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THE EFFECT OF UNREPORTED DEMAND ON THE F/A-18S SUPPLY CHAIN

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THE EFFECT OF UNREPORTED DEMAND ON THE F/A-18'S SUPPLY CHAIN

December 2021

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This research investigates the causes of unreported demand associated with F/A-18 aircraft components during the execution of cannibalization and the issuance of repairable parts from the Stricken Aircraft Reclamation and Disposal Program (SARDIP). The current transition to the F-35 Joint Strike Fighter across the entire Marine Corps F/A-18 Type Model Series (TMS) platform provides an opportunity to research and analyze various aspects of the divestiture process. During the divestiture period of the F/A-18 platform, missing demand signals lead to inaccuracies in demand forecasting. This inaccurate demand capture increases stress on the supply system and future funding requirements within the organization. This study analyzes five years of demand data gathered from the Navy Enterprise Resource Planning (ERP) system in order to identify causes and sources of lost demand associated with cannibalization and SARDIP issues. In addition, this study presents an analysis of current Marine Corps aviation supply policies and cannibalization actions to identify shortfalls in demand reporting. The data gathered suggest that unreported demand leads to increases in demand variability and the ability to allocate funds for F/A-18 components. Although the impacts of unreported demand for the F/A-18 will disappear once the platform is no longer in service, unreported demand will continue to affect all aircraft remaining in service.

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AIMD	Aviation Intermediate Maintenance Depot
ALD	Aviation Logistics Department
ASD	Aviation Supply Department
ASDTP	Aviation Supply Desk-top Procedures
BCM	Beyond Capability of Maintenance
COG	Cognizant Symbol
DECKPLATE	Decision Knowledge Programming for Logistics Analysis and Technical Evaluation
DLA	Defense Logistics Agency
DHA	Demand History Adjustment
D-LEVEL	Depot Level
DLR	Depot Level Repairable
ERP	Enterprise Resource Planning
FAA	Functional Area Assist
FAI	Functional Area Inspection
FLR	Field Level Repairable
FMC	Full Mission Capable
ICP	Inventory Control Point
I LEVEL	Intermediate Level
MAF	Maintenance Action Form
MALS	Marine Aviation Logistics Squadron
MAW	Marine Air Wing
MCO	Marine Corps Order
NALCOMIS	Naval Aviation Logistics Command Management Information Systems
NAVAIR	Naval Air Systems Command
NAVSUP-WSS	Naval Supply Systems Command Weapon Systems Support
NIIN	National Item Identification Number
NMCS	Not Mission Capable

NRFI	Not Ready for Issue
NSN	Navy Stock Number
O-LEVEL	Organizational Level
OTS	OneTouch System
PMA	Program Manager, Air
PMCS	Partially Mission Capable Supply
RFI	Ready for Issue
RO	Requisitioning Objective
RP	Reorder Point
RSupply	Relational Supply
SARDIP	Stricken Aircraft Reclamation and Disposal Program
SMD	Supply Management Division
SOP	Standard Operating Procedure
WASMAT	Wing Aviation Supply Management Assistance Team

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I. INTRODUCTION

A. PURPOSE

In response to the Commandant of the Marine Corps' vision for Force Design 2030, Headquarters Marine Corps, Deputy Commandant for Aviation (DCA), has initiated the 2021–2026 Aviation Supply Campaign Plan to address issues and priorities within the Marine Corps aviation community. The intended long-term outcome of this Campaign Plan is to develop, integrate, and coordinate associated plans, policies, and best practices, which will allow for effective and efficient management of all Marine Corps aviation programs across their entire life cycles and provide an overall enhancement of asset capabilities. Part of this approach necessitates a review of the existing procedures, policies, and practices to identify both strengths and weaknesses and to reestablish an accurate baseline to inform future adjustments.

Demand variability among repair parts for the various Marine Corps aircraft platforms is one of the top issues identified by the DCA for mitigation and correction because these fluctuations have a direct impact on unit and enterprise readiness. Also of concern within this larger issue is the realization that costs associated with repairs and contract support operations increase in correlation with demand variability (and, decrease readiness). This variability results in a significant influence on the level of responsiveness achieved through the enterprise supply chain network and its ability to effectively support aviation forces. Collectively, this all translates to a more challenging forecasting structure which amplifies cost and readiness concerns. Identifying and addressing the root causes will result in increased responsiveness across the network, thereby increasing readiness and capability, and reducing complexity and cost.

As technologies mature and missions change, aviation platforms in the military inevitably reach a point in their life cycle referred to as *divestiture*. Divestiture in its simplest form is the process by which a weapon system is retired from active service. The process of divestment includes the systematic removal of aircraft from service based on a strategic enterprise-wide schedule in order to make way for replacement with new aircraft platforms or systems. Once identified for divestment, these aircraft receive an assessment for foreign military sales potential, enter a demilitarization program, or undergo various levels of preservation and storage to make way for the new systems. The overall divestment period for large service-level resources such as the F/A-18 typically spans 10 to 15 years; the period follows an incremental approach where aircraft and squadrons transition to the new aircraft platform one at a time. Under this model, an F/A-18 squadron would transition its current aircraft from the F/A-18 to the F/A-35 by either transferring the legacy aircraft to another squadron or shipping these aircraft off for disposal. Prior to full squadron transition, squadrons also incrementally reduce the number of individual aircraft maintained in service. During this initial divestment time frame, squadrons must maintain and utilize these aircraft in an operational status until officially divested.

Analyzing the entire Naval Aviation Enterprise as a single system is beyond the scope of this body of work; it is expected that such an analysis would result in similar findings across all aircraft platforms each of the various aircraft platforms. All aircraft and their individual support structures interact with the enterprise supply network in the same manner. Therefore, it is possible to identify the key drivers of demand variability under one of the more complex aircraft platforms and then test those drivers across the network. The F/A-18 platform is the best candidate due to its three plus decades of service and status as a well-established system within the Marine Corps and the aviation enterprise network. This longevity means the platform has a considerable amount of data available and has an established pattern of demand variability with enough frequency to identify areas of concern and key drivers of those variabilities.

The researchers hypothesize that the initial divestment period of the F/A-18 aircraft is causing increased levels of demand variability in repairable components. There is an existing consensus within the aviation supply community that hidden demand is an issue, but the root causes are not clear. The goal is to conduct a case study of F/A-18 repairable component demand data to better understand hidden demand's impact, if any, on demand variability. The researchers believe the initial divestment period of the F/A-18 aircraft is causing high levels of demand variability in repairable components, and corrective measures are required to mitigate continued observance of this issue. This capstone aligns with and supports DCA initiatives and will aid the development of long-term corrective actions to address identified drivers of demand variability throughout the enterprise. Through our research, data analysis, and study of best practices, we provide recommendations on policy changes and/or process improvement, which if implemented across the entire Naval Aviation Enterprise, will improve supply chain effectiveness and readiness.

B. RESEARCH QUESTIONS

i. What are the sources of unreported Demand History Adjustments (DHA) within Naval Supply Systems Command Weapon Systems Support (NAVSUP-WSS)?

ii. Does current policy for processing DHAs provide clear guidance along with actionable instructions? What policy updates can be implemented to improve current policy and guidance?

C. EXPECTED BENEFITS OF STUDY

The objective of this study is to recommend changes to policy, procedures, and maintenance practices to better assist the community in accurately capturing demand signal. This study seeks to increase the accuracy of demand forecasting in the F/A-18 community by improving the accuracy of demand captured. Recommendations are provided on how to reduce spending, reduce the lead time associated with parts received, increase overall maintenance readiness, and increase unit morale, while simultaneously reducing the number of cannibalizations. This work identifies solutions that extend beyond the divestiture F/A-18 and will affect all aviation platforms as they enter divestment. In other words, each aviation platform that undergoes divestment and sundown is susceptible to the current inefficiencies plaguing the F/A-18 repairable supply system. Addressing these inefficiencies now will reduce Navy/Marine Corp spending and increase readiness now and for all future platforms.

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II. BACKGROUND

A. HISTORY

The F/A-18 officially entered service in 1983 and has been serving the United States and selected allies for almost four decades (Boeing, n.d.). It was originally manufactured by McDonnell Douglas, which merged with Boeing in 1999 (Boeing, n.d.). The Marine Corps procured it as a fighter aircraft, and the Navy procured it as an attack aircraft, hence the F/A designator (Boeing, n.d.). The original variants, referred to as Legacy Hornets, include models A-D, which are the same models in current use by the Marine Corps. The Navy began fielding the F/A-18 E/F Super Hornet model in 1999 while the Marine Corps decided to stick with the Legacy models in order to save money (Boeing, n.d.). The Navy went on to procure the EA-18G Growler variant and began fielding it in 2008 (Boeing, n.d.). The Growler is designed to specialize in electronic warfare capabilities and provides full spectrum electronic attack, targeting and self-defense capabilities (Boeing, n.d.). Major F/A-18 milestones are shown in a timeline in Figure 1.

B. SUPPLY SUPPORT

Marine Aviation Logistics Squadrons (MALSs) provide aviation logistics support to aircraft squadrons within the same Marine Aircraft Group (MAG). The MALS is comprised of four major branches that include the maintenance, supply, avionics, and ordnance departments. On average, a MALS provides logistics support to five to eight aircraft squadrons. The Aviation Supply Department manages repairable and consumable parts used to maintain squadron aircraft. Aviation supply departments are responsible for validating squadron requirements, processing requisitions, conducting requisition maintenance, and processing and delivering material in accordance with policies and procedures.

C. DEMAND/FORECASTING

Variation in demand is a major cause of None Mission Capable Aircraft and high-cost, high-volume inventory. The current methodology of inventory buffering for the variation in demand makes the Aviation Combat Element (ACE) less agile and increases cost. Accurate and reliable demand enables more efficient inventory management. Conversations regarding requisitions are currently not effective between Aviation Supply Depot (ASD) and Customer and Wholesale (Marine Corps, 2021). In order to address these issues, changes will need to be made with the personnel (experience, authority) involved in generating, reviewing, accepting, and referring requisitions needs to change to improve communications within the supply system (Marine Corps, 2021). In addition, better tools are needed to access accurate information in a timely manner to develop metrics associated with demand spikes, cancellations, demand for specific NIIN's, part number requisitions, non-moving inventory, and not-carried items.

D. DIVESTITURE/SUNDOWN

For the purpose of this paper, divestiture is the process of retiring aircraft in order to achieve inventory goals in accordance with yearly aviation plans. The term *sundown* describes the point in which the F/A-18 will no longer be in service. Depending on the context used, this term can apply to a particular squadron, a Marine Air Group, or the entire F/A-18 fleet. The timeline of F/A-18 from inception to divesture and expected sundown is shown in Figure 1.

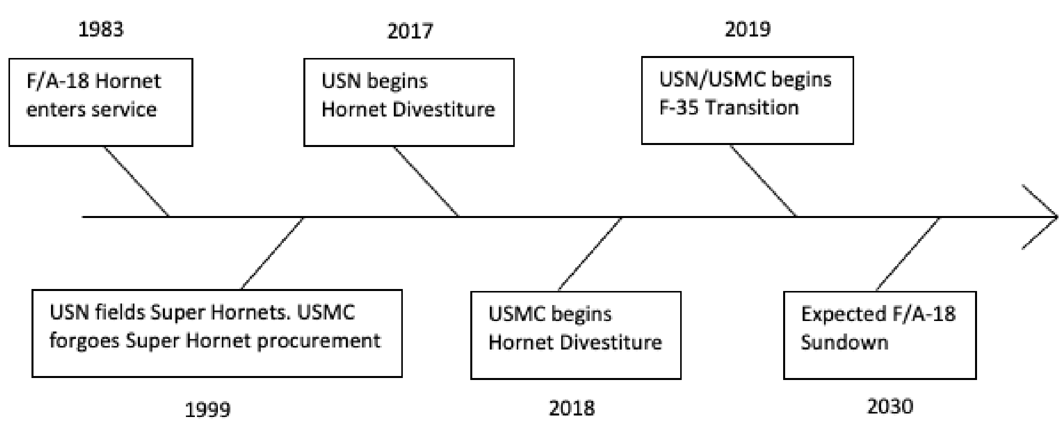

Figure 1. F/A-18 Service Life Timeline. (Note: USN means United States Navy and USMC means United States Marine Corps.)

E. STRIKE AIRCRAFT

The term *strike* identifies a specific aircraft designated for divestiture from the individual squadron readiness accounts. An aircraft already divested from those same squadrons are also considered to be a strike aircraft until release of the X-Ray message transferring custody of the aircraft from the squadron to NAVSUP-WSS; that squadron retains direct access to components from the stricken aircraft. A formal proceeding called a Strike Board, hosted by the platform's program office—in this case Program Management Activity 265 (PMA-265)—officially identifies each strike aircraft. During the board, members review the aircraft inventory and decide which specific aircraft to strike based on factors that amount to the overall condition of the aircraft and target inventory levels as sundown approaches. The Strike Board results, published via a formal naval message, designate specific aircraft for strike listed by aircraft serial number. At this point, the aircraft has only been identified for strike and remains operational depending on service needs. A normal custom is to cannibalize as many components as possible from strike aircraft until release of the X-Ray message transferring custody of the aircraft from the squadron to NAVSUP-WSS for recycling. In the execution of this practice, components are utilized as an immediate source of supply rather than following traditional requisition procedures. It is important to note that demand is not captured during this process.

In 2017, the Navy decided to accelerate the divestiture of their legacy Hornets in order to concentrate resources on their Super Hornet inventory, which was still in production at that point. In 2017 alone, the Navy decided to strike more than 100 legacy Hornets.

F. CANNIBALIZATION

"Aircraft cannibalization is the removal of serviceable materials, parts, or components from one aircraft for installation into another aircraft" (Office of the Chief of Naval Operations (CNO), 2021). Established maintenance procedures for cannibalization ensure proper forecasting and accountability of both required repair parts and the actual repairs to the aircraft itself. However, the initial divestment period of aircraft from individual squadrons creates a high level of demand variability following implementation at each squadron . It is during this time where most of the demand variability originates and complicates forecast accuracy. Following the current procedures, the system captures a demand signal whenever a squadron maintainer places a replacement part on order for a fully operational aircraft. Fulfillment of this demand comes from either the enterprise-level supply network or through local sourcing from divested non-operational aircraft. When local sourcing is the case, there must be a manual entry, referred to as a DHA of the associated demand signal for any situation where a replacement part did not come from retail or wholesale inventories (Headquarters Marine Corps, 2021). The difference in demand generation and reporting procedures results in a complex application process for the maintainers when cannibalizing components from strike aircraft; it is hypothesized that the cannibalization from strike aircraft compromises the reliability of cumulative demand signals throughout the enterprise-level supply network.

The most common instance of local sourcing is when a cannibalization occurs from one aircraft to another. Cannibalizations occur for two main reasons. The primary reason is because the squadron has conducted an inventory check on the required part and found that it is either out of stock or otherwise unavailable. An event referred to as "cannibalizations for convenience" is the second reason for initiating the cannibalization. This typically happens when the squadron is working on a tight timeline to meet the aircraft's flight schedule and chose to cannibalize the part from another down jet to avoid waiting for the supply system to deliver the part. The same requirement applies for harvesting parts from a strike aircraft to use on another aircraft for the purpose of making it mission capable. Cannibalization actions with requisition documents associated to them have demand captured. There are some instances where requisition documents are cancelled upon completion of the cannibalization action. The cancellation of the requisition kills the demand signal, requiring a DHA submittal. The challenge with creating a DHA is that current policy does not provide clear guidance on requirements and instruction for DHA submittal. In addition, aviation supply Marines responsible for processing DHAs into the system deem the manual input method to be tedious, time consuming, and is not formally required. Leaders within the Aviation Supply community believe the inconsistences within the DHA process leads to increased demand variability and degrades demand signal accuracy. As a result, the ability to accurately forecast for repair parts is further complicated and impacts the associated vendor contracts needed to initiate contracting efforts for new parts, or effective part sourcing to occur across the community.

As aircraft begin to sundown, cannibalizations against divested aircraft increase. Actions of this nature are in accordance with current procedures and typically viewed positively because squadrons are taking advantage of parts made available from strike aircraft. However, there is a potential downside in cannibalizing parts from F/A-18 aircraft. Unreported or inaccurate demand signal for a cannibalized part sourced from a strike aircraft negatively impacts the accuracy of future repair and spare part forecasts. There is a belief within the aviation community that there is a significant demand signal that remains uncaptured from strike aircraft cannibalizations. Initial cursory analysis indicates, at a minimum, that registered demand signal is not commensurate with the accounts of harvest actions, yet specific analysis and study of this variation in demand signal data have not occurred. Fleet F/A-18 squadrons have acknowledged conducting these same actions to harvest needed parts, since the divestment process began in 2017. In this same time, the Navy and Marine Corps has divested of at least 186 F/A-18 A-D aircraft from various squadrons, providing a sizeable population of potential data sources to work with and identify both causes and potential solutions.

G. TRANSITION/WHY THE F/A-18 AS THE TEST BED

Given operational impact, quantity of aircraft, and funding involved, the divestment process typically spreads across many years to allow for effective transition from one platform to the next. During these transition periods the outgoing aircraft, in this case the F/A-18, maintains operational requirements until the divestment process is complete. This same format is typical whenever a replacement aircraft, or even an updated model, enters the operational fleet. Because the F/A-18 is currently in the process of divestment it allows for a time relevant analysis of impacts to the supply chain for repair components.

The F/A-18 provides an ideal platform for further study for many reasons, among them is the fact that this platform has a mature supply chain associated to its support, as well as a mature maintenance structure in personnel, procedures, and practices. Because of this maturity and the size of this program of record, there is ample data to draw from and analyze. Therefore, any anomalies or trends in such a large program would also indicate possible trends or anomalies in small and/or less developed programs. Further, because divestment practices follow the same process, information learned on this platform will translate to other aircraft in the future as they are also phased out or replaced with newer technologies. Similar transitions under future platforms such as the CH-53 Heavy Lift Helicopter, or KC-130 are likely to follow this same divestiture / sundowning approach, and therefore will also have similar, if not the same, implications regarding unreported demand, and repair component availability.

Despite the 2030 sundown completion date for all legacy F/A-18 aircraft and the steady divestment in aircraft inventory, there remains an operational capability requirement for active aircraft. This requirement necessitates active F/A-18 aircraft to maintain availability and readiness to meet National Security objectives until the new F-35 Joint Strike Fighter fully covers those capabilities. Unreported demand has the potential to degrade this capability coverage, or possibly create gaps in readiness due to F/A-18 non-availability as a result of inadequate repair component supply.

From the most basic perspective, the F/A-18 is the current aircraft in the process of divestment, and one which includes a long standing, well-developed support infrastructure. Studying effects of unreported demand for such a platform will provide valuable information towards addressing issues more thoroughly for future divestments of aircraft such as the CH-53 or KC-130. Further, because the F/A-18 retains a requirement to provide active capability support to the Marine Corps, identifying gaps created via unreported demand allow for correction to the supply chain while still relevant. Corrections will result in the assurance of accurate demand capture and improved forecasting to ensure the right parts and associated funding are applied while operationally relevant. In other words, corrections are made while the F/A-18 is still in active operations and required to provide coverage in capabilities while the F/A-18 to F-35 transition continues and ultimately completes. Proper inventory management becomes even more important as divestment continues because there is less inventory available resulting in a smaller buffer.

III. LITERATURE REVIEW

This section involves four areas of focus. The first centers on Marine Corps policies and procedure related to aviation supply practices as it pertains to the management of repairable parts. The second area of focus is the cannibalization of repairable parts and the associated effects. The third centers around demand forecasting. The fourth and final area of focus is a discussion and review of demand variability.

A. AIRCRAFT CANNIBALIZATION

Aircraft cannibalization is defined as “the removal of serviceable materials, parts, or components from one aircraft for installation into another aircraft” (CNO, 2021). Figure 2 shows the typical requisition process for repairable parts from the Marine Corps supply system compared to the cannibalization process. When policies and procedures are followed, “cannibalization is an acceptable management choice only when necessary to meet operational objectives” (CNO, 2021). Cannibalization is an acceptable practice only when necessary because there are negative effects to personnel, equipment, and the supply system. According to a United States General Accounting Office (General Accounting Office (GAO), 2001), “cannibalizations have increased the workload of maintenance personnel by millions of hours----costly time that could have spent more productively” (GAO, 2001).

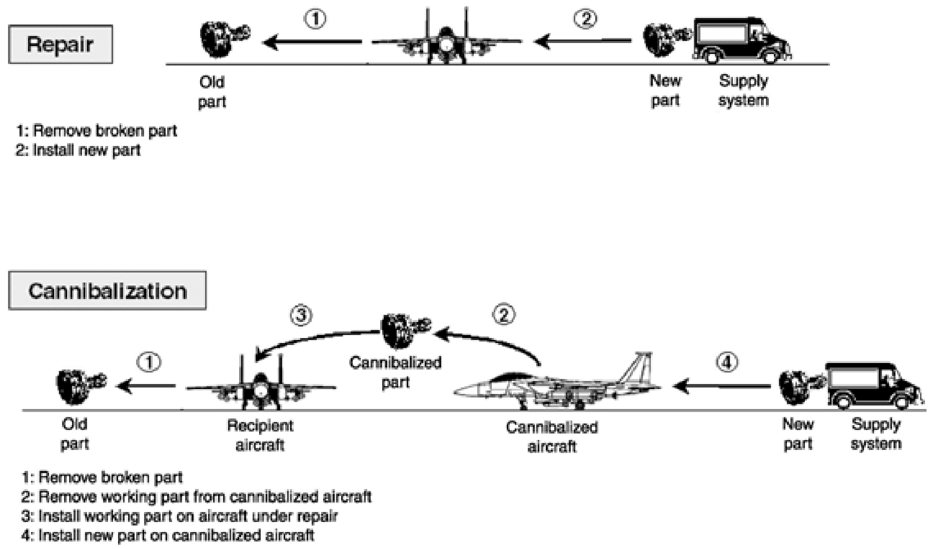

Figure 2. Removal and Replacement of Repairable Parts vs. Cannibalization of Repairable Parts. Source: GAO (2002).

Service officials believe that the majority of cannibalizations occur due to the lack of parts and their quick availability within the supply system (GAO, 2001). The reported number of cannibalizations is not necessarily accurate because not all cannibalizations are recorded. This means, "It is difficult to gauge the precise effects of cannibalization because the services do not know how many are performed, the specific reasons for performing them, or how much time and money are spent on them" (GAO, 2001). Part availability and lack of demand signal due to undocumented cannibalization motivates the analysis of cannibalizations and their associated supply actions to identify discrepancies in the Marines Corps' ability to accurately capture the demand signal for F/A-18 TMS.

B. DEMAND FORECASTING

Demand forecasting is a key component in the management of inventory regardless of industry. Forecasting is difficult and even more so when demand signal is sporadic, uncertain, and in cases where hidden demand exists. Hidden demand can be caused by inadequate policies and lack of training on programs designed to accurately capture demand signal. According to a study on the evaluation of forecasting methods for intermittent parts demand in the field of aviation, "demand forecasting is one of the most crucial issues of inventory management" (Ghobbar & Friend, 2003).

"The selection of forecasting models has a significant impact on system performance"(Zhao, Lee, 1993). In order to efficiently plan for repair parts inventory within the aviation industry, accurate demand forecasting methods must be in place to properly capture demand signals. Zhao and Lee (1993) determined in their study on requirements planning systems under demand uncertainty that "forecasting errors significantly increase total costs and schedule instability and reduce the service level in multilevel [Material requirements planning] systems" (Zhao, Lee, 1993).

There are many methods of forecasting demand, but most are not effective for the management of spare parts; spare parts typically have infrequent or intermittent demand (i.e., many periods with zero demand), making conventional forecasting methods inadequate (Sahin & Demirel, 2013). Sahin and Demirel (2013) demonstrated with a high level of certainty that the use of Croston-based and Artificial Neural Networks (ANN) methods to forecast aviation spare parts is effective. Sahin and Demirel (2013) also demonstrated that ANN methods slightly outperformed Croston-based methods; however, they also highlighted that decision-makers can confidently utilize the simpler Croston-based model to effectively forecast demand for the sporadic nature of spare parts in the aviation industry. The importance of discussing demand forecasting is to emphasize the significance of demand accuracy in forecasting for spare parts. Forecasting is an inherently difficult task to begin with. Unreported demand reduces forecasting accuracy and leads to shortfalls in spare parts availability.

C. DEMAND VARIABILITY

Closely related to forecasting is demand variability, and its impacts to inventory management. In simple terms, demand variability is the measurement of the fluctuation in time between one requisition and the next. When tracked over time, demand variability identifies trends, or lack of, in usage of the item in question, and subsequently informs forecasting decisions. It is no surprise that the dynamic nature of the military operating environment leads to significant fluctuation in demand signal and quantity for many of its systems and their subcomponents. Further complicating the matter is the need to maintain systems such as the F/A-18 in a high state of readiness in order to fulfill operational mission and national security requirements. The combinations of these requirements create an environment where individual components must be available regardless of the time interval between demand signaling. Repair components have infrequent demand signal as well as large variation between required quantities increasing the difficulty of meeting fulfillment requirements.

Previous research conducted by members of the military supply and aviation communities indicates the concern for addressing demand variability, and that there is no "perfect" solution. Nonetheless, applying these previous research efforts to guide and support additional work remains a fruitful endeavor. A research thesis completed by Custard et al. (2016) looked at the effects of using excess stock at reduced demand variability in repairable components within the Naval Aviation Depots. In this case, they identified excess stock as additional items purchased new through contract above the requested amount, effectively creating a safety stock to cover fluctuating demand. Their conclusion was that cannibalization efforts and local procurement stocks provide only a short-term fix, complicate long-term solutions, and increase forecasting inaccuracy. While use of excess materials showed a substantial decrease in lead time, there was also a substantial increase to the cost associated with requisitioning those parts.

D. DEMAND POLICY

The Marine Corps standardizes procedures for aviation supply personnel within a MALS via Marine Corps Order (MCO) 4400.177H. The Marine Corps Aviation Supply Desk-Top Procedures (ASDTP) order provides the policy and processes to execute the daily function of aviation supply operations. Aviation Supply departments use the Relational Supply (RSupply) and the Optimized Naval Aviation Logistics Command Management Information System (OPT-NALCOMIS) as tools to conduct the daily functions of the aviation supply operations (MCO 4400.177H, 2021). The ASDTP policy details the following: how demand is defined within the context of Marine Corps aviation supply; how DHAs are recorded for items requisitioned outside of wholesale and retail inventories; and the guidance or instructions for recording DHAs.

The ASDTP defines *demand* as "a request for material that will be procured or issued from stock" (MCO 4400.177H, 2021, AG-31). Recurring demand is automatically captured through the procedural requisitioning process that takes place via the RSupply and OPT-NALCOMIS systems. Stock levels in RSupply are defined by the Requisitioning Objective (RO), which is the maximum inventory level, and the Reorder Point (RP), which is the level at which more items are ordered (MCO 4400.177H, 2021). Initial stock levels (RO and RP) are established based on allowance lists determined by historical demand (MCO 4400.177H, 2021). Allowance levels are periodically reviewed and can be adjusted as necessary based on historical or forecasted demand (MCO 4400.177H, 2021). Demand signals coming from the retail level (i.e., MALS) interface to the wholesale level (i.e., NAVSUP-WSS in the case of repairable components). These demand signals are used by wholesale Inventory Control Points (ICPs) such as the DLA and NAVSUP-WSS for future forecasting and demand planning.

Instances in which aviation replacement parts are acquired outside of the normal supply chain require manual demand signal processing known as a DHA. Acquiring parts from SARDIP warehouse inventory, open purchase sources, or harvesting directly off a strike candidate aircraft would fall into this category. DHAs should be processed for both repairable and consumable parts to allow the ICPs to use these demand signals for accurate demand planning. However, the ASDTP only provides guidance for submitting a DHA for consumable items. This responsibility falls under the Aviation Supply Department's Operations Management Division (MCO 4400.177H, 2021). The ASDTP states the requirement to manually submit a DHA on a transactional basis for instances in which a requisition was canceled and acquired through other means outside of normal supply channels. For items normally supplied by DLA, a DHA is to be submitted via the Department of Defense FedMall website (MCO 4400.177H, 2021). Although the ASDTP does not provide guidance on submitting DHAs for repairable items, instructions to do so can be found on the NAVSUP One Touch Support website, which Aviation Supply Departments use as an asset visibility tool. The ASDTP does not provide specific step-by-step instructions for submitting a DHA to either FedMall or NAVSUP One Touch.

Aviation Supply Departments undergo periodic Functional Area Inspections (FAI) and Functional Area Assists (FAA) by their corresponding Marine Air Wing's Aviation Logistics Department (MAW-ALD). The Aviation Supply Department is inspected on their performance executing their duties and responsibilities using checklists found in the appendices of the ASDTP. These inspections and assists serve a checks-and-balances function to ensure Aviation Supply Departments are adhering to policy and allow for the opportunity to receive guidance and help on conducting required tasks from an upper echelon command. The inspection checklists within the ASDTP appendices do not include the submittal of DHAs as a function that is inspected. This means this critical task for accurately recording demand signals is not enforced.

IV. METHODOLOGY

This chapter describes how the data in this project was compiled and analyzed to answer the research questions. The sources of data section explain the various sources used to compile the necessary data for the project. The research methods section describes the approach taken to analyze the data, the results of which are presented in Chapter V.

The primary focus on this analysis was to determine generation and submission of proper demand records, through use of a DHA during this same time period. Further examination included the policies and procedures regarding DHAs, and the effect of non-compliance with established requirement towards accurately capturing demand. During this period, the Navy and Marine Corps were also executing their divestment plans of F/A-18 A-D aircraft as they began transitioning to the F-35 Joint Strike Fighter. This is significant because the divestiture of hornets by Navy and Marine Corps' squadrons created a pool of 293 aircraft designated for strike which became prime candidates for cannibalization as the aircrafts transitioned to an inactive status.

A. SOURCES OF DATA

The data used in this project came from various Naval Aviation Enterprise Data sources. Data pulls includes the timeframe between July 1, 2016 to June 20th, 2021.

1. Historical Demand of F/A-18 A-D Repairable Components

NAVSUP-WSS provided a data pull from their Navy Enterprise Resource Planning (ERP) system that includes historical demand data for F/A-18 A-D repairable components. The data includes incoming requisitions to NAVSUP-WSS, reported DHAs, unfilled customer orders, requisition receipt confirmations, and requisition cancellations. This data was used to reconcile issues from SARDIP and requisitions reported in cannibalization data against reported demand signals to NAVSUP-WSS to determine whether signals were via conventional requisition orders or DHA processing.

2. Historical Demand of F/A-18 A-D Repairable Components

PMA-265, NAVAIR publishes a monthly Aircraft Flight Hour and Inventory report which serves as a master database of F/A-18 aircraft inventory, configuration details, flight hours by aircraft, stricken and preserved aircraft, custodian, and squadron site information, reporting status, and service life extension information. This report was used to chart F/A-18 A-D aircraft inventory levels and stricken aircraft quantity during our research period.

3. SARDIP Inventory of Stricken Components

Science Applications International Corporation (SAIC) is contracted by the U.S Navy to support the F/A-18's Stricken Aircraft Reclamation and Disposal Program (SARDIP). SAIC is tasked with receipting, storing, and issuing aircraft components harvested from stricken aircraft. SAIC maintains inventory of these components via excel and publishes a monthly inventory report. The goal with SARDIP data was to reconcile F/A-18 A-D repairable parts issued from the SARDIP warehouse with the demand data provided by NAVSUP-WSS by matching the document numbers associated with each requisition. Since SARDIP issues are not automatically captured by RSupply, ASDs are required to manually submit a DHA to send the demand signal to the appropriate ICP. When completed correctly, this reconciliation process produces a corresponding DHA within the NAVSUP-WSS, and therefore accurately captures demand data for each SARDIP issue. The SARDIP data received includes current SARDIP inventory as well as parts issued over the observed period.

4. Maintenance Data Repository

Decision Knowledge Programming for Logistics Analysis and Technical Evaluation (DECKPLATE) is a maintenance application that serves as a repository of maintenance data such as technical directives, maintenance actions, and cannibalizations. Cannibalization data from DECKPLATE was used to identify cannibalizations that reference the removal and replacement of repairable components and the requisition numbers. The goal with cannibalization data was to reconcile recorded instances of cannibalizations where an F/A-18 A-D repairable part was transferred from one aircraft to another and ensure the demand for that requirement was captured. Demand capture for cannibalization items should occur via a document number or DHA submission if the document was canceled for any reason. To isolate repairable cannibalizations, the data was filtered to pull instances of the following malfunction codes:

- "815: Cannibalization—repairable part carried but not on hand in local supply system" (CNO, 2012)
- "816: Cannibalization—repairable part not carried in local supply system" CNO, 2021)

5. Marine Corps Aviation Supply Policy

Marine Corps Order 4400.177H ASDTP establishes policies and procedures pertaining to the Aviation Supply Department and their operations. The ASDTP also provides inspection checklists to conduct internal audit as well as functional area inspections from higher echelons of supply. A qualitative analysis was conducted on the ASDTP to identify current guidance on processing DHAs and make recommendations consistent with other guidance and protocols.

B. RESEARCH METHODS

This research was conducted utilizing exploratory data analysis and framework analysis. The first three phases within exploratory data analysis, look to answer the primary research question of determining the future implications of unreported DHAs within NAVSUP-WSS. The fourth phase utilizes a qualitative framework analysis to answer the second research question: does current policy for processing DHAs provide clear guidance along with actionable instructions? What updates can be implemented to improve current policy and guidance? The researcher's knowledge and experience on the topics of Marine Aviation Supply and Maintenance practices, policies, and procedures was strongly relied upon in analyzing the data and the various intricacies involved with aviation maintenance and supply maintenance codes.

In Phase I, a demand and aircraft inventory trend analysis was conducted over the observed period. Historical demand data from NAVSUP-WSS was organized using

Microsoft Excel. Pertinent demand quantity, active aircraft inventory, and strike quantity was pulled using a pivot table and converted to a graph to show the relationship between repairable component demand and F/A-18 aircraft inventory over the observed period.

Phase II is an analysis of SARDIP data by reconciling repairable part issues from the SARDIP warehouse against NAVSUP-WSS demand data from Navy ERP; the objective of this phase is to determine if a demand signal for a SARDIP issue was captured. The SARDIP data was first filtered by Cognizant Symbols (COG) category indicators. The COG indicators are two-character symbols used to sub-categorize material based on component or repair type. The two primary COG codes used in aviation are 9B for consumable parts and 7R for repairable parts. Since the analysis is on repairable components, the data was filtered to isolate SARDIP issues of repairable components (COG 7R). The SARDIP data consists of an excel spreadsheet that serves as an inventory list of parts available for issue at the SARDIP warehouse. This listing is manually updated by the SAIC personnel who manage the F/A-18 SARDIP contract. It is not an automated inventory system such as RSupply used by ASDs. This requires attention to detail to maintain inventory accuracy and consistency throughout the spreadsheet. Instances of formatting inconsistency were noted in two of the necessary columns within the spreadsheet. First, lines without a COG code were excluded from this analysis because the type of part was reasonably unidentifiable. Second, lines without a valid document number were excluded from this analysis. Without a valid document number, the researchers are unable to reconcile the SARDIP issue with the NAVSUP-WSS demand data. The remaining lines were reconciled against NAVSUP-WSS demand data from ERP. Finally, the replacement value of the repairable components was calculated using SARDIP data prices to quantify the dollar value of missing demand to the supply chain. In other words, the components that are not budgeted for when conducting forecasts for future repair and spare contracts.

Phase III is an analysis of cannibalization data from DECKPLATE by reconciling document numbers for repairable components listed within the cannibalization data’s remarks section against NAVSUP-WSS demand data from Navy ERP. In this phase, the listed document numbers within the cannibalization data’s remarks section should show receipted or as a pending unfilled customer order within the NAVSUP-WSS demand data. 12,344 cannibalization actions were analyzed to determine demand captured. The cannibalizations were filtered to isolate the ones with 815 and 816 malfunction codes, leaving 8,841 cannibalizations remaining. From there, document numbers needed to be identified to ensure demand was captured however, cannibalization data is not conducive to supply analysis due to formatting. Although the data does include supply information such as National Stock Number (NSN), Part Number, nomenclature, and price info, it does not include a separate field for document numbers associated with the cannibalization, a necessary component for the reconciliation process. Adding to the complexity was the discovery that there is no specific standardized way to annotate corrective actions within that field. For this reason, the analysis relied on reviewing the corrective action field of the data and processing it to extract document numbers. For this reason, the analysis relied on reviewing the corrective action field of the data and processing it to extract document numbers. This process yielded 6,354 cannibalization actions with unique document numbers that could be reconciled against demand data. After reconciling cannibalization data against demand data, pricing information was analyzed to identify potential impact to future repair and replacement component funding due to unreported demand.

Phase IV consists of a process analysis on guidance provided to submit a DHA and supporting inspection criteria listed within MCO 4400.177H (ASDTP). Process maps were created to depict the flow of conventional aviation supply requisitions as well as the procedure for submitting a DHA. An analysis of the ASDTP order was conducted to examine current guidance for submitting DHAs and determining inspection criteria. Process flow maps of conventional cannibalizations versus "dirty cannibalizations" for stricken aircraft were analyzed to identify instances in which demand is unreported.

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V. ANALYSIS AND FINDINGS

This chapter discusses the analysis conducted and findings of F/A-18 A-D demand, cannibalizations, SARDIP, and inventory data. The timeframe of all data is July 1, 2016 to June 30, 2021 to ensure consistency among datasets.

A. EXPLORATORY DATA ANALYSIS AND RESULTS

1. Phase I: Demand and Aircraft Inventory Analysis

The demand data provided by NAVSUP-WSS was used to graphically depict the demand trend as the active F/A-18 A-D aircraft population decreased over the researched period (shown in Figure 3), from 563 to 309 aircraft. That is approximately 54.69% reduction in inventory over the five-year research period, with an average of approximately four aircraft removed from the active inventory (divested) per month. The reduction is attributed to the Navy and Marine Corps' divestiture of Hornets as the services transition to the F-35 Joint Strike Fighter. During this same period, quarterly demand for repairable parts reduced by approximately 38%. Both the overall demand for repairable parts and active inventory showed a decrease across the researched period. These findings align with expectation: reduced active inventory equates to fewer aircraft requiring maintenance and repair. However, the analysis revealed an increasing gap between the aggregate sum of demand over time and the reduction in aircraft inventory depicted by the yellow and blue doted lines on Figure 3. The rate of decrease in demand occurrences of repairable parts follows a slower rate than that of active inventory decrease. In other words, repairable demand is increasing overall, at a per aircraft rate over time; indicating that individual aircrafts are requiring more repairs over time. Aircraft are aging and maintaining increased flight hours, so it is intuitive that more maintenance is required.

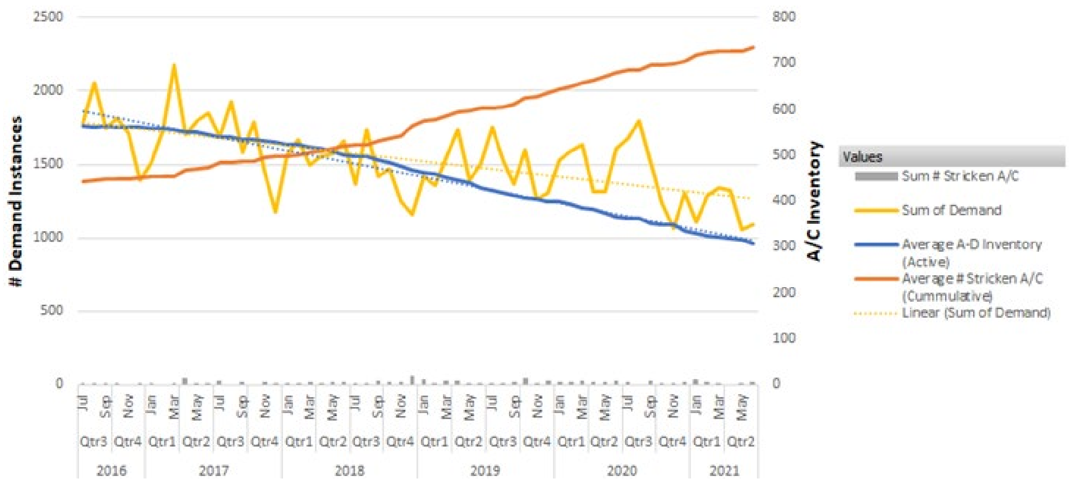

Figure 3. Demand/Inventory Summary. (Note: A/C means aircraft.)
Source: NAVSUP Demand data and NAVAIR Aircraft Inventory Data

2. Phase II: Reconciling SARDIP Issues

In total, there were 4,646 individual issues from the SARDIP warehouse during the research period of those, 660-line items did not have a COG code and were excluded from the analysis; there was no effective and timely way to determine which category they fell under. After sorting the remaining line items with valid COG codes, 509-line items remained. Of those, 169-line items did not have the required document number to reconcile the SARDIP issue with the NAVSUP-WSS demand data. Instead of a document number, the line item was either blank or had other information such as aircraft serial number or depot repair number which was not compatible with the reconciliation method. This left 304 SARDIP issues for repairable components that could be reconciled against NAVSUP-WSS demand data. The results of the SARDIP data reconciliation (shown in Table 1).

Table 1. SARDIP Reconciliation. Source: SARDIP Database and NAVSUP Demand Data

Total SARDIP Issues	304
Incoming Demand	25
Receipt Posted	8
Open Documents	0
Cancelled*	6
Demadn History Adjustments (DHA)	0
Unreported Demand	271

** Demand Signal is Not Created*

In Table 1, the line item categories have the following meaning:

- Incoming Demand: Demand captured by customer placing requisition order
- Receipt Posted: Demand captured by customer acknowledging fulfillment of document
- Open Documents: Demand captured through currently active, unfilled document
- Cancelled: Document cancelled by ASD (Demand not captured)
- DHA: Demand captured through manual submission

Demand must be represented in one of the areas identified above, with exception of the 'Cancelled' category in Table 1, to be accurately captured across the enterprise network. Only 11% of the issues from SARDIP were accurately captured demand occurrences. Based on these findings, the researchers believe a similar result would occur if able to reconcile the entire quantity of SARDIP issues (4646), due to personnel not creating DHAs. The few occurrences which correlate to captured demand support the assertion that there is not a formal process to follow or being followed. The result of which is missed demand signal for (at least) 271 SARDIP issues. All of these SARDIP issues represent a repairable component required by a unit to repair an active aircraft in inventory. Focus of that unit is on returning the aircraft to operational status regardless of where the part comes from, and in the case of an issue from SARDIP, it appears there is no follow through with either cancellations or receipts as expected (or DHAs). Collectively the missed demand increases the variation in demand signaling and complicates the ability to accurately forecast true demand requirements.

Of the 304 SARDIP issues reconciled, 33 issues were positively confirmed having recorded demand signals either through incoming demand or receipt posted. The analysis yielded no instances of a DHA submission. There were 6 matches to cancellations within the data provided by NAVSUP-WSS. Cancelling a requisition is the first step an ASD takes after receiving a component from the SARDIP warehouse to avoid being charged for a part that is no longer required. The next step is to submit a DHA to account for the demand. Document Identifier codes are a three-digit alpha-numeric code that is used in aviation supply management systems to identify the type of transaction and the associated effect it has on the inventory system. The reconciliation also produced 8 matches for issues accomplished by direct delivery from vendor identified by a D7A document identifier code, In the case of those 8-line items, demand was captured by alternate means. There were also 25 matches for requisitions with domestic shipment identified by A0A document identifier code. These 25 documents also captured demand. This left 271 SARDIP issues of repairable parts that did not have demand captured.

In order to capture the effects of the missing demand on the supply chain, the replacement value of the associated parts was calculated using prices on the obtained SARDIP data (shown in Table 2). The total dollar value for uncaptured demand was $3,197,251 over the five-year period. This is important when considering future implications of under-budgeting by these quantities for future requirements. Based on the data, 53% of SARDIP issues are uncaptured through a formal demand identification process and are not included in forecasting efforts at the enterprise level. The unreported demand results in approximately $3.2M over the five-year period not being identified as a potential requirement for funding.

Table 2. Replacement Value of Uncaptured SARDIP Demand. Source: SARDIP Database

Year	# of SARDIP Issues	Total Price
2016*	19	$228,032
2017	35	$467,916
2018	77	$1,133,040
2019	114	$1,495,589
2020	173	$1,403,316
2021*	91	$1,277,276
Grand Total	**509**	**$6,005,169**
** Only Includes 2 Quarters*		
Unreported Demand	271	$3,197,251
	53%	

3. Phase III: Reconciliation of Cannibalization Data

Cannibalization actions show a downward trend over the observed period. These findings are in line with the decreasing Hornet inventory over the observed period. Between 2018–2019, aircraft inventory dropped from 523 to 398 which reduced the active aircraft inventory pool to cannibalize from. Additionally, the Navy and Marine Corps were also executing their divestment plans of F/A-18 A-D aircraft as they began transitioning to the F-35 Joint Strike Fighter. Of note, cannibalization actions experienced a 60% reduction between 2018 and 2019 (shown in Figure 4). The researchers were unable to assess root cause for the sharp decrease between the two years. However, the researchers believe the reduction in cannibalization actions were due to the aggressive speed of divested Legacy Hornets as they shifted focus to their Super Hornet inventory and prepared for the transition to the F-35.

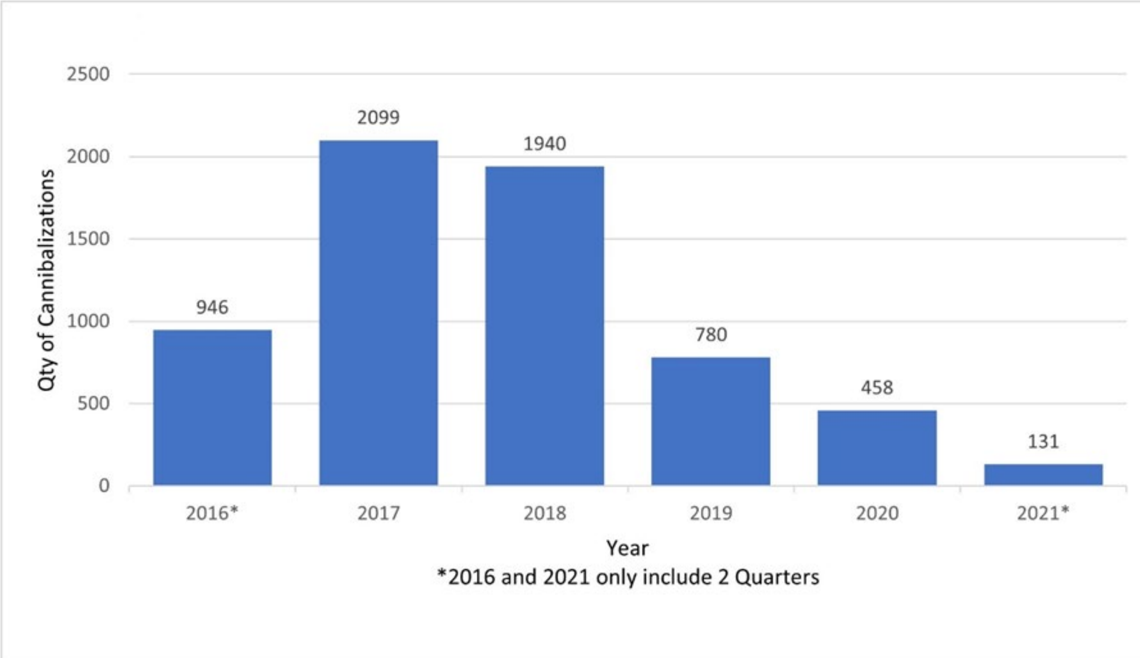

Figure 4. Cannibalizations for Fiscal Years 2016–2021. Source: DECKLATE Data (2021).

Out of a total of 12,344 cannibalizations, 6,354 cannibalizations were reconciled against demand data. The results of the cannibalization data reconciliation are depicted in Table 3.

Table 3. Cannibalization Reconciliation (Note: CANN means cannibalization). Source: DECKPLATE database and NAVSUP demand data.

Total Cannibalization Docs	6354
Incoming Demand	887
Receipt Posted	619
Open Documents	0
Cancelled	74
Demadn History Adjustments (DHA)	3
Unreported Demand	4771

In Table 3, the line item categories have the following meaning:

- Incoming Demand: Demand captured by customer placing requisition order
- Receipt Posted: Demand captured by customer acknowledging fulfillment of document
- Open Documents: Demand captured through currently active, unfilled document
- Cancelled: Document cancelled by ASD (Demand not captured)
- DHA: Demand captured through manual submission

The findings revealed that out of the 6,354 cannibalizations reconciled, 1,509 were able to be positively confirmed having recorded demand signals either through incoming demand, receipt posted, open document, or DHA. As previously discussed, cancelled documents would require a subsequent DHA submittal in order to capture demand. In this case, the 3 instances of DHAs did not match one of the 74 cancellations. This means that the 3 DHA documents were not associated with one of the 74 cancelled documents. Given that valid reasons exist for cancelling documents without the requirement to capture demand, the 74 instances of cancellations were not included in the missing demand total. In total, 4,771 of the 6,354 cannibalizations reconciled did not have a demand signal captured for it. This accounts for approximately 75% of the cannibalizations analyzed.

In order to capture the effects of the missing demand on the supply chain, the repair and replacement value of the associated cannibalized parts were calculated. The total dollar value for these figures were $686,223,483 and $126,452,068, respectively, over the five-year period. This is important when considering future implications of under-budgeting by these quantities for future requirements.

Table 4. Replacement Value of Uncaptured Cannibalization Demand. Source: SARDIP database.

Year	# of Cannibaliztions	Replacement Price	Repair Price
2016*	946	$148,078,495	$23,237,340
2017	2099	$290,994,984	$51,370,509
2018	1940	$287,329,465	$52,004,524
2019	780	$101,143,832	$22,703,562
2020	458	$67,405,696	$14,250,090
2021*	131	$18,957,403	$4,855,687
Grand Total	6354	$913,909,875	$168,421,711
* Only Includes 2 Quarters			
Unreported Demand	4771	$686,223,484	$126,462,069
	75%		

B. FRAMEWORK ANALYSIS AND RESULTS

1. Phase IV: ASDTP and Inspection Checklists

A process map (Figure 5) was created depicting the flow of requisitions filled by conventional retail or wholesale supply means to understand how demand signals are captured. In this case, demand signals are automatically captured through the receipting process as parts are delivered to the customer.

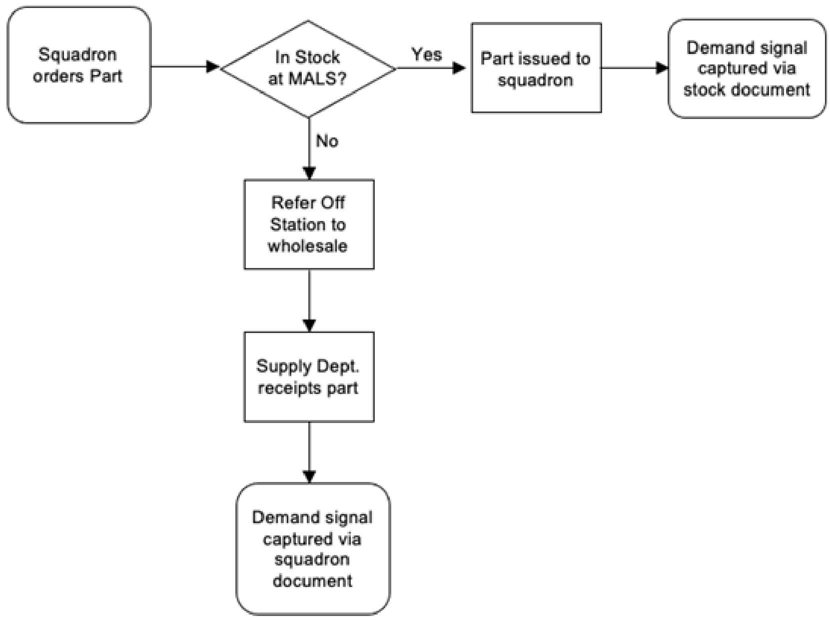

Figure 5. Conventional Demand Flow.

In unconventional instances where parts are acquired through means other than retail or wholesale sources such as SARDIP assets, open purchase, or cannibalization followed by a cancellation of the document, the submittal of a DHA by the ASD is necessary to capture the demand. Requisition documents are tied to lines of accounting to pay for the required parts. When parts are acquired via unconventional means such as SARDIP, it is customary for ASDs to cancel the requisition document to avoid the bill associated with filling the requisition. The cancellation of the document simultaneously eliminates the demand signal associated with the document thus creating the need to submit a DHA to account for the demand. The process to submit a DHA is tedious and is often overlooked because the DHA is not required to ensure delivery of the needed part. Figure 6 demonstrates the process flow of unconventional part issues such as those from the SARDIP warehouse and the point in which the demand signal is not captured if a DHA is not submitted.

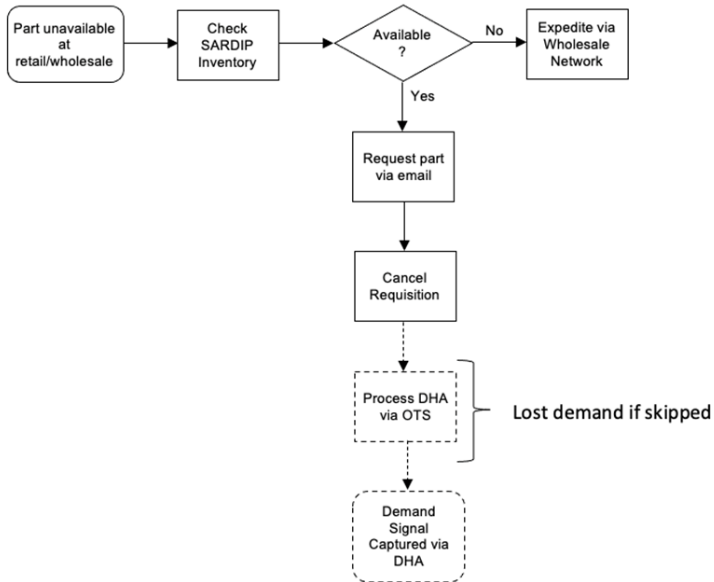

Figure 6. Demand Flow for SARDIP Issues.

An analysis of the ASDTP order was conducted to assess what the policy states regarding DHAs to determine the reasons why DHAs are not submitted. The review of the ASDTP revealed that although the policy mentions the need to process DHAs for consumable parts, there is no mention of processing DHAs for repairable components. We could not determine why the ASDTP requires the submission of a DHA for consumables and not repairables other than an oversight. The Marine Aviation Supply community may understand the benefits of processing DHAs for the required instances but without the policy in place to serve as a forcing function, ASDs are unlikely to do so.

Further discouraging the submittal of DHAs is the fact that the ASDTP does not provide instructions on how to submit DHAs or reference where instructions may be found. DHA submissions are not done via the ASD's RSupply application used for day-to-day supply duties. DHA submissions require aviation supply personnel to access either DLA's FedMall website for consumables or NAVSUP's One Touch Support website for repairables. Instructions for submitting DHAs can be found on the respective sites or by contacting military liaisons within DLA and NAVSUP-WSS.

Another finding that contributes against submitting DHAs is the lack of DHA inspection criteria. Marine ASDs conduct internal audits via their Supply Management Division (SMD) and are also inspected via FAIs conducted by the Aviation Logistics Department's (ALD) Wing Aviation Supply Management Assistance Team (WASMAT) team within their corresponding Marine Air Wing (MAW). The WASMAT team uses inspection checklists found within the ASDTP to assess ASDs adherence to policy. Review of inspection checklist within the ASDTP discovered no instance of DHA submissions as an inspected item. This means there is no enforcement of DHA submissions for SARDIP issues.

2. Cannibalization Process and Execution Analysis

The process flow and execution of cannibalizations was analyzed to identify sources of unreported demand. In accordance with the Naval Aviation Maintenance Program (CNO, 2021), proper cannibalization of repairable parts (Figure 7), and subsequent demand history is captured when the using unit receipts the new part from the supply system (step 4 in Figure 7) for the cannibalized aircraft.

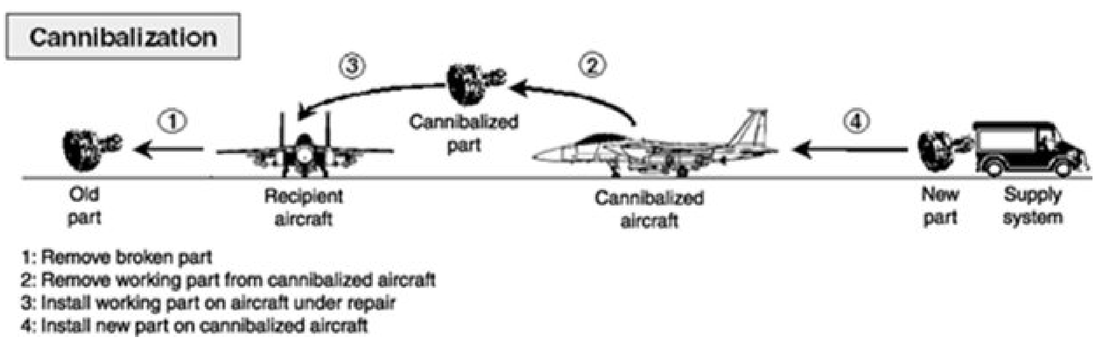

Figure 7. Cannibalization of Repairable Parts. Source: GAO (2001).

It was found that during the divestiture period, stricken aircraft that are removed from individual squadron readiness accounts are being used as cannibalization aircraft to fill repairable parts needs that cannot be sourced through traditional supply means. When aircraft are stricken from inventory and are no longer being reported on, these cannibalized parts are removed from the stricken aircraft and installed on the recipient aircraft, filling the unsupported need (shown in Figure 8). When parts are cannibalized in this manner an unsupported need is filled however, because the stricken aircraft is no longer being reported and does not require a new part from supply, the demand signal for the recipient aircraft part is never captured.

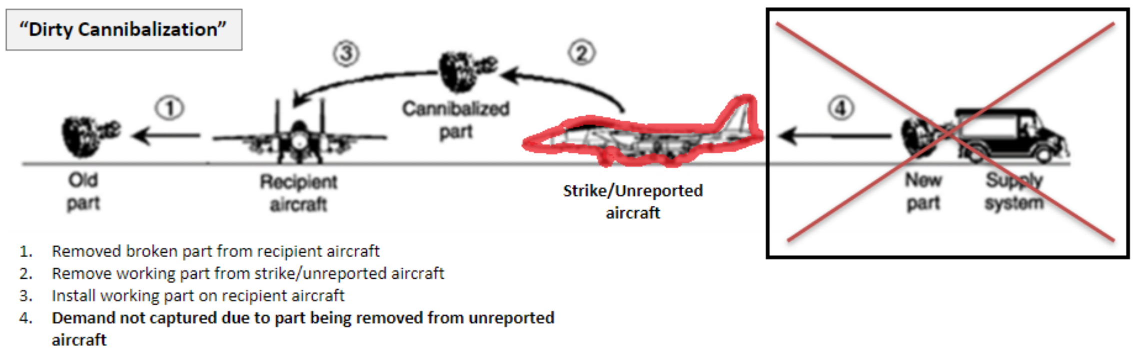

Figure 8. Cannibalization of Repairable Parts from Stricken Aircraft. Source: GAO (2001).

VI. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This Chapter provides conclusions and recommendations as a result of the analysis and examination conducted in this project. The research looked at the causes of unreported DHAs to NAVSUP-WSS, examined current policy for submitting DHAs, and cannibalization actions. A reconciliation of repairable components issued from SARDIP and cannibalization actions against NAVSUP-WSS recorded demand was conducted to determine fidelity of demand signal being reported.

A. FUTURE IMPLICATIONS OF UNREPORTED DHAS

This research found that only 11% of SARDIP issues and approximately 25% of cannibalizations analyzed were captured in the demand data provided by NAVSUP-WSS. This finding in combination with the lack of policy supports the claim that there is a systemic issue in accurately reporting DHAs in instances where required.

By not receiving accurate demand signal, NAVSUP-WSS is not able to make reliable plans for future requirements. If the numbers are not accurate, or worse indicate (0) demand, those contracts will either fall under termination, or simply expire without a replacement. The long-term implication of this course of action at a minimum necessitates the development of a new contract for those specific components. This process may take up to 1–2 years before full implemented, and parts are entering the system again. In a worst-case scenario, the manufacturers(s) for these components also stops producing them. Restarting manufacture of some components simply may not be profitable, and therefore there is no source for these components from new. Further meaning, components must be repaired or otherwise harvested from another aircraft in service. In addition, demand variability leads to inefficient use of resources such as plant capacity and under-budgeting for required expenditures. Supply planners at NAVSUP-WSS heavily rely on accurate and steady demand signal to establish future repair and spare contracts. In order to meet readiness goals, NAVSUP-WSS conducts extensive planning to allocate limited organic and commercial capacity in effort to prime repair and production pipelines with the right mix and quantities of repairable parts. Increased variability in demand affects the ability to maximize capacity planning. Although changes can be made to capacity, it requires time to lay in the right tooling and bit piece parts to ensure the change in capacity is able to support the new output of repairable parts. Meanwhile, backorders continue to accumulate, and readiness is negatively impacted.

The divestment period of the F/A-18 hornet causes increased demand variability as the F/A-18 active aircraft inventory is reduced. Procurement of parts outside of normal supply channels, such as SARDIP issues and "dirty cannibalizations" further exacerbate demand variability. The researchers believe demand variability will continue to rise given the increase in aggregate sum of demand over time as discussed in the analysis chapter. In addition, the upward trend of SARDIP issues coupled with the rising population of stricken aircraft continues to increase, resulting in more "dirty cannibalizations." Accuracy of real demand for F/A-18 components become distorted through unreported demand, as a result of these "dirty cannibalizations" and missing DHAs. Under these conditions unreported demand created a scenario where demand data used within forecasting models does not fully capture the real demand signal. The disparity between observed and real demand created by unreported demand leads to uncertainty and ambiguity, two major contributors of demand variability.

Adequate funding is a major contributor to ensuring a program's ability to meet its required readiness goals. Demand planning is an important contributor in determining a program's required funding for upcoming years. Not having an accurate demand signal can lead to miscalculating future funding requirements for repair and spare contracts which can lead to an underfunded scenario impacting NAVSUP-WSS' ability to provide adequate supply support. It is important to note that this research looks at one specific TMS aircraft. The assumption is made that lack of DHA reporting exists across all TMS aircraft within the Navy and Marine Corps inventory. This would have a multiplicative effect on the scope in which aircraft programs are budgeting below actual needs for the out years.

Currently, there is little issue because part availability is abundant as suggested by declining cannibalization and increase in SARDIP issues. As inventory strike aircraft start to taper off, Legacy hornets have the potential to start experiencing readiness issues as the effects of inaccurate demand signal over the last few years begin to catch up in the form of part shortage available in the supply system. At which point, repair and spare production lines will be cold or operating at a reduced capacity and NAVSUP-WSS will be a lead time away from being able to support the warfighter.

The long-term implications, with continued trends, is that identified demand requirements will actually be short of the true requirements; especially as this airframe continues to age and has less parts availability through stricken aircraft. Both SARDIP and cannibalizations are currently providing a portion of the required demand for the aircraft and will continue to do so as long as there are aircraft available. However, the demand associated with these actions is not accurately captured and tracked over time, it will mean the forecasted amounts will fall short of actual requirements and pose a threat to operational availability. Taking this a step further means there are also potential implications to the supporting supply chain, and contracting efforts, in that they may no longer stock or have contracts in place for requisition of needed repair components. Coupled with this outcome is the associated funding requirements; essentially by missing portions of the demand requirement, there are also correlated funding amounts missing from the total annual requirements for repairs and operations. In short, the program office, and services may not be asking for enough money to support this aircraft in the future because the demand in underreported due to parts fulfillment from within the system itself, and without proper documentation.

The F/A-18 serves as a valuable aircraft platform to study due to its lengthy time in service, mature supporting supply network, and ample quantities of historical data. Identifying anomalies and trends during the current divestment process for such a program allows for continued and effective support of the F/A-18 over the remainder of its service life without undue reductions in aircraft availability. Additionally, the lessons learned under this aircraft enhance future planners' abilities to thoroughly address the potential for similar occurrences during divestment and replacement practices of future aircraft systems.

The following recommendations address communication between NAVSUP-WSS and ASD's, the visibility of available component inventories, and the standardization of information input within NALCOMIS.

First, it is vital to maintain a good working relationship between NAVSUP-WSS and ASDs. Current lines of communication include standard email correspondence and phone conversations. The nature of these informal means of communication lead to gaps in information sharing and are amplified due to competing priorities associated with other billet responsibilities. Improvements to communication methods can be established by documenting meeting minutes, compiling meeting summaries, and executing face-to-face or teleconferences on a quarterly basis vice semi-annually. A good working relationship between NAVSUP-WSS and the ASD promotes communication that allows NAVSUP-WSS to stay abreast of potential demand spikes due to upcoming deployments or other unforeseen maintenance actions such as the incorporation of technical directives. A good working relationship also makes ASDs more likely to understand the importance of accurate demand reporting making them more likely to cooperate with processing DHAs.

Improving demand signal from SAIC can be accomplished by implementing improved inventory technologies. The researchers recommend SAIC Update their inventory software to improve demand accuracy. The intent of this recommendation is to ensure inventory accuracy and data integrity of F/A-18 parts being managed by SAIC's SARDIP contract. Additionally, Navy and Marine Corps units should be given access to the inventory software used by SAIC to allow real time visibility on available inventory instead of relying on excel spreadsheets published monthly.

Improving trends and root causes of maintenance actions can be accomplished by updating the NALCOMIS maintenance database. The researchers recommend adding document number fields within NALCOMIS. This update would require maintainers to add associated document numbers when processing cannibalizations and other maintenance actions. The addition of a document number field within NALCOMIS would enable supply and maintenance data analyst the ability to better identify trends or root causes that allow more informed decision making.

B. CURRENT DHA POLICY

The research found that current policy does not state the requirement to submit DHAs for repairable components. Additionally, current policy does not provide step-by-step instructions for submitting a DHA. Lastly, requirement to submit DHAs is not found on the inspection checklist for functional assessment of ASDs.

The ASDTP serves as the basis for ASDs to conduct the required day to day activities to adequately support aviation squadrons and to contribute towards effective and efficient supply chain operations along the various levels of supply. Policy serves as a guideline that sets the standard and as a forcing function for Marines to adhere to the requirements within the policy in order to meet the intent set forth by HQMC.

Change policy within MCO 4400.177H (ASDTP) to explicitly require the submission of DHAs for both repairable and consumable components. As the order that establishes policy, authority, and responsibilities pertaining to aviation supply operations within the ASD, it should be written to include the requirement to process DHAs for repairable material acquired outside of normal supply channels to adequately capture demand.

In addition, the ASDTP should provide step-by-step instructions for processing DHAs within the ASDTP. Navigating the process for submitting a DHA can be confusing and not following through correctly can lead to the demand signal not being transmitted to NAVSUP-WSS. Some ASDs have local standard operating procedures (SOP) that provide step-by-step instructions for submitting DHAs. Although helpful, local SOPs do not ensure DHAs are being properly submitted at all levels. For that reason, the ASDTP should include instructions on submitting DHAs which establishes a standardized way of submitting DHAs across all ASDs and promotes a unilateral technical understanding amongst the aviation supply community.

As a forcing function for ASDs, DHA processing requirements should be listed in the inspection checklist. Aviation Supply Marines are accustomed to following policy set forth within the ASDTP and ready to stand an inspection on their ability adhere to policy. Having DHA processing listed as an inspection item would serve as a forcing function for ASDs to ensure the process is being done correctly. The fact that inspections are conducted by the corresponding MAW's WASMAT team, serves as a checks and balance function, and allows the opportunity for training to occur if the process is not being done correctly.

Cannibalization policy should require identification of components sourced from stricken aircraft. Cannibalized components from stricken aircraft should first be documented at the squadron level within NALCOMIS. Before a cannibalization Maintenance Action Form (MAF) can be validated and signed-off as completed within NALCOMIS, there should be a mechanism within the MAF the identifies the component as being sourced from a stricken or unreported aircraft, triggering the required action of creating a DHA. Once the associated DHA is created it would then make the MAF valid, allowing the unit to sign-off the MAF as completed. Cannibalizations that have sourced components from stricken or unreported aircraft, that do not have an associated DHA created will cause a MAF to be invalid, resulting in a MAF that cannot be signed-off until the DHA is created. The forcing function within NALCOMIS would ensure DHAs are being created and demand is being captured.

C. LIMITATIONS OF DATA

- The data collected and analyzed from DECKPLATE rely on the units'/squadrons' ability to accurately document maintenance actions. When maintenance actions are improperly recorded or not recorded, those actions are not captured. The data analyzed is only as good as the inputs provided by units/squadrons conducting the maintenance actions.

- The research is limited by the inability to capture unreported demand from components harvested directly from strike aircraft without recording the cannibalization action also referred to as a "dirty cannibalization."

- A back-shop repair is the process in which a repairable component cannot be sourced from the supply system and is inducted for repair at the Intermediate Level. This process does not capture demand. The project did not analyze Intermediate Level maintenance data to assess the impact of back-shop repairs on demand reporting.

- The project uses a five-year period of demand data from NAVSUP-WSS to reconcile SARDIP issues and cannibalizations. The possibility exists that demand was captured at some point before or after the five-year observation period.

- The participants of this project did not have access to the NAVSUP-WSS forecasting models. Having access to the forecasting model would have enabled the researchers to analyze the quantitative implications of unreported demand on future forecasts.

D. RECOMMENDATIONS FOR FUTURE RESEARCH

This project only looks at repairable components, it is recommended that similar analysis be conducted on consumable components by analyzing DLA demand data. In addition, back-shop repairs should be researched by conducting analysis of Intermediate Level maintenance data. Conducting research on consumable components and back-shop repairs would provide a more in-depth view of future implications of unreported demand and the associated effects it has on the supply chain, forecasting, and related costs.

The researchers utilized the F/A-18 as the testbed to explore the effects and causes of unreported demand, it is recommended that future studies expand beyond the F/A-18 platform, to include all Navy and Marine Corps aircraft. This would potentially identify systemic issues across the entire Naval Aviation Enterprise.

Additionally, forecasting models are an important tool utilized in predicting future demand. The researchers recommended that an analysis be conducted into the current forecasting models for repairable components to identify inefficiencies. An analysis of the current forecasting model can be utilized to measure the readiness impact of unreported demand by modeling demand to include the identified unreported demand within this project.

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