TURKISH AIR MOBILITY
MODELING

THESIS

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First Lt. TUAF

AFIT/GOR/ENS/97M-21

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THESIS

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First Lt., Turkish Air Force

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Huseyin Topcuoglu

Table of Contents

List of Figures

List of Tables

Abstract

To fully utilize scarce airlift resources requires effective airlift planning, a more capable air mobility system, and highly mobile forces. Presently, the Turkish Air Mobility Command's (TAMC) airlift planning is performed manually. The aim of this research is to provide a tactical mobility model which is user friendly and flexible so the user is able to change the inputs, and evaluate the situation with the projected data for an operational plan. Thus, the users can analyze their system by using the model to see whether or not mobility requirements can be met within a definite time frame, and how long it takes to satisfy the requirements. The USAF Airlift System and some air mobility models are reviewed, and the applicability of these models to TAMC's airlift system is investigated. Generalized Air Mobility Model (GAMM) was chosen to model TAMC's airlift system and has been found suitable for application to TUAF mobility problems. GAMM is very efficient for theater airlift system operational effectiveness analysis. The model's forte is its ability to quickly compare a wide range of alternative airlifters in realistic operational environments and to ascertain their individual benefits and penalties. The software enables the user to model future or existing airlift system requirements in an existing theater environment or against projected theater airlift requirements. GAMM can be used with classified data for the actual operational plans, and airlift requirement analysis by the Turkish Air Force or by other countries, who have military structures similar to that of Turkey.

TURKISH AIR MOBILITY MODELING

I. INTRODUCTION

Overview

This chapter reviews the background of the Turkish Air Mobility problem, defines the geographic location of Turkey, and outlines the general principles of Turkish foreign policy which aid in establishing the scope and justification for this research.

I.1 Relevant Information About Turkey

Geographic Location of Turkey

Turkey is located at the convergence of three continents. Asia, Africa and Europe are at their minimum proximity to each other, with Turkey straddling the point where Europe and Asia meet. Turkey is roughly rectangular in shape with a width (east to west) of 1,660 kilometers and a length (north to south) of 490 kilometers. Because of its geographical location, the mainland of Anatolia (the Asian part of Turkey) has always been a critical crossroads throughout history. It has also been prominent as a center of commerce with its land connections to three continents and the sea surrounding it on three sides. (33:WWWeb)

The actual area of Turkey, inclusive of its lakes, is 814,578 square kilometers, (slightly larger than the State of Texas) of which 790,200 square kilometers are in Asia and 24,378 square kilometers are located in Europe. The land borders of Turkey measure a total of 2,573 kilometers. The coastlines (including islands) add another 8,333 kilometers to the nation's borders. Turkey has two European and six Asian countries for neighbors along her land borders. (Figure I.1) (33:WWWeb)

Figure I.1 Geographic Location of Turkey (33:WWWeb)

The Goals and Principles of Turkish Foreign Policy

The Turkish Republic was founded in 1923 on the ashes of the Ottoman Empire. Turkey based its political and legal systems on modern, secular European models. The guiding principles of Turkish foreign policy were established by Kemal Ataturk, a great statesman and the founder of modern Turkey. These principles are summarized as follows:

- To remain within our defined boundaries.
- To pursue friendly relations with all neighbors.
- Not to interfere in the internal politics of other states.
- To establish bilateral and multilateral relations, friendships and cooperation schemes.

- To create an environment conducive to national development, and economic, social and cultural advancement in the conduct of our external relations.
- To maintain a commitment to the settlement of differences through dialogue and peaceful means. (27:WWWeb)

Turkey's foreign policy can be best explained by the following statement by Kemal Ataturk:

> "For its existence, the Turkish nation of today is content with what it has as a homeland. Turks are confident that within the boundaries of their country, they can safeguard and enrich the legacy of their forefathers and their long and glorious past." In the context of this Republican diplomatic tradition, Turkey's fundamental tenet in approaching international affairs is, as ever, to have "Peace at home, peace in the world" (27:WWWeb)

Turkey is often regarded as a bridge between the East and the West. Her unique geographical position makes Turkey simultaneously a country with European, Middle Eastern, Balkan, Caucasian, Mediterranean and Black Sea identities. (27:WWWeb)

As a result of Turkey's strategic/bridge location, the intersection of troubled areas with a high level of conflict risk and strong probabilities of developing contingencies, the realities of the post-cold war era have an impact on Turkey.

Brief Summary of Turkey's International Relations

Turkey was one of the founding members of the United Nations (UN) and takes an active part in all the UN specialized agencies. In 1950 Turkey participated in the United Nations Command in Korea, where its forces served with distinction. More recently, following the Iraqi invasion of Kuwait in 1990, Turkey swiftly complied with UN resolutions on economic sanctions, by closing its border with Iraq and shutting off the Iraqi-Turkish oil pipeline. Turkey did this despite a heavy cost to her economy. After the

Gulf War, Turkey also played an important role in UN relief efforts for Kurdish refugees fleeing from the Iraqi armed forces. In addition, she took part in the peace-keeping operations in Somalia (UNOSOM) under the UN command. Turkey has also taken part in the enforcement of the "no-fly-zone" over Bosnia and Herzegovina and in the Peace Implementation Force (IFOR). (27:WWWeb)

Turkey and NATO (North Atlantic Treaty Organization)

Turkey joined NATO in 1952. During the height of the Cold War, the Alliance became the cornerstone of Turkey's foreign and security policy. Turkey is one of only two NATO members sharing a common border with the former Soviet Union. Following the dramatic post-Cold War developments, Turkey's strategic importance remains undiminished, having acquired new dimensions, due to the geographic proximity of several volatile regions. (28:WWWeb)

Turkey is part of the integrated military structure of NATO and maintains NATO's second largest armed forces, after the United States (US). Turkey has almost completed the process of restructuring its armed forces in accordance with NATO's new Strategic Concept. (28:WWWeb)

Relations with the United States of America

Close working relations were developed between Turkey and the US in the areas of political, military, economic, technical, social and cultural affairs with the advent of the Truman Doctrine of 1947. (29:WWWeb)

Bilateral relations faced certain hardships during the early 1960s and mid 1970s. However, despite the problems encountered during this period, they never jeopardized the strong underlying partnership between the two countries. A new chapter in Turkish-American relations opened in the 1980s. US cooperation and support for Turkey increased significantly. In 1991 Turkey and the US agreed to upgrade their cooperation even further, giving it the status of an Enhanced Partnership. Post-Cold War developments have clearly shown that more than ever Turkey and the US currently share a set of common strategic, security and economic concerns and interests which naturally bring them closer together. (29:WWWeb)

Relations with the Balkan Countries

The Balkans figure prominently on Turkey's foreign policy agenda. Turkey regards the Balkans as its gateway to Europe and has always been a key player in the affairs of the Balkans. Therefore, Turkey was profoundly concerned over the human tragedy in Bosnia and Herzegovina that lasted more than three years, and left an indelible mark in the collective conscience of all civilized nations. Turkey enjoys good relations with all the Balkan countries, although a number of issues with Greece remain unresolved. Turkey has concluded agreements on friendship, good neighborly relations, cooperation and security with six countries: Bosnia and Herzegovina, Croatia, Bulgaria, Albania, Romania and Macedonia. As an initiator of multilateral Balkan cooperation since the 1930s, Turkey places special importance on further promoting its relations with the countries of the region. (30:WWWeb)

The Caucasus and Central Asia

Turkey enjoys a special relationship with the states of central Asia and Azerbaijan, derived from ties of a shared historical, cultural, kinship and linguistic background. Turkey was the first country to recognize these new states (Turkmenistan, Kirgizstan, Uzbekistan, Kazakhstan, Tajikistan) and immediately offered to share her experience in democracy and free market economy with them. Turkey provides economic, commercial, technical and cultural support to these countries on a bilateral basis, and urges its Western partners to do likewise. (31:WWWeb)

Russia has always been an important neighbor for Turkey. Relations between the two countries date back many centuries. After the end of World War II, the Soviet Union made territorial claims in eastern Turkey and requested the right to establish military bases on the Turkish straits which connect the Black Sea and Aegean Sea. Relations consequently became very tense and improved only slightly after Stalin's death in 1953. By the early 1960s, after the Soviet Union had officially withdrawn its claims, bilateral relations between the two countries began to steadily improve. Turkey received substantial Soviet Union economic assistance for joint industrial projects. (31:WWWeb)

The collapse of the Soviet Union introduced a new phase in Turkey's relations with the Russian Federation. Both countries, regional neighbors for centuries, now have the responsibility to foster peace and stability in the region where newly independent states have emerged. (31:WWWeb)

The Middle East and the Gulf

The Arab-Israeli conflict and the Palestinian question lie at the core of the problems and tensions in the Middle East. Turkey has always advocated a peaceful solution to the Palestinian problem based on UN Security Council Resolutions. Turkey recognizes the legitimate rights of the Palestinians, though it established diplomatic relations with the State of Israel immediately after its formation. (31:WWWeb)

Turkey attaches great importance to the reintegration of Iraq into the international community by fully implementing all the applicable UN Security Council resolutions. By doing this, the Iraqi Government would bring the suffering of its people to an end. (31:WWWeb)

Turkey and Cyprus

Turkey supports the negotiating process in Cyprus. Turkey will continue to support the legitimate rights of the Turkish Cypriots arising from international agreements. Turkey believes that solution to the Cyprus problem has to be fair, realistic and viable and should be based on the political and sovereign equality of the Turkish and Greek Cypriot communities. Turkey views efforts by the Greek side to involve the European Union (EU) in the process as counterproductive; this would essentially delay reconciliation among the two communities on the island, thus rendering a settlement more difficult. (32:WWWeb)

Relations with Greece

Although Turkey and Greece are NATO allies, associates in the EU and share the same geography and the common values and ideals of the Western world, there are a number of problems between the two countries which need to be resolved. (34:WWWeb)

Relations between Turkey and Greece are based on the 1923 Treaty of Lausanne which established a balance of rights and obligations of both countries. Both countries have long standing disputes over the Aegean sea which still have not been fully resolved. The Aegean problems, in the view of the Turkish Government, are:

- Extent of the territorial waters.
- Delimitation of the continental shelf.
- Violation of the demilitarized status of the Aegean Islands.
- Extent of airspace over the islands.
- Abuse of responsibilities within the Flight Information Region (FIR).

(34:WWWeb)

The Water Problem in the Middle East

Current water resources in the Middle East have become insufficient to meet the needs of the countries in the region. The scarcity of water will continue to increase in the future as the regional population grows. As a result, water is likely to become the cause of conflict among the countries of the region. (35:WWWeb)

The issue of the waters of the Euphrates and the Tigris rivers deserves specific attention, as these two rivers have their own characteristics which differ from many transboundary rivers in other regions of the world. Both rivers stem from a country (Turkey) which is poor in water resources and flow into the territories of two neighboring states, one of which (Syria) is even poorer in water resources than Turkey and the other (Iraq) which is richer than Turkey in water resources. (35:WWWeb)

Furthermore, lack of mutual trust among countries of the region creates additional difficulties in the search for solutions to their shared problems. Syria and Iraq have been strongly opposed to all water installations that had been planned and implemented by Turkey on the Euphrates and the Tigris rivers. Their objections centered on the argument that such installations would reduce the quantity of water flowing to their countries. (35:WWWeb)

Conclusion

In light of Turkey's geographical location and foreign policy, Turkey needs to maintain armed forces both in the eastern and western regions of the country to defend her borders. If a contingency occurred in the eastern part of the country, the forces located in the western part would have to be airlifted to the east and visa versa. Sea lift, which often carries the lion's share in most mobility operations for other nations, is not a practical option for Turkey's current circumstances. The railroad system, unfortunately, is not as efficient as one would desire at the present time. Trucks are used to some extent, but because of the Turkish geographical conditions (mountains, narrow passes and roads) and climate (during winter some roads are closed for a considerable amount of time due to heavy snow) coupled with the vulnerability of trucks' to terrorist attacks, as well as their limited speed, trucks are not practical for a quick deployment of forces. Faced with areas of tension along all of her borders, and possessing a limited, vulnerable infrastructure in some internal regions, the importance of effective tactical airlift in Turkish military planning can not be minimized.

The Turkish Minister of National Defense stated that

> "Serious instabilities in neighboring countries, as well as the decrease in the military aid programs provided to Turkey by its allies in the last years have heightened the need of using the already scarce resources allocated to defense even more productively in order to maintain Turkey's security interests and preserve the deterrent capabilities of its Armed Forces." (1:23)

Effectively using scarce military resources undoubtedly requires effective airlift planning, a more capable air mobility system, and highly mobile forces.

Presently, the Turkish Air Mobility Command's (TAMC) airlift planning is performed manually. Recent exercises and contingencies have revealed the shortcomings of this approach in a world where the pace of warfare, when it occurs, is ever increasing. Deficiencies in planning have resulted in ineffective or inefficient application of airlift.

I.2 Statement Of The Problem

The problem for this study is to identify and test a modeling system which can address the following questions. Given cargo and frequency requirements, a fleet of aircraft and possible routes, the problem is the allocation of aircraft to achieve the most efficient airlift system possible. The first research question is: given a set of forces, support units, supply and resupply requirements, and a fixed set of transportation assets, what is the closure estimate? The second research question is: what is the number of replacement aircraft for the aging C-160 Transall and C-130 Hercules among the candidate airplanes, namely the Future Large Aircraft and the new C-130J, needed to maintain current airlift capability?

I.3 Background

Air Mobility encompasses a system of people, equipment, and infrastructure necessary to deploy, employ, and redeploy forces (unit equipment, troops, personnel, sustainment support) by air from aerial ports of embarkation to aerial ports of debarkation within expected time windows.(20:2)

Materese states that deterrence of limited war is predicated on a delicate balance of military forces. As a part of these forces, and as a key element in the mobility of these forces, airlift plays a critical role. Airlift shortfalls weaken deterrence. Studies, exercises, and elaborate mathematical models all show that the cost and length of a war, as well as the amount of force required to win it, are influenced by the timely ability of airlift and sealift to move those forces where they are most needed. (18:1).

Krisinger defines effective airlift policy making as follows:

> There is a single airlift mission-the delivery of what is needed, where it is needed, and when it is needed. Effective airlift policy making involves asking for what one can get instead of what one actually needs. (17:21)

The problem defined for the Turkish Air Force (TUAF) is not a new one, and while known, it has not received the attention it deserves. Recent contingencies such as the Gulf War proved once more the importance of airlift planning. For Turkey to continue to meet the policy objectives laid by her founder Kemal Ataturk, TAMC's current airlift system must be modeled, analyzed and improved.

I.4 Scope

Based on the previously summarized Turkish foreign policy, scenario requirements for this study are projected within the borders of Turkey. The modeling is done at the tactical level, which can be interpreted as intratheater transportation (intratheater and tactical are used interchangeably in this context). The data related to the aircraft, the airfields, and the routes are unclassified. The data related to the aircrews, refueling capabilities, Maximum on the Ground (MOG), cargo handling capabilities, the amount of forces, equipment, and personnel to be airlifted are notional. The routes are from the Port of Embarkation (POE) to the Port of Debarkation (POD) and return to the POE, which is the typical pattern utilized by TAMC. The type and sequence of the loads are assumed to be known and available at the POE. The only cargo considered is that which will fit on a standard 463L pallet, and any single item which can be loaded on a C-130 or C-160, the primary aircraft utilized by TAMC.

Following the definitions utilized by the USAF, the closure estimate is defined as the amount of elapsed time from the departure of the first aircraft from the POE to the arrival of the last aircraft at the POD that completes the deployment of the initial combat force. (6: 410-7)

I.5 Research Approach

Why model? There are many conceivable reasons why one might prefer to deal with a substitute for the "real thing" rather than with the "thing" itself. Often, the motivation is economic-to save money, time, or some other valuable commodity. Sometimes it is to avoid the risks associated with tampering with a real system. (26:4)

Models are abstractions of real world systems developed to improve our understanding of the real world systems. In general, the real world is complex and difficult to observe and understand; it is all but impossible to analyze directly or to prove anything about it. Any model is necessarily simpler than the real world, which makes it easier to observe the model than to observe the real system under analysis. (19:5)

Computer models have played an important role in analyzing mobility requirements. A transportation system can be so large and complex that it would take far too long to plan or evaluate movements of any size without computer models. (19:xi)

The author of this research has had operational experience in the Turkish Air Force as a cargo pilot; he is familiar with the TAMC airlift planning problem. The USAF Airlift System and some air mobility models are reviewed, and the applicability of these models to TAMC's airlift system is investigated. The most applicable model has been verified and validated for application to TUAF mobility problems. The range of the modeling exercise covers ground time at the origin and destination (refueling, loading/ unloading), flight time to the destination, and flight time back to the origin for an operational deployment requiring airlift. In addition, the transshipment time from entry site to POE and from POD to delivery site is also covered.

After selecting the model which is the most applicable to Turkish Air Mobility Command problems, the model was run with the notional data whose range reflects TAMC's airlift system for the purpose of demonstrating the model's use and applicability and analyzing the system so as to reveal possible bottleneck(s) or shortfall(s) of the system.

I.6 Results

The aim of this research is to provide a tactical mobility model which is user friendly and flexible so the user is able to change the inputs, and evaluate the situation with the projected data for an operational plan. Thus, the users can analyze their system by using the model to see whether or not mobility requirements can be met within a definite time frame, and how long it takes to satisfy the requirements. The model also gives the user the ability to change different inputs such as MOG, refueling and loading capabilities, so additional factors other than simply aircraft can be investigated, to increase TAMC's capability and effectiveness. Ultimately, the model should be able to serve as an actual airlift planning tool, aiding key decision makers in developing actual operational plans.

Analysis based on such a model will help TAMC's key decision makers better utilize their limited resources. The user may decide the number of cargo planes TAMC presently has are insufficient to meet operational requirements within a specified time frame. With a flexible model, the user can input the data reflecting the projected number of aircraft and evaluate the effectiveness of different levels of aircraft type by running the model. The model should also give the user the ability to conduct sensitivity analysis. This would be extremely valuable to the Turkish Air Force. This process may also help other countries which have air force structures and size similar to the TUAF.

The definition of the specific problem for the TAMC has been given, and the importance of the research effort has been emphasized. Chapter II outlines the literature review conducted for this thesis and primarily concerns the exploration of the vehicle routing problem, relevant USAF airlift system information, airlift modeling, and appropriate solution techniques. Chapter III describes the model chosen to address the research questions discussed previously. The first section of Chapter IV presents data generation, scenario creation, and further assumptions in order to run the chosen model and do the necessary analysis. An analysis of a potential scenario is also given in this chapter. The second section of Chapter IV describes the analysis performed. The last chapter presents verification & validation of the results from using the model and suggests further research areas.

II. AIRLIFT SYSTEM AND LITERATURE REVIEW

Overview

This chapter defines a current air mobility system, and its components, by referring to the USAF definitions. Air mobility models in use, and their applicability to the TAMC's airlift system, are discussed. A literature review, several mobility modeling solution techniques, and definitions related to the mobility problem are made. The ideal definitions of an airlift system and its components, and the models currently used can best be found in a review of the USAF air mobility system. The purpose of a review of these systems and models is to increase the background knowledge of the potential user(s) of this research.

II.1. Airlift Basics

The basic concepts, and definitions for an airlift system can be found in Air Force Doctrine Document 30 which addresses airlift operations as follows:

> Airlift provides air and surface forces the latitude to operate in a broader range of situations. Airlift can project power by rapidly transporting personnel and materiel with limited regard to geographic obstacles when compared to other transportation means. This elevates the ability of combat forces to effectively respond to any situation by increasing their responsiveness and flexibility. This global reach capability applies the principles of maneuver and economy of force by providing for the more complete use of available combat forces. In a crisis or contingency situation, the rapid deployment of combat forces can deter a violent situation or limit the scale of the hostilities. An example of this occurred in October of 1994 when Iraqi forces made threatening force deployments toward the Kuwaiti border. The US responded with Operation Vigilant Warrior. During this operation airlift made possible the rapid projection of large numbers of Air Force tactical aircraft units, combat troops, and their required support to Kuwait, effectively preventing any aggressive action by Iraq. Airlift also supports forces in

areas where they cannot be sustained by other transportation means, allowing these forces to utilize a wider range of deployment and maneuver options. Over the years, airlift has on many occasions provided the initial projection or reinforcement of combat forces into a theater. The Gulf War was such an occasion. (5:5)

Two of the basic issues of an airlift system are the classifications and components of the system. The planner has to have a thorough understanding of these issues before undertaking the modeling of airlift systems. Definitions and explanations of these issues can be found in Air Force Doctrine Document 30 which addresses airlift operations.

Airlift Classifications.

There are three functional classifications of airlift: strategic, theater, and organic. These classifications depend on the mission the airlift asset is performing and not on the type of airframe itself.

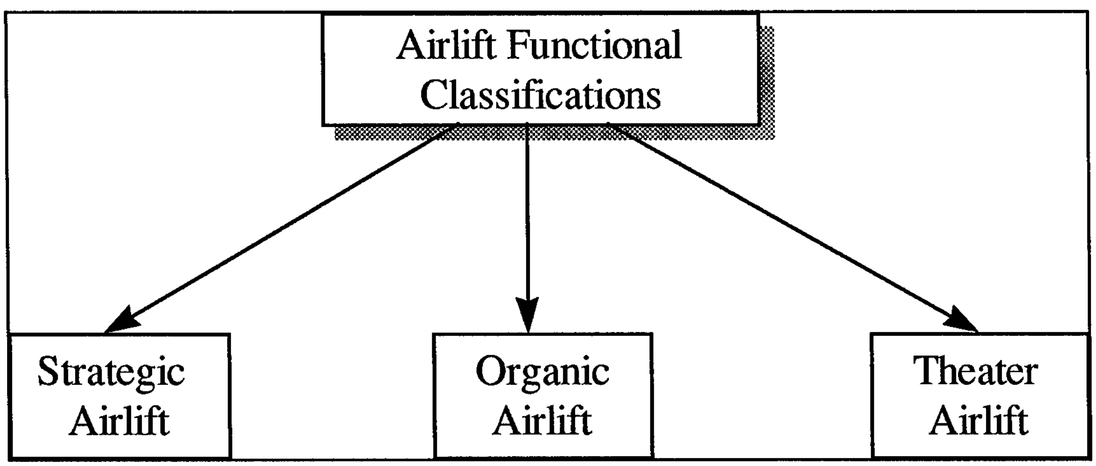


Figure II.1 Airlift Functional Classifications

Strategic airlift forces provide the airbridge that links overseas theaters to the continental United States (CONUS) and to other theaters. Additionally, they perform the airlift within the CONUS. Theater airlift forces provide common-user airlift of personnel and materiel within a Commander In Chief's (CINC) area of responsibility (AOR) and occasionally outside the AOR. The theater airlift mission generally requires aircraft capable of operating under a wide range of tactical conditions including austere, unimproved airfield. Organic airlift forces are those assets that are an integral part of a specific service, component, or Air Force Major Command (MAJCOM) and primarily support the requirements of the organization to which they are assigned. These forces do not directly support the common-user airlift system, except when they are used to reduce extraordinary workload demands. (5:9)

Turkey's air mobility system does not include strategic and organic airlift as a classification. As was reviewed earlier, Turkey does not have strategic targets. An organic airlift structure is not convenient for Turkey's circumstances. Thus this study focuses on intratheater modeling requirements.

Airlift Components

United States Air Force airlift forces are comprised of three organizational components: active, air reserve, and Civil Reserve Air Fleet (CRAF). A thorough understanding of the advantages and disadvantages of each component is necessary to wisely use these limited airlift assets. (5:8)

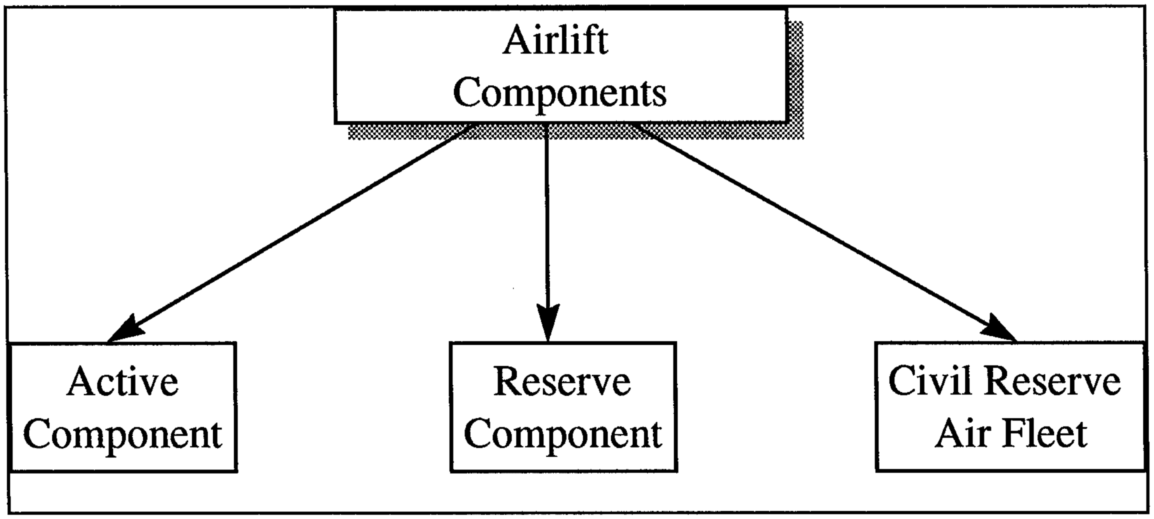


Figure II.2 Airlift Components

Active component airlift forces are attached to various US Air Force Major Commands (MAJCOM). The main contribution of these active forces is to perform the core military airlift missions that require specialized training, equipment, or aircraft physically capable of accommodating the dimensions of military equipment and vehicles. Air Reserve Component (ARC) airlift forces are established in both the Air Force Reserve and the Air National Guard. ARC airlift forces execute airlift missions in support of US requirements on a daily basis. Additionally, a main contribution of the ARC airlift forces is to maintain readiness to augment the active forces as required. The Civil Reserve Air Fleet (CRAF) component program provides commercial augmentation of military airlift capability during contingency or crisis operations. Participation in the CRAF program is voluntary. Commercial carriers commit specific aircraft, crews and their support assets to the CRAF program to support mobilization. (5:8)

Turkey does not have a reserve component. Turkey does have a CRAF component, but it has not been included in this research. As the purpose of this study is to develop a supporting model for planning active component TAMC assets, the CRAF planning issue is left as an area for future study.

The mission of intratheater forces can be found in Air Force Doctrine Document 30, which addresses airlift operations. The tasks of intratheater airlift operations are described as follows:

- Deploy and redeploy forces within the AOR (Area of Responsibility).
- Sustain deployed forces (both routine and combat sustainment).
- Deliver combat forces directly into battle.
- Force extraction from a combat environment.
- Conduct aeromedical evacuation operations.
- Augment strategic airlift forces when required.
- Perform non-lethal air power tasks such as foreign humanitarian assistance, leaflet drops, aerial spray, and fire fighting.

Within the structure of TAMC, the same tasks are given to the Turkish Forces, except augmenting strategic airlift forces, aerial spray, and fire fighting.

Planners must determine which forces should be used: how they should be used, in what sequence they should arrive, and to what level of risk commanders are willing to expose the airlift force. Additionally, deployed forces may have to be self-sufficient during the early stages of an operation since the logistics system may not be in place. As the contingency matures, airlift continues its support of military operations as an important element of the overall mobility and logistics system. (15:7)

The C-130 aircraft is the backbone of intratheater tactical airlift for the US

Armed Forces as well as the military forces of 57 countries around the world. Over 1800 C-130 aircraft have been produced. The original C-130 was designed to a specification issued by the U.S. Tactical Air Command (TAC) in 1951 (14:446). The primary aircraft for Turkish Air Mobility Command are C-130s and C-160s. C-160 Transalls were built by Germany, France and England in the late 60s and early 70s. The dimensions and capabilities are very similar to those of C-130 Hercules. C-160s have two engines, shorter range, less cargo carrying capability, and worse performance, especially in hot weather and at higher altitudes than the C-130. Detailed information about the C-130, C-160, and Future Large Aircraft (FLA) has been included in Appendix A.

Utilization Rate

If the daily total flying hours for a particular type of aircraft are divided by the number of aircraft in the fleet, the result is called the utilization rate (UTE) for that type of aircraft. When discussing UTE rates, three different types are commonly identified; peacetime, objective war time, and obtainable war time. Peace time UTE rates are simply the total flying time divided by the number of aircraft assigned. The objective war time UTE rates, on the other hand, are the airlift capability that is desired to be achieved in war time with the available airlift fleet. The obtainable war time UTE rates are the actual airlift capabilities that were believed to be achieved for a given war time scenario with the resources available. (42:10)

There are four basic factors used in determining obtainable wartime UTE rates for different types of aircraft. These are aircrew manning, maintenance manning, spare parts, and airlift system constraints. (42:10)

When discussing obtainable war time UTE rates, the productive capability of the fleet must be considered. Not all the aircraft are standing by at their home station, available to immediately deploy to aid in meeting requirements in support of a war. The obtainable war time UTE rates may be low for the first few days of a deployment, because those aircraft that are in maintenance must, of course, come out of maintenance before they can be put into the deployment flow. Those aircraft that are off station must return to their home stations, and may then have to proceed to the embarkation base. During the "start up" phase, these planes are non-productive toward the deployment effort, and therefore are not available for deployment computations. (42:11-12)

The published UTE rates are by no means hard constraints. If required by the execution of a contingency operation, the published UTE rates can be exceeded. (42:13)

MOG (Maximum On the Ground)

Maximum On the Ground (MOG) can be defined as the highest number of aircraft being used in an operation which will be allowed on the ground at a particular base during a given span of time based on simultaneous support. (40:15)

MOG is not simply the available ramp space. It depends on many factors such as refueling capability, number of aircraft which require capability for simultaneous loading or unloading, ramp space, and taxi ways. All of these related factors have to be taken into account. MOG will directly influence the capability of the airlift assets. The policy makers have to find the limiting constraints of the MOG and, if necessary, try to increase MOG.

Current models use MOG to represent airfield capability. One such model is a simulation program called Base Resource and Capability Estimator (BRACE). This model is a discrete event simulation model which uses the ModSim II language. The model's inputs are parking resources, aircraft information, payload, refueling capabilities, cargo handling and maintenance factors. The BRACE model outputs are resource utilization, activity times, ground simulation and delay times. Although this model is still under development, its output will aid in addressing the following issues:

- Identify constraining resources and quantifying additional resources needed.
- Quantifying resources required for execution of planned aircraft flow.
- Identifying excess resources that can be reallocated.
- Validating airfield MOG values used for planning and analysis. (38:1-15)

II.2 Review of Key Air Mobility Models and Mobility Problem Solution Techniques

In this section some models that give insight for this research or for future studies in this area are presented. The literature review related to the research problem and solution techniques is discussed along with a review of the models.

Generalized Air Mobility Model (GAMM)

GAMM was developed by the General Research Corporation (GRC) for the Directorate of Advanced System Analysis, Aeronautical System Center at Wright-Patterson Air Force Base. GAMM is a Monte-Carlo simulation of an airlift transportation system. The GAMM program is an event-oriented simulation of the transportation system defined by the scenario and the jobs required to be moved. Version 5.1 of GAMM is written completely in the SIMSCRIPT II.5 simulation language. (10:3-5)

> SIMSCRIPT II.5 is a powerful, free-form , English-like, general-purpose simulation programming language. It is not dependent on any predefined coding forms, nor does its implementation depend on any intermediate language such as FORTRAN or assembler. It supports the application of software engineering

> principles, such as structured programming and modularity, which impart orderliness and manageability to simulation models. (39:1)

GAMM is very efficient for theater airlift system operational effectiveness analyses. One of the positive aspects of the model is its ability to quickly compare a wide range of alternative airlifters in realistic operational environments and ascertain their individual benefits and penalties. (11:1)

A good review of the model can be found in the programmers/analysts manual for GAMM. According to this manual (11:3)

> GAMM is a user friendly, interactive, transparent yet sophisticated transportation simulation of intratheater airlifter operations with associated logistics support and aircraft attrition.

In 1991, Paul Pappas, a Flight Lieutenant in the Royal Australian Air Force, completed a thesis for the Master of Science in Logistic Management program at the Air Force Institute of Technology (AFIT). The objective of the research was to identify which characteristics of tactical airlift aircraft are of greatest importance in determining tactical airlift capability. He made use of the flexibility of the GAMM by changing the inputs for the model. Pappas used a Central American Scenario to test the model because this scenario has many similarities to the type of conflict that Australian Defense Forces foresee in their future planning. Two groups of tactical airlifter characteristics were found to significantly affect the capability of the tactical airlift system in this scenario: the size of the aircraft's cargo bay and the aircraft's ability to operate on unprepared surfaces. (25:14)

A similar study was also done as part of a thesis at AFIT by John J. Koger, a captain in the USAF. Captain Koger used different tactical aircraft characteristics and a different scenario, Southwest Asia, which covers a large geographical area and varying threat levels. The results of his study were compared with those of an earlier study that used the much smaller, low threat Central American scenario. Koger determined that across a range of scenarios, airlift system performance is most affected by the aircraft's size, survivability, cruise speed, ability to operate on short fields, and ability to operate on unprepared surfaces. (16:xii)

Regional Force Projection Tool

The Regional Force Projection Tool (RFPT) model was primarily developed for quick turn analysis and to support interactive and iterative analysis. (7:2) The tool provides airlift capability analysis, airlift requirements analysis and requirements analysis for aerial refueling. The model's advantages are that it requires minimal training to use, provides visualization, produces quick turn results and has an intuitive user interface. The model provides optimal solutions based on an objective function which minimizes total cost or the number of missions. There are three versions of the RFPT model: DOS, Windows, and Unix. (7:2-5) Two related analysis functions between inputs and outputs are as seen in Figure II.3

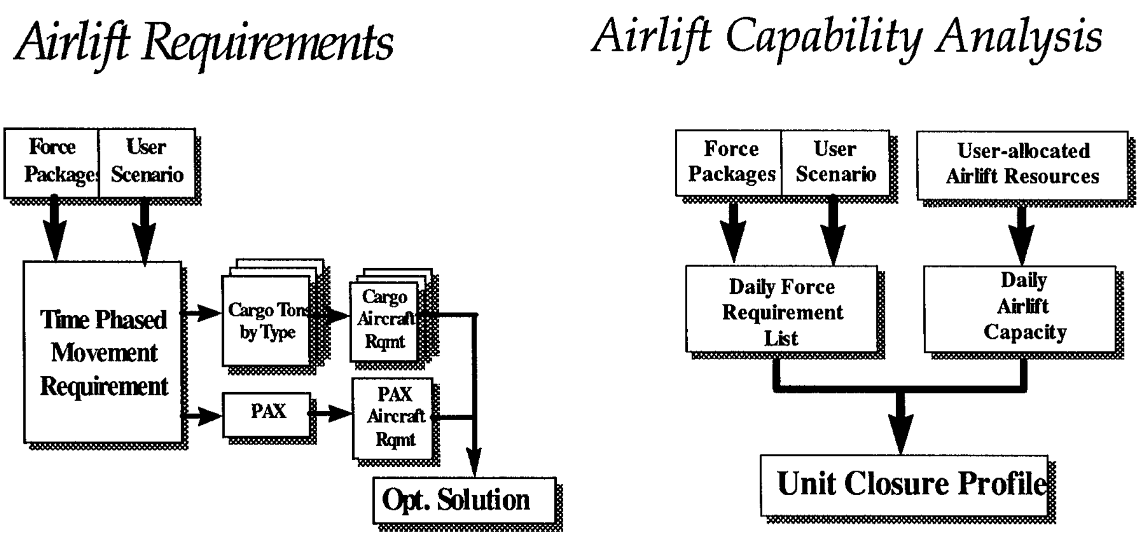


Figure II.3 Functional Relation of the RFPT Model. (7:17-18)

MIDAS (Model for Intertheater Deployment by Air and Sea)

MIDAS uses heuristics to schedule cargo in a timely manner without gross inefficiency in the use of transportation resources. MIDAS is a fort to fox hole (Figure II.4) strategic modeling tool which includes sealift and airlift. The input data preparation of MIDAS is a complicated procedure that can take weeks or months, depending on the study. (19:61-64)

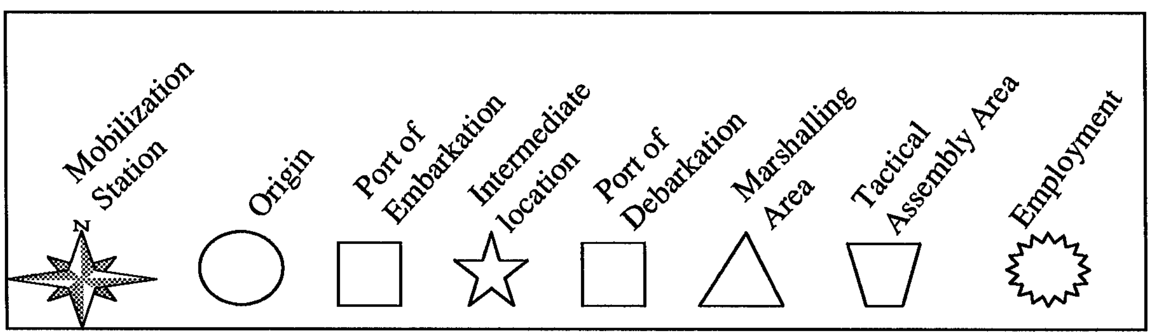


Figure II.4 Strategic Mobility- Fort to Foxhole

The Studies, Concepts, and Analysis Division (SCAD) performs two major types of mobility analysis: In requirements analysis studies, it estimates the numbers and types of airlift and sealift assets needed to meet various commitments; and in capability determination studies, it estimates the capability afforded by a given set of transportation assets. SCAD experienced problems while conducting Revised Intertheater Mobility Studies (RIMS). The study took more than two years to complete, requiring over 400 model runs. SCAD analysts experienced difficulty in using their strategic mobility model, MIDAS. (19:2-3)

RAPIDSIM (Rapid Intertheater Deployment Simulation Model)

This model is similar to MIDAS, but older. It does not include planning from origin to POE, or from POD to destination. RAPIDSIM requires extremely sophisticated users. Only experts can prepare the databases, run the model, and interpret output. (19:64)

General Algebraic Modeling System (GAMS)

GAMS is designed to make the construction and solution of large and complex mathematical programming models more comprehensible to users of models from other disciplines. Because it can make concise algebraic statements of models in a language that is easily read by both modelers and computers, GAMS can greatly expand the extent and usefulness of mathematical programming applications for policy analysis and decision making. (4:1) At this point it is worth defining mathematical programming and its use in mobility requirement studies.

One of the recent studies conducted by RAND entitled *New Capabilities for Strategic Mobility Analysis Using Mathematical Programming* makes a good comparison between simulation and mathematical programming (MP) approaches in designing mobility models. Based on the RAND document, the definition of MP and its use in analyzing transportation requirements can be given as follows:

> Mathematical programming (MP) is the general term that applies to a family of solution techniques for a wide range of problems. MP formulations offer a number of advantages for addressing transportation requirements questions. MP models
> - directly provide optimal answers.
> - consider all possible combinations of inputs.
> - provide information on excess capacities of the system.
> - define the economic advantage of obtaining additional constrained resources. (19:xii)

> Problems of optimization "maximizing or minimizing some weighted sum of decision variables subject to the constraints of loading, unloading, and carrying capacities; limited numbers of lift assets, manpower, and materiel availability; and required closure profiles" are easily stated as pure or mixed integer problems. (37:74)

Mathematical programming approaches have been recommended by RAND after they found shortcomings with existing mobility models, especially in their application to problems of transportation resource requirements. The limitations addressed by the RAND Cooperation research (37:40) of the current simulation air mobility models are:

- They all work in one direction accepting similar types of input data and producing the same general information.
- Their credibility outside the organizations that use them is limited.
- They do not sufficiently recognize uncertainty.
- Their objective functions are too narrow and rigid.

- Their solutions are not optimal.

These problems lead most analysts to view the models as ‘black boxes.” Most of these models are deterministic simulation models.

MASS (Mobility Analysis Support System)

“MASS is simply a deterministic simulation model which flows a fleet of aircraft through a network of onload, enroute, offload, and recovery bases in order to deliver a set of requirements needed to achieve some predefined scenario goal.” (44:10)

Besides the simulation and modeling approach to airlift planning, a vast array of solution techniques relate to vehicle routing problems which can be found in the literature review of similar problems.

In 1995 Edward F. Yang from Washington University did a doctoral dissertation named “Network Optimization with Time Window Constrained Routing and Scheduling.” (29) The primary motivation of his research came from the problems encountered in the Strategic Mobility Analysis of the United States Military.

Yang based his research into the problems and perspectives in the research of MASS by trying to find an alternate solution technique. He addressed the type of problems encountered in the current mobility models, which have been reviewed earlier, as *network optimization problems with routing and scheduling*. For these systems, there are normally feasible solutions. However, optimal solutions are not only hard to find, but many times even hard to define. Traditionally, network optimization problems are solved by a linear programming approach, i.e. network flow, multicommodity flow, etc. According to Yang for network optimization problems with routing and scheduling, two technologies outside the traditional deterministic simulation approach offer promise for a new solution: *Mathematical Programming Techniques* (integer and combinatorial optimization) and *Knowledge-based Modeling Technology.* (44:12)

Yang developed a new model, NETO, to overcome some of the limitations of the existing simulation models. The NETO model consists of a network optimization engine with time window constrained routing and scheduling, and an analysis system with a Management Information System. The optimization engine is formulated as a Pickup and Delivery Vehicle Routing and Scheduling Problem with Time-Window Constraints (PDPTW). This problem is solved by a set-partitioning formulation, column generation and column elimination algorithm (SP-CGCE). The subproblem of the column generation is a Constrained Shortest Path Problem with pairing, precedence, capacity, and time window constraints that is solved by dynamic programming. (44:17)

Yang is essentially modeling the airlift network by specifying every possible route that an aircraft could take and choosing the optimal set of routes. Instead of enumerating each possible route before optimizing the model, the routes are picked by passing a series of feasibility tests that check for route feasibility, allowable pick up and delivery times, and load compatibility with the transportation vehicle. To accomplish this, the first task is to transform an operations network into an optimization network. The operations network consists of all the relevant data such as air bases, air routes, onloads, offloads, cargoes, transportation vehicles, scenario, movement requirements, other logistics factors, etc. The optimization network is a labeled digraph suitable for use in mathematical programming. (44:19)

Some Properties of Fleet Assignment Problem

The general fleet assignment problem can be defined as "Given a daily schedule of flight segments and a set of different types or fleets of planes, the fleet assignment problem is to determine which type of plane (fleet) to assign to each flight segment." (12:59) The driving force of this approach comes from the fact that different fleets produce different revenues if assigned to the same flight segment because of different performances, capacities, etc. (12:59)

A basic routing problem is easily stated as a set of nodes and arcs that must be serviced by a fleet of vehicles. In the basic problem, there are no restrictions on the order or timing in which the nodes must be serviced. The problem is to construct a low-cost, feasible set of routes. Each vehicle is assigned a single route. A route is defined as a sequence of locations that a vehicle visits and includes the service it provides. (3:79)

> The basic daily fleet assignment problem is a min-cost multicommodity flow problem on a time-space directed graph in which there is a node (u,i) for each time t_i when an arrival or departure occurs at a station u. There is a flight arc {(u,i),(v,j)} for the flight segment that departs u at time t_i, and arrives v at time t_j, there are ground arcs {(u,i),(u,i+1)} and a wraparound arc that connects the last node of the day with the first one for all stations u. The fleets correspond to the commodities so that at each node the flow in equals the flow out for each commodity. Flow on the ground arcs is just required to be nonnegative, since integrality on the flight arcs implies integrality on the ground arcs. Finally we have an upper bound on the number of planes in each fleet. The basic fleet assignment problem can be stated as the following 0-1 mixed integer programming problem, (12:59-60)

$$\text{Min} \sum_{k=1}^{K} \sum_{i \varepsilon A_f} c_{ik} \cdot x_{ik}$$

subject to

$$\sum_{i\varepsilon O(v)} x_{ik} - \sum_{i\varepsilon I(v)} x_{ik} + y_{f(v)k} + y_{t(v)k} = 0 \qquad \forall v \in V; k = 1,\ldots,K \qquad (1)$$

$$\sum_{k=1}^{K} x_{ik} = 1 \qquad \forall i \in A_{f,} \qquad (2)$$

$$\sum_{i\varepsilon W} y_{ik} + \sum_{i\varepsilon N_f} x_{ik} \le b_k \qquad k = 1,\ldots,K \qquad (3)$$

$$x_{ik} = 0 \text{ or } 1 \qquad \forall i \in A_{f:} \; k = 1, \ldots, K. \qquad (4)$$

$$y_{ik} \ge 0 \qquad \forall i \in A_{g:} \; k = 1, \ldots, K. \qquad (5)$$

Where

$V =$ set of nodes,

$A_f =$ set of flight arcs,

$A_g =$ set of ground arcs

$N_f =$ set of flights in the air

$K =$ number of fleets

$O(v) =$ set of flight arcs from node v,

$I(v) =$ set of flight arcs to node v,

$W =$ set of wraparound arcs,

$b_k =$ number of planes in fleet k available,

$f(v) =$ ground arc from node v,

$t(v) =$ ground arc to node v,

$y_{ik} =$ decision variable for ground arc i and fleet k,

$x_{ik} =$ decision variable for flight arc i and fleet k,

c_{ik} = cost of assigning fleet k to flight i.

The first constraint can only be satisfied if the number of arrivals equals the number of departures at a station. Equalities (2) require that each flight is flown by exactly one fleet, and inequalities (3) limit the fleet sizes (12:60). This is a basic formulation, since the real problem has other constraints on factors such as maintenance, crews and route connectivity.

A classic routing problem that demonstrates the mathematical simplicity of stating such problems, along with the difficulties associated with their solutions, is the Traveling Salesman Problem (TSP). The TSP is based upon a network of nodes, arcs, and costs. It is called a Traveling Salesman Problem because the problem can be thought of as a salesman that must visit each of the cities in a set once and return to his or her city of origin. Obviously, the salesmen will want to do this by traveling a minimum distance or at minimum cost (3:82).

The General Pickup and Delivery Problem (GPDP)

In general pick up and delivery problems, vehicles have to transport loads from origins to destinations without transshipment at intermediate locations. Savelsberh, from Georgia Institute of Technology, and M. Sol, from Eindhoven University of Technology, conducted a study where they discussed several characteristics that distinguish the GPDP from standard vehicle routing problems and presented a survey of the problem types and solution methods found in the literature. (36:17)

In the GPDP, to satisfy the transportation requests, a set of routes has to be constructed. A fleet of vehicles, with known capacities and routes is available to operate.

Each transportation request specifies the size of the load to be transported, the locations where the load is to be transported, and the locations where the load is to be delivered. Each load has to be transported by one vehicle from its set of origins to its set of destinations without any transshipment at other locations. The vehicle routing problem is a Pick up and Delivery Problem (PDP) in which either all the origins or all the destinations are located at the depot. (36:17)

Philip B. Oglesby, a captain in the USAF, completed a thesis at AFIT in March 1996 entitled "Requirement for C-130 Aircraft in the Intratheater Korean Scenario". The objective of his research was to provide a timely and accurate methodology for the purpose of determining C-130 intratheater airlift requirements. He used a solution technique based on a linear programming spreadsheet model. His formulation included trucks and 22-car trains as well. (24:vii)

Capt. Oglesby did not consider some of the real world constraints on the airlift system such as materiel handling and ramp space. On the other hand, by using aggregation in the problem formulation, he provided a rather simple approach compared to recent efforts at attempting to solve the same problem through sophisticated simulation approaches. (24:6) When the Joint Staff conducted their Revised Intertheater Mobility Studies (RIMS), they had to do 400 runs of the MIDAS model between October 1986 and April 1989 in order to determine airlift requirements. Even with that commitment of time and effort, the studies were not able to explore all the options and left some questions unanswered. (37:3)

Conclusion

The RFPT model is very attractive, due to its quick turn results, user friendliness, and the requirement for minimal training. The RFPT model was originally designed for strategic mobility planning. It does not include MOG, a very important parameter for tactical mobility analysis. The data has to be coded to run the program, which requires extra effort, time, and expertise.

MIDAS is a fort to fox hole strategic model, and it is not well suited for this research problem. RAPIDSIM is also not practical for the same reason.

GAMS is a very strong mathematical programming tool for a variety of fields. USAF AMC (Air Mobility Command) uses this tool in their cargo channel system. All models have drawbacks, and so does mathematical modeling. The primary disadvantage is that Mathematical Programming (MP) requires an enormous number of calculations, which tends to increase exponentially with each additional variable. Partly because of the computational need to reduce the size of the MP formulation and partly because it is difficult to capture the intricate nature of the real world in analytic equations, MP models typically lack the detail necessary to fully represent the real world. (27:xii-xiii) GAMS is not practical for the tactical mobility problem, but it could have been used for this research if the limitations and scope had been different.

MASS is currently being used by AMC as a strategic modeling tool. This model is also not appropriate for the specific research questions.

The NETO model is not chosen because it is a strategic model. The algorithm used is too complex for the prospected users' level. The developed model has many great aspects for the strategic mobility problem, and is a good application of mathematical programming.

Captain Oglesby's study is a good modeling approach for a specific problem. However, it does not include all the details required to meet the objective of this study. His research gives insights for the type of mobility problem where trucks and trains are included. This is a potential future area of interest for the Turkish mobility problem. Although the current railroad system is not efficient in Turkey, if a study were to established that having the necessary railroad net would considerably increase Turkey's mobility capability, such that it provided more mobile forces, a downsizing of the armed forces might be possible. By doing so the system with common railroad transportation in the long run would be more efficient. With more mobile forces, the same capability can be provided with a smaller active duty force.

The Generalized Air Mobility Model (GAMM) provides planners and analysts with detailed information on transportation system effectiveness (down to the individual cargo item level of detail), as well as more aggregate measures of effectiveness. The model's strength is its ability to quickly compare a wide range of alternative airlifters in realistic operational environments and to ascertain their individual benefits and penalties. GAMM's flexibility has made it a popular tool for a variety of applications including: airlifter concept analysis, wholesale versus retail concept evaluations, and mixed-fleet airlift operations investigations. GAMM provides analysts (or users) intratheater mobility analysis capability. The user can model future or existing airlift system requirements in an existing theater environment or against projected theater airlift requirements. In addition, by using GAMM to perform sensitivity analysis (measuring the output results from identical simulations with selected input variations), the influence of individual airlift factors can be observed. (10:1-2)

In this section, the literature review related to the problem, different solution techniques for the air mobility problems, and some models have been reviewed. Based on expected results, the research objectives, and solution techniques found in the literature, the GAMM model has been chosen as the model to answer the specific research questions. In Chapter III the GAMM model is reviewed.

III. GENERILAZED AIR MOBILITY MODEL OVERVIEW

Overview

GAMM was developed by the General Research Cooperation (GRC) for the Directorate of Advanced Systems Analysis, ASC/XR, Aeronautical Systems Center at Wright-Patterson Air Force Base. GAMM provides Air Force analysts with an intratheater airlift analysis capability. The analyst can model future airlift system requirements in an existing theater environment or model existing airlifter capability against projected theater airlift requirements. GAMM aids the user/analyst in investigating the effectiveness of airlift transportation systems in a military theater of operation. While the model serves as an in-house analytical tool for USAF's Aeronautical Systems Center at Wright-Patterson Air Force Base to evaluate airlift system effectiveness, GAMM has also been applied by other organizations in government and industry in the United States and abroad. (11:3)

Version 5.1 of GAMM is written in the SIMSCRIPT II.5 simulation language. A distinguishing feature of this version of GAMM versus its earlier versions is a Graphical User Interface (GUI) which is designed to aid users in setting up model runs. The GUI utilizes a number of graphical features supported by the SIMGRAPHICS utilities of SIMSCRIPT. (10:3-4)

> GAMM is user friendly, interactive, transparent yet sophisticated transportation simulation of intratheater airlifter operations with associated logistics support and aircraft attrition. (11:3)

Some of the array of theater airlift issues where GAMM has been successfully used are airlifter characteristic trade-off studies, evaluations/comparisons of conceptual and conventional airlifters, airlifter fleet size investigations, airlifter fleet mix studies, and scenario-specific investigations. (10:3)

Inputs to the model are movement requests, airfield characteristics, and airlifter performance capabilities and reliability/maintainability (R/M) characteristics. Aircraft payload capacity and cargo bay dimensional limitations are adequately considered. Aircraft are flown, equipment/personnel are moved and statistics as to effectiveness are developed. Graphics are available prior to the start of simulation to review, modify or initially construct the scenario. During the simulation, the user can interactively interrupt the program and select a graphic display in an area of interest. The user can make changes during this interruption to most portions of the scenario, such as usable runway length, and mission and non-mission essential mean time between failures. (10:2)

The Primary GAMM Simulation Elements

GAMM is a simulation of an airlift transportation system, written in the SIMSCRIPT II.5 simulation language. The model also simulates transshipment of airlift jobs including attrition of these jobs during transshipment. The model permits airdrops of troops and cargo with attrition when a destination is not served by an airbase. Aircraft are flown, troops and equipment are moved, maintenance is performed, and statistics are developed throughout the simulation. (10:4-5) Minimum system requirements for running GAMM on a Sun SPARC station include: SunOS 4.0.X, either Open Look (2.0 or 3.0) Motif window managers, 4 MB RAM (8 MB recommended), 40 MB disk space, and an X terminal. (11:5)

There are three basic elements of the GAMM model, as seen in Figure III.1. These elements include the GAMM inputs, the GAMM program, and GAMM outputs. The GAMM inputs consist of the Scenario File, the Jobs File, and the Model Control Data. The descriptions of these are given below from GAMM's analyst/programmer manual. (10)

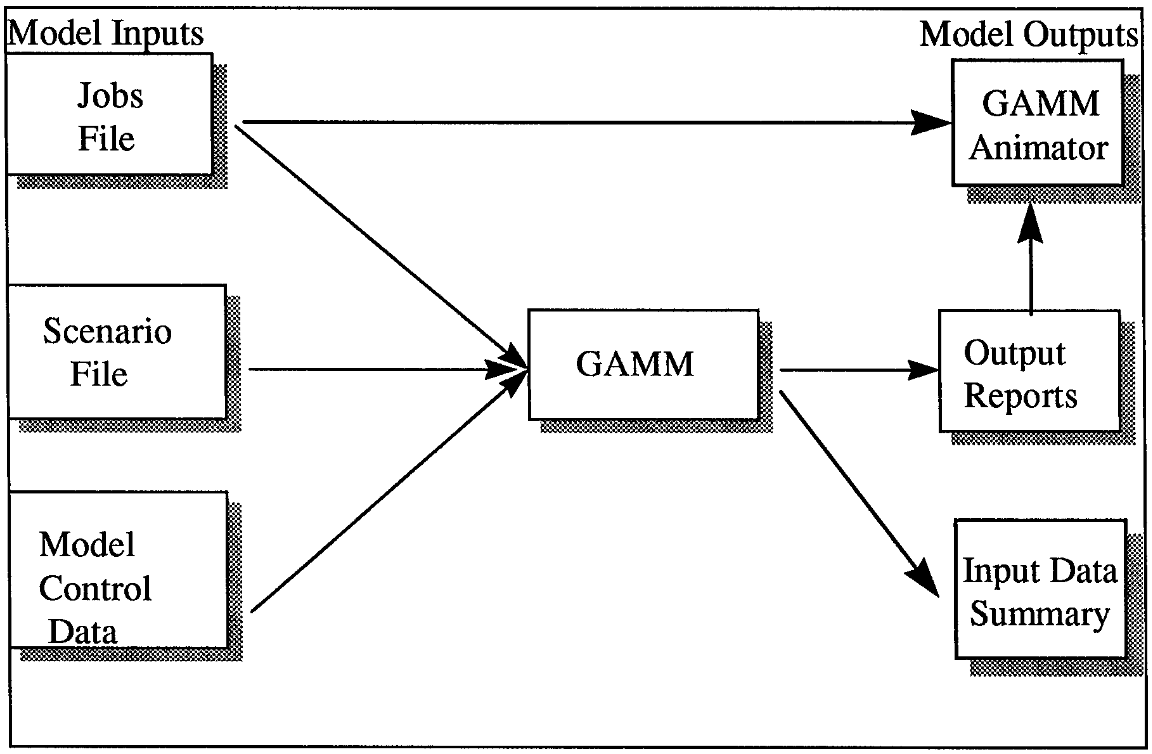


Figure III.1 Elements of GAMM (11:6)

The Scenario File describes the environment being modeled, including airbases and entry/delivery sites. Airbase information provides the location, identification, and descriptive data relative to each airbase. Airbases are defined by their geographic and physical characteristics such as latitude, longitude, elevation, and runway length. Entry/delivery site information describes the name and location of each site where airlift jobs originate and/or terminate. In addition, each entry/delivery site has information identifying airbases which serve that entry/delivery site. The Scenario File also describes each airlifter type's capability to transport cargo in terms of runway length requirements and weight limitations, speed, cargo compartment size, and reliability/maintainability characteristics. In addition, the home base of each airlifter is specified in the Scenario File. The Jobs File describes the cargo that will be flowing through the transportation system. It includes a description of the job request, an entry site, a delivery site, and entry time, a required delivery time and the job priority. Dimensional data and weight are also provided for each item to be moved. Finally, the Model Control Data contains operational and analysis conditions for the simulation such as the length of the simulation and other parameters which influence the model's algorithms. These parameters are modified by the user through the GUI interface. (11:4-5)

> The GAMM outputs consist of a user-controlled animation utility and analysis report products. The GAMM Animator is a graphics-based analysis tool which may be used to play back the simulated airlift events recorded during a GAMM simulation. The airlifter flight histories, scenario data, and airbase characteristics are provided in these reports. A simulation general summary report is provided as a comprehensive summarization of the specific GAMM execution. (21-6)

To use the GAMM model properly, several procedures must be followed. First the model and associated files have to be installed on a computer. Next the Jobs File and Scenario File need to be developed to provide GAMM with the required information to correctly model the desired scenario. After these steps, the model can be executed interactively. When the simulation is complete, the user can analyze the resulting information and make additional runs as necessary. (22:4)

Transportation System Within GAMM

Cargo movements in GAMM for a specific scenario are established prior to starting the simulation. In other words, cargo movement requirements are known prior to starting the war, and do not change as the war progresses. Modeling the tactical airlift system in this way simplifies the primary objective of measuring airlift system performance. (9:3)

A transportation system can be represented as a network in which an item that enters at an entry site is moved, via inter-connected arcs and nodes, to a delivery site. Figure III.2 illustrates the network structure used in GAMM. Nodes represent the entry/delivery (E/D) sites and airbases. These nodes are connected by two types of arcs, which are distinguished by mode of transportation. The air transportation arcs use airlifter assets, while the transshipment arcs do not. (10:6) For each link, the transport mode used for cargo transshipment is defined by specifying the travel time that it takes the cargo to move along the transshipment link. GAMM assumes that there is always sufficient supply of transport equipment eventually available to move the cargo along the transshipment links. If no aircraft are available when the cargo reaches the originating base, the cargo awaits the arrival of aircraft. When an aircraft is available, the cargo is transported to a receiving airbase if its maximum lifetime has not been reached.

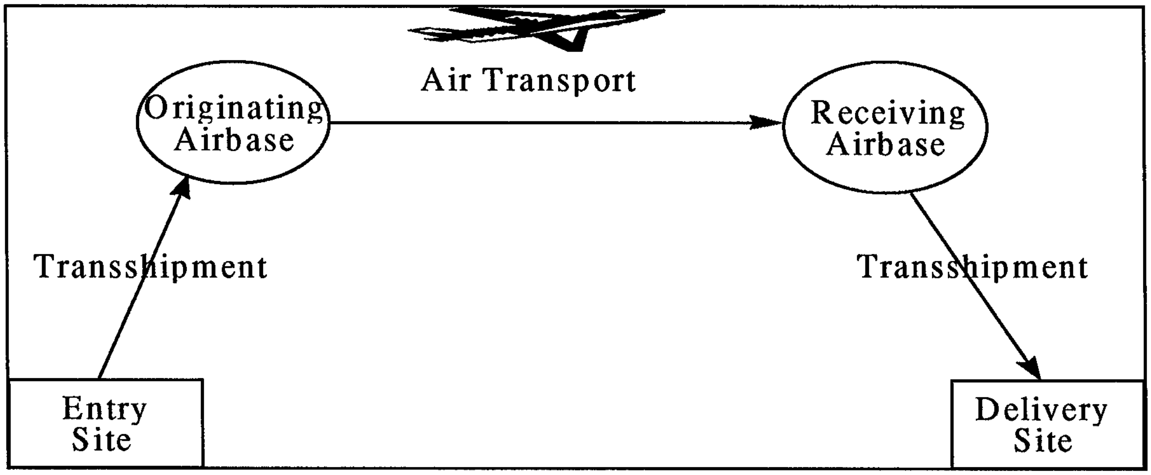


Figure III.2 GAMM's Transportation System (10:6)

As seen in Figure III.3 (10:7) several transportation routes may be evaluated as a function of physical constraints (runway length, service capabilities), user preferences and the current simulation state (number of aircraft being used, amount of backlogged cargo).

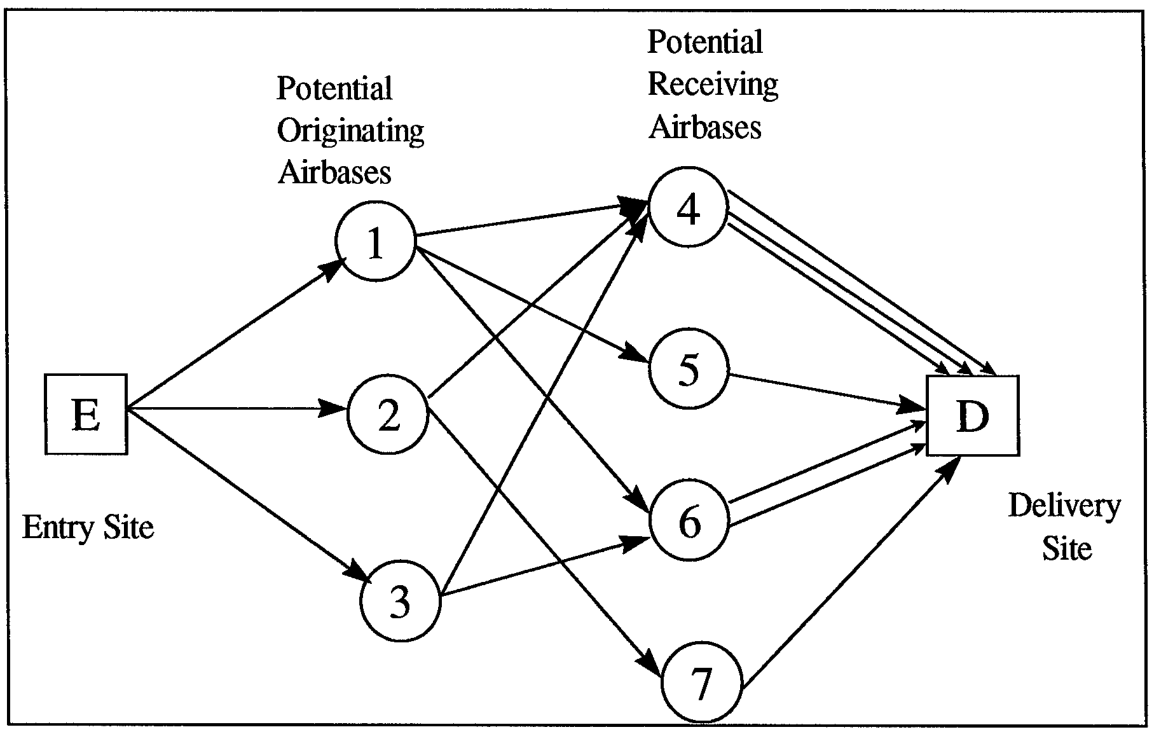


Figure III.3 Potential Transportation Routes

Movement items are defined by weight and physical dimensions (length, width, and height). In the description of the movement item, the identities of the entry site, the delivery site, the desired delivery time, cargo class, priority, and maximum lifetime are included. If the movement item arrives at the delivery site later than the desired time, the movement item is late. The maximum lifetime is an important attribute of the movement item. If the movement item has not been delivered within its maximum lifetime, it is deleted from the system. Deleted items are individually accounted for within GAMM output reports. (10:8-9)

GAMM Simulation Overview

When a GAMM simulation begins, all airlifters are at their home bases. When an airlifter job enters the transportation system at an entry site, it is transported via a transshipment arc to an airbase associated with that entry. For originating airbases with available airlifters, jobs are scheduled to depart based on the priority or the weight of the cargo. There are eight priority levels, 1 to 8, with priority level one being highest. The significance of a priority number is established by the priority scheduling factor, which is set in the Runtime Command File. Jobs with a priority number higher than the priority scheduling factor will be scheduled based on the order of their priority, with ties being broken according to weight. Selection of cargo for airlift is set up in two ways by the user: the weight-only method and priority of the movement items awaiting airlift. With the weight-only method, cargo is selected based on weight, greatest weight first. The airbase with the most backlogged cargo is handled first. The second method is the priority of the movement items awaiting airlift (priority-loading method). Priority one (highest priority) items are considered first. (10:18). Once all these jobs have been scheduled, the scheduler relocates any remaining airlifters to airbases that have a backlog of jobs and either insufficient or no airlift capacity available. (10:31)

The loading and unloading times are the result of a lognormal draw on the mean unloading time. The draw is adjusted to account for the presence of rolling stock in the cargo set, which account for Materiel Handling Equipment (MHE) availability shown in the airbase unloading factor. The unloading operation is simulated before any maintenance or other ground support operations. The computation of an actual unload time accounts for the fact that a given cargo set may not fully load the airlifter, nor be fully palletized. (10:19-20)

Airlifter Flight Planning

Airlifter flight planning in GAMM consists of flight from POE to POD (transport cargo) or from POD to POE (force retrieval, personnel exchange, or medical evacuation) and relocating airlifters (empty flights) where needed. Primary responsibility for performing flight planning in GAMM is accomplished in the subroutines. The scheduling of the aircraft can be accomplished in one of the following two ways: Using the airlifter with the highest overall probability of survival or by the user using the airlifter input priority scheduling values. The user will establish the length of a crew day, which will cause an airlifter to return to its home airbase when the crew day reaches the specified time limit. (10:11-12)

An important aspect of the model is its ability to compute useful load (fuel and cargo) prior to the loading process. Input performance characteristics are used to compute performance on the flight under consideration. The current altitude, temperature, and projected runway conditions at the originating airbase and the receiving airbase are used in calculating the airlifter performance for the specific conditions. Landing capability is restricted by load classification number (LCN) as well as effective runway length. (10:11-12)

Before loading the cargo on an airlifter, the model checks each receiving airbase's capability as to whether or not it has sufficient runway length, runway load bearing limitations, fuel availability, and Maximum Aircraft on the Ground (MOG) limitations. If there is no suitable airfield for delivery, the model considers three possibilities. First, a search for opportune sites that are linked to the delivery site is made. Opportune sites are defined as unimproved airfield sites that can support airlift operations for a limited time. (10:8) Examples of opportune sites are roads, cleared fields, or helicopter pads. Next, the model will schedule an airdrop if an airdrop delivery is acceptable for the cargo. The last possibility is to block the cargo from further progress because no feasible link to the delivery site exists. There are six conditions in which cargo is blocked:

- No originating airbase is accessible from a movement item's entry site.
- The movement item is at an airbase that is inaccessible to all airlifter types due to performance parameters.
- The movement item is at an airbase that can no longer support airlifters.
- A movement item's delivery site has no associated airbases or airdrop sites.
- The movement item is too large or too heavy for any available airlifter types.
- Airlifters can not be used to transport the movement item due to probability of survival (this issue will be explained later) restrictions.(21:10)

The user can decide to load cargo by using the weight-and-volume load module or to have cargo loaded by weight-only. All non-standard loads must be dimensioned to run in the weight and volume mode. Dimensional data for standard load items (PAX, troops, litters, ammunition, bulk cargo, and fuel) need not to be specified, since the program uses predetermined size values for these jobs. (Table III.1)

Table III.1 Weight and Volumetric Data for Standard Movement Items

Item	Subdivided Into	Width (Inch)	Length (Inch)	Height (Inch)	Weight (lb.)
AMMO	AMMO 463L Pallet	84	104	48	6600
AMMO(PLS)	PLS Flatracks	96	240	48	22000
AMMO(MLRS)	2 MLRS Pod Loads	42	166	33	5032
AMMO(TOW)	PLS Flatracks	96	240	72	16720
FUEL	Fuel 463L Pallet	84	104	48	6000
BULK	BULK 463L Pallet	84	104	48	4600
PAX	12 Individuals	56	120	76	2280
LITTERS	9 Individual Litters	52	120	76	2700
TROOPS	16 Paratroopers	104	120	76	5600

Flight time is calculated by dividing the distance between originating airbase and receiving airbase by the cruise speed of aircraft. The amount of fuel required is calculated based on the flight time. If the receiving airbase does not have fuel available, a second flight leg is added to permit landing at an airbase that has fuel available. (10:12)

Combat and Attrition

One important aspect of GAMM is its ability to simulate losses due to combat. Cargo can be destroyed during transshipment. Airbases can be attacked and runways damaged. Combat aspects are modeled by GAMM through the specification of probabilities of survival inflight and on the ground. Probabilities of battle damage in-flight and on the ground are also modeled. The survival and battle damage probabilities for aircraft on the ground are currently set to unity pending the outcome of efforts that will yield realistic estimates for these values. Aircraft can be destroyed or damaged (may require maintenance) during operation. (9:38)

In-Flight Survivability

The in-flight survivability parameter is a function of a given airlifter type, POE, and POD. The equation to determine in-flight probability of survival for a specific route is:

$$P_s(F)=P_s(E)*P_s(D)$$

where $P_s(F)$ is the probability of survival on a flight between POD and POE for the airlifter type;

$P_s(E)$ is the probability of survival factor at the POE for the airlifter type;

$P_s(D)$ is the probability of survival factor at the POD for the airlifter type.

> The check for potential attrition of an airlifter occurs at the landing event. At that time, if a random draw is greater than the $P_s(F)$, the airlifter is considered destroyed in flight. The appropriate attrition and MOG bookkeeping are conducted. If the airlifter was carrying cargo, the movement items which were in the cargo set are replaced at the original entry site if they have not exceeded their maximum lifetime. (10:12-13)

Airlifters can be diverted during the simulation. After loading the aircraft if the conditions at the destination airbase have changed (airbase attack, runway length), then the aircraft is unloaded and the MOG constraints are updated. On the other hand, when the airlifter is in flight at the time a divert is required, then an alternate airbase for landing is checked to see if it could be used. If there is no available airbase within the range of the airlifter, the aircraft continues onto its original receiving airbase. If the conditions at the original receiving airbase are still not convenient, then the aircraft will crash during landing. If an airbase is found for a diverted airlifter, bookkeeping is done to reflect the assignment, and the routine is exited. (10:16)

Maintenance

When the unloading ends, the maintenance of the airlifters is conducted. There are three types of maintenance performed on airlifters: mission essential maintenance, nonmission essential maintenance, and Aircraft Battle Damage Repair (ABDR). Both nonmission essential and the ABDR maintenance are performed at the home base. Each of the three maintenance events selects a time-to-repair from a lognormal distribution with a given mean and standard deviation. Mission essential maintenance can be performed either away from or at the home base. The number of maintenance actions on the airlifter is determined by sampling a Poisson distribution of the three types of failures. The time spent in maintenance under threat conditions is decreased multiplicatively by a combat maintenance scale factor, which allows a decreased time to repair in order to escape from the threat conditions. The schematic representation of a maintenance event is given in Figure III.5 (10:21-22)

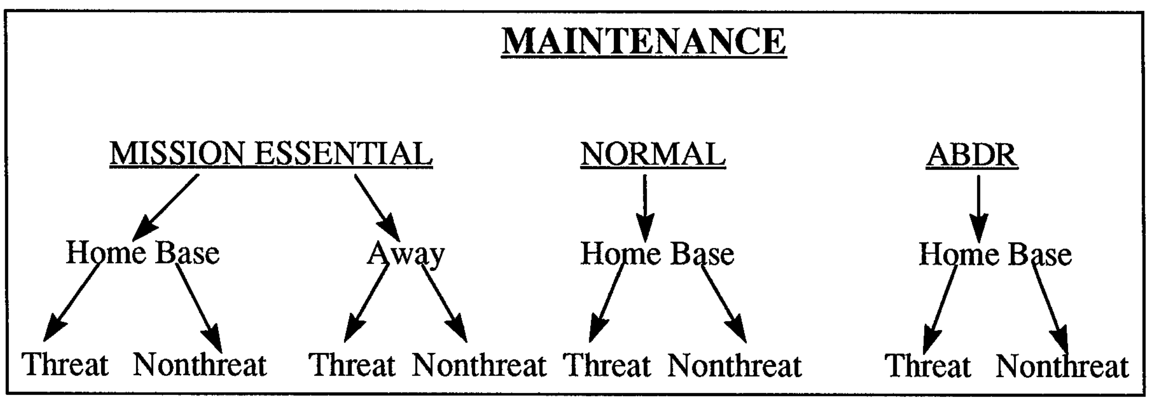


Figure III.5 Maintenance Types (10:21-22)

Conclusion

This chapter provided a brief summary of the Generalized Air Mobility Model (GAMM). First, the primary GAMM simulation inputs were discussed. These were Jobs

File, Scenario File and the Model Control Data files. The other important components were the GAMM program and numerous output reports.

Next, the way that GAMM models a transportation system was reviewed. GAMM modeled the movement of items from entry site to the originating airbase as a transshipment over which the user has control. From originating airbase to the receiving airbase the moving items are transported via airlift. Again from receiving airbase to the delivery site the movement items are transshipped. If no feasible link from the entry site to the delivery site exists, the cargo is blocked from further progress.

Next, the GAMM simulation was reviewed in order to give the reader an understanding of the concepts and logic GAMM uses. Combat and attrition within GAMM were also covered. Other important attributes for air mobility modeling which have been reviewed include maintenance, combat and attrition events.

GAMM is used in answering research questions and evaluating Turkish Air Mobility requirements. With a good set of qualitative notional data, GAMM gives outputs which can be used to analyze its effectiveness in modeling Turkey's current air mobility system. Once the user sets the scenario, he or she always has the flexibility to change, update or revise the inputs. Within the model, there is the option to input new data for the components of the model. For example, to test a new airlifter, the number of available airlift assets or constraints for specific portions of the airlift system (MOG, airfield availability) can be input. Another aspect of the model is its ability to evaluate volumetric data versus just weight. Such an ability is useful in evaluating different types of airlifter assets. Other important parameters such as combat, attrition, maintenance, and user defined priorities are all options in the modeling of a tactical airlift system. The user has these options available to analyze the airlift system effectiveness.

GAMM has been used successfully in the past by the French Air Force, which has airlift assets similar to those of the Turkish Air Force. (43)

In the next chapter, the first operational question posed by the research is "Given a set of forces, support units, supply and resupply requirements and a fixed set of transportation assets, what is the closure estimate?" The second question "what is the number of replacement aircraft among the candidates for the current aging fleet of TAMC". Both questions are answered by establishing a notional scenario based on Turkey's current circumstances as reviewed in the first chapter. A specific unclassified scenario is not available, so two scenarios for this research are written by the author with notional data as defined earlier in Chapter II. Following creation of the scenarios and the jobs files, an analysis of the outputs of the scenario and related sensitivity analysis of the basic assets is made. A verification and validation of GAMM and results obtained from this study and further potential related research topic recommendations are given in the final chapter.

IV. APPLICATION AND ANALYSIS

IV.1 Application

Overview

In this section, two scenarios are developed by the author for this thesis, and the associated jobs files are outlined.

Scenario Portrayal

Based on Turkey's current circumstances, a potential conflict on the Southeastern border of Turkey is assumed to occur because of the water problem outlined in Chapter I. The second scenario is assumed to occur in the Western part of Turkey because of the territorial waters problem. These example scenarios, generated from unclassified sources, provide a notional, generalized conflict on the borders of Turkey for the purpose of studying shifting armed forces with their equipment from East to West or visa versa. Although actual unit designations are employed, any similarity to actual contingency plans is purely coincidental.

Overall Assumptions

The conflicts are limited geographically. Nuclear, chemical, and/or bacteriological warfare are not modeled. Damage to friendly airbases is not considered, since the mobility scenarios are assumed to occur before the actual conflicts begin. Requirements are considered to be those needed for a build up before an actual war. Battle damage to the aircraft, airfields and cargo is not considered, (but this can always be included to meet user needs).

Entry/Delivery Sites

Entry/Delivery sites are chosen, according to the scenario region, from all over Turkey. All the entry/delivery sites are linked to the appropriate airfields by including the transshipment time. Transshipment times from the entry and delivery sites are based on using the available trucks and no delays are expected. In this chapter, a detailed review of information coding is not done; rather the interested reader is referred to the GAMM user's manual (11). Some important parameters are reviewed. Coding of delivery sites are given as: L refers to a delivery which can be reached only by landing at a linked airfield, D refers to delivery by air drop only, and E indicates either delivery method is possible. In the Southeastern Scenario, there are 31 entry sites, 19 delivery sites, and 39 airfields which are linked to these sites. In the Western Scenario, there are 18 entry sites, 11 delivery sites, and 39 airfields which are linked to these sites.

The information for the airfields are taken from the DoD Enroute Supplement (38) which provides General Information, Airport/Facility Directory, Theater Flight Data and Procedures, and related aeronautical information. An important specification for the scenario is MOG. The MOG numbers used for the airfields are notional. The complete scenario file can be seen in appendix C.

The number of aircraft used in the scenario is taken from Jane's World Air Forces. (39) The C-160 aircraft performance information has been obtained from a C-160 squadron in Turkey. The C-130 Hercules information was already included in the GAMM user's manual, but it has been updated with information obtained from a C-130 squadron in Turkey. The Future Large Aircraft information has been obtained from the Internet. (WWWeb:40) This information can be seen in Appendix A.

Another important factor in preparing the data for the scenario was the transformation of the coordinate system from latitude/longitude into distance in NMs from the defined reference point. The algorithm was not given in the user's manual. The algorithm has been provided by Tim Ewartt, who is currently using the GAMM model at ASC/XRE WPAFB-OH. The algorithm can be found in Appendix B.

Job Descriptions

In this section, the methodology used to establish a set of intratheater airlift jobs for the scenarios that are applicable to the 21st century is defined and presented. The airlift jobs are the requirements for the defined scenario. The information contains the name of the group of items that belong together. For example "unit move, F-16 squadron" is an airlift job, and the unit has to be airlifted within the scenario requirements. This particular job contains the list of moving items with related information as mentioned in Chapter III.

As mentioned earlier, the Jobs File contains notional data. However, once a set of jobs is established for a scenario, the research questions can be answered relative to the defined conditions. The important parameters are the type and number of airlift assets, job deletion times, the number of airfields and entry/delivery sites, and MOG. So keeping the same set of jobs and changing other parameters made the required analysis possible. The jobs from Southwest Asia Scenario (9) have been found suitable to be used as notional data.

These airlift jobs were defined without regard to the availability of airlift resources to accomplish the job. Airlift jobs were characterized in terms of job categories, generic intratheater job definitions, and specific jobs. (9:4-1) The job files have been revised to have a reasonable set of jobs.

> The job selection process was guided by the scenario, historical analysis, extensive research, and professional experience of analysts. Doctrinal statements provided the framework for postulated tactical and operational level of options which generated airlift requirements. A working group comprised of Air Force, Army, and airframe contractor representatives has greatly assisted in these airlift job definitions. (35:4-2)

Categories of Airlift Jobs

The requirements have been categorized as follows: (9:4-2)

1. Deployment Support
   - a) Intraththeater Extension
   - b) Propositioning Movement
2. Employment Support
   - a) Attack Support
   - b) Resupply/Sustainment
   - c) Scheduled Service
   - d) Support of Force
3. Retrograde Support
   - a) Evacuation
   - b) Redeployment
   - c) Extraction
4. Theater Reconstitution
   - a) Force
   - b) Civilian Sector

Deployment support includes the jobs that would be performed once a decision to mobilize has been made. This includes airlift performed prior to and after the initiation of hostilities to deploy or redeploy theater forces for battle. Employment support consists of jobs that support the deployed forces. Retrograde support includes all tasking aimed at removing incapacitated men and inoperable equipment from forward areas. Theater reconstitution of jobs involves elements of the full spectrum of deployment, employment and retrograde support, and requires airlift to and from all areas on the battlefield. (9:4-3)

The priority of each job is derived from the scenario. Job priorities are intended to reflect their relative importance rather than to represent absolute measures. (35:4-3) The form of the specific jobs data have been defined in Chapter III.

Jobs

There were 31 representative intratheater airlift jobs in the 21st century Southwest Asian scenario. (35:4-5) These are kept and used for both of the scenarios, because these jobs are typical data for an intratheater analysis and are not classified. Earlier, it was stated the data would be notional. The standard elements of the 21st century Southwest Asian jobs are used as notional data for this study with some required minor changes. The summary information of the first set of jobs is given in Appendix I. (9:4-7)

Appendix D presents the detailed items for each job type containing all the entry/delivery sites, size, weight, priority, frequency and job type information.

Conclusion

In this section the decision has been made to use two appropriate notional scenarios in the simulation program GAMM. Based on Turkey's current circumstances, a conflict in the Southeastern region and a conflict in the Western region are used. Then the entry and delivery sites were defined and data has been gathered. While doing so, no classified resources have been used. Assumptions have been identified and stated. The first research question was "Given a set of forces, support units, supply and resupply requirements and a fixed set of transportation assets, what is the closure estimate?" The set of forces to be used are the C-130 and C-160 squadrons of TAMC. The capabilities of the transportation system have been fixed at notional levels and can be seen in Appendix C. The data related to the movement items is notional, so the standard elements of the jobs files which had been used for the Southwest Asian Scenario were used for the data sets related to Turkish cargo requirements.

In the next section an analysis has been performed to address the research questions. The marginal effects of the MOG, number of aircraft, and job deletion times have been found. By using the same scenario and set of jobs data, the different types of aircraft are inserted into the scenario in order to find the number of airplanes needed to replace the aging C-130s and C-160s of TAMC. The potential replacement candidates are the Future Large Aircraft (FLA) and the C-130J. The information related to these airplanes has been gathered in order to accomplish this research and is presented in Appendix A.

The results related to the above topics are presented in the next section. Following the next section, the validation and verification of the GAMM and results of the research are discussed. Recommendations on areas for further research are also presented.

IV.2 Analysis And The Results

Introduction

This section presents the GAMM results for the example scenarios. These results are discussed to illustrate the usefulness of the model in addressing the basic research questions:

1) Given a set of forces, support units, supply and resupply requirements, and a fixed set of transportation assets, what is the closure estimate?
2) Determine the number of replacement aircraft for the aging C-160 Transall and C-130 Hercules among the candidate airplanes, namely the Future Large Aircraft and the C-130J Hercules.

If a mobility model were available to TUAF, these and other questions could be addressed.

Two scenarios and two types of jobs files have been used in this analysis. First, a situation where the requirements are higher than the capability of the current system was chosen to stress the existing airlift system, in order to explore the marginal increases/decreases of requirements delivered as the number of aircraft, service times, job deletion times, and MOG at the airbases are varied. Since the requirements exceed the capability of the existing airlift system, a 30 day scenario length did not permit closure. It is not possible to deliver all the material within a 30 day time window with the present level of airlift capacity. On the other hand, by keeping the requirements high, it is possible to see the maximum level of requirements that can be met, and the effects of the marginal increases/decreases of key factors.

Southeastern Scenario and High Requirements

The first scenario and the requirements pairing to be analyzed are the Southeastern Scenario and high requirements. The purpose of this analysis is to determine the number of replacement aircraft required to match the performance of the current fleet in this scenario.

The scenario structure and the requirements (job files) have been outlined in the previous section. If a movement item has not been delivered within its maximum lifetime, it is deleted from the system. For data analysis purposes, a run was made with relaxed job deletion times. In such a setting, it is possible to transport more cargo/passengers during the 30 day scenario. This approach allows determination of how much the system is capable of delivering. The results based on both tight and relaxed job deletion times are presented later in this chapter.

The tight job deletion times used in the analysis are (in ascending order of priority) 2.0, 2.0, 4.0, 7.0, 10.0, 30.0, 30.0, and 30.0 days. The relaxed job deletion times are assumed to be 30 days. With relaxed job deletion times, some of the cargo which had previously been deleted from the system because it had exceeded its useful life time, is transported. Thus, it was possible to determine how much throughput was possible in the system and compare the total amount of cargo delivered when the inputs are changed.

When different types of aircraft are used in GAMM, different outputs are obtained. A question is what should have been the priority of the different aircraft used? Other questions which can be investigated are: If the given service times (loading/unloading times, refueling times) actually take longer, what are the effects? If the MOG number increases by two, (for example, by adding a refueling truck, another forklift, and additional personnel) what are the effects on the throughput? How many replacement aircraft are needed, and what is the marginal benefits of the additional aircraft? All these sensitivity type questions, in the specific areas where it aids TAMC to do better airlift planning and usage of its airlift assets, are answered. Based on the analysis required to answer these questions, it was decided to use larger requirements, to facilitate the sensitivity analysis. To find the closure time a smaller level of requirements is used, where the closure time is within the 30 day window.

The service time used at a base is:

30 +/- 3 minutes: Non-maintenance ground operations to prepare an airlifter for flight (e.g. refueling and checklist application).

28.8 +/- 2.4 minutes: Loading/unloading time.

1.25: Load factor for rolling stock. (To load the rolling stock takes longer than the normal loading operation.)

0.94: Unload factor for rolling stock. (To unload the rolling stock takes less time than the normal unloading operation.)

The service time and loading/unloading times have been multiplied by 1.5 and 2.0 respectively for the sensitivity analysis. Since the base numbers are at their minimum level for a typical tactical airlift mission, levels below the base numbers have not been considered.

Table IV.1 outlines the results obtained from the Southeastern scenario and the high requirements. The numbers represent total amount of cargo (tons) delivered within thirty days relative to defined conditions. The standard base values of MOG, service time, and relaxed constraint are used unless indicated by the conditions. Initially the number of Future Large Aircraft (FLA) versus the C-130/C-160s Turkey has is presented.

Table IV.1 Southeastern Scenario Output (C-130/C-160 & FLA)

Aircraft Type	Tight Constraint	Relaxed Constrain	Service Time*1.5	Service Time*2.0	MOG + 2	MOG +3
C-130/C-160 (14+20)	21784	£2902	20386	19789	24385	24704
C-130/C-160	20976	22327	19925	16806	23600	23754
C-130=C-160	21784	22902	20386	19789	24385	24704
16 FLA	21129	21150	19325	17410	21829	22126
17 FLA	22686	22898	19875	18179	22972	22985
18 FLA	23490	23706	21267	19040	24499	24514
19 FLA	24209	25096	22207	19777	25850	25950
20 FLA	25037	25948	23088	20850	26746	26840
21 FLA	25837	26717	24284	221898	27515	27613

Figure IV.1 provides the graph of the values shown in the above table. The first graph is presented relative to the conditions, where the total amount of cargo delivered by the number and types of aircraft given the same conditions can be seen.

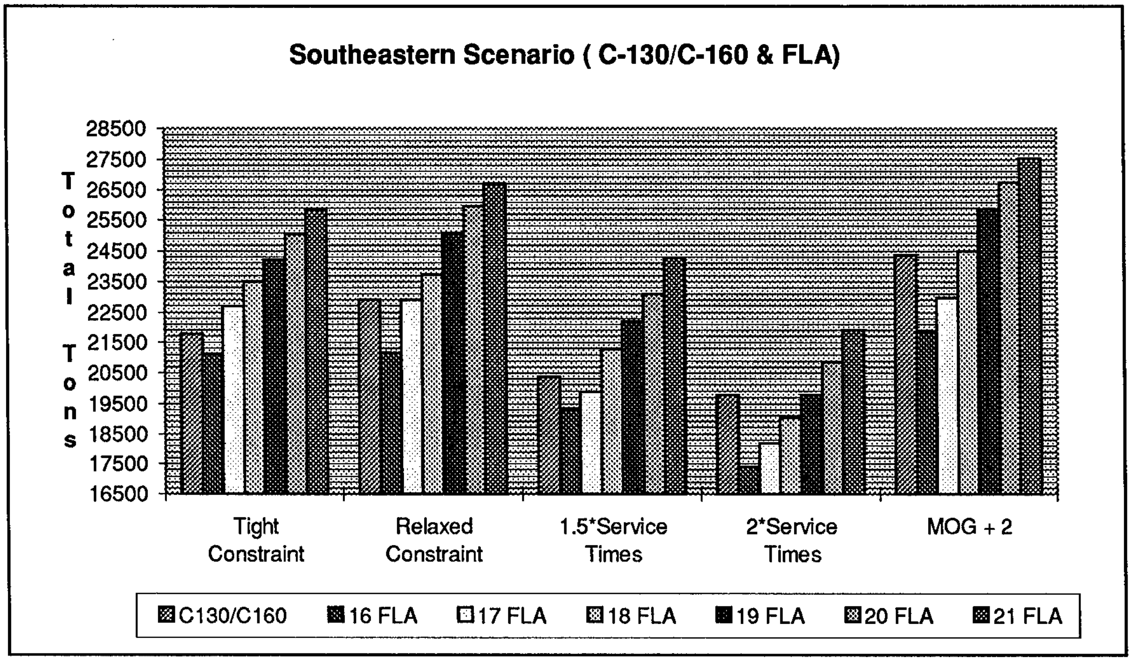


Figure IV.1 The Graph of The Southeastern Scenario Output / (C-130/C-160 & FLA under the same situations)

In Figure IV.1, the current number of C-130/C-160s versus different numbers of FLAs can be compared under the same condition or across the conditions. The comparisons are based on the amount of cargo delivered.

Figure IV.2 presents the results relative to the number and types of aircraft given the different scenario configurations. On this graph, comparisons can be made from a different point of view. In addition, from this graph the behavior of the same number and type of aircraft under the different conditions can be observed.

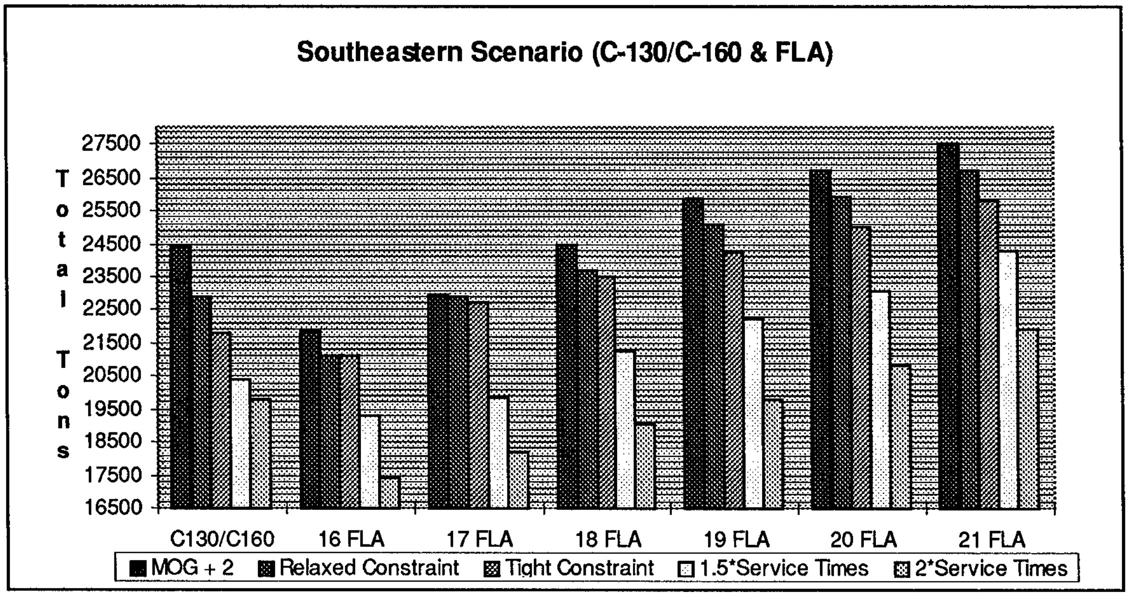


Figure IV.2 The Graph of The Southeastern scenario Output / (C-130/C-160 & FLA by type of aircraft given different conditions)

After careful analysis and inspection of these results, the following options can be presented to the key decision maker(s) for the purpose of increasing the effectiveness of the current airlift system and finding the number of replacement aircraft for the Turkish Air Force.

- Currently, priority should be given to the C-130 rather than C-160; using the C-130 accommodates delivery of more cargo under the same conditions. The amount of cargo delivered is more when the C-130 is used first. (22902 tons>22327 tons (with the relaxed constraint))
- By relaxing the maximum life time constraint, the system is able to deliver more cargo. (This observation is based on delivering greatest amount within a 30 day scenario, thus using the components of the airlift system at their maximum level.) This is reasonable if transportation occurs before the outbreak of hostilities.

- If it is believed the MOG numbers defined are low and would not be increased, then 17 Future Large Aircraft are capable of doing the same amount of delivery as the current fleet, given the same conditions.
- If the service time for the current fleet is the base amount, but the service time for the FLA is 1.5*base amount, then 20 FLA are needed in order to provide the same level of transportation within the 30 day scenario.
- If the system is able to increase the current MOG number by two, then 18 FLA aircraft are needed in order to provide the same capability as the current fleet under the same conditions.
- Further increases in the MOG number does not appear to significantly change the amount of cargo delivered. When the MOG+3 situation did not cause significant increase, the scenario was run with an experimental MOG number of 100, in order to determine the capability of the scenario set up. The greatest amount of cargo delivered was 24770 tons by using base values of service times, relaxed constraint and current fleet.
- The marginal increase in the amount of cargo delivered when there is an increase in the MOG number is greater for the C-130/C-160s than the FLAs. That is an expected outcome, since the total number of current aircraft in use is 34, but the range of the number of FLA is from 16 to 21. The effects of increases in MOG number is more important for the larger numbers of aircraft than the smaller numbers of aircraft given all other conditions stay the same.

Next, C-130J aircraft data is presented in a similar fashion. The table below represents the outputs obtained by running the simulation under the defined conditions. In this analysis, the inferences made from the Southeastern scenario including the FLA, are used to omit the tight constraint and MOG + 3 from the analysis.

Table IV.2 Southeastern Scenario (C-130J & C-130/C-160's)

Aircraft Type	Relaxed Constraint	Service Time*1.5	Service Time*2.0	MOG + 2
C-130/C-160 (14+20)	22902	20386	19789	24385
25 C-130J	22198	19610	17927	23149
26 C-130J	22774	20070	18426	23692
27 C-130J	23450	20917	18998	24393
28 C-130J	23852	21577	19557	24996
29 C-130J	24671	22305	19889	25999
30 C-130J	25334	23031	20429	26529

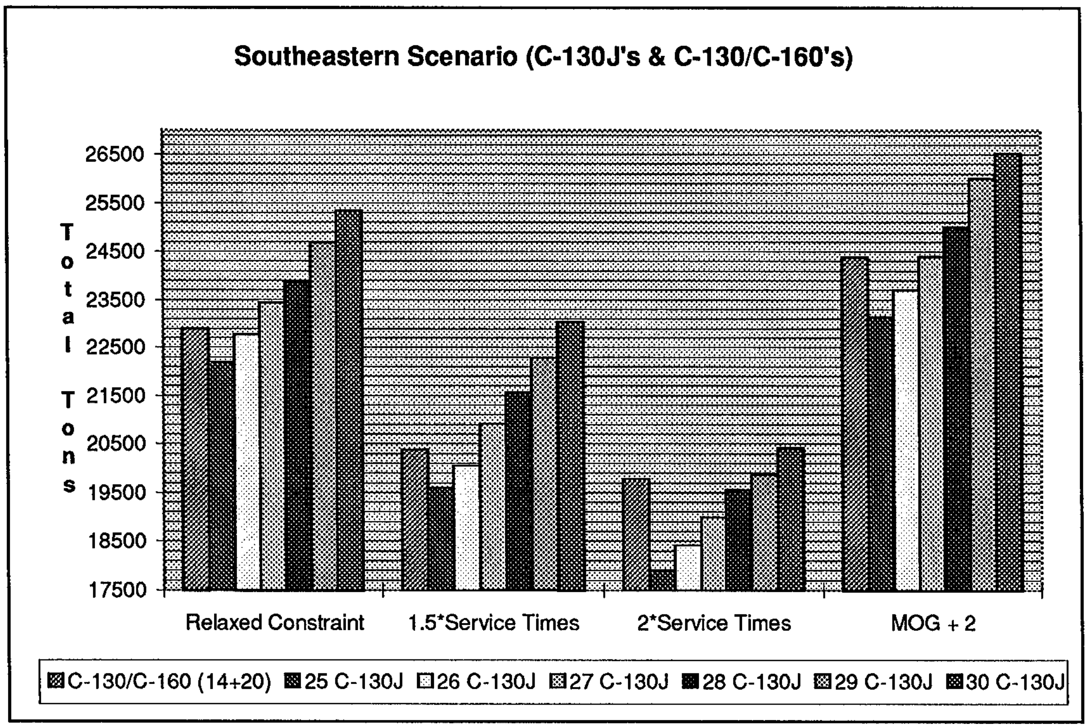


Figure IV.3 The Graph of The Southeastern Scenario Output / (C-130J & C-130/C-160 under the same conditions)

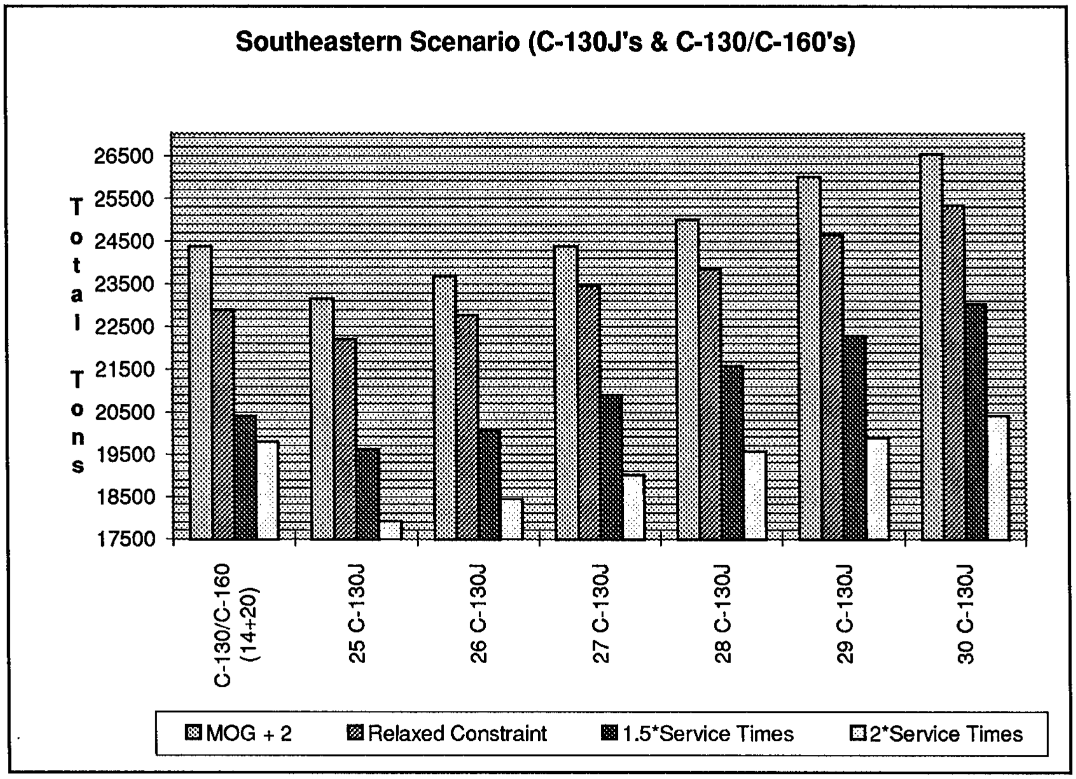


Figure IV.4 The Graph of The Southeastern Scenario Output / (C-130J & C-130/C-160 the same type of aircraft given different conditions)

After careful analysis of these results the following options were selected for presentation to the key decision maker(s) for the purpose of improving utilization of the current airlift assets and to determine the number of C-130J that will provide the same level of capability in terms amount of cargo being delivered within the 30 day Southeastern scenario.

- Under the same conditions (relaxed constraint, MOG + 2, and service time*1.5.) 27 C-130J is capable of transporting the same amount of level of cargo as the current C-130 and C-160 fleet.
- If the service time increases to 2.0 *base values, 28 C-130J provide capability equivalent to the current fleet.

Since the data used was notional, the alternatives have been given based on the different situations. To compensate for the effects of the notional data the different situations provide a spread of options. Relatively correct decisions can be made. These results support the decision to use another scenario where the MOG number is larger, and more airfields are available. The Western scenario for Turkey has these characteristics. The results obtained from Western scenario are also helpful in the next section for validation and verification. The results obtained from the Western scenario are presented next.

High Requirements and Western Scenario

When the Southeastern scenario results were inspected, the need for further analysis was obvious. Because of the low MOG numbers, the number of the replacement aircraft and amount of cargo delivered were significantly different in the Southeastern scenario.

The following table has been obtained by applying the same steps to the Western scenario that were used in the Southeastern scenario.

Table IV.3 Western Scenario (C-130/C-160 & FLA)

Aircraft Type	Tight Constraint	Relaxed Constraint	Service Time*1.5	Service Time*2.0	MOG + 2
C-130/C-160 (14+20)	24042	24538	23651	21426	24689
16 FLA	21037	21424	19357	17047	21866
17 FLA	22116	22768	20379	18237	22931
18 FLA	23250	23825	21555	19039	23912
19 FLA	24661	25409	23024	20296	25467
20 FLA	25881	26638	23570	21165	26667
21 FLA	27007	27638	24388	21974	27668
22 FLA	28040	28702	25550	23173	28824

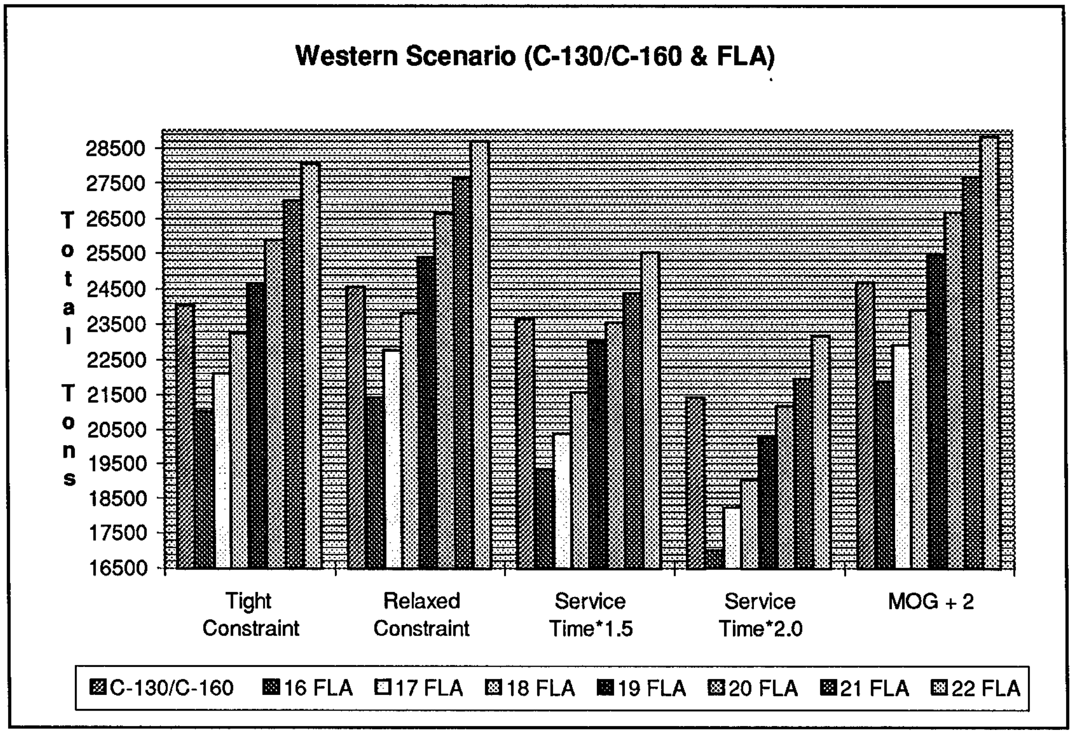


Figure IV.5 The Graph of The Western Scenario Output (C-130/C-160 & FLA under the same conditions)

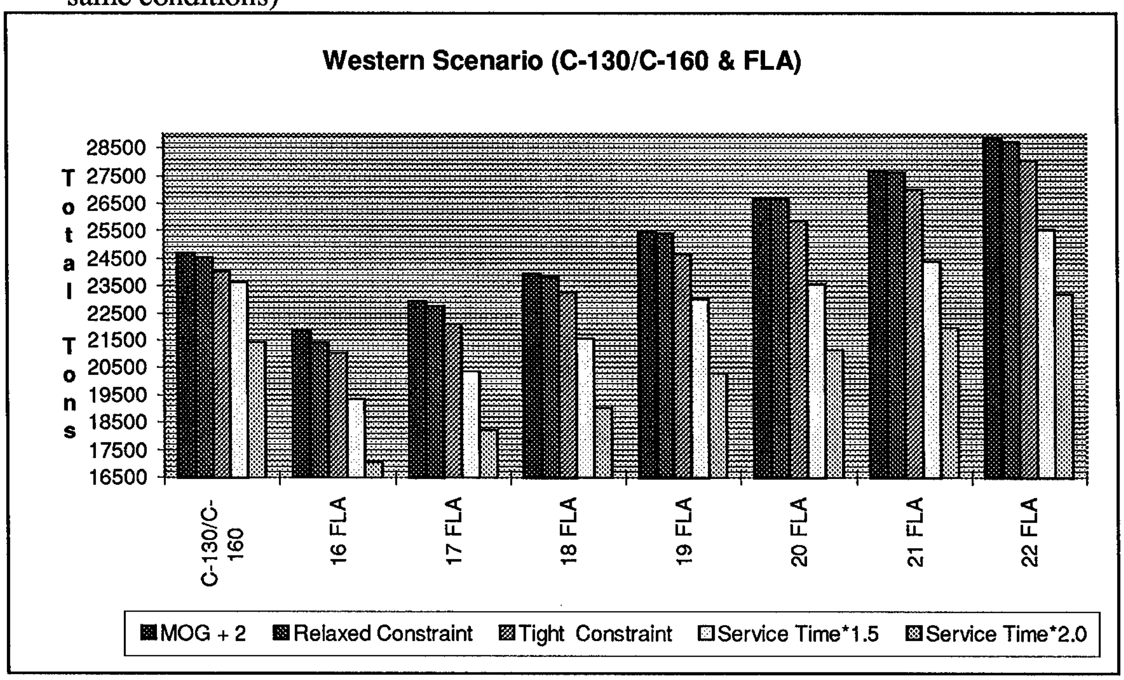


Figure IV.6 The Graph of The Western Scenario Output (C-130/C-160 & FLA the same type given different conditions)

If we analyze these tables and graphs, the following results are obtained to present to the key decision maker(s).

- Under the same situations (Relaxed or tight constraints, the same MOG number +2 level) 19 Future Large Aircraft are capable of meeting requirements at the same level as the current number of C-130/C-160s in terms of total tons of cargo delivered in a 30 day scenario.
- If the service time for the FLA is at 1.5 times higher than that of C-130/C-160's then 21 FLA deliver approximately the same amount of cargo as the C-130/C-160s.

Next the C-130J aircraft is the candidate replacement aircraft in the scenario. The following table presents the results obtained from the GAMM for the Western scenario.

Table IV.4 Western Scenario Output (C-130/C-160 & C-130J)

Aircraft Type	Relaxed Constraint	Service Time*1.5	Service Time*2.0	MOG + 2
C-130/C-160 (14+20)	24444	22151	21426	24589
25 C-130J	22843	20850	18680	22884
26 C-130J	23809	21502	19448	23948
27 C-130J	24583	22200	20154	24658
28 C-130J	25164	22893	20965	25184
29 C-130J	25950	23550	21502	25980
30 C-130J	26394	24500	22047	26446

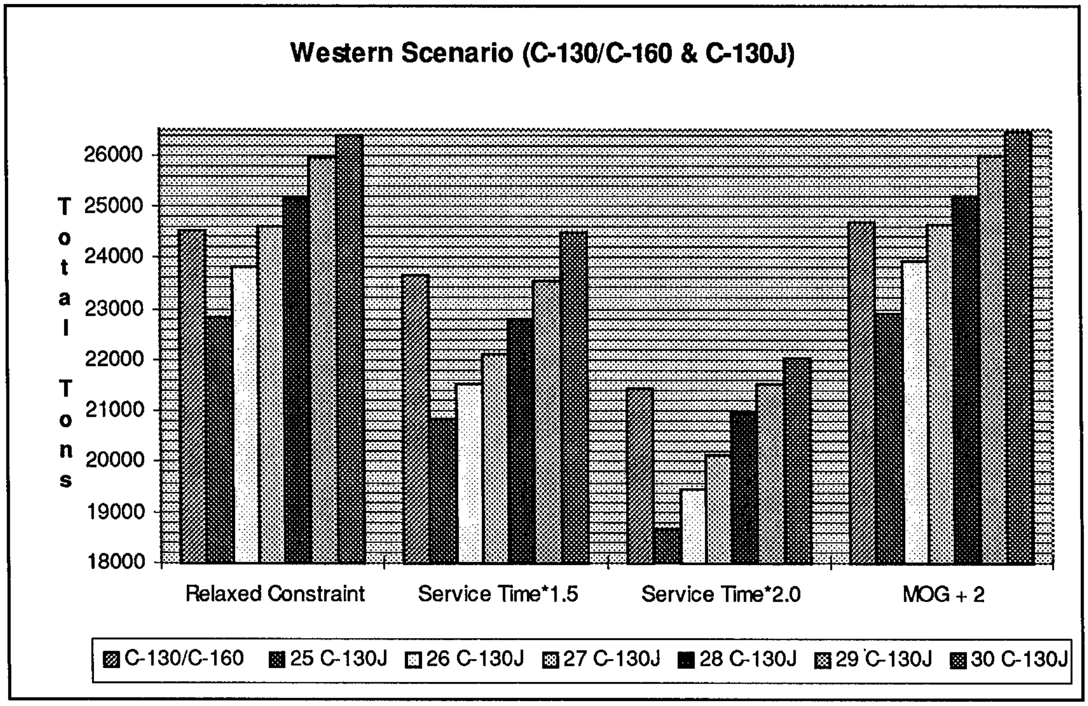


Figure IV.7 The Graph of The Western Scenario Output (C-130/C-160 & C-130J given the same situations)

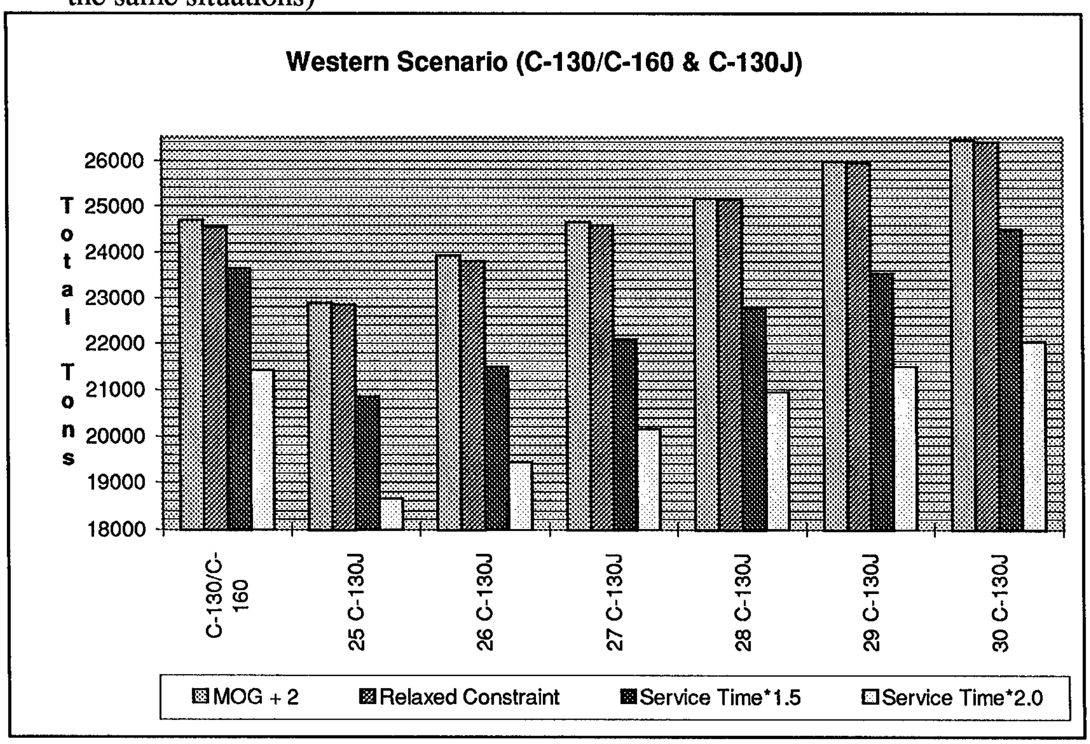


Figure IV.8 The Graph of The Western Scenario Output (C-130/C-160 &C-130J the same type of aircraft given different conditions)

If we analyze these tables and graphs, the following observations can be presented to the key decision maker(s).

- Under the same conditions (relaxed constraint, 1.5*service time, and MOG + 2) 27 C-130J will meet the requirements at the same level as of the current C-130/C-160 fleet.

Closure Times

Next the closure times are found by using a smaller amount of cargo to address the research question: "Given a set of forces, support units, supply and resupply requirements and a fixed set of transportation assets, what is the closure estimate?" The number of equivalent aircraft (19 FLA and 27 C-130J) to the current fleet found by the analysis so far, were tested using a different approach. Given that those replacement aircraft are meeting the requirements of a 30 day scenario in terms of amount of cargo being delivered. The question is "will the closure time be about the same, earlier, or later for those specific number of aircraft found by the earlier analysis?"

The first 11 jobs have been assigned priority one, and entry and delivery times are assigned for the first 10 days of the scenario. The job deletion time has been relaxed. The results presented are the latest arrival time of the movement item at the delivery site for the first 11 jobs from the original jobs set. The issue that has to be kept in mind is the two scenarios are quite different from each other. Therefore, the evaluations and the analysis have to be made within the scenario.

Low Requirements Southeastern Scenario

Table IV.5 outlines the first11 jobs used for the purpose of finding closure time.

Table IV.5 List of jobs used to find closure time for Southeastern scenario.

Job No.	Description	Pr'ty 1=Hi	Total Tons
1	UNIT MOVE, F-16 SQDN	1	522
2	UNIT MOVE, F-4 SQDN	1	814
3	ROUTINE RESUPPLY, POL/AMM	1	2401
4	UNIT MOVE, MLRS BATTERY	1	5095
5	PERSONNEL MOVE, DIVERTED	1	920
6	UNIT MOVE, HAWK BATTERY	1	1278
7	UNIT MOVE ATK HEL	1	507
8	UNIT MOVE, NBC DECON COMPANY	1	614
9	ROUTINE RESUPPLY, POL/AMM	1	512
10	AIRDROP BATTALION TASK FORCE	1	345
11	AIRLAND BRIGADE	1	659
TOTAL			13665

Table IV.6 presents the closure time for the different types and number of aircraft under the same condition.

Table IV.6 Closure Times for the Different Type of Aircraft Given the Same Conditions.

Aircraft Type and Number	Closure Time (Days)
C-130/C-160 (14+20)	15.91
16 FLA	16.18
17 FLA	15.60
18 FLA	14.71
19 FLA	14.06
20 FLA	13.84
21 FLA	13.14
25 C-130J	15.32
26 C-130J	15.07
27 C-130J	14.60
28 C-130J	13.99
29 C-130J	13.80
30 C-130J	13.58

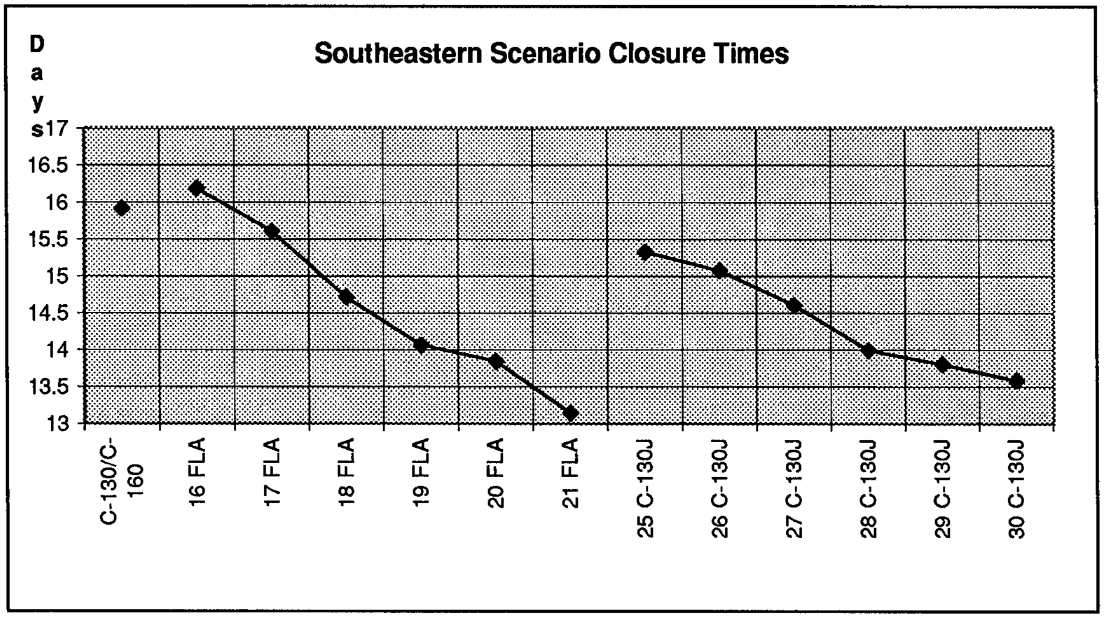


Figure IV.9 Closure Times for the Different Types of Aircraft Given the Same Conditions.

Table IV.6 clearly demonstrates that both candidate aircraft (19 FLA and 27 C-130J) have better closure times than the current fleet.

Low Requirements Western Scenario

Table IV.7 outlines the first 11 jobs from the Western scenario jobs used to find the closure time for the different types and number of airlift assets.

Table IV.7 List of Jobs Used to Find Closure Time for Western Scenario

Job No.	Description	Pr'ty 1=Hi	Total Tons
1	UNIT MOVE, F-16 SQDN	1	522
2	UNIT MOVE, F-4 SQDN	1	814
3	ROUTINE RESUPPLY, POL/AMM	1	1757
4	UNIT MOVE, MLRS BATTERY	1	4318
5	PERSONNEL MOVE, DIVERTED	1	920
6	UNIT MOVE, HAWK BATTERY	1	1277
7	UNIT MOVE ATK HEL	1	693
8	UNIT MOVE, NBC DECON COMPANY	1	111
9	ROUTINE RESUPPLY, POL/AMM	1	224
10	AIRDROP BATTALION TASK FORCE	1	1062
11	AIRLAND BRIGADE	1	968
TOTAL			12665

Table IV.8 has been obtained in the same way.

Table IV.8 Closure Times for the Different Types of Aircraft Given the Same Conditions.

Aircraft Type and Number	Closure Time(Days)
C-130/C-160(14+20)	18.92
16 FLA	14.96
17 FLA	13.99
18 FLA	13.97
19 FLA	12.69
20 FLA	11.74
21 FLA	10.86
22 FLA	10.21
25 C-130J	15.97
26 C-130J	14.51
27 C-130J	14.11
28 C-130J	13.95
29 C-130J	13.70
30 C-130J	13.43

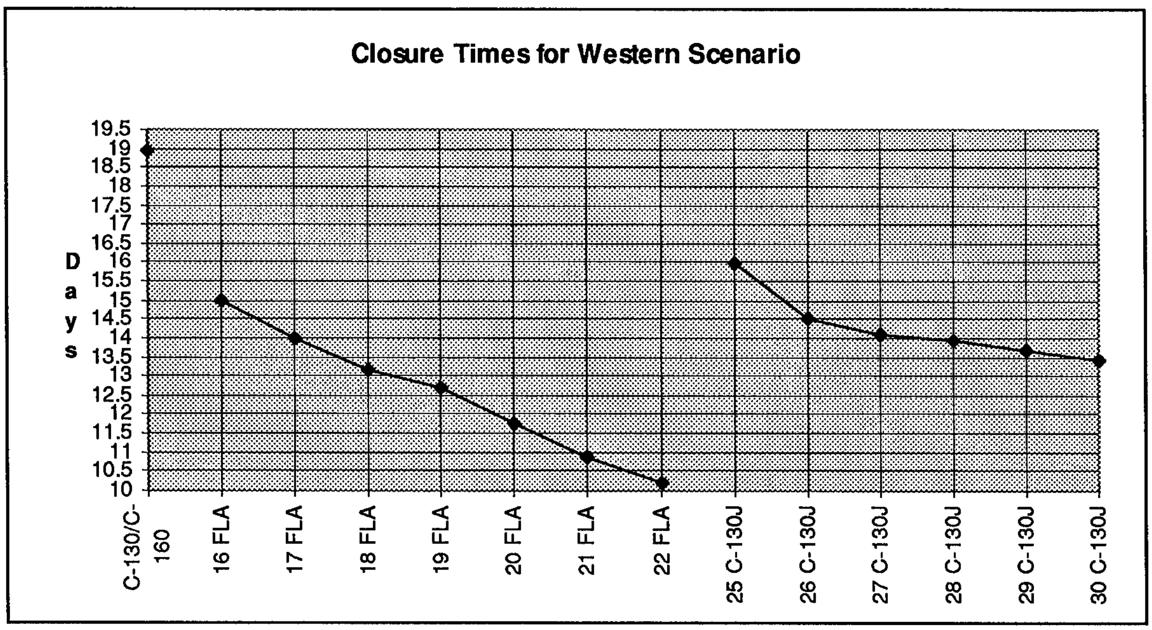


Figure IV.10 Closure Times for the Different Types of Aircraft Given the Same conditions.

If we examine these results, again both candidate aircraft have earlier closer times than C-130/C-160s. The 19 FLA have superiority over the current fleet and 27 C-130J in the closure time dimension.

Metamodeling

A regression model is a formal means of expressing the two essential ingredients of a statistical relation. A statistical relation, unlike a functional relation, is not a perfect one. (45:4-6) The simulation output (total tons) is related to the number of aircraft. Our goal is to approximate this relationship by a simpler mathematical function called a metamodel. In most cases, the functional relationship is unknown, and the analyst must select an appropriate function containing unknown parameters, and estimate those parameters based on a set of data (Y,x). Regression analysis is one method for estimating the parameters. (44:514)

For estimating the amount of cargo delivered for a typical thirty day scenario used in this study, the regression models of interest are established. (See Appendix G for calculations) Thus, for a specific required level of cargo, the number of aircraft can be predicted from the established metamodel.

Y = Amount of delivered cargo for a thirty day scenario used in this study.

x = The number of aircraft.

As an application, the level of cargo is chosen at 36800 tons (which was the amount of cargo for the high requirements), and the number of aircraft to deliver this amount is presented in table IV.9. The conditions were base values for MOG, service times and relaxed constraint for job deletion times.

Table IV.9 Metamodels

Condition	Metamodel	Number of Aircraft
Southeastern Scenario FLA	Y = 3969 + 1096 x	29.9 → 30
Western Scenario FLA	Y = 1220 + 1265 x	28.1 → 29
Southeastern Scenario C130J	Y = 6606 + 622.086 x	48.5 → 49
Western Scenario C-130J	Y = 5337 + 707.4 x	44.5 → 45

Testing for significance of the regression models established are presented in Appendix G. All the metamodels met the criterions for goodness of fit.

When answering the question for Turkish Air Force "What is the number of aircraft required to close the high requirements jobs file (Total of 36800 tons) among the candidate replacement aircraft?", the above estimates can be used for the current scenarios. The above numbers have been confirmed by actually using them in the scenario file, and the amount of delivery and closure time were achieved with these predicted numbers.

Conclusion

This chapter was presented in two sections. In the first section, the scenario and jobs files have been outlined, the reasons for using these two scenarios and the jobs files have been explained. The overall assumptions have been stated. In the second section, the GAMM has been used to answer the research questions and to answer additional questions whose answers should help TAMC accomplish better airlift planning and use its airlift assets better. The findings were presented based on the two scenarios and the requirements under different conditions. In the next section, GAMM is validated and verified. Further research areas related to this study are also addressed.

V. VALIDATION , VERIFICATION AND RECOMMENDATIONS

Introduction and Definitions

This chapter presents the validation and verification of the GAMM model and the insights they provide. Overall evaluation of the study and further recommendations are also presented.

One of the most important problems facing a simulation analyst who uses model outputs to aid in making recommendation(s) (or decision(s)) is that of trying to determine whether or not a simulation model is an accurate representation of the actual system being studied, i.e., whether or not the model is valid. If a model is not valid, then any conclusions derived from the model could be in error. (15:298)

Verification is concerned with building the model correctly. The purpose of model verification is to make sure that the conceptual model is reflected accurately in the computerized representation. (2:1-2)

Validation determines whether or not the conceptual model (as opposed to computer program) is an accurate representation of the system under study. (15:299)

> Validation is concerned with building the right model. It is used to determine that a model is a reasonable and accurate representation of the real system. Validation is usually achieved through the calibration of the model, an iterative process of comparing the actual system behavior and using the discrepancies between the two, and the insights gained, to improve the model. This process is repeated until model accuracy is judged to be acceptable. (2:400)

Discrete event systems simulation is the modeling of systems in which the state variables change instantaneously at separate points in time. (The system changes at only a countable number of points in time.) (2:13)

GAMM is an event-driven simulation written in the SIMSCRIPT II.5 programming language. SIMSCRIPT is an event-oriented simulation language, modeling an object (entity) and sequence of actions (events) it experiences throughout its simulated life. An event-oriented simulation is an ensemble of data structures, each of which describes the status, or state, of each entity being simulated. Interactions involving changes of state of entities are defined as events and are assigned to take place at discrete points in time called event times. (10:24)

Verification

Limited directly related documentation is available on the verification and validation of GAMM. However, a number of documents provide some insight about the extent of verification and validation of GAMM. The GAMM Programmers/Analyst's Manual(10) provided extensive detail about the logic used within the model. Section 3 of this manual describes the most significant software events and routines, and supplemented these descriptions with flow charts that showed the way the actual coding of the event or routine had been carried out. (21: Sec3)

Another formal verification of GAMM was conducted in early 1992 by General Research Cooperation(GRC) and Ball Systems Engineering Division(BSED). Under TASK 0008 of the Future Theater Airlift Studies Southwest Asia Scenario: GAMM Data File Generation, GRC and BSED were contracted to conduct an extensive review of the data base used for the SWA scenario. (35:iii) Along with the review, verification of certain algorithms within the GAMM code was done. Some improvements have been achieved.

GAMM is used in this research as a discrete-event simulation. All related probabilities, where randomness becomes a player, are assigned to 1.0. These are the probabilities of combat attrition. If these probabilities were not assigned a value of 1.0

then the results will vary. If an aircraft was lost on the first day of the simulation versus the 29th day, a significant differences in the output for the individual runs of GAMM would occur. As long as the inputs are reasonable, the output which was created according to the input data was also reasonable. Throughout one run of a scenario there are thousands of simulated times. Each time an airlifter lands and is serviced, the associated times used to determine the turn-around time(loading/unloading, service, and maintenance times) for that specific flight are determined according to the random number generator. During one single run, there are several thousand landings, so these turn-around times are averaged. To test the reasonableness of this approach, on the different stages of the application with different scenario set ups, multiple runs (10 replications) have been made. The results did not differ significantly between a single run and multiple runs as seen in Table V.1. (The decision (number of aircraft) changes at the magnitude of slope the regression equation obtained for each different types of aircraft.) The standard deviation was about 200 tons. (For exact calculations see appendix F) Legend: W = Western Scenario, S = Southeastern Scenario, C. Fleet= Current Fleet, Unit=Tons.

Table V.1 Single Run versus Multiple Runs. (10 Replications)

Condition	One Run	Mean of Multiple Runs	Standard Deviation
W 22 FLA (10 Days)	8421	8389	145
W 27 C-130J (30 Days)	24583	24612	224
W 34(C. Fleet) (30 Days)	24538	24737	205
S 34 (C.Fleet) (30 Days)	22902	22806	200
S 19 FLA	25096	24988	177

Figure V.1 presents graph of these results.

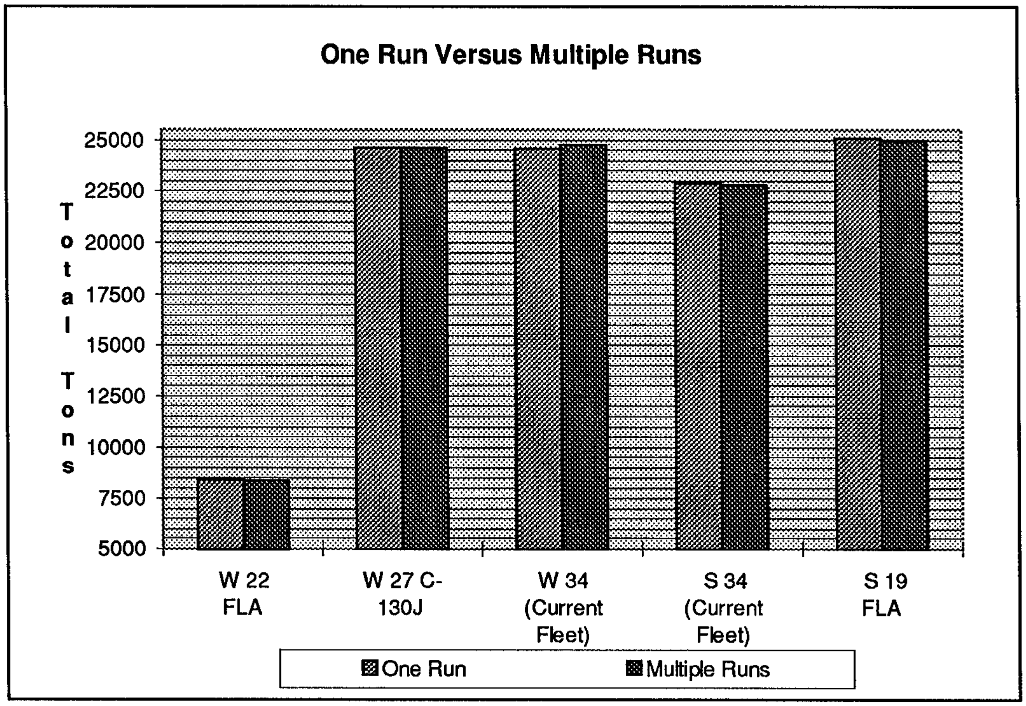


Figure V.1 Graph of One Run versus Multiple Runs.

As reviewed earlier Paul Pappas (25) used GAMM for his study. His research topic was to identify specific tactical airlifter characteristics which, when improved, produce the greatest improvement in tactical airlift capability. To decide the required number of replications for his study, he made 10 runs and inspected the results. In all his calculations he has chosen α as (1 - 0.95), for accuracy level ε to be 1% to 5% of the mean. He used the formula for the minimum number of replications.

$$R \geq (t_{\alpha/2,n-1} S_0 / \varepsilon)^2$$

R = Required Number of Replications, S_0 = Sample Standard Deviation.

Beginning from runs 1 and 2, a sample mean and a sample standard deviation were calculated. Next, the results from runs 1, 2 and 3 were used to calculate another sample mean and standard deviation. He continued until all 10 runs were included. Table V.2 indicates the results.

Table V.2 Required Number of Replications

Number of Cum. Runs	Parameters	Tons Delivered	Number of Runs Required
2	Mean	5833.00	130.91
2	Std. Dev.	104.65	
3	Mean	5796.00	13.03
3	Std. Dev.	97.51	
4	Mean	5797.50	4.75
4	Std. Dev.	79.65	
5	Mean	5795.00	2.73
5	Std. Dev.	69.20	
6	Mean	5794.50	1.87
6	Std. Dev.	61.91	
7	Mean	5799.57	1.49
7	Std. Dev.	58.09	
8	Mean	5810.62	1.60
8	Std. Dev.	62.20	
9	Mean	5808.77	1.34
9	Std. Dev.	58.45	
10	Mean	5810.70	1.16
10	Std. Dev.	55.44	

In general, if the value for the number of runs required is less than the number of runs used in the sample, then the required level of accuracy will be achieved.

He concluded five replications were needed to achieve an accuracy of 2% for the confidence level of 95%. For detailed information, interested readers should refer to his thesis (25: Section IV).

Using this guidance from a prior research effort the above assumption has been tested statistically. Different conditions of interest for the research runs are taken as sample conditions. Mathcad 6.0 software is used for calculations. Table V.3 presents the confidence interval at $\alpha=0.05$ (95 % confidence interval). Unit = Tons. See Appendix G for calculations.

Table V.3 95 % Confidence Interval For Five Replications

Condition	Confidence Interval	Interval Length	2 % of the Mean
S.eastern Scenario Current Fleet	22678-23133	455	458
S.eastern Scenario 19 FLA	24923-25093	170	500
S.eastern Scenario 27 C-130J	23360-23725	365	459
Western Scenario Current Fleet	24465-24788	323	492
Western Scenario 19 FLA	25256-25623	367	508
Western Scenario 27 C-130J	24363-24750	387	491

These results confirm Pappas' findings.

To reduce the effects of randomness on the results, the recommendations which are related as decision making alternatives are presented by giving a 95 % confidence interval for five individual runs. Thus, the risk involved with recommendations are also presented to the decision maker(s).

Closure times were more sensitive to the multiple runs. For this reason, for the alternatives of interest closure times are presented based on 10 replications at a 95 % confidence level. Table V.4 outlines the results.

Table V.4 95 % Confidence Interval for Closure Times

Condition	Confidence Interval	Mean	Standard Deviation
S.eastern Scenario Current Fleet	15.98-16.29	16.13	0.43
S.eastern Scenario 19 FLA	14.25-14.40	14.33	0.20
S.eastern Scenario 27 C-130J	14.92-15.29	15.11	0.51
Western Scenario Current Fleet	18.72-19.41	19.07	0.48
Western Scenario 19 FLA	12.38-12.68	12.52	0.20
Western Scenario 27 C-130J	14.24-14.52	14.38	0.39

Banks (2:401) suggests eight steps for the model verification process. These steps are explored one by one for the verification of the GAMM in its application to the Turkish air mobility problem. These are chosen because the user, as well as the model developer, can go through these steps in order to verify the model and these steps are specifically defined for the discrete event simulation.

1. To have the computerized representation checked by someone other than its developer. This is done by the author of this study. The model has also been reviewed in the Mobility Modeling Course offered at the Air Force Institute of Technology by a group of students which included the author.

2. Make a flow diagram which includes each logically possible action a system can take when an event occurs, and to follow the model logic for each action for each event type is another step suggested by Banks. For this purpose a manual flow diagram (Table V.5) is offered.

   The objective is to transport 10 tons from Diyarbakir to Catalca

Table V.5 Manual Flow Chart (Maintenance is not played in this flow chart.)

	Turn Around Time (Service + Loading + Unloading)(min.)	Flight Time + Taxi Time (min.)	Transshipment Time (min.)
Originating Base	87.6 +/- 7.8	84	15
Destination Base	87.6 +/- 7.8	169	173

This table is for one airplane. Since priority is given to the C-130, we would schedule a C-130 to fly from home base Kayseri to Diyarbakir-Istanbul and back to home base. Of course, for the closure time we only consider the time of latest arrival of the item to delivery site. When we add these numbers (the base values) to find the closure time .

Closure Time = 87.6 + 84 + 15 + 87.6 + 169 + 173 = 616.2 minutes or 0.427 (Days).

The same data was run by GAMM. The result was 0.43375 (Days). There was exactly one C-130 aircraft scheduled, and the total amount of cargo was consistent with the input value of 10 tons, the landings, times and so forth. Everything was as expected.

3. At this step, the model is examined for reasonableness of output under a variety of settings for the input parameters. GAMM had a wide variety of output statistics enabling the user to check for reasonableness. As presented in the previous chapter, a number of input settings were used, and each time, the output was reasonable.

4. Computerized representation should print the input parameters at the end of the simulation to be sure that these parameters have not been changed inadvertently is another step suggested by Banks. The backbone of model validation and verification is the output. A variety of output enables the analyst to examine the model for reasonableness. These outputs are summarized at Appendix E, and some sample printouts are included in Appendix E. (Because some of these output are several hundred pages long.) For further detail, interested readers should refer to the GAMM User's Manual (11). During the process of preparing the scenario and jobs files, the output products (defined in Appendix E) are used widely. When the output was not reasonable, the inputs were inspected and mistakes were corrected. Besides the output, all the inputs are available at the end of the simulation in an easy to read format. Thus, the user is able to check for correctness of the inputs, and that also helps for verification purposes.
5. The computer representation of GAMM is made as self-documenting as possible. A precise definition of every variable used, and a general description of the purpose of each major section of code was given by the model builders.
6. If the computer presentation is animated, verifying that what is seen in the animation imitates the actual system is another step recommended by Banks. The GAMM Animator is a graphical software utility developed to support the analysis of airlift event information generated by GAMM. Graphical interfaces are recommended for accomplishing verification and validation. When the animation is initiated, the input data is read in and the graphical user interface is established. This interface allows the

user to control the display to maximize the utility of the program. The primary function of the program is to graphically play back the airlift events scheduled during the GAMM simulation. The display provided the user a high level view of the area in which the scenario is located including a layout of the airbases and entry/delivery sites defined in the scenario file.(21:30) It was possible to see the placement of the entry/delivery sites on the map, and aircraft flying from originating bases to destination bases and back as scheduled by GAMM. GAMM worked exactly as expected.

7. Banks suggests that the Interactive Run Controller (IRC) is an essential component of successful simulation model building. The IRC assists in finding and correcting errors in the following ways:

   (a) The simulation can be monitored as it progresses.

   (b) Attention can be focused on a particular block, or a particular entity.

   (c) When the simulation is paused, values of selected model components can be observed.

   (d) When the simulation is paused, it is possible to reassign values, or redirect entities.

   GAMM is a user interactive model; it can be paused, and events can be observed at that time. The simulation can be monitored while running as well. During input, a specific output can be defined for a specific time of the simulation, which gives the opportunity to focus on a particular entity, or check on the parameters of interest.

8. The last step suggested by Banks is to have graphical interfaces for accomplishing verification and validation. At the end of a run of GAMM, the graph of supply versus

demand is presented over the life of the simulation on a day by day basis. This simplifies the task of understanding the model.

Validation

Verification and validation, despite differences in concept, should be conducted simultaneously by the modeler. As mentioned above, validation is the overall process of comparing the model and its behavior to the real system and its behavior. Calibration is the iterative process of comparing the model to the real system, making adjustments (or even major changes) to the model, comparing the revised model to reality, making additional adjustments, comparing again, and so on. (2:406)

Both Kelton and Law (15) and Banks (2) suggest three basic steps in model validation:

1. To build a model that has high face validity, i.e., a model that, on the surface, seems reasonable to people who are knowledgeable about the real system being simulated. The continued use of GAMM by ASC/XRE, AMC (Air Mobility Command), Lockheed Aeronautical Systems Company, Boeing Military Aircraft Company, and Douglas Aircraft Company has resulted in an on going process of face validation and improvement of the model. (25:61) Wide dissemination of the GAMM provides a vehicle for communication between DoD, contractors, and foreign allied countries involved in the development of advanced concepts. (10:3) Those users continually evaluate model output for reasonableness, and aid in identifying model deficiencies. Thus, the users were involved in the calibration process as the model iteratively improved based on insights gained about the initial model deficiencies. GAMM has

evolved from a simplistic tactical airlift model to a more elaborate and more realistic model of a future tactical airlift system. With each major change to the model, a new version was released. (11:1)

2. Model assumptions should be validated. The model assumptions can be classified as structural assumptions and data assumptions. Structural assumptions deal with how the system operates and reflects reality. (2:408) As discussed earlier, the model reflects a tactical airlift system and its components fairly well.

   Data assumptions should be based on the collection of reliable data. The data used for this study is obtained from reliable sources and cited as necessary. The jobs used for this study were compiled and reviewed by a Jobs Working Group (JWG).

   > The JWG is comprised of members from the Air Force acquisition, Air Force airlift, Army transportation, Army doctrine, Army aviation, and airframe manufacturer communities. The information among the services and industry concerning the interchange of information among the services and industry concerning the conjunction with other working groups (such as the Cargo Handling Working Group), assisted in the definition of assets, deployments, capabilities, and concept of operations to be depicted within the scenario. (9:1)

   Another important step during the validation of model assumptions is sensitivity analysis. (15:310) The simulation output changed significantly and reasonably when the value of an input parameter was changed.

3. The third step in model validation is to determine how representative the simulation output is. The ultimate test of a model is the model's ability to predict the future behavior of the real system. (2:409) This can be done comparing the model output with the historical data available about the system being simulated. No historical data available for the Turkish Air Mobility Command, but this step is highly recommended

for the potential user(s) of the model to compare model output with available historical data.

Another step taken for validation of the results was using two different scenarios and comparing the results obtained. Table V.6 presents the results obtained from the two scenarios used in this research.

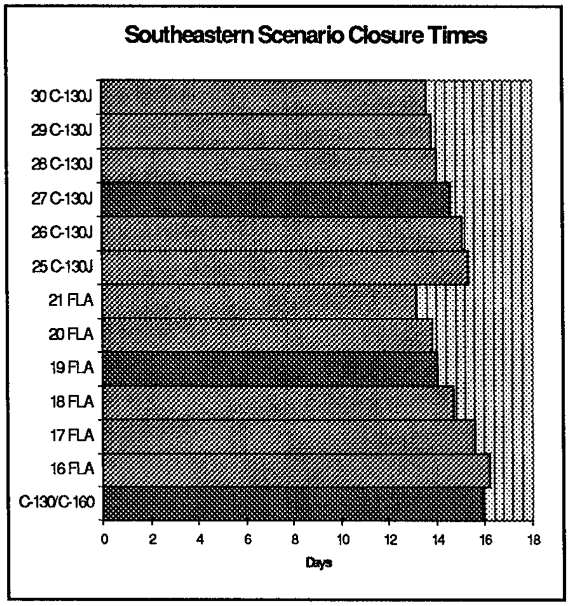
Table V.6 Comparison of Scenarios

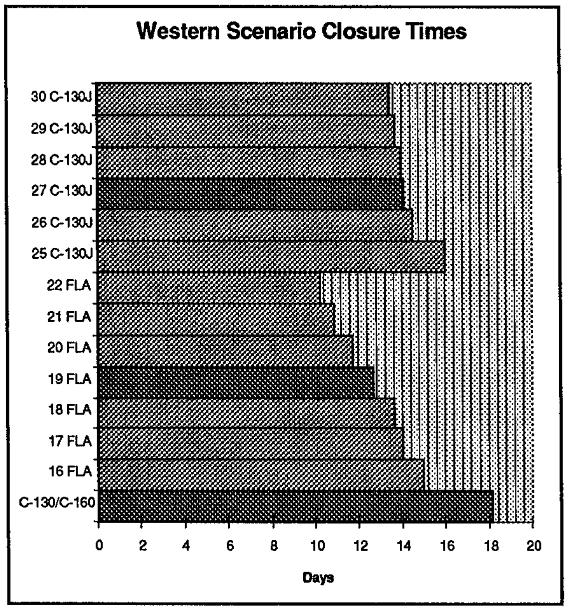
Conditions	Fleet	Southeastern Scenario	Western Scenario
Relaxed	Current & FLA	17 FLA	18 or 19 FLA 19 was selected.
MOG + 2	Current & FLA	18 FLA	18 or 19 FLA 19 was selected.
Relaxed	Current & C-130J	27 C-130J	27 C-130J
MOG + 2	Current & C-130J	27 C-130J	27 C-130J

As seen in the comparison table the outcomes of the two different scenarios are not too different, and the results are reasonable. The final numbers for the replacement aircraft to maintain the same capability as the current fleet under the same conditions in terms of amount of cargo being delivered in a 30-day scenario are 19 FLA or 27 C-130J.

The closure times were better for the C-130J's and FLA's compared to that of the current fleet in both scenarios, thus confirming the validity of the results. Table V.7 presents the closure times for various fleets in each scenario.

Table V.7 Closure Times





As seen on the above graphs, the closure time for the current fleet took the longest, 19 FLA shortest, and 27C-130J is between current fleet time and 19 FLA in both of the scenarios. Again the results were consistent.

Besides answering the research questions, additional information gained from analysis carried out so far which aids in a better utilization of the airlift assets and for planning of future airlift needs are:

1. Crew ratios are obtained from the output.
2. Flight schedules for the airlifters are given at the end of the simulation.
3. Total time each airlifter spends in the maintenance stages are given. The definitions related to these output and all the additional outputs are presented in appendix E.
4. The metamodels established to predict the number of aircraft needed to achieve a desired amount of delivery.

Conclusion

This research has shown how to determine the capability of an airlift system. By following the methodology used in this research, with real input data, potential user(s) can determine whether or not they are able to meet the requirements with the current fleet, and if not, can determine how many more and what type of additional aircraft are needed in order to meet their requirements. If there is an existing airlift shortage, it can be detected by using the procedure used in this study. It has been shown that GAMM is an appropriate model to meet TUAF airlift planning needs. It is highly recommended TUAF obtain GAMM or a similar model. The GAMM is owned by the USAF. Direct and indirect costs have to be taken in account while evaluating the ownership of GAMM.

Recommendations for Further Research

1. The results obtained from this research must be combined with the cost-effectiveness of the alternative configurations of interest. While doing so, one fact which should not be ignored is that, these decisions are based on meeting the same level of performance in terms of the amount of cargo delivered for a 30-day scenario. According to the priorities of the decision maker or system requirements, some sort of goal programming or weighting scheme might also be incorporated into the analysis.
2. This study is based on airlift capabilities of the current fleet of the Turkish Air Force The Civil Reserve Air Fleet (CRAF) is not included. A study which includes the CRAF is recommended.

3. A study similar to that of Oglesby's (33) where trucks, trains and railroad transportation, as well as airlift, are included should be carried out for Turkish Air Mobility Command (TAMC).
4. In the process of defining the airlift jobs, air refueling is not considered as a player for the TAMC. This issue is highly recommended for future analysis, where airlift is a player.
5. Acquisition and support cost of GAMM (and other available models) should be investigated.

Appendix A: The Information about Airplanes Used in the Study

The Airplanes Used In The Scenario

Since the type of airplane and their capabilities are very important, the information related to those airplanes which have been used in this research is presented.

Future Large Aircraft (FLA) (WWWeb:8)

Type: Military transport.

Country (Land) : Belgium, France, Germany, Italy, Portugal, Spain, Turkey, UK

Manufacturer : Airbus Military Company (a division of Airbus Industry; not yet fully established)

General

Crew:3 (Pilot, copilot, loadmaster)

Freight :All sorts of cargo, including Tiger helicopters, armored transport vehicles, six Land Rovers, Roland SAM system, eight palettes (108 x 88 inch) and containers. 96 paratroopers.

Power plant : 4 x turboprops. Candidates include

•Snecma/MTU M138, derived from the M88 core

•BMW Rolls-Royce BR715 TP, derived from the BR710

Allied Signal LP812M, extrapolated from the F124/LF507

Power: approximately 9000 shp (6700 kW)

Dimensions

Length: 42.00 m

Height: 14.50 m

Span: 41.4 m

Wing area: 188 sq m

Cargo hold width: 157.48 inches (4,00 m)

Cargo hold height: 151.57 inches (3,85 m)

Cargo hold length: 679 inches (17,25 m)

Floor area: 89 sq. m

Cargo Volume: 342 cu m

Weights :

Empty weight : 58 tons

Max. payload :55115 lb. (25 tons)

Overload :70547 lb. (32 tons)

Max. fuel: 61800 liters

Max. take-off weight: 110 tons

Performance

Max. cruise speed: 735 km/h (Mach 0.68 - Mach 0.72)

Range : 4800 km (2650 NM) with 20 tons payload; 3700 km (2000 NM) with 25 tons

Endurance: 6 hrs on patrol 1000 NM (1800 km) from base (proposed maritime patrol variant).

Take-off field length: 1350 m at 110 tons

Customers: None yet. Requirement of around 290 aircraft in the partner countries, but political support still uncertain, especially in France

Competitors: Lockheed Martin C-130J Hercules.

Remarks: Struggling to get off the ground for at least a decade, FLA still has no firm commitment from the partner governments. Industry is trying to put together a favorable financing proposal at the moment. Next the information about the C-160 Transall and C-130 Hercules are given.

C-160 Transall (WWWeb:21)

The Transall C-160 is a French-German co-production aircraft designed as a low-cost alternative to the US C-130 Hercules cargo/transport aircraft. Transall is derived from Transporter Allianz, the French-German company group formed in 1959 to produce the aircraft. It has good Short Take-Off and Landing (STOL) performance and can be operated from austere forward bases. The aircraft is highly regarded for its STOL capability and C-130 size cargo hold. Its principle limitation is its relatively short range with payload.

Status: Initial operational capability (France) in 1965; first flight on 25 February 1963. 169 produced from 1963 to 1972. Production line reopened in 1977 to manufacture 29 more aircraft for the French Air Force; deliveries completed in 1985. In September 1992, the South African Air Force announced the phase-out of its 9 Transalls for budgetary reasons.

Users: France, Germany, Turkey.

Characteristics:

Crew: Five (two pilots, a navigator, flight engineer and loadmaster)

Engines: 2 Rolls-Royce Tyne Rty-20 Mk 22

Internal fuel capacity: 5,033 US gal (19,050 liters)

Weights

Empty: 61,730 lb. (28,000 kg)

Max payload: 35,275 lb. (16,000 kg.)

Max take off 112,435 lb. (51.000 kg.)

Dimensions

Wing Span: 131 feet. 3 inches (40 m.)

Length: 106 feet. 3 ½ inches (32.40m.)

Height: 38 feet 2¾ inches (11.65 m.)

Cabin (Length (including ramp), Width, Height): (56 ft.6 inches (13.51 m.), 10 feet 3 ½ inches (3.15 m.), 9 feet. 8 ½ inches (2.98 m.)

Performance

Max speed: 277 kts.

Econ speed: 245 kts.

Ceiling: 27,000 feet.

Range with 17,460 lb. (8,000 kg.) payload 2,750 nm, With 35,375 lb. (16,000 kg.) 1,000 nm.

C-130 Hercules (WWWeb:22)

The Hercules is the most versatile and widely flown military transport to enter service in the post-World War II era. It is a 4-engine, medium turboprop transport used for passengers and cargo, paratroops, aerial refueling, Search and Rescue (SAR), Electronic Warfare (EW), combat command and control, communications relay (TACAMO), and as a gunship.

The C-130 Hercules primarily performs the intratheater portion of the airlift mission. The aircraft is capable of operating from rough, dirt strips and is the prime transport for paradropping troops and equipment into hostile areas.

In its personnel carrier role, the C-130 can accommodate 92 combat troops or 64 fully equipped paratroops on side-facing seats, cargo can include five 463L pallets. For medical evacuations, it carries 74 litter patients and two medical attendants. Paratroopers exit the aircraft through two doors on either side of the aircraft behind the landing-gear fairing. Another exit is off the rear ramp for airdrops. The C-130 Hercules accomplishes mercy flights throughout the world, bringing in food, clothing, shelter, doctors, nurses and medical supplies and moving victims to safety.

Users: USA, Algeria, Argentina, Australia, Belgium, Bolivia, Brazil, Cameroon, Canada, Chad, Chile, Colombia, Denmark, Ecuador, Egypt, France, Gabon, Great Britain, Greece, Honduras, Indonesia, Iran, Israel, Italy, Japan, Jordan, South Korea, Kuwait, Libya, Malaysia, Mexico, Morocco, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Peru, Philippines, Portugal, Saudi Arabia, Singapore, South Africa, Spain, Sudan, Sweden, Taiwan, Thailand, Tunisia, Turkey, United Arab Emirates, Venezuela, Vietnam, Yemen, Zaire.

General Characteristics

Primary Function: Intratheater airlift.

Contractor: Lockheed Aeronautical Systems Company.

Power Plant: Four Allison T56-A-15 turboprops; 4,300 horsepower, each engine.

Weights

Empty: 76469 lb.

Max payload: 42673 lb.

Max take off: 175000 lb.

Normal Take off: 155000 lb.

Dimensions

Length: 97 feet, 9 inches (29.8 meters).

Height: 38 feet, 3 inches (11.66 meters).

Wingspan: 132 feet, 7 inches (40.41 meters).

Cargo hold

length: 40 feet 1 ¼ inches (12.22 m)

width: 10 feet 3 inches (3.30 m.)

height: 9 feet 2 ¾ inches (2.81 m.)

Speed: 325 kts. (Mach 0.57) at 20,000 feet (6,060 meters), econ ;300 kts.

Ceiling: 33,000 feet (10,000 meters) with 100,000 pounds (45,000 kilograms) payload.

Range: With max payload 2,046 nm., with max fuel and 15,000 lb (7,000 kg.) payload 4,250 nm.

Crew: Five (two pilots, a navigator, flight engineer and loadmaster); up to 92 troops or 64 paratroops or 74 litter patients or five standard freight pallets.

Date Deployed: April 1955.

C-130J: Upgraded C-130 with HTTB engines, 2-man crew, and anti-skid brakes. High Technology Test Bed (HTTB): Used to test revised high-lift systems, advanced navigation systems, and cockpit displays, digital controls. Refitted with 5,227-eshp Allison 501-m71K Series IV turboprops driving 4-blade, 13 feet 9 inches (4.2 m.) diameter propellers; the Series 4 engines improve climb rate by 33%, cruise altitude by 22%, and range by 15%. Flight control by 3 independent flight control computers using Fly-By-Wire (FBW) and Fly-By-Light (FBL) technology.

Appendix B: The Algorithm and Calculations for Conversion of Coordinates

Given: L0M0 as battle field origin in latitude and longitude

VWSZ as screen size

L1M1 as latitude and longitude of point.

To find GAMM entry x,y coordinates the steps to follow are:

Let : L0' & L1' represent the degree portion of the latitude.

L0" & L1" represent the minute portion of the latitude.

M0' & M1' represent the degree portion of the longitude.

M0" & M1" represent the minute portion of the longitude.

Let : A = L0 + VWSZ/120

X1 = [(M1'-M0')*60NM/deg + M1"]*cos (A)

Y1 = (L1'-L0')*60 + L1"

Appendix C: The Sample Scenario File

This sample is included to give a better sketch of the actual scenario file, because the user manual presents this partially, here the formatting can be seen better, thus giving potential user(s) better confidence for creating a new scenario file.

```
2
C130E 60112 39599  4000  1
  120  587  108  120  108  300   32    9
 5300.0  930.0
  2.34 99.99   2.400   0.830 132.000
115.0000.5000.0500.4800.0401.001.00
 0.48 0.04 1.25 0.940
 1.0 4600. 9200.0.4200
 75000  4300  4300 37500  3300  3150  1350  2350     0    95
 75000  3750  4100 37500  2050  3000  1300  2250     0    60
 75000  5700  5150 37500  3000  3450  1450  2400     0    70
 75000  4400  4500 37500  2350  3150  1380  2300     0    40

C160A 31255 35273  4000  1
  120  587  108  120  108  245   10    2
 2800.0  600.0
  2.34 99.99   2.400   0.830 132.000
115.0000.5000.0500.4800.0401.001.00
 0.48 0.04 1.25 0.940
 1.0 4600. 9200.0.4200
 33069  6300  3150 22046  5600  3100  1500  2100     0    95
 42218  4600  3050 22046  4500  2850  1400  2000     0    60
 29120  6200  3200 22046  5500  3100  1700  2400     0    70
 37310  5600  3000 22046  4900  2900  1600  2300     0    40

  39
A001      CORLU        78.9 668.01.0001.000 1.00 1.00 0.
 9845  569  100 15.0    5    1
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A002      ATATURK     115.3 658.01.0001.000 1.00 1.00 0.
 9842  158  100100.0  999    1
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A003      CANAKKALE    17.2 608.01.0001.000 1.00 1.00 0.
 5905   23  100  1.0    1    0
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A004      BANDIRMA     78.9 619.01.0001.000 1.00 1.00 0.
 9997  167  100 20.0    5    1
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A005      BALIKESIR    78.9 577.01.0001.000 1.00 1.00 0.
 9810  331  100 15.0    5    1
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A006      CIGLI        41.2 510.01.0001.000 1.00 1.00 0.
 9808   17  100 15.0    5    1
    0.        0.        0.        0.      86   63
1.00001.00001.00001.0000
A007      AMENDERES    47.4 497.01.0001.000 1.00 1.00 0.
```

```
10630  412  100 90.0   10    1
    0.        0.        0.        0.      96  63
1.00001.00001.00001.0000
A008        AKHISAR     75.5 528.01.0001.000 1.00 1.00 0.
 9813  245  100 15.0    5    1
    0.        0.        0.        0.      86  63
1.00001.00001.00001.0000
A009        KUTAHYA    165.4 565.01.0001.000 1.00 1.00 0.
 4950 3021    8  2.0    1    1
    0.        0.        0.        0.      86  53
1.00001.00001.00001.0000
A010        BURSA      123.5 614.01.0001.000 1.00 1.00 0.
 4593  331  100  2.0    1    1
    0.        0.        0.        0.      86  63
1.00001.00001.00001.0000
A011        YENISEHIR  146.2 615.01.0001.000 1.00 1.00 0.
 9810  760  100 15.0    5    1
    0.        0.        0.        0.      86  63
1.00001.00001.00001.0000
A012        ESKISEHIR  188.7 587.01.0001.000 1.00 1.00 0.
10000 2579  100 15.0    5    1
    0.        0.        0.        0.      86  63
1.00001.00001.00001.0000
A013         AFYON     189.4 523.01.0001.000 1.00 1.00 0.
 9840 3313  100 15.0    5    1
    0.        0.        0.        0.      86  63
1.00001.00001.00001.0000
A014        DALAMAN    114.6 403.01.0001.000 1.00 1.00 0.
 9842   20  100 15.0    5    1
    0.        0.        0.        0.      96  63
1.00001.00001.00001.0000
A015        CARDAK     152.3 467.01.0001.000 1.00 1.00 0.
 9842 2795  100  3.0    2    1
    0.        0.        0.        0.      89  63
1.00001.00001.00001.0000
A016        ANTALYA    197.0 414.01.0001.000 1.00 1.00 0.
11155  177  100 15.0    5    1
    0.        0.        0.        0.      96  63
1.00001.00001.00001.0000
A017        ETIMESGUT  275.2 597.01.0001.000 1.00 1.00 0.
 7218 2622  100 15.0    7    1
    0.        0.        0.        0.      86  59
1.00001.00001.00001.0000
A018        ESENBOGA   288.2 607.01.0001.000 1.00 1.00 0.
12302 3125  100 50.0   20    1
    0.        0.        0.        0.      86  60
1.00001.00001.00001.0000
A019        AKINCI     270.4 605.01.0001.000 1.00 1.00 0.
10990 2765  100 15.0    5    1
    0.        0.        0.        0.      86  55
1.00001.00001.00001.0000
A020        ERKILET    390.5 526.01.0001.000 1.00 1.00 0.
```

```
11151 3506  100 40.0   40     1
     0.         0.         0.         0.      86  53
1.00001.00001.00001.0000
A021       INCIRLIK   387.7 420.01.0001.000 1.00 1.00 0.
10000  238  100 25.0    5     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A022       SAMSUN     424.1 676.01.0001.000 1.00 1.00 0.
 5315  524  100  3.0    2     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A023       SIVAS      448.8 589.01.0001.000 1.00 1.00 0.
12500 5236  100  7.0    2     1
     0.         0.         0.         0.      86  53
1.00001.00001.00001.0000
A024       SAKIRPASA  382.2 419.01.0001.000 1.00 1.00 0.
 9022   65  100  8.0    3     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A025       ERHAC      497.5 556.01.0001.000 1.00 1.00 0.
10990 2828  100 15.0    5     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A026       DIYARBAKIR 584.7 474.01.0001.000 1.00 1.00 0.
11644 2254  100 20.0    5     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A027       SURFA      529.1 426.01.0001.000 1.00 1.00 0.
 7103 1483  100  3.0    2     0
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A028       OGUZELI    472.8 417.01.0001.000 1.00 1.00 0.
 9186 2316  100  3.0    2     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A029       MUS        658.1 525.01.0001.000 1.00 1.00 0.
11647 2254  100 15.0    3     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A030       SIIRT      651.9 479.01.0001.000 1.00 1.00 0.
 5448 2001  100  2.0    1     0
     0.         0.         0.         0.      86  53
1.00001.00001.00001.0000
A031       KARS       704.8 634.01.0001.000 1.00 1.00 0.
11483 5889  100  5.0    2     1
     0.         0.         0.         0.      86  53
1.00001.00001.00001.0000
A032       VAN        713.7 508.01.0001.000 1.00 1.00 0.
 9022 5474  100  5.0    2     1
     0.         0.         0.         0.      86  63
1.00001.00001.00001.0000
A033       ERZURUM    624.5 597.01.0001.000 1.00 1.00 0.
```

```
12500 5764  100 15.0    5    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A034      KONYA       270.4 478.01.0001.000 1.00 1.00 0.
10991 3382  100 15.0    5    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A035      BATMAN      622.4 475.01.0001.000 1.00 1.00 0.
10009 3382  100  5.0    3    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A036      ERZINCAN    556.5 583.01.0001.000 1.00 1.00 0.
 9843 3793  100  5.0    3    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A037      TRABZON     567.5 660.01.0001.000 1.00 1.00 0.
 8661  104  100  3.0    2    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A039      MERZIFON    391.8 650.01.0001.000 1.00 1.00 0.
 9584 1783  100 10.0    3    1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
A040      TOPEL       168.1 644.01.0001.000 1.00 1.00 0.
 9842  174  100  3.0    2   1
     0.         0.         0.         0.      86   63
1.00001.00001.00001.0000
  30
201E      EDIRNE       24.0 702.0
   2
A001      1.00  11.00  1 0.16
A002      1.00  21.00  2 0.29
   1
  121.00001.0000  121.00001.0000   11.00
202L      CANAKKALE    17.2 608.0
   2
A003      1.00  11.00  1 0.01
A004      1.00  21.00  2 0.25
   0
208E      IPSALA       17.1 672.0
   2
A001      1.00  11.00  1 0.16
A002      1.00  21.00  2 0.29
   1
  171.00001.0000  171.00001.0000   11.00
204L      BANDIRMA     78.9 619.0
   1
A004      1.00  11.00  1 0.01
   0
205L      BALIKESIR    78.9 577.0
   1
A005      1.00  11.00  1 0.01
```

```
  0
206L      BERGAMA      47.4 550.0
  2
A005      1.00  11.00  1 0.25
A006      1.00  21.00  2 0.29
  0
207L      CATALCA     102.3 672.0
  2
A002      1.00  11.00  1 0.12
A001      1.00  21.00  2 0.15
  0
215L      DALAMAN     114.6 403.0
  1
A014      1.00  11.00  1 0.01
  0
217L      ANTALYA     197.0 414.0
  1
A016      1.00  11.00  1 0.01
  0
214L      CIGLI        41.2 510.0
  2
A006      1.00  11.00  1 0.01
A007      1.00  21.00  2 0.07
  0
218L      AKHISAR      75.5 528.0
  1
A008      1.00  11.00  1 0.01
  0
216L      DENIZLI     129.0 466.0
  1
A015      1.00  11.00  1 0.09
  0
111L      ESKISEHIR   188.7 587.0
  1
A012      1.00  11.00  1 0.01
  0
120L      KONYA       270.4 478.0
  1
A034      1.00  11.00  1 0.01
  0
121L      ANKARA      288.2 607.0
  3
A017      1.00  11.00  1 0.05
A018      1.00  21.00  2 0.06
A019      1.00  31.00  3 0.07
  0
122L      AKINCI      270.4 605.0
  1
A019      1.00  11.00  1 0.01
  0
123L      KAYSERI     390.5 526.0
  1
```

```
A020       1.00  11.00  1 0.02
   0
124L       TOKAT       435.8 621.0
   2
A023       1.00  11.00  1 0.22
A022       1.00  21.00  2 0.23
   0
125L       TRABZON     442.6 660.0
   1
A037       1.00  11.00  1 0.02
   0
126L       ERZURUM     624.5 597.0
   1
A033       1.00  11.00  1 0.03
   0
127L       KARS        704.8 634.0
   1
A031       1.00  11.00  1 0.03
   0
128L       MERZIFON    391.8 650.0
   1
A039       1.00  11.00  1 0.03
   0
129L       VAN         713.7 508.0
   1
A032       1.00  11.00  1 0.03
   0
130L       ERZINCAN    556.5 583.0
   1
A036       1.00  11.00  1 0.03
   0
101L       MALATYA     497.5 556.0
   1
A025       1.00  11.00  1 0.21
   0
102L       HATAY       418.6 374.0
   2
A024       1.00  11.00  1 0.31
A021       1.00  21.00  2 0.32
   0
103L       ADANA       382.2 419.0
   2
A021       1.00  11.00  1 0.01
A024       1.00  21.00  2 0.04
   0
109L       DIYARBAKIR 584.7 474.0
   1
A026       1.00  11.00  1 0.01
   0
110L       BATMAN      622.4 475.0
   1
A035       1.00  11.00  1 0.01
```

```
   0
117L      MUS        644.4 525.0
   1
A029      1.00  11.00  1 0.01
   0
 10.0 10.0 10.0 10.0 15.0 30.0 30.0 30.0
 34
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C130E 20
C160A 20
C160A 20
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C160A 20
C160A 20
C160A 20
C160A 20
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C160A 20
C160A 20
C160A 20
C160A 20
C160A 20
 50
0.02Y
0.04Y
0.06Y
0.08Y
0.10Y
0.12Y
0.14Y
0.16Y
0.18Y
0.20Y
```

```
0.22Y
0.24Y
0.26Y
0.28Y
0.30Y
0.32Y
0.34Y
0.36Y
0.38Y
0.40Y
0.42Y
0.44Y
0.46Y
0.48Y
0.50Y
0.52Y
0.54Y
0.56Y
0.58Y
0.60Y
0.62Y
0.64Y
0.66Y
0.68Y
0.70Y
0.72Y
0.74Y
0.76Y
0.78Y
0.80Y
0.82Y
0.84Y
0.86Y
0.88Y
0.90Y
0.92Y
0.94Y
0.96Y
0.98Y
0.99Y
0.9000.
0.9000.
0.9000.
0.9000.
0.9000.
0.9000.
0.9000.
0.9000.
0.9000.
2000. 30. 26.NE
```

Appendix D: The Sample of Jobs File Used in GAMM

This sample is included to give a better sketch of the actual jobs file, because the user manual present this partially, here the formatting can be seen better, thus giving potential user(s) better confidence for creating a new job(s) file(s).

```
 31
  1 UNIT MOVE, F-16 SQDN
  2 UNIT MOVE, F-4 SQDN
  3 ROUTINE RESUPPLY, POL/AMM
  4 UNIT MOVE, MLRS BATTERY
  5 PERSONNEL MOVE, DIVERTED
  6 UNIT MOVE, HAWK BATTERY
  7 UNIT MOVE ATK HEL BN
  8 UNIT MOVE, NBC DECON COMPANY
  9 ROUTINE RESUPPLY, POL/AMM
 10 AIRDROP BATTALION TASK FORCE
 11 AIRLAND BRIGADE
 12 UNIT MOVE,TACTICAL AIRLIFT SQN
 13 UNIT MOVE,COMBAT ENGINEERS
 14 UNIT MOVE, LIGHT INF BN
 15 UNIT MOVEMENT,  BRIGADE
 16 UNIT MOVE, MLRS BATTALION
 17 PERSONNEL MOVE, REPLACEMENTS
 18 EMER RESUP,AMMO/POL/FOOD/WATER
 19 EMERGENCY RESUPPLY, PGM/POL
 20 ROUTINE RESUPPLY, PAX/REP
 21 ROUTINE RESUPPLY, RATIONS
 22 ROUTINE RESUPPLY, WATER
 23 UNIT MOVE, MASH
 24 WEAPONS DROP TO TROOPS
 25 UNIT MOVE,AIR AMBULANCE CO
 26 MEDICAL EVACUATION
 27 EMERG RESUPPLY,ARTILLERY AMMO
 28 RETROGRADE: PARTS/EQUIP
 29 BACKLIFT KIA'S
 30 PERSONNEL MOVE, REPLACEMENTS
 31 UNIT MOVE, F-5 WING
PAX                        110000  3.25  5.25101L205L 3 1   1 1 0
PAX                        110000  6.00  8.00101L205L 3 1   1 1 0
PAX                        110000  7.50  9.50101L205L 3 1   1 1 0
PAX                        110000  4.75  6.75101L205L 3 1   1 1 0
BULK                        36000  3.25  5.25101L205L 3 1   1 1 0
```

BULK				36000	7.50	9.50101L205L	3	1	1	1	0
BULK				36000	6.00	8.00101L205L	3	1	1	1	0
BULK				36000	4.75	6.75101L205L	3	1	1	1	0
463L PALLE	88	108	20	354	3.25	5.25101L205L	3	1	20	1	0
463L PALLE	88	108	20	354	6.00	8.00101L205L	3	1	20	1	0
463L PALLE	88	108	20	354	7.50	9.50101L205L	3	1	20	1	0
463L PALLE	88	108	20	354	4.75	6.75101L205L	3	1	20	1	0
C-1 STAND	48	47	82	160	3.25	5.25101L205L	3	1	1	1	0
C-1 STAND	48	47	82	160	6.00	8.00101L205L	3	1	1	1	0
C-1 STAND	48	47	82	160	4.75	6.75101L205L	3	1	1	1	0
C-1 STAND	48	47	82	160	7.50	9.50101L205L	3	1	1	1	0
VEH SPARES	55	55	52	650	3.25	5.25101L205L	3	1	1	1	0
VEH SPARES	55	55	52	650	4.75	6.75101L205L	3	1	1	1	0
VEH SPARES	55	55	52	650	7.50	9.50101L205L	3	1	1	1	0
VEH SPARES	55	55	52	650	6.00	8.00101L205L	3	1	1	1	0
HEATER,H-1	73	40	46	580	3.25	5.25101L205L	3	1	2	1	0
HEATER,H-1	73	40	46	580	7.50	9.50101L205L	3	1	2	1	0
HEATER,H-1	73	40	46	580	4.75	6.75101L205L	3	1	2	1	0
HEATER,H-1	73	40	46	580	6.00	8.00101L205L	3	1	2	1	0
HEATER,H-1	78	58	43	1260	3.25	5.25101L205L	3	1	1	1	0
HEATER,H-1	78	58	43	1260	6.00	8.00101L205L	3	1	1	1	0
HEATER,H-1	78	58	43	1260	7.50	9.50101L205L	3	1	1	1	0
HEATER,H-1	78	58	43	1260	4.75	6.75101L205L	3	1	1	1	0
MC-2A SHO	89	48	39	760	3.25	5.25101L205L	3	1	5	1	0
MC-2A SHO	89	48	39	760	7.50	9.50101L205L	3	1	5	1	0
MC-2A SHO	89	48	39	760	6.00	8.00101L205L	3	1	5	1	0
MC-2A SHO	89	48	39	760	4.75	6.75101L205L	3	1	5	1	0
B-4 MAINT	96	53	36	540	3.25	5.25101L205L	3	1	3	1	0
B-4 MAINT	96	53	36	540	7.50	9.50101L205L	3	1	3	1	0
B-4 MAINT	96	53	36	540	4.75	6.75101L205L	3	1	3	1	0
B-4 MAINT	96	53	36	540	6.00	8.00101L205L	3	1	3	1	0
COMPRESSOR	99	70	70	1220	3.25	5.25101L205L	3	1	4	1	0
COMPRESSOR	99	70	70	1220	4.75	6.75101L205L	3	1	4	1	0
COMPRESSOR	99	70	70	1220	7.50	9.50101L205L	3	1	4	1	0
COMPRESSOR	99	70	70	1220	6.00	8.00101L205L	3	1	4	1	0
NF-2 LITE	101	68	59	2040	3.25	5.25101L205L	3	1	1	1	0
NF-2 LITE	101	68	59	2040	6.00	8.00101L205L	3	1	1	1	0

NF-2 LITE	101	68	59	2040	7.50	9.50101L205L	3	1	1	1	0
NF-2 LITE	101	68	59	2040	4.75	6.75101L205L	3	1	1	1	0
TSTR PRESS	105	60	57	2800	3.25	5.25101L205L	3	1	1	1	0
TSTR PRESS	105	60	57	2800	7.50	9.50101L205L	3	1	1	1	0
TSTR PRESS	105	60	57	2800	6.00	8.00101L205L	3	1	1	1	0
TSTR PRESS	105	60	57	2800	4.75	6.75101L205L	3	1	1	1	0
TRACTOR,AG	121	75	93	4240	3.25	5.25101L205L	3	1	1	1	0
TRACTOR,AG	121	75	93	4240	4.75	6.75101L205L	3	1	1	1	0
TRACTOR,AG	121	75	93	4240	6.00	8.00101L205L	3	1	1	1	0
TRACTOR,AG	121	75	93	4240	7.50	9.50101L205L	3	1	1	1	0
GENERATOR	123	55	68	3060	3.25	5.25101L205L	3	1	5	1	0
GENERATOR	123	55	68	3060	4.75	6.75101L205L	3	1	5	1	0
GENERATOR	123	55	68	3060	7.50	9.50101L205L	3	1	5	1	0
GENERATOR	123	55	68	3060	6.00	8.00101L205L	3	1	5	1	0
TRLR,COMP	126	60	55	3400	3.25	5.25101L205L	3	1	2	1	0
TRLR,COMP	126	60	55	3400	6.00	8.00101L205L	3	1	2	1	0
TRLR,COMP	126	60	55	3400	7.50	9.50101L205L	3	1	2	1	0
TRLR,COMP	126	60	55	3400	4.75	6.75101L205L	3	1	2	1	0
TEST STAND	126	77	86	5120	3.25	5.25101L205L	3	1	3	1	0
TEST STAND	126	77	86	5120	6.00	8.00101L205L	3	1	3	1	0

Appendix E: Detailed Output Products Definitions

1. **Status Report**: This report gives the tonnage of cargo awaiting airlift on a specified time of the scenario. The sample is at day 11 time 00.00.

STATUS OF BACKLOGGED AIRLIFT JOBS ON DAY 11 AT TIME 0000

BASE	TOT	TOT	TOTAL	---------------------- TONS VERSUS DESTINATION --------												
- ID	A/C	MOG	TONS	201E	202L	204L	205L	206L	207L	208E	214L	215L	216L	217L	218L	218E
A001	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A002	6	999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A003	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A004	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A005	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A006	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A007	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A008	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A009	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A010	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A011	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A012	1	5	501	0	0	0	0	0	0	0	0	0	0	0	0	0
A013	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A014	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A015	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A016	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A017	1	7	527	0	0	0	0	0	0	0	0	0	0	0	0	0
A018	1	20	1317	0	0	0	0	0	0	0	0	0	0	0	0	0
A019	1	5	255	0	0	0	0	0	0	0	0	0	0	0	0	0
A020	6	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A021	0	5	356	0	0	0	0	0	0	0	0	0	0	0	0	0
A022	0	2	60	0	0	0	0	0	0	0	0	0	0	0	0	0
A023	1	2	58	0	0	0	0	0	0	0	0	0	0	0	0	0
A024	2	3	200	0	0	0	0	0	0	0	0	0	0	0	0	0
A025	1	5	694	0	0	0	0	0	0	0	0	0	0	0	0	0

A026	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0
A027	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A028	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A029	2	3	29	0	0	0	0	0	0	0	0	0	0	0	0	0
A030	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A031	1	2	541	0	0	0	0	0	0	0	0	0	0	0	0	0
A032	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A033	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0	0
A034	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A035	1	3	1349	0	0	0	0	0	0	0	0	0	0	0	0	0
A036	1	3	1326	0	0	0	0	0	0	0	0	0	0	0	0	0
A037	0	2	59	0	0	0	0	0	0	0	0	0	0	0	0	0
A039	0	3	58	0	0	0	0	0	0	0	0	0	0	0	0	0
A040	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2. **Generalized Summary**: The generalized summary is comprised of one report, written to disk, entitled "Summary Data" This product is generated automatically for any simulation run. When running multiple replication, this product is the only report GAMM generates, and all the information in the report is averaged across replications. Below is given description of each section included in the General Summary.

a) Summary Data: This report contains the highest aggregation summary statistics of the model results. (Simulation parameters specified at run time, summary as to jobs; aggregate statistics of the delivery effectiveness by type of material (PAX, BULK, OVERSIZE, FUEL) and by priority rating.)

b) Summary as to Flight Operations: This section provides summary as to total flight hours, total sorties flown, total fuel used and total number of refuelings.

c) Crew Ratio Data: The crew ratio information provides data which shows the number of crews required to support each type of airlifter and the ratio of crews to aircraft for each home base.

d) Detailed Data as to Enroute Flight Survivability: These are all assigned to 1.0 for this study and therefore is not under consideration.

e) Airlifter Utilization: This section provides the amount time each airlifter type spent in 17 stages during simulation.

f) Job summary Data - by Job Level: This section provides a summary of airlift job data by job number. first the summary is presented according to amount of the cargo (late, early, delivered, blocked, deleted, killed, intransit, regenerated), and then summary is provided as to delivery time (delivery time shortest, average, and longest).

g) Job Summary Data - by Airlifter Type: This section provides a summary of tons early/late by airlifter type and job number.

h) Job Summary Data - by Day: This section provides a summary of airlift jobs by simulation day. Tons delivered by airlifter type are expressed for on-time airlift, total delivered both cumulative and by day.

i) Airbase Activity: This section provides airlifter data for home base and nonhome base activities. This section begins with the percentage of simulation time each airlifter type spent at home airbase and percentage of simulation time spent away from home base. The second page of the Airbase Activity Report shows details on nine "Simultaneous Aircraft" categories, each reflecting the number of aircraft, percent of time, and time in days for each of these categories.

j) Individual Airbase Activities: This consists of two parts; 1) a summary of airlifter activities by airbase and 2) a summary of airlifter activities by airbase type. Both parts show total ton-days awaiting airlift, airlifter landings, productive flights, and percentage of maximum cabin payload for landing at an airbase.

S U M M A R Y   D A T A

SIMULATION PARAMETERS

NUMBER OF RUNS:	1				
TIME OF AVERAGE TEMP (HR):	1000	ASAP TAKEOFF WITH RELO:	NO	MIN TRANSIT A/C SPOTS:	2.0
SIMULATION TIME (DAYS):	30.0	CREW DAY(HOURS):	14.0	WT/DIMENSION LOADING:	YES
SCENARIO/CHAIN FILE:		AIRLIFT JOBS FILE:	bac.txt	SCENARIO MOD FILE:	
PS RESTRICTED SCHEDULING:	YES	RATIO LOST TO TRIGGER:	0.	FLIGHT LOWER PS BOUND:	0.
TRIGGER FOR T.O. ASAP:	.998	COMBAT MAINT FACTOR:	.50	COMBAT OFFLOAD FACTOR:	.30
GRD TRANS PLNG (TONS):	25	SCHD BY WT OVERRIDE:	2	DAYS TO RECOVER BLKD A/C:	1.0

SUMMARY AS TO JOBS

	JOBS BY CLASS				TOTAL	JOBS BY PRIORITY							
	PAX	BULK	OVERSIZE	FUEL	JOBS	1	2	3	4	5	6	7	GT7
AVG ON TIME (HR)	14.1	13.5	21.1	16.6	17.8	6.4	3.2	29.9	22.8	6.0	32.1	16.5	17.0
AVG LATE (HR)	103.2	88.2	117.8	101.0	109.3	40.7	60.6	225.9	179.5	328.7	171.3	117.9	12.0
AVG DLRY (DAY)	4.0	3.5	4.8	4.2	4.4	2.0	2.5	7.0	8.4	11.9	6.0	4.0	4.4
DLRY STD DEV	3.8	4.6	6.0	5.2	5.4	1.9	3.1	7.0	5.2	8.4	6.1	3.7	4.1
TONS ON TIME(AL)	1223	911	1227	627	3988	1077	91	1055	112	70	387	991	205
TONS LATE(AL)	2142	4573	8225	1693	16633	8547	1920	1926	1267	565	940	1050	418
TONS ON TIME(AD)	66	237	348	46	696	360	155	0	0	109	32	41	0
TONS LATE(AD)	174	590	759	111	1634	907	552	0	0	12	87	76	0
TONS DELIVERED	3605	6311	10558	2477	22952	10891	2719	2981	1379	755	1445	2158	623
TONS DELETED	0	0	0	0	0	0	0	0	0	0	0	0	0
TONS BLOCKED	0	0	0	0	0	0	0	0	0	0	0	0	
TONS TRANSIT	4422	1965	6624	841	13852	0	11	5013	1462	2368	1468	2258	1273
TONS KILLED	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	8028	8276	17182	3318	36804	10891	2730	7994	2841	3123	2913	4416	1895
RATIO ON TIME	.16	.14	.09	.20	.13	.13	.09	.13	.04	.06	.14	.23	.11
RATIO LATE	.29	.62	.52	.54	.50	.87	.91	.24	.45	.18	.35	.26	.22
RATIO DELIVERED	.45	.76	.61	.75	.62	1.00	1.00	.37	.49	.24	.50	.49	.33
RATIO DELETED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RATIO BLOCKED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
RATIO TRANSIT	.55	.24	.39	.25	.38	0.	.00	.63	.51	.76	.50	.51	.67
RATIO KILLED	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

S U M M A R Y   D A T A

SUMMARY AS TO FLIGHT OPERATIONS

	ALL AIRCRAFT	- - - - - - TYPE AIRLIFTER/SCHEDULE PRIORITY - - - - - - -	
		C130E/1	C160A/2
INITIAL NUMBER OF AIRCRAFT	34	14	20
TOTAL FLIGHT HOURS	6688	2766	3922
TOTAL SORTIES FLOWN	5442	2471	2971
TOTAL PRODUCTIVE FLT HRS	3091	1403	1688
TOTAL PRODUCTIVE SORTIES	2207	1126	1081
AIRCRAFT KILLED OR BLOCKED	0	0	0
RATIO KILLED OR BLOCKED	0.	0.	0.
TOTAL FUEL USED (TONS)	12807.5	7325.0	5482.5
TOTAL REFUELINGS	5571	2743	2828

D E T A I L E D D A T A A S T O E N R O U T E F L I G H T S U R V I V A B I L I T Y

- - - - - - - SORTIE COUNT IN TERMS OF AIRLIFTER TYPE AND ENROUTE SURVIVABILITY - - - - - - -

INTERVAL = .1											
A/C TYPE	.0 < .1	.1 < .2	.2 < .3	.3 < .4	.4 < .5	.5 < .6	.6 < .7	.7 < .8	.8 < .9	.9 < 1.	EQUALS 1.
C130E	0	0	0	0	0	0	0	0	0	0	2472
C160A	0	0	0	0	0	0	0	0	0	0	2971
INTERVAL = .01											
A/C TYPE	.90 < .91	.91 < .92	.92 < .93	.93 < .94	.94 < .95	.95 < .96	.96 < .97	.97 < .98	.98 < .99	.99 < 1.0	EQUALS 1.
C130E	0	0	0	0	0	0	0	0	0	0	2472
C160A	0	0	0	0	0	0	0	0	0	0	2971
INTERVAL = .001											
A/C TYPE	.960<.961	.961<.962	.962<.963	.963<.964	.964<.965	.965<.966	.966<.967	.967<.968	.968<.969	.969<.970	
C130E	0	0	0	0	0	0	0	0	0	0	
C160A	0	0	0	0	0	0	0	0	0	0	
A/C TYPE	.970<.971	.971<.972	.972<.973	.973<.974	.974<.975	.975<.976	.976<.977	.977<.978	.978<.979	.979<.980	
C130E	0	0	0	0	0	0	0	0	0	0	
C160A	0	0	0	0	0	0	0	0	0	0	
A/C TYPE	.980<.981	.981<.982	.982<.983	.983<.984	.984<.985	.985<.986	.986<.987	.987<.988	.988<.989	.989<.990	
C130E	0	0	0	0	0	0	0	0	0	0	
C160A	0	0	0	0	0	0	0	0	0	0	
A/C TYPE	.990<.991	.991<.992	.992<.993	.993<.994	.994<.995	.995<.996	.996<.997	.997<.998	.998<.999	.999<1.00	EQUALS 1.
C130E	0	0	0	0	0	0	0	0	0	0	2472
C160A	0	0	0	0	0	0	0	0	0	0	2971

A I R L I F T E R   U T I L I Z A T I O N

- - - - - - PERCENTAGE OF TIME - - - - - -

AC TYPE	BLOCK	FLIGHT	LOAD	TRANSIT	KILLED	HOMEBASE MAINTENANCE MISN ESTNL NON-THR	HOMEBASE MAINTENANCE MISN ESTNL THR'T	HOMEBASE MAINTENANCE NORMAL NON-THR	HOMEBASE MAINTENANCE NORMAL THR'T	HOMEBASE MAINTENANCE ABDR NON-THR	HOMEBASE MAINTENANCE ABDR THR'T	MISN ESNTL MAINT AWAY NON-THR	MISN ESNTL MAINT AWAY THR'T	READY	SERV	TAXI	UNLOAD
C130E	0.	13.95	3.12	13.53	0.	5.06	0.	.58	0.	0.	0.	17.25	0.	22.78	11.68	9.92	2.12
C160A	0.	11.75	2.19	15.52	0.	3.59	0.	.47	0.	0.	0.	18.49	0.	27.64	9.77	8.68	1.89

- - - - - - TIME SPENT IN EACH STATE BY AIRLIFTER - - - - - -

AC NUMBER	BLOCK	FLIGHT	LOAD	TRANSIT	KILLED	HOMEBASE MAINTENANCE MISN ESTNL NON-THR	HOMEBASE MAINTENANCE MISN ESTNL THR'T	HOMEBASE MAINTENANCE NORMAL NON-THR	HOMEBASE MAINTENANCE NORMAL THR'T	HOMEBASE MAINTENANCE ABDR NON-THR	HOMEBASE MAINTENANCE ABDR THR'T	MISN ESNTL MAINT AWAY NON-THR	MISN ESNTL MAINT AWAY THR'T	READY	SERV	TAXI	UNLOAD
1	0.	3.71	.95	4.25	0.	1.48	0.	.33	0.	0.	0.	5.46	0.	6.50	3.58	3.10	.64
2	0.	4.14	.87	4.06	0.	1.16	0.	.10	0.	0.	0.	5.85	0.	6.93	3.41	2.86	.62
3	0.	3.91	.86	3.90	0.	2.11	0.	0.	0.	0.	0.	5.93	0.	6.48	3.37	2.83	.62
4	0.	4.27	.93	4.03	0.	1.88	0.	.09	0.	0.	0.	5.27	0.	6.64	3.31	2.89	.69
5	0.	4.23	.87	3.98	0.	1.74	0.	.12	0.	0.	0.	4.81	0.	7.20	3.56	2.93	.56
6	0.	4.32	1.01	4.19	0.	1.67	0.	.09	0.	0.	0.	4.86	0.	6.73	3.39	2.97	.76
7	0.	4.10	.97	3.94	0.	1.19	0.	.14	0.	0.	0.	5.25	0.	7.17	3.55	3.04	.66
8	0.	4.35	.87	3.87	0.	1.88	0.	.27	0.	0.	0.	4.86	0.	6.91	3.52	2.94	.54
9	0.	4.22	1.02	4.12	0.	1.19	0.	.21	0.	0.	0.	5.01	0.	6.72	3.68	3.13	.69
10	0.	4.27	1.01	4.52	0.	1.55	0.	.12	0.	0.	0.	4.69	0.	6.47	3.60	3.09	.68
11	0.	4.43	.95	3.97	0.	1.23	0.	.32	0.	0.	0.	4.86	0.	7.03	3.58	3.01	.63
12	0.	4.10	.92	4.07	0.	1.46	0.	.19	0.	0.	0.	5.38	0.	6.75	3.55	2.97	.62
13	0.	4.26	.95	4.19	0.	1.40	0.	.08	0.	0.	0.	5.27	0.	6.79	3.47	2.92	.67
14	0.	4.32	.93	3.75	0.	1.32	0.	.37	0.	0.	0.	4.92	0.	7.35	3.49	2.98	.55
15	0.	3.79	.69	5.12	0.	.78	0.	.09	0.	0.	0.	6.09	0.	7.07	3.03	2.79	.56
16	0.	3.76	.70	4.90	0.	1.21	0.	.21	0.	0.	0.	4.57	0.	8.08	3.15	2.78	.64
17	0.	3.00	.59	4.78	0.	.89	0.	.27	0.	0.	0.	6.17	0.	8.66	2.73	2.43	.47
18	0.	3.29	.61	4.52	0.	1.26	0.	.18	0.	0.	0.	5.89	0.	8.42	2.83	2.48	.51
19	0.	3.68	.74	4.52	0.	1.47	0.	.07	0.	0.	0.	5.23	0.	8.07	2.96	2.62	.64
20	0.	3.62	.71	4.51	0.	.89	0.	.06	0.	0.	0.	5.26	0.	8.61	3.01	2.72	.61
21	0.	3.50	.68	5.05	0.	1.03	0.	.12	0.	0.	0.	6.17	0.	6.99	3.16	2.77	.54
22	0.	3.47	.59	4.97	0.	.88	0.	.12	0.	0.	0.	4.79	0.	8.95	3.01	2.69	.53
23	0.	3.56	.58	5.00	0.	1.10	0.	.21	0.	0.	0.	6.16	0.	7.49	2.83	2.54	.53
24	0.	3.22	.61	4.58	0.	1.23	0.	.18	0.	0.	0.	5.38	0.	9.05	2.79	2.46	.50
25	0.	3.60	.63	4.88	0.	1.05	0.	.12	0.	0.	0.	5.70	0.	7.72	3.01	2.75	.56
26	0.	3.90	.75	4.28	0.	1.20	0.	.47	0.	0.	0.	5.92	0.	7.22	2.93	2.66	.66
27	0.	3.40	.53	4.78	0.	1.59	0.	.14	0.	0.	0.	5.64	0.	8.25	2.78	2.44	.44
28	0.	3.48	.70	4.58	0.	1.31	0.	.09	0.	0.	0.	4.51	0.	9.26	2.94	2.53	.61
29	0.	3.23	.62	4.39	0.	.97	0.	.09	0.	0.	0.	5.91	0.	8.84	2.89	2.52	.54

JOB SUMMARY DATA --- JOB LEVEL

JOB NUM	JOB DESCRIPTION	JOB PRITY	TONS ON TIME	TONS LATE	TONS DELIVERED	TONS INTRANS	TONS BLOCKED	TONS DELETED	TONS KILLED	TONS REGENERATED	TON-DAYS AWAITING AIRLIFT
1	UNIT MOVE, F-16 SQDN	3	109	187	296	226	0	0	0	0	7685.9
2	UNIT MOVE, F-4 SQDN	3	316	107	423	392	0	0	0	0	11739.1
3	ROUTINE RESUPPLY, POL/AMM	6	202	891	1093	1307	0	0	0	0	35109.5
4	UNIT MOVE, MLRS BATTERY	1	243	4851	5094	0	0	0	0	0	7333.6
5	PERSONNEL MOVE, DIVERTED	7	29	87	116	804	0	0	0	0	3937.3
6	UNIT MOVE, HAWK BATTERY	1	503	775	1278	0	0	0	0	0	2985.5
7	UNIT MOVE ATK HEL BN	3	11	299	310	608	0	0	0	0	9213.1
8	UNIT MOVE, NBC DECON COMPANY	1	19	606	625	0	0	0	0	0	746.6
9	ROUTINE RESUPPLY, POL/AMM	6	217	134	351	161	0	0	0	0	3881.5
10	AIRDROP BATTALION TASK FORCE	1	44	301	345	0	0	0	0	0	631.1
11	AIRLAND BRIGADE	1	312	1023	1335	0	0	0	0	0	2048.2
12	UNIT MOVE,TACTICAL AIRLIFT SQN	4	0	27	27	114	0	0	0	0	1145.8
13	UNIT MOVE,COMBAT ENGINEERS	4	0	631	631	366	0	0	0	0	10581.5
14	UNIT MOVE, LIGHT INF BN	1	316	1899	2215	0	0	0	0	0	3308.2
15	UNIT MOVEMENT, BRIGADE	5	70	566	636	2369	0	0	0	0	61984.2
16	UNIT MOVE, MLRS BATTALION	3	15	440	455	2456	0	0	0	0	48217.7
17	PERSONNEL MOVE, REPLACEMENTS	7	849	718	1567	1079	0	0	0	0	10032.0
18	EMER RESUP,AMMO/POL/FOOD/WATER	2	137	1143	1280	0	0	0	0	0	1929.0
19	EMERGENCY RESUPPLY, PGM/POL	2	109	291	400	0	0	0	0	0	977.7
20	ROUTINE RESUPPLY, PAX/REP	7	79	114	193	291	0	0	0	0	3100.2
21	ROUTINE RESUPPLY, RATIONS	8	67	88	155	205	0	0	0	0	1494.0
22	ROUTINE RESUPPLY, WATER	4	32	264	296	501	0	0	0	0	11232.6
23	UNIT MOVE, MASH	4	65	201	266	481	0	0	0	0	11968.5
24	WEAPONS DROP TO TROOPS	5	109	12	121	0	0	0	0	0	24.3
25	UNIT MOVE,AIR AMBULANCE CO	4	16	144	160	0	0	0	0	0	1804.5
26	MEDICAL EVACUATION	8	68	209	277	563	0	0	0	0	5949.0
27	EMERG RESUPPLY,ARTILLERY AMMO	2	0	1039	1039	11	0	0	0	0	3729.2
28	RETROGRADE: PARTS/EQUIP	8	59	53	112	101	0	0	0	0	1546.1
29	BACKLIFT KIA'S	8	11	68	79	404	0	0	0	0	4100.7
30	PERSONNEL MOVE, REPLACEMENTS	7	76	207	283	85	0	0	0	0	3265.1
31	UNIT MOVE, F-5 WING	3	604	893	1497	1332	0	0	0	0	29731.3

JOB SUMMARY DATA --- JOB LEVEL

JOB NUM	JOB DESCRIPTION	JOB PRITY	DELIVERY TIME SHORTEST	DELIVERY TIME AVERAGE	DELIVERY TIME LONGEST	DELIVERY TIME STD DEV	IN FLIGHT TIME SHORTEST	IN FLIGHT TIME AVERAGE	IN FLIGHT TIME LONGEST	IN FLIGHT TIME STD DEV
1	UNIT MOVE, F-16 SQDN	3	.26	7.33	24.91	7.93	.10	.11	.12	.01
2	UNIT MOVE, F-4 SQDN	3	.33	2.03	24.84	4.81	.03	.06	.08	.02
3	ROUTINE RESUPPLY, POL/AMM	6	.11	6.42	22.71	6.42	.03	.07	.13	.03
4	UNIT MOVE, MLRS BATTERY	1	.12	1.70	11.82	1.87	0.	.07	.13	.03
5	PERSONNEL MOVE, DIVERTED	7	.25	6.06	8.84	3.61	.03	.04	.10	.02
6	UNIT MOVE, HAWK BATTERY	1	.51	2.83	10.72	2.59	.03	.08	.12	.03
7	UNIT MOVE ATK HEL BN	3	.30	9.44	14.26	3.93	.06	.08	.12	.01
8	UNIT MOVE, NBC DECON COMPANY	1	.22	2.33	7.85	2.22	.04	.06	.07	.01
9	ROUTINE RESUPPLY, POL/AMM	6	.20	4.57	14.04	4.64	.03	.05	.09	.02
10	AIRDROP BATTALION TASK FORCE	1	.20	2.22	6.96	1.37	.02	.02	.02	.00
11	AIRLAND BRIGADE	1	.40	1.99	5.53	1.08	.07	.08	.13	.01
12	UNIT MOVE,TACTICAL AIRLIFT SQN	4	4.82	6.14	8.04	.92	.07	.08	.10	.01
13	UNIT MOVE,COMBAT ENGINEERS	4	.61	9.38	21.93	4.94	.05	.08	.11	.02
14	UNIT MOVE, LIGHT INF BN	1	.13	2.00	11.02	1.82	.04	.07	.12	.03
15	UNIT MOVEMENT, BRIGADE	5	.27	13.84	24.69	7.45	.06	.08	.10	.02
16	UNIT MOVE, MLRS BATTALION	3	.40	10.68	17.55	5.42	.08	.10	.12	.01
17	PERSONNEL MOVE, REPLACEMENTS	7	.21	3.13	11.55	2.69	.04	.10	.13	.02
18	EMER RESUP,AMMO/POL/FOOD/WATER	2	.06	1.96	14.54	2.17	.03	.06	.12	.02
19	EMERGENCY RESUPPLY, PGM/POL	2	.09	2.25	20.13	3.52	.02	.04	.11	.03
20	ROUTINE RESUPPLY, PAX/REP	7	.10	3.08	11.80	3.20	.04	.08	.12	.02
21	ROUTINE RESUPPLY, RATIONS	8	.24	2.84	8.29	2.25	.08	.08	.09	.00
22	ROUTINE RESUPPLY, WATER	4	.36	9.51	21.37	6.81	.06	.08	.08	.01
23	UNIT MOVE, MASH	4	.41	3.25	5.75	1.51	.08	.08	.09	.01
24	WEAPONS DROP TO TROOPS	5	.11	.34	.54	.13	.02	.02	.02	.00
25	UNIT MOVE,AIR AMBULANCE CO	4	2.43	11.91	14.72	3.95	.08	.11	.12	.01
26	MEDICAL EVACUATION	8	.17	4.62	14.13	3.95	.05	.08	.12	.02
27	EMERG RESUPPLY,ARTILLERY AMMO	2	.64	3.79	20.75	4.02	.03	.08	.12	.03
28	RETROGRADE: PARTS/EQUIP	8	.30	4.43	8.67	3.45	0.	.07	.09	.03
29	BACKLIFT KIA'S	8	.24	4.60	16.00	4.97	.05	.07	.10	.01
30	PERSONNEL MOVE, REPLACEMENTS	7	.33	6.25	22.68	6.36	.05	.06	.08	.01
31	UNIT MOVE, F-5 WING	3	.16	7.85	20.57	5.94	.04	.09	.12	.03

J O B   S U M M A R Y   D A T A --- B Y   A I R L I F TE R   T Y P E

	JOBS BY CLASS PAX	BULK	OVERSIZE	FUEL	TOTAL JOBS	JOBS BY PRIORITY 1 2	3	4	5	6	7	GT 7	
AIRLIFT JOB NUMBER 1													
C130E TNS ERLY	1	0	28	0	28	0	0	28	0	0	0	0	0
C130E TNS LATE	0	0	58	0	58	0	0	58	0	0	0	0	0
C160A TNS ERLY	0	36	45	0	81	0	0	81	0	0	0	0	0
C160A TNS LATE	0	36	92	0	129	0	0	129	0	0	0	0	0
TONS AIRLIFTED	1	72	223	0	296	0	0	296	0	0	0	0	0
AIRLIFT JOB NUMBER 2													
C130E TNS ERLY	0	40	82	0	122	0	0	122	0	0	0	0	0
C130E TNS LATE	0	0	0	39	39	0	0	39	0	0	0	0	0
C160A TNS ERLY	0	60	20	114	194	0	0	194	0	0	0	0	0
C160A TNS LATE	0	50	0	18	68	0	0	68	0	0	0	0	0
TONS AIRLIFTED	0	150	102	171	422	0	0	422	0	0	0	0	0
AIRLIFT JOB NUMBER 3													
C130E TNS ERLY	0	12	34	15	61	0	0	0	0	0	61	0	0
C130E TNS LATE	26	352	72	15	465	0	0	0	0	0	465	0	0
C160A TNS ERLY	1	35	45	60	142	0	0	0	0	0	142	0	0
C160A TNS LATE	15	127	49	235	427	0	0	0	0	0	427	0	0
TONS AIRLIFTED	42	526	201	325	1094	0	0	0	0	0	1094	0	0

The rest is in the same format.

J O B   S U M M A R Y   D A T A --- B Y D A Y

DAY	TONS ON TIME C130E	TONS ON TIME C160A	TONS ON TIME TOTAL	DELIVERY BY AIRLIFTER C130E	DELIVERY BY AIRLIFTER C160A	DELIVERY BY AIRLIFTER DAILY	DELIVERY BY AIRLIFTER CUM	TOTAL DELIVERED DAILY	TOTAL DELIVERED CUM	UTILIZATION C130E	UTILIZATION C160A	SORTIE RATE C130E	SORTIE RATE C160A	END OF DAY FORCE C130E	END OF DAY FORCE C160A
1	0	0	0	0	0	0	0	0	0	0.	0.	0.	0.	14	20
2	0	0	0	0	0	0	0	0	0	0.	0.	0.	0.	14	20
3	0	0	0	0	0	0	0	0	0	0.	0.	0.	0.	14	20
4	65	9	74	65	9	74	74	74	74	2.70	.75	2.36	.50	14	20
5	107	67	174	214	79	219	293	219	293	5.19	3.00	4.29	2.45	14	20
6	243	229	472	407	284	398	691	398	691	6.44	4.68	6.07	4.05	14	20
7	449	444	893	742	546	597	1288	597	1288	6.42	5.08	6.21	5.15	14	20
8	677	556	1233	1235	855	802	2090	802	2090	6.54	5.43	5.79	5.00	14	20
9	678	578	1256	1585	1106	601	2691	601	2691	6.19	6.32	5.71	5.05	14	20
10	905	712	1617	2123	1458	890	3581	890	3581	7.11	4.73	5.86	4.10	14	20
11	1058	787	1845	2590	1800	809	4390	809	4390	7.29	8.47	5.00	5.10	14	20
12	1259	904	2163	3017	2164	791	5181	791	5181	8.90	9.16	5.43	6.05	14	20
13	1272	923	2195	3318	2666	803	5984	803	5984	8.61	9.58	5.36	6.45	14	20
14	1350	1014	2364	3893	3237	1146	7130	1146	7130	7.45	7.95	6.57	6.80	14	20
15	1434	1149	2583	4420	3757	1047	8177	1047	8177	9.32	8.63	6.50	5.95	14	20
16	1481	1178	2659	4853	4141	817	8994	817	8994	8.11	8.12	6.29	6.60	14	20
17	1581	1312	2893	5387	4647	1040	10034	1040	10034	7.65	8.22	7.43	6.40	14	20
18	1661	1373	3034	5766	5200	932	10966	957	10991	6.86	7.97	6.07	6.35	14	20
19	1739	1415	3154	6311	5709	1054	12020	1054	12045	7.79	8.73	6.29	6.10	14	20
20	1844	1527	3371	6749	6245	974	12994	974	13019	8.47	8.28	6.29	5.85	14	20
21	1955	1590	3545	7118	6601	725	13719	725	13744	6.58	7.20	5.43	5.30	14	20
22	2014	1683	3697	7600	7025	906	14625	906	14650	8.11	7.65	6.50	5.40	14	20
23	2168	1716	3884	8237	7442	1054	15679	1054	15704	8.03	7.03	6.79	5.55	14	20
24	2321	1808	4129	8793	7997	1111	16790	1111	16815	7.47	8.12	6.57	5.85	14	20
25	2344	1833	4177	9281	8514	1005	17795	1005	17820	7.62	8.42	7.50	6.00	14	20
26	2403	1846	4249	9635	9043	883	18678	883	18703	7.21	8.15	5.93	6.55	14	20
27	2430	1876	4306	10336	9591	1249	19927	1249	19952	7.72	8.42	6.93	6.25	14	20
28	2606	1963	4569	10904	10138	1115	21042	1115	21067	7.51	8.68	6.71	7.00	14	20
29	2619	2012	4631	11376	10560	894	21936	894	21961	8.18	9.00	7.07	6.45	14	20
30	2630	2030	4660	11908	11020	992	22928	992	22953	8.11	8.34	6.36	6.25	14	20
								AVG:		6.59	6.54	5.44	4.95		

A I R B A S E   A C T I V I TY

- - - - - - PERCENTAGE OF TIME - - - - -

TYPE OF AIRCRAFT	% HOME	% AWAY
C130E	31.16	68.84
C160A	31.52	68.48

- - - - - - DETAILS BY AIRLIFTER - - - - - -

AIRCRAFT NUMBER	TYPE OF AIRCRAFT	DAYS HOME	DAYS AWAY
1	C130E	9.35	20.65
2	C130E	8.85	21.15
3	C130E	9.24	20.76
4	C130E	9.50	20.50
5	C130E	9.54	20.46
6	C130E	9.75	20.25
7	C130E	8.89	21.11
8	C130E	10.59	19.41
9	C130E	8.77	21.23
10	C130E	9.41	20.59
11	C130E	9.10	20.90
12	C130E	9.15	20.85
13	C130E	9.16	20.84
14	C130E	9.57	20.43
15	C160A	8.38	21.62
16	C160A	8.49	21.51
17	C160A	9.71	20.29
18	C160A	9.61	20.39
19	C160A	9.75	20.25
20	C160A	9.04	20.96
21	C160A	9.13	20.87
22	C160A	9.45	20.55
23	C160A	9.34	20.66
24	C160A	10.09	19.91
25	C160A	9.52	20.48
26	C160A	9.42	20.58

A I R B A S E   A C T I V I TY

SIMULTANEOUS AIRCRAFT AT HOME:	MAX							
NUMBER OF AIRCRAFT	0	0						
PERCENT OF TIME		.3						
TIME IN DAYS		.1						
			---- AT HOME ----					
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINT:	MAX							
NUMBER OF AIRCRAFT	7	0	1	2	3	4	5	6
PERCENT OF TIME		31.1	26.61	22.3	12.2	5.2	1.7	.7
TIME IN DAYS		9.3	8.0	6.7	3.6	1.6	.5	.2
			---- AT HOME ----					
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINT:	MAX							
NUMBER OF AIRCRAFT	7	7						
PERCENT OF TIME		.2						
TIME IN DAYS		.1						
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINT THREAT:	MAX	---- AT HOME ----						
NUMBER OF AIRCRAFT	0							
SIMULTANEOUS AIRCRAFT IN NORMAL MAINTENANCE:	MAX							
NUMBER OF AIRCRAFT	3	1	2	3				
PERCENT OF TIME		13.3	2.05	.0				
TIME IN DAYS		4.0	.6	.0				
SIMULTANEOUS AIRCRAFT IN NORMAL MAINTENANCE THREAT:	MAX							
NUMBER OF AIRCRAFT	0							
SIMULTANEOUS AIRCRAFT IN BATTLE DAMAGE REPAIR:	MAX							
NUMBER OF AIRCRAFT	0							
SIMULTANEOUS AIRCRAFT IN BATTLE DAMAGE REPAIR THREAT:	MAX							
NUMBER OF AIRCRAFT	0							
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINTENANCE:	MAX							
NUMBER OF AIRCRAFT	16	1	2	3	4	5	6	7
PERCENT OF TIME		1.8	3.30	4.5	8.0	10.8	12.9	11.8
TIME IN DAYS		.5	1.0	1.4	2.4	3.3	3.9	3.5
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINTENANCE:	MAX							
NUMBER OF AIRCRAFT	16	8	9	10	11	12	13	14
PERCENT OF TIME		9.1	9.26	7.5	4.4	3.2	1.2	.5
TIME IN DAYS		2.7	2.8	2.2	1.3	1.0	.4	.2
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINTENANCE:	MAX							
NUMBER OF AIRCRAFT	16	15	16					
PERCENT OF TIME		.1	.06					
TIME IN DAYS		.0	.0					
SIMULTANEOUS AIRCRAFT IN MISN ESNTL MAINTENANCE THR:	MAX							
NUMBER OF AIRCRAFT	0							

INDIVIDUAL AIRBASE ACTIVITIES

AIRBASE IDENTITY	AIRBASE DESCRIPTION	ELEV	RUNWAY LENGTH	LCN	FUEL	MOG	TOTAL TON-DAYS AT AIRBASE AWAITING LIFT	C130E AIRLIFTER LANDINGS TOTAL	C130E PROD	C130E %CABIN	C160A AIRLIFTER LANDINGS TOTAL	C160A PROD	C160A %CABIN
A001	CORLU	569	9845	100	YES	5	238	1	0	0.	1	0	0.
A002	ATATURK	158	9842	100	YES	999	11920	146	0	0.	193	0	0.
A003	CANAKKALE	23	5905	100	NO	1	0	1	0	0.	1	0	0.
A004	BANDIRMA	167	9997	100	YES	5	4405	51	0	0.	69	0	0.
A005	BALIKESIR	331	9810	100	YES	5	2213	40	31	57.87	50	38	65.40
A006	CIGLI	17	9808	100	YES	5	6311	40	0	0.	72	0	0.
A007	AMENDERES	412	10630	100	YES	10	7188	52	15	58.51	59	9	57.15
A008	AKHISAR	245	9813	100	YES	5	0	0	0	0.	0	0	0.
A009	KUTAHYA	3021	4950	8	YES	1	187	0	0	0.	2	0	0.
A010	BURSA	331	4593	100	YES	1	406	9	0	0.	12	0	0.
A011	YENISEHIR	760	9810	100	YES	5	4163	37	0	0.	94	6	63.95
A012	ESKISEHIR	2579	10000	100	YES	5	5260	92	0	0.	108	0	0.
A013	AFYON	3313	9840	100	YES	5	2254	26	0	0.	31	0	0.
A014	DALAMAN	20	9842	100	YES	5	741	20	0	0.	14	0	0.
A015	CARDAK	2795	9842	100	YES	2	1095	29	0	0.	24	0	0.
A016	ANTALYA	177	11155	100	YES	5	141	1	0	0.	2	0	0.
A017	ETIMESGUT	2622	7218	100	YES	7	3592	44	0	0.	77	0	0.
A018	ESENBOGA	3125	12302	100	YES	20	9830	112	0	0.	135	0	0.
A019	AKINCI	2765	10990	100	YES	5	1760	27	0	0.	30	0	0.
A020	ERKILET	3506	11151	100	YES	40	4523	509	128	63.01	616	0	0.
A021	INCIRLIK	238	10000	100	YES	5	900	151	151	65.71	186	186	63.00
A022	SAMSUN	524	5315	100	YES	2	1602	5	0	0.	19	0	0.
A023	SIVAS	5236	12500	100	YES	2	1561	12	0	0.	13	0	0.
A024	SAKIRPASA	65	9022	100	YES	3	0	34	34	66.77	67	67	66.02
A025	ERHAC	2828	10990	100	YES	5	0	59	59	73.69	90	90	63.28
A026	DIYARBAKIR	2254	11644	100	YES	5	1163	140	137	68.31	211	203	56.76
A027	SURFA	1483	7103	100	NO	2	475	67	67	70.51	87	87	58.05
A028	OGUZELI	2316	9186	100	YES	2	403	61	57	63.86	112	99	61.64
A029	MUS	2254	11647	100	YES	3	0	51	51	81.76	98	97	62.13
A030	SIIRT	2001	5448	100	NO	1	0	26	26	60.16	34	34	43.09
A031	KARS	5889	11483	100	YES	2	6537	48	0	0.	59	0	0.
A032	VAN	5474	9022	100	YES	2	864	1	0	0.	8	0	0.
A033	ERZURUM	5764	12500	100	YES	5	2605	77	0	0.	65	0	0.
A034	KONYA	3382	10991	100	YES	5	1104	48	0	0.	53	0	0.
A035	BATMAN	3382	10009	100	YES	3	147	185	185	50.83	166	165	51.58
A036	ERZINCAN	3793	9843	100	YES	3	1242	5	0	0.	14	0	0.
A037	TRABZON	104	8661	100	YES	2	2500	27	0	0.	25	0	0.
A039	MERZIFON	1783	9584	100	YES	3	2480	40	0	0.	45	0	0.
A040	TOPEL	174	9842	100	NO	2	1025	12	0	0.	29	0	0.

INDIVIDUAL AIRBASE ACTIVITIES

AIRBASE SUMMARY DATA BY AIRBASE TYPE

AIRBASE TYPE	NUMBER OF AIRBASES	TOTAL LANDINGS	TOTAL TON-DAYS AWAITING LIFT	C130E AIRLIFTER LANDINGS TOTAL	C130E PROD	C130E %CABIN	C160A AIRLIFTER LANDINGS TOTAL	C160A PROD	C160A %CABIN
A	39	5257	90835	2286	941	63.91	2971	1081	9.11

Details as to Transportation System Effectiveness: This product provides a detailed look at the disposition of each movement item during the course of the simulation.

D E T A I L S   A S   T O   T R A N S P O R T A T I O N   S Y S T E M   E F F E C T I V E N E S S

MOVEMENT ITEM DESCRIPTIN	JOB NO	PRI'Y OF ITEM	WDTH OF ITEM	LGTH OF ITEM	HGHT OF ITEM	WGHT OF ITEM	EN'Y SITE ID	JOB ENTRY DAY TME	ORIGINATING AIRBASE BASE ID	ORIGINATING AIRBASE ARRIVAL DAY TME	ORIGINATING AIRBASE DEPART DAY TME	RECEIVING AIRBASE BASE ID	RECEIVING AIRBASE ARRIVAL DAY TME	PF NO	AC NO	DLVRY SITE ID	DESIRED DELIVRY DAY TME	FINAL DISPOSAL DAY TME	COMMENTS AS TO DISPOSITION OF THE JOB
AMMO 463 L	9	6	84	520	48	33000	121L	4 0000	A017	4 0112	4 0830	A014	4 0953	1	1	215L	6 0000	4 1027	0 1 1 A
AMMO 463 L	9	6	84	208	48	7000	121L	4 0000	A017	4 0112	4 1317	A014	4 1441	1	3	215L	6 0000	4 1517	0 1 1 A
FUEL 463 L	9	6	84	312	48	18000	121L	4 0000	A017	4 0112	4 1317	A014	4 1441	1	3	215L	6 0000	4 1517	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
VEH SPARES	1	3	55	55	52	650	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
PASSENGERS	1	3	52	21	76	560	101L	4 0600	A025	4 1102	4 1258	A005	4 1500	1	2	205L	6 0600	4 1535	0 1 1 A
FUEL 463 L	9	6	84	104	48	6000	121L	4 0000	A017	4 0112	4 1401	A014	4 1524	1	5	215L	6 0000	4 1540	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
C-1 STAND	1	3	47	48	82	160	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
463L PALLE	1	3	108	88	20	354	101L	4 0600	A025	4 1102	4 1358	A005	4 1600	1	4	205L	6 0600	4 1639	0 1 1 A
AMBULANCE,	14	1	91	228	102	7370	111L	4 1424	A012	4 1438	4 1707	A008	4 1802	1	8	218L	5 0224	4 1832	0 1 1 A
AMBULANCE,	14	1	91	228	102	7370	111L	4 1424	A012	4 1438	4 1707	A008	4 1802	1	8	218L	5 0224	4 1832	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1709	A008	4 1804	1	7	218L	5 0224	4 1834	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1709	A008	4 1804	1	7	218L	5 0224	4 1834	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1709	A008	4 1804	1	7	218L	5 0224	4 1834	0 1 1 A
AMBULANCE,	14	1	91	228	102	7370	111L	4 1424	A012	4 1438	4 1712	A008	4 1807	1	9	218L	5 0224	4 1839	0 1 1 A
AMBULANCE,	14	1	91	228	102	7370	111L	4 1424	A012	4 1438	4 1712	A008	4 1807	1	9	218L	5 0224	4 1839	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1716	A008	4 1810	1	10	218L	5 0224	4 1844	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1716	A008	4 1810	1	10	218L	5 0224	4 1844	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1716	A008	4 1810	1	10	218L	5 0224	4 1844	0 1 1 A
PASSENGERS	14	1	52	1083	76	24940	110L	4 1424	A035	4 1438	4 1747	A029	4 1829	1	15	117L	5 0224	4 1922	0 1 1 A
PASSENGERS	14	1	52	1000	76	23040	110L	4 1424	A035	4 1438	4 1751	A029	4 1833	1	17	117L	5 0224	4 1923	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1907	A008	4 2002	1	1	218L	5 0224	4 2033	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1907	A008	4 2002	1	1	218L	5 0224	4 2033	0 1 1 A
TRK,5/4T,M	14	1	85	186	74	6104	111L	4 1424	A012	4 1438	4 1907	A008	4 2002	1	1	218L	5 0224	4 2033	0 1 1 A
PASSENGERS	14	1	52	1000	76	23040	110L	4 1424	A035	4 1438	4 1944	A029	4 2026	1	16	117L	5 0224	4 2112	0 1 1 A

The rest is in the same format.

Blocked/Deleted Jobs: This output is comprised of list of a movement items, which have not been transported during the course of simulation by reason. (For example outsize or delivery time and so on.)

B L O C K E D   A N D   D E L E T E D   A I R L I F T   J O B S

AIRLIFT JOB REQUEST DESCRIPTION	NO	WIDTH OF ITEM	LENGTH OF ITEM	HEIGHT OF ITEM	WEIGHT OF ITEM	ENTRY SITE ID	JOB ENTRY DAY TIME	PRI'TY OF ITEM	DELIVERY SITE ID	DESIRED DELIVERY DAY TIME	BLOCKED/ DELETED DAY TIME	COMMENTS AS TO CAUSE OF BLOCKAGE/DELETION
TRK LIFT F	7	103	186	93	53950	129L	19 1200	3	215L	20 1200	0 ----	ENTRY W/O FEAS FLT
CARRIER PE	8	130	192	84	19996	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
CARRIER PE	8	130	192	84	19996	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
CARRIER PE	8	130	192	84	19996	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
CARRIER PE	8	130	192	84	19996	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
CARRIER PE	8	130	192	84	19996	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK,5T,M92	8	97	332	112	22275	120L	22 1200	1	208E	22 1800	22 1200	BLKD (OUTSIZE OR WT)
TRK LIFT F	7	103	186	93	53950	121L	23 0600	3	206L	24 0600	0 ----	ENTRY W/O FEAS FLT

Jobs in Transit: This report gives detailed information (movement item level) on the items not at their delivery site oat the time of simulation end.

AIRLIFT JOBS THAT ARE IN TRANSIT AT SIMULATION END

AIRLIFT JOB REQUEST DESCRIPTION	NO	WIDTH OF ITEM	LENGTH OF ITEM	HEIGHT OF ITEM	WEIGHT OF ITEM	ENTRY SITE ID	JOB ENTRY DAY TIME	PRI'TY	DESTINATION OFSITE ITEM ID	DESIRED DELIVERY DAY TIME	SITUATION START DAY TIME	COMMENTS AS TO SITUATION
TRK LIFT	31	53	145	42	3800	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
HEATER,DUC	31	55	85	42	734	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
FUEL LDR	31	68	205	53	2770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRLR,NI	31	35	35	59	493	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
MAINT STAT	31	53	95	86	805	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
463L PALLE	31	108	88	20	1770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRK LIFT	31	53	145	42	3800	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
MAINT STAT	31	53	95	86	805	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
LOX CART	31	50	93	34	1050	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRLR,MHU	31	93	202	91	6650	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
463L PALLE	2	108	88	20	354	111L	6 0000	3	202L	8 0000	6 0014	LOCATED AT A012
TRACTOR,AG	31	87	135	86	4500	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
LOX CART	31	50	93	34	1050	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
FUEL LDR	31	68	205	53	2770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRLR,ENG	31	61	157	92	3444	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
HEATER,DUC	31	55	85	42	734	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
463L PALLE	31	108	88	20	1770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRK LIFT	2	53	145	42	3800	111L	6 0000	3	201E	8 0000	6 0014	LOCATED AT A012
MAINT STAT	31	53	95	86	805	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRLR,LIFT	31	70	197	42	6320	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
463L PALLE	31	108	88	20	1770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRLR,ACFT	31	61	154	88	1631	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
463L PALLE	31	108	88	20	1770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
AMMO LDNG	31	69	208	92	2900	111L	16 1648	3	207L	18 1648	16 1702	LOCATED AT A012
GEN SET,60	31	67	118	67	3500	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
FUEL LDR	31	68	205	53	2770	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
AMMO LDNG	31	69	208	92	2900	111L	16 1648	3	207L	18 1648	16 1702	LOCATED AT A012
GEN SET,60	31	67	118	67	3500	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
MAINT STAT	31	53	95	86	805	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
HEATER,DUC	31	55	85	42	734	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRK LIFT	31	53	145	42	3800	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
TRK LIFT	31	53	145	42	3800	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
25K LOADER	31	110	312	38	22500	111L	16 1648	3	207L	18 1648	16 1702	LOCATED AT A012
MAINT STAT	31	53	95	86	805	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012
MAINT STAT	31	59	190	67	2430	111L	16 1648	3	215L	18 1648	16 1702	LOCATED AT A012

The rest is in the same format.

Airlifter Flight History: This report gives a detailed breakdown (sortie level) of all airlifter activity and it is generated during the model execution.

A I R L I F T E R   F L I G H T   H I S T O R Y

A/C TYPE	A/C NO	SPD (KTS)	TURNAROUND TIME (HRS)	TAKEOFF AIRBASE	TAKEOFF DAY TIME	AIRDROP SITE	AIRDROP DAY TIME	LANDING AIRBASE	LANDING DAY TIME	PL WGT VS MAX	PL VOL VS MAX	COMMENTS AS TO MISSION AND DISPOSITION OF
C130E	1	260.0	.2	A020	4 0627	-NA-	NA -NA-	A017	4 0658	0.	0.	RELOCATION
C130E	1	260.0	1.3	A017	4 0843	-NA-	NA -NA-	A014	4 0941	.83	.28	NORMAL FLIGHT
C130E	2	260.0	.2	A020	4 1115	-NA-	NA -NA-	A025	4 1141	0.	0.	RELOCATION
C130E	3	260.0	.2	A020	4 1115	-NA-	NA -NA-	A017	4 1146	0.	0.	RELOCATION
C130E	1	260.0	1.3	A014	4 1115	-NA-	NA -NA-	A020	4 1225	0.	0.	FLIGHT TO HOMEBASE
C130E	4	260.0	.2	A020	4 1213	-NA-	NA -NA-	A025	4 1238	0.	0.	RELOCATION
C130E	5	260.0	.2	A020	4 1213	-NA-	NA -NA-	A017	4 1244	0.	0.	RELOCATION
C130E	3	260.0	1.3	A017	4 1330	-NA-	NA -NA-	A014	4 1428	.63	.28	NORMAL FLIGHT
C130E	2	260.0	1.4	A025	4 1310	-NA-	NA -NA-	A005	4 1447	.08	.18	NORMAL FLIGHT
C130E	5	260.0	1.0	A017	4 1413	-NA-	NA -NA-	A014	4 1512	.15	.06	NORMAL FLIGHT
C160A	19	220.0	.2	A020	4 1505	-NA-	NA -NA-	A025	4 1536	0.	0.	RELOCATION
C130E	4	260.0	1.4	A025	4 1411	-NA-	NA -NA-	A005	4 1547	.06	.17	NORMAL FLIGHT
C130E	11	260.0	.2	A020	4 1505	-NA-	NA -NA-	A026	4 1552	0.	0.	RELOCATION
C130E	12	260.0	.2	A020	4 1505	-NA-	NA -NA-	A026	4 1552	0.	0.	RELOCATION
C130E	13	260.0	.2	A020	4 1505	-NA-	NA -NA-	A026	4 1552	0.	0.	RELOCATION
C130E	14	260.0	.2	A020	4 1505	-NA-	NA -NA-	A026	4 1552	0.	0.	RELOCATION
C130E	6	260.0	.2	A020	4 1505	-NA-	NA -NA-	A012	4 1554	0.	0.	RELOCATION
C130E	7	260.0	.2	A020	4 1505	-NA-	NA -NA-	A012	4 1554	0.	0.	RELOCATION
C130E	8	260.0	.2	A020	4 1505	-NA-	NA -NA-	A012	4 1554	0.	0.	RELOCATION
C130E	9	260.0	.2	A020	4 1505	-NA-	NA -NA-	A012	4 1554	0.	0.	RELOCATION
C130E	10	260.0	.2	A020	4 1505	-NA-	NA -NA-	A012	4 1554	0.	0.	RELOCATION
C160A	18	220.0	.2	A020	4 1505	-NA-	NA -NA-	A026	4 1600	0.	0.	RELOCATION
C160A	15	220.0	.2	A020	4 1505	-NA-	NA -NA-	A035	4 1610	0.	0.	RELOCATION
C160A	16	220.0	.2	A020	4 1505	-NA-	NA -NA-	A035	4 1610	0.	0.	RELOCATION
C160A	17	220.0	.2	A020	4 1505	-NA-	NA -NA-	A035	4 1610	0.	0.	RELOCATION
C130E	3	260.0	1.4	A014	4 1603	-NA-	NA -NA-	A020	4 1713	0.	0.	FLIGHT TO HOMEBASE
C130E	2	260.0	1.2	A005	4 1603	-NA-	NA -NA-	A020	4 1716	0.	0.	FLIGHT TO HOMEBASE
C130E	8	260.0	1.2	A012	4 1720	-NA-	NA -NA-	A008	4 1749	.37	.56	NORMAL FLIGHT
C130E	1	260.0	3.2	A020	4 1701	-NA-	NA -NA-	A012	4 1749	0.	0.	RELOCATION
C130E	7	260.0	1.3	A012	4 1722	-NA-	NA -NA-	A008	4 1751	.46	.46	NORMAL FLIGHT
C130E	9	260.0	1.2	A012	4 1725	-NA-	NA -NA-	A008	4 1754	.37	.56	NORMAL FLIGHT
C160A	20	220.0	.2	A020	4 1701	-NA-	NA -NA-	A026	4 1755	0.	0.	RELOCATION
C130E	10	260.0	1.4	A012	4 1728	-NA-	NA -NA-	A008	4 1758	.46	.46	NORMAL FLIGHT
C160A	15	220.0	1.6	A035	4 1800	-NA-	NA -NA-	A029	4 1816	.71	.56	NORMAL FLIGHT
C160A	17	220.0	1.8	A035	4 1804	-NA-	NA -NA-	A029	4 1821	.65	.52	NORMAL FLIGHT
C160A	21	220.0	.2	A020	4 1729	-NA-	NA -NA-	A035	4 1834	0.	0.	RELOCATION
C160A	27	220.0	.2	A020	4 1827	-NA-	NA -NA-	A025	4 1857	0.	0.	RELOCATION

The rest is in the same format.

Summary Data at Airlift Job Level: This report gives the summary statistics by type of job.

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                          SU M M A R Y   D A T A   A T   A I R L I F T   J O B   L E V E L
                   - - - - JOBS BY CLASS - - - - - - -        TOTAL     - - - - -- - - - - - JOBS BY PRIORITY - - - - - - - - - - -
                     PAX       BULK    OVERSIZE    FUEL       JOBS        1       2       3       4       5       6       7 GT7
AIRLIFT JOB NUMBER  1                  TOTAL TON-DAYS AT AIRBASES AWAITING LIFT =  7106
AVG EARLY (HRS)     35.5       29.9      24.7       0.        25.1       0.      0.    25.1      0.      0.      0.      0. 0.
AVG LATE (HRS)     456.8      107.7     217.3       0.       238.5       0.      0.   238.5      0.      0.      0.      0. 0.
AVG DLRY (DAYS)     17.3        4.6       6.1       0.         6.8       0.      0.     6.8      0.      0.      0.      0. 0.
DLRY STD DEV         8.2        3.2       6.3       0.         7.1       0.      0.     7.1      0.      0.      0.      0. 0.
TONS REQUIRED        220         72       230        0         522        0       0     522       0       0       0      0  0
TONS EARLY(AL)         1         36        89        0         126        0       0     126       0       0       0      0  0
TONS LATE(AL)         58         36       135        0         229        0       0     229       0       0       0      0  0
TONS EARLY(AD)         0          0         0        0           0        0       0       0       0       0       0      0  0
TONS LATE(AD)          0          0         0        0           0        0       0       0       0       0       0      0  0
TONS DELIVERED        59         72       224        0         354        0       0     354       0       0       0      0  0
C130E TNS ERLY         1          0        64        0          65        0       0      65       0       0       0      0  0
C130E TNS LATE        12         16        42        0          69        0       0      69       0       0       0      0  0
C160A TNS ERLY         0         36        24        0          61        0       0      61       0       0       0      0  0
C160A TNS LATE        46         20        94        0         160        0       0     160       0       0       0      0  0
TONS AIRLIFTED        59         72       224        0         354        0       0     354       0       0       0      0  0
TONS DELETED           0          0         0        0           0        0       0       0       0       0       0      0  0
TONS BLOCKED           0          0         0        0           0        0       0       0       0       0       0      0  0
TONS TRANSIT         161          0         6        0         168        0       0     168       0       0       0      0  0
TONS KILLED            0          0         0        0           0        0       0       0       0       0       0      0  0
AIRLIFT JOB NUMBER  3                  TOTAL TON-DAYS AT AIRBASES AWAITING LIFT =         41026
AVG EARLY (HRS)     18.5       13.6      33.8       0.        31.7       0.      0.      0.      0.      0.    31.7      0. 0.
AVG LATE (HRS)     218.2      231.7     137.5     322.4      192.7       0.      0.      0.      0.      0.   192.7      0. 0.
AVG DLRY (DAYS)      9.3       10.6       4.3      15.4        6.9       0.      0.      0.      0.      0.     6.9      0. 0.
DLRY STD DEV         6.4        7.0       4.8       5.5        6.6       0.      0.      0.      0.      0.     6.6      0. 0.
TONS REQUIRED        108       1258       235      800        2401        0       0       0       0       0    2401      0  0
TONS EARLY(AL)        23         39        86        0         148        0       0       0       0       0     148      0  0
TONS LATE(AL)         33        376        63      107         579        0       0       0       0       0     579      0  0
TONS EARLY(AD)         0          0         0        0           0        0       0       0       0       0       0      0  0
TONS LATE(AD)          0          0         0        0           0        0       0       0       0       0       0      0  0
TONS DELIVERED        57        415       148      107         727        0       0       0       0       0     727      0  0
C130E TNS ERLY         0         10        33        0          43        0       0       0       0       0      43      0  0
C130E TNS LATE         1        205         9       30         245        0       0       0       0       0     245      0  0
C160A TNS ERLY        23         29        52        0         105        0       0       0       0       0     105      0  0
C160A TNS LATE        32        171        54       77         334        0       0       0       0       0     334      0  0
TONS AIRLIFTED        57        415       148      107         727        0       0       0       0       0     727      0  0
TONS DELETED           0          0         0        0           0        0       0       0       0       0       0      0  0
TONS BLOCKED           0          0         0        0           0        0       0       0       0       0       0      0  0
TONS TRANSIT          51        843        86      693        1674        0       0       0       0       0    1674      0  0
TONS KILLED            0          0         0        0           0        0       0       0       0       0       0      0  0
The rest is in the same format.
```

Additionally input parameters are also available in an easy to read format, where . enables the analyst to see if there has been any mistake during input and input parameters have not been changed inadvertently. Below is summary of the outputs report produced from model inputs.

Scenario Structure: This consists of six reports which will be summarized below.

a) Origin to Airbase Data (By origin ID): This contains data for entry site-to-airbase connections.

b) Origin to Airbase Data(By Airbase ID): This report contains data for entry site to airbase arcs.

c) Airdrop: This report contains a list of permitted/allowed airdrops during the scenario.

d) Airbase to Delivery (By Airbase): This report contains data for airbase to delivery site arcs.

e) Airbase to Delivery Site (By Delivery Site): This report contains data for airbase to delivery site arcs.

f) Beddown: This report provides basic characteristics for airbases being used as home bases.

ORIGIN TO AIRBASE DATA :::::: ../output/ :::::: ORIGIN TO AIRBASE DATA

(LISTED ALPHABETICALLY BY ORIGIN ID)

ORIGIN				ASSOCIATED AIRBASES															
ID	FULL NAME	LATITUDE	LONGITUDE	BASE ID	TRANSIT DAYS	PS	PREF	BASE ID	TRANSIT DAYS	PS	PREF	BASE ID	TRANSIT DAYS	PS	PREF	BASE ID	TRANSIT DAYS	PS	PREF
101L	MALATYA	39:16N	38:09E	A025	.21	1.00	1												
102L	HATAY	36:14N	36:14E	A021	.32	1.00	2	A024	.31	1.00	1								
103L	ADANA	36:59N	35:20E	A024	.04	1.00	2	A021	.01	1.00	1								
109L	DIYARBAKIR	37:54N	40:17E	A026	.01	1.00	1												
110L	BATMAN	37:55N	41:13E	A035	.01	1.00	1												
111L	ESKISEHIR	39:47N	30:37E	A012	.01	1.00	1												
117L	MUS	38:45N	41:45E	A029	.01	1.00	1												
120L	KONYA	37:58N	32:36E	A034	.01	1.00	1												
121L	ANKARA	40:07N	33:03E	A019	.07	1.00	3	A018	.06	1.00	2	A017	.05	1.00	1				
122L	AKINCI	40:05N	32:36E	A019	.01	1.00	1												
123L	KAYSERI	38:46N	35:33E	A020	.02	1.00	1												
124L	TOKAT	40:21N	36:39E	A022	.23	1.00	2	A023	.22	1.00	1								
125L	TRABZON	41:00N	36:49E	A037	.02	1.00	1												
126L	ERZURUM	39:57N	41:16E	A033	.03	1.00	1												
127L	KARS	40:34N	43:13E	A031	.03	1.00	1												
128L	MERZIFON	40:50N	35:34E	A039	.03	1.00	1												
129L	VAN	38:28N	43:26E	A032	.03	1.00	1												
130L	ERZINCAN	39:43N	39:36E	A036	.03	1.00	1												
201E	EDIRNE	41:42N	26:35E	A002	.29	1.00	2	A001	.16	1.00	1								
202L	CANAKKALE	40:08N	26:25E	A004	.25	1.00	2	A003	.01	1.00	1								
204L	BANDIRMA	40:19N	27:56E	A004	.01	1.00	1												
205L	BALIKESIR	39:37N	27:56E	A005	.01	1.00	1												
206L	BERGAMA	39:10N	27:10E	A006	.29	1.00	2	A005	.25	1.00	1								
207L	CATALCA	41:12N	28:30E	A001	.15	1.00	2	A002	.12	1.00	1								
208E	IPSALA	41:12N	26:25E	A002	.29	1.00	2	A001	.16	1.00	1								
214L	CIGLI	38:30N	27:00E	A007	.07	1.00	2	A006	.01	1.00	1								
215L	DALAMAN	36:43N	28:48E	A014	.01	1.00	1												
216L	DENIZLI	37:46N	29:09E	A015	.09	1.00	1												
217L	ANTALYA	36:54N	30:49E	A016	.01	1.00	1												
218L	AKHISAR	38:48N	27:51E	A008	.01	1.00	1												

O R I G I N   T O   A I R B A S E   D A T A ::::: ../output/ ::::: O R I G I N   T O   A I R B A S E   D A T A

ORIGIN ID	TRANSIT DAYS	TRANSIT PS	PREF	ORIGIN ID	TRANSIT DAYS	TRANSIT PS	RNWY PREF	ID	FUEL FULL NAME	A/C GPS LATITUDE	C PRB LONGITUDE	SERV LENGTH	LOAD LCN	AVA	SPOTS	MOG	/DAY	NO BD	FAC	FAC
201E	.16	1.00	1	208E	.16	1.00	1	A001	CORLU	41:08N	27:56E	9845	100	YES	15.0	5	1.000	1.000	1.00	1.00
207L	.15	1.00	2					A001	CORLU	41:08N	27:56E	9845	100	YES	15.0	5	1.000	1.000	1.00	1.00
207L	.12	1.00	1	201E	.29	1.00	2	A002	ATATURK	40:58N	28:49E	9842	100	YES	100.	99	1.000	1.000	1.00	1.00
208E	.29	1.00	2					A002	ATATURK	40:58N	28:49E	9842	100	YES	100.	99	1.000	1.000	1.00	1.00
202L	.01	1.00	1					A003	CANAKKALE	40:08N	26:25E	5905	100	NO	1.0	1	1.000	1.000	1.00	1.00
204L	.01	1.00	1	202L	.25	1.00	2	A004	BANDIRMA	40:19N	27:56E	9997	100	YES	20.0	5	1.000	1.000	1.00	1.00
205L	.01	1.00	1	206L	.25	1.00	1	A005	BALIKESIR	39:37N	27:56E	9810	100	YES	15.0	5	1.000	1.000	1.00	1.00
214L	.01	1.00	1	206L	.29	1.00	2	A006	CIGLI	38:30N	27:00E	9808	100	YES	15.0	5	1.000	1.000	1.00	1.00
214L	.07	1.00	2					A007	AMENDERES	38:17N	27:10E	10630	100	YES	90.0	10	1.000	1.000	1.00	1.00
218L	.01	1.00	1					A008	AKHISAR	38:48N	27:51E	9813	100	YES	15.0	5	1.000	1.000	1.00	1.00
NONE	....	....						A009	KUTAHYA	39:25N	30:03E	4950	8	YES	2.0	1	1.000	1.000	1.00	1.00
NONE	....	....						A010	BURSA	40:14N	29:01E	4593	100	YES	2.0	1	1.000	1.000	1.00	1.00
NONE	....	....						A011	YENISEHIR	40:15N	29:34E	9810	100	YES	15.0	5	1.000	1.000	1.00	1.00
111L	.01	1.00	1					A012	ESKISEHIR	39:47N	30:37E	10000	100	YES	15.0	5	1.000	1.000	1.00	1.00
NONE	....	....						A013	AFYON	38:43N	30:38E	9840	100	YES	15.0	5	1.000	1.000	1.00	1.00
215L	.01	1.00	1					A014	DALAMAN	36:43N	28:48E	9842	100	YES	15.0	5	1.000	1.000	1.00	1.00
216L	.09	1.00	1					A015	CARDAK	37:47N	29:43E	9842	100	YES	3.0	2	1.000	1.000	1.00	1.00
217L	.01	1.00	1					A016	ANTALYA	36:54N	30:49E	11155	100	YES	15.0	5	1.000	1.000	1.00	1.00
121L	.05	1.00	1					A017	ETIMESGUT	39:57N	32:44E	7218	100	YES	15.0	7	1.000	1.000	1.00	1.00
121L	.06	1.00	2					A018	ESENBOGA	40:07N	33:03E	12302	100	YES	50.0	20	1.000	1.000	1.00	1.00
122L	.01	1.00	1	121L	.07	1.00	3	A019	AKINCI	40:05N	32:36E	10990	100	YES	15.0	5	1.000	1.000	1.00	1.00
123L	.02	1.00	1					A020	ERKILET	38:46N	35:33E	11151	100	YES	40.0	40	1.000	1.000	1.00	1.00
103L	.01	1.00	1	102L	.32	1.00	2	A021	INCIRLIK	37:00N	35:28E	10000	100	YES	25.0	5	1.000	1.000	1.00	1.00
124L	.23	1.00	2					A022	SAMSUN	41:16N	36:22E	5315	100	YES	3.0	2	1.000	1.000	1.00	1.00
124L	.22	1.00	1					A023	SIVAS	39:49N	36:58E	12500	100	YES	7.0	2	1.000	1.000	1.00	1.00
102L	.31	1.00	1	103L	.04	1.00	2	A024	SAKIRPASA	36:59N	35:20E	9022	100	YES	8.0	3	1.000	1.000	1.00	1.00
101L	.21	1.00	1					A025	ERHAC	39:16N	38:09E	10990	100	YES	15.0	5	1.000	1.000	1.00	1.00
109L	.01	1.00	1					A026	DIYARBAKIR	37:54N	40:17E	11644	100	YES	20.0	5	1.000	1.000	1.00	1.00
NONE	....	....						A027	SURFA	37:06N	38:56E	7103	100	NO	3.0	2	1.000	1.000	1.00	1.00
NONE	....	....						A028	OGUZELI	36:57N	37:33E	9186	100	YES	3.0	2	1.000	1.000	1.00	1.00
117L	.01	1.00	1					A029	MUS	38:45N	42:05E	11647	100	YES	15.0	3	1.000	1.000	1.00	1.00
NONE	....	....						A030	SIIRT	37:59N	41:56E	5448	100	NO	2.0	1	1.000	1.000	1.00	1.00
127L	.03	1.00	1					A031	KARS	40:34N	43:13E	11483	100	YES	5.0	2	1.000	1.000	1.00	1.00
129L	.03	1.00	1					A032	VAN	38:28N	43:26E	9022	100	YES	5.0	2	1.000	1.000	1.00	1.00
126L	.03	1.00	1					A033	ERZURUM	39:57N	41:16E	12500	100	YES	15.0	5	1.000	1.000	1.00	1.00
120L	.01	1.00	1					A034	KONYA	37:58N	32:36E	10991	100	YES	15.0	5	1.000	1.000	1.00	1.00
110L	.01	1.00	1					A035	BATMAN	37:55N	41:13E	10009	100	YES	5.0	3	1.000	1.000	1.00	1.00
130L	.03	1.00	1					A036	ERZINCAN	39:43N	39:36E	9843	100	YES	5.0	3	1.000	1.000	1.00	1.00
125L	.02	1.00	1					A037	TRABZON	41:00N	39:52E	8661	100	YES	3.0	2	1.000	1.000	1.00	1.00

A I R D R O P   F I L E ::::::::::: ../output/ ::::::::::: A I R D R O P   F I L E

AIRDROP DATA

ID	FULL NAME	LATITUDE	LONGITUDE	A/C TYPE	STAGING BASE	INGRESS PS/CPND	DROP PS	EGRESS PS/CPND	RECOVERY BASE	A/C TYPE	STAGING BASE	INGRESS PS/CPND	DROP PS	EGRESS PS/CPND	RECOVERY BASE
201E	EDIRNE	41:42N	26:35E	C130E	A012	1.0000/1.00	1.00	1.0000/1.00	A012						
208E	IPSALA	41:12N	26:25E	C130E	A017	1.0000/1.00	1.00	1.0000/1.00	A017						

A I R B A S E   T O   D E L I V E R Y   D A T A :::: ../output/ :::: A I R BA S E   T O   D E L I V E R Y   D A T A

ID	FULL NAME	LATITUDE	LONGITUDE	RNWY LENGTH	LCN	FUEL AVAIL	SPOTS	A/C MOG	GPS /DAY	C PRB NO BD	SERVLOAD FACFAC	SITE ID	TRANSIT DAYS	TRANSIT PS	PREF	SITE ID	TRANSIT DAYS	TRANSIT PS
	AIRBASE											ASSOCIATED DESTINATIONS						
A001	CORLU	41:08N	27:56E	9845	100	YES	15.0	5	1.000	1.000	1.000+E+	207L	.15	1.00	2	201E	.16	1.00
A001	CORLU	41:08N	27:56E	9845	100	YES	15.0	5	1.000	1.000	1.000+E+	208E	.16	1.00	1			
A002	ATATURK	40:58N	28:49E	9842	100	YES	100.0	999	1.000	1.000	1.000+E+	201E	.29	1.00	2	208E	.29	1.00
A002	ATATURK	40:58N	28:49E	9842	100	YES	100.0	999	1.000	1.000	1.000+E+	207L	.12	1.00	1			
A003	CANAKKALE	40:08N	26:25E	5905	100	NO	1.0	1	1.000	1.000	1.000+E+	202L	.01	1.00	1			
A004	BANDIRMA	40:19N	27:56E	9997	100	YES	20.0	5	1.000	1.000	1.000+E+	202L	.25	1.00	2	204L	.01	1.00
A005	BALIKESIR	39:37N	27:56E	9810	100	YES	15.0	5	1.000	1.000	1.000+E+	206L	.25	1.00	1	205L	.01	1.00
A006	CIGLI	38:30N	27:00E	9808	100	YES	15.0	5	1.000	1.000	1.000+E+	206L	.29	1.00	2	214L	.01	1.00
A007	AMENDERES	38:17N	27:10E	10630	100	YES	90.0	10	1.000	1.000	1.000+E+	214L	.07	1.00	2			
A008	AKHISAR	38:48N	27:51E	9813	100	YES	15.0	5	1.000	1.000	1.000+E+	218L	.01	1.00	1			
A009	KUTAHYA	39:25N	30:03E	4950	8	YES	2.0	1	1.000	1.000	1.000+E+	NONE	.....	....	...			
A010	BURSA	40:14N	29:01E	4593	100	YES	2.0	1	1.000	1.000	1.000+E+	NONE	.....	....	...			
A011	YENISEHIR	40:15N	29:34E	9810	100	YES	15.0	5	1.000	1.000	1.000+E+	NONE	.....	....	...			
A012	ESKISEHIR	39:47N	30:37E	10000	100	YES	15.0	5	1.000	1.000	1.000+E+	111L	.01	1.00	1			
A013	AFYON	38:43N	30:38E	9840	100	YES	15.0	5	1.000	1.000	1.000+E+	NONE	.....	....	...			
A014	DALAMAN	36:43N	28:48E	9842	100	YES	15.0	5	1.000	1.000	1.000+E+	215L	.01	1.00	1			
A015	CARDAK	37:47N	29:43E	9842	100	YES	3.0	2	1.000	1.000	1.000+E+	216L	.09	1.00	1			
A016	ANTALYA	36:54N	30:49E	11155	100	YES	15.0	5	1.000	1.000	1.000+E+	217L	.01	1.00	1			
A017	ETIMESGUT	39:57N	32:44E	7218	100	YES	15.0	7	1.000	1.000	1.000+E+	121L	.05	1.00	1			
A018	ESENBOGA	40:07N	33:03E	12302	100	YES	50.0	20	1.000	1.000	1.000+E+	121L	.06	1.00	2			
A019	AKINCI	40:05N	32:36E	10990	100	YES	15.0	5	1.000	1.000	1.000+E+	121L	.07	1.00	3	122L	.01	1.00
A020	ERKILET	38:46N	35:33E	11151	100	YES	40.0	40	1.000	1.000	1.000+E+	123L	.02	1.00	1			
A021	INCIRLIK	37:00N	35:28E	10000	100	YES	25.0	5	1.000	1.000	1.000+E+	102L	.32	1.00	2	103L	.01	1.00
A022	SAMSUN	41:16N	36:22E	5315	100	YES	3.0	2	1.000	1.000	1.000+E+	124L	.23	1.00	2			
A023	SIVAS	39:49N	36:58E	12500	100	YES	7.0	2	1.000	1.000	1.000+E+	124L	.22	1.00	1			
A024	SAKIRPASA	36:59N	35:20E	9022	100	YES	8.0	3	1.000	1.000	1.000+E+	103L	.04	1.00	2	102L	.31	1.00
A025	ERHAC	39:16N	38:09E	10990	100	YES	15.0	5	1.000	1.000	1.000+E+	101L	.21	1.00	1			
A026	DIYARBAKIR	37:54N	40:17E	11644	100	YES	20.0	5	1.000	1.000	1.000+E+	109L	.01	1.00	1			
A027	SURFA	37:06N	38:56E	7103	100	NO	3.0	2	1.000	1.000	1.000+E+	NONE	.....	....	...			
A028	OGUZELI	36:57N	37:33E	9186	100	YES	3.0	2	1.000	1.000	1.000+E+	NONE	.....	....	...			
A029	MUS	38:45N	42:05E	11647	100	YES	15.0	3	1.000	1.000	1.000+E+	117L	.01	1.00	1			
A030	SIIRT	37:59N	41:56E	5448	100	NO	2.0	1	1.000	1.000	1.000+E+	NONE	.....	....	...			
A031	KARS	40:34N	43:13E	11483	100	YES	5.0	2	1.000	1.000	1.000+E+	127L	.03	1.00	1			
A032	VAN	38:28N	43:26E	9022	100	YES	5.0	2	1.000	1.000	1.000+E+	129L	.03	1.00	1			
A033	ERZURUM	39:57N	41:16E	12500	100	YES	15.0	5	1.000	1.000	1.000+E+	126L	.03	1.00	1			
A034	KONYA	37:58N	32:36E	10991	100	YES	15.0	5	1.000	1.000	1.000+E+	120L	.01	1.00	1			
A035	BATMAN	37:55N	41:13E	10009	100	YES	5.0	3	1.000	1.000	1.000+E+	110L	.01	1.00	1			
A036	ERZINCAN	39:43N	39:36E	9843	100	YES	5.0	3	1.000	1.000	1.000+E+	130L	.03	1.00	1			
A037	TRABZON	41:00N	39:52E	8661	100	YES	3.0	2	1.000	1.000	1.000+E+	125L	.02	1.00	1			
A039	MERZIFON	40:50N	35:34E	9584	100	YES	10.0	3	1.000	1.000	1.000+E+	128L	.03	1.00	1			

A I R B A S E   T O   D E L I V E R Y   D A T A :::: ../output/ :::: A I R BA S E   T O   D E L I V E R Y   D A T A

(LISTED ALPHABETICALLY BY DELIVERY SITE)

ASSOCIATED AIRBASES

BASE ID	TRANSIT DAYS	TRANSIT PS	PREF	BASE ID	TRANSIT DAYS	TRANSIT PS	PREF	BASE ID	TRANSIT DAYS	TRANSIT PS	PREF	BASE ID	TRANSIT DAYS	TRANSIT PS	PREF
A025	.21	1.00	1												
A024	.31	1.00	1	A021	.32	1.00	2								
A021	.01	1.00	1	A024	.04	1.00	2								
A026	.01	1.00	1												
A035	.01	1.00	1												

DESTINATION

ID	FULL NAME	LATITUDE	LONGITUDE
101L	MALATYA	39:16N	38:09E
102L	HATAY	36:14N	36:14E
103L	ADANA	36:59N	35:20E
109L	DIYARBAKIR	37:54N	40:17E
110L	BATMAN	37:55N	41:13E

```
A012   .01 1.00   1
A029   .01 1.00   1
A034   .01 1.00   1
A017   .05 1.00   1   A018   .06 1.00   2   A019   .07 1.00   3
A019   .01 1.00   1
A020   .02 1.00   1
A023   .22 1.00   1   A022   .23 1.00   2
A037   .02 1.00   1
A033   .03 1.00   1
A031   .03 1.00   1
A039   .03 1.00   1
A032   .03 1.00   1
A036   .03 1.00   1
A001   .16 1.00   1   A002   .29 1.00   2
A003   .01 1.00   1   A004   .25 1.00   2
A004   .01 1.00   1
A005   .01 1.00   1
A005   .25 1.00   1   A006   .29 1.00   2
A002   .12 1.00   1   A001   .15 1.00   2
A001   .16 1.00   1   A002   .29 1.00   2
A006   .01 1.00   1   A007   .07 1.00   2
A014   .01 1.00   1
A015   .09 1.00   1
A016   .01 1.00   1
A008   .01 1.00   1
```

```
111L  ESKISEHIR   39:47N   30:37E
117L  MUS         38:45N   41:4
120L  KONYA       37:58N   32:36E
121L  ANKARA      40:07N   33:03E
122L  AKINCI      40:05N   32:36E
123L  KAYSERI     38:46N   35:33E
124L  TOKAT       40:21N   36:39E
125L  TRABZON     41:00N   36:49
126L  ERZURUM     39:57N   41:16E
127L  KARS        40:34N   43:13E
128L  MERZIFON    40:50N   35:34E
129L  VAN         38:28N   43:26E
130L  ERZINCAN    39:43N   39:36
201E  EDIRNE      41:42N   26:35E
202L  CANAKKALE   40:08N   26:25E
204L  BANDIRMA    40:19N   27:56E
205L  BALIKESIR   39:37N   27:56E
206L  BERGAMA     39:10N   27:10E
207L  CATALCA     41:12N   28:30E
208E  IPSALA      41:12N   26:25E
214L  CIGLI       38:30N   27:00E
215L  DALAMAN     36:43N   28:48E
216L  DENIZLI     37:46N   29:09E
217L  ANTALYA     36:54N   30:49E
218L  AKHISAR     38:48N   27:51E
```

```
        ::::::::  B E D D O W N   F I L E  ::::::::    ../output/    ::::::::  BE D D O W N   F I L E  ::::::::
                                                          - - - - - AIRCRAFT BEDDOWN - - - - - - -
                                       RNWY        FUEL        A/C  GPS   C PRB SERV   LOAD  TOTAL TOTAL  QTY   QTY
 ID   FULL NAME  LATITUDE LONGITUDE  LENGTH  LCN  AVAIL SPOTS  MOG /DAY   NO BD FAC    FAC   SPOTS  A/C  C130E C160A
A020  ERKILET     38:46N    35:33E   11151   100   YES   40.0   40 1.000 1.0000+E+   1.00   34.0   34    14    20
```

Airbase Characteristics: This report provides the data describing all the airbases used in the scenario.

RNWY ID	BASE DAY FULL NAME	NTE LATITUDE	FUEL LONGITUDE	A/C SERV LENGTH	PIPE ELEV	LOAD TMP	TMP	GPS LCN	C PRB Y/N	ATKS SPOTS	MOG	CUTS FAC	REP DELAY	REP FAC	/DAY	NO BD	/DAY	/ATK	TIME SD
A001	CORLU	41:08N	27:56E	9845	569	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A002	ATATURK	40:58N	28:49E	9842	158	86	63	100	YES	100.0	999	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A003	CANAKKALE	40:08N	26:25E	5905	23	86	63	100	NO	1.0	1	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A004	BANDIRMA	40:19N	27:56E	9997	167	86	63	100	YES	20.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A005	BALIKESIR	39:37N	27:56E	9810	331	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A006	CIGLI	38:30N	27:00E	9808	17	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A007	AMENDERES	38:17N	27:10E	10630	412	96	63	100	YES	90.0	10	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A008	AKHISAR	38:48N	27:51E	9813	245	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A009	KUTAHYA	39:25N	30:03E	4950	3021	86	53	8	YES	2.0	1	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A010	BURSA	40:14N	29:01E	4593	331	86	63	100	YES	2.0	1	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A011	YENISEHIR	40:15N	29:34E	9810	760	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A012	ESKISEHIR	39:47N	30:37E	10000	2579	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A013	AFYON	38:43N	30:38E	9840	3313	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A014	DALAMAN	36:43N	28:48E	9842	20	96	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A015	CARDAK	37:47N	29:43E	9842	2795	89	63	100	YES	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A016	ANTALYA	36:54N	30:49E	11155	177	96	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A017	ETIMESGUT	39:57N	32:44E	7218	2622	86	59	100	YES	15.0	7	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A018	ESENBOGA	40:07N	33:03E	12302	3125	86	60	100	YES	50.0	20	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A019	AKINCI	40:05N	32:36E	10990	2765	86	55	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A020	ERKILET	38:46N	35:33E	11151	3506	86	53	100	YES	40.0	40	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A021	INCIRLIK	37:00N	35:28E	10000	238	86	63	100	YES	25.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A022	SAMSUN	41:16N	36:22E	5315	524	86	63	100	YES	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A023	SIVAS	39:49N	36:58E	12500	5236	86	53	100	YES	7.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A024	SAKIRPASA	36:59N	35:20E	9022	65	86	63	100	YES	8.0	3	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A025	ERHAC	39:16N	38:09E	10990	2828	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A026	DIYARBAKIR	37:54N	40:17E	11644	2254	86	63	100	YES	20.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A027	SURFA	37:06N	38:56E	7103	1483	86	63	100	NO	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A028	OGUZELI	36:57N	37:33E	9186	2316	86	63	100	YES	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A029	MUS	38:45N	42:05E	11647	2254	86	63	100	YES	15.0	3	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A030	SIIRT	37:59N	41:56E	5448	2001	86	53	100	NO	2.0	1	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A031	KARS	40:34N	43:13E	11483	5889	86	53	100	YES	5.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A032	VAN	38:28N	43:26E	9022	5474	86	63	100	YES	5.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A033	ERZURUM	39:57N	41:16E	12500	5764	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A034	KONYA	37:58N	32:36E	10991	3382	86	63	100	YES	15.0	5	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A035	BATMAN	37:55N	41:13E	10009	3382	86	63	100	YES	5.0	3	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A036	ERZINCAN	39:43N	39:36E	9843	3793	86	63	100	YES	5.0	3	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A037	TRABZON	41:00N	39:52E	8661	104	86	63	100	YES	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A039	MERZIFON	40:50N	35:34E	9584	1783	86	63	100	YES	10.0	3	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE
A040	TOPEL	40:44N	30:06E	9842	174	86	63	100	NO	3.0	2	1.00	0.	1.00	1.000	1.000	NONE		NOT APPLICABLE

Airlifter Characteristics: This report consists of five reports: Airlifter Characteristics Report, Survivability Factors, No battle Damage Conditional Probability Factors, Survival Probability of No battle Damage.

A I R L I F T E R   C H A R A C T E R I S T I C S :: ../output/ :: A I R L I F T E R   C H A R A C T E R I S T I C S

AIRLIFTER TYPE	C130E				C160A			
	- SEA LEVEL -		- 4000 FEET -		- SEA LEVEL -		- 4000 FEET -	
	HOT	COLD	HOT	COLD	HOT	COLD	HOT	COLD
	95 F	60 F	70 F	40 F	95 F	60 F	70 F	40 F
CTOL MAX USEFUL LOAD (LBS)	75000	75000	75000	75000	33069	42218	29120	37310
CTOL TO AT MAX USEFUL LOAD (FT)	4300	4100	5150	4500	3150	3050	3200	3000
CTOL LD AT MAX USEFUL LOAD (FT)	4300	3750	5700	4400	6300	4600	6200	5600
CTOL MID USEFUL LOAD (LBS)	37500	37500	37500	37500	22046	22046	22046	22046
CTOL TO AT MID USEFUL LOAD (FT)	3150	3000	3450	3150	3100	2850	3100	2900
CTOL LD AT MID USEFUL LOAD (FT)	3300	2050	3000	2350	5600	4500	5500	4900
CTOL TO AT ZERO USEFUL LOAD (FT)	1350	1300	1450	1380	1500	1400	1700	1600
CTOL LD AT ZERO USEFUL LOAD (FT)	2350	2250	2400	2300	2100	2000	2400	2300
LCN - MAX USEFUL LOAD (NO)	32				10			
LCN - AT ZERO USEFUL LOAD (NO)	9				2			
MAXIMUM FERRY FUEL (LBS)	60112				31255			
MAXIMUM CABIN PAYLOAD (LBS)	39599				35273			
CRUISE FUEL (LBS/HR)	5300.				2800.			
CRUISE SPEED (KNOTS)	260				220			
CARGO BAY WIDTH (INCH)	120				120			
CARGO BAY HEIGHT (INCH)	108				108			
CARGO BAY LENGTH (INCH)	587				587			
CARGO BAY DOOR WIDTH (INCH)	120				120			
CARGO BAY DOOR HEIGHT (INCH)	108				108			
MISSION ESSENTIAL FHBF (HRS)	2.34				2.34			
NON MISN ESSENTIAL FHBF (HRS)	99.99				99.99			
MEAN TIME TO REPAIR (HRS)	2.40				2.40			
MTTR STANDARD DEVIATION (NO)	.83				.83			
MEAN TIME TO SERVICE (HRS)	.50				.75			
MTTS STANDARD DEVIATION (NO)	.05				.08			
MEAN TIME TO LOAD (HRS)	.48				.72			
MTTL STANDARD DEVIATION (NO)	.04				.06			
LOAD FAC FOR ROLLING STOCK (NO)	1.25				1.90			
MEAN TIME TO UNLOAD (HRS)	.48				.72			
MTTU STANDARD DEVIATION (NO)	.04				.04			
UNLD FAC FOR ROLLING STOCK (NO)	.94				1.42			
MEAN TIME TO REPAIR BATTLE DAMAGE (HRS)	132.00				132.00			
MTTRBD STANDARD DEVIATION (NO)	115.00				115.00			
AIRCRAFT SPOT FACTOR (NO)	1.00				1.00			
VULNERABILITY EXPONENT (NO)	1.00				1.00			
RESERVE FUEL (HRS)	1.00				1.00			
TAKEOFF/LANDING FUEL BIAS(LBS)	-5.0				-6.0			
PAYLOAD MARGIN NEXT FLT (LBS)	4600.				4600.			
TAXI, TAKEOFF & LANDING TIME (HRS)	.42				.42			
CARGO THRSHLD FOR RELOCATION (LBS)	9200.				9200.			
PALLET ROTATION FLAG	NO				NO			

Operational Parameters: This report lists key parameters that influence the decision algorithms of the model. And contains two reports; Survivability Job Scheduler, Airlift Job Deletion Times.

Flight Schedule - Load Times: This section lists the times (24 hour clock) during each day that loading/relocation occurs. Up to 100 times per day can be specified. This report also gives the random number seeds. Random number seed (1) is used to seed the probability of survival calculations and random number seed (2) is used to seed all other random number calculations. This report is generated from model input.

```
::::: O P E R A T I O N A L   P A R A M E T E R S :::::  ../output/  ::::: O P ER A T I O N A L   P A R A M E T E R S
                              =======  S U R V I V A B I L I T Y   J O B   S C HE D U L E R  =======
         FLIGHTS WILL ONLY BE SCHEDULED IF                                    FLIGHTS WILL ONLY BE SCHEDULED IF
          ENROUTE PS IS BETTER THAN SHOWN                                 24 HR PS AT LANDING IS BETTER THAN SHOWN FOR
   FOR HIGHEST PRIORITY JOB OR FOR A RELOCATION                             HIGHEST PRIORITY JOB OR FOR A RELOCATION
 - - - - - - - - PRIORITY - - - - - - - -        RELO       - - - -- - - PRIORITY - - - - - - - -        RELO
 1      2      3      4      5      6      7      8      -NA-       1      2  3      4      5      6      7      8  NA-
900   .900   .900   .900   .900   .900   .900   .900   .900     0.     0.     0.     0.     0.     0.     0.     0  0.
                           =======  A I R L I F T   J O B   D E L E T I O N   T IM E S  =======
                                AIRLIFT JOBS ARE DELETED WHEN CURRENT TIME EXCEEDES
                                  LISTED TIME PLUS DESIRED DELIVERY TIME IN (DAYS)
                          - - - - - -  PRIORITY - - - - - - - - - - - - - - - -
                           1          2          3          4          5          6          7          8
                          30.0       30.0       30.0       30.0       30.0       30.0       30.0       30.0
                      ======= F L I G H T   S C H E D U L E  -  L O A D   T I M E S  =======
                              1      2      3      4      5      6      7      8      9      10     11     12
TIME LOADING COMMENCES      0029   0058   0126   0155   0224   0253   0322   0350   0419   0448   0517   0546
RELOCATION AUTHORIZED         Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y
                             13     14     15     16     17     18     19     20     21     22     23     24
TIME LOADING COMMENCES      0614   0643   0712   0741   0810   0838   0907   0936   1005   1034   1102   1131
RELOCATION AUTHORIZED         Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y
                             25     26     27     28     29     30     31     32     33     34     35     36
TIME LOADING COMMENCES      1200   1229   1258   1326   1355   1424   1453   1522   1550   1619   1648   1717
RELOCATION AUTHORIZED         Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y
                             37     38     39     40     41     42     43     44     45     46     47     48
TIME LOADING COMMENCES      1746   1814   1843   1912   1941   2010   2038   2107   2136   2205   2234   2302
RELOCATION AUTHORIZED         Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y      Y
                             49     50
TIME LOADING COMMENCES      2331   2346
RELOCATION AUTHORIZED         Y      Y
                                              TIME OF AVERAGE AIRBASE TEMPERATURE
                                                             1000

 RANDOM NUMBER SEEDS FOR RUN   #   1 SEED(1) =  2116429300 SEED(2) =   683743814
 RANDOM NUMBER SEEDS AFTER RUN #   1 SEED(1) =  1364845499 SEED(2) =  1673540626
```

Airlift Jobs by Day: This report gives summary information by type of material entering or requiring delivery on a particular day during the scenario.

A I R L I F T   J O B S   B Y   D A Y   :::::   ../output/:::::   A I R L I F T   J O B S   B Y   D A Y

DAY OF SIMULATION	PAX ENTRY TONS	BULK ENTRY TONS	OVERSIZE ENTRY TONS	FUEL ENTRY TONS	TOTAL ENTRY TONS	PAX DELIVERY TONS	BULK DELIVERY TONS	OVERSIZE DELIVERY TONS	FUEL DELIVERY TONS	TOTAL LIVERY TONS
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	135	57	324	15	532	0	0	0	0	0
5	147	38	58	12	255	80	19	267	3	369
6	435	309	1209	396	2348	147	38	58	12	255
7	444	183	2098	24	2750	555	73	1367	15	2009
8	176	809	116	307	1408	55	584	1074	500	2213
9	39	171	834	57	1101	401	169	526	57	1153
10	519	1388	1568	788	4262	138	1014	1347	282	2782
11	176	370	655	82	1283	382	396	1107	82	1966
12	174	222	326	285	1007	313	1127	1081	763	3284
13	215	622	2500	157	3494	147	399	267	85	898
14	86	613	415	112	1226	242	893	2974	412	4521
15	176	232	326	285	1019	86	190	0	82	358
16	244	719	1378	548	2889	164	272	646	45	1127
17	65	45	0	37	147	146	168	690	237	1242
18	164	302	682	45	1192	190	629	782	548	2148
19	406	343	1245	42	2037	149	89	267	15	520
20	358	116	469	0	942	166	349	1714	42	2271
21	334	50	35	0	419	334	130	35	12	511
22	724	362	1253	33	2372	596	324	925	30	1875
23	371	100	245	0	716	462	88	328	3	881
24	348	263	379	30	1021	385	313	660	30	1388
25	414	129	267	3	813	334	50	0	0	384
26	578	473	415	30	1496	659	552	646	33	1890
27	334	50	35	0	419	334	50	0	0	384
28	576	253	379	30	1239	578	263	379	30	1251
29	301	60	0	0	361	562	40	35	0	637
30	88	0	0	0	88	336	60	35	0	431
TOTALS	8028	8276	17211	3318	36833	7940	8276	17211	3318	36745
DAILY AVGS	268	276	574	111	1228	265	276	574	111	1225

Airlift Jobs File : This report provides entry/delivery site, information in terms of time, latitude and longitude of the individual jobs.

A I R L I F T J O B S F I L E :::: ../output ::::A I R L I F T J O B S F I L E

AIRLIFT JOB DESCRIPTION	JOB NO	ORIGINATION SITE INFO IDEN	NAME	LAT	LONG	DAY	TIME	DESTINATION SITE INFO IDEN	NAME	LAT	LONG	DAY	TIME	DIMENSIONS WH	LH	HT	JOB WEIGHT	JOB PRI	JOB QTY
AMMO	9	121L	ANKARA	40:07N	33:03E	4	0000	215L	DALAMAN	36:43N	28:48E	6	0000	0	0	0	40000	6	1
FUEL	9	121L	ANKARA	40:07N	33:03E	4	0000	215L	DALAMAN	36:43N	28:48E	6	0000	0	0	0	24000	6	1
PAX	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	0	0	0	110000	3	1
BULK	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	0	0	0	36000	3	1
463L PALLE	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	108	88	20	354	3	20
C-1 STAND	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	47	48	82	160	3	1
VEH SPARES	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	55	55	52	650	3	1
HEATER,H-1	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	40	73	46	580	3	2
HEATER,H-1	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	58	78	43	1260	3	1
MC-2A SHO	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	48	89	39	760	3	5
B-4 MAINT	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	53	96	36	540	3	3
COMPRESSOR	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	70	99	70	1220	3	4
NF-2 LITE	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	68	101	59	2040	3	1
TSTR PRESS	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	60	105	57	2800	3	1
TRACTOR,AG	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	75	121	93	4240	3	1
GENERATOR	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	55	123	68	3060	3	5
TRLR,COMP	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	60	126	55	3400	3	2
TEST STAND	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	77	126	86	5120	3	3
TRLR,F-2	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	48	147	62	1600	3	2
MJ-1 SHORI	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	54	148	42	3840	3	2
TRLR,ACFT	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	60	154	63	740	3	6
TRLR,30T	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	65	155	86	2300	3	1
TMAC ACFT	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	79	161	97	11120	3	1
MJ-4 SHORI	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	77	181	42	6600	3	1
MAINT PLAT	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	59	186	48	1080	3	1
TANK DOLLY	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	79	199	87	1424	3	1
TRLR,30T	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	60	213	85	4540	3	2
TOWBAR,SHO	1	101L	MALATYA	39:16N	38:09E	4	0600	205L	BALIKESIR	39:37N	27:56E	6	0600	58	297	32	500	3	2
PAX	14	110L	BATMAN	37:55N	41:13E	4	1424	117L	MUS	38:45N	41:45E	5	0224	0	0	0	160300	1	1
BULK	14	121L	ANKARA	40:07N	33:03E	4	1424	218L	AKHISAR	38:48N	27:51E	5	0224	0	0	0	14000	1	1
AMMO	14	109L	DIYARBAKIR	37:54N	40:17E	4	1424	218L	AKHISAR	38:48N	27:51E	5	0224	0	0	0	24000	1	1
FUEL	14	109L	DIYARBAKIR	37:54N	40:17E	4	1424	217L	ANTALYA	36:54N	30:49E	5	0224	0	0	0	6000	1	1
TRK,5/4T,M	14	109L	DIYARBAKIR	37:54N	40:17E	4	1424	207L	CATALCA	41:12N	28:30E	5	0224	83	223	76	5920	1	24
TRLR,1/4T,	14	109L	DIYARBAKIR	37:54N	40:17E	4	1424	207L	CATALCA	41:12N	28:30E	5	0224	61	108	43	620	1	2
TRLR,CARGO	14	109L	DIYARBAKIR	37:54N	40:17E	4	1424	207L	CATALCA	41:12N	28:30E	5	0224	74	147	50	1350	1	16
TRK,5/4T,M	14	111L	ESKISEHIR	39:47N	30:37E	4	1424	207L	CATALCA	41:12N	28:30E	5	0224	85	180	74	7195	1	21
TRK,5/4T,M	14	111L	ESKISEHIR	39:47N	30:37E	4	1424	218L	AKHISAR	38:48N	27:51E	5	0224	84	181	53	5280	1	21
AMBULANCE,	14	111L	ESKISEHIR	39:47N	30:37E	4	1424	218L	AKHISAR	38:48N	27:51E	5	0224	91	228	102	7370	1	4
TRK,5/4T,M	14	111L	ESKISEHIR	39:47N	30:37E	4	1424	218L	AKHISAR	38:48N	27:51E	5	0224	85	186	74	6104	1	10
TRLR,1 1/2	14	111L	ESKISEHIR	39:47N	30:37E	4	1424	207L	CATALCA	41:12N	28:30E	5	0224	83	166	55	2670	1	1

The rest is in the same format.

Appendix F: Statistical Results From Multiple Runs for Total Tons Delivered.

Basic Statistics on Replications from West Scenario (Current Fleet)

Enter a vector of data to be analyzed:

$$data := \begin{bmatrix} 24444 \\ 24695 \\ 24649 \\ 24950 \\ 24483 \\ 24538 \\ 24983 \\ 24890 \\ 24783 \\ 24961 \end{bmatrix}$$

Number of data points:

$n := length(data)$

$n = 10$

$SD(x) := stdev(x) \cdot \sqrt{\frac{n}{n-1}}$

Mean

$mean(data) = 24737.6$

Median

$median(data) = 24739$

Standard dev.

$SD(data) = 205.766$

Variance

$SD(data)^2 = 42339.6$

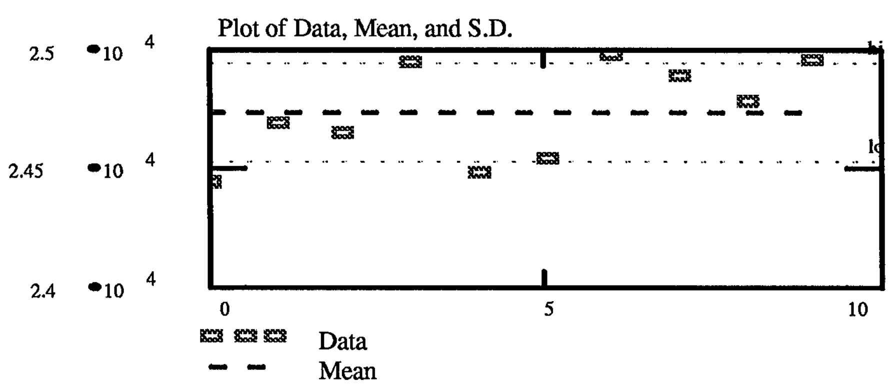
$i := 0 .. n-1$

$hi := mean(data) + SD(data)$

$hi = 24943.366$

$lo := mean(data) - SD(data)$

$lo = 24531.834$



Basic Statistics on Replications from West Scenario (27 C-130J)

Enter a vector of data to be analyzed:

$$data := \begin{bmatrix} \begin{bmatrix} 24683 \\ 24815 \\ 24302 \\ 24554 \\ 24984 \\ 24807 \\ 24409 \\ 24562 \\ 24684 \\ 24323 \end{bmatrix} \end{bmatrix}$$

Number of data points:

$n := \text{length}(data)$

$n = 10$

$SD(x) := \text{stdev}(x) \cdot \sqrt{\frac{n}{n-1}}$

Mean

$\text{mean}(data) = 24612.3$

Median

$\text{median}(data) = 24622.5$

Standard dev.

$SD(data) = 224.731$

Variance

$SD(data)^2 = 50504.011$

$i := 0..n-1$

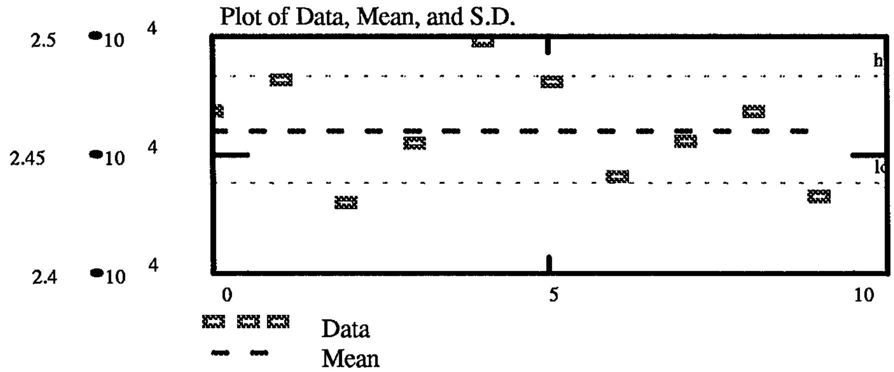
$hi := \text{mean}(data) + SD(data)$

$hi = 24837.031$

$lo := \text{mean}(data) - SD(data)$

$lo = 24387.569$

Plot of Data, Mean, and S.D.



Basic Statistics on Replications from Southeastern Scenario (Current Fleet)

Enter a vector of data to be analyzed:

$$data := \begin{bmatrix} 22902 \\ 22690 \\ 22761 \\ 23087 \\ 23090 \\ 22942 \\ 22656 \\ 22835 \\ 22479 \\ 23017 \end{bmatrix}$$

Number of data points:

$n := length(data)$

$n = 10$

$SD(x) := stdev(x) \cdot \sqrt{\frac{n}{n-1}}$

Mean

$mean(data) = 22845.9$

Median

$median(data) = 22868.5$

Standard dev.

$SD(data) = 200.466$

Variance

$SD(data)^2 = 40186.767$

$i := 0..n-1$

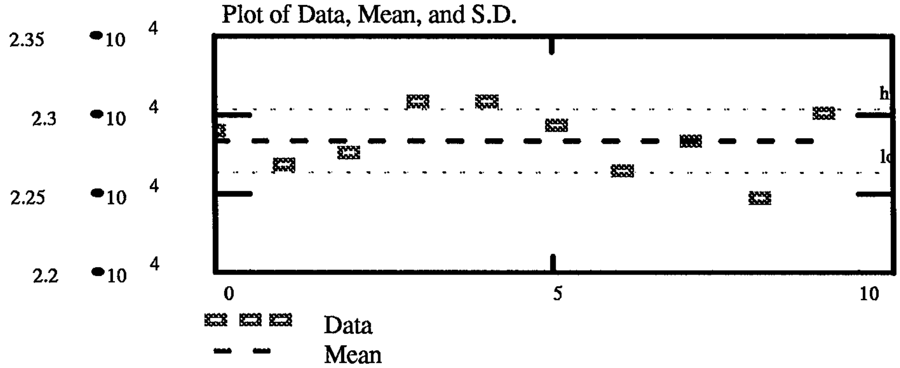
$hi := mean(data) + SD(data)$

$hi = 23046.366$

$lo := mean(data) - SD(data)$

$lo = 22645.434$

Plot of Data, Mean, and S.D.



Basic Statistics on Replications from Southeastern Scenario (19 FLA)

Enter a vector of data to be analyzed:

$$data := \begin{bmatrix} 25018 \\ 24968 \\ 24915 \\ 24504 \\ 25055 \\ 24809 \\ 24983 \\ 24971 \\ 25087 \\ 25114 \end{bmatrix}$$

Number of data points:

n := length(data)

n = 10

$$SD(x) := stdev(x) \cdot \sqrt{\frac{n}{n-1}}$$

Mean

mean(data) = 24942.4

Median

median(data) = 24977

Standard dev.

SD(data) = 177.204

Variance

$SD(data)^2 = 31401.378$

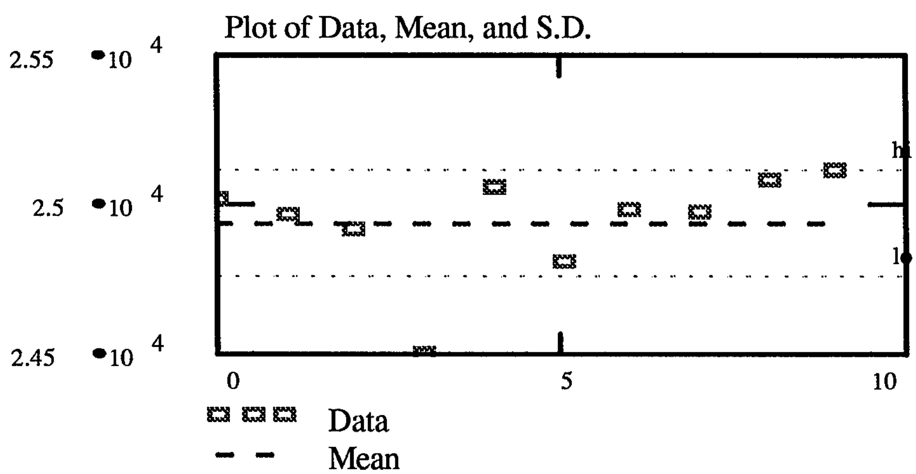
i := 0.. n − 1

hi := mean(data) + SD(data)

hi = 25119.604

lo := mean(data) − SD(data)

lo = 24765.196



Appendix G: Statistical Calculations For Confidence Interval

Confidence Interval for Estimating Mean of Replications Southeastern Scenario (Current Fleet)

Enter data to be tested:

$$X := \begin{bmatrix} 22902 \\ 22690 \\ 22761 \\ 23087 \\ 23090 \end{bmatrix}$$

$n := \text{length}(X)$

$n = 5$

Enter level of significance:

$\alpha := 0.05$

Confidence level:

$1 - \alpha = 95 \cdot \%$

Sample standard deviation:

$$s := \sqrt{\frac{n}{n-1} \cdot \text{var}(X)}$$

Degrees of freedom:

$df := n - 1$

$df = 4$

Limit determination: critical value:

$$t_0 := qt\left(1 - \frac{\alpha}{2}, df\right)$$

$t_0 = 2.776$

upper limit:

$$U := \text{mean}(X) + t_0 \cdot \frac{s}{\sqrt{n}}$$

$U = 23133.528$

$\text{mean}(X) = 22906$

lower limit:

$$L := \text{mean}(X) - t_0 \cdot \frac{s}{\sqrt{n}}$$

$L = 22678.472$

95% Confidence interval (22678,23133)

Confidence Interval for Estimating Mean of Replications Southeastern Scenario (19 FLA)

Enter data to be tested:

$$X := \begin{bmatrix} 25018 \\ 24968 \\ 24915 \\ 25087 \\ 25055 \end{bmatrix}$$

$n := \text{length}(X)$

$n = 5$

Enter level of significance:

$\alpha := 0.05$

Confidence level:

$1 - \alpha = 95 \cdot \%$

Sample standard deviation:

$$s := \sqrt{\frac{n}{n-1} \cdot \text{var}(X)}$$

Degrees of freedom:

$df := n - 1$

$df = 4$

Limit determination: critical value:

$$t_0 := qt\left(1 - \frac{\alpha}{2}, df\right)$$

$t_0 = 2.776$

upper limit:

$$U := \text{mean}(X) + t_0 \cdot \frac{s}{\sqrt{n}}$$

$U = 25093.718$

$\text{mean}(X) = 25008.6$

lower limit:

$$L := \text{mean}(X) - t_0 \cdot \frac{s}{\sqrt{n}}$$

$L = 24923.482$

95% Confidence interval (24923,25093)

Confidence Interval for Estimating Mean of Replications Western Scenario (Current Fleet)

Enter data to be tested:

$$X := \begin{bmatrix} 24444 \\ 24695 \\ 24649 \\ 24562 \\ 24784 \end{bmatrix}$$

$n := \text{length}(X)$

$n = 5$

Enter level of significance:

$\alpha := 0.05$

Confidence level:

$1 - \alpha = 95 \cdot \%$

Sample standard deviation:

$$s := \sqrt{\frac{n}{n-1} \cdot \text{var}(X)}$$

Degrees of freedom:

$df := n - 1$

$df = 4$

Limit determination: critical value:

$$t_0 := qt\left(1 - \frac{\alpha}{2}, df\right)$$

$t_0 = 2.776$

upper limit:

$$U := \text{mean}(X) + t_0 \cdot \frac{s}{\sqrt{n}}$$

$U = 24788.062$

$\text{mean}(X) = 24626.8$

lower limit:

$$L := \text{mean}(X) - t_0 \cdot \frac{s}{\sqrt{n}}$$

$L = 24465.538$

95% Confidence interval
(24465,24788)

Confidence Interval for Estimating Mean of Replications Western Scenario (27 C-130J)

Enter data to be tested:

$$X := \begin{bmatrix} 24683 \\ 24562 \\ 24302 \\ 24554 \\ 24684 \end{bmatrix}$$

$n := \text{length}(X)$

$n = 5$

Enter level of significance:

$\alpha := 0.05$

Confidence level:

$1 - \alpha = 95 \cdot \%$

Sample standard deviation:

$$s := \sqrt{\frac{n}{n-1} \cdot \text{var}(X)}$$

Degrees of freedom:

$df := n - 1$

$df = 4$

Limit determination: critical value:

$$t_0 := qt\left(1 - \frac{\alpha}{2}, df\right)$$

$t_0 = 2.776$

upper limit:

$$U := \text{mean}(X) + t_0 \cdot \frac{s}{\sqrt{n}}$$

$U = 24750.421$

$\text{mean}(X) = 24557$

lower limit:

$$L := \text{mean}(X) - t_0 \cdot \frac{s}{\sqrt{n}}$$

$L = 24363.579$

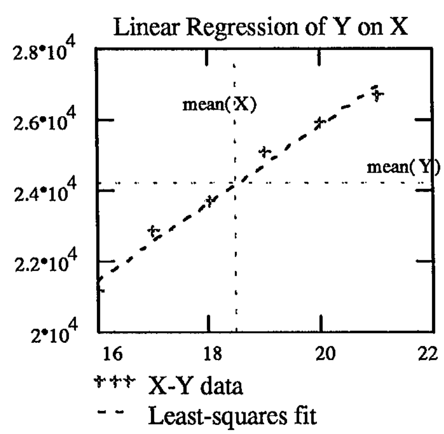
95% Confidence interval
(24363,24750)

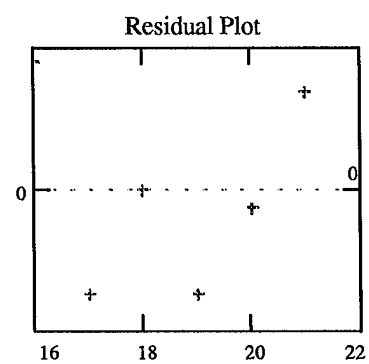
Appendix H: Linear Regression Models

Linear Regression of Southeastern Scenario FLA

Uses **Mathcad** statistical functions for linear regression of X-Y data.

Enter matrix of X-Y data to be analyzed:	**Regression Statistics**	**Correlation coeff.**
$data := \begin{bmatrix} 21150 & 16 \\ 22898 & 17 \\ 23706 & 18 \\ 25096 & 19 \\ 25948 & 20 \\ 26717 & 21 \end{bmatrix}$	**Intercept** $b_0 := \text{intercept}(X, Y)$ $b_0 = 3.969 \cdot 10^3$ **Slope** $b_1 := \text{slope}(X, Y)$ $b_1 = 1.096 \cdot 10^3$ $m := \frac{36800 \quad b_0}{b_1}$ $m = 29.94$	$\text{corr}(X, Y) = 0.9911$ **R²** $\text{corr}(X, Y)^2 = 0.982$ **Covariance** $\text{cvar}(X, Y) = 3.198 \cdot 10^3$ **Plots** $i := 0..n-1$ $r(x) := b_0 + b_1 \cdot x$ $scale := \max\left(\overrightarrow{\lvert r(X) - Y \rvert}\right) \cdot 1.1$
$X := data^{<1>}$ $Y := data^{<0>}$ **Number of data points:** $n := \text{rows}(data)$ $n = 6$		





Linear Regression of Southeastern Scenario C-130J

Uses **Mathcad** statistical functions for linear regression of X-Y data.

Enter matrix of X-Y data to be analyzed:

$$data := \begin{bmatrix} 22198 & 25 \\ 22774 & 26 \\ 23450 & 27 \\ 23852 & 28 \\ 24671 & 29 \\ 25334 & 30 \end{bmatrix}$$

$X := data^{<1>}$

$Y := data^{<0>}$

Number of data points:

$n := rows(data)$

$n = 6$

Regression Statistics

Intercept

$b_0 := intercept(X, Y)$

$b_0 = 6.606 \cdot 10^3$

Slope

$b_1 := slope(X, Y)$

$b_1 = 622.086$

Correlation coeff.

$corr(X, Y) = 0.9972$

$$m := \frac{36800 - b_0}{b_1}$$

$m = 48.53$

R^2

$corr(X, Y)^2 = 0.994$

Covariance

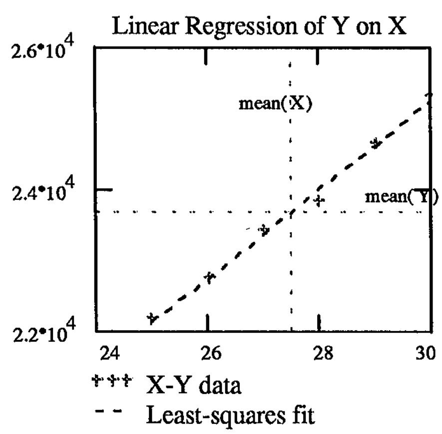
$cvar(X, Y) = 1.814 \cdot 10^3$

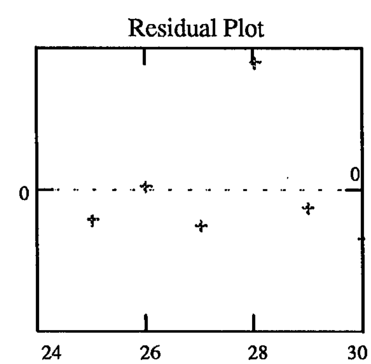
Plots

$i := 0 .. n - 1$

$r(x) := b_0 + b_1 \cdot x$

$scale := max\left(\overrightarrow{\left|r(X) - Y\right|}\right) \cdot 1.1$





Linear Regression of Western Scenario FLA

Uses **Mathcad** statistical functions for linear regression of X-Y data.

Enter matrix of X-Y data to be analyzed:

$$\text{data} := \begin{bmatrix} 21424 & 16 \\ 22768 & 17 \\ 23825 & 18 \\ 25409 & 19 \\ 26638 & 20 \\ 27638 & 21 \end{bmatrix}$$

$X := \text{data}^{\langle 1 \rangle}$

$Y := \text{data}^{\langle 0 \rangle}$

Number of data points:

$n := \text{rows}(\text{data})$

$n = 6$

Regression Statistics

Intercept

$b_0 := \text{intercept}(X, Y)$

$b_0 = 1.22 \cdot 10^3$

Slope

$b_1 := \text{slope}(X, Y)$

$b_1 = 1.265 \cdot 10^3$

Correlation coeff.

$\text{corr}(X, Y) = 0.9984$

$$m \quad \frac{36800 \quad b_0}{b_1}$$

$m \cdot 28.13$

R²

$\text{corr}(X, Y)^2 = 0.997$

Covariance

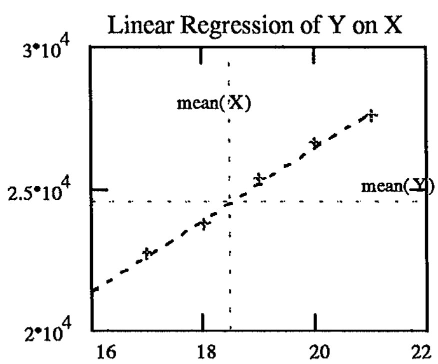
$\text{cvar}(X, Y) = 3.689 \, 10^3$

Plots

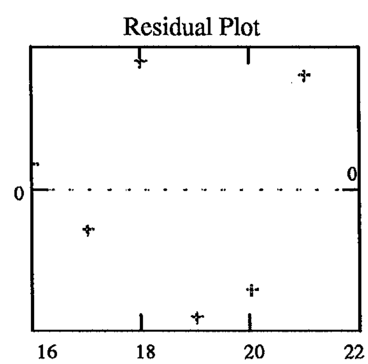
$i := 0 .. n - 1$

$r(x) := b_0 + b_1 \cdot x$

$\text{scale} := \max\left(\overrightarrow{|r(X) - Y|}\right) \cdot 1.1$



+++ X-Y data
- - Least-squares fit



Linear Regression of Western Scenario C-130J

Uses **Mathcad** statistical functions for linear regression of X-Y data.

Enter matrix of X-Y data to be analyzed:

$$data := \begin{bmatrix} 22843 & 25 \\ 23809 & 26 \\ 24583 & 27 \\ 25164 & 28 \\ 25950 & 29 \\ 26394 & 30 \end{bmatrix}$$

$X := data^{<1>}$

$Y := data^{<0>}$

Number of data points:

$n := rows(data)$

$n = 6$

Regression Statistics

Intercept

$b_0 := intercept(X, Y)$

$b_0 = 5.337 \cdot 10^3$

Slope

$b_1 := slope(X, Y)$

$b_1 = 707.4$

$m := \dfrac{36800 \quad b_0}{b_1}$

$m = 44.47$

R^2

Correlation coeff.

$corr(X, Y) = 0.9945$

$corr(X, Y)^2 = 0.989$

Covariance

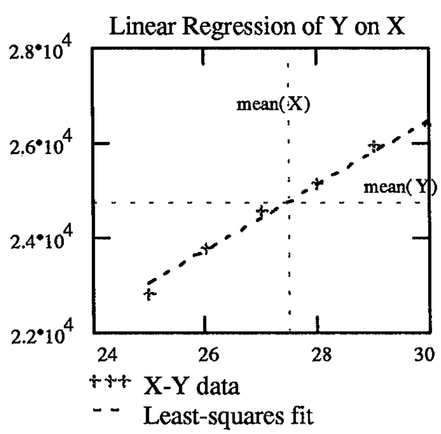
$cvar(X, Y) = 2.063 \cdot 10^3$

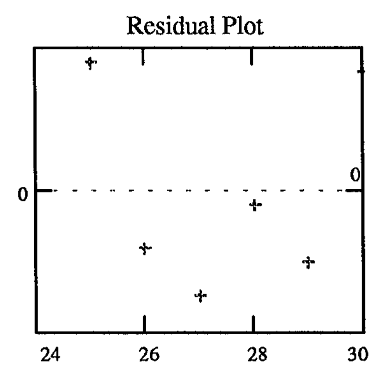
Plots

$i := 0..n-1$

$r(x) := b_0 + b_1 \cdot x$

$scale := max\left(\overrightarrow{|r(X) - Y|}\right) \cdot 1.1$





Appendix I : The First Set of Jobs

Job No.	Description	Pr'ty 1=Hi	Freq	Total Tons Pax	Bulk	Veh	Average Tons/Occ
1	UNIT MOVE, F-16 SQDN	3	4	220	72	230	131
2	UNIT MOVE, F-4 SQDN	3	1	55	657	102	814
3	ROUTINE RESUPPLY, POL/AMM	6	4	108	3184	235	882
4	UNIT MOVE, MLRS BATTERY	1	8	118	3109	5810	1130
5	PERSONNEL MOVE, DIVERTED	7	4	920			230
6	UNIT MOVE, HAWK BATTERY	1	2	38		1260	649
7	UNIT MOVE ATK HEL	3	3	105	120	1305	510
8	UNIT MOVE, NBC DECON COMPANY	1	1	18	61	548	627
9	ROUTINE RESUPPLY, POL/AMM	6	16		512		32
10	AIRDROP BATTALION TASK FORCE	1	1	120	22	203	345
11	AIRLAND BRIGADE	1	1	22	135	972	1335
12	UNIT MOVE,TACTICAL AIRLIFT SQN	4	1	50	29	61	140
13	UNIT MOVE,COMBAT ENGINEERS	4	2	48	23	926	499
14	UNIT MOVE, LIGHT INF BN	1	6	481	132	1601	369
15	UNIT MOVEMENT, BRIGADE	5	2	759	31	2213	1502
16	UNIT MOVE, MLRS BATTALION	3	1	54	649	2669	3371
17	PERSONNEL MOVE, REPLACEMENTS	7	10	2645			265
18	EMER RESUP,AMMO/FOOD/WATER	2	8	1280			160
19	EMERGENCY RESUPPLY, PGM/POL	2	8	400			50
20	ROUTINE RESUPPLY, PAX/REP	7	40	83	400		12
21	ROUTINE RESUPPLY, RATIONS	9	12		360		30
22	ROUTINE RESUPPLY, WATER	4	2	26	40	730	398
23	UNIT MOVE, MASH	4	1	28		729	757
24	WEAPONS DROP TO FORCES	5	1	120			60
25	UNIT MOVE,AIR AMBULANCE CO	4	1	14		152	166
26	MEDICAL EVACUATION	8	40	840			21
27	EMERG RESUPPLY,ARTILLERY AMMO	2	5	1050			210
28	RETROGRADE: PARTS/EQUIP	8	6			212	35
29	BACKLIFT KIA'S	8	21	483			23
30	PERSONNEL MOVE, REPLACEMENTS	7	4	368			92
31	UNIT MOVE, A-X WING	3	2	220	1084	805	1414

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The aim of this research is to provide a tactical mobility model which is user friendly and flexible so the user is able to change the inputs, and evaluate the situation with the projected data for an operational plan. Thus, the users can analyze their system by using the model to see whether or not mobility requirements can be met within a definite time frame, and how long it takes to satisfy the requirements. Generalized Air Mobility Model (GAMM) was chosen to model TAMC's airlift system and has been found suitable for application to TUAF mobility problems. The software enables the user to model future or existing airlift system requirements in an existing theater environment or against projected theater airlift requirements.

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