



**MITIGATING THE ERRATIC BEHAVIOR OF THE TRANSPORTATION
WORKING CAPITAL FUND THROUGH ACCURATE FORECASTING**

GRADUATE RESEARCH PAPER

Rahsul J. Freeman, Major, USAF

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**DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY**

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Abstract

Sequestration and its accompanying budget cuts demand the DoD enter into a new era of fiscal responsibility. The need to leverage the rising cost of readiness with exploding personnel cost has led to dramatic force reductions and among many AFSCs ominous clouds of uncertainty have been cast. If America is to remain the preeminent global force, then we must break our reliance on antiquated frameworks containing basic assumptions, ways of thinking, and methodologies that promote, and even reward, inefficiency. The time is ripe for overhauling our thoughts on estimating cargo demands and the number of assets required to meet those demands. The primary focus of this research will be on mitigating the erratic behavior of the TWCF through modeling cargo demand with higher fidelity than is currently enjoyed by the United States Transportation Command. The research will create a more stable environment for customers, Civil Reserve Air Fleet partners, and budgeters by reducing the need to make quarterly expansion buys via the CRAF program and potentially saving tens of millions of dollars per year. The secondary focus of this research project is to cast light on an alternative view of the CRAF expense and aerial Port Hold Time (PHT).

Dedication:

To my wife and son who both help me to live Proverbs 3:5-6 every day. I love you.

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MITIGATING THE ERRATIC BEHAVIOR OF THE TRANSPORTATION WORKING CAPITAL FUND THROUGH ACCURATE FORECASTING

I. Introduction

Following the Budget Control Act of 2011, a new word was introduced into the world's lexicon. Political pundits, Department of Defense (DoD) officials, cynics and ordinary Americans did not believe the scare tactics espoused in the media would ever come to fruition. Almost half a decade later the Air Force and large pockets of American society are living with the intended and unintended consequences of sequestration. Though the country may or may not be better off as a result of the sequester most would readily admit that not only has it been painful, but it has been unnecessarily painful. The grim reality is the Air Force we know and love today will be vastly different tomorrow if we do not reengineer our thoughts on how we execute our mission. Flying expensive aircraft carrying a small fraction of their payload capacity is a luxury that we can no longer afford. This inefficiency has not been caused by anyone's intentional malfeasance, but rather on relying on old methods. A great place to start when looking for ways to save money is the Transportation Working Capital Fund (TWCF) and Civil Reserve Air Fleet (CRAF) Programs. There is money to be saved in both programs; however, it requires an open mind and the willingness to change course. With respect to estimating future cargo demand it could be said that right now the United States Transportation Command (USTRANSCOM) is enjoying a local optimal solution whereas a revision to the model and interpretation of the costs associated with CRAF could produce a global optimal solution. In

non-linear programming, algorithms terminate whenever they detect that no feasible direction exists in which it can move to produce a better objective function value (or when the amount of potential improvement becomes arbitrarily small). In such a situation, the current solution is the local optimal solution—a solution that is better than any other feasible solution in its immediate, or local vicinity. However, a given local optimal solution might not be the best possible or global optimal solution to the problem. Another local optimal solution in some other area of the feasible region could be the best possible solution to the problem (Ragsdale, 2012: 354). This type of anomaly is illustrated in Figure 1. Additionally, when the solution must be an integer, like a fixed number of aircraft, this creates even more complexity.

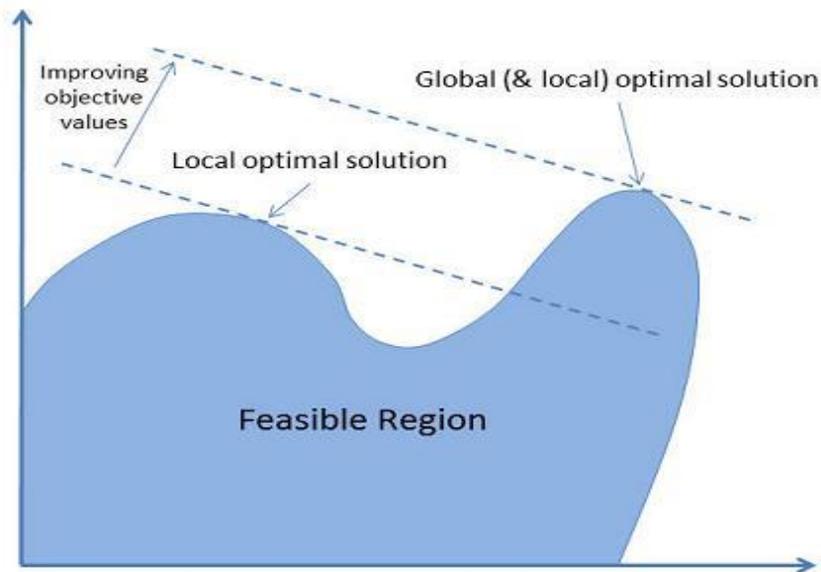


Figure 1. Local vs. Global Optimal Solution

This researcher had the privilege of serving as the Officer In Charge of the 733rd Air Mobility Squadron, Air Terminal Operations Center located at Kadena AB, Japan in the early part of his career. During this assignment it was common to lobby the squadron commander for authorization to request cancellation of CRAF 747s scheduled to transit the airbase. When asked for the rationale for cancellation the response was generally the same; the aircraft is coming to pick up cargo destined for a specific location for which we have very little to no cargo prepared to travel. Unfortunately, these cancellation requests were seldom granted. The reasons were two-fold. First, many of the senior leaders in the aerial port community incorrectly believed canceling a scheduled commercial aircraft would cost Air Mobility Command (AMC) over \$100,000. There is a prevailing thought that cancellation meant we were being poor stewards of the

taxpayers' dollars. An equally wrong approach was taking a myopic view of PHT. PHT is the time difference between arrival and departure time at the airfield. "Because aircraft only earn revenue when they are moving" (Cunningham, 2014) it is easy to misinterpret this truism thereby confusing activity with productivity. Further complicating this fact is "in an effort to monitor cargo delivery progress, AMC leadership routinely views pallet inventory and port hold time metrics. Leadership interprets rising port hold times as an indicator of transportation system problems and looks to aerial port improvements to correct the problems" (Casey, 2010). Aware that AMC is watching their PHT, aerial port commanders respond by keeping velocity high and PHT to a minimum. On the surface the approach taken by decision makers at the point of use seem reasonable. Though the intentions are pure the results are predictably bad. The cost of cancelling a CRAF mission is significantly less than the cost of flying the aircraft underutilized, meaning it was possible to save money just by cancelling the flight. If cancellations are viewed as sunk cost that cannot be recovered similar to a re-stocking fee at a major department store and unrelated to the additional cost of flying, one can quickly see savings grow exponentially by restricting flights to increased payload utilization. Failing that, cost savings can still be realized by taking an enterprise view of transportation as opposed to simply viewing individual PHT. For example a pallet sitting at Misawa AB, Japan may need to move to Osan AB, Korea. If only concerned with their PHT, Misawa could conceivably send the pallet to Kadena AB, in Okinawa in the name of progress. Though Kadena is several hundred miles closer to Osan than Misawa, once the pallet arrives at Kadena it will need to be processed and may sit at that port for an additional day or

two (or more) awaiting onward transportation to Osan. Had Misawa taken an enterprise view they may have learned that if they were willing to sacrifice an extra day of PHT they may have had a direct flight to Osan in the next day or so which could have eliminated an unnecessary trip to Kadena and ultimately accelerating the arrival of the needed cargo at Osan.

Research Problem Statement

The Air Force and the USTRANSCOM are not maximizing potential TWCF savings as a result of:

- Their inability to estimate cargo demands and the number of aircraft required for future support of a given installation with a high degree of confidence.
- Fluctuating TWCF rates resulting from less than ideal forecasting.

Research Objectives and Focus

This research project will address the current method USTRANSCOM uses to estimate future demand of CRAF as well as explore research done previously on this topic. It will provide an analysis of cargo moved into the United States Pacific Command (USPACOM) Area of Responsibility from fiscal year 2011 through fiscal year 2013 and will attempt to estimate future cargo demand with a high degree of fidelity thereby saving millions of dollars. The primary focus of this research will be on mitigating the erratic behavior of the TWCF and create a more stable knowledge base from which to make decisions for customers, CRAF partners, and

budgeters. The secondary focus of this research project is to cast a light on an alternative view of the CRAF expense and aerial PHT.

Primary Research Questions:

- Is a better forecast of shipments possible?
- Can some CRAF expenses be avoided?
- Are decision makers at the point of use viewing CRAF expenses in their proper context?

Hypothesis

George Box, a British mathematician and professor of statistics at the University of Wisconsin, and a pioneer in the areas of quality control, time series analysis, design of experiments and Bayesian inference cautioned “All models are wrong, but some are useful” (Box, 1987:424). The meaning of this quote is models are about insight not answers. Figure 2 describes characteristics and techniques associated with each category of model. With this understanding as the backdrop we can hypothesize a more accurate predictive model will have the multi-pronged benefit of:

1. Being useful to AMC, USTRANSCOM, and their CRAF partners by affording the opportunity for better utilization of organic aircraft; thus, requiring fewer CRAF missions.

- Mitigation of the decision-making strategy or cognitive heuristic known as satisficing that entails searching through the available alternatives until an acceptability threshold is met (Colman, 2006:670).

		Model Characteristics:		
Category		Form of $f(\cdot)$	Values of Independent Variables	Management Science Technique
Prescriptive Models		known, well-defined	known or under decision maker's control	Linear Programming, Networks, Integer Programming, CPM, Goal Programming, EOQ, Nonlinear Programming
Predictive Models		unknown, ill-defined	known or under decision maker's control	Regression Analysis, Time Series Analysis, Discriminant Analysis
Descriptive Models		known, well-defined	unknown or uncertain	Simulation, Queuing, PERT, Inventory Models

Figure 2 Characteristics and techniques associated with each category of model.

Assumptions

The most important assumption is the data used is a representative sample of the overall population. Therefore, the results can be used given the independent factors are known.

Limitations

For the purpose of conforming to allotted research time constraints, this research will be limited to cargo terminating at one of six USPACOM bases. The bases used for this study are Andersen AB, Guam, Elmendorf AFB, Alaska, Kadena AB, Japan, Misawa AB, Japan, Osan

AB, Republic of Korea, Yokota AB, Japan. In addition to data availability, these bases were selected for the following reasons:

1. The USPACOM area of responsibility has been relatively stable when compared to other combatant commands like United States Central Command (USCENTCOM). The vast amounts of cargo and personnel flowing in and out of the CENTCOM area of responsibility since September 11th, 2001 was primarily a function of shifting foreign policies by two presidential administrations, three Secretaries of Defense (SecDef), and the vacillating American support for operations in the Middle East thereby making USCENTCOM a poor choice as a model.
2. United States Africa Command (AFRICOM) is the newest of the combatant commands having begun “initial operations on Oct. 1, 2007, and officially became an independent command on Oct. 1, 2008” (AFRICOM.mil); as such it simply has not generated enough activity to serve as a model when compared to USPACOM.
3. United States Northern Command (NORTHCOM) conducts Homeland Defense and Civil Support operations within the assigned area of responsibility to defend, protect, and secure the United States and its interests (NORTHCOM.mil). Though NORTHCOM has the all-important mission of safeguarding the United States, they do not as an enterprise generate the volume of cargo or passenger movements upon which to base a model.

Likewise, the intelligence focused mission set of United States Southern Command (SOUTHCOM.mil) is equally unsuited to use as a model for predicting future cargo demands.

4. European Command (EUCOM) is responsible for military activities across more than 40 countries (EUCOM.mil). EUCOM moves a tremendous amount of cargo and passengers and makes it a good candidate upon which to base research for building a more predictive model. Unfortunately, research time constraints and available data make it necessary to narrow the scope of this project by only focusing on one combatant command.

Implications

While speaking at the National Defense Executive Reserve Conference in 1957, President Eisenhower famously recited the maxim “Plans are worthless, but planning is everything.” He went on to say “But if you haven’t been planning you can’t start to work, intelligently at least” (Eisenhower, 1957). This maxim is apropos as it relates to CRAF because intelligent planning and the correct execution of the plan can translate into millions of dollars in not only cost avoidance, but in actual savings. Additionally, it will require fewer logistical gyrations by our CRAF partners and Tanker Airlift Control Center (TACC) planners.

II. Literature Review

This chapter will provide the basis for understanding the CRAF program, how it was established and the program's intent. Additionally, this chapter will provide an overview of USTRANSCOM as the DoD Distribution Process Owner (DPO) responsible for coordinating and synchronizing distribution processes. It will also look at how they currently estimate demand and explain how TWCF rates are set.

Civil Reserve Air Fleet

A primary responsibility of military commanders at all levels is to allocate resources to mitigate risks in order to execute the mission. Inherent in this responsibility is planning for future contingencies and emergencies. The current Air Force inventory of mobility aircraft is ill-equipped to provide the President with global options for military engagements without considerable augmentation. This realization led the DoD and the Department of Commerce to establish the CRAF program via a joint agreement on December 15, 1951. "The program was generated by DOD's realization, following the Berlin Airlift, of the need for supplemental airlift to support a major national defense emergency. The Secretary of Commerce, under Executive Order 10999, had the responsibility for developing plans for a national emergency preparedness program, of which CRAF is a part.

The transportation portion of the emergency preparedness program, which included CRAF, was transferred to the Department of Transportation upon the establishment of the Department in 1967.

A simple way to view the CRAF program is as an insurance policy and peacetime is where we pay our premiums. Drivers and homeowners are required by law to maintain insurance. This insurance guarantees varying degrees of financial support if an accident were to occur. Few could bear the cost of maintaining an unlimited fleet of automobiles or real-estate if our vehicles were rendered in-operable or homes unlivable; insurance is how we mitigate this risk. Likewise, the DoD mitigates its airlift needs through CRAF. The program is built on the voluntary participation of air carriers via the annual International Airlift Services Contract.

The decision for commercial carriers to participate in the program is to a large extent an economic decision where they balance the risks associated with activation with peacetime incentives. During peacetime, CRAF carriers are guaranteed a percentage of DoD business and are able to plan. This guaranteed business helps ensure carrier participation and will be explained, in more detail later. CRAF is divided into three stages. Stage I of the program has the fewest number of aircraft and is designed to meet a minor regional crisis. Stage II is designed to meet the needs of a major theater war while Stage III is designed to meet the needs of national mobilization. Figure 3 shows the capability added to AMC during the various stages of CRAF in terms of number of aircraft added while Figure 4 shows the passenger seat capability added per day during CRAF Activation.

AIRCRAFT SUMMARY (number of aircraft *)	STAGES		
	I	II	III
LONG-RANGE INTERNATIONAL PAX	38	112	217
LONG-RANGE INTERNATIONAL CARGO	29	68	144
DOMESTIC SERVICES PAX	N/A	23	36
SHORT RANGE INTERNATIONAL CARGO	N/A	4	4
SHORT-RANGE INTERNATIONAL PAX	N/A	115	121
TOTAL AIRCRAFT	67	322	522

Figure 3 Capability added during CRAF activation.

INTERNATIONAL LONG RANGE - PASSENGER											
AIRCRAFT TYPE	SEATS (avg)		STAGE I			STAGE II			STAGE III		
			# of A/C	=	TOTAL SEATS	# of A/C	=	TOTAL SEATS	# of A/C	=	TOTAL SEATS
B-757	115	x	1	=	115	1	=	115	2	=	230
B-767	181	x	7	=	1,267	14	=	2,534	25	=	4,525
B-777	213	x	9	=	1,917	63	=	13,419	117	=	24,921
A-330	237	x	8	=	1,896	12	=	2,844	42	=	9,954
B-747	311	x	13	=	4,043	22	=	6,842	31	=	9,641
TOTALS			38	=	9,238	112	=	25,754	217	=	49,271
Unrestrained Pax Delivered Per Day (3-Day Cycle Time)			3,079			8,585			16,423		

Figure 4 Passenger Seat Capability Added Per Day During CRAF Activation

During activation, CRAF assets fly missions in support of the DoD and are compensated at negotiated ton-mile and passenger-mile rates; both are typical measurement units in the transportation sector. However, “both units are heterogeneous. Two units may have very

different costs of production and very different service requirements” (Cunningham, 2014).

Though participation in the CRAF program is heavily laden with incentives, commercial airlines still bear at least a modicum of risk since participation in the program comes at the expense of commercial revenues. That is, participation in the program could deliver a lost opportunity for the airlines to fly commercial routes with the same assets potentially earning higher profits.

During peacetime, CRAF participants are guaranteed a portion of DoD business. These business agreements are divided into two separate categories called fixed buys and expansion buys. Fixed buys are essentially a contract between the DoD and commercial carriers each fiscal year for a number of guaranteed payments for particular routes flown. These payments are not made in full until the mission is executed though approximately one third of the expected value of the contract is paid up front. The benefit of the “fixed buy” for the DOD is to ensure that routine missions to transport people and cargo to overseas stations are already accounted for (Arthur, 2007).

In the event the DoD under tasks relative to the fixed buys the difference is dispensed at the end of the fiscal year. The other category, expansion buys, occur whenever the DoD tasks the CRAF participants beyond the agreed upon fixed buy level as a result of unanticipated requirements to include but not limited to forecasts that fall short of estimating demand. According to USTRANSCOM, during the solicitation phase of their two year contract with CRAF carriers for FY13/14, they estimated approximately \$450M in expansion buys; however, actual CRAF expenditures totaled \$618M (Halama, 2015).

USTRANSCOM

USTRANSCOM headquartered at Scott Air Force Base, IL, is a total force team of active duty, guard, reserve, civilian, contractors, and commercial partners. Since becoming the DOD DPO in September 2003 (see Appendix A), USTRANSCOM is the single entity to direct and supervise execution of the strategic distribution system (TRANSCOM.mil). As the DPO, USTRANSCOM is responsible for end-to-end movement and distribution of DoD cargo and passengers. As such, USTRANSCOM has the capacity to deliver logistics and distribution capability to support power projection in both peace and war. They use Air Mobility Command to employ a wide range of military aircraft to achieve the Global Reach mission. Figure 5 shows the types of mobility aircraft in the AMC inventory as well as the carrying capacity for cargo and passengers of the various airframes.

Aircraft Type	Pallet		Cargo (s/t)		Passengers ⁴		Standard passengers
	Positions						
		ACL ²	Planning ³	ACL	Planning		
C-9	-	-	-	40	32	40	
C-130	6	17	12	90	80	92/74 ⁵	
C-141	13	30	19	153	120	200/153 ⁵	
C-17	18	65	45	102	90	102	
C-5A/B	36	89	61.3	73	51	73	
KC-10(Air- lift)	25	60	32.6	75	68	75	
KC-135	6	18	13	53	46	53	
B-747	44	100	86	335	335	390	
B-757	15	38	33	110	110	216	
B-767	24	65	56	205	205	215	
DC-8	16	38	33	125	125	190	
DC-10	30	72	62	210	210	280	
L-1011	26	59	51	180	180	350	
MD-11	35	93	80	315	315	300	

Figure 5 Aircraft Payloads AFPAM10-1403 1 MARCH 1998

Notes:

1. Cargo and passenger payloads (except for the C-5) are exclusive of one another.
2. Organic calculated as the maximum allowable cabin load for a 3200 nm leg, CRAF calculated for a 3500nm leg.
3. Historical averages from Desert Storm/Shield. CRAF based on mixed service averages (B-747-100 Eq = 78 s/tons).
4. CRAF MAX and AVG passengers are the same because pax are loaded to the max allowable by weight.
5. Lower NEO number reflects life raft capacity.

In all, approximately 1,300 mobility aircraft are used to support combat delivery and strategic airlift, air refueling, and aeromedical evacuations around the world (see Appendix B). Despite the massive workload these aircraft and their well-trained crews can support; the fleet is grossly inadequate to meet the user demands evidenced by the fact that prior to the tragic events of September 11th, 2001, CRAF flew 24% of channel missions and post 9/11, CRAF flew 72% of all channels (Costello, 2009). To continue to meet the pressing demands for air transportation the DoD is left with two alternatives; buy thousands of new C-5s or C-17s at a unit cost of approximately 200 million dollars in this fiscally constrained environment while absorbing the personnel and maintenance costs associated with that or rely on our commercial partners to provide airlift via the CRAF program. In fact the Office of Management and Budgets (OMB) which has the responsibility of overseeing the performance of federal agencies estimates that it would have cost the country perhaps as much as \$128 billion in inflation-adjusted dollars for the DoD to maintain the same capacity over the life of this program (Costello, 2009). It is clear the CRAF expense is still necessary. According to General Duncan McNabb, during his testimony to the 111th Congress on the topic: Hearing on the Economic Viability of the Civil Reserve Air Fleet Program, “we simply could not accomplish our mission without the unique capabilities our commercial industry partners provide. It is this championship team, working together, that gives our nation unrivaled global reach, committed to serving our nation's war fighters by delivering the right stuff to the right place at the right time (McNabb, 2009).” During the same hearing Congressman Jerry F. Costello noted prior to September 11, 2001 the DoD’s unique partnership

with the civilian airlines was about \$600 million annually. Post 9/11, that amount grew tremendously, and we are now in excess of \$3 billion per year (Costello, 2009); an amount that is unsustainable in the current fiscal environment and era of shrinking military budgets. In a crisis, the situation is dynamic, with the body of knowledge growing hour by hour from the latest information sources and intelligence reports. An adequate and feasible military response in a crisis demands flexible procedures keyed to the time available. A crisis is not the time to learn up to a third of your organic air fleet is in depot or some level of disrepair relegating it unfit for flight. To guard against this, USTRANSCOM needs an insurance policy or some sort of safety stock to ensure they can provide time critical transportation solutions to the President. An optimal solution is the CRAF program; however, because our CRAF partners want as much advance notice as possible prior to accepting a mission; usually 1-year in advance, accurately forecasting how much cargo will be moved organically versus the amount to be contracted out has proven to be a difficult task. This difficulty lends itself to the bullwhip effect. The bullwhip effect is “an important observation in supply chain management, that suggests demand variability increases as one moves up a supply chain. For example, empirical evidence suggests that the orders placed by a retailer tend to be much more variable than the customer demand seen by that retailer. This increase in variability propagates up the supply chain, distorting the pattern of orders received by distributors, manufacturers, and suppliers (Chen, et al., 1999:417). For the purpose of this research it may be helpful to view the United States Army as the customer, with AMC being the retailer, USTRANSCOM acting as the supplier, and our CRAF partners as the

manufacturer. The medium of exchange for services (in this case air transportation) is the TWCF. TWCF is a financing mechanism that uses a revolving fund concept; the fund delivers transportation services at its expense in return for reimbursement from its customers.

Rate Setting

Using guidance from the Office of the Under Secretary of Defense, Comptroller OUSD(C) and the respective DoD components, managers of the Defense Working Capital Fund (DWCF) business areas must set their rates and prices to recover all operating and capital costs associated with their products or services. Rates and prices for a budget year are set to recover the cost of products or services to be provided in that year. This means rates and prices are set to achieve an accumulated operating result of zero in that budget year (Jones, et al., 2011:267), that is, the primary goal is to neither make nor lose money. Naturally situations will arise forcing the TWCF to miss the mark by either making or losing money. One such example is after rates are stabilized (fixed rate for the entire year of execution) there is a sudden spike in aviation fuel prices. A substantial rise in fuel prices will undoubtedly raise AMC's operating costs; in the end that will mean AMC undercharged its customers for its services. By law this money must be recovered. Conversely, unanticipated and rapid mobilization will increase demand for AMC assets providing them with revenue not considered the previous year while setting the stabilized rate. Again, the TWCF is not supposed to make money so there are really only two solutions for

both examples. One option is designed to control cost; while the other option focuses on the budget concerning itself with both cost and revenue.

In the near term, the activity can attempt to control cost through conservation efforts or hiring freezes. They might also attempt to affect revenue by marketing their services to additional customers. In the budget process, the Working Capital Fund activity will always drive the accumulated operating result back to zero since the goal is full cost recovery, no more, no less. So a positive accumulated operating result represents past recovery of more than the full cost and therefore rates will be lowered in the budget to intentionally lose money to reset the accumulated operating result to zero. Conversely a negative accumulated operating result represents less than full cost recovery in the past and budgeted rates will be increased to recover the remaining cost (Jones, et al., 2011:267).

Once approved, the rates and prices remain fixed (stabilized) during the year of execution. The stabilized rate policy protects DWCF customers from unforeseen cost changes that would otherwise deplete their funds before the end of the fiscal year, with serious mission implications. Final approved rate changes are established and approved by the OUSD(C) and recorded in Program Budget Decision documents. As AMC's workload rises as a result of unforeseen contingencies, humanitarian relief operations, or large scale mobility exercises, the corresponding overhead costs are dissipated across a larger business base and to more customers thereby resulting in lowering rates for users. Conversely, as workload decreases as a result of drawdowns in Afghanistan, the same costs are now shouldered by a smaller group of users who will now see higher TWCF rates. The formula for TWCF rates is shown below:

$$TWCF \text{ rate} = \frac{\text{forecasted fixed cost} + \text{forecasted variable cost} - \text{accumulated operating result}}{\text{forecasted workload}} \quad (1)$$

Equation 1 TWCF Formula

Determining Cargo Demand

Much like in the commercial airline industry, fixed cost are relatively easy to predict; forecasting future variable cost less so and forecasting workload is even more difficult. As noted previously, AMC's fleet of aircraft cannot adequately meet user demand and fulfill all mission objectives on its own. The starting point to determining how much augmentation they will need from their commercial partners is to estimate future cargo demands. The current process used by USTRANSCOM to estimate demand is building a baseline forecast based on simple regression (i.e., linear / exponential best fit) (Nance, 2014). The least squares regression method line formula is:

$$\hat{y} - b_0 = b_1(x_1 - \bar{x}_1) + b_2(x_2 - \bar{x}_2) + \dots + b_k(x_k - \bar{x}_k) \quad (2)$$

Where: b_0 is a constant

b_1 = regression coefficient

x = value of the independent variable

\hat{y} = predicted value of the dependent variable.

Equation 2 Least Squares Regression

If the historic workload is volatile and does not fit a regression; which happens fairly often given current global changes (Nance, 2014), they use a weighted average, weighting the current year / quarters / months more heavily than prior year data. For the regression, they generally use 12-36 months of historic data depending on the line of business (i.e. commercial liner (sea), air channel, Special Assignment Airlift Mission, etc.). One challenge to this approach is deciding when the regression has reached a steady state point. In other words, if a particular area saw workload decreases in 2013 and 2014, they project 2015 will continue to decline. Given they forecast out through the next 5 years, one would expect the decline would level out at some point in the future. Deciding where that point happens is not more than an approximation that may or may not be accurate. Further complicating an accurate forecast is AMC's competing objectives of maintaining readiness, providing competitive pricing and service, and recouping its operating costs. According to the DoD FMR, AMC should recover 100 percent of its airlift operating costs, excluding the costs of maintaining readiness. "Because of deficient financial systems, the actual costs of airlift missions are not being accumulated reliably. Therefore, when AMC rates are set, USTRANSCOM concentrates more on setting a commercially competitive rate than a rate that would recover peacetime airlift operating costs from customers" (Connor et al., 2008).

III. Methodology

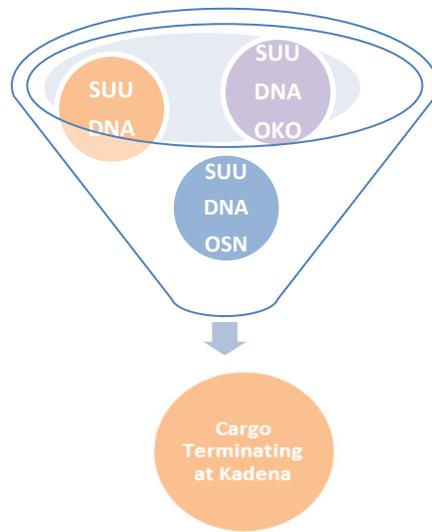
This chapter examines various forecasting models, and the model selected for this study. The purpose of this study was to create a mathematical model to estimate cargo demands with a high degree of fidelity. Similar studies have been conducted in the past using linear regression to estimate relationships between variables. However, the vast majority of past studies point to the primary dependent variable as current and or projected boots on the ground (BOG). This research project hinges on the hypothesis that these studies are using the wrong primary dependent variable for their regression. This research sought to isolate variables with more predictive value. Generally, an Air Force base with a large number of personnel assigned also has a large number of aircraft assigned. What differentiates this study from others is the recognition that *people* or BOG will never generate as much cargo as Aircraft Mission-Design Series (or aircraft for short). Though there is no doubt a high correlation between BOG and expected cargo demand, in his seminal book, “The Grammar of Science”, first published circa 1892, Karl Pearson illustrates correlation does not necessarily indicate causation (Aldrich, 1995: 364-376). “Selecting the right independent variable is critical to getting a good forecast. However, if you have several independent variables a relationship can be stated between the dependent variable Y and the independent variable X by computing the correlation between variables” (Chase, 2009:133). This research made use of Microsoft’s Excel (2007) Data Analysis Tool. Specifically, the regression application was used to find correlation coefficients

with additional reference to *Statistics for Business and Economics, 11th Edition* (McClave et al., 2011).

Data and Scope

The data used for forecasting was provided by two sources, AMC/A9 and the HQ PACAF Commander's Action Group (CAG). First, AMC/A9 provided data that would ultimately form the Y axis of the regression (total pallet count) and two of the X variables to include Air Commodity Codes (ACC) (more on ACCs later) and Department of Defense Activity Address Codes (DoDAAC). The DoDAAC is a six digit code managed by the Defense Logistics Agency that functions similar to an address for a specific DoD organization. It quickly identifies a unit's authority to requisition, contract for, receive, have custody of, issue, or ship DoD assets. AMC/A9 pulled the raw data from AMC's Global Air Transportation Execution System (GATES). GATES is an automated system used by aerial port personnel for the scheduling of unit and cargo movement and shipment planning. The original data provided by AMC/A9 were AMC generated cargo missions from fiscal year 2011 – 2013. The data set consisted of more than 2.5 million records in an Access database. The database provided 31 separate categories by which data could be sorted. The categories included pallet ID number, Transportation Control Number, aerial port of debarkation (APOD) and others. The remainder of the X axis was provided by the HQ PACAF CAG. The CAG provided a snapshot of number and types of aircraft assigned to each base in the Pacific.

Realizing that many pallets transit a given installation en route to other destinations, this research took specific steps to not double count pallets and eliminated the chance of receiving an inflated snapshot of cargo demand. See Figure 6 for terminating pallet illustration.



For each of the six bases the model only studied pallets terminating at one of the pre-identified bases. Any other format would involve counting the same pallet multiple times and not provide a true picture of how much cargo each base was generating.

Figure 6 Terminating Pallet Illustration

Air Commodity Codes

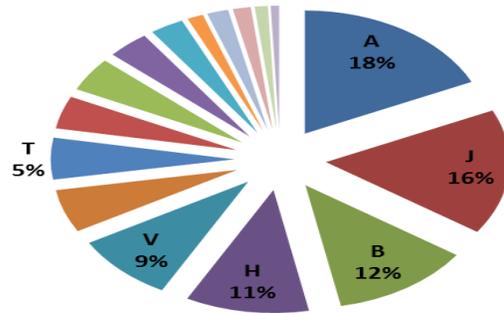
Each piece of DoD cargo is characterized by a commodity code. Commodity codes quickly communicate the classification of the cargo to those involved with the storage or transportation of DoD cargo. Additionally, it alerts the handler to any special handling requirements or hazardous conditions that may exist. Commodity codes cover everything from aircraft parts to office supplies (see Appendix C for full list). Taking a close look at the commodity codes transiting an installation can lend a great deal of insight into its operations and

even help predict future cargo demands. For example, an installation void of cargo classified as ACC “A” is likely a base with no assigned aircraft. With this knowledge you can begin to make other inferences like the installation is also without an Operations or Maintenance Group. Likewise, an installation showing cargo classified as ACC “J and T” with a combined percentage of 15% or less, likely has limited personnel assigned and has very low turnover. A high proportion of the aforementioned ACCs would indicate the opposite. Of the 27 different ACCs, a closer look at the cargo destined for the USPACOM theater revealed over 71% of all cargo was one of only six commodity codes. The six most prevalent ACCs are shown in Figure 7 along with the corresponding description of the code. Figure 8 depicts the percentage of cargo represented by the three aforementioned ACCs.

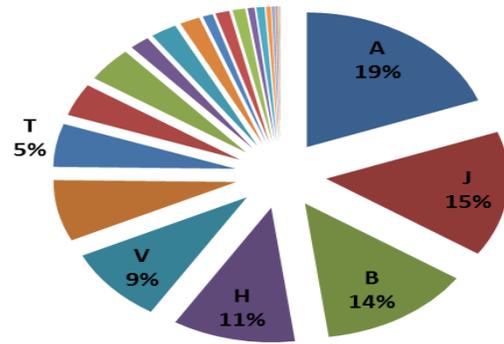
ACC	Description
A	Supplies and equipment for aircraft and aerial targets including aircraft and maintenance parts.
B	Construction Materials including Paint and Related Materials, Prefabricated Buildings, Wood Products, Metal and Composition Materials.
H	Signal Corps Supplies and Equipment including Radio Equipment and Supplies, Communications Equipment and Supplies, Electrical Equipment.
J	Unaccompanied Baggage
T	Household Goods
V	Vehicles, Machinery, Shop and Warehouse Equipment and Supplies including Special Tools and Equipment, Ground Servicing and Special Purpose Vehicles

Figure 7 Six Most Prevalent Air Commodity Codes

FY11 AIR COMMODITY CODES



FY12 Air Commodity Codes



FY13 Air Commodity Codes

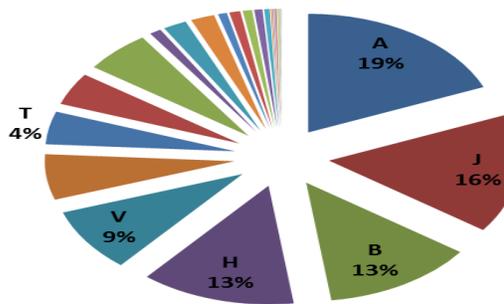


Figure 8 Percentage of cargo represented by the most prevalent ACCs

Statistics

In “Statistics For Business and Economics” McClave, Benson and Sincich (McClave, et al., 2011:3) describe statistics as the science of data and that data are obtained by measuring the values of one or more variables on the units in the sample. All data can be classified as one of two general types: quantitative or qualitative. Quantitative data are measurements that are recorded on a naturally occurring numerical scale. It can be sub-classified as either interval or ratio. For ratio data, the origin (i.e., the value 0) is a meaningful number. But the origin has no meaning without interval data. Consequently, we can add and subtract interval data, but we cannot multiply or divide them. Qualitative data are measurements that cannot be measured on a natural numerical scale and can be sub-classified as either nominal or ordinal. The categories of an ordinal data set can be ranked or meaningfully ordered, but the categories of a nominal data set cannot be ordered. This Graduate Research Project (GRP) relied heavily on quantitative statistics to construct the ASAM-15 Cargo Demand Model (ACDM). The model performs linear regression analysis by using the least squares method to fit a line through a set of observations. The model can be used to analyze how a single dependent variable is affected by the values of one or more independent variables. Specifically, this GRP sought to analyze how a given installation’s cargo demands were affected by number and types of aircraft assigned. After apportioning shares in the cargo demand to each of these factors, based on a set of operational constraints, the results can be used to predict future cargo demands.

Types of Time Series Forecast Models

Box-Jenkins

Box and Jenkins popularized an approach that combines the moving average and the autoregressive approaches in the book "Time Series Analysis: Forecasting and Control."

Although both autoregressive (AR) and moving average (MA) approaches were already known, the contribution of Box and Jenkins was in developing a systematic methodology for identifying and estimating models that could incorporate both approaches. This makes Box-Jenkins models a powerful class of models. The Box-Jenkins ARIMA model is a combination of the AR and MA where the terms in the equation have the same meaning as given for the AR and MA model.

Box-Jenkins models can be extended to include seasonal autoregressive and seasonal moving average terms (E-Handbook of Statistical Methods, 2013).

Rolling Average Models

Sometimes the best way is the simplest way. The moving average is probably the easiest extrapolation method for stationary data to use and understand. With this technique, the predicted value of the time series in period $t + 1$ (denoted by \hat{Y}) is simply the average of the k previous observations in a series; that is:

$$\hat{Y}_{t-1} = \frac{Y_t + Y_{t-1} + \dots + Y_{t-k}}{k} \quad (3)$$

Where:

\hat{Y} = forecast value

Equation 3 Rolling Average

The value of k is determined by the number of previous observations to be included in the moving average (Ragsdale, 2012:504).

Weighted Average

A weighted average model as the name might imply is very similar to a rolling average only it affords you the opportunity to weight time periods differently as opposed to equally like the rolling average. As mentioned previously, USTRANSCOM occasionally uses weighted averages in their regressions to estimate future cargo demand.

Model Selection and Statistical Analysis

Despite having a track record that lends itself to accuracy, Box-Jenkins models are complex and difficult to explain to senior leaders who do not command advanced statistical knowledge (Chase, 2009:174). Also, this technique models how the future will unfold dependent upon the past of a closed system. This research sought to use a technique that models how demand will change based upon activities being supported by an aerial port. We use these techniques to model the variation for a given aerial port with 'known' activities. As a result this

research opted not to use such a technique. Additionally, this researcher did not have a justifiable reason for weighting any time period more heavily than the others so it did not use the weighted average technique. Instead the ACDM uses a rolling average. However, to give the user of the model more insight, the *k-value* can take on a 1-year, 2-year, or 3-year value separately or together in the model.

Ordinary Least Squares Regression

A common method for estimating the unknown parameters in a linear regression model is ordinary least squares (OLS). The least-squares method is usually credited to German mathematician Carl Friedrich Gauss (Bretscher, 1995). Gauss' goal with OLS was to minimize the differences between the observed responses in some arbitrary dataset and the responses predicted by the linear approximation of the data. Figure 9 depicts an OLS regression; the sum of the vertical distances between each data point in the set and the corresponding point on the regression line. The smaller the summed differences, the better the model fits the data.

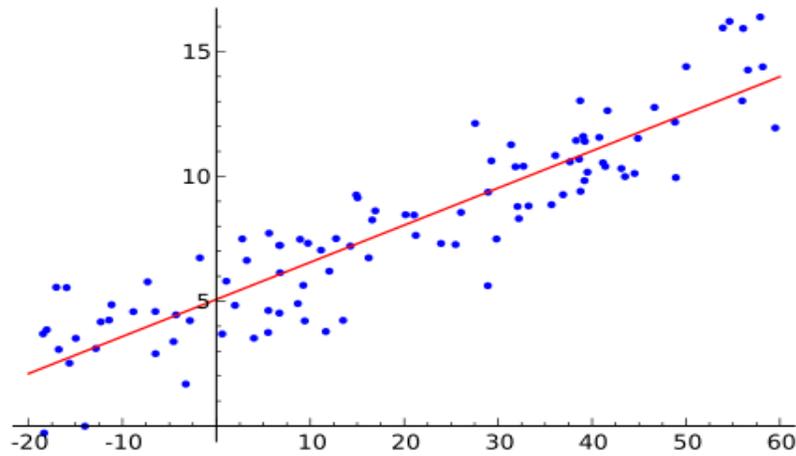


Figure 9 Ordinary Least Squares

When using regression it is important to evaluate both the R^2 and the Adjusted R^2 . The R^2 can be interpreted as a proportion of the variance in Y that is explained in X and is calculated as:

$$R^2 = 1 - \frac{SSE}{SST} \quad (4)$$

Where:

$$SSE = \sum_{i=1}^N (y_i - \hat{y}_i)^2$$

\hat{y}_i = the forecast series values

$$SST = \sum_{i=1}^N (y_i - \bar{y}_i)^2$$

\bar{y}_i = the mean of series values

Equation 4 R-Squared

R^2 ranges from 0-1 with 1 being perfect. On the other hand R^2 does not take degrees of freedom into consideration. Degrees of freedom is defined as the number of observations included in the formula minus the number of parameters estimated using the data. The adjusted R^2 value attempts to correct over-parameterization of a model by offsetting the R^2 score as more parameters are added. Without adjusting R^2 , we could expect the R^2 value to increase as the number of model parameters increase, although this “better” score likely does not translate to a better predictive value (DeYoung, 2012) . The Adjusted R^2 results in a more accurate or desirable goodness of fit (Chase, 2009, 136, 150) and is calculated as:

$$\text{Adjusted RSquared} = 1 - \left[\frac{(N - 1)}{(N - m)} (1 - RSquared) \right] \quad (5)$$

Where:

m = # parameters in model

N = # of observations

Equation 5 Adjusted R-Squared

In the case of the ACDM created as a result of this research, the average R^2 is .92 and the average Adjusted R^2 is .86%. If only considering the R^2 and the Adjusted R^2 one could reasonable conclude the ACDM is a good model. Fortunately, Microsoft’s Excel’s (2007) Data Analysis Tool; regression application gives us additional opportunities to check the validity of a model and contribution of each variable. One such method is by providing p-values. The p-value is used to determine statistical significance in a hypothesis; it describes the probability of getting

a value more extreme than the null hypothesis. Even if a distribution is not symmetrical, more extreme results are usually less probable so the practice of determining the probability of results at least as extreme as those found in a study is useful. Additionally, p-values are commonly reported for most research results involving statistical calculations, in part because intuition is a poor guide to how unusual a particular result is (Boslaugh, 2013). A generally accepted threshold for a good p-value is .05. A p-value of .05 suggests given the null hypothesis there is a less than a 1 in 20 chance of randomly getting a more extreme value.

IV. Results

Figure 10 shows data used for the ACDM regression. The model made use of seven separate regressions; one for each of the six most prevalent ACCs and one regression for the remaining 21 ACCs (labeled in the model as “ACC Other”). Columns 3 through 10 represent the number of pallets and pallets by type for each location that were used as dependent variables. Columns 11 through 18 are descriptors of demands for pallets and were used for the independent or predictor variables. After multiple trial regressions, the model excluded the least significant predictors for the final regressions. Each of the seven regressions began with the same eight variables. Upon completion of each individual trial, the least significant variable as determined by the p-value was removed until each variable coefficient was a positive number or zero. The mean number of final variables used in each regression was 3.7, while the median and mode were both 3, and the standard deviation was 1.38. Figure 11 shows the variables included for each of the seven regressions. Figure 12 shows the analysis of the regressions.

FY	Base	Total Pallet	ACC A	ACC B	ACC H	ACC J	ACC T	ACC V	ACC Other	Cargo/Pax	Refueler	Assigned Fighters	DoDAACs	Persnl	Other	Bomber	Helo
2011	Kadena	3559.8	944.3	93.2	359.2	1115.7	390.5	265.5	391.4	8	15	48	69	18000	3	0	8
2012	Kadena	3352.1	832.6	116	260.6	944.2	400.6	243.6	554.5	8	15	48	77	18000	3	0	8
2013	Kadena	2207	635.9	111	179	559.6	296.4	159.5	265.6	0	15	60	53	18000	5	0	8
2011	Elmendorf	1158.2	429	68	92.5	65.1	56.1	128.5	319	19	8	39	40	53318	5	0	5
2012	Elmendorf	1109.7	396.7	25.4	110	69.1	91	102.6	314.9	18	0	42	55	53318	3	0	5
2013	Elmendorf	890	425.4	50.5	74	37	36	94.2	598.3	22	0	53	37	53318	6	0	6
2011	Misawa	982	336.2	23	53	176	141	44.2	208.6	0	0	36	15	9000	0	0	0
2012	Misawa	861.6	317.2	25	38.4	161.1	125	36.2	475.9	0	0	36	10	9000	0	0	0
2013	Misawa	502.2	219.3	4	23.2	93	103.1	18	41.6	0	0	36	6	9000	0	0	0
2011	Yokota	3186.3	639.6	257.7	150	815.4	224.5	161.5	937.6	17	0	0	109	9246	0	0	3
2012	Yokota	3094	772.5	201.9	136.1	775	275	165.5	768	17	0	0	87	9246	0	0	4
2013	Yokota	2171.4	622.1	151.9	107.1	460.1	204.5	128.7	497	17	0	0	86	9246	0	0	4
2011	Osan	4617.8	473.3	305.7	160.2	2155.7	305.1	447.5	770.3	0	0	45	86	7746	3	0	0
2012	Osan	5019.3	584.6	234	242.4	2345.8	211	465.4	936.1	0	0	57	63	7746	3	0	0
2013	Osan	2840.7	402.7	142.6	110	1161.6	142	305.8	576	0	0	45	52	7746	3	0	0
2011	Andersen	1820	550	107.4	143.2	301.2	175.3	170	372.9	0	4	0	65	7772	2	7	0
2012	Andersen	1689.2	550.3	60.7	140.1	268	120	191.4	358.7	0	4	0	78	7772	3	6	0
2013	Andersen	1172.2	400.8	96.2	79.9	192	90	97.4	215.9	0	4	0	40	7772	3	6	10

Figure 10 Data Used For ACDM

ACC A
Cargo/Pax
Assigned
Fighters
Refueler
DoDAACs
Persnl
Bomber

ACC B
Intercept
DoDAACs
Persnl
Other

ACC H
Intercept
Assigned
Fighters
Refueler
DoDAACs

ACC Other
Assigned
Fighters
DoDAACs

ACC J
Assigned
Fighters
DoDAACs
Persnl

ACC T
Cargo/Pax
Refueler
Assigned
Fighters
DoDAACs
Persnl

ACC V
Assigned
Fighters
DoDAACs
Persnl
Other

Figure 11 Variables included for each regression.

SUMMARY OUTPUT ACC A

<i>Regression Statistics</i>				
Multiple R		0.994151		
R Square		0.988337		
Adjusted R Square		0.900144		
Standard Error		74.17105		
Observations		18		

ANOVA				
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	6	5594155	932359.1	169.4784112
Residual	12	66016.13	5501.344	
Total	18	5660171		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Cargo/Pax	35.18407	7.292945	4.824398	0.000415922
Assigned Fighters	9.844964	1.674331	5.879938	7.48183E-05
Refueler	16.07336	3.486349	4.610371	0.000600083
DoDAACs	2.295247	0.953022	2.408388	0.033009692
Persnl	-0.01596	0.003466	-4.60558	0.000605073
Bomber	66.30445	14.48044	4.578896	0.000633642

SUMMARY OUTPUT ACC B

<i>Regression Statistics</i>				
Multiple R		0.93723		
R Square		0.878401		
Adjusted R Square		0.795521		
Standard Error		54.52368		
Observations		18		

ANOVA				
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	3	322123.6	107374.5	36.11861156
Residual	15	44592.47	2972.831	
Total	18	366716.1		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
DoDAACs	2.215662	0.280993	7.885112	1.02854E-06
Persnl	-0.00169	0.000964	-1.75348	0.099923959
Other	7.330341	8.548401	0.85751	0.404656147

SUMMARY OUTPUT ACC H

<i>Regression Statistics</i>	
Multiple R	0.966037
R Square	0.933228
Adjusted R Square	0.857659
Standard Error	45.02752
Observations	18

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	3	425053.6	141684.5	69.88215398
Residual	15	30412.17	2027.478	
Total	18	455465.7		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Assigned Fighters	0.884982	0.392925	2.25229	0.039712904
Refueler	7.208152	2.06252	3.494828	0.003257922
DoDAACs	1.52465	0.221751	6.87551	5.27427E-06

SUMMARY OUTPUT ACC J

<i>Regression Statistics</i>	
Multiple R	0.921733
R Square	0.849592
Adjusted R Square	0.762871
Standard Error	396.7847
Observations	18

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	3	13339579	4446526	28.2430064
Residual	15	2361572	157438.1	
Total	18	15701151		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Assigned Fighters	18.13889	3.937754	4.606406	0.000342603
DoDAACs	10.42092	1.95458	5.331539	8.38745E-05
Persnl	-0.02526	0.006026	-4.19193	0.000785611

SUMMARY OUTPUT ACC T

<i>Regression Statistics</i>	
Multiple R	0.984204
R Square	0.968658
Adjusted R Square	0.882091
Standard Error	44.96287
Observations	18

ANOVA

	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	5	812248.4	162449.7	80.35461952
Residual	13	26281.57	2021.66	
Total	18	838530		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Cargo/Pax	4.935749	2.444635	2.019013	0.064600027
Refueler	8.98697	2.110035	4.259156	0.000931222
Assigned Fighters	2.931347	0.575151	5.096655	0.000204941
DoDAACs	2.082932	0.30086	6.923271	1.0479E-05
Persnl	-0.00518	0.001252	-4.13604	0.00117139

SUMMARY OUTPUT ACC V

<i>Regression Statistics</i>	
Multiple R	0.957021
R Square	0.91589
Adjusted R Square	0.826438
Standard Error	71.46928
Observations	18

ANOVA				
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	4	778686.1	194671.5	38.11216139
Residual	14	71510.02	5107.859	
Total	18	850196.2		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Assigned Fighters	2.580602	0.805085	3.205379	0.006352226
DoDAACs	2.292441	0.371453	6.171551	2.42835E-05
Persnl	-0.0045	0.001286	-3.50306	0.003513761
Other	23.4394	12.71885	1.842887	0.086618957

SUMMARY OUTPUT ACC Other

<i>Regression Statistics</i>	
Multiple R	0.94541
R Square	0.8938
Adjusted R Square	0.824663
Standard Error	185.6656
Observations	18

ANOVA				
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Regression	2	4641952	2320976	67.32983389
Residual	16	551547.7	34471.73	
Total	18	5193500		

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0	#N/A	#N/A	#N/A
Assigned Fighters	3.020304	1.491016	2.025668	0.05981158
DoDAACs	6.749784	0.882993	7.64421	9.9551E-07

Figure 12 Regression Analysis

Using the regression data found in Figures 11 and 12, this researcher built the ACDM. The ACDM is an excel based predictive model that provides planners with historical insight into past cargo demands at various APODs. The ACDM has 12 dropdown menus to help planners estimate future cargo demand. The dropdown menus listed in order of use are: Base, Fiscal Year (FY), Actual Pallet Count (from previous years), Expected Pallet Count (number of pallets predicted by the ACDM), Assigned Fighters, Cargo/Pax (C-17, C-130, etc), Helo (helicopter), Refueler (KC-135, KC-10, etc), Bomber (B-52), Other (various Reconnaissance aircraft), DoDAACs at installation, and personnel assigned. All aforementioned aircraft correspond with the types and number of aircraft assigned to the base selected from the first dropdown menu. Figure 13 provides a snapshot of the ACDM along with future estimates for the six bases of interest. For illustrative purposes, the future expected number of various aircraft, DoDAACs and personnel assigned takes on the actual 3-year average of each respective base with the exception of Kadena AB which is discussed later. One can then see how the model compares to the actual pallet counts of 2011 through 2013 individually; a 2012 through 2013 average; or a three year average consisting of the years 2011, 2012, and 2013.

Base	FY	Actual Pallet Count	Expected Pallet Count	Assigned Fighters	Cargo/Pax Helo	Refueler	Bomber	Other DoDAACs	Persnl		
Kadena	2011	3559.8	3216.44	48	8	8	15	0	3	69	18000
Kadena	2012	3352.1	3500.61	48	8	8	15	0	3	77	18000
Kadena	2013	2207	2836.53	60	0	8	15	0	5	53	18000
Kadena	2 Yr Avg	2779.55	3168.57	54	4	8	15	0	4	65	18000
Kadena	3 Yr Avg	3039.63	3184.53	52	6	8	15	0	4	67	18000
Kadena Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		3215.39	53	5	8	15	0	4	66	18000
Elmendorf	2011	1158.2	342.23	39	19	5	8	0	5	40	53318
Elmendorf	2012	1109.7	1352.94	42	18	5	0	0	3	55	53318
Elmendorf	2013	890	1780.07	53	22	6	0	0	6	37	53318
Elmendorf	2 Yr Avg	999.85	1606.31	48	20	6	0	0	5	46	53318
Elmendorf	3 Yr Avg	1052.63	1158.41	45	20	6	3	0	5	44	53318
Elmendorf Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		1197.57	45	20	6	3	0	5	44	53318
Misawa	2011	982	1119.86	36	0	0	0	0	0	15	9000
Misawa	2012	861.6	942.26	36	0	0	0	0	0	10	9000
Misawa	2013	502.2	800.17	36	0	0	0	0	0	6	9000
Misawa	2 Yr Avg	681.9	871.21	36	0	0	0	0	0	8	9000
Misawa	3 Yr Avg	781.9	954.1	36	0	0	0	0	0	10	9000
Misawa Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		1558.63	36	0	0	0	0	0	10	9000
Yokota	2011	3186.3	3393.96	0	17	3	0	0	0	109	9246
Yokota	2012	3094	2619.02	0	17	4	0	0	0	87	9246
Yokota	2013	2171.4	2583.49	0	17	4	0	0	0	86	9246
Yokota	2 Yr Avg	2632.7	2601.26	0	17	4	0	0	0	87	9246
Yokota	3 Yr Avg	2817.23	2865.49	0	17	4	0	0	0	94	9246
Yokota Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		2867.67	0	17	4	0	0	0	94	9246
Osan	2011	4617.8	4344.81	45	0	0	0	0	3	86	7746
Osan	2012	5019.3	4323.37	57	0	0	0	0	3	63	7746
Osan	2013	2840.7	3137.08	45	0	0	0	0	3	52	7746
Osan	2 Yr Avg	3930	3730.23	51	0	0	0	0	3	58	7746
Osan	3 Yr Avg	4159.26	3935.09	49	0	0	0	0	3	67	7746
Osan Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		3935.09	49	0	0	0	0	3	67	7746
Andersen	2011	1820	1808.98	0	0	0	4	7	2	65	7772
Andersen	2012	1689.2	2079.39	0	0	0	4	6	3	78	7772
Andersen	2013	1172.2	794.87	0	0	10	4	6	3	40	7772
Andersen	2 Yr Avg	1430.7	1437.13	0	0	5	4	6	3	59	7772
Andersen	3 Yr Avg	1560.46	1561.08	0	0	4	4	7	3	61	7772
Andersen Expected Future Value	Insert expected number of ACFT, DoDAACs, and Persnl to the right		1670.81	0	0	5	4	7	3	60	7772

Figure 13 ACDM

Planners can use operational insight combined with historical averages to estimate the number of aircraft, DoDAACs, and personnel that will be assigned to a given installation. After

inputting the estimates, the ACDM will provide an expected pallet count based on the inputs provided. In the snapshot above, the model assumes Kadena AB will see one unit increase in number of fighters from its 3-year average, a one unit decrease in its Cargo/Pax aircraft, and one less DoDAAC. The value returned is 3215.39. The planner can quickly determine that the expected pallet count falls within one standard deviation of the mean. See Figure 14 for the related descriptive statistics.

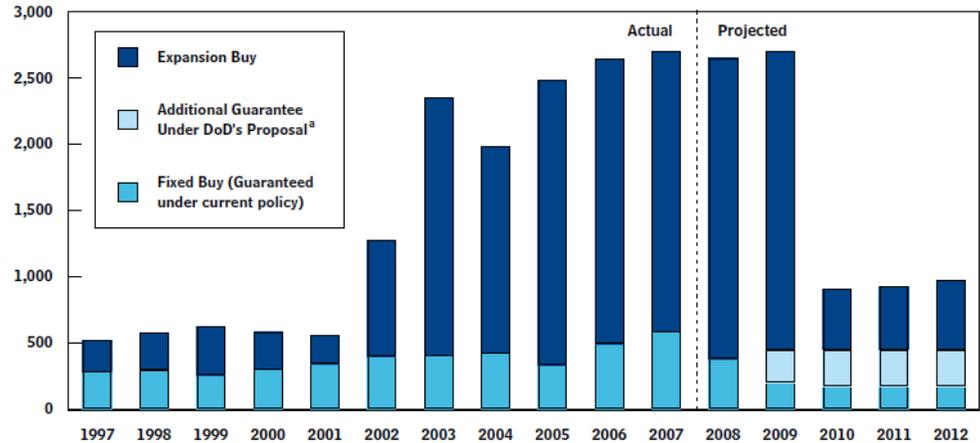
Kadena AB Snapshot	
Mean	3039.633333
Median	3352.1
Mode	#N/A
Standard Deviation	728.5214639
Expected Pallet Count - Mean =	175.75
Standard Deviation =	728.52

Figure 14 Kadena AB, Total Pallet Count Descriptive Statistics

The ACDM created as a result of this research has an average p-value of .03 suggesting the alternative hypothesis should be accepted since there is a less than 1 in 30 chance of randomly getting a value more extreme for the given data modeled. Based on the above findings, one should be able to reasonably assume this model may produce values representative of future demand with a high degree of fidelity. Courtesy of the Congressional Budget Office based on historical and projected data on fixed and total buys from USTRANSCOM, Figure 15 provides a visual representation of the actual and projected CRAF expenditures between 1997 and 2012; the

disparity between the forecast and the actual number is stark. AMC has not had a year in recent history where their forecast was more than 30% accurate. What is not known is will the ACDM produce better results. Despite it having a relatively high R^2 , with correspondingly low p-values, the ACDM should only be used as a tool to provide historical insight not as a foundation on which to base decisions. Much like the ACDM, the AMC model should be relied upon to provide historical insight but not necessarily used for its predictive value; but why? During what has become one of former Secretary of Defense Donald Rumsfeld's more famous press conferences, when responding to a question about Iraq the Secretary said "There are known knowns, the things we know that we know. There are known unknowns that is to say there are things that we know we don't know. Then there are unknown unknowns...the things that we don't know we don't know. One can then posit it is the unknown unknowns that are negatively affecting a potentially useful model. As more data becomes available we would expect the ACDM accuracy to increase, however; one must remember that linear regression provides a point estimate of future demand and there will always exist variability, specifically modeled as normally distributed error.

(Millions of dollars)



Source: Congressional Budget Office based on historical and projected data on fixed and total buys from the United States Transportation Command.

Note: CRAF carriers are offered a "fixed buy" based on known airlift needs for the coming year and an "expansion buy" for additional needs as they arise. Under current policy, the fixed buy is guaranteed at the beginning of each fiscal year.

a. CBO estimates.

Figure 15 Actual and Projected CRAF Expenditures

Conclusions of Research

Models will likely never be able to replace human decision makers. Unfortunately, it is common for decision makers to believe operational research models are supposed to provide *the* answer versus *an* answer. This idea leads to a further misconception that once the model is built one can simply plug in the known variables and wait for the model to calculate *the* answer.

Models can account for myriad data sets; however, when attempting to predict complex outcomes there will almost always be at least one variable omitted that should be considered (an unknown unknown). The omission of certain variables can render the model only marginally useful at best. Operational research software such as Excel, VBA, and Tableau are programs

based on mathematics and a complex array of ones and zeroes; as such the model will never produce what you want, rather it will produce what you tell it to produce based on the data provided. Intuitive to this notion is the truism garbage in, garbage out. When it comes to predicting cargo demand with a high degree of certainty, AMC and USTRANSCOM are not inputting garbage yet their forecasts often miss the mark. Two possible explanations exist. One possible explanation that was not explored at great length is “The price we pay for expansion is the same as the fixed. It is based on a uniform rate applied to the aircraft type and the number of miles flown” (Halama, 2015). Perhaps it is an oversimplification of the problem; however, identical pricing provides USTRANSCOM with no financial incentive to provide an accurate forecast nor are there any negative financial consequences for not doing so. If the forecast for fixed buys are wrong they can simply initiate the expansion buy process. This leads to satisficing and accepting a ‘good enough’ solution. More often than not that is exactly what happens. During a March, 2015 visit with Spencer Schwartz, ATLAS Air, Chief Financial Officer, said “USTRANSCOM’s forecast seldom plays out the way it is presented.” He went on to say cargo in 2015 has been moving at a rate considerably higher than forecasted; in fact, as of 1 March, 2015, ATLAS Air had already exceeded the FY15 fixed buy forecast. No one should conclude that this research questions the integrity or efforts of USTRANSCOM planners. This researcher believes USTRANSCOM is providing a good faith estimate; however, one cannot ignore the fact that an appropriately incentivized model would yield the most favorable results. Dr. Robert Overstreet, an AFIT professor, is fond of saying you get the behavior you reward. One can then

extrapolate you will not get the behavior that is not rewarded. If an accurate forecast is desired, it must be rewarded. The dangers of continually providing inaccurate forecasts are far reaching. As noted previously, USTRANSCOM's CRAF forecast for FY14 called for \$450 million in lift yet \$618 million was actually spent. Publicly traded companies such as CRAF participants, make business plans based on the forecast provided. For large carriers producing tens of billions of dollars of revenue each year, underestimating demand by \$168 million dollars may not be significant. However, an error of this magnitude may force a smaller carrier to falsely believe they will become financially insolvent. This type of misjudgment could conceivably cause a disincentive for participating in the CRAF program and could potentially lead to bankruptcy thereby limiting the DoD's access to increased capacity in an emergency.

Another potential and perhaps more likely explanation for missing the forecast mark is USTRANSCOM's calculations are incomplete. Multiple AFIT research projects conducted on the subject of forecasting cargo demand point to the idea that regression is the absolute best place to start, but the equally wrong place to conclude. The application of many operational assumptions is likely the best way to improve a forecast model. Of course by definition assumptions can be wrong irrespective of how logical they may appear through the biased lenses of framing and anchoring. Additionally, valid operational assumptions can vary from person to person thereby yielding different variables to be included in a given model which will then produce different optimal solutions; all of which will usually be locally optimal solutions. So this begs the question why does AMC and USTRANSCOM continue to use incomplete calculations?

It is clear that these professionals are using the most complete data available to them and are only using the most reasonable of all assumptions. The fact remains that many of the predictive variables are unquantifiable or unknowable. The spending habits and patterns of consumers are easily understood hence it is relatively easy to predict with a high degree of certainty that more commerce will be ordered/shipped during the last two months of a calendar year than the first two months of the same calendar year. It does not take a great deal of analytical rigor to know the Christmas holiday triggers more buying/shipping of products; therefore, the United States Postal service, United Parcel Service, and Federal Express can posture their staffs and resources to meet most demand on a predictable basis. The nature of military operations is not as predictable. Tyrants, despots, and Mother Nature refuse to align their destructive behavior and desires with our predictive models or calendar of scheduled events. In 2012 when AMC and USTRANSCOM were working on their forecasts for FY14 they had no indication that the military would require a massive amount of airlift to help fight an Ebola outbreak in western Africa. In 2011, strategic transportation planners were not given a warning that in 2013 we would see the leader of North Korea make provocative moves and statements prompting the United States to move missile defenses to the Pacific as a show of force and to show its readiness. In 2009 it was not possible to know nor plausible to consider, that in just two years AMC's presence would be needed as a result of a 9.0 magnitude earthquake in Japan that would trigger a massive tsunami hitting the Fukushima Nuclear Power Plant creating the largest nuclear incident since the Chernobyl disaster in 1986. The preceding three examples remind us that

hindsight is not wisdom; they show some of the mercurial demands for which the TWCF must respond. In addition to the uncertainty of natural disasters, TWCF must contend with the man-made disasters created by the Legislative and Executive branches of our government refusing to agree on a budget. TWCF cannot be sustained without Special Airlift Assignment Missions (see Appendix B for full list of AMC mission types). These are funded airlift missions that cannot be supported by Channel Missions because of the unusual nature, sensitivity, or urgency of the cargo or that require operations to points other than the established channel structure. The largest user of this service is the United States Army. Another government shutdown or the continued policy of sequestration will have a damning effect on the Army's ability to pay for Special Airlift Assignment Missions so heavily relied upon by TWCF. The more the Army is unable to pay and the more natural and man-made disasters place a strain on our organic assets; the more erratically we will see TWCF rates behave. A high fidelity predictive model that can provide USTRANSCOM and AMC with the confidence and empirical support to make fewer CRAF buys, for better usage of the organic fleet and potentially fewer expansion buys would be favorable; however, it remains elusive.

Significance of Research

During a recent visit to the Pentagon, Air Force Vice Chief of Staff General Larry Spencer shared with ASAM 2015 "When things get tough, Airmen figure out a way to get it done. We have some of the most innovative folks in the world, so I know there are ideas about

how we can do things better." The General went on to discuss the Air Force's "Every Dollar Counts Campaign" and advocated for the class to find new and innovative ways to save money. The recommendations made by this research may meet his intent. At the cost of \$23K per operating hour for a CRAF 747 or \$24K per operating hour for a C-17, if annually we were able to cancel 4-5 CRAF and organic missions that are only using a small fraction of their payload capacity across the COCOMs, the savings would be in the tens of millions of dollars.

Recommendations for Action

This research showed how selecting more appropriate independent variables can dramatically improve a forecast. USTRANSCOM and AMC may benefit from taking a hard look at this model, expanding the data set available to which this methodology is applied, and consider adopting the ACDM as an additional source of insight; the result may be a global optimal solution.

Recommendations for Future Research

The primary focus of this research was to show how better cargo forecasting could mitigate TWCF rate fluctuations from year to year, creating a more stable planning environment for TACC planners, our CRAF partners and users who ultimately fund the TWCF. Future research should focus on expanding the model data set and pinning an exact dollar amount to these potential savings. If the potential savings are substantial USTRANSCOM and AMC will

be forced to do business differently; the final result will be a stronger more agile force and savings to the American taxpayer. Additionally, the following question needs to be answered by legislators and the taxpayers they represent: Is dollar saving efficiency as valuable to the United States as war winning agility? The answer may relegate this research to an academic exercise without real practical value or it may spark the need for additional research; irrespective of the answer, the question needs to be asked.

Appendix A

Distribution Process Owner

Department of Defense

INSTRUCTION

NUMBER 5158.06

July 30, 2007

Incorporating Administrative Change 1, September 11, 2007

USD(AT&L)

SUBJECT: Distribution Process Owner (DPO)

References: (a) Unified Command Plan (UCP), current edition¹

(b) DoD Directive 5158.04, "United States Transportation Command,"

July 27, 2007

(c) Joint Logistics (Distribution) Joint Integrating Concept – Initial Capabilities Document, August 17, 2006²

(d) Joint Logistics (Distribution) Joint Integrating Concept, Version 1.0, February 7, 2006³

(e) through (n), see Enclosure 1

1. PURPOSE

This Instruction:

1.1. Implements policy for overseeing, coordinating, and synchronizing the DoD-wide distribution processes, including force projection, sustainment, and redeployment/retrograde operations, in accordance with the responsibilities and authorities stated in References (a) through (c).

1.2. Specifies the functional responsibilities of the DPO, and outlines the interface with the Joint Deployment and Distribution Enterprise (JDDE). Pursuant to Reference (a), the Commander, United States Transportation Command (CDRUSTRANSCOM), is assigned the responsibility to serve as the DPO for the Department of Defense.

2. APPLICABILITY AND SCOPE

2.1. This Instruction applies to the Office of the Secretary of Defense (OSD), the Military Departments, the Chairman of the Joint Chiefs of Staff, the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as the "DoD Components"). The term "Military Services," as used herein, refers to the Army, the Navy, the Air Force, and the Marine Corps.

1 Request this reference by sending an email to atl.lmr@osd.mil

2 Request this reference by sending an email to atl.lmr@osd.mil

3 Request this reference by sending an email to atl.lmr@osd.mil DoDI 5158.06, July 30, 2007

Appendix B

Types of Missions Flown By AMC

Denton Program

The Denton Program is a commodities transportation program authorized under Title 10 U.S.C. Section 402. The U.S. Agency for International Development (USAID), the Department of State (DOS), and the Department of Defense (DoD) jointly administer the Denton program. The program provides the authority for DoD to use any extra space on U.S. military cargo aircraft to transport humanitarian assistance materials donated by non-governmental organizations (NGOs) for humanitarian relief. Since Denton is a space available program, it is impossible to predict when transportation will be provided; therefore, no guarantees can be made regarding completion of a donated humanitarian goods shipment.

Categories of Denton cargo: medical and dental supplies; non-perishable food; clothing; educational supplies/equipment; vehicles & equipment for vocational training.

Space Available/Opportune Flight Requirements

Space Available (also sometimes referred to as “Opportune”) refers to transportation capability (capacity) that exists because a lift asset with available load space is moving to or near the intended destination of the cargo requiring movement. The Defense Transportation Regulation (DTR) determines cargo eligible for space available movement. Approved

movements are performed without cost to the customer. Air Cargo movements are normally performed using Special Assignment Airlift Mission (SAAM) procedures. Active duty, Reserves and National Guard crew training provides for space available cargo support. This practice helps to optimize both the Defense Transportation System (DTS) and crew proficiency.

Special Airlift Assignment Missions

Air Mobility Command (AMC), Special Airlift Assignment Missions (SAAMs) are missions performing and providing an exclusive service. They perform an exclusive service for specific users at their desired movement times. They are funded airlift missions that cannot be supported by Channel Missions because of the unusual nature, sensitivity, or urgency of the cargo or that require operations to points other than the established channel structure. The designated DoD component representative will forward SAAM request via the applicable validating office to USTRANSCOM/AMC. Criteria for establishing SAAM priorities may be found in Joint Chiefs of Staff (JCS) Pub 15, Mobility System Policies, procedures and Considerations and Appendix B of the Defense Transportation Regulation (DTR) 4500-9R Part 2. Submission of SAAM priorities and request are outlined in Appendix B and Appendix C. See Appendix K for listing of SAAM validators grouped under unified commands and/or Services.

Operational Support Airlift (OSA)

OSA missions and associated flights are movements of high-priority passengers and cargo with time, place or mission-sensitive requirements. These flights are scheduled within the CONUS by the Joint Operational Support Airlift Center (JOSAC). The JOSAC is located at Scott Air Force Base in Illinois about 20 miles from St. Louis, Missouri. JOSAC is the single manager for scheduling all Department of Defense's (DoD) continental United States (CONUS) fixed wing Operational Support Airlift (OSA) requirements.

Channel Flight

Cargo and passenger channel airlift is defined as common-user airlift provided on a recurring basis between two points. The routes can be served by either scheduled DoD aircraft or commercial aircraft under contract to, and scheduled by, the 618 TACC/XOG. Based on a number of factors, channel missions will be categorized as Frequency or Requirements Channels. Contingency Channels can only be validated by the Joint Staff to support missions specifically directed by the Secretary of Defense.

Types of Channel Flights

Distribution channels- Channel that services two points on a recurring basis with actual movements dependent on the volume of traffic; on the basis of operational necessity for support of a mission sensitive area; or for quality of life purposes in remote areas.

Contingency Channels: Channels that service two points based on operational necessity to support mission, operation, and contingencies, directed by the SECDEF and are in accordance with the Joint Chiefs of Staffs DoD Transportation Movement Priority System.

Appendix C Air Commodity Codes

Air Commodity Code	Name
2	Arms/Weapons
3	Ammunition
4	Explosives (any explosive item not included in Code 3)
A	Supplies and equipment for aircraft and aerial targets including aircraft and maintenance parts, aircraft accessories, aircraft instruments
B	Construction Materials
C	Chemical corps items and all other chemicals not covered in other classifications.
D	Animals
E	Engineer supplies, other than those listed under Code B
F	Fuels and Lubricants
G	Printed Forms, Publications, Drawings, etc
H	Signal Corps Supplies and Equipment including Radio Equipment and Supplies, Communications Equipment and Supplies, Electrical Equipment and Supplies, etc
J	Unaccompanied Baggage
K	Clothing including Clothing Equipment, Cordage, Fabrics and Leather, Parachutes, etc
L	Defense Courier Service Material including Communication Documents, State Department Diplomatic Material, and Cryptologic Equipment
M	Medical Supplies
N	Parts, Navy
P	Photographic Supplies and Equipment including Training Films
Q	Plants, Insects, Mites, Nematodes, Mollusks, Soil
R	Rations and Subsistence Supplies
S	Office and School Supplies and Equipment including Office Machines, Furniture and Stationary
T	Household Goods
U	Mail
V	Vehicles, Machinery, Shop and Warehouse Equipment and Supplies including Special Tools and Equipment, Ground Servicing and Special Purpose Vehicles, Marine Equipment and Supplies, Repair and Maintenance Parts for the above
W	Any material not otherwise specified that may require special handling with special instructions identified in the DI T_9 trailer data. Primarily used with channel airlift 463-L pallets
X	Intelligence materials including maps, charts data, and information vital to military functions such as flight safety, escape and evasion, current offensive/defensive operations, foreign clearance requirements, targeting and NASA Projects
Y	Personnel Services
Z	Human Remains



Mitigating The Erratic Behavior of The Transportation Working Capital Fund (TWCF) Through Accurate Forecasting



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 Advanced Studies of Air Mobility (ENS)
 Air Force Institute of Technology



Problem Statement

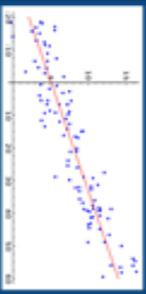
The United States Air Force and United States Transportation Command are not monetizing potential TWCF savings due to an inability to estimate cargo demands and the number of aircraft required for future support of a given installation with a high degree of confidence.

Hypothesis

A more predictive model will afford the opportunity for better utilization of organic aircraft, thus requiring fewer O&M missions & mitigation of the cognitive burden known as staffing.

Methodology

The ordinary least squares method helps to minimize the differences between the observed responses in some solitary dataset & the responses predicted by the linear approximation of the data.



ACGM uses a moving average. With this technique, the predicted value of the time series in period $t+h$ (denoted by \hat{y}_t) is simply the average of the k previous observations in a series, that is: $\hat{y}_t = \frac{1}{k} \sum_{i=1}^k y_{t-i+1}$

Year	Actual	Forecast	Target	Capacity	Available	Required	Surplus	Deficit
2011	1,838.8	2,012.55	0	0	0	0	0	0
2012	1,838.8	2,012.55	0	0	0	0	0	0
2013	2,057	2,057	0	0	0	0	0	0
2014	2,057	2,057	0	0	0	0	0	0
2015	2,057	2,057	0	0	0	0	0	0
2016	2,057	2,057	0	0	0	0	0	0
2017	2,057	2,057	0	0	0	0	0	0
2018	2,057	2,057	0	0	0	0	0	0
2019	2,057	2,057	0	0	0	0	0	0
2020	2,057	2,057	0	0	0	0	0	0
2021	2,057	2,057	0	0	0	0	0	0
2022	2,057	2,057	0	0	0	0	0	0
2023	2,057	2,057	0	0	0	0	0	0
2024	2,057	2,057	0	0	0	0	0	0
2025	2,057	2,057	0	0	0	0	0	0
2026	2,057	2,057	0	0	0	0	0	0
2027	2,057	2,057	0	0	0	0	0	0
2028	2,057	2,057	0	0	0	0	0	0
2029	2,057	2,057	0	0	0	0	0	0
2030	2,057	2,057	0	0	0	0	0	0
2031	2,057	2,057	0	0	0	0	0	0
2032	2,057	2,057	0	0	0	0	0	0
2033	2,057	2,057	0	0	0	0	0	0
2034	2,057	2,057	0	0	0	0	0	0
2035	2,057	2,057	0	0	0	0	0	0
2036	2,057	2,057	0	0	0	0	0	0
2037	2,057	2,057	0	0	0	0	0	0
2038	2,057	2,057	0	0	0	0	0	0
2039	2,057	2,057	0	0	0	0	0	0
2040	2,057	2,057	0	0	0	0	0	0
2041	2,057	2,057	0	0	0	0	0	0
2042	2,057	2,057	0	0	0	0	0	0
2043	2,057	2,057	0	0	0	0	0	0
2044	2,057	2,057	0	0	0	0	0	0
2045	2,057	2,057	0	0	0	0	0	0
2046	2,057	2,057	0	0	0	0	0	0
2047	2,057	2,057	0	0	0	0	0	0
2048	2,057	2,057	0	0	0	0	0	0
2049	2,057	2,057	0	0	0	0	0	0
2050	2,057	2,057	0	0	0	0	0	0
2051	2,057	2,057	0	0	0	0	0	0
2052	2,057	2,057	0	0	0	0	0	0
2053	2,057	2,057	0	0	0	0	0	0
2054	2,057	2,057	0	0	0	0	0	0
2055	2,057	2,057	0	0	0	0	0	0
2056	2,057	2,057	0	0	0	0	0	0
2057	2,057	2,057	0	0	0	0	0	0
2058	2,057	2,057	0	0	0	0	0	0
2059	2,057	2,057	0	0	0	0	0	0
2060	2,057	2,057	0	0	0	0	0	0
2061	2,057	2,057	0	0	0	0	0	0
2062	2,057	2,057	0	0	0	0	0	0
2063	2,057	2,057	0	0	0	0	0	0
2064	2,057	2,057	0	0	0	0	0	0
2065	2,057	2,057	0	0	0	0	0	0
2066	2,057	2,057	0	0	0	0	0	0
2067	2,057	2,057	0	0	0	0	0	0
2068	2,057	2,057	0	0	0	0	0	0
2069	2,057	2,057	0	0	0	0	0	0
2070	2,057	2,057	0	0	0	0	0	0
2071	2,057	2,057	0	0	0	0	0	0
2072	2,057	2,057	0	0	0	0	0	0
2073	2,057	2,057	0	0	0	0	0	0
2074	2,057	2,057	0	0	0	0	0	0
2075	2,057	2,057	0	0	0	0	0	0
2076	2,057	2,057	0	0	0	0	0	0
2077	2,057	2,057	0	0	0	0	0	0
2078	2,057	2,057	0	0	0	0	0	0
2079	2,057	2,057	0	0	0	0	0	0
2080	2,057	2,057	0	0	0	0	0	0
2081	2,057	2,057	0	0	0	0	0	0
2082	2,057	2,057	0	0	0	0	0	0
2083	2,057	2,057	0	0	0	0	0	0
2084	2,057	2,057	0	0	0	0	0	0
2085	2,057	2,057	0	0	0	0	0	0
2086	2,057	2,057	0	0	0	0	0	0
2087	2,057	2,057	0	0	0	0	0	0
2088	2,057	2,057	0	0	0	0	0	0
2089	2,057	2,057	0	0	0	0	0	0
2090	2,057	2,057	0	0	0	0	0	0
2091	2,057	2,057	0	0	0	0	0	0
2092	2,057	2,057	0	0	0	0	0	0
2093	2,057	2,057	0	0	0	0	0	0
2094	2,057	2,057	0	0	0	0	0	0
2095	2,057	2,057	0	0	0	0	0	0
2096	2,057	2,057	0	0	0	0	0	0
2097	2,057	2,057	0	0	0	0	0	0
2098	2,057	2,057	0	0	0	0	0	0
2099	2,057	2,057	0	0	0	0	0	0
2100	2,057	2,057	0	0	0	0	0	0

The ACGM made use of seven separate regressions, one for each of the 8 modal regression. Air Commodity Codes and one regression for the remaining 31 Air Commodity Codes. Actual pallet count represents the number of pallets terminating at each respective AFOD during the FY. Using a historical rolling average and operational insight (the scenario) assign a value to the eight independent or predictor variables & the model will calculate an expected pallet count for the year.

Future Research

1. Focus on expanding the model data set and plating an exact dollar amount to these potential savings.
2. Determine if dollar saving efficiency is demonstrably opposed to war winning agility.

Conclusion of Research

1. Models will likely never be able to replace human decision makers.
2. Modelers should not...not answers.
3. The best predictive variables may be unquantifiable or unknown...insight is not wisdom.

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Appendix D Quad Chart

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14. ABSTRACT Sequestration and its accompanying budget cuts demand the DoD enters into a new era of fiscal responsibility. The need to leverage the rising cost of readiness with exploding personnel cost has led to dramatic force reductions and among many AFSCs ominous clouds of uncertainty have been cast. If America is to remain the preeminent global force, then we must break our reliance on antiquated frameworks containing our basic assumptions, ways of thinking, and methodologies that promote and even reward inefficiency. The time is ripe for overhauling our thoughts on estimating cargo demands and the number of assets required to meet those demands. The primary focus of this research will be on mitigating the erratic behavior of the TWCF through modeling cargo demand with higher fidelity than is currently enjoyed by the United States Transportation Command. The research will create a more stable environment for customers, Civil Reserve Airfleet partners and budgeters by reducing the need to make quarterly expansion buys via the CRAF program and potentially saving tens of millions of dollars per year. The secondary objective of this research project is to cast light on an alternative view of the CRAF expense and aerial Port Hold Time (PHT).					
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