1,500 tons, quickly, and at a low cost (Losi, 1995:4).

Congress was lobbied by Hooker's Aerocon Company to look into the WIG's potential as a solution to the military's long-standing mobility shortfall. In 1993, Congress appropriated five million dollars for the Pentagon's Defense Advanced Research Projects Agency (DARPA) to determine the military's need for the WIG (Losi, 1995:5). The study was an evaluation of international WIG technology. It took into account designs in Sweden, Japan, and China, but focused mainly on the work by the Russians. Government and industry experts, to include DARPA, Aerocon, and Lockheed conducted the study. The team made two visits to the Soviet Union to assess the Soviet's WIG designs (WIG, 1993:n.p.).

DARPA's main objective was to look at the technical feasibility of the WIG. Ultimately, the study showed that the Soviet design, although a comprehensive 30 year effort, was nothing more than an inefficient and excessively heavy flying boat. An unfortunate fact is that ship builders, not aircraft builders, built the Soviet WIGs. DARPA and industry experts determined that the Soviet WIG design was not technically acceptable and that the pursuit of the WIG as a transporter was not feasible at that time (Losi, 1995: 9). Hooker's Aerocon proposal also lost favor. Until there was proven and useful large-scale WIG technology, Hooker's and the Soviet's vision of a "wingship" transporter would have to wait. It was back to the drawing board for a large-scale WIG.

Current Systems and Technology

Back to the drawing board meant taking a look at proven, successful technology and looking at a more feasible large-scale WIG design. The Soviet's design was not technically useful, and Hooker's design was not practical. DARPA concluded that the Soviet design could benefit from advanced materials like composites and have more sophisticated flight controls (WIG, 1993:n.p.). On top of this, the overall design of the Soviet WIGs could benefit from reengineering to break away from the flying ship mold. This poor design was evident in the fact that their WIGs could not fly out of ground effect, and that the aircraft skin was made of three-quarters inch thick aluminum sheeting (Donaldson, 2000:n.p.).

Hooker's design was too big. There was no data or history on anything of the size that Hooker was proposing. His design, at 5000 tons, was nearly ten times the size of the Soviets largest WIG. DARPA believed that an order of magnitude jump such as this would pose a serious engineering problem. DARPA's next concern was cost. They

feared that Hooker's design could cost over \$60 billion in developmental cost alone. Finally, like the Soviet's design, Hooker's design had the problem of large take-off power requirements. DARPA stated, "the large power requirement associated with take-off is the single greatest impediment to overall efficiency and utility of this vehicle and must be overcome if wingships are to become efficient transporters (Losi, 1995:9)."

This power requirement, and getting out of the water, has been a main reason for the slow development of the WIG. Another reason for slow development was the size of the proposed aircraft. To be safe and efficient at trans-oceanic transport, a WIG design must be big. How big is the question. Investment in a super-sized WIG is difficult if the technology is not proven on smaller designs (WIG, 2000:n.p.). Somewhere between Hooker's vision and Lippisch's design may be the right answer.

WIG technology in general has progressed over the past two decades. There have been numerous designs that have proven important in demonstrating technology, building on operational experience, and initiating certification rules. Over the last 20 years, there has been a great advancement in the small-scale WIG designs. In conjunction with the rapid advancement in material, engine, and design technology over the last 10 years, these designs may have just laid the foundation for the future of the WIG transport.

Since 1980, several countries have developed Lippisch-type WIGs. These developments have advanced WIG technology, and have been very useful in the commercial transportation sector. An example is the German RFB X-114, which was based on the purchased patent rights to Lippisch's WIG designs. Both the commercial and the military versions of the RFB X-114 showed great stability and efficiency. The RFB-114 is shown in Figure 8. One of RFB's engineers, Fischer, started his own

company, and has built a very successful family of WIGs. In fact, his eight seat Airfisch 8, used as a water taxi, went into series production in 2000. Additionally,

Germany is currently sponsoring a R&D program for the development of an 80

passenger fast-ferry WIG. Three German companies have already conducted research and demonstrated prototypes of fast-ferry WIGs (WIG, 2000:n.p.).



Figure 8. RFB X-114 (WIG, 2000:n.p.).

Although the Soviet large WIG designs were not useful, they did pursue several small versions at their Hydrofoil Design Bureau. These designs included circular wings, Lippisch designs, and converted aircraft. In 1985, their research led to the development of the Volga-2, shown in Figure 9. The Volga-2 was a very effective WIG, and series



Figure 9. Volga-2 (WIG, 2000:n.p.).

production started soon after. However, financial problems halted production.

Because of these problems, some engineers left the Bureau and formed their own company, Technologies and Transport (TET). The TET design was the Amphistar, a very similar WIG to

the Volga-2. TET teamed up with Pacific Technique Development, which combines Russian technology and Asian money to pursue markets in the west. The joint venture is

called Amphistar USA, and the aircraft is called the Xtreme Xplorer. By 1999, the Russians had built ten Xplorers (WIG, 2000:n.p.).

One other interesting series of designs by the Soviets was the S-90 passenger and cargo amphibious WIG family. These designs featured high speed, comfort and cost effectiveness. They incorporated new aerodynamics, advanced scientific and engineering solutions, advanced power plants, and advanced on-board equipment. The development of the S-90-8 was aimed at creating a base-line vehicle that they could build, test, and gain experience in order to proceed with the much larger S-90-200, seen

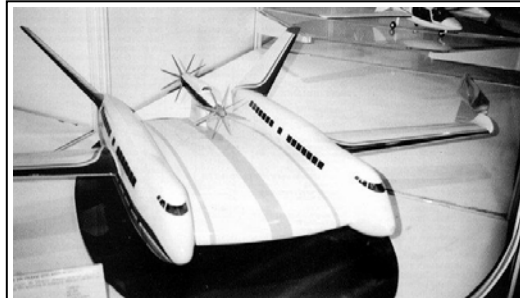


Figure 10. S-90-200 (Wing, 2000:n.p.).

in Figure 10. This process was a model for WIG technology growth and technical risk reduction. The S-90-200 was designed for a maximum speed of 292 mph, a maximum range with 220 passengers of 4,968 miles, a maximum flight altitude of 4,920 feet, a ground effect altitude of 6.6 to 18 feet, and a maximum payload of 44,080 lbs. In the 1990s, the S-90 plans were frozen as basic designs for further investigation. Like the Volga-2, the Soviets ran out of money to pursue the development of these craft (Wing, 2000:n.p.).

The Soviets clearly exported their WIG technology to China. In 1999, China began building a WIG to carry 100 lightly armored troops for the People's Liberation Army and Navy. This capability may prove to be highly effective for troop transport and beach assault in scenarios such as a Taiwan invasion. China has already built the 15 seat, Hubei TY-1, shown in Figure 11. The TY-1 has a top speed of 140 knots, an endurance

of two hours, and cruises at a height of 3 to 16 feet above the water (China's, 2000:n.p.).

This design is based on the Volga-2, and is speculated to be the prototype for a new, substantially larger WIG (Sae-Liu, 1999:n.p.). China currently has two different groups working on



Figure 11. Hubei TY-1 (WIG, 2000:n.p.).

WIGs, the China Ship Scientific Research Centre and the China Academy of Science and Technology Development. China also started work on an advanced Lippisch type design, called the XTW-2 (WIG, 2000:n.p.).

Australia has accelerated their WIG efforts. Studies are under way at the University of New South Wales and by the Institute of Marine Engineers in conjunction with Russia's Marine Technical University in Saint Petersburg. There are currently four companies working on WIGs. Two of the companies have already fielded vehicles both as passenger planes and as coastal patrol vessels (Park, 1996,n.p.). Australia sees a great benefit in the use of WIGs between the islands of the Great Barrier Reef, along its expansive coastline, and across its flat mainland areas (Trottman, 1997:n.p.).



Figure 12. Wingship's test model (Wingship, 2000:n.p.).

There has been growing interest in the US, although not to the extent of other countries. Many smaller companies like Flarecraft, Hydroflyht, Wingship, and Hydroski are pursuing Lippisch type designs for commercial and recreational uses

(WIG, 2000:n.p.). The recreational interest revolves around designs such as the one shown in Figure 12. Hydroski has signed a production agreement to build a line of jetski type WIG craft. Hydroski plans to further develop commercial and military vehicles as they build on their technology and experience (No, 2000:n.p.). The commercial interest revolves around using WIGs as fast ferries. This paper will go into more detail about commercial WIG use in Chapter IV. It is important to note that many US companies see the great benefits WIGs may offer and have been positively influenced by WIG efforts in other countries.

The various research and development efforts cited above have brought the technology to a level that makes the large-scale WIG feasible. There is now a large database of WIG technology that can be passed on to large-scale designs. In addition, many of the technical limitations of the past have been answered with the use of new composite materials, new power plants designs, and especially new hull designs. The catamaran hull design seen in Figure 12 is prevalent in most recent WIG designs. This hull design cuts down on water-drag and decreases take-off power requirements. It also allows for better shallow water use and more beaching applications (Wingship, 2000:n.p.). Other WIG technology advancements include the use of terrain following radar and the ability to conduct high altitude flight.

One final note on the state of WIG technology involves the efforts by the US Navy and Lockheed Martin. The Navy has been looking at the WIG to perform roles such as ASW, counter-mine warfare, theater ballistic missile defense, sea interdiction and strike, ship and submarine resupply, and rescue operations. The Navy is showing great interest in WIG use and has just appropriated a large amount of money to the Naval Air



Figure 13. British Avro Vulcan XL426 (Donaldson, 2000:n.p.).

Studies Unit at Patuxent River NAS.

Although the Navy has tested several WIG designs, they have now focused research around a delta-wing type WIG. The Navy has used a great deal of data from Vulcan flights in ground effect. The Vulcan is shown in Figure 13. This data is critical,

since many characteristics of ground effect are not testable in wind tunnels. As far as a transporter, John Reeves, WIG Engineer at the Naval Air Studies Unit, states

A 170,000 lb payload and 6,000 nm range is certainly doable with a gross weight of 1.3 million lbs. However, the efficiency increases with size and that should give at least 10,000 nms and 500,000 lbs on the payload at 3.5 million lbs gross weight [up to 100 feet above the sea]. . . . Thus you have a Battlespace Dominance platform and commercially it would carry 1,000 passengers and 250 cars over the same distance (Reeves, 2000:n.p.).

Lockheed's efforts are very similar. Since their efforts are proprietary, this report can not cover the specifics of the Lockheed design characteristics. However, Larry Donaldson, Director, Advanced Technologies for Lockheed Martin Aeronautics Co. stated

I have been working the field of surface effect for almost ten years. I was under contract to DARPA in the early 90's doing formal assessment of Russian WIG capabilities, technologies and roles and missions. [Their] biggest negatives . . . were altitude limitations and extra power required to get up and out of the water. As a result, we initiated an IRAD [Independent Research and Development] program to develop an entirely new vehicle design . . . that could sea sit like a ship, fly in ground effect like a WIG, fly at altitude like a modern airliner, and be amphibious (Donaldson, 2000:n.p.).

Lockheed has focused WIG designs of C-130 and C-5 size. This allows for realistic parametric analysis. They have also looked closely at the Vulcan for delta-wing flight data in ground effect. In all, Lockheed sees the same opportunities that the Navy sees in the use of the WIG, to include additional roles such as reconnaissance, Special Operations and SEAL transport, strategic sealift and airlift, global and theater strike, and civilian use in cargo carrying, firefighting, and environmental missions (Donaldson, 2000:n.p.).

This chapter looked at the technical concepts of the WIG, its history, and its current development. Lockheed, the Navy, and many companies around the world are advancing WIG technology and providing the groundwork for future WIG designs. The designers today are finding that the optimum large-scale WIG design is a match of a Lippisch-type model and Hooker's dream of a large-scale WIG. With the application of the technologies above, a true large-scale WIG design is not only feasible, but also practical, and will soon be a part of the global transportation system. It may just be the right time for a revolution in transportation.

Chapter III

Methodology

To develop anything, the underlying thought and reason must govern, and then the organization must be built up to meet it.

- Brigadier General William “Billy” Mitchell

Background

The basic research question is: *Should the WIG be the DoD’s next mobility platform?* This research is not a technical feasibility study of the WIG, but a qualitative investigation of the mobility requirements of the DoD and the WIG’s possible use as the platform to meet future lift requirements. The basic research is predicated on the theoretical relationship between the constructs of mobility needs and shortfalls, mobility platform requirements and political technology demands, and practical and affordable production size through multi-service and commercial orders. This resembles any large military acquisition program: one must define that there is a need (mobility requirements) and then show that the system (WIG) is the best and most practical selection to meet that need. This research approach led to decomposing the basic research question into two:

- 1. Does the DoD have a strategic lift shortfall based on National Military Strategy?*
- 2. Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?*

Strategy

This research will answer the investigative questions individually using a thorough literature review to build a case for answering the overall research question.

Although the strategy for answering the investigative questions is mostly qualitative in nature, a small portion of the discussion of investigative question two will involve a quantitative modeling analysis.

The types of individual analysis and goals for answering each investigative question are defined in the following sections.

Investigative Question 1: *Does the DoD have a strategic lift shortfall based on National Military Strategy?*

The literature review will portray the critical nature of mobility, from our National Security Strategy through the National Military Strategy, to the Joint Staff's Strategy, to the Air Force's Strategy, and then to Air Mobility Command's Strategy. This NMS strategy will be weighed against the new administration's strategic vision for the military.

This includes researching the services Major Theater of War (MTW) deployment requirements. The research will specifically examine the Army's new Initial Brigade Combat Team (ICBT) vision and Air Force's new Aerospace Expeditionary Force (AEF) vision and why they will directly impact airlift mobility requirements. Along with these visions and mobility requirements, releasable portions of MRS-05 are examined to determine if there is a mobility shortfall and how a shortfall would effect AMC's future airlift force.

Investigative Question 2: *Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?*

The answer to investigative question two will involve the examination of the WIG's selection as the possible best choice for a future airlifter. This involves an

examination of the WIG's unique mobility characteristics, its multi-service and commercial use, its affordability, and its fit into the new administration's strategic review and force structure vision. The research investigation and answer to question two will be through a qualitative literature review and a quantitative model analysis.

The literature review in this section will look at previous military research studies and projects, research papers, interviews, and industry briefs. This research will attempt to show the WIGs importance in the mobility system, especially considering MOG, tanker support, and airfield accessibility. Also, the research will look at the WIG's unique characteristics, and why it might have the best capabilities to meet the future needs of the commercial and military National Transportation System (NTS).

This section will also look at the multiple service and commercial uses of the WIG. This will involve the examination of numerous military publications, future military and commercial concept studies, theses establish the viability of the WIG in multiple military roles and scenarios, previous studies and theses establishing the need to look at joint, military and commercial aircraft and their benefit to the Civil Reserve Air Fleet (CRAF), and a study that establishes multiple commercial applications of the WIG.

The purpose of this portion of the research will be to establish the multiple military and the commercial uses of the WIG. These requirements must be met before the production order, to include the mobility aircraft, is large enough to make the purchase of the WIG feasible, and answer whether the WIG is affordable.

The quantitative analysis in this section will involve using the Airlift & Sealift Cycle Analysis Model (ASCAM). ASCAM is a mathematical model designed to provide quick, rough estimates of closure, a measure of how long it takes to move cargo from one

point to another for deployment of units and cargo (O’Fearn, 1998:8). This research will use ASCAM to run several iterations of the same “US West Coast-Korean” scenario to compare the results, based on changing the airlift assets. The analysis will first focus on the closure time using an airlift fleet of C-5s, C-17s, KC-10s, and KC-135s. Subsequent analysis will (1) replace C-5s with the WIG and (2) replace C-5s and C-17s with the WIG. These results will provide a rough indicator and general overview of the WIGs impact on the mobility system. ASCAM is used because of its ease of use and simplicity, and the fact that higher power modeling is neither necessary nor feasible in the conceptual framework of this study.

The literature review and the analysis will be tied into the President’s and SecDef’s new military strategy. In particular, is the WIG the type of system that the new administration is looking for to meet our country’s future technology needs?

Summary

The answers to the investigative questions should lead to a clear understanding of the factors that dictate a new mobility platform procurement and in particular answer the overall research question: *Should the WIG be the DoD’s next mobility platform?* The bottom line of the results section should be to establish a mobility need and shortfall, show that the WIG is the best selection to meet that need, and that the WIG can be affordably produced.

Chapter IV

Results

Air power may be defined as the ability to do something in the air. It consists of transporting all sorts of things by aircraft from one place to another, and as air covers the whole world there is no place that is immune from influence by aircraft.

-William “Billy” Mitchell

This chapter builds a qualitative case that answers the overall research question: Should the WIG be the DoD’s next mobility platform? The analysis in this chapter answers the two supportive investigative questions. The ultimate results establish a mobility need and shortfall, and show that the WIG is the platform of choice to meet that mobility need. The following are the results of the analysis of the two investigative questions.

IQ 1 – National Military Strategy and Rapid Global Mobility Needs

I have directed prompt action to increase our airlift capacity. Obtaining additional airlift mobility – and obtaining it now – will better assure the ability of our conventional forces to respond with discrimination and speed to any problem spot on the globe at any moment’s notice. In particular, it will enable us to meet any deliberate effort to avoid or divert forces by starting limited wars in widely scattered parts of the globe.

-President John F. Kennedy
State of the Union Message, 30 January 1961

Investigative Question 1: *Does the DoD have a strategic lift shortfall based on National Military Strategy?*

In answering this question, the analysis focuses on the National Security Strategy, the resulting National Military Strategy, the United States Air Force Strategy, and Rapid Global Military Service Requirements, based on these needs, and finally, the culminating

mobility shortfalls associated with these strategies, to include the Mobility Requirements Study for 2005 (MRS-05).

National Security Strategy

As the Cold War environment of the past changes to a New World order, many of the steady influences on the country's security strategy have been replaced with complicated new threats and alliances. The U.S. no longer has one enemy to focus on, but now has to focus on numerous small-scale contingencies, humanitarian assistance operations, and at times, larger scale contingencies such as the Gulf War. Complicating this New World order is an increase in technology available to nearly every country, to include the enemies of the U.S. On top of this, the U.S. has decreased its overseas basing dramatically, while still finding it necessary to keep a strong presence around the world. This is in fact a perceived necessity, as many countries look to the U.S. as a stabilizing force around the world.

The Scientific Advisory Board stated it clearly, "After 1945, the United States moved to establish bases and influence abroad, but in 1995 we are reducing our physical presence abroad while we attempt to maintain a moral presence (SAB, 1995b:n.p.)." However, the moral presence is in the form of soldiers and equipment now "deployed" to areas where they were once were "stationed."

Although the U.S. was still in the heart of the Cold War, President Kennedy's words above would be quite prophetic in describing the country's security environment over the next 40 years. Mobility is at the heart of the country's global engagement. It is this global engagement that dictates the country's National Security Strategy.

The United States has always been, and probably always will be, interested in global events, and consequently finds itself engaged in influencing these global events. Former President Clinton stated, “Our strategic approach recognizes that we must lead abroad if we are to be secure at home (Clinton, 1998:n.p.).” Leading abroad means projecting the country’s national values. President Clinton went on to say:

National Security Strategy (NSS) must start with the values that we as a nation prize...values such as human dignity, personal freedom, individual rights, the pursuit of happiness, peace, and prosperity. These are the values that lead us to seek international order that encourages self-determination, democratic institutions, economic development, and human rights. The ultimate purpose of our National Security Strategy is to protect and advance those values (Clinton, 1998:n.p.).

This desire to project the nation’s values led to the Grand Strategy of engagement and enlargement. No matter the administration, the values of the nation will always be to seek the betterment of mankind, through engagement and enlargement.

The NSS is implemented through diplomatic, economic, and military tools that are closely coordinated to achieve the nation’s security objectives. However, it may appear that the burden of the NSS rests disproportionately on the U.S. military. All too often the nation calls upon its military as the instrument of choice to project and protect the country’s interest. The NSS looks to the military to effectively deter aggression, conduct a wide range of peacetime activities and small-scale contingencies, and at any moment, win two overlapping major theater wars (Clinton, 1998:n.p.).

A RAND study intended for the president-elect expressed this point:

Even in the absence of a super power rival, U.S. military strength remains a critical component of U.S. power, influence, and position in the world. The United States uniquely has the ability to project military power and sustain it over long distances. It is this capability that underpins all U.S. alliance and security commitments (Carlucci, 2000:28).

The report went on to say, “Since U.S. forces cannot be routinely deployed everywhere in large numbers, this puts a premium on forces that can deploy quickly to theaters where conflict is occurring and that can quickly seize the initiative (Carlucci, 2000:29).”

The NSS of engagement and enlargement falls squarely on the nation’s military. As a consequence, the National Military Strategy directly reflects the needs of the NSS. Given this extraordinary global environment and NSS, rapid global mobility will undoubtedly be the cornerstone of this nation’s security and global influence.

National Military Strategy

The National Military Strategy (NMS) supports the imperative of engagement set forth by the NSS. The NSS requires a national military that is capable of a wide range of military activities and operations to include deterring and defeating large-scale, cross-border aggression, smaller-scale contingencies, combating transnational threats like terrorism and the development and proliferation of dangerous military technologies, and responses to humanitarian Disasters (OSD, 2000:2). The U.S. is uniquely suited to be a leader in the world with its extremely capable military and its willingness to use the military to meet its global interest. In an effort to meet the NSS requirements, the NMS focuses on three elements. The NMS directs the Department of Defense (DoD) to:

[H]elp shape the international security environment in ways favorable to U.S. interest, respond to the full spectrum of crises when directed, and prepare now to meet the challenges of an uncertain future. These three elements – shaping, responding, and preparing – define the essence of U.S. defense strategy between now and 2015 (OSD, 2000:4).

The efforts of the three elements are to evolve the military's Cold War force structure into one of engagement as both an effective combat military able to win wars, and as one that is a critical non-combatant component of U.S. foreign policy in peace efforts. "Shape" means to shape the international environment in ways favorable to U.S. interests by promoting regional stability, reducing threats, and preventing conflicts. "Respond" means respond to the full spectrum of crises that threaten U.S. interests by deterring aggression and coercion in crisis, conducting smaller-scale contingency operations, and fighting and winning major theater wars. "Prepare" means prepare now for an uncertain future through modernization, programs to ensure high quality personnel, and hedge against threats that could emerge in the form of a regional power (NMS, 1997:3-4).

A factor influencing the accomplishment of these objectives is the two major theater wars (MTW) scenario. In Secretary of Defense (SecDef) Cohen's 1998 report to Congress, the importance of the NMS guideline was described by the following:

As a global power with worldwide interest, it is imperative that the United States, now and for the foreseeable future, be able to deter and defeat nearly simultaneous large-scale, cross-border aggression in two distant theaters in overlapping time frames, preferably in concert with regional allies. Maintaining the core capability is central to credibly deterring opportunism – that is, to avoiding a situation in which an aggressor in one region might be tempted to take advantage when U.S. forces are heavily committed elsewhere – and to ensuring that the [U.S.] has sufficient military capabilities to deter or defeat aggression . . . (OSD, 2000:7).

On top of this, the military does not know where these conflicts will occur, who they can count on to join in as a coalition partner, and ultimately what demands will be placed on the soldiers sent to meet these global challenges.

So how does the DoD meet the requirements of the NMS of Shape, Respond, and Prepare, and structure itself for two MTWs? Joint Vision (JV) 2010 and 2020 are guides to meeting these requirements. JV 2010 is:

[F]ocused on achieving dominance across the range of military operations through the application of new operational concept . . . [it] provides a common direction for our services in developing their unique capabilities within a joint framework of doctrine and programs as they prepare to meet an uncertain and challenging future (CJCS, 1996:1).

To that end, JV 2010 prescribes how the military will fight in the early 21st Century by focusing on four operational concepts: dominant maneuver, precision engagement, full dimension protection, and focused logistics (CJCS, 1996:1).

Dominant maneuver is the multidimensional application of information, engagement, and mobility capabilities to position and employ widely dispersed joint air, land, sea, and space forces to accomplish the assigned operational task. Precision engagement consists of a system of systems that enables forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess levels of success, and retain the flexibility to reengage with precision when required. Full dimension protection is the control of the battle-space to ensure forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses for forces and facilities at all levels. Finally, focused logistics is the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while enroute, and to deliver tailored logistics packages and sustainment directly to all levels of operation (CJCS, 1996:20-24).

JV 2010 states, “These four new concepts will enable us to dominate the full range of military operations from humanitarian assistance, through peace operations, up

to and into the highest intensity conflict (CJCS, 1996:25).” Just as with our NSS, the major enabler of these military tasks will be the overseas presence of the military, and the ability of the military to accomplish power projection throughout the world. JV 2010 expresses this importance by saying:

Power projection from the [U.S.], achieved through rapid strategic mobility, will enable the timely response critical to our deterrent and war-fighting capabilities. Our overseas presence and highly mobile forces will both remain essential to future operations (CJCS, 1996:4-5).

Joint Vision 2020 builds upon the guidance outlined in JV 2010. JV 2020 looks at dominant maneuver, precision engagement, full dimension protection, and focused logistics with an emphasis on joint operability from peace operations to full-scale war. JV 2020 also emphasizes innovation and the building of new military capabilities to meet the objectives of JV 2010 with a force that can carry America’s military into 2020.

JV 2010 and 2020 incorporate a total vision of full spectrum dominance which implies:

U.S. forces are able to conduct prompt, sustained, and synchronized operations . . . given the global nature of our interest and obligation, the [U.S.] must maintain its overseas presence forces and the ability to rapidly project power worldwide in order to achieve full spectrum dominance (CJCS, 2000:6).

The key words above are sustained, global, and rapid projection. Based on NSS, NMS, and JV2010 and 2020, global mobility is the key element in attaining nearly all military or national goals.

This need for mobility, tied in with global engagement, is what now dictates the focus of the U.S.’s military restructuring. The environment the military faces now is high operations tempo, over the entire expanse of the globe, in every type of scenario. As

hinted by JV 2020 and described by the USAF Scientific Advisory Board's New World

Vistas Study:

The operational demands generated by new missions, and the geographical constraints produced by a decreasing number of worldwide bases will require weapon system performance beyond that of existing systems. New technologies will permit improvement of existing systems, but new systems and new concepts will be needed to cope with the world of the 21st century (SAB, 1995a:n.p.).

The military's current systems and force structure may not satisfy the requirements of the NSS of global engagement and enlargement, the NMS of shape, respond, and prepare, and the two MTW requirements. Ultimately, the military, and its future systems, should be shaped in accordance with its own JV 2010 and JV 2020 requirements, all of which revolve around global projection and sustainment of power.

Although JV 2020 starts to look at innovation as a means to meeting NMS needs, a real insight into the direction the military will take comes from its current Commander-In-Chief. President Bush provides the following:

We will modernize some existing weapons and equipment . . . our goal is to move beyond marginal improvements to harness new technology that will support new strategy . . . we must put strategy first, then spending . . . our defense vision will drive our defense budget, not the other way around...on land, our heavy forces will be lighter, our light forces will be more lethal. In the air we will be able to strike across the world . . . (Allen, 2001:8).

All of this spells changes in the military's structure, and in particular its mobility forces.

Although the NSS and NMS may not change, the new administration plans to match military capability with the nation's security strategy.

The new SecDef, Donald Rumsfeld, will be pushing a change in the military that he says, "is long overdue." He is looking for a leaner, nimbler military that is suited to

fighting missions that include regional wars and supporting peacekeeping missions, to surviving highly capable missile systems, to striking against terrorist bases deep inside hostile territory, and to operating over vast distances of the Asia-Pacific region (Moran, 2001a:n.p.) Again, as with the NSS, NMS, and JV's, mobility will be a key, if not the key, enabler of national and military interest.

President Bush adds, "We do not know the shape of our future military, but . . . all will be easier to deploy and to sustain (Sanger, 2001:1)." Again mobility is critical when considering any new force structure and NMS. The Chairman of the Joint Chiefs-of-Staff (CJCS), General Shelton, expresses the importance of mobility on NMS by saying:

Indeed, our ability to move large forces rapidly anywhere in the world . . . is the foundation of our military strength. I saw it vividly demonstrated during our deployment on Desert Shield/Desert Storm. And the foundation has shaped the American way of war for over a century (Shelton, 2000:n.p.).

The President, SecDef, and CJCS, all have stated the importance of global mobility in meeting the needs of the NSS and NMS. The next section spells out what this global mobility importance means for the USAF, and how the USAF attempts to meet its obligation to the NMS.

USAF Strategy and Rapid Global Mobility

The USAF's strategy is a product of the CJCS's JV 2010 and 2020 strategy of dominant maneuver, precision engagement, full-dimension protection, and focused logistics. The overarching goal of the USAF as stated by the Air Force's Vision (AFV) 2020 is:

In a world that is globally connected, national security and international stability are vital foundations of America's prosperity. Assuring security and stability requires global vigilance, reach, and power . . . will provide

balanced aerospace capabilities key to meeting national security objectives and realizing the full spectrum dominance envisioned by Joint Vision 2020 (DAF, 2000a:forward).

The USAF's vision is in line with the NSS, NMS, and JV 2010 and JV 2020. The Air Force sees itself as a key element in all military operations. In fact, General Ryan, USAF Chief of Staff (CSAF) and F. Whitten Peters, Secretary of the Air Force (SecAF) say, "...the Air Force Vision embodies our belief that aerospace power will be the nation's strategic instrument of choice in the 21st century (DAF, 2000b:forward)."

The Air Force "instrument" is defined in Air Force Doctrine Document 2 (AFDD-2), Organization and Employment of Aerospace Power. Although aerospace operations differ greatly depending on national objectives, forces available, area of operations, allied involvement, and many other variables, AFDD-2 lists the areas of use for the "instrument" of aerospace power as peacetime engagement and crisis response, deterrence and contingency actions, and winning-war actions (DAF, 2000c:12).

AFDD-2 states that peacetime engagement and crisis response anchors aerospace power to the basic objectives of the NSS – protecting the nation and its vital interest. In sum, peacetime engagement and crisis response promotes long-term international stability. Examples of peacetime engagement and crisis response actions include military-to-military contacts, unilateral and multilateral exercises, humanitarian assistance/disaster relief operations, arms control operations, counter-drug operations, counter-terrorism operations, and rescue/noncombatant evaluation operations (DAF, 2000c:12-15).

Deterrence and contingency actions involve the projection of the nation's aerospace power with a rapid and responsive global force that deters aggression, or

prevents conflicts from escalating to higher levels of aggression. Examples of deterrence and contingency actions include intelligence, surveillance, and reconnaissance, show of force, forced entry, aerial denial, raids, coercion, and air siege (DAF, 2000c:16-18).

Finally, war-winning actions occur when all other measures fail and the last step is armed conflict. Aerospace power is a key contributor, if not “the” key contributor, to successful military operations. Typically airpower is the most rapid and lowest cost means to victory. Examples of war-winning operations include destruction, disruption, diversion, delay, deception, halt, deployment and sustainment, and information operations (DAF, 2000c:18-23).

To facilitate the accomplishment of the Air Force vision of global vigilance, reach, and power, and ultimately the use of aerospace power, the Air Force has established six core competencies. AFV 2020 lists the six core competencies as aerospace superiority, information superiority, global attack, precision engagement, rapid global mobility, and agile combat support (DAF, 2000b:7-8). AFV 2020 gives the following definitions and purposes of the six core competencies:

- Aerospace Superiority: The ability to control what moves through the air and space...ensures freedom of action.
- Information Superiority: The ability to control and exploit information to our nation’s advantage...ensures decision dominance.
- Global Attack: The ability to engage adversary targets anywhere, anytime...holds an adversary at risk.
- Precision Engagement: The ability to deliver desired effects with minimal risk and collateral damage...denies the enemy sanctuary.
- Rapid Global Mobility: The ability to rapidly position forces anywhere in the world...ensures unprecedented responsiveness.
- Agile Combat Supports: The ability to sustain flexible and efficient combat operations...is the foundation of success (DAF, 2000b:7-8).

These six core competencies ultimately provide the nation's war fighters freedom from attack, freedom to attack, and freedom to maneuver. The Air Force Strategic Plan states, "Air Force Basic Doctrine, AFDD-1, stresses the reliance on core competencies as the building blocks of our doctrine. They are at the heart of our strategic perspective and the service's contribution to the nation's total military contributions (DAF, 2000b:4)."

Aerospace power is a critical instrument in projecting and influencing our national interest around the world. More important is the critical nature that mobility plays in not only every Air Force effort, but also in every military effort in which the U.S. gets involved. From the overall Air Force vision of global vigilance, reach, and power, to the contribution of aerospace power listed in AFDD-2, to the six core competencies of the Air Force, mobility is the common thread and common enabler that makes the Air Force capable of fulfilling its requirements to the NMS and ultimately the NSS.

As stated before, the NSS is continually relying on CONUS-based, expeditionary type forces to protect America's critical global interest. Air mobility forces are the backbone of this expeditionary national military. The next section will cover the structure of this expeditionary military and its reliance on air mobility in greater detail.

Rapid global mobility provides the majority of all initial time-critical forces – the expeditionary military – over the entire full-spectrum of operations from humanitarian assistance to all out war. A Government Accounting Office (GAO) report states, "Air mobility would deliver the bulk of the initial time critical forces and supplies [in a MTW], and it is the cornerstone for the nation's security strategy for the foreseeable future (GAO, 2000:6)."

The importance of air mobility is spelled out in Joint Pub (JP) 4-01.1, Joint tactics, Techniques and Procedures for Airlift Support to Joint Operations. JP4-01.1 states, “Airlift is a cornerstone of global force projection. It provides the means to rapidly deploy and re-deploy forces, on short notice, to any location worldwide (DoD, 1996a:I-1).” A quote by Admiral James R. Hogg, USN, during a speech on “Reinforcing Crisis Areas,” also shows the importance of mobility to the nation’s military. He said, “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 (Fellows, 1996:1).”

Airlift provides the war fighting commanders with the forces and equipment they need, when and where they need it. Only airlift can deliver this critical capability with speed and flexibility, and provide the initial impact on operations that directly influence the outcome of any contingency. The CJCS is responsible for providing the warfighting Commanders-in-Charge (CINC)s with the tools they need to prosecute operations that are vital to the military, their region, and ultimately the United States. Airlift is critical. Airlift requirements span every phase of military operation in which this country is involved. This is evident in how the CJCS describes airlift support in JP 4-01.1.

JP 4-01.1 describes airlift support of US national strategy by six broad tasks. These tasks are deployment, employment, redeployment, sustainment, aeromedical evacuation, and military operations other than war, such as humanitarian assistance and noncombatant evacuation (DoD, 1996a:I-1). Air mobility has been a capability of the military for most of the past century. However, rapid global mobility is now more important than ever. The Kosovo campaign is a perfect example of air mobility’s importance and use over the entire spectrum of operations.

Air Mobility Command (AMC) committed nearly two-thirds of its total airlift fleet to move U.S.-based fighters, bombers, and support assets to the area of conflict. AMC in turn provided much of the munitions resupply and other sustainment. In 78 days, air mobility increased theater forces from 3 to 10 expeditionary wings. The airlift forces immediately turned to several humanitarian-relief operations and large US Army deployments. Airlifters flew 468 C-17 and 269 C-130 missions in support of Task Force Hawk, the movement of 24 Apache helicopters to Tirana-Rinas airport in Albania. This force package included the movement of 36 M1 Abrams tanks and 58 M2 Bradley fighting vehicles. During the same time, Joint Task Force Shining Hope kicked off. The relief operations for the Kosovar refugees required over 60 flights a day. Air mobility followed up with supporting Task Force Falcon, the US Army's contribution to KFOR. This movement required 253 C-17 missions to move over 2,500 passengers and 12,000 tons of cargo (Begert, 1999:11-16).

These are just a few examples of the use of air mobility from operations requiring air and ground combat forces to operations requiring humanitarian relief. As seen in Kosovo, rapid global mobility is the key to the success of nearly every operation that is vital to military and national interest. Transportation Command (TRANSCOM) CINC, and AMC Commander, Gen Charles T. Robertson stated, "For AMC, expeditionary operations are synonymous with airlift, aerial refueling, and air mobility support missions. This reality is reflected in our participation in virtually every expeditionary mission the [DoD] undertakes (Robertson, 1999:4)." Since the NSS is focused on engagement, it is natural that the NMS and Air Force strategy would also be

expeditionary. Ultimately, air mobility enables nearly every aspect of the nation's international policy effectiveness and the success of global military operations.

Service Requirements

The previous three sections covered the goals of the NSS, NMS, Air Force Strategy, and the importance of air mobility on each. This section will look at the services' structure for the next century, and the mobility requirements that they will require in their attempt to meet NMS demands.

In 1995, SecDef William Cohen worked with the JCS to transform the military from a Cold War force, to one that could meet the needs of the nation in the 21st Century. The effort was called a "Revolution in Military Affairs" (RMA). The services evaluated their future strategies and equipment in an effort to shaped their forces for the next century. This change involved not only technology driven capabilities, but the overarching need to be expeditionary – that is deployable throughout the world, throughout the full spectrum of operations.

This expeditionary focus was a big change from the strategically positioned forces of the Cold War that focused on training and not deployment. The new challenge was to be able to deploy this expeditionary force from CONUS, through overseas bases outfitted to handle mobility airlifters. In 1989, there were 40 overseas locations with permanently assigned personnel to handle mobility missions. Now, AMC operates only six bases in Europe and six bases in the Pacific. Gen Robertson, CINCTrans, says, "The infrastructure is absolutely critical to being able to get to the fight (Butler, 2000:5)."

Today, the military has continued to deploy at a high operational tempo, and mobility is the enabler of the expeditionary forces. All the services are looking to shape

their forces around mobility. Hence, terms like lighter, leaner, and more lethal are used as force structure vision for the 21st Century.

JV 2010 and 2020, guided by NMS, gave the services vision in their development and experimentation efforts. JV 2010 and 2020's objectives for the military services' effort were for forces to be smaller, faster, more agile, more precise, better protected, more rapidly deployed, and more easily sustained in the field (OSD, 2000:125).

Again, mobility is at the forefront of the services' vision. An example of this is the Chief-of-Staffs' of the Army and the Marines joint meetings on the evolving nature of "real world" military commitments and joint-force contingency operations. The outcome of these meetings were the recognition of both services' operational shortcomings, such as the need for improved fire support and heavy-lift capabilities. Besides the Army and the Marines, the other organizations focusing on mobility centric efforts are the Army, special operations forces, non-DoD agencies that handle emergency and humanitarian operations, and finally, the Air Force itself (Roos, 2000:2).

Ultimately, as the services continue to shrink, they will rely more frequently on airlift to cover the same ground. SecAF Peters puts it best:

It is clear to me that expeditionary operations, as planned by the Air Force, and now as planned by our sister services, are going to require more strategic airlift. Today, we cannot meet the wartime requirements we already have without accepting risk – and we never could – and our future requirements are growing (Tirpak, 2000b:24).

The following is a brief look at what is dictating these requirements. In particular, it is a look at each service's efforts toward their vision of how they plan to shape their forces for the 21st Century, and what their vision means to the mobility system.

Emphasis will be placed on the Air Force and the Army, since they historically have been the major users of mobility airlift.

The previous section covered the Air Force's vision of global vigilance, reach, and power. Consequently, the Air Force develops and fields critical future capabilities to meet this vision in the core competencies set down by AFV 2020. These efforts culminated into the Air Force's Expeditionary Forces (AEF) concept. AFV 2020 calls the AEF, "the core of our deployable combat power and forward presence (DAF, 2000a:5). SecDef Cowhen reported to the president:

In the place of the Cold War construct of fighter wing equivalents, the [AF] is reorganizing many of its combat forces into ten [AEF]s that are versatile, tailorable, and highly responsive. Each will be capable of deploying a full spectrum of tailored air-to-air, air-to-ground, command and control, and support capabilities. This restructuring involves organizational, cultural, and operational changes designed to enhance the Air Force's warfighting capability (OSD, 2000:12B).

One AEF can provide warfighting CINCs with a force-package that gives them air superiority, while striking some 200 targets per day, 24 hours a day (DAF, 2000a:5). The Air Force's AEF vision is to give the CINCs options to begin offensive operations, halt the enemy's advances, and ultimately win MTW engagements. SecAF Peters explains:

Each [AEF] contains the essential traits of aerospace power-versatility to respond to an entire spectrum of conflict for humanitarian operations to war – with the agility to decisively shape the scene with forces that are lighter, leaner and more lethal than ever before (Rapid, 1999:6).

Rapid global mobility makes the AEF possible. Every quarter, AMC moves nearly 200 airplanes and over 10,000 people to spots like the Middle East and South America. Gen. Robertson, CINCTrans said, "To put this in perspective, once each quarter, AMC will move roughly 10 percent of the [AF]'s aircraft and approximately 5

percent of its deployable personnel to or from deployed operating locations around the globe – a big job (Robertson, 1999:4)!”

This is only the scheduled AEF rotations. In times of crisis or conflict the Air Force plans to deploy an AEF in 48 hours to curb many crises before they escalate, and if needed deploy up to 5 AEFs in 15 days (DAF, 2000a:6). Each AEF equals 25,500 tons of cargo and 10,000 passengers (Merrill, 2000:n.p.). Five AEFs in 15 days can only be moved by airlift – lots of airlift. Gen. Robertson said, “As the Air Force’s desire to move to five AEFs in 15 days takes effect, speed is of the essence...The weight on strat-airlift is going to get heavier (Lowe, 2000:1).” Gen. Robertson also said, “we have reinforced, in the eyes of many, the unbreakable link between air mobility and aerospace power that has existed since the first days of our Air Force. EAF is our future – our collective future as an Air Force (Robertson, 1999:5).” Air mobility will be a very big part of that collective future.

Along with AEFs, the warfighting CINCs will soon have the Army’s new expeditionary, Initial Brigade Combat Teams (IBCT) to add to the fight. The Army was hit hard because of its slow deployment, and subsequent nonparticipation in the 1999 Balkan conflict. Based on the enormous amount of airlift needed to deploy Task Force Hawk to Albania, the Army saw the need to transform itself into a lighter and quicker-moving force. Army Chief of Staff Gen. Eric K. Shinseki stated, “Heavy forces must be more strategically deployable and more agile . . . the Army will not buy any field equipment that won’t fit in either a C-130 tactical transport or in the back door of a C-17 strategic airlifter (Tirpak, 2000a:24).” The Army is trying to shape itself into an

expeditionary force, because they have been deployed primarily as an expeditionary force since the end of the Cold War, and they are not equipped for it.

To fulfill JV 2010 and 2020 goals the Army has adopted the “objective force” slogan to guide transformation to its IBCTs. Like the AEF, these IBCTs are the new units that the Army will send in support of global crisis. The IBCT is a total restructure of today’s Army Brigade. Bradley fighting vehicles and M-1A1 Abrams main battle tanks will be replaced by a Future Combat System (FCS) that will be lighter and wheeled, for ease of airlifting (Owen, 2001:n.p.)

The Army is looking to improve capability. As the Army vision states, this allows the national command authority flexibility by, “responding rapidly with land forces to crisis and small-scale contingency operations, to engage to deter conflict, to fight and win decisively, and to maintain peace (Army, 1999:n.p.). Gen. Shinseki’s goal is to deploy, anywhere in the world, a brigade within four days, a division in five days (3 brigades), and five divisions within 30 days (OSD, 2000:125). The Army has admitted that the success of the objective force depends on global and theater air mobility. This is especially true, given that each IBCT will have nearly 500 vehicles and equipment at 13,000 tons, and 4,000 passengers (Merrill, 2000:n.p.). Again, the Army wants 3 of these brigades in 5 days, and up to 15 in 30 days. The Army’s new force will rely heavily on airlift. Congress sees this transformed lighter, faster, and more mobile Army as, “...more or less a nullity if it were marooned by lack of airlift (Mann, 2000:56).”

The Army with its IBCTs and the Air Force with its AEFs are not the only users of airlift. Airlift is relied on heavily by other users such as the Marine Corps, special operations forces, Coast Guard, civilian agencies, foreign governments’ multinational

organizations, non-government organizations, private volunteer organizations, and by many other organizations that support national objectives. For example, in contingency operations the USMC looks at airlifting nearly 15,000 Marines to join their maritime pre-positioned equipment at off-load sites. Additionally, airlift is needed to fly in personnel, equipment, and supplies to complete and sustain the Marine Forces (DoD, 1996a:I-7). From the Marines in conflict, to humanitarian relief operations, to the airlifting of the President, airlift is a vital resource that has an enormous list of customers. The NMS and ultimately the warfighting CINCs will have to decide how to use these critical airlift assets. Marine Corps Assistant Commandant, Gen. Terrence R. Dake postures:

There is a finite amount of lift and all the forces that must be brought to bear in the early part of a conflict have to be managed inside the lifts. In each scenario, the [CINC] will have to put priorities on airlift for the kinds of forces he thinks are most crucial at the outset (Tirpak, 2000a:24).

After looking at the Air Force's and Army's requirements, and other users, the question may not be about the priority of airlift, but does the DoD have enough airlift at all? The next section looks at how, and if, these service lift requirements will be met in the 21st Century.

Mobility Shortfall

Over the past two decades, there has been several major mobility studies that have attempted to define mobility requirements. In 1982, the Congressional Mandated Mobility Study (CMMS) showed JCS estimates of airlift requirements as high as 150 million-ton-miles/day (MTM/D). The CMMS resulted in a 66 MTM/D figure. This figure was well short of the airlift capability by 14 MTM/D – USAF providing 37 MTM/D and Civil Reserve Air Fleet (CRAF) providing 15 MTM/D (Long, 1999:7).

More importantly, the 66 MTM/D was significantly short of the JCS estimate, even though the least demanding scenario studied required 83 MTM/D of airlift capacity (Bence, 1999:37). The 66 MTM/D figure was a compromise between what Congress deemed affordable and what the JCS deemed necessary to achieve national security objectives. This compromise, between Congress and the JCS, became the standard way of deciding mobility requirements over the next two decades. However, because they recognized the significant shortfall, Congress initiated the first steps in what became the C-17 program.

Following this study came several more mobility studies that continually showed shortfalls, but the level of mobility requirements remained at about 60 MTM/D. After the Cold War security strategy was replaced with two MTWs, mobility requirements were actually reduced to 57 MTM/D. This was mainly due to the assumption that overseas bases could be used to deploy forces to crisis. However, in the early 1990's, the U.S. began to downsize and close its overseas bases, and consequently drove up mobility requirements. Because of fiscal constraints, airlift capability remained at 57 MTM/D.

In 1995 MRS Bottom-Up Review (BURU) set mobility requirements at 49.7 MTM/D. Once again this number was a compromise. MRS BURU examined three warfighting phases: halting, buildup, and counterattack. The study stated, "Due to its speed and flexibility, the dominant factor during the halt phase was airlift, since sealift could not arrive in time to affect the halting phase of the fight (Bence, 1999:39)." The JCS expressed its need for a robust airlift fleet. However, fiscal pressures drove the final figure down to the 49.7 MTM/D. The problem for national decision makers and the JCS was how to best meet this requirement, since 49.7 MTM/D was below what was truly

needed and the DoD's airlift fleet capability was well below even that number. The outcome of the MRS BURU dictated the SecDef's and Congress's outline for the Air Force's airlift fleet over the last five years.

The Air Force is currently replacing 266 C-141s with 120 C-17s. Although the initial requirement called for 210 C-17s, fiscal constraints and political pressure drove the production down, and once again created a mobility shortfall (Long, 1997:7). One additional problem for airlift was that, while replacing C-141s with C-17s increased capacity, it dramatically reduced operational flexibility due to the decrease in tail numbers. Gen Robertson, CINCTRANS, testified during a hearing of the Senate Armed Services Committee that the DoD needs 180 C-17s, and all 126 C-5s to meet requirements (Selinger, 2001:n.p.). That equals 306 aircraft. This is compared to a FY 2001 airlift force of 58 C-17s, 88 C-141s, and 104 C-5s (OSD, 2000:50). These OSD numbers equal 250 aircraft, and do not include the 53 percent mission reliability rate of the C-5, 63 percent for the C-17, and 68 percent for the C-141 in FY 2000 (Simon, 2001b:8). AMC's aircraft fleet appears to be well short in numbers and in reliability.

A JCS review determined in 1999 that air mobility shortfalls would not preclude U.S. forces from winning two MTWs, but could delay implementation of war plans. DoD has reported to Congress that these delays could "increase the potential for higher casualties in the interim and during the warfight . . . the [U.S.] is at high risk in the second major theater war, in part, due to current airlift shortfalls (GAO, 2000:12)." Furthermore, some analysis showed that risks increased for even one MTW (GAO, 2000:12).

Congress, fed up with how the Air Force let airlift capability lapse, set aside a separate National Defense Airlift Fund. This fund is separated from the Air Force Budget, because Congress felt that the Air Force was not setting spending priorities to assure the readiness of its airlifter fleet (Simon, 2001a:10). Even SecAF Peters adds, “Unfortunately, we do not have an executable plan to meet these [airlift] growing needs Tirpak, 2000a:24).” In all, AMC has been unable to meet the 49.7 MTM/D requirement, because of hardware problems associated with spare parts shortages, the retirement of the aging C-141 fleet, and the growing obsolescence of key systems like the C-5 (Tirpak, 2000a:24).

Congress also ordered four new mobility studies, the main one of which is MRS-05, the mobility requirement study for the year 2005. Congress wanted detailed readiness studies of the Air Force’s C-17, C-5, and C-141 fleets. MRS-05 specifically spells out the airlift capacity that the DoD needs to carry out the NSS of two MTWs. The results of MRS-05 showed that the requirement is 54.5 MTM/D to fight two MTWs in 2005 (Simon, 2001b:8). Rumors had that number much higher, but again, political pressure and the presidential elections may have caused the DoD to lower the requirement number, just as they had done every other time. Several key concerns have surfaced with the release of MRS-05.

First, MRS-05 results do not include the Army’s transformation plans. A senior U.S. Defense official told Jane’s Defense Weekly, that to include the Army’s new vision and timeline would place, “significantly greater demands on the lift fleet (Koch, 2001:n.p.).” This demand comes on top of the Air Force’s AEFs and the Marine’s MEUs, and all other lift priorities.

Second, a GAO report and CINCTrans, Gen. Robertson agree that the U.S. is short of the military airlift capacity required by MRS-05. Before MRS-05, AMC claimed to be 17 percent short of the 49.7 MTM/D, and the GAO claimed the shortfall to be 30 percent (Lowe, 2000:1). No matter the estimate, both show a shortfall for the old requirement. The new requirement only exacerbates the shortfall. In fact, the GAO has come out with its assessment of MRS-05, and puts the shortfall at a minimum of 31 percent by 2005 (Simon, 2001b:8). The bottom line is that not only is the 54.5 MTM/D requirement set artificially low, but that the airlift fleet cannot even meet these requirements. Gen. Robertson put it this way, “There is no subject talked about more when the warfighting CINCs get together...than the shortfall in mobility...and we know (there is a shortfall) because we’re shortfailing customers every day in peacetime (Lowe, 2000:1).”

Finally, the third concern brought on by MRS-05 is how meet these requirements. Traditionally, CRAF was looked at to help meet requirements, and MRS-05 reflects this strategy as well. CRAF may be relied on for up to 50 percent of mobility requirements. This may be a bad plan based on political and legal constraints when using civil aircraft in wartime operations. Any loss in CRAF assets will only place greater lift requirements on AMC’s airlift fleet.

On top of the CRAF problems, the airlift fleet faces the choices on C-5 enhancements and additional C-17 purchases. With the reliability problems facing the C-5, Defense Department offices are trying to decide if, and how many C-5s will be upgraded. Also, there are growing concerns at the Pentagon that 120 C-17s are well short of what is required. Thus discussions now revolve around the purchase of up to 60 more

C-17s. Gen Robertson has made it quite clear that to even come close to meeting the MRS-05 requirements, he needs every C-5A and C-5B upgraded and he needs, at a minimum, 180 C-17s (Selinger, 2001:n.p.). Whatever the plan, the DoD is not funded or structured to meet these requirements. Gen. Robertson says,

My concern is that, once we decide what that strategy is to be, that it be quantifiable enough that we can fund . . . adequately to meet strategy . . . It is a particular concern to me because right now, with the current two [MTW] strategy . . . I am only funded and resourced with a one [MTW] transportation force. I deliver the one and have to have time to deliver the other (Butler, 2000:5).

Ultimately, the CINCs are faced with the reality that today's, and even tomorrow's airlift fleet may not meet their needs. This airlift shortfall may mean delays in force arrival, and in some cases, an increase in casualties. Based on the requirement studies over the last two decades, the DoD not only has a shortfall in airlift to meet NSS requirements, but the requirements themselves also are short of "real" requirements. The airlift force for 2005 will be stretched to the limits of its capability, and maybe beyond.

Answering Investigative Question 1

This analysis of Investigative Question 1 has shown that through the NSS of engagement, to the NMS of shape, respond, prepare, to the Air Force strategy of global vigilance, reach, and power, mobility will be the key to successfully projecting military forces and meeting the nation's global interest. The bottom line is that mobility is critical and the DoD does not have enough of it. Even as MRS-05 was released, the DoD was 10 MTM/D short of meeting the 54.5 MTM/D requirement (Grossman, 2000:1). 10 MTM/D is equal to 90 C-17s (GAO, 2000:54). The Fiscal 2001 National Defense Authorization Act, the latest military policy statute called strategic lift, "the most

compelling deficiency theater commanders-in-chief would face in prosecuting two regional wars simultaneously (Mann, 2000:56).”

Unfortunately, the past has proven, whether influenced by political, fiscal, or budgetary constraints, that the DoD is nowhere close to establishing the correct level of mobility requirements or even meeting them. However, President Bush, as shown before, says, “[W]e must put strategy first, then spending . . . our defense vision will drive our defense budget, not the other way around (Allen, 2001:8).” Although fiscal constraints limited mobility requirements in the past, the new administration may see the necessity to establish “actual” mobility requirement and match the airlift force structure to it.

Also in question is whether the new administration will change the NMS of two MTWs to one MTW and several small-scale contingencies (SSCs). Unfortunately, SSCs at times require even more mobility, given the expeditionary nature of the forces needed to support these operations. Either way, mobility will be at the center of the nation’s capability to engage and support its global interest. So the answer is, yes the DoD has a strategic lift shortfall based on National Military Strategy.

IQ 2 – WIG: The Mobility Platform of Choice

You will not find it difficult to prove that battles, campaigns and even wars, have been won or lost primarily because of logistics.

-General Dwight D. Eisenhower

Investigative Question 2: *Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?*

The previous section established the need for mobility. This section establishes the fact that the WIG should be the platform meeting that need. To answer Investigative

Question 2, this section analyzes future airlift requirements, platform alternatives, unique WIG characteristics and the factors that favor the WIG, a Korean scenario using ASCAM and a WIG fleet, the multiple uses and affordability of the WIG, and the technological vision and guidance from the new administration.

Future Airlift Requirements

According to the Winter 1995-96 issue of Joint Force Quarterly:

Most senior military and civilian leaders agree that the specific technologies [associated with RMA include those] . . . that provide us the capacity to use force with speed, accuracy, precision, and great effect over long distances (Todd, 1999:3).

This aligns with JP 4-01.1's characteristics of airlift – speed, flexibility, range, and responsiveness. Any future innovative airlift system should have these traits. On top of this, any evolution in mobility platforms should include, as the analysis of Investigative Question 1 covered, the concept of CONUS based, global power projection. In turn, the Air Force Strategic Plan calls for RGM to, “precisely position forces and equipment on the globe quickly and decisively in response to unexpected challenges to protect national interest (DAF, 2000b:29).”

Several military studies have described the characteristics required in future airlift platforms, given these overriding goals. In 1995 the Scientific Advisory Board (SAB), under the auspices of Gen Fogleman's RMA push, conducted the New World Vistas study. This study was a “search for the most advanced air and space ideas and project them into the future (SAB, 1995b:1).” The SAB study, conducted by over 130 preeminent individuals from research, academia, government, and industry, contained recommendations and guidance that addressed technologies and concepts for the future

Air Force. Mobility was one of the twelve panels of study. Based on many of the same strategies and service requirements covered in Investigative Question 1, the panel looked at mobility missions, shortcomings, and advanced technologies, and evaluated them against criteria which included:

- Contribution to mobility mission effectiveness
- Affordability
- Supportability, including training
- Technology maturity
- Applicability of commercial development and/or dual use

The mobility missions and operational objectives the panel looked at were power projection, force sustainment, and peacekeeping or humanitarian support. These were accomplished through cargo airlift, airdrop, passenger airlift, aeromedical evacuation, special ops, and air refueling for nuclear deterrence and conventional applications. Some of the improvement areas the panel studied were longer range, faster response time, improved all-weather operation, and improved refueling capability. In all, the panel saw a future airlifter with improved aircraft survivability, better material handling equipment and capability, improved reliability and maintainability, global range, and higher speed (SAB, 1995a:iii-9).

A very important aspect of the SAB study was that global range and higher speed could “eliminate the refueling problem of transport operations (SAB, 1995a:9),” along with limiting or eliminating the enroute infrastructure and the material handling equipment (MHE) needed to support these same transport operations. Finally, the panel concluded that any future airlifter would need the capability to carry oversized and outsized cargo.

Airlift 2025 was a parallel study to the SAB's effort. Airlift 2025 was a follow on to Air Force 2025, a study directed by the CSAF, Gen Fogleman. The airlift study focused on the concepts, capabilities, and technologies that the U.S. required to dominate air and space in the future. The study's required capabilities were a reflection of the following environment:

The pending retirement of the C-5, C-141, and much of the C-130 fleets, the aging of the remaining air mobility assets [enroute structure and MHE], 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 (Fellows, 1996:3).

The study met this challenge by analyzing customers' needs and the attributes of the air mobility system of 2025.

The study ultimately found that customers need speed, and that airlifter attributes include long, unrefueled range (12,000 miles round-trip), modularity (multiple payload configurations), interoperability (intermodal and commercial), survivability, infrastructure independence, and low cost. Part of this low cost meant that the airlifter of the future should be operable within the civilian infrastructure, that commercial air carriers would use the aircraft, and therefore the airlifter would be usable for CRAF (Fellows, 1996: 3-16).

Other less specific, but influential dictators of future airlifter requirements are found in JV 2010 and the Strategic Deployment White Paper by U.S. Joint Forces Command (USJFCOM) J9. On a macro level, JV 2010 calls for any future technologies, including mobility assets, to support the concepts of dominant maneuver, precision engagement, focused logistics, and full-dimensional protection. JV 2010 also calls for

technology to provide capabilities above the enemy's in the areas of stealth, mobility, dispersion, and higher operations tempo (CJCS, 1996:14).

On a joint, and less macro view, the Strategic Deployment paper guides future development with the following:

As potential adversaries acquire modernized weapon systems and gain more speed and agility, our response time must be in hours and days? not weeks and months? . . . There is a general recognition of the need to accelerate the early arrival of forces to effectively influence the early phases of operations, decrease the risk to US and coalition forces, and influence the earliest resolution of [Rapid Decisive Operations]. Speeding up the flow of forces will require changes to the way the joint deployment community currently conducts business (USJFCOM, 2000:ii).

To facilitate these changes, the study calls for enhanced and versatile sealift and airlift assets that are faster, carry more, and have longer range. The study listed desired operational capabilities (DOCs) to include alternatives to bases and fixed ports in the joint operational areas (JOA), such as the joint logistics over the shore (JLOTS) system, and heavy, supersonic, and ultra large airships for inter-theater airlift. Additionally, the study lists limitations that currently impair strategic deployment operations. These limitations are the number of transportation assets, speed, range, and payload of platforms, resistance to change, time-distance factors from origin to destination, and infrastructure in the JOA (USJFCOM, 2000:2-29/33).

Finally, the Strategic Deployment paper calls for future developments to focus on strengthening the military's partnership with the commercial airline industry. This means incorporating national defense features in commercially designed aircraft, such as a wide rear ramp versus side loading doors, and strengthened rear ramps and cargo floors to accommodate heavy equipment (USJFCOM, 2000:2-22).

Overall, several studies have defined the requirements for the next generation airlifter. The next platform needs global range, and speed, to limit or eliminate air refueling and enroute infrastructure requirements; it should be modular and compatible with the commercial sector, to include CRAF use; it should be interoperable for multi-service use; it should be survivable; and it has to be affordable. The next section looks at some of the alternative platforms to meet these requirements.

Future Platform Alternatives

This section looks at possible platforms for the DoD's 21st Century mobility airlift fleet. These platforms include future concept aircraft, current aircraft in the military inventory, and commercial aircraft. Also, some sealift platforms are analyzed to complete the study of possible alternatives. Most of these platforms have been analyzed in detail by studies such as the SAB's New World Vistas, Airlift 2025, and USJFCOM's J9 Deployment Strategy White Paper. The following is a look at the findings of these studies, to include a description of the platforms, their benefits, their limitations, and the technology needed to pursue their development.

The SAB's Mobility Volume looked at eight future, strategic mobility transport systems. These systems included the global range transport (GRT), supersonic transport, WIG, rocket transport, stealth transport, twin fuselage transport, modular transport aircraft, and sea-based transport. The WIG is covered separately in the next section.

The GRT showed the most promise in 1995, as the panel voted it the number one mobility platform for the future. The design looked very similar to a C-17 with two engines, extra long wings, and a long fuselage. The goal and benefits of this aircraft were a take-off weight below one million pounds, a cargo capacity of 150,000 pounds, and a

range of 12,000 miles (unrefueled global reach). The ultimate benefit of such a craft would be the elimination of the need for air refueling and enroute staging facilities. Additionally, the GRT was extremely attractive to the commercial carriers. The limitations of such an aircraft included maximum on the ground (MOG) constraints at offload locations, limited suitable airfields (needs 10,000+ foot runway), airfield deniability by enemy (survivability), and modular, multi-service use. Finally, for the GRT to be feasible, the following four technologies were needed: improved propulsion efficiency and advanced engines, improved aerodynamic efficiency and advanced wing design, light weight and low cost advanced materials, and innovative concepts for design and digital technology (SAB, 1995a:11-12). To date, these technologies have not been reached for the GRT envisioned by the SAB.

Two very similar proposed systems by the SAB were the supersonic transport and the rocket transport. Both had the benefit of extremely fast delivery capability, but lacked the ability to carry large loads. Other limitations included those of the GRT, and the lack of commercial interest due to the expensive nature of the systems. Also, both systems required significant technology advances such as engines for the supersonic transport, and reentry and landing requirements for the rocket transport (SAB, 1995a:12-21).

Two other SAB proposed systems, which were also very similar, were the twin fuselage aircraft and modular transport aircraft. Both have the benefit of extremely high aspect ratios, and consequently could operate from small airfields, carry very large cargo loads, and fly long ranges. For the twin fuselage, the only limiting factor was aesthetics. However, the modular transport, which looked like a train flying sideways, had several

limitations, to include propulsion system technology, robust flight controls, and the reliance on good weather for join-ups (SAB, 1995a:23-26).

The next system proposed by the SAB was the stealth transport. The stealth transport, naturally offered the benefit of survivability, but included the several drawbacks. The drawbacks included extremely high costs, limited cargo capacity, limited global range, large runways, and no commercial interest (SAB, 1995a:22-23).

Finally, the SAB looked at the sea-based transport. Its design was basically a C-130 with pontoons. Its benefits included seabased takeoffs and landings, ship resupplies, special operations use, and rapid response and rapid force projection using float prepositioning of equipment and supplies such as the USMC uses now (SAB, 1995a:28). There were commercial applications for such a platform, to include firefighting, and search and rescue. However, being a derivative of the C-130, this aircraft had a very limited range and cargo capacity. The technology for such a platform already exists, as Lockheed is already testing versions of the C-130 Floatplane for the USMC (Donaldson, 2000:n.p.).

The next study, Airlift 2025 looked at several of the same platforms, but included studies of the oblique wing, airship (dirigible), and very large aircraft (VLA). The oblique wing was very similar to the twin fuselage and offered no real difference in capabilities or limitations. However, the study did find significant use for the airship. In fact, the study concluded that the airlift system of the future should include the airship. The benefits of the airship were its global range of 12,000 miles and its cargo carrying capacity of over 500 tons (Fellows, 1996:23). Additionally, the airship benefited from commercial interest. Even today, the company ATG is producing, for numerous

European commercial air carriers, its SkyCat family of Airships, with a cargo capacity of 220 tons (Design, 2000:n.p.). Unfortunately, for military applications, the airship had several limitations. They included slow speeds, low survivability, and dependence on good weather.

One promising platform from Airlift 2025 was the VLA. This aircraft, also known as the blended-wingbody, had several benefits. They included longer range, although not GRT distance, increased payload from 150 to 500 tons, and commercial interest. However, this aircraft, with a nearly 300 foot wingspan, put increased pressure on infrastructure support and compatibility, and it required increased runway length for takeoff and landing. Because of its commercial application, Boeing is currently working on a family of blended-wingbodies for passenger and cargo use.

The USJFCOM Strategic Deployment White Paper, in addition to most of the platforms above, studied the concept of the Advanced Mobility Aircraft, or “box-wing.” The box-wing looked like a typical airliner, but with two sets of wings joined at the end. It also had similar capabilities to the twin fuselage and oblique wing designs. The biggest benefits for this aircraft were a short runway requirement, multi-use as a tanker and cargo lifter, and commercial application. The only downside was that there was not a significant improvement over current systems, other than the fact that it would be new (USJFCOM, 2000:2-16).

The next aircraft considered as future platforms are the DoD’s current C-5, C-17, and C-130 airlifters. Like most aircraft, these airlifters have long service lives that will take them well into the 21st Century. The possibility even exists for newer models of these aircraft to be produced, like the C-5B and C-130J.

The first airlifter, the C-5, is a very capable airlifter, able to carry oversized and outsized cargo normally up to 130,000 pounds over a range of 4,500 miles. It is also air-refuelable, which can normally increase its range well over 12,000 miles (Willingham, 2000:17). However, the downside of the C-5 is its low mission capability (MC) rate, which is below 60 percent, with no improvement in sight (USJFCOM, 2000:2-12). Gen Robertson, CINCTRANS, is pushing a C-5 reengineering reliability program (RERP) on top of an ongoing avionics modernization program (AMP) to help raise the MC rate to 75 percent. Gen Robertson also testified that without immediate funding, the C-5 would not begin to approach the required 75 percent MC rate until 2014. With a total price tag of \$43 million per plane, a non-guaranteed payoff of only 75 percent MC rate, and a fleet age in the 20s, the idea of extending the C-5 as the future airlifter is a difficult proposition to take.

The C-17, on the other hand, is becoming the backbone of AMC's airlift fleet. It has a payload capacity of 170,000 pounds, but usually operates with a load of 90,000 pounds over an unrefueled range of 3,600 miles. It also is exceptional at tactical, intra-theater lift, where one C-17 can do the work of nearly four C-130s. Other benefits of the C-17 are its minimally manned crew of three, and its possible applications in the commercial sector. The negatives of the C-17 are its price tag, at nearly \$200 million, and its dependence on tanker support (Willingham, 2000:17). The qualities that make the C-17 excellent at short field operations are the qualities that hurt it as a strategic airlifter. The C-17 is very fuel-inefficient, and consequently has a comparatively short range when used as a strategic airlifter. In all, although the C-17 is very capable, it may not be the best choice as a "strategic" airlifter of the future.

The final airlifter of the military is the C-130. The Air Force currently has over 700 “E” and “H” models of the C-130, with a new C-130J currently in production. The C-130 is a very versatile and reliable aircraft, and is used globally in the commercial sector, and in foreign militaries (USJFCOM, 2000:2-13). Unfortunately, the C-130 does not make for a good strategic airlifter, with its small payload and short range.

On the civilian side, there are numerous aircraft that are capable of being the airlifter of the future. Aircraft like the Boeing 747-400 and Airbus A380 can carry nearly 150,000 pounds over 10,000 miles (Bence, 1997:49). These aircraft naturally benefit from commercial use, and even provide extremely valuable lift through the CRAF. A downside with these aircraft is their limit on cargo size. There are no commercial aircraft that can carry outsized or oversized cargo. This capability is a very important prerequisite for a future strategic airlifter. Additionally, they require long runways, they have heavy infrastructure requirements for onloading and offloading, and they have poor survivability capabilities.

The final options for future strategic lift come from the sea. Organizations such as TRANSCOM and USJFCOM are putting more emphasis on studies of Fast Sealift assets. The idea for many of these fast ships is to reach a speed of 40 knots over 10,000 miles with a cargo load of 5,000 tons. The commercial uses of such craft are enormous, with some models already in use, like the Royal Australian HMAS Jervis Bay. Unfortunately, the Jervis Bay only has a range of 1,000 miles, which is a common technological problem for fast speed ship. Speed and range are competing characteristics in the design of these craft. Currently, technology is a limiting factor for large-scale, fast ship development. Other problems for fast ships include the limit on available points of

debarkation and speed. Even at 40 knots, these ships still require nearly seven days to travel 12,000 miles, not to include the 12 hours needed for both loading and unloading (USJFCOM, 2000:2-19/29). These fast ships do offer great capability, but fall short of providing the key characteristics needed for a future strategic lift platform.

This section looked at several possible future mobility platforms including advanced aircraft transports, current military transports, civilian airliners, and even sealift assets. These platforms were analyzed in light of the critical capabilities needed in the airlifter of the future. Although not exclusive, these characteristics included speed, range, payload, survivability, infrastructure requirements, technological capability, modularity, and commercial application. The next section will look at the one aircraft not covered above, but which has the best mix of all the required characteristics of the airlifter of the future.

The WIG's Unique Characteristics and Factors Favoring the WIG

Many of the WIG's characteristics and its description were covered in Chapter II. However, this section looks specifically at the WIG as it fulfills the mobility roles of the airlifter of the future, as defined by the studies above. The SAB study found the WIG beneficial in several areas. Foremost were its range and payload capabilities. Since fuel economies from ground effect flight increased as much as five times, the WIG truly was a global range transport. The SAB's WIG, shown back in Figure 1, transported an estimated 250,000 pounds of cargo over 6,000 miles at 400 to 450 knots (SAB, 1995a: 14). These estimates were slightly high, but are in line with the current studies by Lockheed's Aeronautics Division in Marietta, GA and the Navy's studies at Paxtuxant NAS, VA.

Since Lockheed has plenty of data already on the C-5, its studies revolve around a parametric comparison analysis between the C-5 and a C-5 sized WIG. Again, because of proprietary issues, this research paper can not look at the specific design of Lockheed's WIG effort. However a general study of the parametric comparisons of payload, range, and cargo volume, is quite appropriate. One additional note is that Lockheed picked the C-5 for comparison because it will likely be the next airlifter replaced in AMC's inventory.

At 90,000 pounds of cargo, Lockheed's WIG version, similar to the WIG seen in Figure 1, has a range of 7,000 miles, compared to 5,700 miles for the C-5, and 3,600 miles for the C-17. Additionally, the Lockheed WIG, not constrained by the traditional cylindrical fuselage design, can carry nearly 35 percent more volume than the C-5 (Donaldson, 2000:n.p.). This additional volume is important, since aircraft typically bulk-out, before they weigh-out. What this means is that an aircraft usually can carry more weight, but can not fit any more cargo on its floor. Hence, the WIG can carry more, both in size and in weight.

With this increased range, payload, and volume capacity, the WIG essentially offers more "throughput," or as the Army calls it, "strategic velocity." The WIG gets to the fight quicker, because (1) it needs no air refueling, and (2) it does not need enroute infrastructure support (gas stops) when tankers are unavailable. These are key benefits to using the WIG as a future mobility platform.

The DoD does not have enough tanker support to get strategic airlifters and fighter aircraft to the fight at the same time, which is critical in the first days of any MTW scenario. Even the SAB study pointed out that the biggest benefit a GRT offered

was the elimination of air refueling that would free up tanker assets to support refueling of other airplanes of the combat force (SAB, 1995a:37).

For example, the Kosovo campaign required intensive support of 160 tanker aircraft. This ultimately led AMC to conduct the “Tanker Requirement Study,” which called for the purchase of additional tankers (Leonard, 2000:10). Is the DoD supposed to buy tankers, along with new airlifters, in order to have a global range capability? AMC should not have to rely on its tanker fleet to offer global range. It makes more sense to buy a mobility platform that does not need tanker support and has the flexibility and capability of self-sustained, global range.

Additionally, the WIG would not need enroute support when tankers are unavailable, unlike the C-5 and C-17 mission requirements today. Gen Fogleman says, “Lack of enroute support facilities reduces rapid deployment capabilities and limits the options of the [NCA] during crisis . . . With a strategy based on power projection and U.S.-based forces, we will need sufficient enroute infrastructure (Fogleman, 1994:n.p.).” The idea is not to eliminate enroute facilities. However, tactical and support aircraft typically overburden these facilities when a crisis occurs. Plus, the DoD has a limited number of these facilities that they can access. The idea is to eliminate the need for mobility support from these facilities in order to conduct global airlift operations.

The bottom line is that the WIG can carry more cargo, to include outsized and oversized cargo, further, and ultimately faster than any current or future mobility platform alternative. The payload, range, and volume characteristics of the WIG are important benefits when looking at rapid global mobility. Their importance will be evident in the ASCAM simulations of the next section.

The next benefit of the WIG is its flexibility, when considering air and seaports of debarkation (APODs and SPODs). Lockheed's WIG has the capability of landing and taking off from both land and water. This amphibious characteristic offers the combatant commanders flexibility to use air or sea PODs, or a combination of the two, to best gain access to offloading facilities, and ultimately get soldiers and equipment where they need to be, when they need to be there. The WIG uniquely offers this flexibility.

Although the WIG does not offer the short field, austere landing ability of the C-17 and C-130, it is quite capable, requiring a runway of only about 5,000 feet. Plus, every airfield in the world that can handle the C-141, the C-5, and commercial airliners, can also handle the WIG. Additionally there has seldom been an APOD at a short, austere airfield. The WIG does not need this capability as a future strategic airlifter. The numbers show, as in the C-17's case, that airlifters that are very good at direct, short field delivery are not very good at strategic airlift.

Along with no special runway requirements, WIG requires no extra or special infrastructure at APODs or enroute facilities. With a cargo ramp capability, the WIG can onload and offload cargo just like the C-5 and C-17, and use the same MHE. Plus, the WIG has a footprint slightly less than the C-5, and both commercial and military facilities can handle the WIG's servicing and cargo handling.

Whenever airfields are not available, the WIG has the unique ability to land in water. This is an exceptional characteristic of the WIG as there has never been an airlifter with this ability. The WIG can use commercial and military port facilities throughout the world, as well as the military's joint logistics over the shore (JLOTS) port facilities. In addition, if these port facilities are unavailable, the WIG, with its shallow

draft, can uniquely land on lakes, rivers, or by the beach, and directly onload from, or offload onto the shore (Fellows, 1996:25). In short, the WIG can go places that were once only relegated available to ships, it can go places even ships can not go, and it can give commanders the options and flexibility they so critically need in the early stages of crisis operations.

Because of its ability to operate at airfields and ports, the WIG also gives commanders alternatives as they face crucial issues such as MOG and anti-access. MOG will always be an issue for mobility deployment. However, the WIG offers alternative PODs which typical airlifters do not offer. Additionally, having several options for PODs is especially important when considering anti-access and survivability issues.

Out of the five major points that SecDef Rumsfeld made in his outline for the Pentagon's overhaul, two points concerned anti-access and survivability:

- The proliferation of missiles and other weapons of mass destruction could cause U.S. allies to limit access to overseas bases, requiring the U.S. military to be able to sustain itself while operating at long distances.
- Missile proliferation in the Third World also means that the U.S. military should also place greater emphasis on acquiring planes, ships, and vehicles that have "stealth," or radar-evading, capabilities (Ricks, 2001:n.p).

The WIG provides relief from the first problem by offering options to operate not only into different airfields, but also ports, JLOTS, and other bodies of water. For the second problem, the WIG is also exceptionally capable of offering relief.

As covered in Chapter II, the WIG has the benefit of stealth characteristics, which lead to survivability. The WIG is survivable in two ways. First, its design is radically different than the standard "T-tail" designs of the C-17 and C-5, which have enormous radar cross-sections. The WIG's design, especially the one Lockheed is proposing, has

aerodynamic characteristics similar to stealth planes such as the B-2. Second, the WIG is highly survivable because it operates in a low-level environment (ground effect), which, because of radar clutter, makes it naturally hard to detect.

Another trait of the WIG, not particularly associated with survivability, is its freedom from controlled airspace. The WIG can operate on the open ocean, free of detection, free from air traffic control, and free from airway congestion. This freedom from congestion is not only important to the military, as it surges in time of conflict, but it also provides a great benefit to the commercial transportation industry, which is already wrought with congestion.

Finally, because of its over-the-ocean and amphibious ability, the WIG is highly desirable for commercial and multi-military uses. The WIG is interoperable and has a modular cargo bay, with the ability to perform commercial and civilian missions, such as container, cargo, and passenger transport, firefighting, and search and rescue. The WIG also has the ability to perform multiple military missions such as theater missile defense, reconnaissance, special operations, anti-mine operations, and ship and submarine resupply. These characteristics of commercial and multi-service use, added to its strategic lift role, make the WIG ultimately affordable due to a large-scale order and production. Because of the importance of affordability, the multiple use of the WIG and the its subsequent large-scale order and production is covered in more detail later in this section

In all, this section shows how the WIG possesses unique characteristics that make it the best choice as the strategic airlifter of the future. Better than any other current platform or future concept, the WIG meets all the critical requirements set forth by the Airlift 2025 and the SAB New World Vistas studies. The WIG has the best combination

of speed, global range, payload, to include outsized and oversized cargo, survivability, air refueling and enroute infrastructure independence, modularity, interoperability, commercial application, and technological feasibility. The next two sections further expand on some of the WIG's unique characteristics. In the first section, ASCAM simulations are used to show the enormous effects that the WIG's speed, range, and payload capacity have on a deployment scenario. The second section is a more detailed look at how the WIG's unique characteristics of modularity, and multi-service and civilian application make it a desirable and affordable platform for the DoD and the commercial industry.

Asian (Korean) Scenario and ASCAM

This section examines the effect of the WIG on the Airlift & Sealift Cycle Analysis Model (ASCAM). ASCAM is a non-random, mobility deployment simulation model used by TRANSCOM to help solve what mobility leaders call, the "Mobility Problem." Its goal is to provide quick, rough estimates of lift requirements and closure time, a measure of how long it takes to move units' personnel and cargo from one point to another. Although ASCAM is not a robust simulation model, it provides decision-makers with a 70 percent solution that gives them a quick and flexible analysis capability (O'Fearn, 1998:n.p.).

The research uses ASCAM to support some of the conceptual, qualitative analysis of the WIG with a basic quantitative look at the WIG's global mobility characteristics. Since the WIG may be a possible replacement for the C-5, the ASCAM analysis gives a simple parametric comparison between the C-5 and the WIG.

Several assumptions are made in order to use ASCAM for the purpose of the parametric comparison. The scenario involves North Korea's invasion of South Korea. This in turn sets the ports of embarkation (POE)s on the West Coast of the U.S. and the PODs in South Korea. Consequently, the first assumption is that the airfield and port MOG for the Korean Theater are a cumulative 10 each. Second, since the Korean scenario involves the need for rapid and global deployment of troops, the simulation only looks at the first seven days worth of equipment and personnel. The assumption also means that airlifters are the only mobility assets used for this first deployment phase.

The third assumption is that the warfighting CINC will only want a portion of each of the Army's IBCT and Air Force's AEF initial, seven-day deployment force. The simulation is run using three of the ASCAM default Light Brigades, at 6,000 tons of cargo and 3,700 passengers. Therefore, for the Army, total force deployment equals 18,000 tons of cargo and 11,100 passengers, which is close to the Army's goal of 3 IBCTs, at 39,000 tons of cargo and 12,000 passengers total.

For the Air Force, the simulation is run using 10 of the default ASCAM Fighter Squadrons, at 294 tons of cargo and 400 passengers, for a total force of 1,200 tons of cargo and 11,100 passengers. This is as close to one AEF as ASCAM could provide, since it has no Lead Mobility Wing (LMW) or AEF equivalents. A typical AEF equals 25,000 tons of cargo and 10,000 passengers (Merrill, 2000:n.p.). Although an attempt is made to base the first seven days of deployment on practical force numbers, the true intent is to provide a common force package for the parametric study between the C-5 and the WIG.

Next, since ASCAM does not use air refueling, the simulation only takes into account enroute stops for refueling. ASCAM uses a distance of 5,996 miles from the U.S.'s West Coast ports to the Korean ports. Therefore, based on a load of 62.5 tons and an associated range of 5,500 miles, the C-5 requires an enroute refueling stop. Alternatively, the WIG's range, with the same load, is 6,800 miles, which does not require a stop (Donaldson, 2000:n.p.).

The 62.5 ton cargo capacity is set as an ASCAM C-5 default. This is because the model builders had the C-5 bulking-out before it weighted-out. The WIG's capacity is set at 85 tons, based on Lockheed's numbers showing the WIG having a 35 percent greater cargo capacity than the C-5. This 85 ton capacity is over a range of 6,000 miles. Even with the increase in load by 35 percent, the WIG can still reach the Korean ports without needing an enroute stop for fuel. The simulation shows the importance of this fact.

For the first simulation run, a base airlift fleet is set with 50 C-5s, 120 C-17s, 25 KC-10s, 50 KC-135s, and 100 commercial passenger carriers. The tankers are used for cargo carrying only. It is assumed that the rest of the tankers will ferry the fighters (this assumption helps, since ASCAM does not simulate air refueling) and that the C-17s will transition to intra-theater airlift once the initial air-land phase has finished, and sealift shows up. The ASCAM results for the first simulation show that the airlift fleet has force closure in 11.70 days.

For the second simulation run, the 50 C-5s are replaced with 50 WIGs that each have a 62.5 ton cargo capacity (same cargo volume of the C-5). The ASCAM results for the second simulation show that the airlift fleet has force closure in 9.51 days.

For the third simulation, the 50 C-5s are replaced with 50 WIGs that each have an 85 ton cargo capacity (35 percent increase in volume and capacity). The ASCAM results for the third simulation show that the airlift fleet has force closure in 8.75 days.

For the fourth simulation, the 50 C-5s are replaced with 15 WIGs that each have a cargo capacity of 85 tons. The ASCAM results for the fourth simulation show that the airlift fleet has force closure in 11.64 days. Therefore, comparing the 11.64 closure days of simulation four with the 11.70 days of simulation one, 15 WIGs can do the job of 50 C-5s.

The final simulation goes in the same direction, by trying to decide how many WIGs it takes to provide the same lift as the initial 50 C-5s and 120 C-17s. Through an interactive process, the ASCAM results show that with no C-5s and no C-17s, it takes 38 WIGs 11.67 days for closer. Therefore, 38 WIGs have the same “throughput” as 50 C-5s and 120 C-17s in this Korean (Asian) scenario.

There are several important facts taken from these simulations, based on NMS and the probable airlift force structure over the next decade. First, the Korean scenario was picked because of the likelihood of the U.S.’s involvement in that region in the near future. In addition to his anti-access and survivability points covered in the previous section, SecDef Rumsfeld’s other points for Pentagon reform included a focus on the Asian theater. These plans included:

- The Pacific Ocean is the most likely theater of future major U.S. military operations, as China becomes more powerful and Russia less so. This would require a reorientation of a defense policy that has been geared since the end of World War II to keeping peace in Europe and deterring the Soviet Union.
- Operating in the Pacific will require additional emphasis on “long-range power projection, **which means greater attention to airlift capacity** and other ways of sending troops and firepower across thousands of miles (Ricks, 2001,n.p.).

Global reach and mobility are at the heart of any Asian Theater operation, and a capable airlift fleet is a must.

Additionally, U.S. Pacific Command (USPACOM) already sees a shortfall in deploying forces to areas such as Korea. They argue that enroute infrastructure is the limiting capability in the Pacific. USPACOM blames this on the “tyranny of distance” of their theater. USPACOM also says that no matter how many C-17s are added to the fleet, USPACOM will never be able to reach war-planning force deployment goals (Weeks, 2001:n.p). However, based on the simulations above, if the DoD had a fleet of WIGs, USPACOM may not have this problem. The simulations show that enroute stops are the key factor in driving up closure time. Because of its unique traits, the WIG does not require enroute refueling, and consequently proves its benefit as a mobility asset.

The second important fact gathered from the simulation, and very much associated with USPACOM’s situation, is that the DoD airlift fleet for the near future offers no relief. The reason the simulation is run with 50 C-5s and 120 C-17s is that this combination may represent the airlift force structure for the foreseeable future. The bottom line is that in this possible Korean scenario, 38 WIGs can do the job of 50 C-5s and 120 C-17s. With a fleet of WIGs, that can go not only into APODs, but also SPODs, USPACOM could offer the warfighters in Korea a force closure time vastly better than the simulated 11.7 days, and vastly better than what they rely upon today.

On top of this unacceptable closure time is the fact that the notional force size is nowhere near what is required in a Korean Scenario. The Korean scenario, although classified, calls for a force much larger than the one used in the ASCAM simulation.

Thus, it is likely that the closure date, based on the current airlift force, would dramatically increase. As the JCS said, “air mobility shortfalls [and delays] could increase the potential for higher casualties in the interim and during the warfight . . . (GAO, 2000:12).”

Although the simulations are not robust, they do give a clear indication of the WIGs potential. It may be time for the WIG to be viewed in favor of some of today’s mobility systems and even in favor of some of the future concepts covered previously. The next section looks at the multiple military and commercial uses of the WIG and ultimately, its affordability.

Affordability, Multi-Military Application, and Commercial Use

This section analyzes, in more detail, the WIG’s unique characteristic of modularity, to include its multi-service and civilian applications. In turn, this modularity can make the WIG desirable and affordable for the DoD and the commercial industry.

Affordability of the WIG will only come through a large-scale order. Industry standards for a break-even point on large-scale aircraft is a production of about 300 aircraft (Donaldson, 2000:n.p.). At 300, large aircraft prices level off at nearly \$150 million, which is the current rate for the new, and very popular Boeing 747-400 cargo jet, and about \$20 million less than the last C-17s to come off of the Boeing production line. So the DoDs goal is a total production order of 300. To facilitate this large-scale order, the DoD needs to push the unique benefits of the WIG – those being modularity for multi-military and commercial uses to both its services and to the commercial sector

In addition to its previously mentioned mobility uses, the WIG may fill several key roles throughout the DoD, as the Pentagon shapes itself for the 21st Century. SecDef

Cowhen, in his report to Congress states, “This full spectrum force [of the future] must not only be capable across mission areas but it must also be highly versatile (OSD, 2000:15).” The Air Force’s vision to meet these full spectrum force requirements has been covered earlier. To define other military uses of the WIG, it is important to understand the visions of the Marine Corps and the Navy.

The Marine Corps vision for future sea-based power projection operations is *Operational Maneuver From the Sea* and Ship-to-objective Maneuver. The vision states:

Marine landing forces will move directly from their ships through and across the water, air, and land of the littoral battlespace to their objectives ashore uninterrupted by topography or hydrography, thereby achieving greater surprise and complicating the adversary’s defensive operations (OSD, 2000:127).

The Marine Corps appears to be well suited to use the WIG in meeting their vision.

The Department of the Navy’s future vision is *Forward . . . From the Sea*, which identifies five fundamental roles: sea control and maritime supremacy, sea-based power projection to the land, strategic deterrence, strategic sealift, and forward naval presence (OSD, 2000:126). Although the Navy has a robust and established fleet of ships, research shows that the WIG can also help in meeting their vision.

In his research on WIGs, Harden shows the feasibility and practicality of the WIG in performing several naval missions. Harden stated the following in his findings:

The wingship provides a possible alternative to forward deployed naval forces. Utilizing the lift enhancement provided by flight-in-ground-effect, a very large aircraft can carry weapons loads similar to those carried on a surface combatant, but at speeds much faster than the surface craft. This revolutionary capability would allow wingships stationed at naval bases in the [U.S.] to rapidly respond to a crisis anywhere in the littoral world, without requiring forward deployment of surface forces (Harden, 1994:1).

Based on these benefits, his study found that the WIG could perform several missions for the Navy, and provided a common platform to replace, or augment several of the different Naval ships performing those same roles. These missions included Cruise Missile Carrier, Naval Tactical Missile System (NTACMS) Carrier, Mine Warfare Ship, and Air Defense Ship. The platforms performing these mission were the Ticonderoga Class Cruiser, Arleigh Burke Class Destroyer, Spruance Class Destroyers, Avenger and Osprey Class ships, and SH-60 Seahawk helicopter (Harden, 1994:17-21).

Harden also found the WIG to be very versatile and survivable, because of its ability to sit offshore, and attack or defend sea or land forces. He also favored the WIG over Navy ships due to the WIG's rapid maneuverability to and from hostility as needed by commanders (Harden, 1994:110).

Additionally, Lockheed's studies of the WIG include several other Naval and Marine Corps missions. These are ship, sub, and shore supply transport, C4I, Early Warning and Surveillance, Special Ops, and Search and Rescue (Donaldson, 2000:n.p.). Along these lines, the White House is looking at a sea-based national missile defense (NMD)(Sirak, 2000:1). Because of its rapid maneuverability and loiter ability, the WIG would be very capable in performing this mission.

In all, it is possible that the Navy and the Marines could order up to 75 WIGs to replace current systems as described by Harden, and perform other missions as described by Lockheed's studies, and the NMD plans.

One additional role of the WIG, although not service specific, is its ability as an unmanned aerial vehicle (UAV) launch platform. Lockheed focused a large portion of its WIG study on UAV deployment, since it appears that the new administration may push

for these types of over-the-horizon recognizance and strike packages. A WIG and UAV combination would give commanders unprecedented flexibility and capability. Although estimated, this package could represent a total order of at least 20 WIGs, and if the new administration's philosophy holds true, this number could easily grow.

Finally, as a mobility platform of the future for the Air Force, a good estimate for the number of WIGs to order is 120. This is slightly less than the number of C-5s which it would probably replace, but 120 would maintain approximately the same number of "tails." With the airlift order at 120, the Navy and the Marine order at 75, and the WIG/UAV package order at 25, the DoD's final order is 220.

The next use of the WIG includes commercial and civil applications. Because of the relatively new technology of the WIG, and the public's lack of knowledge of the aircraft, the research assumes that the first commercial applications of the WIG will be in the cargo carrier market. Therefore, the research does not look at commercial passenger applications of the WIG, but assumes that over time, the WIG will prove itself as a desirable and practical passenger transport.

Commercial cargo carriers, such as Fed-Ex and UPS, are obvious beneficiaries of WIG technology. These cargo carriers outfit their fleets with passenger aircraft, such as DC-10s, L-1011s, and B-747s, specifically modified for cargo operations. Although these aircraft are not the ideal design for cargo handling, they are the only affordable and available aircraft for these carriers to use, as they try to keep up with their air freight market demand. The WIG may be just what these cargo carriers need, as their industry shapes itself for the 21st Century.

The world-wide air freight market is seeing one of the largest expansions ever, through growing world economies, but more importantly, through the modal change of cargo movement from ground, rail, and sea shipment, to air transport. This air transport demand is expected to triple by 2015 and the aircraft fleet to handle this new demand is expected to double (Wilson, 1998:n.p.). There is a fundamental shift in customers' buying habits. This shift to air freight has a direct link to supply management. There is the growing desire for rapid delivery of goods in days or even hours. This supply-chain-management process minimizes inventory, insurance, handling cost, and many other elements (MD-17, 2000:n.p.). Jack W. Boisen, Continental's vice president for cargo said,

It's becoming more and more of a customer-driven business. And I think you'll see the majority of the carriers responding accordingly. The market for deferred air freight, I think, is going to shrink. The supply chain time frame is shrinking. More and more of our customers are looking at time-definite and are willing to pay for that kind of service. (Wilson, 1998)

Air carriers need to meet the customer demands of quick, reliable, low-cost, trouble-free shipment of goods, no matter the size, point of origin, or destination. Air freight used to be a luxury, but with today's logistic requirements, it is considered a necessity. One good example of this is the Honda Motor Co. For every minute its Marysville, Ohio assembly line is down, the company loses \$24,000 (Orton, 2000:64).

Between January 1999 and January 2000, ATA U.S.-member airlines increased their revenue ton-miles of air freight by 24.2 percent, from 657 to 816 million (Orton, 2000:64). On top of this air freight growth, is the growth of the heavy and outsized cargo sector. There is now a growing demand for global heavy and outsized cargo airlift. This includes such cargo as satellites, construction equipment, and power generating

equipment. Key industry users for new air-freight opportunities are freight forwarding (as above), construction, humanitarian and disaster relief, infrastructure development, manufacturing, mining, oil and gas, power generation, space, and telecommunications (MD-17, 2000:n.p.).

Boeing estimates a potential \$10 billion worldwide commercial heavy and outsize air cargo market in the year 2008. Of special note is the current air freight market of \$300 to \$400 million per year (Krause, 1998:6). This market is dominated by the Antonov, An-124. Volga-Dnepr flies 10 An-124-100 Rulsan airlifters and holds over 50 percent of the world's heavy and outsized cargo market. Antonov Airlines holds another 34 percent of this market (Velovich, 2000:n.p.). These two companies share an oligopoly in the heavy and outsized air cargo market. One-time flights cost as much as \$1 million dollars for shippers. This potential heavy and outsized market, along with the growing standard air freight market, can easily benefit from the addition of a dedicated cargo carrier like the WIG.

The commercial cargo carrier industry is in need of airlifters. Atlas Airlines is currently looking to fill part of the long-haul (3,000 nautical miles), heavy air cargo market. China Air, for example, leases 7 Atlas B-747s for its heavy cargo movement. The cargo business represents 40 percent of China Air's overall revenues and they are looking to grow (Gallo, 2000:13). Passenger carriers are also increasingly interested in expanding their dedicated freighter fleet. 50 percent of the B-747 construction for the first half of 2000 will be freighters (Schwartz, 1999:22). In fact, Atlas has ordered 10 new B-747-400Fs. Also, Continental will replace its old widebodies with new B-777s and B-767-400s (Wall, 2000:45). This upgrade and addition of freighter aircraft is

increasing throughout the industry. Boeing anticipates 390 new freighter only aircraft orders in the next 15 years (Schwartz, 1999:22). The WIG could be one solution to these upgrades, but more importantly, it could offer new airlift in the heavy and outsized cargo market, which is currently not being addressed except by a few companies flying aged An-124s. Plus the WIG offers the benefits of airfield and port use, as discussed earlier. The uses of the WIG in the commercial market are untapped. What is known is an estimated \$10 billion heavy and outsized cargo market that is suited perfectly for the WIG.

Besides the military and commercial carrier industry, the WIG has applications in the civil sector. These WIG uses include Coast Guard patrol and search and rescue, fire-fighting, and sea-based research. In all, commercial and civil WIG orders could reasonably reach 75, which is well below the Boeing estimate of 390 freighter orders.

In the end, to be the platform of choice, the WIG will have to be affordable. The research shows, with very modest assumptions, that the total production order can easily reach the required 300. This is in no small part due to the WIG's unique mobility and modularity characteristics. With the WIG, both the military and the commercial carriers have a platform that can literally "carry" them into the 21st Century.

New Administration's Technology Vision

This section ties the analysis of the previous sections in with President Bush's focus on a new military strategy and his associated focus on new, innovative weaponry. As far as the strategy that dictates the path of the military in the near future, SecDef Rumsfeld spelled it out quite clearly in his points for the Pentagon's overhaul, as described above. In all, SecDef Rumsfeld's military strategy calls for "a fundamental

change toward a leaner, nimbler military (Moran, 2001b:n.p.).” His strategic review of U.S. military capabilities calls for new missions that include:

- Regional wars and support for peacekeeping missions.
- Surviving highly capable missile systems in the hands of U.S. foes.
- Strikes against terrorist bases deep inside hostile territory.
- The need to be able to operate over the vast distances of the Asia-Pacific region (Moran, 2001b:n.p.).

The changes driving the military’s transformation include the proliferation of cheap, powerful missiles, the spread of satellite intelligence capabilities, the sophistication of stateless terrorist groups, the spread of nuclear weapons in the Mideast and Asia, and the likelihood that Asia, not Europe, would be the site of future conflicts (Moran, 2001b:n.p.) These are the issues that shape President Bush’s future military strategy and how he plans to equip the military to implement this strategy.

President Bush pledged to “design a new architecture [for defense] to move beyond marginal improvements to harness new technologies that will support a new strategy . . . [the ultimate goal is] a revolution in the technology of war (Newman, 2001:n.p.).” He also pledged to “increase the military’s research and development budget by 20 percent – in an effort to skip a generation of military weaponry (Jaffe, 2001:n.p.).” President Bush wants a break from Cold War systems and incremental development of such systems as heavy tanks, traditional fighter aircraft, and aircraft carriers. He wants his administration and the Pentagon to build a military ready to meet the challenges of the 21st Century.

However, getting the military to move from these legacy systems might be quite difficult. The military theorist Liddell-Hart stated, “The hardest thing in the military is not to get a new idea in, but to get the old idea out (Todd, 1999:n.p.).” Even SecDef

Cohen's words to Congress in 1998 subtly spell out the unwillingness for true change. He stated, "that the current [Clinton] administration's legacy is to evolve the inherited defense structure that won the Cold War into one that will meet the perils of a new century (Champoux, 1999:9)." The key word is evolve, which is exactly what President Bush is fighting against when he makes comments like "skipping a generation of weaponry technology" and doing away with "incremental force changes." President Bush wants true change. The military can take a lesson from its own doctrine. JV 2010 states in its conclusion:

Today, America's Armed Forces are the world standard for military excellence and joint warfighting. We will further strengthen our military capabilities by taking advantage of improved technology and the vitality and innovation of our people to prepare our forces for the 21st Century (CJCS, 1996:34).

Innovation should drive the DoD's approach for acquiring new systems, and particularly its critical mobility platforms. President Bush said, "Effective military power is increasingly defined not by size or mass but by mobility and swiftness (Jaffe, 2001:n.p.)." This is similar to Andrew Marshall's assessment of U.S. defense policy, where he calls for flexibility and adaptability. He said, "We really need a set of programs that are broad enough to provide us with the right options as the future unfolds (Bay, 2001:n.p.)." What President Bush, SecDef Rumsfeld, and Mr. Marshall mean is that, just as the analysis of Investigative Question 1 concluded, rapid global mobility will be the key to the U.S.'s strategic vision. Any future systems, especially mobility systems, should fulfill the President's vision for global reach, survivability, and revolutionary innovation. Clearly, the new administration is looking for a paradigm shift from Cold

War systems of the past, to innovative platforms for the 21st Century. The WIG may be just what they are looking for.

Answering Investigative Question 2

This analysis of Investigative Question 2 shows that the WIG may be the DoD's mobility platform of choice as the nation's airlifter of the 21st Century. Again, better than any other future concept, current military airlifter, commercial aircraft, or even fast sealift ship, the WIG meets all the critical requirements set forth by the Airlift 2025 and the SAB New World Vistas studies. The WIG has the best combination of speed, global range, payload, to include outsized and oversized cargo, POD flexibility, survivability, air refueling and enroute infrastructure independence, interoperability, modularity, multiple military and commercial application, affordability, and technological feasibility.

The WIG can be critical in meeting the mobility requirements set forth in Investigative Question 1. From the new President, to his NSS, to his NMS, down to the warfighting CINCs, rapid mobility is the key to this country's vision of global engagement and worldwide peace. As Investigative Question 1 showed, the military's airlift fleet will bear the burden of this vision and this airlift fleet should thus be structured and transformed to meet this challenge. President Bush's vision of the military best sums up by this transformation:

Eleven years after the Cold War, we are in a time of transition and testing, when it will be decided what dangers draw near or pass away, what tragedies are invited or averted. We must use this time well. We must seize the moment (Allen, 2001:8).

A future airlift fleet should not have only C-17s and RERPed C-5s. These are the incremental changes that the DoD continues to push, and that the President is fighting. Now is the time to come up with truly innovative technologies that move the U.S. into the 21st Century with solutions, and out of the Cold War with limitations. The time and reasons for the WIG are right. So the answer is yes, the WIG should be the mobility platform of choice, based on requirements, characteristics, and technology.

Chapter V

Discussion

Amateurs talk tactics, professionals talk logistics.

- Anonymous
Logistics and Mobility Axiom

Conclusion

The goal of this research paper was to discuss whether the WIG may be a viable platform when considering the next mobility aircraft to help solve the DoD deployment challenges inherent in “global engagement.” This goal translated into the research question: *Should the WIG be the DoD’s next mobility platform?* To answer this research question the following two factors were taken into consideration. First, there must be an identified mobility shortfall which, based on national military strategy (NMS), defines the DoD’s mobility needs (requirements). Second, the need should be met with the most practical platform in terms of strategic mobility performance, unique capabilities, such as modularity, commercial application, affordability, and one that meets the President’s mandate for technological innovation.

Based on these two factors, this research paper answered the overall research question by answering the following two investigative questions:

- 1. Does the DoD have a strategic lift shortfall based on National Military Strategy?*
- 2. Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology?*

The analysis of Investigative Question 1 showed that mobility will be the key to successfully projecting military forces and meeting the nation’s global interest.

However, the Mobility Requirements Study for 2005 (MRS-05) showed the DoD 10 MTM/D, or 90 C-17 equivalents short of meeting the DoD's 2005 airlift requirement of 54.5 MTM/D. This shortfall directly effects the services' strategies as they structure their forces of the future. Consequently the airlift shortfall effects the NMS, and ultimately the nation's strategy of "global engagement." Air mobility is at the center of the nation's capability to engage and support its global interest. So in fact the DoD does have a strategic lift shortfall based on National Military Strategy.

The analysis of Investigative Question 2 showed that the WIG should be given serious consideration as the DoD's mobility platform of choice as the nation's airlifter of the 21st Century. The WIG was compared to future concepts, current military airlifters, commercial aircraft, and fast sealift ships against critical requirements set forth by the Airlift 2025 and the SAB New World Vistas studies. The WIG had the best combination of speed, global range, payload, to include outsized and oversized cargo, POD flexibility, survivability, air refueling and enroute infrastructure independence, interoperability, modularity, multiple military and commercial application, affordability, and technological feasibility and innovation. Thus, the WIG should be the mobility platform of choice, based on requirements, characteristics, and technology.

Recommendations

Since the research showed that the WIG should be the DoD's next mobility platform, the DoD should not spend \$43 million on upgrading the C-5 for marginal improvements and incremental changes. This research recommends that the DoD and Air Force consider the WIG as a replacement for the C-5 over the next 15 to 20 years.

The DoD airlift fleet of the future should potentially include 120 WIGs to do strategic airlift, 180 C-17s, as proposed by Gen Robertson, to do strategic and tactical airlift roles such as airdrop and direct delivery, and over 700 C-130s for intra-theater tactical airlift. With this airlift force, the DoD would have the mobility assets it requires for the full spectrum of operations, from major theater wars to humanitarian airlift. With this airlift force, the DoD would be able to meet the NMS, and ultimately the nation's strategy of "global engagement."

President Bush stated to graduates of the Naval Academy at Annapolis, Md:

Our national and military leaders owe you a culture that supports innovation and a system that rewards it . . . We must build forces that draw upon the revolutionary advances in the technology of war that will allow us to keep the peace by redefining war on our terms . . . I'm committed to building a future force that is defined less by size and more by mobility and swiftness, one that is easier to deploy and sustain, one that relies more heavily on stealth, precision weaponry and information technologies (Diamond, 2001:n.p.).

The time is right for an innovative change in the DoD's airlift force. The time is right for a change in the world of transportation, just as the train, the car, and the airplane did for their generations. Now is the time for the WIG.

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14. ABSTRACT The genesis of this research was the USAF Scientific Advisory Board's advanced air and space ideas study, New World Vistas, and its mobility volume's analysis of the WIG. This research project was a more in-depth look into the WIG's feasibility and capability. The research looked at how the WIG helps meet the national security strategy of "global engagement," and the resulting growth in expeditionary demands on the DoD. Thus, the research question was: Should the WIG be the DoD's next mobility platform? This research decomposed the basic research question into two: (1) Does the DoD have a strategic lift shortfall based on National Military Strategy? and (2) Should the WIG be the mobility platform of choice, based on requirements, unique characteristics, and technology? First, the analysis focused on the national security strategy, the resulting national military strategy, the USAF Strategy, and rapid global military service requirements, based on these needs, and finally, the culminating mobility shortfalls associated with these strategies, to include the Mobility Requirements Study for 2005. Second, the analysis focused on future airlift requirements, platform alternatives, unique WIG characteristics and the factors that favor the WIG, a Korean scenario using ASCAM and a WIG fleet, the multiple uses and affordability of the WIG, and the technological vision and guidance from the new administration. Overall, this study establishes the importance, and shortfall, of mobility airlift in meeting the nation's global engagement strategy, and the fact that, because of its unique characteristics, the WIG is the platform of choice to help fulfill this global strategy as the DoD's strategic airlifter of the future.					
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