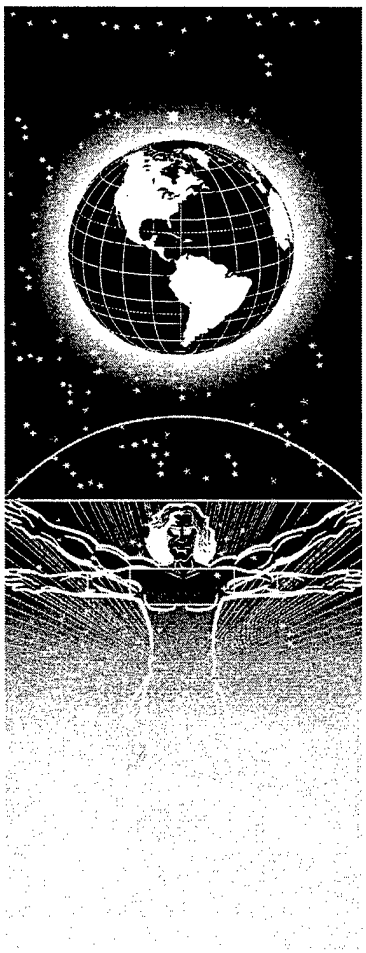
AFRL-HE-WP-TR-1999-0242



UNITED STATES AIR FORCE RESEARCH LABORATORY

Next Generation Cargo Movement System Analysis

Volume 1: Transportation Research

Kenneth Evers
SYNERGY, INC.
3100 Presidential Drive, Suite 300
Fairborn OH 45324-6224

Samuel R. Kuper
Air Force Research Laboratory

October 1998

Final Report for the Period February 1998 to October 1998

Approved for public release; distribution is unlimited.

Human Effectiveness Directorate
Deployment and Sustainment Division
Sustainment Logistics Branch
2698 G Street
Wright-Patterson AFB OH 45433-7604

NOTICES

When US Government drawings, specifications, or other data are used for any purpose other than a definitely related Government procurement operation, the Government thereby incurs no responsibility nor any obligation whatsoever, and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise, as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

Please do not request copies of this report from the Air Force Research Laboratory. Additional copies may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Federal Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to:

Defense Technical Information Center
8725 John J. Kingman Rd., STE 0944
Ft. Belvoir, VA 22060-6218

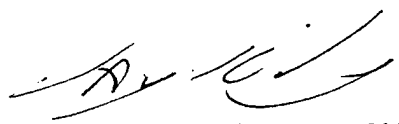
TECHNICAL REVIEW AND APPROVAL

AFRL-HE-WP-TR-1999-0242

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER



JAY KIDNEY, Col, USAF, Chief
Deployment and Sustainment Division
Air Force Research Laboratory

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	October 1998	Final - February 1998 - October 1998

4. TITLE AND SUBTITLE
Next Generation Cargo Movement System Analysis - Volume 1: Transportation Research

5. FUNDING NUMBERS
C - F41624-98-F-5013
PE - 62202F
PR - 1710
TA - D1
WU - 06

6. AUTHOR(S)
Kenneth Evers
Samuel R. Kuper

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Synergy, Inc.
3100 Presidential Drive, Suite 300
Fairborn OH 45324-6224

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory, Human Effectiveness Directorate
Deployment and Sustainment Division
Air Force Materiel Command
Sustainment Logistics Branch
Wright-Patterson AFB OH 45433-7604

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFRL-HE-WP-TR-1999-0242

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This task is the first of two research phases conducted to determine future Air Force transportation requirements with the purpose of identifying potential future research initiatives. This first phase of the effort identified needs and deficiencies documented or stated formally or informally by transportation experts. Analysis of these needs and deficiencies identified trends considered critical to meet future requirements of the Air Force transportation system. The collection and analysis of the deficiencies, needs, and trends is documented in this report.

14. SUBJECT TERMS
Transportation Cargo Movement Air Force Research Transportation Technology Needs Deficiencies

15. NUMBER OF PAGES
54

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

THIS PAGE INTENTIONALLY LEFT BLANK

PREFACE

This report documents the results of a study titled Next Generation Cargo Movement Analysis System (Contract Number F41624-98-F-5013) managed by the Air Force Research Laboratory, Sustainment Logistics Branch (AFRL/HESS) at Wright-Patterson AFB OH to identify technology development needs and research opportunities in the area of Air Force cargo movement. The task was conducted by Synergy, Inc. from 25 Feb 98 to 5 Oct 98. In this first of two phases, research identified and analyzed needs and deficiencies documented or stated formally or informally by transportation experts.

TABLE OF CONTENTS

LIST OF
FIGURES AND TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

1 INTRODUCTION

Performed under Government Contract GS-35F-4657G for the Air Force Research Laboratory (AFRL/HESS), the Next Generation Cargo Movement System Analysis program evaluated future transportation requirements for the purpose of identifying potential future research initiatives. The first phase of the effort identified needs and deficiencies documented or stated formally or informally by transportation experts. Analysis of these needs and deficiencies identified trends within transportation considered critical for improvement. This collection and analysis of deficiencies and needs is documented in this report.

The second phase of the Cargo Movement System Analysis analyzed the trends to select those critical deficiencies and needs that could be addressed through research within AFRL and provides significant benefit to users as they proceed into the future of cargo movement. The trend analysis and research roadmap is documented in the companion document entitled Transportation Research Agenda.

1.1 Background

With the end of the Cold War, changes in world situations require the military to adjust their operational capabilities to allow them to effectively respond to the changing mission requirements. Specifically, military support requirements changed from one of supporting major, long-term conflicts in a relatively predictable set of global sites to supporting shorter-term conflicts and humanitarian missions at almost any point in the world. This change in global mission requirements necessitates a responsive, sustainable, and survivable support force prepared to promote and defend national interest anytime and anyplace. Such a force must be highly tailorable, trained, organized, mobile, and technologically capable to operate effectively at forward, deployed locations. Also impacting the capabilities of military operations are reduced military resources in terms of funding, and infrastructure of inventory and personnel.

Thus, the traditional practice of using massive quantities of troops and large stockpiles of supplies available in theater to engage hostile forces is quickly becoming obsolete.

Additionally, extensive build-up time, and lengthy supply and repair pipelines to sustain forces are unrealistic. The Air Force logistics of the future faces its greatest challenge - how to engineer itself to support modern warfare with a precise, agile response capability.

To address these changing conditions, the United States Air Force (USAF) is embarking on a new set of initiatives under the banner Global Engagement as documented in Joint Vision 2010. These initiatives are the core competencies of Air and Space Superiority, Global Attack, Rapid Global Mobility, Precision Engagement, Information Superiority, and Agile Combat Support (ACS). The core competencies support the Air Expeditionary Force (AEF) concept by providing the necessary military support for the changing global military requirements. This is accomplished by satisfying the operational goals of increased flexibility to address changing mission requirements, increased responsiveness, minimized footprint, within the constraints of reduced personnel and equipment, and reduced military funding. Through the AEF, regional Commander-in-Chiefs (CINCs) receive theater-specific rapid and responsive air and space power, across the spectrum of response options ranging from humanitarian relief to combat operations.

Figure 1 represents a flow of impacts resulting from global changes on military operations. These global changes directly impact the integrated process consisting of Readiness, Deployment, Employment, Sustainment, and Redeployment phases of military operations. The changes to the phases within the integrated process generate new performance requirements that force the various Air Force components as well as other services to evaluate and adjust their operational capabilities to satisfy the operational phase performance requirements.

Because of the support provided to the components and other services, transportation must not only react to the changes imposed by the core competency initiatives, transportation must also react to the additional operational requirements resulting from the Air Force component and service changes. If transportation does not react to the requirements by continually improving processes and technologies, transportation can quickly become the long pole in the operational scenario by negating the operational capabilities available through the Air Force components and other services.

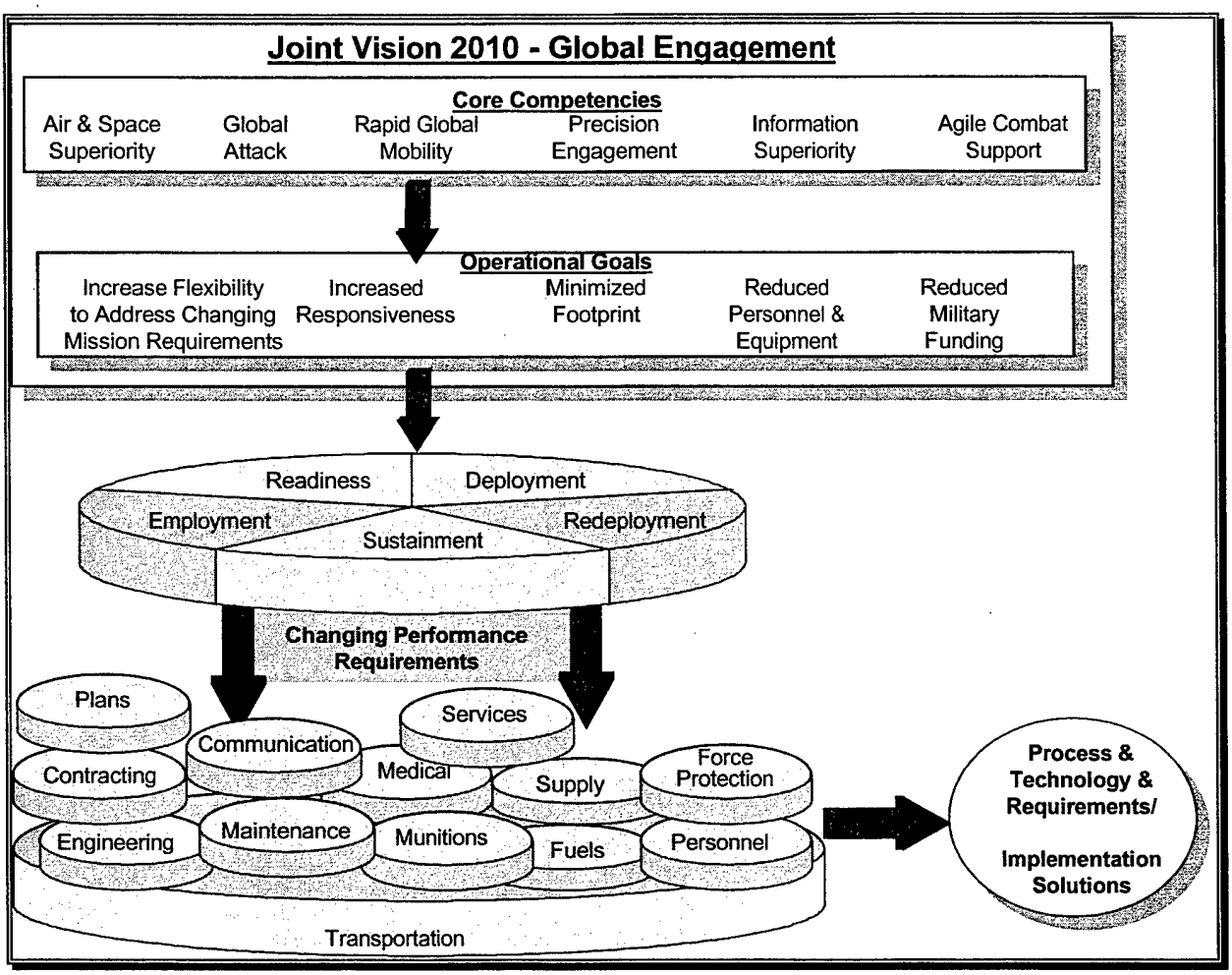


Figure 1. Changing Operational Environment Forces the Components to Find Better Ways of Doing Business

Transportation currently delivers resources to reception sites using various means of air, ground, rail, and sea modes of transport. As anticipated in the AEF concept, the needed delivery speed will require resource movement primarily by airlift. Also, future airlift of resources may not be performed totally by military aircraft, but may also include an increased reliance on commercial aircraft contracted to support airlift. Thus, the resource movement technologies must be compatible with both military and commercial airlift.

2 INFORMATION COLLECTION

Effective identification of research opportunities for the resource movement process requires an understanding of the current process along with the identification of those aspects of the process viewed by transportation experts as needing improvement to successfully meet future movement needs in both military and commercial organizations. Collecting the needs occurred as a literature search and as interviews and observations with military and commercial organizations involved with transportation.

2.1 Literature Review

The literature review focused on the collection of both formally and informally stated transportation deficiencies and needs documented in high-level Air Force documents. At times, potential technologies were identified in association with the listed deficiencies and needs. As this literature review occurred early in the project and prior to interviews with selected transportation experts, the identified requirements were often discussed with the experts to obtain their views of the formally stated needs.

Included in the literature review was the Logistics Analysis to Improve Deployability (LOG-AID) Concept of Operation (CONOP) describing a streamlined deployment process supported by technologies. The information contained in this document came from 245 data collection interviews with personnel responsible for wing-level deployment process at AF bases throughout the United States, Europe, Japan, and Korea and from observations of the deployment process. These data collection visits provided an in-depth understanding of the resource movement from tasking receipt by the unit until the unloading and distribution at the reception site. Of the 245 interviews, 21 were with transportation representatives, providing significant insights in the transportation technologies used, the user-stated problems with the technologies, and improvement suggestions provided by the users. A complete list of the sites visited during LOG-AID and the types of personnel interviewed are presented in Figure 2.

- Headquarters (HQ) USAF
- Air Combat Command (ACC)
- United States Air Force, Europe (USAFE)
- Air Mobility Command (AMC)
- Pacific Air Forces (PACAF)
- 7thAF
- Air Force Special Operations Command (AFSOC)
- Aviano AB
- Charleston AFB
- Eglin AFB
- Elmendorf AFB
- Ft. Wayne ANG
- Hickam AB
- Holloman AFB
- Hurlburt Field
- Kadena AB
- Langley AFB
- Maxwell AFB
- McGuire AFB
- Mt. Home AFB
- Osan AB
- Ramstein AB
- Randolph AFB
- Scott AFB
- Seymour-Johnson AFB
- Shaw AFB
- Spangdahlem AB
- Springfield ANG
- Tyndall AFB
- Wright-Patterson AFB

Functional Area	Interviews
Command & Control	21
Planning	125
Unit Support	63
Manpower & Personnel	15
Transportation	21
TOTAL	**245**

Figure 2. Data Collection Sites During LOG-AID

In addition to the review of printed materials, Internet searches directed at various Department of Defense (DoD), Government, and commercial sites provided information related to personnel and cargo transportation visions and objectives for those organizations.

Table 1 lists the sources for the literature search along with a brief summary of the information contained in each document. The formal deficiencies and needs extracted from these sources are presented and discussed in Section 3.1. The informal needs extracted from these documents are included in Table A-1 and discussed in Section 3.2.

Table 1. Sources for Literature Review

SOURCE IDENTIFICATION	CONTENT SUMMARY
Report on United States Expeditionary Forces Volume 1: Summary SAB-TR-97-01 November 1997	This document defines and discusses the AEF vision, how it is enabled, and what the Air Force should do to meet the AEF needs. Transportation requirements extracted from this document are presented in Table A-1 and identified as document 1.
United States Air Force Long-Range Plan **7 March 1997**	The Air Force Long-Range Plan describes the implementation concept for Global engagement. The stated transportation requirements extracted from this document are presented in Table A-1 and identified as document 2.
Long Range Plan: Implementing United States Space Command (USSPACECOM) Vision for 2020	The plan assembles the best ideas from the military, civil, and commercial space communities to produce a roadmap for achieving USSPACECOM's vision for 2020. While the document provides significant insight into the future, it did not present needs directly focused at transportation.
Army Vision 2010	This document is a blueprint for the Army's contribution to the operational concepts identified in Joint Vision 2010. It presents a conceptual template for how the United States Army will channel the vitality and innovation of its soldiers and civilians, and leverage technology opportunities to achieve new levels of effectiveness as the land component member of the joint warfighting team. From a transportation perspective, the needs focus more on the operational aspects, with very limited needs aimed at transportation.
2025 Operational Analysis: A Research Paper Presented to Air Force 2025 LtCol Jack Jackson, Jr., PhD LtCol Brian Jones, PhD Maj Lee Lehmkuhl, DrSci	This analysis represents a year-long study to generate ideas and concepts on the capabilities required by the United States to possess the dominant air and space forces in the future; to identify new or high-leverage concepts for employing air and space power; and to identify the necessary technologies. The study resulted in eleven system concepts, none of which addressed transportation for the movement of cargo and personnel.
Agile Combat Support: Executive Summary Mission Areas Assessment (MAA) Mission Needs Analysis (MNA) Mission Solution Analysis (MSA)	The information focused primarily on the need for force protection operating in a Nuclear, Biological, and Chemical (NBC) environment. While stating the need for a nimble, focused logistics capability, the number of transportation needs are very limited.
Air Force Modernization Planning Agile Combat Support Mission Area Plan (MAP) FY 1998 1 November 1997	MAPs influence changes to Air Force doctrine, tactics, training, and procedures that guide the acquisition, sustainment, and enhancement of new capabilities by identifying warfighter needs. The stated transportation requirements extracted from this document are presented in Table A-1 and identified as document 4.
1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	As AMC's roadmap to meeting the current and future requirements of air mobility systems, this document identified key concerns include shortages and shortcoming of the MHE fleet; enhancement of global reach through the Global Air Traffic Management (GATM) program; In Transit Visibility (ITV) of personnel, patients, and cargo; aircrew shortages; acquisition and modernization of critical aircraft.
Global Attack Mission Area Plan (MAP) 1996	Review of the Global Attack MAP Executive Summary indicated the MAP highlighted the operational aspects, with generic statements directed at transportation needs. These general needs identified the requirements to move resources quickly without identifying specific transportation needs or

SOURCE IDENTIFICATION	CONTENT SUMMARY
	deficiencies.
Army Science and Technology Master Plan (ASTMP)	Reviewed the outline of the document to identify discussions directed at transportation needs. The document is setup with six chapters. The transportation aspects focus on ground vehicles used to move troops and cargo on battlefield as opposed to movement from deployment source to reception site.
Commander's Intent Letter from United States Command-in-Chief, Transportation (USCINCTRANS) and Commander of AMC General Walter Kross	Requirements focus on the need to provide the warfighting commanders the transporting capabilities necessary to rapidly deploy forces. The stated requirements are presented in Table A-1 and identified as document 6.
USAF Logistics Research, Studies, and Analysis Top Ten Requirements List 30 March 98	Requirements focus on needs for all aspects of Air Force operations. Associated with each requirement is associated a list of specific technology requirements, and the organization responsible for that type of technology. The sources of this top ten requirements list are (1) the AF Logistics Strategic Plan (AFLSP), (2) Coordinated Civil Engineering Science and Technology Priorities Supporting ACS/RAEF, (3) Technology Planning Integrated Process Teams (TPIPTs), and (4) comments from the Major Commands (MAJCOMs) and S&TW organizations. The stated requirements are presented in Table A-2 and identified as document 5.
ACC MPP	The document presented a complete list of needs used by ACC in the MPP process and details the generic shortfalls in mission capability. Of the 109 needs identified and ranked, the one need of cargo support provided limited specifics.
Office of Naval Research (ONR): Science and Technology	ONR's mission is to maintain a close relationship with the research and development community. This relationship supports long-range research relevant to the future Navy and marine Corps. Their primary directions are the following: Information, Electronics, and Surveillance; Ocean, Atmosphere, and Space; Engineering, Materials, and Physical Science; Human Systems; Weapons, Marine Corps, and Special Programs; and Industrial Programs. No transportation needs were apparent through these areas.
Assessment Execution Document for Air Force Expeditionary Force Battlelab (AEFB) and Integrated Planning and Execution Capability (IPEC) Air Force Operational Test and Evaluation Center, Test and Assessment Directorate April 1998	Document provides direction and procedures for the Air Force Operational Test and Assessment Center (AFOTEC), Rapid Test and Assessment (TA) Directorate's support of the Air Force Expeditionary Force Battlelab (AEFB) assessment of an automated Integrated Planning and Execution Capability (IPEC). The IPEC concept is to advance the core competencies of Rapid Global Mobility and Agile Combat Support. Focusing on the information aspects of operational phases, needs for transportation were not addressed.
Thrust Areas: Transformation Paths (TATPs) to a Future Aerospace Force Presentation by the HQ USAF Directorate of	Thrust areas identify corporately approved, long-range priorities that will shape the future Air Force and its core capabilities. The designated thrust areas are: develop airman of the future; conduct seamless operations to control the aerospace dimension; find, fix, track, engage, and assess any significant target; be an expeditionary aerospace force; maintain a credible nuclear deterrent force; shape 21st century infrastructure for future

SOURCE IDENTIFICATION	CONTENT SUMMARY
Strategic Planning 24 March 98	aerospace operations; and produce integrated TATPs. Within the expeditionary aerospace force thrust, the goals were discussed but no transportation needs identified.
Enhancing the Effectiveness of Air Expeditionary Forces Phase I Results: Focus on the Challenges Project Air Force AEF Team RAND May 1997	Investigated ways in which the concept of AEF could be enhanced and expanded. The briefing identifies the most important challenges to wider application of the AEF concept, and makes recommendations on which challenges should be addressed first. From a transportation perspective, the only recommendation was the need for a very long-range airlifter to add robustness to the AEF concept.
Mobility Technical Planning Integrated Product Team (TPIPT) Development Planning ASC/XRM WPAFB FY96	The goal is to help the Mobility TPIPT community with information required to make sound, logical decisions to identify approaches for solving near, mid, and far refueling, strategic, and theater airlift.
Transportation Science and Technology Strategy Address by Rodney Slater U.S. Secretary of Transportation	Addresses the issues needed to build a transportation system for the 21st century. Secretary of Transportation Federico Pena established an Interagency Coordinating Committee on Transportation R&D. This presentation brings together the insights and lessons learned by the group. For this program, two needs were included. One, the goal was identified for more efficient vehicles that have less impact on the environment. Two, to develop smart structures, meaning roads, bridges, runways, tunnels, etc. with a network of embedded sensors.
Enabling Technologies for Advanced Transportation Systems DOT Research and Special Programs Administration; Volpe National Transportation Systems Center September 97	This meeting and resulting report focused on technology disciplines of: Information Technology, Micro/Nano-technology, and Materials Technology. Directed at the commercial transportation environment, focused the discussion on information and sensors to gain a continuous knowledge of movement status and to control the movement.
Air Force Special Operations Command (AFSOC) Needs/Deficiencies List **1 Nov 97**	This document identifies 171 needs/ deficiencies separated into functional areas. These areas are C4I, Intelligence, Avionics, Advanced Weapons, Armament, Flight Vehicles, Propulsion and Power Subsystems, Mission Planning and Rehearsal, Training Support Systems, Crew Systems and Aerospace Medicine, and Special Tactics Teams. None of which include transportation needs.
Internet searches for commercially available resource movement capabilities.	Identified the types of resource movement technologies currently being marketed, thus providing insights into what they consider important and the general direction they are taking to address transporting requirements.

SOURCE IDENTIFICATION	CONTENT SUMMARY
Logistics Analysis to Improve Deployability (LOG-AID) Concept of Operation (CONOP)	Describes a streamlined wing-level deployment process from the time to tasking receipt by the unit until the deploying resources are loaded into the transporting aircraft. The stated transportation requirements are listed in Appendix A.

2.2 Organizational Interviews

Expanding upon the information gained through the literature search, interviews were held with personnel from several functional areas within the military, Government, and commercial sectors. These interviews provided the opportunity to discuss the needs and deficiencies obtained from the literature search and to gain the interviewees' perspectives of transportation needs, trends, and issues. Of specific interest during these interviews was a visit to the commercial entity of Emery Worldwide at the Dayton International Airport.

The list of organizations and personnel interviewed is contained in Table 2 along with a brief summary of the information collected. The list of information deficiencies and needs obtained from the interviews and visits are contained in Table A-1 and discussed in Section 3.2.

Table 2. Sources for Organizational Interviews.

SOURCE IDENTIFICATION	SUMMARY
AFIT Transportation Class, WPAFB	This senior-level class provided the project team with insight into commercial transportation issues. Having toured various commercial facilities and were able to offer comparisons between commercial and military operations.
Emery Worldwide, Dayton International Airport	This commercial carrier of large cargo items provided a look into the state-of-the-art In Transit Visibility (ITV) systems available today. Their facility was highly automated, organized, and computerized. In their industry, a significant trend is increased demand for Just-In-Time (JIT) delivery of goods. This requires use of Electronic Data Interchange (EDI) with both suppliers and customers to be cost-effective. Also, backup routing plans were an important factor of their success.
ASC/ENFG (ATTLA); WPAFB, OH	Air Force Transport Test Load Agency (ATTLA) sees a trend toward use of rolling stock and commercial equipment. Their concern is that purchased or developed equipment should include deployability considerations, and they find wheeled items easier to move, especially those that are self-propelled. One trend noted is that load crews are being reduced by using deployed personnel on the aircraft to assist with unloading. Airdrop and combat unloading are used only when necessary, rather than as a standard unloading

SOURCE IDENTIFICATION	SUMMARY
	method, the office reports. System reliability and maintainability, especially for MHE, are key concerns.
AMC/XP, AMC/XR, others; Scott AFB, IL	AMC representatives brought forth issues from several functional areas. One concern is the contamination of cargo and aircraft and the difficulty in decontamination using today's pallets and netting. Chemical and biological contamination are also issues in patient care and evacuation. It was noted that the AEF concept will change today's view of readiness, and that the need for coordination with commercial and the other services continues to increase. This interview generated several ideas for technology research, including: ◆ Remote-controlled robotics for cargo movement ◆ New pallet lifting capability ◆ How wheeled pallets can be used with the current airframes ◆ Interface between Army PLS and aircraft ◆ Stacking cargo higher on the plane to allow more weight per aircraft ◆ Reduce the types of loaders as the types of aircraft are reduced ◆ Use UAVs for heavy equipment movement ◆ Pallet materials that are lighter, stronger ◆ Use of a space station as a depot
AFSOC; Hurlburt, FL	From an AFSOC perspective, the requirements for deployment are speed accomplished by taking minimal resources and packing them effectively. The interviewees believe that the pallets are the best means of packing, but the bottleneck is problems with K-loaders. Reported problems primarily involved their operational status and their ability to fit to various aircraft. This organization previously was involved with establishing the requirements for a new 60K-loader and believes its ability to work with various aircraft will provide a major benefit.
AMC/DOZ; Scott AFB, IL	AMC/DOZ views the current resource movement process as being well established and working, and does not foresee any significant changes in the future. Much of their work is directed at the replacement of current types of technologies, specifically the acquisition and testing of the new 60K loader. Since this type of equipment is not easily deployable, testing focuses on its fit with various aircraft, and possible plans for including it into the mix of current MHE. With the effort invested in this upgrade, no future MHE improvement goals have been identified The DOZ office recognizes that each site uses a different combination of MHE, indicating the possibility that one combination may be more effective than others may. Information has been the primary focus for changes and improvement, with the next major adjustments being contemplated relate to planning and tracking of resources from source to destination.
Deputy Commander, Combined Arms Support Command (CASCOM)	CASCOM is very active in the limited application, experimentation, and evaluation of transportation technology for full Army use. They see the areas of greatest transportation potential to be information technology and "intellectual technology." Terminals and their sorting activities were characterized as major bottlenecks of the transportation pipeline. Principal causes of poor cycle time performance are Aerial and Sea Ports of Debarkation. This organization highlights the following current and future transportation thrusts: ◆ Next generation of Radio Frequency tags ◆ Radar responsive tags

SOURCE IDENTIFICATION	SUMMARY
	♦ Real-time Cargo Asset Control Tracking System (RCATS) ♦ cargo configuration schemes ♦ containers and palletized loading systems ♦ general cargo movement design
Dr. Frank Hassler, Volpe National Transportation Systems Center	The level of commercial investment in transportation infrastructure supports the DoD reliance on commercial capabilities. System design issues are critical to ensure that military requirements do not significantly diverge with commercially available capabilities. The Volpe Center believes that management of throughput in the transportation system is crucial to its continued effectiveness. Technologies that will support this "flow control" include the following: ♦ sensing and surveillance technologies ♦ modeling and information technologies ♦ enterprise-wide systems
Col Craig Koontz Deputy Director, Joint Transportation CIM Center	There is a need for a stronger "marriage" between extended logistics functions (maintenance, procurement, transportation, supply, etc.) Automated Identification Technologies area key area of interest for the transportation community. The CIM Center believes that standard applications of technology through a standard architecture is important for standardization and synergy of efforts. Col Koontz views information technology as the biggest transportation problem, with MHE as the second. Areas for improvement in material handling technologies include collapsible containers, Army capability to move 463L pallets on helicopters and trucks, and common vehicle and lift systems between military and commercial carriers. Improvements in TAV and ITV will be necessary for supporting the CINCs' changing requirements. Technologies that will support these concepts include: ♦ smart cards ♦ RF tags and transponders ♦ web-based technologies ♦ microburst satellite
Dr. John Kasarda Director, Kenan Institute for Private Enterprise	The physical infrastructure of the transportation movement process has failed to keep pace with technology advancements. Dr. Kasadra believes that the DoD and NASA will assume the roles of catalysts in the development of new transportation technologies. He predicts the development of the super jumbo passenger and freighter aircraft within the next 10 years, and the hypersonic aircraft within 20 years. Technology will provide the transportation industry with the capability to trace, track and communicate from the raw material source to the customer along the value chain. This will be supported by the following technologies and processes: ♦ material handling systems at intermodal interfaces moving form warehouses to crossdocking ♦ advancement of EDI for resource control ♦ internet-based EDI standards supported by satellite and GPS
Mr. William Crowder Senior Analyst, Logistics Management Institute	Mr. Crowder believes that the transportation community lacks a clear articulation of force multiplier benefits, therefore understating their importance when expressing required changes only as transportation issues. He advocates new aircraft designs that trade off speed for volume, given the demands of future operations plans. It is difficult to estimate the payoffs from any proposed technology insertion without end-to-end process views

SOURCE IDENTIFICATION	SUMMARY
	supported by simulation. Lack of a "teaming" vehicle between military and commercial entities is another major bottleneck to transportation technology insertion. Mr. Crowder believes that improvements in MHE will be commercially developed and available for the DoD's purchase, while advances in end-to-end flow through models could only expect to be developed through DoD investment.
Mr. Jim Turpin Senior Technology Fellow, Federal Express	Mr. Turpin views technology as integral part of transportation operations. He identified vision systems such as optical character recognition systems as critical to enhanced transportation system performance. Specific bottlenecks for transportation movement processes include: ♦ bureaucracy and "rice bowls" ♦ implementation costs of technology ♦ cooperation of government with industry ♦ physical network constraints
Mr. Bob Jones Senior Consultant, United Parcel Services	Mr. Jones emphasized the importance of advanced information for both defense and commercial transportation. He views source data capture as a major bottleneck to the transportation movement process. One of UPS's clients views shipment information as worth half the value of the physical product. He advises the DoD to move to commercial standards and applications where possible, to reduce the business expense of its unique requirements.
Mr. Mike Rohrlick Program Manager Boeing Advanced Airlift Systems	Boeing is developing an aircraft integrated system that takes a container off a truck and places it on the aircraft directly. If successfully adopted, this could eliminate sorties into a forward area to support positioning of MHE. The company is also involved in development of a modified aircraft floor utilizing belts instead of rollers, in conjunction with a special ISO locking system. Developments in Boeing's Advanced Theater Transport (ATT) aircraft include an articulated aircraft ramp that adjusts its height from 36# to 70" to meet the height of a flatbed truck, and a wide aircraft door to permit the side loading of flatbed trucks directly from the aircraft. Mr. Rohrlick views these developments as instrumental to eliminating or reducing breakbulk aerial port capabilities at major APOD/Es. A long-term objective is to design aircraft which more effectively handle containerized loads and PLS flatracks.
Mr. Ivo Stibbe Director of Electronic Commerce, Emery Worldwide	Their objectives include ITV at the item detail level, and real time tracking via satellite transmission. Technologies which support these objectives include: ♦ development of an effective C2 system ♦ barcode scanning ♦ document image processing ♦ web-based applications
Brig Gen Thomas Mikolajcik, USAF (Ret) and LtCol Robert McCauley: Thomas Mikolajcik, retired AF Brig General, served as Director of Transportation for HQ USAF in the mid-	There has been limited progress in improving the timeliness and accuracy of cargo and load preparation in recent years. Therefore, these areas are prime candidates for technological changes. While there are many organizations conducting research regarding Information Systems (ISs), need exists for transportation Decision Support Systems (DSSs). The introduction of the C-17 will cause some significant paradigm shifts. In

SOURCE IDENTIFICATION	SUMMARY
90s. He served as Commander of several airlift wings and squadrons and represented the JCS as a HQ USAF Airlift Action Officer. With the Air Force, he was a major player in implementing a new Transportation Information System LtCol Robert McCauley, retired AF LtCol, served as Chief of the HQ USAF's Express Delivery Reinvention Laboratory and Strategic Mobility Development Deployment Organization	contrast to the common hub-and-spoke configuration of the current airlift, the C-17 is designed to fly directly to forward areas. This new concept effectively combines strategic and tactical airlift, thus simplifying a key airlift process. Nurturing of DoD/civilian partnerships and use of Commercial-Off-The-Shelf technologies where possible are key to the military's continued success. Candidates may include subcontract of terminal management and channel missions (scheduled airlift) to commercial entities. Since military and commercial aircraft are not interchangeable for most functions, needs for Air Force technologies will certainly change if this occurs. Ideas for technology research include: ♦ wireless or microwave communications ♦ enhanced GPS ♦ logistics optimization models ♦ intelligent highway systems ♦ electric vehicles ♦ collision warning systems ♦ safety monitoring of hazardous/sensitive freight
Commercial Trucking Industry	Research into the trucking industry highlighted some of the commercial practices in moving cargo. The trucking hub studied was responsible for transferring cargo among trucks on different routes. In addition to information capabilities, their primary concern is the efficient movement of cargo within the transfer building. Currently, much is done by forklifts. Future efforts are focusing on reducing forklift reliance and installing more roller systems. In the near term the roller system would allow personnel to push cargo as necessary. For the future, the goal is to control the rollers using either manual or automated techniques. The automated control would use sensor systems to determine the appropriate path. Also, all movement occurs at the same height level, so adjustable ramps are not required. Trucks are loaded and unloaded in various ways, depending on the type of truck. For flatbeds and car haulers, items are driven or lifted into position by using a ramp or lifting capabilities. Tie downs are used for restraints. For box trailers, items are driven, lifted or pushed through the rear door, with tie down used as necessary. The loading docks can provide a single-height loading capability with the box trailers. Tank trailers are loaded by pouring materials into the tank, and are unloaded through dumping or pumping. Containers are pulled onto truck beds using a winch in combination with a winch. Commercial containers also have a limited skid capability.
Commercial Railroad Industry	Railroad cars are loaded in several ways depending on the type of transporting car and type of cargo. Driving or lifting containers or other items into position using a ramp or lifting capabilities loads flatbed cars, using tie downs as restraints. For boxcars, items are driven, lifted or pushed through the side doors. Cargo is poured or lifted into side-boarded cars. Lifting is primarily done by stationary lift mechanisms.

3 INFORMATION COLLECTION RESULTS

Officially documented Air Force deficiencies were noted in many of the documents reviewed for this effort. These are numbered and tracked by each MAJCOM, as high priority concepts. The review of the literature also produced a set of operational needs that were more informal. These problems were easily recognized in the literature based on the applicable symptoms listed.

3.1 Formal Needs/Deficiencies

The formal deficiencies identified during the literature search are listed in Table 3, with the same or similar deficiencies grouped to facilitate their analysis. As indicated in the "Category" column, ten categories were identified as follows along with the number of needs within each group:

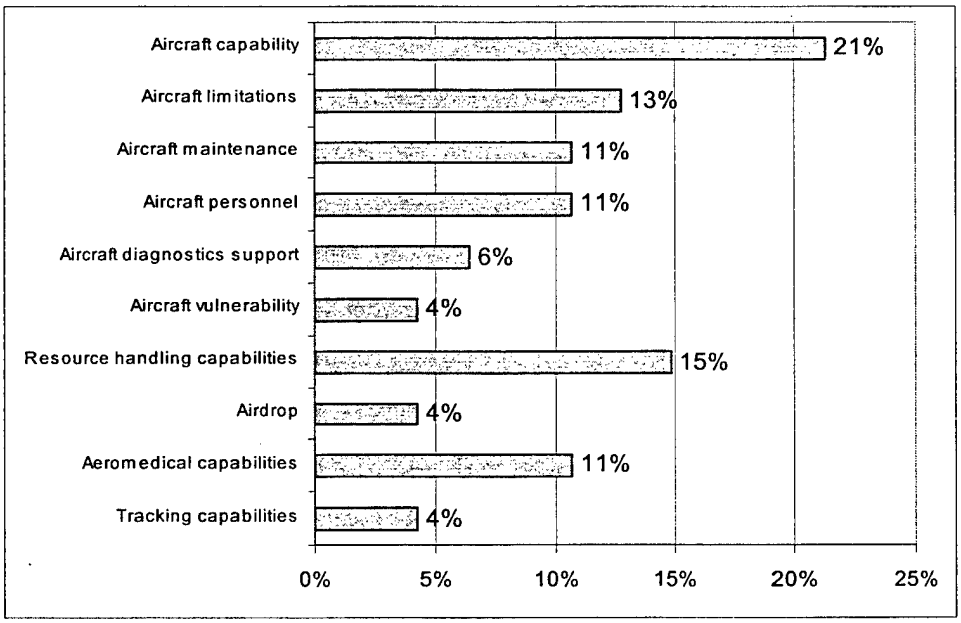


Figure 3. Formal Needs/Deficiencies

This grouping shows that 6 of the 10 groupings (and 66% of the needs) relate to the aircraft. The remaining needs are spread relatively evenly over the other 4 groupings, with resource handling being the next largest group.

Table 3. Formally Identified Deficiencies

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
Aircraft Capability			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-34X	Lack of adverse weather formation/rendezvous capability
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-7X	Aircraft are noisy
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-5X	Limited in flight refueling methods
	Mobility TPIPT Development Planning ASC/XRM WPAFB FY96	n/a	C-130 combat delivery flight management systems are a limiting factor in mission accomplishment
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Insufficient organic strategic airlift
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-9 does not meet noise requirements
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-137 does not meet noise requirements
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-20 does not meet noise requirements
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	KC-135 does not meet noise requirements

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
	Air Force Modernization Planning Agile Combat Support Mission Area Plan FY 1998 1 November 1997	M2	Current support package required for lift is obsolete, heavy, inefficient, inflexible
Aircraft Maintenance			
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Maintenance manpower inadequate to support C-17 acquisitions
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Reliability, maintainability, operations of C-5
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Reliability, maintainability, operations of C-141
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Reliability, maintainability, operations of C-130
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Uncertain C-130 service life
Aircraft Personnel			
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-141 flight engineer manning level is too low, causing cancellation of missions
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-5 loadmasters and flight engineers are undermanned
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	C-130 navigators, flight engineers, and loadmasters undermanned
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Insufficient ground training devices for loadmasters
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Aircrews lack sufficient protective equipment for NBC environment

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
Aircraft Diagnostics Support			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-17X	Lack of onboard diagnostic equipment
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	No multi-functioning AGE
	Air Force Modernization Planning Agile Combat Support Mission Area Plan FY 1998 1 November 1997	I3	Lack full second and third echelon diagnostic capability for on-ground or in-flight oxygen systems, etc.
Limited Aircraft Capabilities			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-31X	Limited passive adverse weather air traffic control capability
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-32X	Lack of capability for passive, autonomous adverse weather precision landing capability
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-39X	Obsolete avionics to support Global Air Navigation
	Mobility TPIPT Development Planning ASC/XRM WPAFB FY96	MOB-C96-029	Combat delivery aircraft lack access to real-time and threat order of battle information
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-INT-2	Obsolete intel support to SOF aircraft

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-MPR-9X	Limited ability to perform in-flight planning
Aircraft Vulnerability			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-5D	SOF aircraft vulnerable to detection and destruction (NBC contamination)
	Mobility TPIPT Development Planning ASC/XRM WPAFB FY96	MOB-XXX-96-INF-009	Combat operations vulnerability; aircraft lack adequate defensive systems, protective equipment, and threat analysis capability
Airdrop			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-AV-33X	Lack of accurate adverse weather airdrop capability
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Strategic brigade airdrop shortfall
Resource Handling Capabilities			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-22X	Insufficient personnel/equipment processing
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-28X	Overly dependent on limited MHE
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	MHE fleet capability/shortage/ condition/reliability/ maintainability

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
	Air Force Modernization Planning Agile Combat Support Mission Area Plan FY 1998 1 November 1997	M3	Lack the ability to carry and perform handling on oversize and outsize cargo with current cargo handling equipment and combat delivery platforms.
	Air Force Modernization Planning Agile Combat Support Mission Area Plan FY 1998 1 November 1997	M3	Lack adequate support for austere load and unload capability for operations in forward contingency operating areas.
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-TRN-9X	Lack of air and ground platform contamination control
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-CAM-1	Inadequate air crew NBC protection
Aeromedical Capabilities			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-CAM-7X	Limited in-flight aeromedical evaluation capability
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Current air evacuation patient care equipment is inadequate to meet taskings
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Patient Loading System (PLS) used to load CRAF is insufficient
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	There is a lack of development of joint air evacuation service equipment
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-C4I-19X	Lack of aircraft commander/crew communication

CATEGORY	SOURCE	NEED/ DEFICIENCY ID	DESCRIPTION
Tracking Capability			
	Air Force Special Operations Command (AFSOC) Needs/Deficiencies List 1 Nov 97	AFSOC-98-FV-29X	Antiquated management systems
	1998 Air Mobility Master Plan (AMMP 98) Rapid Global Mobility	n/a	Insufficient ITV

3.2 Informal Deficiencies

The following list presents groupings of transportation related needs extracted from Table A-1 of Appendix A and collected during the literature review and interviews with personnel and organizations. Along with each grouping is the number of needs included in that grouping. As with the formal needs, those directed at the transport aircraft are the highest (20%+8%+10%+1%=39%). Following next is information handling at 34%, and efficient ground movement at 22%.

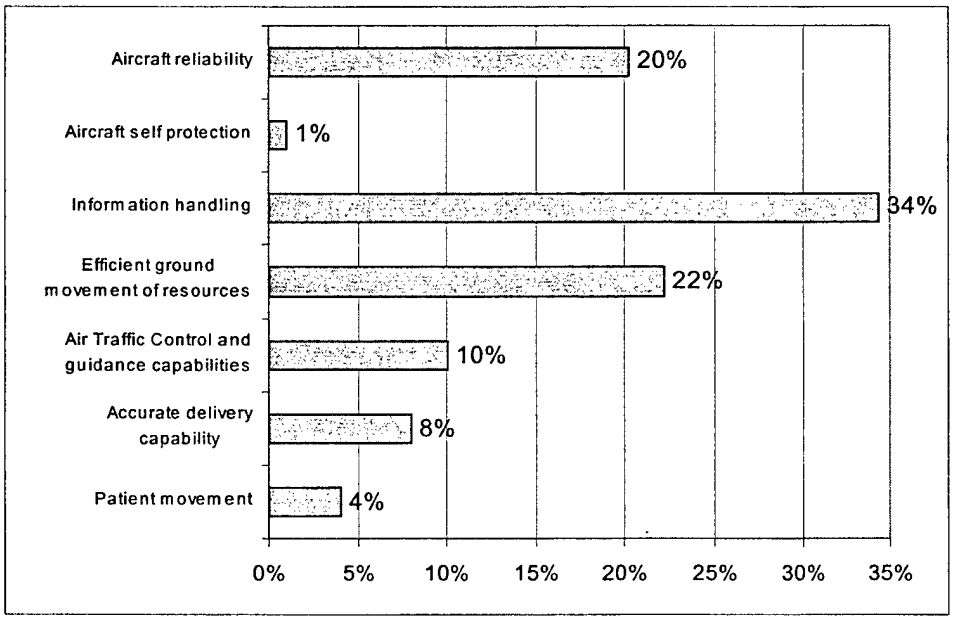


Figure 4. Informal Deficiencies

Combining the formal and informal needs groupings results in similar patterns of importance. Aircraft related needs are again highest (21%+3%+3%+2%+4%+2%=36%). Information handling is 23%, resource handling is 20%, and airdrop is 7%. The numbers provide a trend as to the importance placed on the various areas.

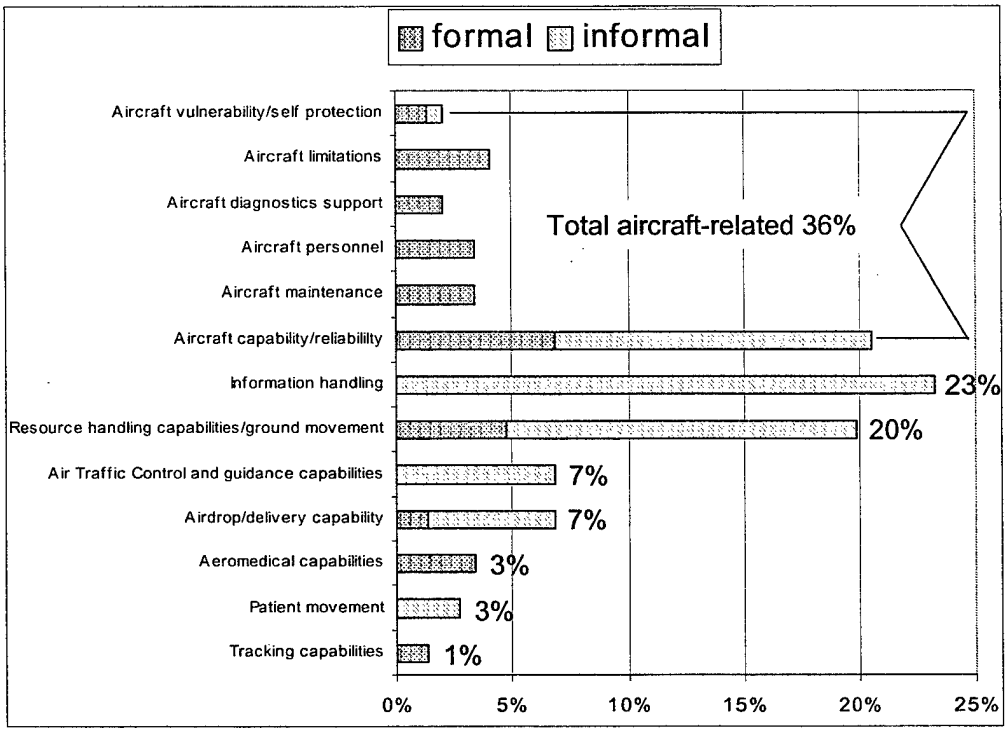


Figure 5. Combined Deficiencies

3.3 Technology Ideas

In addition to the identification of deficiencies and needs, those individuals interviewed were asked for technology ideas that could be used to benefit the resource movement process, but without necessarily being linked to the formal and informal deficiencies and needs. The intent of this collection was to identify research opportunities that would improve a processing area not specifically identified as an area requiring improvement. Table 4 presents this list of technology ideas grouped according to transportation needs and will be used in the analysis and prioritization research opportunities as presented in the next document.

Table 4. List of Transportation Needs and Possible Technology Solutions

TRANSPORTATION NEEDS	SUMMARY DESCRIPTION	POTENTIAL SOLUTIONS
Stealth cargo	Future military missions require airdrop of resources without being sighted by the foes. As stealth aircraft become more widely used, the need arises for the airdropped resources to be more stealth in nature to maintain the element of surprise. Thus the need arises for stealth resources as they are delivered.	Development of a stealth blanket that can be placed over resources being air dropped.
Retrieval of dropped cargo	Airdropped cargo may have to land in a wide variety of terrain types. Thus the need arises to access and effectively move the cargo from the landing site to the usage site.	Development of blimps. Development of lifting balloons
Ease of moving cargo during loading and unloading	Reduce the need for personnel and support equipment to move increments	Development of an air floatation device that will allow cargo to manually moved by one person. Develop retractable wheels into pallets and containers (roller blades) Develop transferable, battery operated drive devices to allow the movement of wheeled pallets and containers. Wheel barrows Pneumatic tube delivery system Troops using poles for lifting and moving cargo Unmanned cargo movement system (and development of related sensor/processor technologies) Portable conveyor systems Passenger/cargo matching to minimize queue time for cargo and troops - where both are required to perform at function
Improved container capabilities	The future concept of short reaction times between tasking and mission start indicates the need for increased used of containers for moving cargo.	Develop containers out of lighter and cheaper materials, and designed to reduce production cost.

TRANSPORTATION NEEDS	SUMMARY DESCRIPTION	POTENTIAL SOLUTIONS
		Changes to pallet shape - circular, triangular Adjustable height containers Eliminate packaging and containers
Improved/reduced hazardous handling	The transporting of hazardous materials presents limitations due to the packaging, documenting, and placement in the transport. Providing the capability to process and transport hazardous materials as non-hazardous materials would remove a processing roadmap.	Develop containers in which hazardous materials can be safely transported without being restricted by current guidelines Develop ways of reducing hazardous materials requirements
Improved low level drops of resources (personnel and equipment)	Low level airdrops will not be supportable by parachutes and too high for standard pullout unloading. Improved packing will allow the resources to be dropped from this medium altitude.	Develop a landing system with the imbedded resources to soften the landing shock to the dropped resource.
Controlled air dropping of resources	Effective site operations require the delivered resources to be accessed quickly. This may include the capability to load the air dropped cargo directly onto the transporting vehicle or to position dropped wheeled containers in a pattern allowing for fast hookup and distribution.	Develop controlled parachutes to pinpoint the landing of resources. Possibly adapt laser guided bomb technologies to direct and rotate the cargo as necessary. Air inflatable shelters as parachutes and cargo delivery systems Skydiving technologies for cargo Skydivers drop with cargo to assist in steering and landing "Stuntman" landing bag of cargo drop Inflatable airbags below cargo to enable cargo movement Air vehicles/air cushioned vehicles Technology for locating airdropped cargo

TRANSPORTATION NEEDS	SUMMARY DESCRIPTION	POTENTIAL SOLUTIONS
		Gravitational field identification/location technologies Technology for protecting airdropped cargo from enemy Use of rockets to launch and land cargo Weapon guidance technology for cargo and passenger delivery Precision autonomous or towed gliders for cargo and passenger delivery Velocity reduction techniques
Improved ways of securing cargo in the aircraft	Currently, palletized cargo is efficiently secured in the aircraft using a locking mechanism. Non-palletized cargo is much less efficient in their use of a chain-down system.	Hammock storage systems in aircraft Suction technology for securing cargo to aircraft. Affixing cargo to aircraft ceiling could increase space utilization. May provide a means of reducing the need for chain tiedowns.
Improved concepts for handling spares	Spares are needed during a mission. A limited number are deployed, with additional spares delivered during the sustainment phase.	Give all spares to user Eliminate requirement for prepositioned spares Movement of prepositioned materials to deployed location
Increase availability of aircraft for transport	The movement of resources in a timely manner is caused in part by the availability or aircraft to perform the move.	Use of additional commercial carriers Dramatically increase speed of cargo/transport aircraft Dramatically increase fuel efficiency of cargo/transport aircraft Maximize the number of transported vehicles that can act as additional functions, to include the handling of cargo,

TRANSPORTATION NEEDS	SUMMARY DESCRIPTION	POTENTIAL SOLUTIONS
		personnel, and equipment (such as step vans with lift platform on back) Eliminate airspace rights Minimize aircraft turn time at embarkation and debarkation points. Direct aircraft on-load and off-load to/from terminal - plane back right up to terminal
Improve the tracking and cost of resource movement		Use of IMPAC card Use of credit card at point of delivery Tax cargo by weight and cube to incentivize units to only take the minimum required cargo and passengers Trip counters/measurement systems on cargo containers Total asset visibility technologies - ability to find and locate cargo and personnel in any weather conditions from anywhere on the planet.

4 CONCLUSION

The collection of transportation related deficiencies and needs collected through the literature review, interviews, and observation presents well defined areas requiring improvement that are consistent among the information sources. These grouped sets of deficiencies and needs now provide the foundation for analysis, resulting in a suggested set of potential research opportunities for AFRL/HES. This analysis is presented in the document entitled Transportation Research Agenda.

THIS PAGE INTENTIONALLY LEFT BLANK

APPENDIX A

NEEDS IDENTIFIED DURING INFORMATION COLLECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Needs Identified During the Literature Search

The following list relates the individual transportation needs back to the source document through the assigned document number (DOC #).

DOC #	SOURCE IDENTIFICATION
1	**Report on United States Expeditionary Forces**, Volume 1: Summary, SAB-TR-97-01, November 1997
2	**United States Air Force Long-Range Plan**, 7 March 1997
3	LOG-AID Final System Concept Paper (CONOP), 2 March 1998
4	**Air Force Modernization Planning, Agile Combat Support Mission Area Plan**, FY 1998, 1 November 1997
5	**USAF Logistics Research, Studies & Analysis Ten Top Requirements List** 30 March 98
6	**Commander's Intent Letter from USCINCTRANS and Commander of Air Mobility Command (AMC)** General Walter Kross
7	**Long Range Plan: Implementing USSPACECOM Vision for 2020** No transportation related requirements identified
8	**Army Vision 2010** No transportation related requirements identified
9	**2025 Operational Analysis: A Research Paper Presented to Air Force 2025**, LtCol Jack Jackson, Jr., PhD, LtCol Brian Jones, PhD, Maj Lee Lehmkuhl, DrSci No transportation related requirements identified
10	**Agile Combat Support: Executive Summary**, Mission Areas Assessment (MAA), Mission Needs Analysis (MNA), Mission Solution Analysis (MSA) No transportation related requirements identified
11	**1998 Air Mobility Master Plan (AMMP 98),** Rapid Global Mobility
12	**Global Attack Mission Area Plan (MAP)**, 1996 No transportation related requirements identified
13	**Army Science and Technology Master Plan (ASTMP)** No transportation related requirements identified
14	**ACC MPP** No transportation related requirements identified
15	**Office of Naval Research: Science and Technology** No transportation related requirements identified
16	**Assessment Execution Document for Air Force Expeditionary Force Battlelab (AEFB) and Integrated Planning and Execution Capability (IPEC),** Air Force Operational Test and Evaluation Center, Test and Assessment Directorate, April 1998 No transportation related requirements identified
17	**Thrust Areas: Transformation Paths to a Future Aerospace Force,** Presentation by the

DOC #	SOURCE IDENTIFICATION
	HQ USAF Directorate of Strategic Planning, 24 March 98 No transportation related requirements identified
18	**Enhancing the Effectiveness of Air Expeditionary Forces** **Phase I Results: Focus on the Challenges,** Project Air Force AEF Team, RAND, May 1997
19	**Mobility TPIPT,** Development Planning, ASC/XRM, WPAFB, FY96
20	**Transportation Science and Technology Strategy,** Address by Rodney Slater U.S. Secretary of Transportation
21	**Enabling Technologies for Advanced Transportation Systems,** DOT Research and Special Programs Administration; Volpe National Transportation Systems Center, September 97
22	**Air Force Special Operations Command (AFSOC),** Needs/Deficiencies List, 1 Nov 97 No transportation related requirements identified
23	**Internet searches for commercially available resource movement capabilities.**
24	**Emery Worldwide, Dayton International Airport**
25	**ASC/ENFG (ATTLA) WPAFB, OH**
26	**AMC/XP, XR, etc., Scott AFB, IL**
27	**AFSOC, Hurlburt, FL**
28	**AMC/DOZ, Scott AFB, IL**
29	**Deputy Commander, Combined Arms Support Command (CASCOM)**
30	**Dr. Frank Hassler, Volpe National Transportation Systems Center**
31	**Brig. Gen. Tom Mikolajcik (Ret)** **Lt. Col Bob McCauley (Ret)**
32	**Commercial trucking industry**
33	**Commercial railroad industry**
34	**445 AES**

Table A-1. List of Transportation Focused Needs Identified During the Literature Search

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
		To successfully enable an expeditionary Air Force, there is a need to improve the capability and capacity of mobility forces		
			Establish the availability of reliable transporting resources	The need to provide transporting resources, especially airlift, that is reliable while in service and requiring less out-of-service time for standard maintenance.
1	44		Reliable and rapid transport between engaged forces and sources of supply	
1	64		Commit to the C-17s as the AEF airlifter or fix the C-5s to assure transport reliability.	
1	40		Provide for reliable airlift Transition to the C-17s from the C-5s for reliability. • Both C-17s and C-130s can offload pallets onto the ground without external material handling equipment (MHE) if required. • Increased range and ability to transport fuel into the operational base.	
1	59		Use the C-17 over the C-5 and C-130 due to its increased reliability, flexibility, and capability.	
5	Para 2		Continue the buy out and complete maturing of the C-17 - the core airlifter of the future. In addition to the original buy decision, the current and future requirement to rapidly move special operations forces represents an additional tasking factored into the C-17 buy decision.	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
6	Para 9		Modernize the C-5 with new engines and avionics to correct its unacceptable low mission reliability rate and improve its performance to that of the KC-10. Program must begin in earnest in FY00 with earlier Research and Development if possible.	
6	Para 10		Delay the loss of the C-141 to offset the slower replacement receipt of the C-17s. Accomplished by additional maintenance and upgrading as necessary to ensure the continued use of the C-141.	
6	Para 11		Continue the successful aeromedical evacuation capability working towards the replacement and modernization of the C-9A aircraft.	
1	59		Develop a new in-theater subsonic airplane concept called the Common Air Transport (CAT).	
2	29-86		Identify new airlift capabilities to satisfy the requirements	
2	8-19		Modernize air refueling capability	
2	9-19		Air refueling capabilities to concurrently support wartime refueling requirements.	
2	9-19		Modernize and acquire air mobility assets (aircraft and material handling equipment to satisfy requirements established by the Mobility Requirements Study, Bottom Up Review Update)	
2	9-19		Spacelift systems that are reliable, operable, responsive, and economical.	
2	10-19		Spacelift technologies with a reduced life cycle cost and increase responsiveness	
2	21-86		Develop UAV payload capabilities • ISR • High altitude endurance to UAV communications relay system • SEAD capability	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
6	Para 14		Upgrade the quality of life facilities at en route facilities and refueling facilities. These can build on highly successful efforts such as FOCUS DORMS, FOCUS HOMES, Squadron Operations/ Aircraft Maintenance Unit Facilities, and FOCUS LOGISTICS programs.	
11			Need for the acquisition and modernization of critical aircraft	
11			Need for a very long-range airlifter to add robustness to AEF concept.	
11			Need to develop vehicles having less impact on the environment.	
			Establish an accurate delivery capability	The need to accurately locate and position deploying resources. This includes knowing where transporting resources are located and the accurate in-flight unloading of resources from aircraft.
1	7		Provide a low-cost point-of-use delivery capability to support AEF. Parachute delivery of supplies by implementing simple modifications to conventional round parachutes.	
1	66		An affordable system for precisely controlled point of use cargo delivery • An inventory of parachutes and airdrop equipment in combination with GPS guidance and a novel type of pneumatic actuator to comprise an • This is being developed as the Affordable Guided Airdrop system (AGAS).	
2	10-19		Precision airdrop capability	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
2	9-19		Timely positioning and sustainment of military forces and capabilities through air and space. Provides a high state of readiness and modernization capable of sustaining high tempo operations	
2	9-19		Timely positioning and sustainment of military forces and capabilities through air and space. Provides a high state of readiness and modernization capable of sustaining high tempo operations	
2	9-19		Maintain a global enroute infrastructure to support transportation requirements - transporting visibility	
2	9-19		Maintain efficient transport capability (Air Mobility Express and Worldwide Express systems)	
2	67-86		Transition from a concept of operational sustainment via "push" resupply to one based on accurate information, responsive production, and daily, time-definite airlift	
			Establish Air Traffic Control (ATC) and guidance capabilities at reception sites	The need to establish effective ways of controlling aircraft into deployed locations. This is especially directed at controlling transporting aircraft, which are often first in and last out.

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
1	61		Support the landing of aircraft. • A GPS-aided Category II landing capability for all aircraft using the AEF FOL to achieve a decision to proceed with the landing at 100-ft altitude. [The AFRL currently has an unfunded program called Pathfinder Autonomous Landing Guidance to address Category III Landing for the first aircraft into a bare base. • Employ ultraviolet sensor to detect runway lights in fog at over three times the pilot's vision capability and project them on the HUD. [NASA Dryden Flight Research Center may partially fund a program called the Pilot's Landing System.]	
1	31		Air Traffic Control (ATC) services to any AEF location Use GPS and communications reachback capabilities to greatly reduce AEF footprint while increasing the timeliness of achieving desired outcomes.	
1	7		Air traffic control (ATC) from CONUS or a theater so as to further reduce forward-deployment of personnel and equipment • GPS coupled with communications	
6	Para 4		Equip the transporting fleet with communications, navigation, and surveillance equipment required to meet more stringent airspace performance standards envisioned for the future. Without these improved capabilities, the air mobility aircraft may well be excluded from critical airspace over the North Atlantic.	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
2	9-19		Acquire global air traffic management system for the air mobility fleet	
2	9-19		Achieve true global management of air mobility forces and secure global transportation control of scheduling systems against adversary attack and exploitation. Develop an enhanced Command and Control (C^2) systems.	
4	90		Deployable airfield lighting systems to support Harvest Eagle/Falcon contingencies. To contain edge lights, threshold end lights, approach lights, approach strobes, distance-to-go marker lights, taxiway lights/markers, generators, regulators, control panels, and cabling.	
6	Para 8		A "first in" pathfinder force capability for rapid deployment worldwide to operate under adverse weather conditions into austere airfields for the C-130.	Current acquisition of the AMC-Precision Approach Capability (AMCPAC) system to include a state-of-the-art airport surveillance radar and precision approach radar and microwave landing capability. Nest step is to operate in near zero-zero conditions is to harness synthetic vision technologies that are maturing now.
11			Need for enhancement of global reach through the Global Air Traffic Management (GATM) program	
20			Need to develop smart structures, meaning roads, bridges, runways, tunnels, etc. with a network of embedded sensors.	
			Establish self protection for transport aircraft landing and taking off	The need to establish self-protection capabilities for personnel and aircraft during landings and takeoff. This is especially important at first-in and last-out situations, and is of primary importance to transporting aircraft.

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
1	71		Means for aircraft to self protect during takeoff and landing. • Near term development is carried out in the joint Advanced Threat IR Countermeasure ATIRCM) program sponsored by the Army Night Vision Laboratory (NVL). • Semiconductor lasers - This small size, high efficiency capability with a potential for low-cost production is effective against several types of seekers. • Wideband HPM sources offer defense against a wide variety of missile threats, including EO- and RF-guided missiles, without depending on specific attributes of the target. Development is underway at the Phillips Research Site, with field demonstration planned for FY 03.	
			Move resources over the ground efficiently and quickly	The need to more quickly move resource during the deployment phase of operations, since the preparation and loading/unloading provides an opportunity for reducing the time between tasking and sortie generation.
1	44		Improve the responsiveness and decrease the cost of materiel support to systems. Accelerate organic and contractor repairs	
3	32		Pack and move pallets quickly between units and the transporting aircraft without special MHE [Pallet dollies]	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
3	32		Facilitate the movement of cargo from ground level to the aircraft loading door. [A K-Loader-type equipment item that can be positioned next to the aircraft for the duration of the loading and unloading process, and can be used against numerous aircraft types.]	
5	Para 1		Technology that will aid in optimizing the deployment footprint to decrease the amount of transportation and storage requirements while still fully supporting the mission.	Lighter and stronger cargo restraint devices (AF/ILX) Combine equipment pieces to make smaller, lighter, multi-functional AGE, i.e., electrical converter on the F-22. (AF/ILX) MHE improvement (AF/ILX) • Standard blocking and bracing techniques and materials for moving ammunitions (Presently using lumber for one time use; cost for large theater swapouts can be very expensive.) (AF/ILT) • Roll on/Roll out pallets (Multi-use for ammunitions and equipment) (AF/ILT) • Improve process and equipment for palletizing equipment, i.e., single-net system (AF/ILT) • Redesign JEIM equipment to combine functionality (ACC)
5	Para 6		Real-time capabilities for asset movement and management to reduce transportation and handling times.	Standardized and adapt cargo and container specifications to allow for quick cargo movement between commercial and military aircraft (AF/ILX)

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
6	Para 3		Enhance the current fleet of material handling equipment (MHE). The current capabilities represent the weakest link in the air mobility process.	• The full buy of 318 Tunner loaders possesses the capability to solve the large cargo handler shortfall. • Delivery of the Next Generation Small Loader (NGSL) must begin in FY00.
11			Need to correct shortages and shortcomings of the MHE fleet.	•
25			Increase the reliability of MHE and use more rolling stock and commercial MHE to increase movement flow.	•
25			K-Loaders are the main bottleneck in the cargo movement process and need to be improved or replaced. Pallets are the best for cargo movement.	•
28			The mix of MHE is often wrong at given location. This forces varied, inefficient use of available MHE.	•
29			The poor cycle times at the Port of Debarkation is the most significant bottleneck in the cargo movement process.	•
31			The cargo preparation and loading of cargo provides areas for technology improvement	•
32			Looking towards increasing the use roller systems to minimize the use of forklifts	•
30			Need to encourage similarities between military and commercial MHE to increase joint operations between the two groups	•
11			Need for enhancement of global reach through the Global Air Traffic Management (GATM) program	•
19			Need help for the Mobility Technical Planning IPT community with information required to make sound, logical decisions to identify approaches for solving near, mid, and far refueling, strategic, and theater airlift.	•

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
31			Upgrade material handling systems for aircraft floors and MHE.	
27			Better operational status and use with a wider range of aircraft for K-Loaders	
26			NBC sensors which provide more type of contamination information. Replacement for inefficient chemical-sensitive tape strips. NBC protective gear should be improved to provide personnel more protection and allow them to work longer in contaminated environments. Pallets and netting that prevent NBC contamination and/or are easily decontaminated. Covers for pallets, possibly that peel off in layers.	
26			Self-contained functions made of lighter, but equally strong materials, so airlifting is more feasible. Pallets that are made of a lighter material	
26			Simplify the process of packing items.	
31			Pallet/skid concepts which make it easier for the Army to combine surface movement with airlift. Containers more suitable for airlift. Next Generation replacement for the 463L rollerized system.	
34		Patient Movement	Better interchange among medical personnel	A common base of terminology between the services. Reduce use of non-medical personnel (pilot, administrative, etc.) to transmit medical messages. Require medically trained critical care personnel to be available to receive messages and make decisions.

41

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
34			Medical information systems	Adequate and proper use of medical IS. ITV to the patient level in addition to the high level currently available.
34S			Medical equipment	Additional types of medical monitoring equipment onboard during wartime.
445AES			AE airlift assets	Resolve conflict of retiring C-141s and oncoming C-17s, which carry fewer litter positions. Assurance that SOP for preparing CRAF for AE purposes is adequate.
		To successfully enable an expeditionary Air Force, reduce the crisis action planning and employment tasking cycle time		
			Real time tasking capability	The need to assign or change taskings after the aircraft leaves the ground.
1	61	C^2 - Mid-term	Generation of flyable schedules in a format ready for insertion into the daily Air Tasking Order.	The In-Theater Airlift Scheduler (ITAS) prototype is available and AMC and DARPA are funding the development of an operational strategic airlift and air refueling scheduler.
1	61	C^2 - Mid-term	Plan and control air operations using a continuous planning, execution, assessment, and planning model.	Tools being developed by DARPA JFACC After Next program.
1	61	C^2 - Mid-term	Reachback capability to the Tanker Airlift Control Center and in-transit status for aircraft, crew, cargo, and passenger.	Being developed through the Information for the Warrior Program (IFTW)
1	68	Enabling Technology for AEF Logistics Support	Improve the quality and timeliness of wing logistics planning for short notice contingencies.	Being accomplished through LOGCAT and LOG-AID

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
1	6	Enroute aircraft targeting and tasking	Enroute tasking of aircraft. This tasking allows for the dynamic changes to targeting. The system could adjust the current Air Tasking Order (ATO) system into one based on mission orders and dynamic targeting.	
1	14	Inflight C^2I capability	Provide inflight C^2I capability. The only capability currently available is the Multi-Source Tactical System (MSTS) strap-on package.	Develop an improved and extended in-flight C^2I capability.
2	15-19	Global awareness and command and control	A fully integrated command and control process that enables airmen to influence the battlespace with the effective use of information through ubiquitous, survivable, multi-level secure information systems	
2	67-86	Information operations		Integrate Joint Total Asset Visibility JTAV) capabilities with Air Force asset management process and logistics data systems.
2	67-86	Information operations		Transition from a concept of operational sustainment via "push" resupply to one based on accurate information, responsive production, and daily, time-definite airlift
2	13-19	Information superiority	Enables real-time control and execution of air and space power.	
2	3-86	Integrate air and space	Integrate, operate, and sustain air and space assets in a seamless manner.	
2	7-86	Integrate air and space	Capability to support cost/ effectiveness trades using modeling tools.	
3	13		Effectively communication among employment personnel	Personal information device
3	25		Compute the anticipated preparation time for each chalk and integrate the chalk times into a complete Deployment Schedule of Events (DSOE)	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
3	20		Identify and present transportation requirements to TRANSCOM in a timely manner based on standard size and weight for items. [Transportation module]	
3	33		Interrogate RF and personnel tags during the loading process, compare the list to the load plan, and generate the final chalk manifest [Manifest Generator]	
4	102		Vehicle locating capability to the control centers. Use a GPS tracking capability, linking the vehicle location and other data to the control center computer.	
21			Need for sensors to collect information providing continuous knowledge of movement status and to control the movement.	•
24			Improve the capability for In-Transit Visibility (ITV)	
24			Improve Data Interchange (EDI) between suppliers and customers	
26			Improve information technology, specifically to support the decision making process needed for scheduling of cargo preparation and transportation resource assignment.	
30			Improve process flow control. This includes the collection of asset status and the scheduling of assets using modeling and simulation techniques.	
31			Increased use of decision support systems and process streamlining using modeling and simulation	

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
		To successfully enable an expeditionary Air Force, implement a highly integrated information and communications network structure.		
2	18-19	Infrastructure	Reduce test cycle time, increase efficiency, and sustain affordability by implementing productive and process quality improvements.	
3	24		Track each military person using a credit card size tag containing specific information about that individual sufficient to support the deployment process.	Personnel Tag
			Secure information and communications capabilities	The need for hardware and software to access, process, and communicate all the information necessary to develop and support the control of a global-level awareness capability.
1	68	AEF Avionics and Power Technologies	Integrate up to 20 federated systems into a single integrated system. The integrated Modular Avionics (IMA) for AEF allows functional requirements to be added to aircraft, and reduces support costs because of increased commonality and fewer individual modules.	
1	61	C^2 - Mid-term	Enriched communications connectivity with flexible use of a variety of communications links.	DARPA Airborne Communications node (ACN) program.
1	61	C^2 - Mid-term	Collaboration of distributed operators to collaborate across wide-area networks, thus allowing JTF Commander and the JFACC to provide full AOC capabilities without deploying the full staff.	The Distributed Air Operations Center Task (DAOC)

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
1	61	C^2 - Mid-term	Provide for Information collection and management	Requirement for a meta-software technology that can facilitate rapid replanning, rapid adaptation, and rapid reverification of Air Force software-intensive system across the spectrum of sensor processing through C^2, avionics, satellite control, and logistics. [Air Force Science and Technology (S&T) has some initiatives with DARPA.]
1	31	C^2 capability	New communications, navigation, and surveillance/air traffic management (CNS/ATM) concept that will capitalize on military and commercial technology advancements to improve air traffic management.	
1	3	Communications	Harness or link into commercial communications technology.	
1	37	Improve Crisis Action Planning (CAP)	Transition from the stovepipe exchange of information late in the cycle to collaborative environment supported by tools facilitating communications and decision making. The requires the transition to an employment-driven planning model.	Requires procedures, decision aids, databases, and other tools that automate the process and facilitate integration of operations, transportation, logistics, force protection, and other functional areas. A number of current initiatives, notably the Logisticians' Contingency Assessment Tools (LOGCAT) program and DARPS's Joint Logistics ACTD (JLACTD) and JFACC After Next programs, will, if completed, substantially meet the need.
1	44	Lean Logistics	Information connectivity to logistics support system	
2	39-86	Information operations	Information protection for all Air Force assets	
2	13-19	Information superiority	Ability to collect, control, exploit, and defend information while denying an adversary the ability to do the same.	
2	13-19	Information superiority	Assure availability, reliability, and integrity of information needed for Global Engagement.	Develop defensive counter information capabilities.

DOC #	PAGE	GENERAL TRANSPORTATION NEED CATEGORY	SUB TRANSPORTATION NEEDS CATEGORIES AND SPECIFICALLY STATED TRANSPORTATION NEEDS	DESCRIPTION OF SUB TRANSPORTATION NEEDS
2	18-19	Infrastructure	Increase the support of decision making, especially in defining modernization requirements by using models and simulations.	

47