EVALUATING POINT-OF-SALE
ALTERNATIVES WITHIN NAVAL AVIATION

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Joint Planner

by

DANIEL D. DAVIDSON, LIEUTENANT COMMANDER, USN
MBA, Webster University, St. Louis, Missouri, 2005
B.S., Oklahoma University, Norman, Oklahoma, 1993

Fort Leavenworth, Kansas
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This thesis models three Point-of-Sale (POS) alternatives to improve cost wise readiness (CWR). A POS is described as the location where a financial transaction occurs. CWR in very simple terms is dollar-for-dollar readiness. The POS alternatives are to maintain the status quo (do nothing), move the transaction closer to the customer (the Squadron), or move the transaction closer to the supplier (the Original Equipment Manufacturer). The question as to which POS alternative is the most effective and efficient arises as a result of the consolidation.

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Name of Candidate: Lieutenant Commander Daniel D. Davidson, USN

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Approved by:

_____, Thesis Committee Chair
Mike E. Weaver, M.A.

_____, Member
David A. Anderson, Ph.D.

_____, Member or Consulting Faculty
Thomas E. Creviston, MSA

Accepted this 13th day of June 2008 by:

_____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

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any other governmental agency. (References to this study should include the foregoing
statement.)

ABSTRACT

EVALUATING POINT-OF-SALE ALTERNATIVES WITHIN NAVAL AVIATION, by Daniel D. Davidson, 89 pages

The Base Realignment and Closure Commission (BRAC) 2005 decision resulted in the consolidation of Naval Air Depots (NADEPs) and non-deployable Aircraft Intermediate Maintenance Departments (AIMDs) to form six Fleet Readiness Centers (FRCs). The intent behind this consolidation is to avoid redundant maintenance procedures, supply overhead charges and reduce aviation maintenance costs. The Department of Defense (DoD) estimates FRCs will yield $3.7 billion in net savings over 20 years. This is more savings than any other of the 2005 BRAC recommendations. This consolidation presents the opportunity to examine potentially significant changes within current NADEP, AIMD and supply support processes in order to gain the efficiencies that are required to yield the expected savings.

This thesis models three Point-of-Sale (POS) alternatives to improve cost wise readiness (CWR). A POS is described as the location where a financial transaction occurs. CWR in very simple terms is dollar-for-dollar readiness. The POS alternatives are to maintain the status quo (do nothing), move the transaction closer to the customer (the Squadron), or move the transaction closer to the supplier (the Original Equipment Manufacturer). The question as to which POS alternative is the most effective and efficient arises as a result of the consolidation.

ACKNOWLEDGMENTS

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ACRONYMS

AIMD	Aircraft Intermediate Maintenance Department
ASD	Aviation Supply Department
AVDLR	Aviation Depot Level Repairable
BCM	Beyond Capability of Maintenance
BRAC	Base Realignment and Closure Commission
CNAF	Commander, Naval Air Forces
COMFRC	Commander, Fleet Readiness Centers
DLA	Defense Logistics Agency
DLR	Depot Level Repairable
FISC	Fleet and Industrial Support Center
FRC	Fleet Readiness Center
ICP	Inventory Control Point
IMA	Intermediate Maintenance Activity
NADEP	Naval Aviation
NAE	Naval Aviation Enterprise
NAVICP	Naval Inventory Control Point
NAVSUP	Naval Supply Systems Command
NIMS	National Inventory Management System
NSN	National Stock Number
NWCF	Navy Working Capital Fund
RFI	Ready For Issue
RFT	Ready For Tasking
TAT	Turnaround Time
WIP	Work In Process

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CHAPTER 1

INTRODUCTION

Context and Problem Statement

The Base Realignment and Closure (BRAC) Commission 2005 decision resulted in the consolidation of Naval Air Depots (NADEPs) and non-deployable Aircraft Intermediate Maintenance Departments (AIMDs) to form six Fleet Readiness Centers (FRCs).[1] Establishment of FRCs consolidates two distinct maintenance organizations, intermediate and depot, to one "off-flightline" maintenance activity. Organizational level maintenance will become "on-flightline" maintenance. Three distinct levels of maintenance remain. Organizations are consolidating.

The intent behind this consolidation is to avoid redundant maintenance procedures, supply overhead charges and reduce aviation maintenance costs. The Department of Defense (DoD) estimates FRCs will yield $3.7 billion in net savings over 20 years.[2] This is more savings than any other of the 2005 BRAC recommendations.[3]

This consolidation presents the opportunity to examine potentially significant changes within current NADEP, AIMD and supply support processes in order to gain the efficiencies that will be required to yield the expected savings. The Navy has already included projected BRAC savings in its budget plans for fiscal years 2007 through 2011.[4] According to the Government Accountability Office (GAO), the projected savings are overstated.[5] If savings are not obtained, the Navy may have to take funds from other Navy programs, request additional funds to offset shortfalls or delay repairs to aviation components affecting readiness.

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<u>Thesis Statement</u>

This thesis models three Point-of-Sales (POS) alternatives to improve cost wise readiness (CWR).

<u>Operational definitions of POS alternatives and CWR</u>

A POS is described as the location where a financial transaction occurs. The POS alternatives are to maintain the status quo (do nothing), move the transaction closer to the customer (the Squadron), or move the transaction closer to the supplier (the Original Equipment Manufacturer). Historically, there has been a financial charge between the IMA and the NADEP. The question as to which POS alternative is the most effective and efficient arises as a result of the consolidation. Evaluating the POS alternatives determines if a financial charge should still exist between these traditional organizations within FRC.

Cost wise readiness (CWR) is a relatively new term. First introduced in 2003 by the Chief of Naval Operations, CWR in very simple terms is dollar-for-dollar readiness. CWR involves evaluating and adopting best business practices from other disciplines, across other professions, to include government and industry, in order to make Naval Aviation as effective and efficient as possible. In mathematical terms CWR is readiness output over cost. It has casued the Navy to find efficiencies in achievement and to move away from the idea of readiness at any cost.

No longer are Squadron Commanders expected to maintain 100 percent readiness of all their aircraft 100 percent of the time. Squadron Commanders are now told how many aircraft are required to be ready for tasking (RFT). RFT is defined as a Full or Partial Mission Capable (FMC/PMC) aircraft, in the custody of the reporting custodian

(Squadron), that is operationally mission ready and physically able to be flown in support of the Navy's goals. In other word, CWR takes all the aircraft for a given Squadron that are RFT and divides that by the total cost required to produce that output. The Naval Aviation Enterprise (NAE) measures its efficiency and effectiveness through this single fleet-driven metric of aircraft RFT at reduced cost.[6]

The NAE is a warfighting partnership in which interdependent issues affecting multiple commands are resolved on an enterprise-wide basis. The NAE enables communication across all elements of the enterprise, fosters organizational alignment, encourages inter-agency and interservice integration, stimulates a culture of productivity, and facilitates change when change is needed to advance and improve.[7]

Research Question

Which POS alternative has the greatest improvement on CWR?

Secondary and Tertiary Research Questions

Secondary Question. What are the requirements for a POS?

Tertiary Questions. What are the requirements to move the POS closer to the Customer? What are the requirements to move the POS closer to the Supplier?

Secondary Question. What are the requirements for a POS in Naval Aviation?

Tertiary Questions. What are the requirements for the current Naval Aviation POS? What are the requirements to support a move to the customer? What are the requirements to support a move to the supplier?

Secondary Question. How does an organization determine if it is effective (doing what it should be doing) and efficient (doing it economically)?

Tertiary Questions. What are the metrics that drive CWR within Naval Aviation? How does NAE measure these metrics? How do these metrics rank against each other?

Background

As mentioned earlier, a POS is described as the location where a financial transaction occurs. There are currently three locations where financial transactions occur for AVDLR components. Figure 1, illustrates the transactions that take place as the component passes from one maintenance level to the next. Using this visual depiction as an aid, it is beneficial to provide a very broad overview of the maintenance activities and the financial charges that occur as components pass from one level of maintenance to another.

Current Aviation Maintenance

Organizational   Intermediate   Depot   OEM
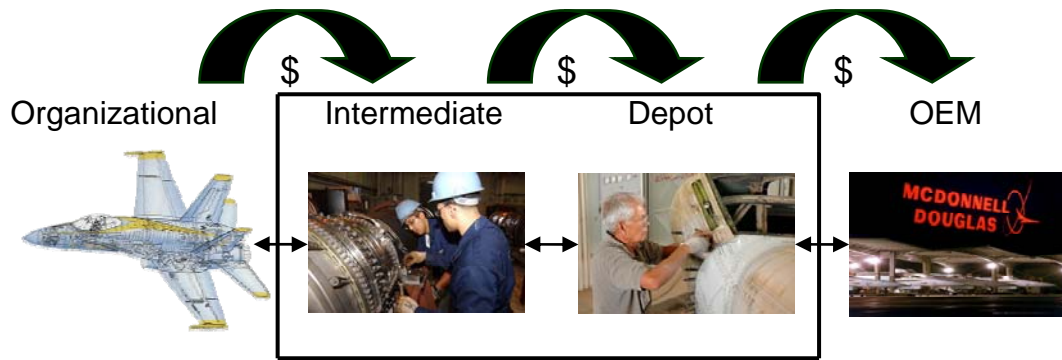
Figure 1 Current Aviation Maintenance Process
Source: F-18 (Photo, NAVICP Brief on Supply and Financial Structure Options, 20 September 2006; Aviation Machinist's Mate Airmen Kevin Mendoza and Angel Sanchez ready an F-414 jet engine for performance testing AIMD jet shop (Photo by Photographer's Mate Airman Jason D. Landon onboard USS Kitty Hawk (CV 63) 16 October 2003); Bonifacio Vergara replacing a tail section on a CH-53D Sea Stallion (Photo by Lance Cpl. Brian J. Holloran at Al Asad, Iraq 25 August 2006); McDonnell Douglas (Photo F/A-18A 18 September 1987)

There are over 150 Navy and Marine Corps Squadrons that perform Organizational Maintenance.[8] Sailors and / or Marines perform Organizational Maintenance on the flightline. This is the lowest echelon of maintenance and generally consists of routine, system and component preventive maintenance, such as inspections, systems operability tests and diagnostics, lubrication calibration and cleaning.[9] Repairs take place on the aircraft, whether at sea or at a Naval Air Station. If organizational maintenance crews are unable to repair a failed aircraft component, they send it to the IMA through the Aviation Supply Department (ASD). The ASD will provide a Ready-

For-Issue (RFI) repairable component off the shelf and charge the Squadron. The final

charge will depend upon the effectiveness of the IMA. If the repair only requires bit

piece parts, the financial charge to the Squadron is the cost of the materials. However, if

the bit piece parts ordered by the IMA do not correct the fault, the Squadron pays for the

ordered materials plus the cost of a new component from the supply system. The supply

system is a general term referring to all the possible sources that may provide a given

component.

There are 25 traditional IMAs.[10] Repairs by the IMA are a higher level of

maintenance primarily performed by Sailors and / or Marines. The focus is on

component repair in close proximity to the flightline but off-aircraft. IMA facilities are

equipped with space, machinery and diagnostic equipment not available at the

organizational activities. If the IMA is not capable of repairing an item, it declares the

component Beyond Capability of Maintenance (BCM). ASD collects the broken item

from the IMA and requisition a replacement part through a more the supply system in

exchange for the repairable carcass. The supply system charges the ASD for the

exchanged component.[11] As mentioned above, the ASD will charge the Squadron to

balance out the charge. This process allows ASD and the IMA to maintain a much

smaller budget. Financial charges apply to the ASD or IMA only when items are lost or

damaged while in their respective custody.

Depending on the available inventory of the failed item, the Naval Inventory

Control Point will either direct the non-RFI component to storage at a Defense

Distribution Depot or ship it to one of the three NADEP Fleet Industrial Supply Center

(FISC) Annexes. NADEP FISC Annexes provide supply support functions to the

NADEPs. The NADEP FISC Annex will deliver the non-RFI component to the NADEP

for repair. Work completed by a NADEP is more comprehensive and is a combination of

major repair, overhaul, and modifications to weapons systems, components, assemblies

and subassemblies.[12] In general, civilian aviation technicians with many years of

experience perform these repairs. If the NADEP cannot repair the item at a reasonable

cost, it declares the component Beyond Economic Repair (BER). The NADEP FISC

Annex will collect the non-RFI component. They will then either disposed of the non-

RFI component or send it to the Original Equipment Manufacturer (OEM) for repair or

carcass cannibalization.[13] The NADEP charges its customers for the total costs of repair;

this includes labor, material, and operational costs. As inventories are exhausted, the

Naval Inventory Control Point will procure more assets from the OEM.

<div align="center">Ongoing Analysis</div>

This thesis will serve as an independent analysis in the context of ongoing Navy

studies. These studies are a FRC contracted evaluation of the impacts of integrating all

"off-flightline" maintenance activities and the transfer of supply, storage, and distribution

functions from military services to Defense Logistics Agency (DLA).

Commander Fleet Readiness Centers (COMFRC) recently contracted Logistics

Management Institute (LMI) to evaluate the financial alternatives, functional and

organizational alignment implications of realigning and integrating all "off-flightline"

maintenance activities to effectively and efficiently provide readiness to the fleet.

Included in the financial alternatives is POS alternatives and implications. LMI is a non-

profit consulting firm with over 45 years of experience. LMI offers civil agency and

defense managers capabilities in six mission areas: acquisition, facilities and asset

management, financial management, information and technology, logistics, and organizations and human capital.[14] In accordance with the contract, LMI should complete the deliverables in early 2009.[15]

An additionally result of the 2005 BRAC round, is the requirement by the military services to transfer all supply, storage and distribution functions at specified depot maintenance locations to DLA. The intent is to reduce both the number of supply distribution depots and related excess capacity, while providing the DoD with a logistics base that saves money and enhances the effectiveness of logistics support to operational forces. DLA contracted LMI to assess the supply, storage and distribution operations at all affected depots, identify the risks to depot operations of transferring these functions, and recommend which functions should transfer to DLA at each site.[16] The transfer of functions will start in 2008 with the Air Force. All transfers should be complete by 2011.

Methodology

The desired effect of any POS alternative is to optimize CWR. This thesis models the POS alternatives (independent variable) as the cause that effects a result in CWR (dependent variable). Real world processes are complex, interactive systems in which policies do not always cause linear results. This process has many interconnected components (variables) to model in order to determine the best POS alternative. The literature review develops these interconnected components.

The elements of a model are drawn from personal experience, consulting with key players, published literature, asking experts, existing data sets and pilot studies.[17] Components of a model are variables. Variables are measurable characteristics, properties of people or things that can take on different values. Dependent and independent variables refer to values that change in relationship to each other.[18] Dependent variables change in response to the independent variables. Deliberately manipulating independent variables invoke a change in the dependent variables. In more simple terms, the cause is the independent variable; and the effect is the dependent variable. In contrast, characteristics that do not vary are constants. The model examines the cause and effect of each POS alternative.

To fully understand the dynamics of a POS alternative a quantitative model is needed. Dynamic Modeling techniques develop useful and realistic quantitative models of key aspects of processes to include the interactions between variables and their notional effect on measures of interest. Dynamic Modeling provides a graphically based model to help stakeholders understand the interrelationships of the various policy levers.[19] The ability to include feedback loops, where the output from one portion of the

model affects future iterations of the system is an additional benefit of a Dynamic

Modeling that is not present in many causal models developed using statistical

techniques.

In addition to being a visual tool of how elements interact, Dynamic Modeling

allows exploratory analysis. This has two beneficial features. First, it helps determine

the key variables that are critical to achieve a desired set of final results.[20] Dynamic

Modeling identifies critical elements and flags them for further examination. This helps

to ensure the model correctly captures each element. In contrast, elements that are not

critical to the modeling process may be simplified or reduced. Secondly, exploratory

analysis includes the consideration of many different scenarios. This allows the model to

determine how certain policy configurations will affect the outcomes of the system. This

analysis helps policy makers better understand the cause and effect relationships in the

system, and thereby aid in the development of arguments for or against proposed changes

to the existing system. Examining a large number of different scenarios allows the

strength of a given set of policy alternatives to be determined. This ensures that the

solution selected for implementation is not only close to optimal, but resilient in relation

to changes in the real world environment that may or may not be perfectly capture all the

interconnects in the model.

<center>Significance</center>

Evaluating the alternatives through a model determines which will have the

greatest improvement to CWR. As mentioned above, GAO feels that the projected FRC

savings of $3.7 billion over 20 years is overstated. The Navy has already taken the

<center>10</center>

savings in its budget plans for fiscal years 2007 through 2011. Every effort must be made to achive this savings without affecting readiness.

Determining the best alternative is more than just a cost-anaylsis question. Recent history shows us that the answer is not easy. The Naval Shipyards (Depots) and Ship Intermediate Maintenance Activities recently consolidated under a CNO directive to form Regional Maintenance Centers (RMC). One of the by-products of this reorganization effort is the consolidation of the financial management systems used to govern RMCs. RMC consolidated the financial management system to direct appropriations.

Congress provides direct appropriations at a level sufficient to pay for work that a facility expects to perform in a given fiscal year without identifying specific work. RMC facilities now provide maintenance services to Fleet customers at no charge other than the bit piece parts required for the repair. This in essence is a move of the POS closer to the customer. The Department of Defense Office of the Inspector General (DoD IG) did not support this consolidation of the financial management system to direct appropriations in their 2005 and 2007 reports.

An alternative would have been to consolidate to a revolving fund. Deports have successfully used revolving funds since the 1950s.[21] Revolving funds allow Shipyards to finance their own operations by charging for the services provided to the customers. Funding is available to finance their continuing operations without fiscal year limitations.

Assumption

The following assumption must be accepted in order to proceed with this thesis. In developing the model it is presumed that by changing the POS (the location where a

financial transaction occurs) the organization and the systems that support it must change. The degree of change may very depending on the organizaiton and the system. The point is that there will be some change. Specifically, by changing the location of the financial transaction the financial management system must change. This would be a consolidation either to a revolving fund or a direct appropriation fund similar to the process used by the RMCs.

Limitations

The data used in the model are from Commander, Naval Air Force (CNAF) and Commander, Fleet Readiness Center (COMFRC). The two different commands use slightly different criteria to develop their metrics. As a result, some manipulation is required to fit the model.

Thesis Organization

The organization of this thesis is broken into five chapters. Chapter one is an introduction to the context and problem statement. The intent is to define the research questions and provide background into the topic. Chapter two reviews literature to set the boundaries of the model and choose the appropriate level of detail needed to map a real world process. Chapter three discusses the methodology used to conduct the analysis. Chapter four provides the details of the analysis. Conclusions and recommendations are in Chapter five.

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[1] Defense Base Closure and Realignment Commission, Individual Sections of the Final Report to the President, Chap 1, Navy/Marine Corps, p. 87, available at http://www.brac.gov/finalreport.html (accessed March 10, 2008)

[2] GAO-07-304, Military Base Closures, *Projected Savings from Fleet Readiness Centers Likely Overstated and Actions Needed to Track Actual Savings and Overcome Certain Challenges, June 2007*

[3] Ibid. p. 1

[4] Ibid. p. 8

[5] Ibid. p. 2

[6] *The NAE: A Warfighting Partnership*, The Hook Magazine, Summer 2006, available at http://www.tailhok.org/hookmag.htm (accessed April 05, 2008)

[7] Ibid. p. 1

[8] Commander, Naval Air Forces, Terms and Definitions, available at http://www.cnaf.navy.mil/ (accessed March 25, 2008)

[9] Commander, Naval Air Forces Instruction 4790.2J, *Maintenance Policy For U.S. Naval Aviation*, 2005, Vol 1, chapter 7, p. 7-1

[10] Commander, Naval Air Forces, Terms and Definitions, available at http://www.cnaf.navy.mil/ (accessed March 25, 2008)

[11] Commander, Naval Air Forces Instruction 4790.2J, *Maintenance Policy For U.S. Naval Aviation*, 2005, Vol 1, chapter 7, p. 7-2

[12] Commander, Naval Air Forces Instruction 4790.2J, *Maintenance Policy For U.S. Naval Aviation*, 2005, Vol 2, chapter 2, p. 2-1 – 2-19

[13] Commander, Naval Air Forces Instruction 4790.2J, *Maintenance Policy For U.S. Naval Aviation*, 2005, Vol 2, chapter 2, p. 2-1 – 2-19

[14] Logistics Management Institute (LMI) information obtained from home page http://www.lmi.org/ (accessed March 01, 2008.

[15] Statement of Work for LMI received from the Deputy Supply Officer of Commander, Fleet Readiness Centers, February 18, 2008.

[16] GAO-08-121R, *BRAC Transfer of Supply, Storage, and Distribution Functions from Military Services to Defense Logistics Agency*, 2007

[17] Saint-Germain, M.A., Research Methods 696, *Application of relevant research techniques to problems in public policy and administration*, available at http://www.csulb.edu/~msaintg/ppa696/696vars.htm last reviewed 20Mar08 (accessed May 2, 2008)

[18] Ibid.

[19] Bickel, Robert W., *Improving Air Force Purchasing and Supply Management of Spare Parts*, RAND, 2003, p. 8

[20] Ibid.

[21] Congressional Budget Office (CBO) Paper, *Comparing Working-Capital Funding And Mission Funding For Naval Shipyards*, April 2007

CHAPTER 2

LITERATURE REVIEW

Introduction

If the 1980's were about quality, and the 1990's were about reengineering, then the 2000's will be about velocity. About how quickly the nature of business will change. About how quickly business itself will be transacted. About how information access will alter the lifestyle of consumers and their expectations of business. Quality improvements and business process improvements will occur far faster . . . A manufacturer or retailer that responds to changes in sales in hours instead of weeks is no longer at heart a product company, but a service company that has a product offering.[1]

Bill Gates, Business@the Speed of Thought - Warner Books, 1999, p 57.

The intent of this chapter is to identify and evaluate available literature relevant to the research topic. It defines the requirements of a POS system in very broad terms. The literature sets the boundaries of the model. It helps to identify the appropriate level of detail needed to map a real world process.

The constant demand for process improvement initiatives to meet customers, suppliers, or stakeholder needs has resulted in a wealth of available literature. More specifically, information technically (IT) improvements in POS systems has allowed organizations to better understanding customers and suppliers. The information gained by these systems enables organizations to achieve results effectively and efficiently. This has predictably produced a number of published and academic works.

While, the high cost of maintaining today's weapon systems in tandem with the development and procurement of future platforms has stimulated a high level of interest from both the Military and Congress to find effective and efficient solutions to depot maintenance and supply chain processes. As a result, there are a number of professional

journals, military doctrine and RAND Corporation reports that cover business system improvements.[2]

The literature is organized to systematically answer the research questions listed in chapter one. This provides three focus areas. These are to determine the requirements for: a POS system, the current Naval Aviation POS system and an effective and efficient organization. Finally, dynamic modeling relevant to the literature review as it answers the primary research question.

Requirements for a POS system

Assuming Bill Gates' comments on velocity are accurate, then the answer to how a business gains that velocity is through the flow of information. The flow of information has become just as importance if not more so than the individual product.[3] Companies must tailor their POS system to gather and apply the information effectively. A POS system is not merely the method used by the organization to gain that information. It allows the organization to analyze the information across key business processes in order to apply it effectively, allowing the organization to be more efficient.

Douglas Lambert supports this in his depiction of a simplified Supply Chain Management (SCM) network structure. As illustrated in Figure 2, information and product flow run from original supplier through end user.[4] He further states that the transactional view of business process management is rooted in advances and availability of information and communication technology. That is as technology improves organizations are able to change business processes to achieve effective and efficient results. Standardizing transactions and the transfer of information sets the foundation to redesign the business processes of an organization.[5]
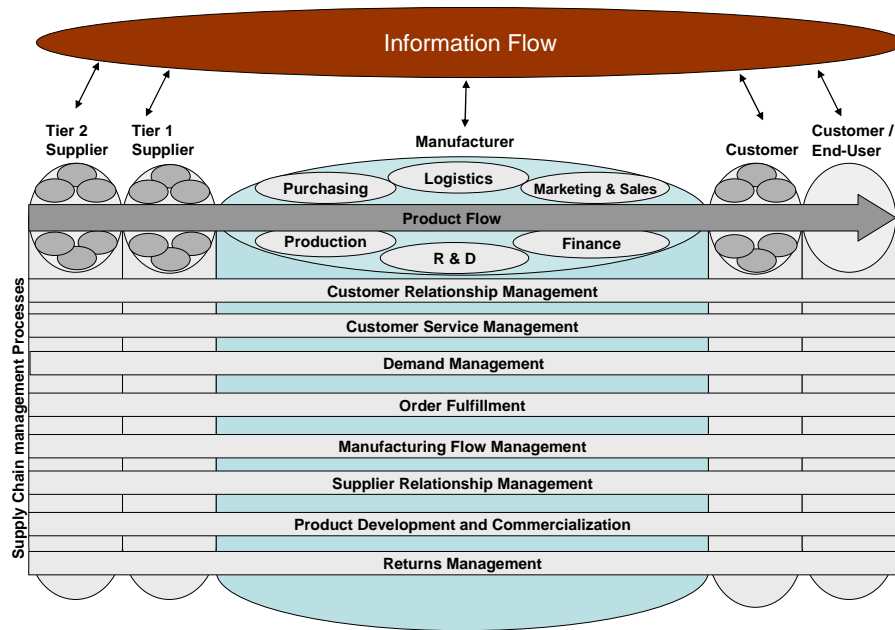
Figure 2, Supply Chain Management (SCM) network structure.
Source: Douglas M. Lambert, Supply Chain Management: Processes, Partnerships, Performance, Second Edition, Supply Chain Management Institute, p. 3.

Information flow meets the broad requirement of a POS system. It is perhaps to broad. This should be of little surprise considering the diversity of the commercial industry. Each company has a slightly different POS system requirement. Caroline Lam helps to narrow this down. She provides six must-have core components for any POS system regardless of the type and size of company or its intended application. Lam follows this with a number of non-essential features to consider before implementing a POS system.

The first core component is transaction management. This feature includes all the information required to complete a transaction.[6] The list of transaction data can be extensive. At a minimum, this component should capture sales data, cancellations, voids, refunds, returns, and creation of special orders. POS systems with transaction

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management save time and reduce manpower requirements to validate item information, total purchases and process payments.

Price changes are required when managing any type of product. The price management component allows modification of product prices for a number of different reasons. Items can be discounted as a result of damage, after negotiations with customers, to remain competitive or to help move a product. An items price may increase to balance supply and demand, to cover other expenses or gain profits. POS systems should track these price changes, assign a code to the reason and have the capacity to generate reports for auditing purposes.[7]

The cash flow or register management component tracks opening funds, incoming / outgoing transactions, tenders, currencies, and taxes.[8] This component monitors cash flow for a given day's business. It flags any unusual events. A POS system with cash flow management allows organizations to take appropriate action quickly on flagged items.

Knowing the location of inventory in accurate quantities allows sales to be closed well increasing customer service and satisfactions. The inventory management component includes item localization tools, physical inventory procedures, and inventory adjustments.[9] This component ensures that inventory is up to date and tracks who made the changes for auditing purposes. POS systems with inventory management functionality can reduce the level of inventory required to meet customer demands.

Customer relationship management (CRM) makes it possible to manage customer interactions, sales histories, preferences, loyalty programs and so forth.[10] To gain the insight required to put CRM to use, the data quality and availability must be present. A

POS system with CRM can help ensure a healthy relationship between the customer and provider.

Reports and inquiries enable organizations to analyze its performance by day, by week, by month or even by year. This component allows managers to identify anomalies and to take corrective action as necessary.[11] POS systems allow employees to use this component daily to extract information on inventory, sales summaries, items in transit, shipping information and more.

Two of the non-essential features to consider before implementing a POS system are purchase orders and financials. Lam does not list these components as core because she maintains that these functions exist in other systems (i.e. retail management systems).

The purchase order feature enables buyers to communicate a purchase to vendors and to receive the goods ordered.[12] POS systems with this feature simplify the ordering and receiving functionalities. The purchase order module allows the generation of different types of purchase orders, automatic creation of purchase orders or the ability to add vendor information at an item level.

The financial feature includes general ledger, fixed assets, cost accounting, cash management, budgeting, accounts payable, reporting, and other bookkeeping requirements.[13] POS systems with this feature allow communication with third-party financial systems.

Purchase order and financial features require communication outside the organization to be effective. This communication or information flow is more available today through the use of Enterprise Resource Planning (ERP) solutions. This is an

attempt to integrate several data sources and processes of an organization into a unified

system. This unified system is often the POS system used by the organization.

<u>Moving the POS closer to the customer</u>

The constant theme within the literature for moving a POS closer to the customer

is Customer Relationship Management (CRM). As mentioned above Lam believes this

to be a core component of any POS system. According to Merlin Stones, customer

insight implies sensible use and understanding of consumer information. This insight

allows companies to modify their organizational strategy and give the consumers the

ability to fulfill their own needs.[14] This type of insight is the result of combining market

research and customer database analysis to manage consumers.[15] "Good consumer

insight is the foundation of good customer relationship management."[16]

CRM is the strategy of connecting different players within an organization to

coordinate their efforts in creating an overall valuable series of experiences, products and

services for the customer. Categorizing customers allows an organization to focus its

effort to meet strategic goals. The criteria for categorizing customers will be different

from company to company based on the needs and goals of the organization, both in the

short and long-term. As a general rule companies segment customers by: profitability,

growth, volume, competitive positioning, market knowledge, market share goals /

penetration, margin, technology, resources, compatibility, trade channel, and buying

behavior.[17]

To gain the insight required to put CRM to use, the data quality and availability

must be present. Sears and Wal-Mart require all component companies and subsidiaries

to operate within a standard systems framework that result in an integrated system and do

not allow individual systems development.[18] At the strategic level, the CRM process

provides the structure for how relationships with customers will be developed and

managed.[19]

CRM software has the potential to gather customer data quickly, determine

customer needs, and allow the organization to customize product and service

development. Organizations do not always achieve the desired results. According to the

Gartner Group, 55 percent of CRM software solutions fail.[20] It is common for

organizations to spent millions only to scrap the entire CRM project. The ultimate

measure of success for CRM is the impact it is having on the financial performance of the

organization.

Moving the POS closer to the supplier

Similar to the above, the constant theme for moving the POS closer to the supplier

is Supplier Relationship Management (SRM). The goal of SRM is to streamline and

make more effective the processes between an organization and its suppliers.[21] Just as

CRM streamlines and make more effective the processes between an organization and its

customers. Organizations tailor SRM software to create a common frame of reference

that enables effective communication between an organization and suppliers who may

use quite different business practices and terminology. As a result, SRM increases the

efficiency of processes associated with acquiring goods and services, managing

inventory, and processing materials.

Suppliers are a key part of profitable business development. They impact the

product quality, availability, lead-time and access to critical technology. Reviewing the

strategies of each supplier allows organizations to develop criteria to segment providers.

Potential criteria include profitability, growth, stability, service level; sophistication, compatibility, technology capability, volume purchased, capacity, culture of innovation and anticipated quality level. Organizations may choose to develop a close relationship with a few key suppliers based upon the above criteria, while maintaining traditional relationships with others. For the few key suppliers a detailed and tailored product and service agreement (PSA) is critical to a successful SRM program. The goal should be to develop the PSAs to address the major business drivers of both the organization and the supplier. Similar to CRM, the ultimate measure of success of each relationship is the impact that it is having on the financial performance of the organization. Consequently, it is necessary to have a system that tracks the financial performance.[22]

Current Naval Aviation POS system

Identifying the systems used and the organizations they support establishes the requirements for the current Naval Aviation POS system. In contrast to Sears and Wal-mart, the Navy has a proliferation of nonintegrated systems using nonstandard data.[23] The Department of Defense (DoD) as a whole is moving toward ERP solutions to help ultimately integrate this data. DoD spends billions of dollars each year to implement business systems with the intent of improving effectiveness and efficiency.[24] In fiscal year 2005, the Navy spent $3.5 billion to operate, maintain, and modernize its IT infrastructure that supports business processes. This represents about 27 percent of the $13 billion spent by DoD for all of its business systems that fiscal year. Of the 4,150 business systems that DoD reported in its 2005 inventory, the Navy accounted for 2,353, or about 57 percent, of the total.[25]

According to CAPT Timothy Holland, Deputy Program Manager for Commander

Fleet Readiness Center (COMFRC), plans are underway to employ Navy ERP as the

FRC IT solution in 2014.[26] Given the 2,353 business systems in the Navy's inventory,

there are a number of disparate legacy systems to integrate. Many of these business

systems are bolt-on software developed over the years to enhance the flow of information

or to improve a process. This thesis looks at five core legacy systems used by or

supporting the FRC. These five legacy systems are Naval Aviation Logistics Command

Management Information System - Optimized Organizational Maintenance Activity

(NALCOMIS-OOMA), Naval Aviation Logistics Command Management Information

System - Optimized Intermediate Maintenance Activity (NALCOMIS-OIMA), Relational

Supply (RSUPPLY), Naval Air Systems Command Depot Maintenance System (NDMS)

and Uniform Automated Data Processing System Revision 2 (U2). These legacy systems

provide the core components for a POS system as identified by Lam.

Naval Aviation Logistics Command Management Information System

(NALCOMIS) is the information system used to support maintenance at both the

Organizational and Intermediate Level. NALCOMIS has been around, in one form or

another, for 25 years. Continuous modifications within NALCOMIS allow it to support

these two different organizations. These modifications have given rise to two different

systems known as NALCOMIS-OOMA and NALCOMIS-OIMA.

NALCOMIS-OOMA provides aviation maintenance managers at the

Organizational Level a tool to make effective day-to-day decisions affecting assigned

aircraft and equipment.[27] This includes aircraft component troubleshooting, servicing,

inspection, removal and replacement. While, NALCOMIS-OIMA provides aviation

maintenance managers at the Intermediate Level a tool to make effective day-to-day management decisions affecting component repair.[28] Repairs by the IMA are a higher level of maintenance for components removed from the aircraft. IMA facilities are equipped with space, machinery and diagnostic equipment not available to the organizational activities.

Relational Supply (RSUPPLY) is a windows based retail, distribution and ordering system used by ASD to support both NALCOMIS-OOMA and NALCOMIS-OIMA.[29] First deployed in 1997, RSUPPLY functionality is derived from a combination of afloat and ashore 1960s vintage retail, distribution and ordering software. RSUPPLY provides online inventory, logistics, and financial management tools.[30]

Naval Air Systems Command (NAVAIR) approved a commercial off the shelf Manufacturing Resource Planning / Maintenance Repair and Overhaul application for all NADEPs in 1995. This application known as NAVAIR Depot Maintenance System (NDMS) replaced many legacy systems used by the three NADEPs. It took until 2002 to implement NDMS. This information system delivers processes and tools that address major end item management, commodities repair, facilities management, advanced planning and scheduling, workload execution and support for specialized operations (i.e. tool management, hazardous material management, laboratory management and inter-service workload tracking). The NDMS program enhances the business processes of the depot maintenance environment in several ways. It allows NADEPs to conduct workload planning, to negotiate workload with customers, to establish structure for workload budgeting and to maintain forecasts of workloads against business plans. NDMS improves production management by planning, authorizing, developing project and

production schedules and by assigning work to specific resources. Finally, NDMS increases the velocity, manageability and cost effectiveness of NADEP repair.[31]

Uniform Automated Data Processing System Revision 2 (U2) is the Navy's standard legacy automated information processing system supporting a wide variety of retail material management, inventory accounting and physical distribution functions. U2 is the retail system used by the Fleet Industrial Supply Center (FISC) to support NDMS requirements. U2 uses 1960s computer language that is costly to maintain. The number of technicians skilled to maintain the system continues to diminish. The rising cost and diminishing technicians help drive the need to modernize the IT solution for Navy retail management.

Naval Supply Systems Command (NAVSUP) is the lead for Navy ERP. The Chief of the Supply Corps, Rear Admiral Upper Half Alan S. Thompson, recently released a message reinforcing the commitment to the successful implementation of Navy ERP. NAVSUP will implement release 1.0 across the Navy enterprise in October 2008.[32] This will be the first release with a focus on resource and project management. The hope is that the Navy will be able to enhance its capability to record cost. Navy ERP should provide the visibility of all labor and non-labor costs associated with major products and services, such as supply chain management.[33] The goal is to establish a common framework across all Navy activities in a commercial software system. As indicated by the name release 1.0, the implementation will happen over time and in segments. As mentioned earlier, the ERP solution for FRC organizations will not happen until 2014. This is six years after the first release. Navy ERP may provide the optimum POS solution. This thesis provides an interim POS solution using the systems available.

According to the message from Rear Admiral Thompson, the replacement of RSUPPLY and U2 will occur in the second phase of Navy ERP. Dates have not been set for the second phase. However, the author assumes that the second phase will not take six years. This indicates that the FRC solution is just for NALCOMIS and NDMS. This supports Lam's argument that features to consider before implementing a POS system may exist in a retail solution. RSUPPLY and U2 are retail systems.

It is important to note that DLA has already implemented its ERP solution. This major reengineering effort replaced 35-year old materiel management systems with SAP's Business Systems Modernization (BSM) software. As mentioned in chapter one, the 2005 BRAC decision requires the military services to transfer all of their supply, storage, and distribution functions to DLA.[34] This will happen starting with the Air Force in 2008. All transfers should to be complete by 2011. Depot maintenance officials expressed concern that if the transfer of production integrated supply functions to DLA takes place using DLA's existing price structure, it will increase the cost of depot maintenance operations and depots will have to pass these additional costs on to their customers by increasing their hourly rates. Customers would thus pay more for equipment maintenance. This would affect their operation and maintenance budgets. According to depot officials, under DLA's standard schedule of supply transaction charges, customers receive charges for each transaction. DLA has stated that it will develop a new pricing methodology as it gains experience in managing the depots. What is not clear is the extent of supply functions and systems that will transfer to DLA.

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The organizational structure supporting the POS system was briefly discussed in chapter one. In accordance with BRAC law, the FRC organization is already changing. The supply support structure has the potential to change. This thesis will model the Supply organizations supporting the FRC as represented in figure 3.
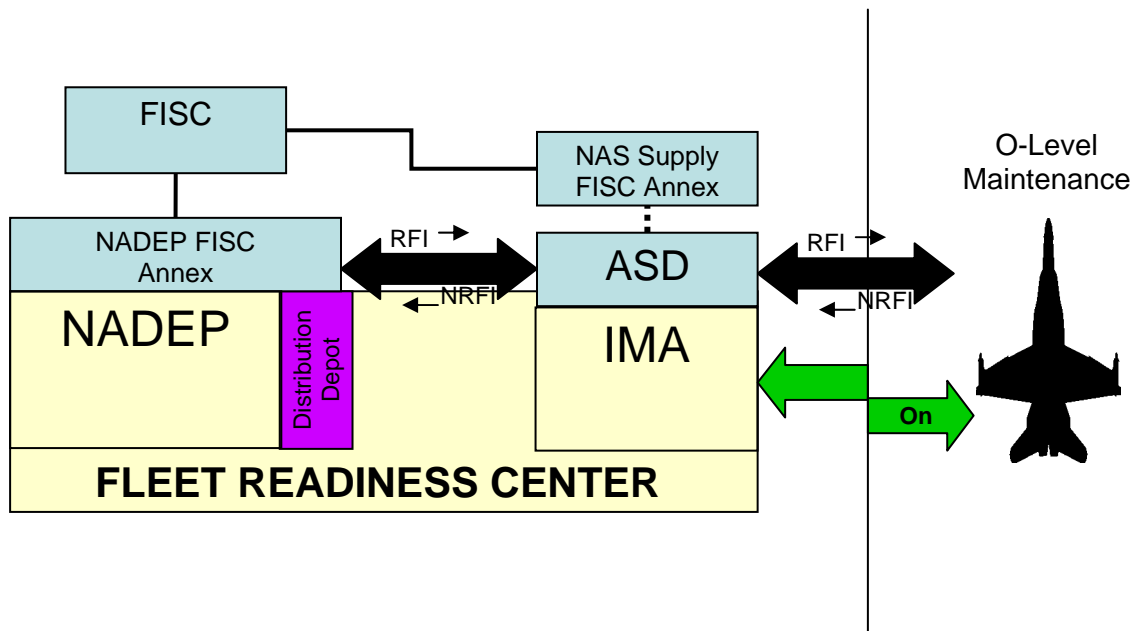
Figure 3, FRC and Supply organizations
Source: The above representation is a modification of a PowerPoint brief given by Rear Admiral Lower Half Michael Hardee from 2006.

There are four Fleet and Industrial Supply Centers (FISC) located in Norfolk, Virginia; Jacksonville, Florida; San Diego, California; and Bremerton, Washington. In the 1990s, the Navy sought to reduce costs and increase efficiency through the concept of regionalization.[35] This was a consolidation of support functions for all activities in a specific geographic area. Bill Gates called the 1990s a time of reengineering. This reengineering had distinct differences across each of the FISC regions.

The 25 FISC Annexes curved out of the traditional Naval Air Station (NAS), Supply Departments are of importance. Prior to the regionalization, the NAS Supply Officer reported to the NAS Commanding Officer (CO). Today the NAS Supply Officer will often report to the NAS CO, the FISC CO, the Regional Commander, and the Wing Commander. The FISC CO signs the NAS Supply Officer's fitness report. Yet, the majority of the NAS Supply Officer's efforts are supporting the Wing Commander.

At the same time, the reporting structure for the ASD Officers changed. Traditionally, each ASD Officer would report directly to the NAS Supply Officer. This is not always the case today. It is more common for the ASD Officer to report directly to the Wing Commander. This allows the ASD Officer to report to the customer. However, this gets confusing when there is more than one Wing Commander on an Air Station. A few ASD Officers report directly to the IMA Officer. Some have continued to report to the NAS Supply Officer.

There are three NADEP FISC Annexes supporting the three traditional NADEPs. Each NADEP FISC Annex performs supply functions in support of NADEP production. The NADEP FISC Annex Supply Officers receive their fitness reports from the FISC CO. Two NADEPs are collocated with a regional FISC Headquarters and a NAS. These are NADEP Jacksonville and NADEP San Diego. These two organizations can be simplified and still capture the complexity of the POS requirements in the model.

<u>Moving the Naval Aviation POS closer to the customer</u>

The Naval Shipyard consolidation provides the best example of moving the POS closer to the customer. Similar to the consolidations of FRCs, the Navy consolidated the management and operation functions of Naval Shipyards (Depots) and Ship Intermediate

Maintenance Activities (SIMAs) to form Regional Maintenance Centers (RMCs).[36] The

Chief of Naval Operations (CNO) introduced the concept of the Regional Maintenance

Plan (RMP) in 1994.[37] Since this was a CNO plan, the Navy was able to consolidate the

organizations over a greater period than that directed by BRAC law for FRCs. One of the

by-products of this reorganization effort is the consolidation of the financial management

systems used to govern RMCs. The Navy is in the process of shifting the financial

management system from Navy Working Capital Funds (NWCF) to direct appropriated

funds. In essence, this change in financial management systems is a shift of the POS

closer to the customer.

The direct appropriation mechanism used is Mission Funding. According to the

Congressional Budget Office, the Navy believes that the shift to Mission Funding gives it

more flexibility in allocating its resources across regions and types of maintenance.[38]

Direct appropriations are set at a level sufficient to pay for work that a facility expects to

perform in a given fiscal year without identifying specific work. Under a Mission

Funded organization, the workforce assignments do not require full funding of

maintenance. This gives the organization the flexibility to assign the workforce as

needed. Mission Funded facilities provide maintenance services to Fleet customers at no

charge. However, the cost of direct civilian labor and materials require reimbursement

for ship modifications and conversions, a policy consistent with the guidance of the DoD

Financial Management Regulation (DoDFMR).[39] In reorganizing maintenance facilities

under its regional plan, the Navy aims to eliminate duplication and overlapping of

maintenance resources by placing the depot and intermediate level maintenance facilities

in a region under one command. The Navy concluded that fully integrating the facilities required a common financial system under direct appropriation funds.

The Department of Defense Office of the Inspector General did not support this conclusion during their December 2005 and April 2007 reports. Naval Shipyards had been operating successfully under some form of revolving fund financial system since the 1950s.[40] Revolving funds allow Shipyards to finance their own operations by charging for the services provided to the customers. Funding is available to finance their continuing operations without fiscal year limitations. "For the organizations that utilize this financial strategy, it creates a pseudo-entity, which attempts to adopt private business practices in meeting the needs of its customers."[41]

The market-like system provides customers with incentives to make cost effective repair decisions at the local level. Shipyards determine the total cost of doing business and bill the customer for services with a goal of breaking even. Direct costs, indirect costs, overhead and general / administrative expenses determine the cost of each job. An organization's goal when using NWCF is to streamline operations and maximize resources by establishing clear customer / supplier relationships, adopting private sector techniques for resource management, consolidating key functions, and using activity-based accounting policies to display full costs. NWCF provides managers with the cost and performance data required to make effective and efficient decisions.[42] Department of Defense Office of the Inspector General and the Congressional Budget Office did not believe that the change in financial systems could provide the cost visibilities to properly manage the RMC. Due to the fiscal year constraints, they felt that the Navy was taking risks without properly accounting for it prior to the shift.

Moving the Naval Aviation POS Closer to the Supplier

In the late 1990s, the Department of the Army initiated the Single Stock Fund (SSF) to reengineer inventory management functions and associated financial processes.[43] The SSF consolidates the management of existing wholesale, theater, corps, installation and division authorized stockage list (ASL) inventories creating a single virtual supply and maintenance operation.[44] In essence, SSF creates a single POS for Army Working Capital Fund (AWCF) items. It eliminates what was the Retail Stock Fund (RSF), closes 49 general ledgers and eliminates two legacy financial inventory accounting systems.[45]

National managers of repair parts are now able to look beyond depot stock to satisfy requirements.[46] The Army was able to realize a number of benefits after implementing SSF. The Secretary of the Army testified in 2003 before the Senate Armed Services Committee that from May 2000 through November 2002, the SSF met soldier requirements by redistributing $758 million assets. He further stated that the Army reduced customer wait time (CWT) by 18.5 percent.[47] According to field commanders, SSF provides additional flexibility to fill demand-supported ASL requisition objectives. This is because a continuously sinking retail stock fund no longer restrains commanders. Additionally, the surcharge for Army Material Command (AMC) managed items dropped by 20 percent between fiscal year 2001 and 2002. The surcharge is the amount that AMC adds to the cost of the repair part to cover management, storage, and shipping. Reduced surcharges translate into lower repair parts costs for the customer.[48]

In order for SSF to be successful, the Army had to make changes to its wholesale and field logistics systems. It had to synchronize the business processes. This was possible using an interim software strategy called middleware. Which allows wholesale and retail legacy systems to remain in place until the optimum solution is ready for implementation. The middleware intercepts incoming and outgoing transactions, modifies them in accordance with SSF business rules, and routes them to the appropriate logistics and financial information system.[49]

The Defense Logistics Agency (DLA) initiated a similar strategy call National Inventory Management Strategy (NIMS). NIMS is an effort to merge distinct wholesale and retail inventories of consumables into a national inventory, providing a more integrated management system, tailoring inventory services' requirements, and reducing redundant inventory levels. Put more simply, NIMS extends supply chain management of consumable items beyond the wholesale level in order to provide products and services to the point of consumption. This reduces the number of layers of inventory management and improves demand forecasting and stocking efficiency.[50]

Like SSF the success of NIMS relies heavy on middleware. Middleware allows each service to maintain its own legacy system while intercepting incoming and outgoing transactions, modifying them in accordance with NIMS business rules and routing them to the appropriate logistic and financial system. The business rules are similar to the products and services agreement (PSA) mentioned above as being critical to a successful Supplier Relationship Management (SRM) program. The goal should be to develop the PSAs to address the major business drivers of both the organization and the supplier.

NIMS is still in the implementation stage. DLA put NIMS on hold until the installation of ERP was complete.

The Government Accountability Office (GAO) determined that by taking SRM as a strategic approach clearly paid off, as private sector companies found that they could save millions of dollars and improve the quality of services received.[51] In some cases, organizations were able to reduce thousands of suppliers to a few, enabling the companies to negotiate lower rates. In other cases, new information systems enabled companies to better match their business managers' needs with potential providers.[52] This is important as the cost of material as a percentage of sales is on average 53 percent for all types of manufacturing in the United States.[53]

The Air Force depot maintenance activity group's average price for in-house work doubled between fiscal years 2000 and 2004 from $119.99 per hour to $237.84 per hour.[54] GAO was able to determine the top five factors causing the sales price increase. In descending order of significance these were: (1) higher material costs, (2) higher labor costs, (3) higher business operations costs (non-labor, non-material overhead costs), (4) a surcharge intended to recoup anticipated losses on work carried over from the previous fiscal year (carryover surcharge), and (5) a surcharge to generate additional cash (cash surcharge). By far the most significant of these factors was higher material costs, which accounted for about 67 percent of the total increase. Further, the Air Force Materiel Command has not been successful in its efforts to control costs. Although several promising initiatives are underway, the Air Force Materiel Command has not developed a successful methodology for analyzing the reasons for the rapid material cost increase. Nor has it effectively utilized an established data repository for sharing cost-saving ideas

among the three air logistics centers to process improvements and to demonstrate whether its cost savings initiatives have been successful.[55] A tailored POS system could assist in analyzing the rapid material cost increases and in data sharing of cost-saving ideas.

<u>An Effective and Efficient Organization</u>

In 2003, when the Chief of Naval Operations coined the phrase cost-wise readiness (CWR) to realize efficiencies in achieving readiness it changed how Naval Aviation viewed readiness. CWR involves evaluating and adopting best business practices from other disciplines, across other professions, to include government and industry, in order to make Naval Aviation as effective and efficient as possible. In mathematical terms CWR is readiness output over cost. In other word, it takes all the aircraft for a given Squadron that are ready for tasking (RFT) and divides that by the total cost required to produce that output. RFT is defined as a Full or Partial Mission Capable (FMC/PMC) aircraft, in the custody of the reporting custodian (Squadron), that is operationally mission ready and physically able to be flown in support of the Navy's goals.

The Naval Aviation Enterprise (NAE) measures its efficiency and effectiveness through this single fleet-driven metric of aircraft RFT at reduced cost.[56] This metric tracks how well the NAE delivers on the things it values. There are five overarching values. The first is to improve component time on-wing. This means providing better equipment with better maintenance so that the components stays on the aircraft longer. The metric used to track this value is known as Mean Time Between Failure (MTBF). Next is to produce greater speed. Put differently, this is to reduce the cycle time for aircraft and components in the maintenance process. Increasing the speed of repair

reduces inventory requirements. There are two metrics used to track this value: turn around time (TAT) and work in progress (WIP). Linked to speed, but consider its own value stream is to improve first past yeild. This means to improve the reliability of the maintenance and supply support functions required to repair the component. That is being able to repair the component the first time it is touched. Idenifing the total cost of the process is key to determining CWR. The value is determining the individual cost and improving them in order to reduce the total cost of the process. Finally, there is value in implementing process efficiencies.

As mentioned above with the Air Force, this requires the establishment of a data repository for sharing cost-saving ideas among FRCs. The desired effect of any POS system alternative is to optimize CWR. Thus the cause (independent variable) is the POS system alternative and the effect (dependent variable) is CWR. As mentioned earlier, real world processes are complex, interactive systems in which policies do not always cause linear results. This chapter has identified many elements and has set boundaries for them in order to use Dynamic Modeling software to determine the best POS system alternative.

<div align="center">Dynamic Modeling</div>

This thesis uses ithink Dynamic Modeling software to conduct a quantitative analysis. The modeling effort highlights the gaps in knowledge about the process. It allows the modeling of a variety of scenarios (i.e. POS system alternatives). Dynamic modeling reveals normal variation in a system and gives the quantitative results.[57]

A model is a simplification of reality, which attempts to capture critical aspects of a system or process, while removing details thought to be omit-able or extraneous to the

objectives of the decision.[58] It is hypothesized that system dynamic modeling techniques can be used to develop a useful and realistic model of key aspects of processes to include not only the interactions between the various policy levers but their notional effect on measures of interest. Chapter three further develops the methodology used to conduct the Dynamic Modeling analysis.

<div align="center">Conclusion</div>

There is relevant literature on the topic of POS systems. The literature defines in very broad terms the requirements of a POS system. Specifically, it provides six must-have core components of any POS system. The literature sets the boundaries of the model. These are the five IT systems current used by Naval Aviation. It sets the scope of the organizational changes to just those within the supply support structure. As the FRC organizational changes have been directed by BRAC law. It provides examples for moving the POS closer to both the customer and the supplier. This helps to identify the appropriate level of detail needed to map this real world process. The above provides broad terms that will be used to achieve the desired endstate of this thesis. This is to determine the organizational and systems changes required to achieve CWR through one of the POS alternatives. The next chapter lays out the methodology and provides a clear roadmap to the successful selection the best POS alternative.

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CHAPTER 3

METHODOLOGY

Introduction

"You cannot meddle with one part of a complex system from the outside without the almost certain risk of setting off disastrous events that you hadn't counted on in other, remote parts. If you want to fix something you are first obliged to understand … the whole system…"[1]

Lewis Thomas, 1974 p. 90

In answering the research quesiton a Dynamic Modeling software compares Point of Sale (POS) alternatives. The software used is called *ithink®*. The intent is to show the link between the different elements and illustrate their relationships. The modeling effort highlights the gaps in knowledge about the process. Dynamic Modeling reveals normal variation in a system and gives the quantitative results.[2] A model is a simplification of reality, which attempts to capture critical aspects of a system or process, while removing details thought to be omit-able or extraneous to the objectives of the decision.[3] Dynamic Modeling provides a graphically based model to help stakeholders understand the interrelationships of the various elements.[4] The ability to include feedback loops, where the output from one portion of the model affects future iterations of the process is an additional benefit of a Dynamic Model that is not present in many causal models developed using statistical techniques.

In building the model, it is important to understand the symbols used to illustrate the variables. The following is a brief description of each symbol. The intent is to start with a very simple model. This allows for a foundation of the process. Adding complexity makes the model more realistic. Including known variation in the process ensures the modal is resilient.

As mentioned earlier, the model uses the POS as the cause that brings about some effect in CWR. Figure 4, illustrates a simple model of this process.
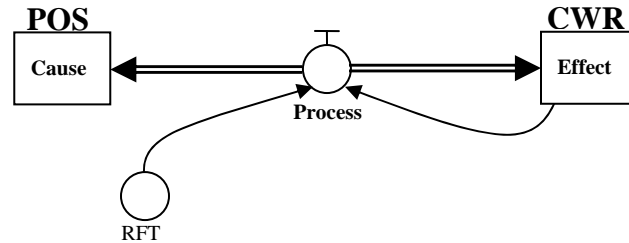
Figure 4, Simplified POS model

The Dynamic Modeling software uses a rectangle as a stock. A stock is something that can be contained and conserved.[5] Think of a stock as a reservoir. In the POS model the reservoir contains the repair parts. Stocks may act as a conveyor or a queue. Conveyors are used when the parts are in the process of being repaired. Queues are used when the parts are waiting to be repaired. Stocks are the basis for calculating all the other variables in the model. Each rectangle must have a starting value in the model. The value will be the number of repair parts. For simplicity, the remainder of the thesis will refer to repairs parts or components as a circuit card. The desired endstate of the model is to determine the impact of the POS alternatives on CWR as a circuit card moves through the maintenance process.

The arrows represent information. The arrows are the connectors in the model. The model illustrates information passing back and forth between the two stock variables. It can happen that the information goes one way. The literature highlights the importance

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of information on the POS alternatives. The information gained through the various information technically (IT) systems enables organizations to achieve results effectively and efficiently. A POS system allows the organization to analyze the information across key business processes. It integrates several data sources and processes of an organization. Information connects the individual departments of the organization.

The circle with the control valve on the top labeled as "Process" is a flow. Flows are the factors that control the variables. They may add to or subtract from the initial value provided in the stock. There are many factors in the process that can affect the repair of the circuit card. Increasing the flight hours flown by an aircraft can affect the number of circuit cards that require repair. Having the bit piece parts on-hand or the technicians to repair the circuit cards are other examples. The list can be extensive; each factor controls the variables in a slightly different manor.

The circle labeled "RFT" is a convertor. The convertor represents aircraft that are ready for tasking (RFT). As mentioned in chapter one, the Naval Aviation Enterprise (NAE) measures its efficiency and effectiveness through this single fleet-driven metric of aircraft RFT at reduced cost.[6] Connecting flows to a convertor controls the degree to which the variables change. This allows the model to include the variation in the process. Again, dynamic modeling reveals normal variation in a system and gives the quantitative results.[7] Adding convertors to the model is a technique that is useful and realistic in determining the interactions between the various policy levers and their notional effect on measures of interest.

Arrows that connect a stock to a flow provide the feedback in the process. This again adds a dimension of reality. Feedback describes the process wherein one segment

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of the model initiates changes in other segments, and those modifications lead to further

changes in the process as a whole.[8] There can be both positive and negative feedback.

Positive feedback leads to changes that reinforce the repair on the circuit card.[9] An

example of a positive feedback would be increasing the mean time between failure rate of

a circuit card. This would lead to fewer repairs and more time to work on the circuit

cards that do fail. Having more time to complete the repair may lead to a continual

increase in the MTBF rate. While negative feedback tends to counteract a disturbance

and lead systems back toward a steady state.[10] A negative feedback might be an increase

in the price of fuel. This may limit the number of hours an aircraft is flown. Thus,

reducing the circuit cards that fail. Feedback processes produce complex system

behavior. This type of behavior is present in most systems and thus provides reality to

the model.

<u>Building the Model</u>

Chapter one provides a broad overview of the maintenance activities and the

financial charges that occurred as components passed through the maintenance process.

The overview starts with the Organizational Level. Figure 5, is an illustration of the

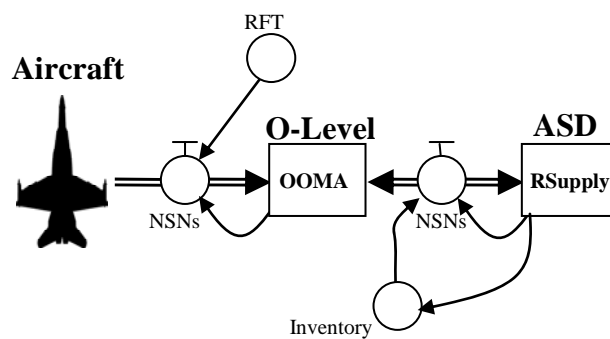Organizational Level maintenance processes.

Figure 5, Organizational Level Model

A typical Squadron has 12 or less aircraft assigned at any one time. Commander Naval Air Force (CNAF) determines RFT requirements. The Wing Commander passes RFT requirements down to the Squadron. The number of aircraft required to be RFT varies. This acts as a convertor and drives the usage of aircraft up and down. In general, the gradual physical deterioration of circuit cards, results from use, passage of time and weather. Using RFT as the converter that controls the degree of change in the number of aircraft flown and thus the number of circuit cards that may deteriorate and need repair simplify the model by highlighting the affects of the change. Throughout the model convertors are adjusted to determine variables that have little or no affect on the desired endstate.

National stock numbers (NSNs) allow tracking of repair parts through the supply system. A NSN is a 13-digit number. Chapter Four, reviews 50 NSNs that are repaired at both the IMA and the NADEP. Items pulled off an aircraft will have some repair capability at the Organizational Level. Since this is not the focus of the thesis the control factor for the number of NSNs that pass to the ASD will be set between 85 and 95 percent. This assumes that the Organizational Level is able to repair 15 and 5 percent of the circuit cards that fail. This allows the model to maximize the number of circuit cards that moves through the maintenance process but still provides some reality to the model.

Forecasted requirements drive the inventory held by ASD. Ideally, ASD is able to provide a ready for issue (RFI) circuit card to the Organizational Level when the non-RFI circuit card is not repairable. CNAF's goal to meet customer requirements for demand based items is an 85 percent on-hand inventory level. That is for 100 requests for circuit cards; ASD should fill the circuit card on-hand at least 85 times. The model

again allows variation in the process by setting the on-hand inventory to something above

and below this goal. Not having a circuit card on-hand may affect the RFT rating for a

Squadron. The variation in the on-hand inventory and its affect on RFT provides the

feedback loop in the process.

All non-RFI circuit cards pass to the IMA if the maintenance plan list some repair

capability for that item. The maintenance plan is developed by the NAE based on the

level of maintenance required to repair the failed item. Circuit cards not listing repair

capability in the maintenance plan are forwarded to the NADEP or the OEM. As

mentioned earlier, the model only reviews components repairable by both the IMA and

the NADEP. ASD expedites the failed part through the IMA if it does not have a RFI

circuit card to fill the requirement by the Organizational Level. Figure 6, illustrates the

next few steps in the process.
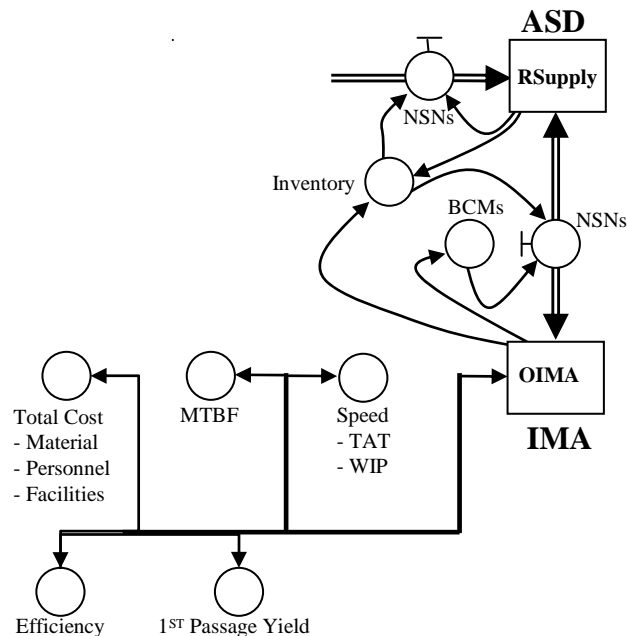
Figure 6, Intermediate Level Model

Expediting the items through the process means that non-RFI circuit cards move through the flow at different speeds based upon the inventory level. This provides variation and reality in the process. Once the IMA receives the non-RFI circuit card the NAE measures its efficiency and effectiveness through the five overarching values mentioned in the literature review. These are total cost, mean time between failure (MTBF), speed, efficiency, and first passage yield. Speed is broken down into two subcatagories. These are trun around time (TAT) and work in progress (WIP). The model uses actual numbers from the NSNs reviewed. These overarching values are measured at the organizational level, but the focus of this thesis is the Fleet Readiness Center (FRC). As a result, there is no benefit of reviewing the overarching values at the organizational level and this process may be eliminated.

Given the IMA's space, machinery and diagnostic equipment, their repair capability is much higher than that at the Organizational Level. The NSNs selected for the review have a RFI rate of 50 percent or higher at the IMA. RFI rates are equal to the number of NSNs passed to the IMA, subtracted by the number of beyond capability of maintenance (BCM) NSNs and divided by the total number passed (i.e. 100-50/100 = 50 percent). The overarching values highlight IMA that are efficient and effective in the maintenance process.

If the IMA is not able to complete the repair, ASD collects the circuit card. If the NADEP has repair capability the part is forwarded to the NADEP through the FISC organization.   Figure 7, illustrates the steps in this process.
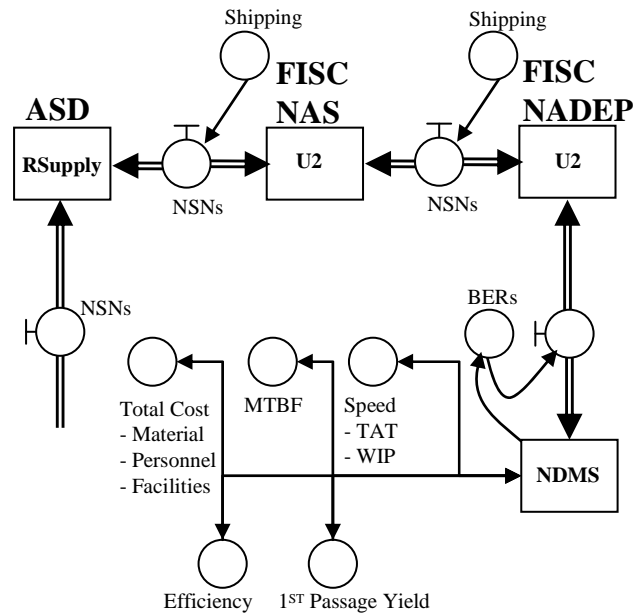
Figure 7, Depot Level Model

The FISC Annex located at the NAS may have the circuit card required. This speeds up the process of getting the part back to the customer. If not a time-delay is built into the model for shipping. The part passes between the two FISC organizations. The FISC NADEP delivers the part to the correct department within the NADEP.

Again, ASD may expedite the broken part through the NADEP to fill the initial requirement. This means the non-RFI circuit card passes through the flow at different speeds. Similar to the IMA, the NAE measures the efficiency and effectiveness of the

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NADEP using the same five overarching values. The model uses actual numbers for the NSNs reviewed.

If the NADEP cannot repair the item at a reasonable cost, it declares the circuit card beyond economic repair (BER). The NADEP FISC Annex will collect the non-RFI circuit card. They will then either disposed of the non-RFI circuit card or send it to the Original Equipment Manufacturer (OEM) for repair or carcass cannibalization. The NADEP charges its customers for the total costs of repair; this includes labor, material, and operational costs. As inventories are exhausted, the Naval Inventory Control Point will procure more assets from the OEM. Declaring non-RFI circuit cards BER stops the model for that NSN. The model will highlight shortfalls in the inventory. Corrections / modifications are possible with multiple runs of the model. The model will illustrate the data monthly over a 20-year period. The supports the timeframe listed by BRAC for the projected savings of $3.7 million. The first run will be the status quo scenario of the POS alternative.

The affects of the POS alternatives will be determined by the model. In doing so, assumptions are made to manipulate the data from the Shipyard consolidation to fit this scenario of moving the POS closer to the customer. Assumptions from the Single Stock Fund consolidation will be used to manipulate the data to fit the scenario of moving the POS closer to the supplier. Advantages and disadvantages from the literature will help to frame the required modifications to the model.

In closing, it is useful to review the model as a whole. Figure 8, illustrates the status quo POS alternative. Dynamic Modeling identifies critical elements and flags them for further examination. This helps to ensure the model correctly captures each

element. The ability to consider many different scenarios allows the model to determine

how certain policy configurations will affect the outcomes of the system. This analysis

helps policy makers better understand the cause and effect relationships in the process.

This aids in the development of arguments for or against proposed changes to the existing

system. This ensures that the solution selected for implementation is not only close to

optimal, but resilient in relation to changes in the real world environment that may or

may not be perfectly capture all the interconnects in the model.
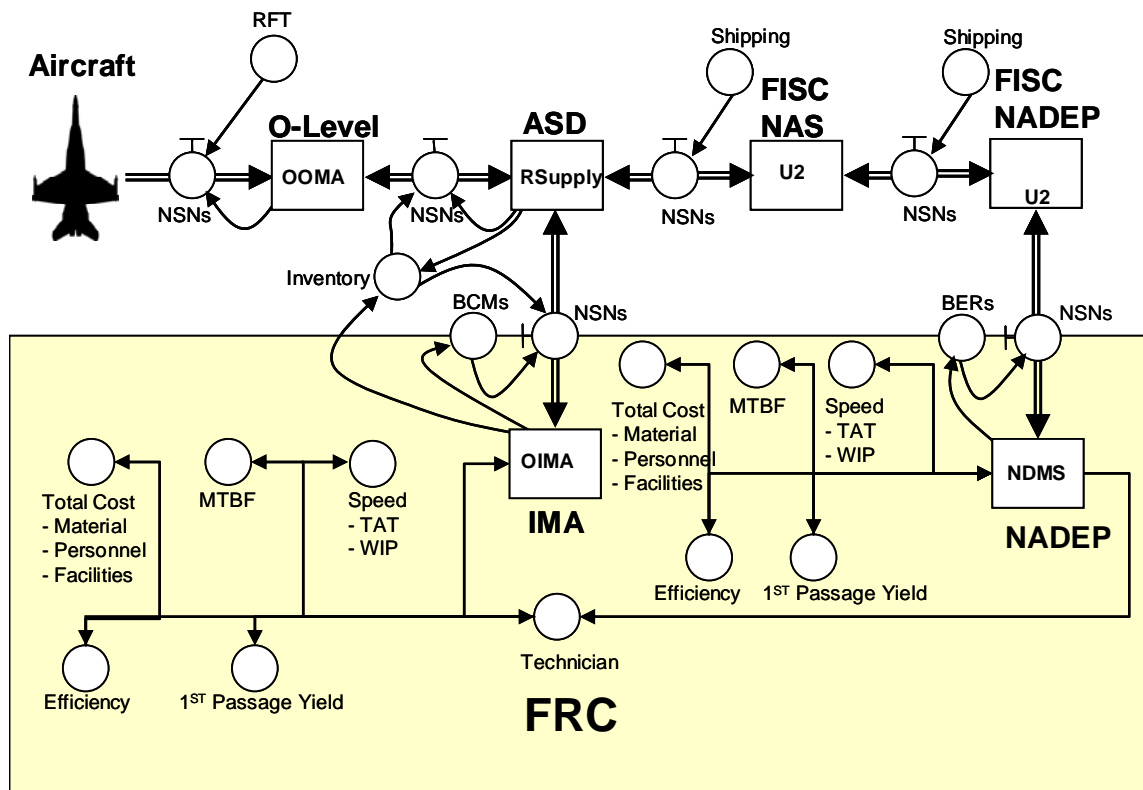
Figure 8, Status Quo POS Alternative Model

[1] Thomas, L. (1974) *The Lives of a Cell: Notes of a Biology Watcher.* New York: Viking Press. p. 90

[2] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p.1-18

[3] Bickel, Robert W., *Improving Air Force Purchasing and Supply Management of Spare Parts*, RAND, 2003, p. 27

[4] Ibid. p. 8

[5] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p. 8

[6] *The NAE: A Warfighting Partnership*, The Hook Magazine, Summer 2006, available at http://www.tailhok.org/hookmag.htm (accessed April 05, 2008)

[7] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p.1-18

[8] Ibid. p. 6

[9] Ibid.

[10] Ibid.

CHAPTER 4

ANALYSIS

Introduction

The purpose of this chapter is to integrate the information discussed in the

literature review with the methodology in order to answer the primary research question,

which POS alternative has the greatest improvement on cost wise readiness (CWR)?

This chapter answers all secondary and tertiary research questions. Answers are

compiled at the end of the chapter in order to answer the primary research question.

Requirements for a POS System

Defining the requirements for a POS system establishes the foundation for

answering the primary research question. According to the literature, information is the

primary requirement for a POS system. This information may be different from

organization to organization. Information drives the decisions of the organization. These

decisions are made at all levels within the organization. As technology improves

organizations change business processes to achieve effective and efficient results.

The literature provides six must-have core features for any POS system. These

are described as; transaction, price, cash flow, inventory, customer relationship and report

management. Two features of a POS system that may not be essential due to their

existence in other systems (i.e. retail management systems) are purchase orders and

financials. The six core and two non-essential features provide the information needed

by the organization to made decisions across the business processes.

Fleet Readiness Centers (FRCs) are responsible for repairing aviation depot level repairable (AVDLR) components. The Naval Aviation Enterprise as a whole must decide when items are to be repaired and how many to repair. The information provided by the eight features of a POS system must drive these two critical decisions. The brief background provided in chapter one on the traditional Intermediate Maintenance Activity (IMA) and the Naval Aviation Depot (NADEP) illustrates two different maintenance processes. The IMA repairs items that have failed. In contrast, the NADEP repairs items based upon demand. That is the NADEP tries to predict when items will be required. Due to budget and material lead times this prediction must be made two years in advance of product delivery. Waiting until the item fails is referred to as a reactive maintenance process. While repairs based upon demand is a predictive maintenance process.[1] Both maintenance processes determines when and how many items are repaired. The manner in which this determination is made provides some justification for the two different financial systems used. The IMA uses direct appropriation funding. While the NADEP uses a revolving fund. Both financial systems are described in some detail in the literature review. Changing the POS will require the maintenance processes (i.e. reactive or predictive) and the financial systems (i.e. direct or revolving) to be synchronized.

<u>Moving the POS closer to the customer</u>

The synchronization supports the Customer Relations Management (CRM) strategy of connecting different players within an organization to coordinate their efforts in creating an overall valuable series of experiences, products and services for the customer. As mentioned in the literature review, CRM is the constant theme for moving the POS closer to the customer. The ultimate measure of success for CRM is the effect

on the financial performance of the organization. This supports the link between the maintenance process and the financial systems mentioned above.

The predictive and reactive maintenance processes resemble a push and pull system respectively. A push system schedules items based on demand. A pull system authorizes release of work based on system status. In modeling either system there are three attributes that must be considered. These are work-in-progress (WIP), turn around time (TAT) and throughput.[2] This covers the Speed overarching value of CWR.

The dynamic model developed in the methodology moves a circuit card through each business process. The research questions were developed to flow across the model from start to end, building upon the foundation needed to answer the primary research question. Using the circuit card and modeling the push and pull aspects of a system highlight some important points in choosing a POS alternative.

In a predictive maintenance process the model pushes the circuit card at a fixed rate. Estimations are made of the process' capacity. Circuit cards are sent at a mean rate or below the capacity. Circuit cards move along according to the ability of each step in the process. WIP builds up at various points as TAT fluctuates according to the dynamics of the process. Thus the only measureable attribute is throughput. In this chapter measureable attributes are called parameters. In this model throughput is controlled. However, WIP is allowed to find its natural value consistent with Little's Law and the process dynamics.[3]

Little's Law is both fundamental and simple. It relates three critical performance measures of any production system into a basic manufacturing principle. Although it has deep mathematical roots, it is extremely intuitive. Little's Law applies to systems with

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and without variability. Models can be built using this law for single and multiple product systems. It even applies to non-production systems where inventory represents people, financial orders, or other entities. Little's Law states that the fundamental long-term relationship between WIP, throughput and TAT of a production system in steady state is the equation:

$$WIP = Throughput \times TAT$$

There are only two requirements to validate Little's Law: the variables must represent long-term averages of a stable system and they must be measured in consistent units.[4] The model developed ensures that the long-term averages represent a stable system. This is because the model is a closed network structure. Throughout the model the components will be distributed in three states. These are working, waiting for repair, and being repaired. This implies that the rate at which the components exit each step must be the same (on average), resulting in a steady state of repair. It is the same set of equipment that stays in the process. Although, not mentioned in the above equation the relationship of inventory can not be forgotten. All the items that are in a WIP status should be considered as inventory. Thus the above equation can be written as:

$$Inventory = Throughput \times TAT[5]$$

Looking at the pull system as it relates to the reactive maintenance process provides another alternative. The process begins when a customer request a circuit card. Using the model, this is when the item fails to pass an inspection at the organizational level of maintenance. At this point, an item is authorized to enter the maintenance

process to be worked to meet the customer's demand. At this level, the control is on the WIP. Thus the inverse is true in that the throughput will find its natural value consistent with Little's Law and the process dynamics.[6] A pull system has two requirements: there is a pull mechanism that allows a feedback signal from the downstream demand to the upstream authorization of the production and a control mechanism that decides how much production to authorize at anytime – this is usually done by imposing a cap on WIP in the process. For a given throughput, a pull system has smaller WIP and in accordance with Little's Law lower TAT than an equivalent push system. This implies that the reactive maintenance process has the greatest improvement on cost wise readiness (CWR).

Moving the POS closer to the supplier

Supplier Relationship Management (SRM) was the constant theme of the literature for moving the POS closer to the supplier. Suppliers are a key part of profitable business development. Naval Aviation does not desire a profit. Its desire is to maintain the current fleet of aircraft while procuring future platforms. It must do so with the funding provided by Congress. Saving achieved through the maintenance process allows more aircraft to be procured. According to Ptak, suppliers impact production quality, availability, lead-time and access to critical technology.[7] SRM has a clear effect on CWR.

As mentioned in chapter one, Depots provide more comprehensive repair. In general, civilian aviation technicians at the NADEP have many years of experience. Intuitively, this implies that a more comprehensive repair completed by an experienced technician is a better repair. That is, the component will remain on the aircraft longer

before requiring repair again. This is referred to as a higher Mean Time Between Failure (MTBF).

The model illustrates a circuit card failing in a random fashion. This was done using an exponential distribution. Exponential distributions are continuous probability distributions used as a reliability evaluation of systems. Exponential distribution is used where the rate at which events occur does not vary. Exponential distribution is the only distribution to have a constant failure rate or MTBF.[8]

Equipment failure can be expressed as a function of either time or cycles. That is equipment fails as a result of the stress placed on it over time or based upon the number of cycles completed by the equipment. An aircraft's landing gear provides a good example of cycle failure. Landing gear failure rate is measured based upon the number of take off and landing cycles. An exponential distribution can be developed by taking the overall failure rate over time or cycles. This leads to the equation:

$$P(x) = (1/\lambda)e^{-(x-a)\lambda}, \ x \geq a$$

The distribution is meant to determine the failure times. Thus the models only needs to define $x \geq a$. In the model a impacts the mean but not the standard deviation of the distribution. As mentioned above measureable variables are call parameter. Parameter a is call the location parameter. According to McGarvey, many applications have $a = 0$, so that the distribution has only a single parameter.[9] The mean and standard deviation are given by the following:

$$\mu = a + \lambda, \qquad \sigma^2 = \lambda^2$$

Using the above equations requires the mean and standard deviation to be the same when $a = 0$. This allows λ to represent the mean failure time for the equipment.

Running the circuit card through the model using the above equation does not yield significant results. This is because exponential distribution models have a unique *memoryless* property. The equipment has no memory of the fact that it has ran for a time t without failure; hence the idea of describing this as a *memoryless* property. It turns out that the exponential distribution is the only probability distribution with this property. This is compounded by the fact that Naval Aviation does not track components using serial numbers. This would allow MTBF to be tracked back to the repairing activity. Although, no significant results were provided this allows the model to be simplified. Essentially, we do not have to keep track of the previous event times.[10]

Using the observation mentioned above that a repair process is under a steady state, the model can be modified to look at throughput (*Tp*), system availability (*SA*) and the repairmen utilization (*RU*). McGarvey provides the following three equations:

$$T_p = \frac{N_m}{MTBF + MTAT}$$

$$RU = \frac{MTAT}{MTBF + MTAT}$$

$$SA = (1 - RU)^{N_m}$$

There are a fixed number of components in any closed maintenance process. This is represented by N_m. The exponential distribution model above allows us to simplify the Mean Time Between Failure rate to *1/MTBF* for a given piece of equipment, and the Mean Turn Around Time rate to *1/TAT*.[11] This allows the model to examine the

availability of a component in a closed network structure using the two maintenance

processes. Assigning the number of machines and the MTBF as a constant of ten the

model reviews the circuit card and provides the following results in table 1.

Table 1. Results for repair process: Adding extra technicians

Number of repair people	MTAT	Throughput	RU	SA
1	1	0.57	0.82	0.16
2	1	0.74	0.62	0.42
3	1	0.87	0.43	0.45
4	1	0.90	0.33	0.47
5	1	0.91	0.19	0.47

Table 1. Results for repair process: Adding extra technicians

Adding the first technician provides a significant benefit, increasing availability

from 0.16 to 0.42. However, the benefits stop after adding the initial technician to the

process. This is a good example of diminishing returns on investment. The rate of

utilization continues to get smaller and smaller as more technicians are added. The

model allows the focus to be changed to Mean Turn Around Time (MTAT). Here, table

2 illustrates that by reducing the MTAT the model provides better results.

Table 2. Results for repair process: Reducing the MTAT

Number of repair people	MTAT	Throughput	RU	SA
1	1	0.57	0.82	0.16
1	0.9	0.68	0.77	0.27
1	0.8	0.74	0.72	0.35
1	0.7	0.82	0.65	0.43
1	0.6	0.88	0.51	0.58
1	0.5	0.91	0.43	0.61
1	0.4	0.94	0.37	0.66
1	0.3	0.96	0.26	0.73
1	0.2	0.97	0.19	0.79

Table 2. Results for repair process: Reducing the Mean Turn Around Time (MTAT)

Reducing the MTAT continues to increase throughput and availability of the circuit card. In both cases, the rate of utilization is reduced. This leads to the conclusion that the effectiveness of the technicians is greater when MTAT is reduced. This is not surprising because, intuitively one would imagine that good technicians would have a short TAT. However, a maintenance process that has 20 percent personnel utilization and 80 percent availability may not have the greatest impact on CWR. It can be assumed that some spare capacity for training and other activities is desirable, but 80 percent seems excessive.

In either POS alternative the expertise of the technician moves with the alternative. Thus, the advantages of moving closer to the supplier highlighted in the literature seem to be insignificant. The model illustrated that increased production quality (MTBF) is difficult to determine at best using the current Naval Aviation processes. It further exemplifies that availability is significantly increased by reducing the lead-time. Here lead-time was equivalent to TAT. Access to critical technology was

not modeled. The assumption is that if the technician moves the technology will move with him / her. Clearly, if the technology requires a piece of equipment that can not move then neither does the technician. This limits the number of components that can benefit from the move, but this can also be mediated by transportation. Using the above assumption reduces the POS alternative down to a process in how the maintenance is completed.

<div align="center">Current Naval Aviation POS System</div>

The Navy accounts for 57 percent of all DoD business systems illustrates the need for integration. This was further highlighted in the plans to employ Navy ERP as the solution for FRC and its five disparate legacy systems. What is not clear from the literature is when the solution will take place. Navy ERP will implement release 1.0 across the Navy enterprise in October 2008.[12] The Deputy Program Manager for Commander Fleet Readiness Center (COMFRC) stated that the FRC solution for Navy ERP will not happen until 2014. The literature illustrated that the time difference in the implementation may be overcome by using Middleware software. Middleware allows legacy systems to intercept incoming and outgoing transactions, modify them in accordance with business rules and route them to the appropriate logistic and financial system.

The two retail distribution systems (i.e. RSupply and U2) used by the supply support activities will be included in Navy ERP release 2.0. Hopefully, it will not take six years between release 1.0 and 2.0. Once these two systems are integrated the likelihood of efficiencies through the consolidation of supply organizations is very high. The model helps to illustrate this by focusing on queues.

Since the supply support activities in the model do not repair the components they are considered queues. That is they control the rate at which components enter the process. Queues can not be negative. The rate at which components enter the process are dependant upon the queue. The more queues in the process the more variation. As the queue begins to rise the term *backlog* is often used in discussing orders, shipments, or other factors. Organizations tend to counteract the rise in backlog by applying more resources to the process. This in effect, raises the capacity of the work process and the backlog begins to fall. Once the backlog is reduced to an acceptable level the resources are removed. Overtime the backlog begins to rise again and the whole cycle is repeated.[13] Table 3, illustrates the affects of adding random variation to three queues similar to the model.

Table 3. Adding random variation to queues

	Case 1	Case 2	Case 3	Case 4	Case 5
Overall TAT (hours)	9.87	13.92	17.87	21.77	23.87
Overall WIP	6.73	10.11	13.24	16.45	17.91
Overall Throughput	0.79	0.76	0.76	0.76	0.76
Interarrival Times	0.98	0.98	0.97	0.97	0.97
Avg queue 1	2.97	3.12	3.09	3.10	3.11
Avg queue 2	1.47	3.01	2.98	3.03	3.00
Avg queue 3	0.00	1.47	3.03	3.01	3.01

Table 3. Adding random variation to queues

The queues act independent of each other. Adding random variation in each case adds four TAT hours and three WIP items to the total. The exception is case five, where there is no downstream queue. Here there is an increase in the TAT by two hours and the

WIP by one and a half items. The increase is due to the upstream queue. Reducing the number of queues clearly has a positive impact on both TAT and WIP.

There are three queues in the model. These are the Aviation Supply Department (ASD), the Fleet Industrial Supply Center (FISC) located at the Naval Air Station (NAS) and the FISC NADEP. Each plays a vital role in collecting and distributing information that impacts the Supply Chain process. There should be no attempt to reduce the number of queues without ensuring that the critical information continues to be captured and managed properly. As mentioned above, when technology improves organizations should change business processes to achieve effective and efficient results. Combining the functions of these three queues using improved technology has the potential to increase TAT and WIP.

<center>Moving the Naval Aviation POS</center>

This section does not provide a distinction between moving the Naval Aviation POS closer to the customer or supplier. The two examples provided by the literature (i.e. Naval Shipyards and Army Single Stock Fund) again highlight the linkage between the POS and the financial system. An earlier assumption linked the POS alternative to the maintenance process. This implies that the three are linked.

McGarvey states in his book that "every experienced manager knows that the world is filled with tradeoffs." Given that the Naval Shipyards moved the POS closer to the customer; that the Army's Single Stock Fund moved the POS closer to the supplier; and finally that the Navy has been successful with the status quo for over 50 years confirms that all three alternatives are possible. Although, the model was used to review the tradeoffs among quality (MTBF), speed (TAT and WIP) and cost it was not

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successful in distinguishing between the POS alternatives. The model simply confirmed that an optimum throughput for the goal of maximizing profit could be found.[14]

Conclusion

The Naval Aviation Enterprise (NAE) measures its efficiency and effectiveness through the single fleet-driven metric of aircraft Ready For Tasking (RFT) at reduced cost.[15] This metric tracks how well the NAE delivers on the things it values. Once again, there are five overarching values. This first is to improve component time-on-wing. This means providing better equipment with better maintenance so that the component stays on the aircraft longer. This chapter referred to this as Mean Time Between Failure (MTBF). Next is to produce greater speed. Put differently, this is to reduce the cycle time for aircraft and components in the maintenance process. Increasing the speed of repair reduces inventory requirements. This is supported by Little's Law described above. There are two metrics used to track this value: turn around time (TAT) and work in progress (WIP). Linked to speed, but considered its own value stream is to improve first past yield. This means to improve the reliability of the maintenance and supply support functions required to repair the component. That is being able to repair the component the first time it is touched. This requires maintenance expertise and an inventory of bit piece parts to repair the component. Identifying the total cost of the process is key to determining CWR. The value is determining the individual cost and improving them in order to reduce the total cost of the process. Finally, there is value in implementing process efficiencies. In total these five values allow dollar for dollar readiness. In short they allow CWR to be achieved.

The model developed allows each of the five values to be linked. The most substantial findings of the model are the linkages between the maintenance process used, the financial system and the POS alternative. Using the five values to drive the selection of the POS alternative leads to a move closer to the customer. As determined above, this results in reduced WIP and TAT. In accordance with Little's Law, this will reduce inventory and thus overall cost. The affect on MTBF was tied to the experience and access to technology used by the technician. In this value the impact on the POS alternative was equal or at least mediated by the use of transportation. First Passage Yield is tied to the experience of the technician and the availability of the pit piece parts to repair the component. The model illustrated that reducing the mean TAT had the greatest impact on availability and technician utilization. With additional capacity in utilization there is greater time for training. This leads to increased efficiencies and reduced cost. Thus the POS alternative with the greatest impact to CWR is to move closer to the customer.

[1] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p. 154-162

[2] Ibid.

[3] Ibid. p. 131-139

[4] Ibid. p 77-84

[5] Principles of Little's Law, *The Relationship of Inventory and WI*P, available at http://www.factoryphysics.com (accessed May 2, 2008)

[6] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p. 131-139

[7] Ptak, Carol A, Eli Schragenheim, *ERP: Tools, Techniques, and Applications for Integrating the Supply Chain,* Second Edition, CRC Press, 2003, p, 60.

[8] Ibid. p. 267-269

[9] Ibid

[10] Ibid

[11] Ibid. p. 154-162

[12] Message from the commander, NAVSUP *Moving Forward with Navy ERP: Gaining Speed*, February 6, 2008, 110-08.

[13] McGarvey, Bernard, Bruce Hannon, Dynamic *Modeling For Business Management: an Introduction*, Springer-Verlag New York, 2004, p. 86-101

[14] Ibid. p. 192-199

[15] The NAE*: A Warfighting Partnership*, The Hook magazine, Summer 2006, available at http://www.tailhook.org/hookmag.htm (accessed April 05, 2008)

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

<u>Conclusions</u>

This chapter provides conclusions and recommendations based on the analysis discussed in chapter four in order to answer the primary research question, which POS alternative has the greatest improvement on cost wise readiness (CWR)? This chapter first discusses the conclusions of the study, what they mean, what the implications are, and whether there were any unexpected findings. Next, recommendations are discussed, to include suggestions for future study, unanswered questions, items that could have been approached differently, and subsequent actions to be taken.

The analysis performed for this thesis indicated that moving the POS closer to the customer is the alternative that provides the greatest improvement to CWR. This answers the primary research question. The dynamic model links each of the overarching values of mean time between failure (MTBF), speed, cost, efficiency, and first passage yield. Once again, speed has two subcategories. These are work in progress (WIP) and turn around time (TAT). The most substantial findings of the model are the linkages between the maintenance process used, the financial system and the POS alternative. The selection of the POS alternative of moving closer to the customer results in greater speed. In accordance with Little's Law, this will reduce inventory and thus overall cost. The affect on MTBF was tied to the experience and access to technology used by the technician. In this overarching value it was challenging to selection one alternative over another. Transportation mediates the impact of the alternatives with respect to MTBF. First passage yield is tied to the experience of the technician and the availability of the pit

piece parts to repair the aviation depot level repairable (AVDLR) component. The model illustrated that reducing the mean TAT had the greatest impact on availability and technician utilization. The results of reducing the mean TAT have a positive feedback on the process. With additional capacity in utilization there is greater time for training. This leads to increased efficiencies and reduced cost. Thus the POS alternative with the greatest impact to CWR is to move the POS closer to the customer.

Moving the POS closer to the customer will align the maintenance processes of both Regional Maintenance Centers (RMCs) and the Fleet Readiness Centers (FRCs). This alignment will require Middleware solutions to integrate information technology (IT) systems used by the Naval Aviation Enterprise (NAE). Capturing the financial data historically collected by Navy Working Capital Funded (NWCF) activities and providing it to the Congressional Budget Office would be a critical requirement prior to the change. This was one of the significant shortfalls of the RMCs initial move of the POS closer to the customer.

The findings of this thesis were not intuitive to the author. Revolving funds allow organizations to finance their own operations by charging for the services provided to the customers. Funding is available to finance their continuing operations without fiscal year limitations. The attempt of this financial strategy is to adopt private business practices in meeting the needs of the customer. This is one of the primary goals of CWR. As CWR is meant to evaluate and adopt the best business practices from other disciplines, across other professions, to include government and industry, in order to make Naval Aviation as effective and efficient as possible.

The market-like system provides customers with incentives to make cost effective repair decisions at the local level. Organizations determine the total cost of doing business and bill the customer for services with a goal of breaking even. Direct costs, indirect costs, overhead and general / administrative expenses determine the cost of each job. An organization's goal when using NWCF is to streamline operations and maximize resources by establishing clear customer / supplier relationships, adopting private sector techniques for resource management, consolidating key functions, and using activity-based accounting policies to display full costs. NWCF provides managers with the cost and performance data required to make effective and efficient decisions. Given the above and then reducing CWR to the overarching values provided a surprising result. Using the model to manipulate the POS alternatives clearly illustrated that moving the POS closer to the customer had the greatest improved on CWR. Yet, the only considerations used to make this determination are the overarching values of mean time between failure (MTBF), speed, cost, efficiency, and first passage yield. Once again, speed has two subcategories. These are work in progress (WIP) and turn around time (TAT). What needs to be determined is weather or not the overarching values are not all inclusive.

<div align="center">Recommendations</div>

It is highly recommended that further study be conducted with respect to the POS alternatives. To date, analysis of these systems has been largely qualitative in nature. The analysis has been based on observations that do not involve detailed cost analysis and measurements to readiness. In depth, quantitative analysis is desperately needed. The analysis should be expanded to review the effects on the NAE as a whole using both

cost analysis and the impacts to readiness. Expanding the review beyond the overarching values may lead to a completely different conclusion.

There are two very significant changes on the horizon that impact the decision of moving the POS closer to the customer. These are the impacts of the Navy's ERP solutions and the extent of functions the Defense Logistics Agency (DLA) will takeover as part of the Base Realignment and Closure (BRAC) Commission 2005 decision. Both have the potential to change the conclusion provided by this thesis.

The Navy ERP release 1.0 is scheduled to be implemented October 2008. However, there is no date available for release 2.0. Release 2.0 will impact the retail systems used by the supply support activities that support the FRC. This may be the right time to combine the functions of the Aviation Supply Department (ASD), the Fleet Industrial Supply Center (FISC) located at the Naval Air Stations (NAS) and the FISC NADEP. It will be critical to ensure that the information is captured and managed while reducing the number of queues that the repair parts must pass through. The ERP solution for the FRC information systems (i.e. NALCOMIS and NDMS) are not currently planned until 2014. It may not be cost effective to implement a Middleware solution only to have it can with release 2.0 and the FRC solution for ERP.

The BRAC Commission 2005 decision requires the military services to transfer all of their supply, storage, and distribution functions to DLA. This will happen starting with the Air Force in 2008. All transfers should to be complete by 2011. Depot maintenance officials expressed concern that if the transfer of production integrated supply functions to DLA takes place using DLA's existing price structure, it will increase the cost of depot maintenance operations and depots will have to pass these additional

costs on to their customers by increasing their hourly rates. Until it is clear what functions will be transferred to DLA it is difficult to determine the impacts it will have on the recommended POS alternative.

There are three subsequent actions required prior to implementing a change in the POS system. The first is to work with the lead for Navy ERP to establish a timeline and the effects of implementation across the NAE. This will help to develop a cost analysis approach to changing the POS alternatives prior to, during or after the implementation. The return on investment of changing the POS during these three time periods may result in the status quo alternative until after all changes have been completed. The second subsequent action is to work with DLA to determine the functions that will be transferred. Until this is clear it is not possible to change the POS alternative. As highlighted by the thesis, the maintenance process is linked to the financial system, and POS alternative. Changes by DLA will have dramatic consequences on the POS alternative. Finally, a by-product of changing the POS alternative is to realign the supply organization that supports the FRC. Just as the maintenance process is linked to the POS alternative the supply process is linked. Today the NAE supply organization is disparate; depending on the region each supply organization may reports to a different reporting senior. This adds confusion and complexity. This in turn provides confusion and complexity to the organizations they support. The alignment was determined prior to the establishment of the NAE. Allowing the supply process to drive the alignment provides the best solution for the NAE.

The linkages of each POS alternative are extensive and should be reviewed in detail prior to making the final decision. If the NAE truly holds the overarching values as the key to being efficient and effective in its goal toward CWR then the best POS alternative is to move closer to the customer. The decision will set the course of the NAE. It will impact every organization within the enterprise.

GLOSSARY

Aircraft Intermediate Maintenance Department. Off flight line maintenance activities (now known as FRCs) that have the ability to enact repairs up to, but not including major rework and overhaul on a variety of Weapons Replaceable Assemblies (WRAs) and Shop Replaceable Assemblies (SRAs).

Aviation Supply Department. Provides on-air station logistics support by supplying FRCs and squadrons with parts handling, packaging, shipping, and storage services.

Aviation Depot Level Repairables. Repairable items for which the final condemnation decision should be made at the depot level. These items may also be repaired at the organizational or intermediate level as determined by the assigned Source, Maintenance, and Recoverability (SM&R) code.

Beyond Capability of Maintenance. A repair action that exceeds a given maintenance facility's ability to repair, typically by design. Once a BCM condition is declared, a BCM code that best describes the reason why is chosen from a consolidated list of possible codes and placed in the appropriate block on the Maintenance Action Form (MAF). This allows the item in question to then be further routed to the appropriate source of repair.

Commander, Naval Air Forces. In October 2001, the Chief of Naval Operations placed Type Commanders (TYCOM) in a "Lead-Follow" arrangement. Under this arrangement COMNAVAIRPAC became the TYCOM for Air, and assumed the additional title of Commander, Naval Air Forces (COMNAVAIRFOR).

Commander, Fleet Readiness Centers. Newly assigned Flag level position providing leadership and guidance oversight to all established FRCs. COMFRC is aligned with the Chief, Naval Air Forces with FRC Area Commands as subordinate elements.

Defense Logistics Agency. Provides worldwide logistics support for the missions of the Military Departments and the Unified Combatant Commands under conditions of peace and war.

Depot Level Repairable. Durable item which, when unserviceable, can normally be economically restored to a serviceable condition through repair procedures by an intermediate or depot level maintenance activity.

Fleet and Industrial Support Center. Provides supply support services to Fleet units as assigned and perform such other functions as may be directed by the Commander, Fleet and Industrial Supply Centers.

Fleet Readiness Center. Integrated depot and intermediate aircraft maintenance activities designed to improve Naval warfighting effectiveness at reduced cost.

Inventory Control Point. An organizational unit or activity within a Department Of
Defense (DOD) supply system, assigned the primary responsibility for the
material management of a group of items either for a particular service or for the
DOD as a whole.

Intermediate Maintenance Activity. Now known as FRCs. Responsible for repairs up to,
but not including major rework and overhaul.

Maintenance, Repair and Overhaul. Refers to services provided for aircraft, relating to
the regular upkeep and airworthiness using specially trained personnel and
equipment.

Naval Aviation Depot. Former title for the Navy's rework and overhaul facilities (now
Fleet Readiness Centers) located in Cherry Point, NC; North Island, CA; and
Jacksonville, FL.

Naval Aviation Enterprise. The NAE is a warfighting partnership in which
interdependent issues affecting multiple commands are resolved on an enterprise-
wide basis. The NAE enables communication across all elements of the
enterprise, fosters organizational alignment, encourages inter-agency and
interservice integration, stimulates a culture of productivity, and facilitates change
when change is needed to advance and improve..

Naval. In the context of this thesis Naval is mean to incorporate the entire Department of
the Navy elements including the Marines Corps, Department of the Navy Civilian
employees, etc.

Naval Inventory Control Point. A single command organization operating as a tenant
activity of the Naval Support Activities in Mechanicsburg and Philadelphia.
Thier mission is to provide program and supply support for the weapons systems
that keep our Naval forces mission ready. NAVICP's primary mission is to
procure, manage, and supply spare parts for Naval aircraft, submarines and ships
worldwide.

National Inventory Management System. A new Defense Logistics Agency strategy that
will comply with and enhance the Single Stock Fund initiative by eliminating
redundant asset management operations and the costs associated with them.

National Stock Number. A 13-digit number assigned by the Defense Logistics Services
Center (DLSC) to identify an item of material in the supply distribution system It
consists of the four-digit FSC and the nine-digit NIIN.

Navy Working Capital Fund. The NWCF is a *revolving fund*, an account or fund that relies on sales revenue rather than direct Congressional appropriations to finance its operations. It is intended to generate adequate revenue to cover the full costs of its operations, and to finance the fund's continuing operations without fiscal year limitation.

Ready For Issue. Repairable items that have successfully completed the repair process and are ready to be used to fill Fleet requisitions.

Ready For Tasking. A Full or Partial Mission Capable (FMC/PMC) aircraft, in the custody of the reporting custodian, that is operationally mission ready and physically able to be flown in support of the Navy's goals.

Turn Around Time. The interval between the time a repairable item is removed from use and the time it is available for reissue in a serviceable condition.

Work In Process. Repairables that have been placed in-work but have yet to complete the repair process.

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Mr. Mike E. Weaver
DLRO
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301

Dr. David A. Anderson
DJMO
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301

Mr. Thomas E. Creviston
DLRO
USACGSC
100 Stimson Ave.
Fort Leavenworth, KS 66027-2301