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THESIS

**POTENTIAL APPLICABILITY OF
JUST-IN-TIME INVENTORY
MANAGEMENT WITHIN THE NAVY**

by

Rebeca M. Giacoman

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Thesis Co-Advisors: Paul J. Fields
Donald Eaton

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There is growing concern over inventory management policies within the Navy as well as questions as to how to improve supply management efficiency. Just-in-time is an inventory management system that has enabled private industries to reduce inventories and waste to become more efficient and profitable. The primary focus of this study is to determine the potential for JIT application within the Navy based on certain criteria necessary for a successful JIT system. Navy organizations are categorized and certain aspects of their resupply functions are analyzed to determine the appropriate inventory management system. A comparison is made of the Navy inventory management system to the elements of a JIT resupply system. An assessment is made to determine eligibility of Navy operations for a JIT inventory management system. Finally, a case study of Naval Aviation Depot North Island, an organization that exhibits potential for JIT, is examined for the specific conditions necessary to permit a JIT resupply system. The study of the NADEP reveals a viable potential for a JIT system within the component repair function. Further research involving review of the current inventory management procedures for the NADEP is recommended.

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POTENTIAL APPLICABILITY OF JUST-IN-TIME INVENTORY MANAGEMENT WITHIN THE NAVY

Rebeca M. Giacoman
Lieutenant, United States Navy
B.S., Troy State University, 1988

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Author: ______________________
Rebeca M. Giacoman

Approved by: ______________________
Paul J. Fields, Thesis Co-Advisor

____
Donald Eaton, Thesis Co-Advisor

____
Reuben T. Harris, Chairman
Department of Systems Management

ABSTRACT

There is growing concern over inventory management policies within the Navy as well as questions as to how to improve supply management efficiency. Just-in-time is an inventory management system that has enabled private industries to reduce inventories and waste to become more efficient and profitable. The primary focus of this study is to determine the potential for JIT application within the Navy based on certain criteria necessary for a successful JIT system. Navy organizations are categorized and certain aspects of their resupply functions are analyzed to determine the appropriate inventory management system. A comparison is made of the Navy inventory management system to the elements of a JIT resupply system. An assessment is made to determine eligibility of Navy operations for a JIT inventory management system. Finally, a case study of Naval Aviation Depot North Island, an organization that exhibits potential for JIT, is examined for the specific conditions necessary to permit a JIT resupply system. The study of the NADEP reveals a viable potential for a JIT system within the component repair function. Further research involving review of the current inventory management procedures for the NADEP is recommended.

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I. INTRODUCTION

A. RESEARCH INTENT

In today's era of force reduction and fewer resources, it is paramount that the Navy find ways to achieve greater levels of efficiency and productivity while maintaining readiness. The Just-In-Time (JIT) philosophy maintains that lower levels of inventory in conjunction with a commitment to continual improvement of quality can reduce waste and inefficiencies and improve cost effectiveness. It is unlikely that a large percentage of Navy inventories can convert to a JIT system, but there are some operations within the Navy where JIT concepts could be applicable.

This thesis examines aspects of consumer inventory characteristic of Navy organizations, categorized by mission, and compares these characteristics to those elements necessary for a JIT system. In addition, this study explores the question of whether certain operations within the Navy might lend themselves to a JIT inventory management system. Hence, those organizations whose environments that might be suited for a JIT system will be examined further in an attempt to demonstrate the applicability and benefit of a JIT system. The intent of this research is to present the JIT management philosophy and demonstrate its potential for certain organizations such as a specialized industrial based activity like the Naval Aviation Depot (NADEP).

The industrial managers interviewed at the NADEP, North Island agreed that there are certain industrial conditions which must be present in order for a JIT system to be successful. All of these managers decisively stated that not all of the conditions necessary for a JIT system exist in certain areas of the operation. However, these program managers do believe there are some production functions within the NADEP industry that lend themselves to a JIT system. Therefore, this study attempts to identify and define the circumstances through which JIT principles may be applicable in a military industrial environment.

B. BACKGROUND

As the Department of Defense continues to face force and budget reduction, the Navy is tasked with exploring opportunities that could provide maximum supportability subject to resource constraints. One area of opportunity available to the Navy in becoming more efficient is through re-evaluating and streamlining some of its inventory management with respect to production practices currently supporting fleet activities. Inventory management in the military is an expensive part of military logistics required to sustain operations and it has a direct impact on mission success.

The Department of Defense and the Navy have sought ways to reduce inventories and save costs without sacrificing readiness, such as with the CV Aviation Consolidated Allowance List (AVCAL) restoration program and Readiness Based Sparing. While these initiatives were successful with inventory reduction and readiness sustainability, their focus was to support organizations directly involved with mission oriented operations. However, not all organizations within the Navy require the same inventory management programs developed for sea-faring missions. There are other organizations within the Navy, indirectly supporting fleet operations, like industrial-based activities (shipyards, NADEPs, etc...) which are production driven activities that possess the conditions applicable to a JIT system. These industrial-based shore activities continue to incorporate traditional inventory management systems designed for mission oriented organizations even though other inventory management practices could be incorporated that might improve efficiency.

In private industry, initiatives have been undertaken to increase efficiency, productivity and profitability with the implementation of an inventory management system know as Just-in-time. JIT has already proven, in private industry, that its use reduces holding costs, improves product quality and increases efficiency. Certain organizations within the Navy have the opportunity to promote greater efficiency and economy in material logistics operation by implementing a JIT inventory management system, similar to that successfully used by many commercial industries.

C. SCOPE OF THESIS

The study is be divided into two major parts. First, evaluation of inventory management practices utilized at various levels within the Supply system are developed as well as key factors required for success in support of fleet activities.

Second, the research focuses on factors measuring JIT applicability, determines which Navy organizations might benefit from JIT implementation, and, provides corresponding recommendations to increase efficiency in supply management at a typical NADEP industrial facility. However, a cost/benefit analysis of the proposed recommendations is not provided.

D. METHODOLOGY

First, information regarding JIT concepts and applications to production organizations was obtained through published literature and case studies. A thorough review of the information concerning inventory management programs within the Navy, through published service instructions, and records was examined. The purpose of this review was to determine the elements required and characteristic of current inventory programs with regard to effectiveness in the supportability of operations within the Navy. Furthermore, a heuristic model was developed to compare conditions and elements of current inventories, at a macro level, to those elements of a JIT system to determine the organizations with the best potential for JIT.

Once the applicability of a JIT system was narrowed down to certain organizations, the focus of the research turned to one industrial-based repair organization and the inventory system used to support it. An on-site visit to the Naval Aviation Depot, North Island was conducted to observe operations and to interview key personnel. The depot's supply management support, Fleet Industrial Center (FISC), was the key source of data used for this research. Sample data was collected regarding forecasted demands, resupply sources available in support of the NADEP's production schedule, and the resupply logistic structure. Finally, elements of a JIT system were applied to the management of the hydraulic and avionic component section and analyzed to determine the extent to which JIT can be applied.

E. ORGANIZATION

There are five remaining chapters. Chapter II describes the key concepts of the Just-in-Time management philosophy. Specifically, the questions explored are the goals and major principles of JIT inventory management and the benefits of a JIT inventory management system. Chapter III examines current Navy Inventories by breaking them down into categories on a macro level, and identifies the value these inventories provide to the end user. Chapter IV looks at the macro-classification of Navy and JIT Inventories, describing their elements and the conditions needed to support certain organizations. The focus of this chapter is to determine the organizations best suited for JIT inventory management. A heuristic model compares the Navy's inventory management system to a JIT inventory management. Chapter V describes: (1) the current organization of the NADEP North Island, and (2) the elements of this organization's supply support function. It contains a description and analysis of a potential application of a JIT system. Chapter VI contains a summary of the thesis, conclusions and recommendations.

II. JIT PHILOSOPHY

A. INTRODUCTION

Just-in-time represents a philosophy of continual improvement to obtain performance excellence in the operations of an inventory system. This management philosophy is primarily applied in manufacturing companies but there is no reason why similar concepts could not be applied in other environments as well. One of the principle tenets of JIT is to have all goods and materials in work, or being processed in some manner, rather than sitting on shelves or residing in work-in-process queues. Material that is stored in inventory accumulates costs rather than value and is, therefore, an example of the waste that JIT seeks to minimize.

This chapter examines a brief history of the JIT philosophy and how it has been applied in the manufacturing industry. The major principles of the JIT philosophy are also identified. The intent of this research is to identify the various Navy organizations that might exhibit potential for a JIT system. Intuitively, the industrial organizations of the Navy exhibit greater potential for JIT applicability and, therefore, this research addresses how JIT techniques may be adapted or modified for applicability to a military industrial facility. The goal for both manufacturing and military industrial operations is the same: to eliminate wasteful activities and improve the quality of the product.

B. HISTORY

The productivity of American industry dominated the world after World War II, but, there is no question that today our manufacturing industries face tough competition from overseas. In particular, Japan has gained a competitive edge in manufacturing quality products through the adaption of innovative management strategies. The Japanese have sought new processes "to reduce waste in operations while increasing quality." [Ref. 1:p.7]

Recognizing their resource limitations and the need to survive economically, Japanese industrialists realized that they had to concentrate on the export business. However, to compete in their export market, the stigma of poor quality associated with "made in Japan" had to be overcome. In searching for solutions, the Japanese turned to an American, Dr. W. Edward Deming. Dr. Deming's ideas about improving quality and hence the products' overall value gained wide acceptance. Dr. Deming and others taught the Japanese principles of quality management in the late 1940s and 1950s, which were was instrumental in the development of their JIT philosophy.

The term "Just-in-time" describes a manufacturing philosophy in which the right amount of raw materials arrive to a designated place at the exact time to meet demand. Even though the Japanese are widely credited with developing the JIT philosophy, the original application of JIT started with Henry Ford [Ref. 3, p.9]. Henry Ford developed JIT techniques for discrete goods manufacturing, specifically automobiles, at his Highland Park factory in 1914 and later at his River Rouge factory in 1921. The Model T cars were able to be produced in a four-day production cycle at the River Rouge plant. The production cycle began with the processing of iron ore into steel at the steel mill located on the plant site and finished with a Model T rolling off the assembly line.

Today's version of JIT was developed in Japan beginning in 1949 and continues to be refined today. The most notable JIT developments began with Taiici Ohno and the Toyota Motor Company in the 1960's and early 1970's. Toyota's inventory control system was the first large-scale application of JIT.

Another Toyota innovation is the "kanban" system. A Kanban (card) is a system to signal for more material as it is needed. While, the terms JIT and kanban are often used interchangeably, there is a difference. Kanban is a production control method used to support JIT which is a production philosophy. [Ref 4/5:p. 3, 17] The roots of the Kanban system stemmed from Taiichi Ohno's development of a pull inventory system for manufacturing assembly lines.

The pull inventory system Ohno incorporated into the Toyota Motor company's management strategy resulted from his study of the American supermarket operations. Ohno's observation of the supermarket business was that items, especially perishable ones, were replenished as quickly as customers drew them from the shelves. Recognizing that if replenishment did not match demand, either inventory would accumulate or stockouts would occur. Inventory accumulation resulted in increased holding costs and product degradation while stockouts resulted in disgruntled customers and/or lost sales.

He realized that the supermarkets had a superior ability to coordinate the supply and demand of a plethora of items. He also realized that the turnover of items and the timing of orders were managed efficiently since holding costs were minimal. Ohno was able to translate the "supermarket solution" into a management concept which he incorporated into the manufacturing assembly lines at the Toyota plant. Essentially, the system was designed to precisely meet customer demand with a minimum of delay and with the pace of work determined by the last worker in the production line. [Ref. 1/6: p.9/15]

C. APPLICATION IN INDUSTRY

The pull inventory system characteristic of Ohno's management system contrasted with the push inventory management system traditionally used in American industry. Under the pull system, material flows into a "downstream" unit having been pulled from an "upstream" unit only as needed. Hence, the "upstream" unit does not produce parts necessary for the production process unless a requirement is generated from a "downstream" unit. The throughput of the manufacturing process is, thus, based on the capacity of the last unit, whose capacity is determined by the customer demand for the product. Therefore, subassemblies are produced "just-in-time" within the manufacturing process and the final products are produced "just-in-time" to meet demand.

On the other hand, the push inventory system is characterized by the "upstream" units continually processing parts without respect to demand and pushing them to the "downstream" units for further processing. If a "downstream" unit does not have sufficient capacity to process all of the material it receives, then WIP inventory accumulates which remains idle and unnecessarily incurs holding costs. An unnecessary cost is waste.

[Ref. 7:p. 556] Excess inventories help hide problems in the process such as poor quality. With excess inventories, the worker has ample buffer stock to replace a defective subassembly with another or ignore defects altogether. Hence, the quality of the product decreases and defects can remain hidden during the entire manufacturing process and may not be discovered until final inspection or customer receipt. As a result, additional waste is incurred as items are discarded, reworked and/or customer orders are delayed and sales lost. Therefore, excess inventory goes against the objective of JIT to improve quality and eliminate waste. [Ref.6/8:p 16-17, 37-38]

D. MAJOR PRINCIPLES

A JIT principle states: "The smaller the lot size, the better." Reducing manufacturing lot size reduces the amount of in-plant inventory, both awaiting processing and work-in-process. As a result, inventory reduction allows increased visibility of process or parts quality problems and forces timely solutions to those problems. Under the JIT system, continual quality improvement becomes an important objective.

The degree of success of JIT depends on the existence of several factors and conditions: corporate commitment to quality, efficiency of production, employee involvement, supplier responsiveness, transportation responsiveness, and accuracy of requirements determination and production planning. Of course, these are not the only factors but the most influential and relevant to the Navy's ability to employ such a concept. [Ref. 9:p. 1]

Basic to a complete understanding of JIT is the philosophy of "value added", the increase in value of a component or product as defined by the end user or customer. Hence, from the customer's perspective, nothing should be done which does not add value to the final product. A manufacturer can then avoid waste by avoiding those actions that do not add value.

Toyota identifies "seven wastes" to be avoided: overproduction, waiting time, transportation, processing, inventory, motion, and product defects. [Ref. 10: p.1-10]

E. ELEMENTS OF JIT

Four value-adding elements basic to the JIT philosophy and applicable in a military environment are: suppliers, quality, quantity, and logistics.

1. Suppliers

The customer-supplier relationship is a primary area of focus in a JIT program. Traditionally, suppliers were thought of and treated as adversaries and so safety stock levels were built based on the belief that manufacturers needed insurance against poor performance by suppliers. JIT requires that users strive to develop trusting and shared partnerships with their suppliers. Vendors must become part of the team and share in the goal for total quality control, delivering zero defect parts, frequently and on time to eliminate wasteful in-house safety stock. Suppliers must be flexible and have the capability to make and deliver parts as necessary. Part of the supplier selection process involves establishing a dual sourcing network. Suppliers must be innovative and have the technology and expertise to assist in problem solving.

2. Quality

Another vital element of JIT is the assurance of quality in every part. Total quality control requires that all incoming parts be defect-free. Suppliers should inspect at the source in keeping with defect free delivery. This eliminates the necessity for inspections upon delivery which are costly, redundant, increase lead times, cause accumulation of inventory in delivery areas of the plant, and add no value. The emphasis is to shift from a store-room operation to a front-line operation. The goal of defect-free parts requires building quality into the process and ultimately into the final product. Improving product quality also eliminates the need for incoming inspection which increases turn-around and delivery times as well as manpower efforts and associated costs.

3. Quantity

The major premise behind JIT is that inventory levels will be as low as practical to meet the production schedule. The objective is to eliminate waste in both time and materials through the reduction of inventories. [Ref. 11: p. 1-2] The traditional purchasing and procurement of materials system relies on the "just-in-case there is a disruption in supply" concept of large batch quantities that often results in lower quality of goods and greater cost. Large lot purchases rather than small quantities are also used because shipping and handling costs are considered constant, regardless of lot size. Part of the justification for these large quantity purchases is the perceived cost savings associated with lower shipping and handling costs discounted for size.

JIT purchasing practices, however, emphasize the purchase of minimum lot sizes allowing for tighter control over inventory and eliminating large stockpiles of parts. Under the JIT system, the improved product quality, decrease in holing costs, and increase in customer responsiveness and sales far outweigh the cost savings associated with large quantity discount rates. [Ref. 12:p. 29]

4. Logistics

All activities related to product flow and movement of material from vendors to the factory, through the factory, and on to the customer are known as industrial logistics.

Inventory levels, efficient factory operations and customer-delivery performance are the by-products of industrial logistics. Under JIT, the goal is to establish efficient logistics which will ensure that frequent, low-quantity, high-quality supplies are delivered by vendors and shipped directly to the production line. [Ref. 11:p. 2]

One factor often overlooked in the supply logistical area is packaging specification and handling. Better packaging and precise listing of product content not only reduces manpower requirements but also affect the entire chain of customers within the process, distributor and transportation departments. Therefore, the purchasing agents should be concerned with not only the flow of materials into the plant and finished products out of the plant, but also with product specification packaging and handling. These issues can be quite complex and costly. Packaging improvements may consist of such a small thing as specifying smaller containers to permit one-person handling or to prevent losses due to opened, partially emptied containers, which can result in loss, deterioration, contamination and delays. In a JIT system, standard containers are provided in small, reusable packaging with only the precise quantity (no overage or underage) of part types and numbers required. The advantages of this packaging approach include precise specification of parts on the containers, easy accurate count of parts, reduction of packaging costs, and reduction of waste. [Ref. 12:p. 37-38]

F. BENEFITS OF JIT

The major benefits of JIT are lower production costs, higher rates of productivity, better quality products, and on-time delivery of finished goods. According to the National Academy of Engineering, by 1980 the Japanese had lowered costs and improved product quality in more manufacturing industries than their U.S counterparts as a result of JIT management practices. The benefits are derived through cooperative relationships between buyers and suppliers creating an environment in which they share business strategies and the common goals of achieving high product quality, productivity and profitability. The Japanese' primary objective and that of JIT is to make the product right the first time in the needed quantity at the necessary time. This reduces the amount of effort and resources required and eliminates the accumulation of wasteful inventories which results in efficient allocation of resources and reduction of costs. [Ref. 12:p. 40]

III. NAVY INVENTORY MANAGEMENT

A. INTRODUCTION

The U.S. Navy Supply System is a complex organization responsible for the material management and distribution of a plethora of components, parts, and equipment that is ever changing in type and quantity needed for supporting the stationing of American forces in every hemisphere of the earth. The Navy and the Department of Defense (DOD) own a large number of submarines, surface ships, aircraft, missiles, weapons, wheeled vehicles and other items of equipment and property that can be repaired. These systems and platforms are the tools essential to the mission readiness of the military units whose supportability and sustainablity depend invariably on the capability these tools provide. Hence, these units and the supporting buildings and other structures must be maintained, a task which requires appropriate stocks of repair and spare parts, tools and construction material to be made available.

Inventory management must, then, provide the right material in a timely manner to approximately 700,000 military and 360,000 civilian personnel working for the Navy. In 1990, the Navy directly managed some 740,000 line items of material, a value of $35.2 billion which represents consumption of 50 to 65% of the Navy's total budget. Additionally, the Navy requisitioned and/or stocked approximately 1,820,000 line items for other departments and agencies of the U.S. Government which are stocked and managed by Navy supply organizations in inventories located throughout the world. Thus, the supply support provided by these inventories has been recognized as a "key contributor to the operational readiness of Naval forces. [Ref. 13:p. 2]

Efficient and cost effective inventory management significantly affects the ability of Naval combat forces to successfully accomplish their missions. The underlying purpose and focus of the supply system is not just to provide items of supply but to keep fleet weapons systems operating. To understand the Navy supply and material management programs the remainder of this chapter examines the categories and elements of supply operations with respect to Navy Inventory, on a macro level, and the various levels and purposes of these inventories with respect to the end user.

B. CATEGORIES AND ELEMENTS OF SUPPLY OPERATIONS

The segment of military logistics by which direction and control of all phases of supply operations are exercised is known as supply management. An overview of the supply management function can be gained by considering the general supply operation responsibilities and categories of the material managed.

1. General Supply Operation responsibilities

The following is a list of certain key elements and responsibilities of Supply Operations and a brief definition:

Cataloging - The collection, storage and publication of all technical information regarding equipment and parts support for the Navy.

Identification - Properly identifying systems, equipment and spare parts as they become Navy property.

Standardization - The effort to procure standardized weapons systems for the Navy without compromising readiness.

Requirements determination - Determining when and how much of each spare part to procure.

Procurement - The act of purchasing material and equipment.

Inspection/Quality Control - Ensuring the accuracy of Navy stock inventories and validating that procured material meets the highest standards for use.

Storage- Ensuring the safe stowage of material prior to use by the customer.

Distribution - The location of Navy material so that it is available for customer use when required.

Disposal - The proper removal from the Navy's inventories of an item of stock at the end of its useful service life.

Repair Management - Arranging for the rebuild and restoration of economically repairable material.

Transportation - Proper shipment of material to customers, repair activities, and inventories.

War reserve planning - Participating in mobilization planning, industrial readiness planning and item management classification.

The purpose of introducing these elements of supply operations is to provide insight into, not only the support responsibilities of these function, but to relate how a JIT system may or may not be applicable within certain organizations. [Ref. 13:p. 4]

2. Categories of Materials Managed

The materials that are managed and supported for Navy use are categorized as either principal items or secondary items. A principal item is defined as a "final combination of end products, component parts, and/or materials which is ready for its intended use." Examples of principal items are ships, tanks, mobile machine shops, and aircraft.

Principal items are specifically designated by the Chief of Naval Operations (CNO) as principal items and are characterized by the following:

*Requirements for the items are determined on a planned basis by the cognizant hardware systems command with the exception of the Naval Supply Systems Command (NAVSUP). The key hardware systems commands (HSCs) are the Naval Sea Systems (NAVSEA), Naval Air Systems (NAVAIR), Naval Facilities Engineering (NAVFAC), Naval Space and Warfare Systems (SPAWARS), and Naval Supply Systems (NAVSUP).

* Requirements for the items are based solely on planned end-use allowances and planned reserve/retention requirements.

* Disposal of the items is based on major or total destruction, intended destructive use, (for example, the Trident missile), or planned retirement (aircraft).

* Issues to end-users are strictly limited to approved authorizations from the hardware systems command which manages principal items.

Secondary items are items that are not classified as principal items and include a majority of consumables, repair parts, and repairable items. Examples of these are gaskets, nuts and bolts, paper products, gear boxes, circuit boards and electronic "black boxes". The management of these items is characterized by the following:

* Requirements for the items are determined by the cognizant inventory control point (ICP). An ICP is an activity having wholesale inventory management responsibilities for a group of items. For the Navy, those ICPs include Ships Parts Control Center (SPCC) and the Aviation Supply Office (ASO).

* Requirements for the items are based either on estimated or observed demands, or on non-demand based insurance levels.

* Disposal decisions are based on normal in-service wear-out or consumption.

To effectively manage both categories of material, the supply system incorporates its knowledge of the customers' technical requirements into lists known as the Allowance Parts Lists (APLs). An APL is a tailored listing of the required repair or spare parts each customer needs to carry locally. The APLs for a particular ship are combined into a Coordinated Shipboard Allowance List (COSAL) or an Aviation Consolidated Allowance List (AVCAL) for each aviation system. The customers use the AVCAL and COSAL to obtain the information needed to requisition items to repair and maintain their equipment.
[Ref. 13:p. 5/6]

C. LEVELS AND PURPOSE OF NAVY INVENTORY

Navy inventories are established and maintained to support peacetime operations and to provide an adequate supply of war reserve material. During peacetime operations, the Navy maintains three levels of inventories recognized as wholesale, retail intermediate and retail consumer. This stock of material designated to meet peacetime force requirements is known as Peacetime Operating Stock and the levels of inventories are defined as follows:

1. Wholesale Inventory

Material over which the wholesale inventory manager has visibility and control at the national level. The general characteristics of wholesale inventories are:

*inventory levels are computed based on worldwide demand data;

*the material is available for unrestricted use by the wholesale item manager;

*the wholesale manager knows where the stock is located;

*the material is under the accountability of the designated ICP; and

*the material is "pushed" by the wholesale level to the retail intermediate level.

2. Retail Intermediate Inventory

A level of inventory between the consumer and wholesale levels to support a given geographic area, including area resupply and the Navy's maintenance system. Maintenance and inventory functions are closely related and are key to understanding inventory and management approaches.

The Navy uses three levels of maintenance which are known as the organizational, intermediate and depot levels of maintenance:

a. Organizational - includes those upkeep maintenance functions normally performed by an operating unit on a day-to-day basis in support of its own operations. Maintenance at this level is limited to periodic checks of equipment performance, visual inspections, cleaning of equipment, some servicing, external adjustments, and the removal and replacement of defective parts and components.

b. Intermediate - includes that upkeep maintenance which is performed by designated maintenance activities in support of organizational maintenance activities. Aviation Intermediate Maintenance Departments for Marine Air Groups of Naval Air Stations, tenders and repair ships for ships and submarines, and Shore Intermediate Maintenance Activities for non-aviation fleet units are a few examples. At this level, the maintenance functions include: repair, test, inspection, modification and check of equipment; calibration; manufacture of some parts; and accomplishment of certain periodic inspections. End items may be repaired by the removal and replacement of major modules, assemblies, or piece parts. Scheduled maintenance requiring equipment disassembly may also be accomplished.

c. Depot - Naval Air Depots (NADEP), Naval Shipyards, weapons stations, weapon centers and Naval Ordnance Stations. This level of maintenance is the most complex level. The depot level of maintenance includes rework maintenance performed on material/systems requiring major overhaul, rework, and update, normally beyond the capability of lower level activities. Rework maintenance includes but not limited to: standard depot level maintenance; repair/rework of components and structure frames of weapon systems; calibration of standards; modification of aircraft, engines, and related equipment; technical and engineering assistance/field teams/planning and estimating. [Ref 17:p. 8-1] [Ref. 13:p. 14] The general characteristics of intermediate inventories are:

*requirements are computed based on historical demands arising in a geographical area or from designated activities;

*the material is "pulled" from the wholesale system;

*each transaction concerning an item is reported to the wholesale level; and *the stock is not usually available to satisfy demands outside the stock point's geographical area of support.

3. Retail Consumer Inventory

This level of inventory is material held strictly for a specific unit's own use. The general characteristics of consumer inventories are:

*the materials are stocked to provide direct support associated with readiness goals;

*computations are made to set up inventories via an allowance list (COSALs and AVCALs) established to meet operational readiness goals based on specific unit endurance goals;

*the material is issued directly to the maintenance technician;

*inventories are not used to resupply another level of inventory; and

*the material is used by the activity in performing its function.

In addition to the peacetime operating stock levels of inventory, the Services are required to determine and maintain war reserve requirements as an essential part of "a credible conventional deterrent." The war reserve material includes the War Material Requirement (WMR), War Reserve Material Requirement, and Prepositioned War Reserve Material Requirement. Further discussion of this level of inventory is not relevant to this study.

[Ref. 13:p. 15/16]

A major responsibility of the Navy Supply System is the management of all parts in a principal item from the time of the Navy support date in the life cycle to final disposal of the last unit. There are several sources of supply support within the Navy's Supply System.

However, the provisioning and requirements determination responsibilities fall under the umbrella of ASO and SPCC, the major inventory control points for the Navy. Most ICP functions can be categorized into two broad areas of supply support and program support.

Supply support involves item management such as requirements determination, material distribution and procurement of replenishment stock, repairables management, and disposal. The supply support functions usually deal with supply centers, material requisitions at all levels, depot level component repair activities and program managers. Program support includes life cycle weapons support (most of the logistics elements of the system), provisioning, allowance and load lists determination, determining replacement or failure rates for spare parts, and analysis of weapon system performance. [Ref 13:p. 25-27]

The size of the wholesale inventory supported by these functions and managed by these ICPs is over 242,000 line items, valuing approximately $6.6 billion for ASO and over 500,000 line items, valuing approximately $2.6 billion for SPCC. ASO receives 6,000 requisitions from its customers daily, while SPCC receives some 3,200. The Navy's supply system customers include U.S. naval fleet units and shore stations (shipyards, NADEPs, weapon stations, air stations, training stations, hospitals), and other Department of Defense organizations and agencies. The ICPs do not stock material at their localities, rather they are responsible for the requirements determination, material distribution and fulfillment of customers' demands for wholesale assets located worldwide at activities called stock points. [Ref. 13:p. 3-2/4]

The actual physical distribution of material is accomplished from a stock point such as the Fleet Industrial Supply Center (FISC) in North Island, California who supports the

NADEP there. The two key performance indicators for a stock point are timeliness and accountability. Their main functions include: receiving material, stowing material, issuing and shipping material, billing the customer for material, budgeting and accounting for funds to procure material, and reporting receipts and issues to each item's ICP.

Overall, the Navy Supply System is similar to operations in the private sector in that it provides goods and services to a variety of customers. One of its primary objectives is attaining and keeping customers satisfied, which translates to enhanced combat readiness of our national defense forces. In order to accomplish this objective, the Supply System must strive to maintain the proper mix of items in inventory at all echelons of supply.

IV. MACRO CLASSIFICATION OF NAVY/JIT INVENTORIES

A. INTRODUCTION

The operating forces of the Navy are charged with supporting national policy under all conditions, ranging from peacetime through unlimited armed conflict. For this reason, the Navy Supply System is designed with sufficient flexibility to function in support of the operating forces under any conditions existing at any given time. From a macro perspective, the organizations supported by the Navy Supply System are broken down into Ashore and Afloat units. In general, ships or afloat units, are loaded with sufficient supplies to assure a prescribed period of self- sufficiency and to permit maximum retaliation when necessary. Shore bases are used to supply the operating forces as circumstances require. [Ref. 14:p. 1-20]

There are certain conditions that exist specific to Navy facilities categorized as either an afloat or ashore unit which lend themselves to various resupply functions based on their mission. This chapter examines the categories of typical fleet organizations at the consumer level, ashore and afloat; describes the resupply methodologies for each; and makes a comparison of the conditions for the various Navy inventory management systems to the elements of a JIT resupply system. A heuristic model of the Navy's resupply system compared to a JIT system is analyzed to determine the potential for JIT applicability in certain Navy organizations.

B. CATEGORIES OF FLEET ORGANIZATIONS

Normally, consumer level activities (afloat and ashore) will stock demand-based material based on requisitions received from supported customers such as (1) afloat customers comprised of surface ships, aviation units, and submarines; and, (2) ashore customers comprised of Naval stations, Naval aviation depots, and Shipyards. For the purposes of this study, fleet support is described through the "organic level of supply" comprised of a first and second echelon of resupply. For resupply purposes, the first echelon of resupply is material positioned in ships of the Combat Logistic Forces (CLF) in support of the other operating ships in a battle group scenario. The CLF includes the following ship types: Combat stores ship (AFS/T-AFS), Stores ship (T-AF), Oiler (AO/T-AO), Replenishment oiler (AOR), Fast combat support ship (AOE), Ammunition ship (AE), Repair ship (AR), and Destroyer tender (AD). Aviation peculiar material is, however, not provided from the first echelon of resupply, but provided for by the aviation contingency (AVCAL) aboard aircraft carriers. The second echelon of resupply is material stocked at ashore activities for resupplying the operating forces. [Ref 14:p. 1-21]

The consumer level of supply maintains inventory of required material for its customers as described by the following:

1. Afloat Activities:

Organic maintenance aboard surface combatants are supported from the ship's Coordinated Shipboard Allowance List (COSAL). Intermediate maintenance is accomplished aboard the tender which is part of the CLF and carries a consumer level of inventory known as the Tender and Repair Ship Load List (TARSLL). Additionally, the aircraft carrier has a consumer level of inventory depicted by its Aviation Consolidated Allowance List (AVCAL) for aviation peculiar material and a COSAL specifically for the ship's support.

2. Ashore Activities:

A Coordinated Shore Based Allowance List (COSBAL) provides a consolidated listing of components, repair parts, and consumable items tailored to the requirements of shore activities to support organizational level maintenance for authorized equipments. The Selected Restricted Availability Stock List (SRASL), a consumer level inventory, consists of material determined specifically to support the planned maintenance mission of industrial activities performing depot level maintenance. The Shore Intermediate Maintenance Stock List (SIMSL), consists of material tailored to support the corrective and planned maintenance missions of a Shore Intermediate Maintenance Activities (shipyard), or a U.S. Naval Ship Repair Facility overseas. A Shore Based Consolidated Allowance List (SHORCAL) is a requirements package identifying consumable items and fixed allowance requirements for depot and field level repairable items required to support planned operational and maintenance missions at designated Naval and Marine Corps Air stations. In turn, intermediate levels of inventory are positioned in a geographic area for resupply of all eligible consumer levels [Ref.16:p. 4]. Recently, the Navy Supply Command has determined that Intermediate level inventories are actually duplication of consumer level inventory and, therefore, will not replenish Intermediate level stock as it is consumed. The intent of the Supply Command is to eventually do away with Intermediate level stocks completely.

C. RESUPPLY METHODOLOGIES

The objective of the Navy Supply System is to provide a level of support for operating forces afloat and ashore which will ensure a readiness posture and achieve specified performance goals. Some examples of these performance goals include: supply response time goals, net availability goals, gross availability goals, and average customer wait time (ACWT). Each performance goal is defined as follows:

1. Supply Response Time

The elapsed time between when a requirement is placed with the supply department and when the requested material is received a the specified delivery point. A range of response times corresponds to criticality codes assigned to the various items associated with each mission definition.

2. Net Availability

The percent of total demands, for stocked items, received and satisfied from stock on hand at any given echelon of inventory. A net availability goal of 85% is established for every activity holding a retail level of inventory.

3. Gross Availability

The percent of total demands, for both stocked and nonstocked items, received and satisfied from stock on hand at any given echelon of inventory. A gross availability goal of 65% is established for every activity holding a retail, consumer level of inventory except for aviation ships which require a 75% gross availability goal.

4. Average Customer Wait Time

The ACWT is a primary performance measure linking supply responsiveness to operational requirements. ACWT is the collective indicator of supply system response time for all customer demands, as measured from requisition generation until receipt of the material by the customer. It represents average time required in the supply system to satisfy those demands. This performance indicator is ultimately expressed in terms of hours and depends on subsidiary performance measures such as those previously mentioned. Shortfalls in availability at one echelon of supply may be compensated for by higher availability in other echelons. The purpose of these measures of effectiveness is for the Navy to evaluate supply system performance.

The motivating force driving inventory levels at various Navy activities is the need to support deployed forces. To this end, inventory managers must consider the criticality of each item and the protection level needed for each item. It is the responsibility of inventory managers to consider the *criticality* of secondary items to the mission of the ship or aircraft the items are installed on as well as their importance to the weapon system they are a part of. There are two levels of criticality coding used in the Navy. The first is applied at the part level to denote the importance of a part to the applicable end item. If the failure of an item would render the end item inoperable, the item is assigned a Military Essentiality Code (MEC) of "1." If the failure of an item would affect personnel safety, a MEC "5" is assigned, all other items are assigned a MEC of "3." The second part of the Navy's essentiality coding system is at the equipment or system level and relates the criticality of the equipment or system to a ship or aircraft mission accomplishment. [Ref 13:p. 2-24]

Protection levels are needed to provide support and *protection* against stockout to operating forces for a given *endurance level.* Endurance levels refer to the material required for a specified period a unit is at sea, usually 90 days. Protection levels refer to the safety stock added to the endurance level requirements. Hence, determining fleet material requirements, providing fleet asset distribution, and prescribing shipboard endurance levels for the operating forces is the responsibility and fleet support policy of the Navy Supply Systems.

Computational techniques for determining stockage quantities specifically tailored to an activity for support of the maintenance and/or supply mission of that activity are known as "allowance models." There are two types of allowance models that have been developed for computing Navy activity allowance lists and they are defined as follows:

a. Fixed Protection Level

Computes allowances on the basis of a single factor (demand). This technique provides the same level of protection against stockout to all items having the same demand rate. The fixed level models referred to as the Fleet Logistic Support Improvement Program (FLSIP) and Modified FLSIP (MOD-FLSIP) are the most commonly used ship's models to compute on board inventory requirements. These models are also used to compute initial stockage requirements for most shore activities authorized at the consumer level of inventory. The goal of the FLSIP and the MOD-FLSIP models is to provide an endurance level with safety stock for all demand based items based on a predetermined constant parameter (e.g. 90%). Non-demand based or insurance[1] item range criteria depend upon the item's criticality to the ship's mission. [Ref 13:p. 2-50]

b. Variable Protection Level

Computes allowances on the basis of several factors (e.g. demand, item price and item essentiality). This technique provides a higher level of protection for more essential items having low unit prices while providing a lower level of protection for less essential, high cost items. The variable protection level models are used by Ships Parts Control Center (SPCC) for the Fleet Ballistic Missile (FBM) weapon system and Trident Submarines. [Ref 13:p. 2-51]

Inventory levels are tailored and based on the support mission of the activity holding the inventory. These levels can consist of demand based and non-demand based items. Demand based items are those items for which the decision to stock, not to stock, or continue stockage is based upon actual demands previously recorded at, or transferred to, that particular activity or location. The transfer of actual demand data is applicable when operating units are transferred from one location to another, and/or equipment is actually transferred. Non-demand based items are those items for which the decision to stock is based upon program related data or weapons system essentiality data rather than previously recorded demands.

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[1]A non-demand supported, essential, maintenance related item for which replacement is not anticipated as a result of normal usage and, for which, an unacceptable leadtime has been established. However, if failure is experienced or loss occurs through accident, abnormal equipment/system failure, or other unexpected occurrences, the excessive leadtime required to obtain a replacement would seriously degrade the operational capability of a critical facility or weapon system.

Levels of inventory for non-demand based items are usually developed and monitored by the Program Support Inventory Control Point (PSICP). The Navy Ships Parts Control Center (SPCC) and the Aviation Supply Office (ASO) are the two inventory control points for the Navy as described in chapter II. Non-demand based items can be authorized only for program support and can normally be documented on an allowance list prepared by the PSICP. AVCALs, COSALs, COSBALs, SIMSLs, SRASLs, and SHORCALs are updated at frequency intervals specified by the PSICP. All items have both a requisitioning objective (RO) and a reorder point established. [Ref 16:p. 6-7]

D. GENERAL CONDITIONS OF NAVY CONSUMER INVENTORY

The primary purpose for providing military inventories is to provide supply support to the fighting units of the fleets. The goal is to of attain a high level of operational readiness in all equipment necessary for the ship's mission. Computations are made to set up inventories via an allowance list which is established to meet operational readiness goals based on specific unit endurance goals. At times, the Navy's goal of maximizing operational readiness may be contradictory to the classic inventory management goals of minimizing costs.

Operational readiness dictates that parameters are set for determining range and depth of inventory levels for the various activities. These parameters are based on the following conditions:

(1) . ship deployments,

(2) . non-routine operations,

(3) . extraordinary circumstances, and

(4) . criticality coding.

These conditions represent an element of variability significant enough to warrant holding safety stock associated with operational tempo. The objective is to manage mission readiness in a dynamic operational environment.

As a result of operational tempo, traditional inventory management is best utilized when:

* demand is unpredictable due to variable meantime between failures and operational tempo;

* supplier changes and/or proximity of location to operation and/or geographic location of mission changes;

* stocks are in large lots and small quantities and deliveries are infrequent;

* the penalty for mission readiness is critical; and

* safety stock is essential for compensation in lead time and deployment readiness requirements.

The question explored in this research is whether there exists an organizational environment within the Navy that might benefit from a non-traditional inventory management system, such as JIT, that does not compromise readiness. Achieving effectiveness without compromising readiness in a JIT inventory management system requires an understanding of the operating elements peculiar to JIT and comparing those elements to those of the Navy's operating elements. The following sections describe general elements of a JIT system and a comparison of those elements to the Navy inventory system.

E. ELEMENTS OF A JIT RESUPPLY SYSTEM

A JIT inventory management can be applied where:

* there is limited fluctuation in supply and demand, such as in a scheduled production process;
* the supplier is geographically close, and close cooperation and communication are characteristic;
* supplies can arrive in small lots and frequent deliveries are made; and
* administrative considerations, such as contracting with suppliers, can be controlled. [Ref 18:p. 8-9]

The JIT environment operates where parts and end items arrive according to their predicted need and unanticipated requirements can be compensated for easily so as to avoid any negative impact on operations.

F. TRADITIONAL INVENTORY MANAGEMENT VS JIT

For comparison purposes, the elements of both traditional and JIT inventory management systems are grouped and addressed from the perspectives of supplier, delivery, and demand characteristics.

1. Supplier:

From the perspective of the supplier, the issues of location, administrative control and responsiveness are considered (see Table 4.1). The proximity of a supplier is one of the factors which determines type of resupply management. If a supplier is geographically close to its customer, it can provide the anticipated and unanticipated requirements with relative ease without degrading the operation. Also, close location of supplier allows the supplier to be responsive to, not only filling material requirements, but to ensuring the quality of material is provided. Hence, there needs to exist the capability of an organization to maintain administrative control and over the supply operations to ensure the needs and requirements are met. A contractual liaison assists the suppliers and organization to establish the cooperative and long-term commitment necessary for an effective resupply system. The suppliers ability to compensate for possible unanticipated requirements and defective parts is key to an organization meeting its operational mission. Therefore, those organizations that are stationary with suppliers who are geographically close and where the responsiveness and administration needs can be established and maintained might be eligible for a JIT system. Those organizations that are mobile and whose locations change frequently due to the nature of their missions have to employ the use of a traditional resupply system of carrying its consumer level inventory.

SUPPLIER

TRADITIONAL	JIT
-SUPPLIER LOCATION IS NOT CLOSE	-SUPPLIER LOCATION IS CLOSE
-ADMINISTRATIVE CONTROL IS NOT AVAILABLE	-ADMINISTRATIVE CONTROL IS AVAILABLE
-RESPONSIVENESS IS IMPAIRED DUE TO MOBILITY OF UNITS	-RESPONSIVENESS IS ENHANCED BECAUSE BECAUSE UNITS ARE STATIONARY

Table 4.1

2. Delivery:

The delivery of supplies is another criteria for determining whether a traditional or JIT inventory system might be more effective with respect to the operational environment (See Table 4.2). Deliveries of materials that can be made more frequently in smaller lot sizes can reduce the related costs of inventories and safety stock held at on-site locations. Also, the leadtime between ordering and delivery needs to be short enough as not to impact mission readiness. If frequent deliveries of small lot sizes cannot be made to an organization in time to meet its mission readiness requirements and quality of items cannot be ensured, then a traditional inventory system is more appropriate. Those organizations that are underway for a period of time and their position changes do not operate in an environment where deliveries can be made frequently in small lots. Also, leadtimes are affected by unit mobility and not knowing exactly where an afloat unit is positioned on a regular basis.

DELIVERY	
TRADITIONAL	JIT
-NON-FREQUENT DELIVERIES USED	-FREQUENT DELIVERIES ARE USED
-REQUIRES LARGE LOT SIZES	-SMALLER LOT SIZES ARE AVAILABLE
-LEADTIME IS LONGER DUE TO MOBILITY OF UNITS	-LEADTIME IS SHORTER DUE TO PROXIMITY AND RESPONSIVENESS OF SUPPLIERS

Table 4.2

3. Demand:

The degree to which demand can be anticipated based on material requirements for known operational needs will dictate the kind of inventory system most appropriate for an operation. The demand pattern can greatly differ, depending on the nature of an organization's mission for which the material manager must plan (See Table 4.3). Demand is derived from the requirements either specified in an established production schedule or forecasted when specific requirements are variable or unknown. Those operations where there are limited fluctuations in demand, as those driven by a production schedule, are more suited for a JIT system. In environments where demands are unpredictable due to variable mean-time-between failure and usage rates and a dynamic operating tempo, a traditional inventory system is appropriate.

DEMAND	
TRADITIONAL	JIT
-MISSION VARIES	-MISSION IS PREDICTABLE AND DRIVEN BY A SCHEDULE
-EQUIPMENT/COMPONENT USAGE VARIES	-EQUIPMENT/COMPONENT USAGE IS DETERMINISTIC
-DEMAND PATTERN VARIES	-DEMAND PATTERN IS DETERMINISTIC

Table 4.3

G. INVENTORY MANAGEMENT METHOD APPLICABILITY

Based on the supplier, delivery and demand criteria, the Navy's afloat and ashore activities are examined for inventory management method applicability.

1. Afloat Activities - Surface Ships and Submarines

Supplier:

*Supplier location is not close since these units deploy to sea for an extended period of time. Also, the period of deployment varies from mission to mission and can change in a moment's notice.

*Administrative control of suppliers is not available to deployed units. This involves the ability to establish strong liaisons and/or contract for services with suppliers which is facilitated by the proximity of suppliers.

*Responsiveness is impaired when suppliers are not close and control of services is limited. The mobility of deployed units prevents the ability of suppliers to be as responsive to the needs and services of these units that a JIT system requires.

Therefore, a tradition inventory management system is appropriate.

Delivery:

*Non-frequent deliveries of material are typical for afloat units since they are deployed and position changes frequently. Hence, these units carry with them inventories tailored to their mission according to their specific APLs.

*Large Lot sizes of material are provided for these units through their APLs which are designed to sustain them for a period of time, usually 90 days.

*Leadtimes of material are longer for afloat units because they are mobile and change position frequently.

Therefore, a traditional inventory management system is appropriate.

Demand:

*Mission varies for afloat units because they are the platforms available to the governing authority for protection and implementation of national security strategies and, thus, must be prepared for any contingency as it arises.

*Equipment Usage varies as mission requirements vary and, therefore, reliability and maintainability rates will vary.

*Demand varies for replacement and maintenance of equipment and components.

Therefore, a traditional inventory management system is appropriate.

2. Ashore Activities - Naval Stations/Naval Air Stations

Supplier:

*Supplier location is close in that wholesale and intermediate inventories are geographically positioned in proximity to their customers.

*Administrative control is available to these organizations through contracts with local vendors for material requirements should the Department of Defense wholesale and intermediate inventories not be able to provide certain items.

*Responsiveness of suppliers is enhanced be the fact that these organizations are stationary and providing for material can be established and maintained.

Therefore, a JIT inventory management system has potential for application.

Delivery:

*Frequent deliveries can be possible since these units are stationary and in proximity to suppliers as well as having the ability to contract with local vendors.

*Smaller lot sizes of material can be delivered since these units are close to suppliers and possess the ability to receive frequent deliveries and retain administrative control.

*Leadtime for receipt of material can be short since these units are close to suppliers and possess the ability to retain administrative control over the ordering and delivery process.

Therefore, a JIT inventory management system has potential for application.

Demand:

*Mission varies since these organization's primary mission is to support the operating units afloat. Their objective is to be prepared to respond to the needs and requirements of the deployed fleet while it operates in a very dynamic environment.

*Equipment usage varies with the ever changing missions of the operating units and therefore the element of unpredictability regarding maintainability is present. Also, the degree of degradation to equipment varies with the kind of operating environments the equipment has been exposed to. For example, if an aircraft has been operating at sea versus the desert, the type of corrosion to the aircraft will be different.

Predicting for the degree of impact that exposure to certain environments will have on equipment is difficult.

*Demand pattern varies for replacement and maintenance of equipment components.

Therefore, a traditional inventory management system is appropriate.

3. Ashore Activities - Shipyards and NADEPs

Supplier:

*Supplier location is close in that wholesale and intermediate inventories are geographically positioned in proximity to their customers.

*Administrative control is available to these organizations through contracts with local vendors for material requirements should the Department of Defense wholesale and intermediate inventories not be able to provide certain items.

*Responsiveness of suppliers is enhanced be the fact that these organizations are stationary and providing for material can be established and maintained.

Therefore, a JIT inventory management system has potential for application.

Delivery:

*Frequent deliveries can be possible since these units are stationary and in proximity to suppliers as well as having the ability to contract with local vendors.

*Smaller lot sizes of material can be delivered since these units are close to suppliers and possess the ability to receive frequent deliveries and retain administrative control.

*Leadtime for receipt of material can be shorten for the same reasons as mentioned above.

Therefore, a JIT inventory management system has potential for application.

Demand (For Major Rework Programs):

*Mission is based on a master production schedule with a general knowledge of the number and type of major equipment platform, such as an aircraft, due for maintenance repair based on the original equipment integrated logistics maintenance plan. However, even though these organizations operate under a master production schedule, there exist variation in scheduled repair versus actual repair as a result of the following impacting elements:

*Deferred maintenance plan options established for some platforms that defers expected level maintenance repair to later dates,

*Varying degree of component and part degradation due to various operating environments,

*Budget constraints as a result of an unpredictable funding appropriations for the major equipment rework,

*Unpredicted mishaps due to unexpected failure rate of equipment and/or accident that impact readiness of operating fleet.

*Equipment usage also varies with the ever changing missions of the operating units and therefore the element of unpredictability regarding maintainability is present.

*Demand pattern for material requirements varies with the schedule revisions and varying usage and maintainability rate of components and equipment.

Therefore, for major rework programs a traditional inventory management system is appropriate.

Demand (For certain components whose usage rate are deterministic):

*Mission is based on a production schedule and there are certain components that exhibit minimal failure rates and frequency in usage which lends itself to more accurate prediction of their requirement.

*Equipment Usage is deterministic based on a predetermined repair schedule derived from a standard flight hour usage maintenance plan developed from the original integrated logistics plan for component maintenance.

*Demand is deterministic based on predetermined schedule of repairs for inducted components.

Therefore, for certain components, a JIT inventory management system has potential for application.

H. SUMMARY

The results of this examination of the Navy's afloat and ashore activities are summarized below in Table 4.4.

ACTIVITY					
	AFLOAT		ASHORE		
ELEMENTS	**SURF SHIP**	**SUBS**	**NS/NAS**	**SHIPYARD**	**NADEP**
SUPPLIER -LOCATION -ADMIN CONTROL -RESPON-SIVENESS	TRAD	TRAD	JIT	JIT	JIT
DELIVERY -FREQUENCY -LOT SIZE -LEADTIME	TRAD	TRAD	JIT	JIT	JIT
DEMAND -MISSION -USAGE -PATTERN	TRAD	TRAD	TRAD	TRAD	TRAD/JIT

Table 4.4

TRAD = Traditional Inventory Management

JIT = Just-In-Time Inventory Management

Determining which organizations require a traditional inventory system and which might be able to apply a JIT system is based primarily on their missions and ability to predict and provide for material requirements when they are needed. The organizations within the Navy that are examined for a particular resupply methodology are characterized by afloat, ashore and industrial activities. Their mission elements and capabilities are described as follows:

1. Afloat Activities:

The mobile units or afloat activities such as the surface ships, Combat Logistic Force (CFL), aviation units, and submarines deploy for a period of time and their location and mission change frequently. Afloat units are designated to support the national security strategies "from the sea." In general, these strategies require naval forces to be prepared for rapid response to area conflicts should they arise. Unpredictable situations occur frequently requiring naval forces to respond rapidly, which contributes to the unpredictability of their missions. Basically, the Navy deploys as if it were "going to war." This means that each unit deploys with enough supplies for self-sustaining operations for a given period of time. Under these circumstances, a traditional consumer level inventory and safety stock are required to assure mission fulfillment .

2. Ashore Activities:

Likewise, the ashore activities at Naval Stations (NS) and Naval Air Stations (NAS), whose primary mission is to support the operating forces at sea, also have to respond to afloat requirements as the operating tempo dictates during unpredictable periods. Since they primarily have to respond to the needs of the afloat units in a myriad of mission requirements, they too experience unpredictable failure and usage rates for component and equipment systems. Hence, in the area of predicting usage and demand rates their support is subject to the variabilities associated with the afloat units and require a traditional inventory supply system.

There are environments where operations are more predictable such as the industrial based activities which operate under an established production schedule. For example, shipyards and NADEPs operations are based on a production schedule based on anticipated demand by customers for major rework of equipment. For instance, the NADEP has a general knowledge of the number and type of aircraft due for depot maintenance repair, according to an aircraft's original Integrated Logistics Maintenance Plan, but its predicted schedule can be impacted by several elements.

The elements that can impact the production schedule for a major aircraft rework are as follows:

*Deferred maintenance plan such as the Aircraft Service Period Adjustment (ASPA) which defers scheduled depot level maintenance for certain aircraft if the aircraft passes a condition inspection of sorts.

*Varying degree of component/part degradation due to various operational environments such as salt or sand corrosion. The degree of rework to the components, equipment and system is not realized until such a system is inducted into the facility.

*Budget constraints often cause aircraft maintenance funding to be reduced when least expected.

*Emergency situations where unexpected equipment failures or accidents cause a degradation to readiness for operational units. Under these circumstances, a traditional inventory supply system is more appropriate for major rework programs.

Although, the overall mission of the industrial facility present variability in its demand forecasting for major program rework scheduling purposes, there is potential for more deterministic forecasting associated with certain components that exhibit minimal failure rates and frequent usage rates so that their demand is more predictable. Examples include hydraulic and avionic components. Providing the necessary parts for these component repairs reflect some eligibility for a JIT resupply system.

Viewing Navy consumer inventories at the macro level, the industrial base activities such as the depots, shipyards and NADEPs possess potential JIT conditions. For a further look at JIT potential in a typical industrial activity within the Navy, a case study of the Naval Aviation Rework Facility, NADEP North Island, California is presented in the following chapter.

V. NADEP NORTH ISLAND CASE STUDY

A. INTRODUCTION

An industrial facility such as the NADEP Corporation possesses the potential to benefit from a JIT inventory system in certain component repair operations. The basis for this assertion is that the criteria for a JIT system exists for component repair operations since demand rates can be predicted with little variance and reasonable supplier and delivery commitment can be expected.

This chapter examines the current organization of the NADEP Corporation, NADEP North Island (NI), and its supply support function. A description and analysis of the resupply elements and potential for a JIT inventory system are provided.

B. NADEP CORPORATION

There are six Naval Aviation Depots that comprise the NADEP Corporation under the cognizant of the Naval Air Systems Command (NAVAIR). The corporation serves two "hubs," one on the east and one on the west coast and they include NADEPs Jacksonville, Florida; Cherry Point, North Carolina; Norfolk, Virginia; Pensacola, Florida; Alameda, California; and North Island, California. Their mission is to provide principal in-service logistic support fulfilling Program Management and Cognizant Field Activity responsibilities as well as providing industrial maintenance and engineering functions in support of the operating fleet. [Ref. 19:p. 24-25]

C. NADEP NI

NADEP North Island provides a wide range of engineering, calibration, manufacturing, overhaul and repair services performed on both aircraft and ships. Their primary responsibility is to repair and modify aircraft, engines, and components, however, they provide a number of specialized services also. The maintenance and engineering services are provided for U.S. naval aircraft, engines and ships that include:

1. Aircraft:

The F/A-18 HORNET, (fighter/attack aircraft), F-14 TOMCAT (fighter), E-2 HAWKEYE (airborne early warning aircraft), C-2 GREYHOUND (carrier on-board delivery aircraft), and the S-3 VIKING (anti-submarine aircraft).

2. Shipboard:

The arresting gear, catapults, and the LM2500 engines for the Aegis, Perry, and Spruance class ships. The Component Section makes up 15 percent of the workload for 38,550 aircraft subassemblies, avionics, and engine accessories that are repaired in direct support of the Aviation Supply Office (the biggest customer), the fleet, Defense Intraservice Support Agreement (DISA), and Foreign Military Sales (FMS). In addition, the specialized services include logistics support (reliability centered maintenance and Life Cycle Support), Field service (on-call 24 hours a day for world wide on-site repair), mobile facilities and manufacturing services. [Ref. 20:p. 5-6]

D. NADEP NI ORGANIZATION

Basically, NADEP NI is organized as a matrix organization comprised of vertical and horizontal relationships to the Commanding Officer and Executive Officer. The staff positions are headed by the Plant Manager and include the offices of Competency Management, Industrial Planning, Operations Planning, Industrial Technology Corporate Operations, and a partnership with the Fleet Industrial Support Center (FISC). The staff elements provide service and support functions. For the line relationships, the Product

Manager heads the primary Project Programs known as the Program Management Team Offices and include the F/A-18, F-14, S-3, E-2/C-2, Components, Field Services, and Manufacturing programs. The following chart shows the major functional areas of the command and the major program management areas.

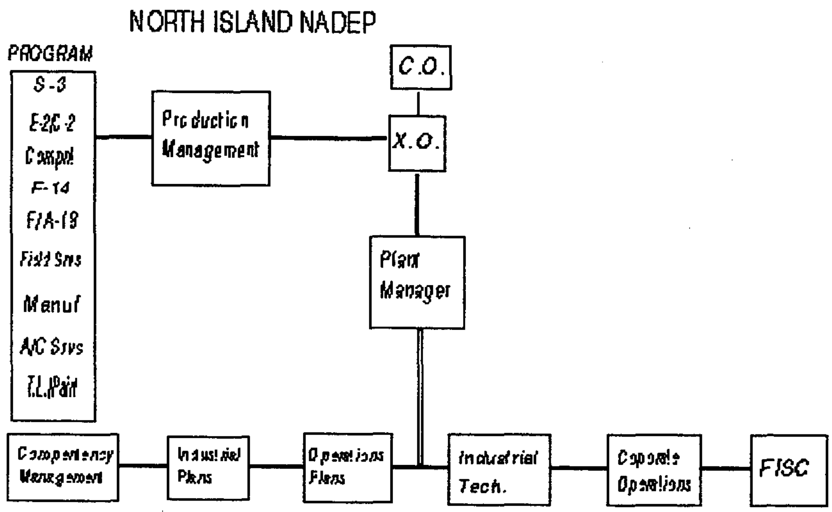

Figure 5.1

A major Navy aerospace complex, NADEP NI employees over 3,000 people, occupies 75 buildings with a capacity of over 2 million square feet, and supports $345 million per year in salary and contracts. Their unique contributions include the ability to ensure readiness and safety of a mobile, operationally ready Naval aviation force. "Of the Aviation Depots in the Navy, North Island is the largest, most diversified, and most experienced in years of service.... [Ref. 21:p. 3]."

E. SUPPLIER SUPPORT FUNCTION FOR THE NADEP

The Fleet and Industrial Supply Center, North Island (FISC NI) is responsible for providing supply support to NADEP NI. They manage a consumer level inventory of material required for the re-stock function. This includes ordering, tracking, and delivering the required stock.

The unique element regarding the "stock" required for the NADEP is the military specification and standard requirement associated with the parts currently in use. This creates limited flexibility for stock procurement. When considering a JIT system, the lack of standardization among parts may impede the process of providing the right material in the right amount exactly when needed for the current supply structure.

Nonstandardized parts traditionally associated with the military specification and standards require that equipment and parts designed for military use be built according to strict guidelines not usually seen in other commercial equipment. This means that a select number of manufacturers produce the equipment and parts according to the original integrated logistics plan for spares required. Unfortunately, there is a growing problem for the Navy and DOD due to the diminishing number of manufacturing sources and material shortages (DMSMS). DMSMS is defined as the loss or impending loss of manufacturers of items or suppliers of items or raw material as a result of the last known source deciding to cease production.

[Ref. 22:p. 5]

However, the Secretary of the Navy, Dr.William Perry has established a policy that eliminates military specification and standard requirements, with few exceptions, for new weapon system acquisition programs. The new policy dictates that newly designed equipment and parts are to be standardized and the integrated logistics plan for spares and repair be compatible with commercial standards. Hence, an element of flexibility with regards to supplier options is provided through standardization.

When considering a JIT system, the flexibility to negotiate supplier commitment is crucial and relies on having several suppliers available. A production facility must be able to find the supplier who can enter into a long term commitment to supply the right material when needed. If supplier options are limited and supplies are limited than the flexibility needed to be responsive is hampered and, therefore, a JIT system could be jeopardize.

Currently, the Defense Logistics Agency (DLA) provides the inventory requirement for the FISC from their wholesale stock. The DLA, in turn, acquires their wholesale stock from the Original Equipment Manufacturers (OEMs). Hence, the FISC is not directly involved with the OEMs for their specific part requirements. DLA serves as the "middleman" in this inventory resupply process.

For planning purposes, FISC manages their inventory according to the requirements of several customers including the Aviation Supply Office (ASO), members of the Defense Intraservice Support Agreement (DISA), Foreign Military Sales (FMS), and NADEP NI. The inventory management process occurs simultaneously in two phases: the planning phase and the execution phase. During the planning phase, FISC consolidates all of its customers' requirements into a single forecast for each family of components. FISC forecasts demand for 541 families of components on a quarterly master schedule produced by the NADEP. The inventory is prepositioned into Focus Stores and Pre-expended bins. The Focus Stores are individual inventory sites located near each rework program facility at the NADEP.

The second phase of this process involves the execution phase. During the execution phase, the components are inducted into the NADEP where they undergo a two part evaluation process. The component is initially evaluated for material condition and requirements for repair are noted. Secondly, the components are disassembled for further evaluation to determine the extent of degradation and repair needed. At this point, the exact material required for repair is determined and sought from the prepositioned inventory.

When the necessary material is not available from the prepositioned inventory, the component goes into the delay mode. The delay mode is broken into two areas: awaiting parts and "G" condition. If the delay for parts is less than 45 days, they are considered "awaiting parts", but if the delay is greater than 45 days, they become condition "G" parts. Requisitions are submitted for material required and FISC places the necessary items on order. There is on average 30-day turn around time for DLA to provide material back to the FISC. [Ref. 24 & 25]

Finally, the process is evaluated for net effectiveness during the analysis portion of the inventory management process. Net effectiveness measures how well supply and demand matched when comparing forecast in the material planning phase to actual repair requirements determined in the execution phase. Currently, the FISC reports a net effectiveness in inventory turnover of about 60% [Ref. 25]. The material management process is depicted in the following flow chart:

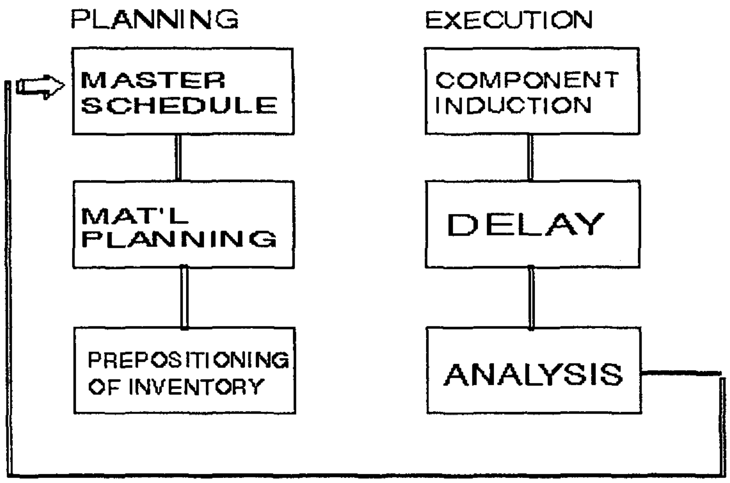

Figure 5.2

From the stance that the military specific parts and equipment are developed and maintained by military specifications and standards and the supplier for these items are the DLA who requires an average 30-day turn around time, a JIT system is not appropriate under these conditions. In addition, from the perspective that there exists a 60% net effectiveness between forecasting for requirements and satisfying requirements, a JIT system would not be an effective option.

F. JIT APPLICABILITY

Based on the supplier, delivery, and demand criteria, the resupply methodology is examined for JIT applicability:

1. Supplier:

*<u>Supplier Location</u> is close and a cooperative supplier relationship is established. The FISC is located in a building next to the NADEP and a staff of FISC representatives

have entered into a partnership with the NADEP and their offices are located within the facility.

*Administration control is available with the NADEP/FISC partnership established to better monitor and administer to the supply support function. Their supply support function primarily involves managing the Focus stores recently established for each rework program sponsored by the NADEP. There are Focus Stores for the F/A-18, E-2/C-2, S-3, Avionics and Hydraulic components. Two of these Focus Stores, the Avionic and Hydraulic component stores, are further subdivided into Kits. These Kits are stocked with the piece/parts needed for the avionic and hydraulic component repairs. The advantage of these Focus Stores is to increase asset visibility and move material closer to the artisan.

*Responsiveness of the FISC to manage supply requirement for the NADEP is enhanced by the increased asset visibility provided by the Focus Stores. The NADEP/FISC partnership also increases the responsiveness of FISC to NADEP and vice versa. Therefore, under the supplier criteria for JIT inventory management the Focus Store initiative exhibits potential for a JIT system.

2. Delivery:

*Smaller Lot Sizes are ideal for a JIT resupply system and the possibility to reduce the quantity of material provided at any one time promotes asset visibility and reduces inventory held. The Focus Stores for the F/A-18, E-2/C-2, and S-3 carry inventory to support their rework programs and the material requirements are not as easy to forecast for and too extensive to cost effectively kit for. However, the Avionic and Hydraulic components exhibited a higher induction and usage rate and piece/part requirements are not as extensive, making these components easier to forecast and kit for. Each of the 17 kits prepared contain the exact number of piece parts required to accomplish a component repair. Depending on the extent of repair, not all of the piece parts are required every time. This means that excess piece parts are accumulated.

*Frequent deliveries are made as the Kits are reviewed and inventoried and restocked daily once a Kit is turned back into the Focus Store after use. This is currently accomplished manually.

*Leadtime is shorter due to the proximity of the Focus Stores and responsiveness of the Focus Stores to restock the Kits as they are turned in. However, Kits are maintained at the Focus Stores and are not sent directly to the artisan at the rework production line. The Kits are required to be turned back into Production Control and then into the Focus Store after use by the artisan. Once the Kits are turned in, they are inventoried manually for restock. A Kanban system is not in place to assist with this process.

Since the Kits are not delivered directly to the artisan at the production line, and the artisan is required to obtain and return Kits upon use, some leadtime and possible excess inventory for parts not used is generated. (See figure 5.3)

A true JIT system requires the prescribed lot of material to be delivered to the production line exactly when needed and this system is facilitated by a Kanban signaling process. Therefore, under the criteria for delivery, the Kiting initiative for the two components with deterministic usage rates shows some potential for a JIT system, but does not fully qualify as a JIT system.

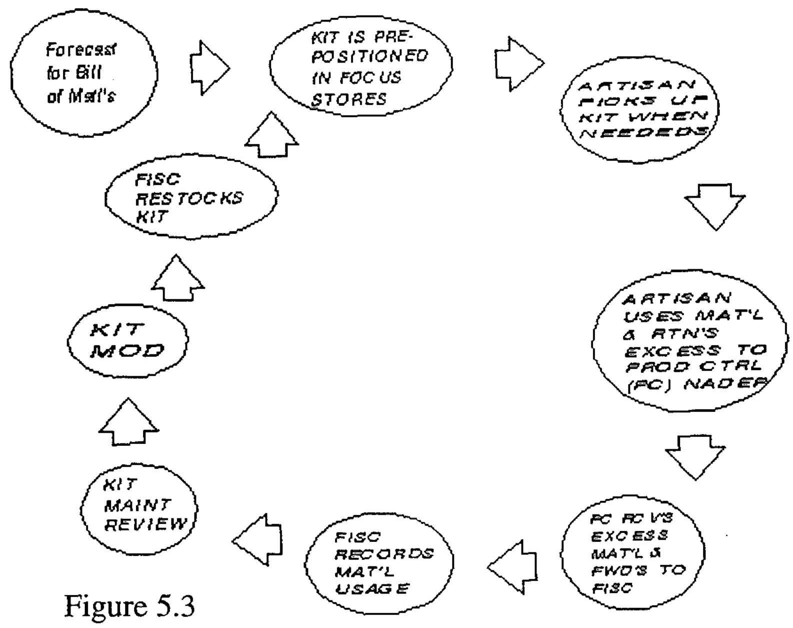

Figure 5.3

3. Demand:

*<u>An operation that is predictable</u> and driven by a production schedule is more appropriate for a JIT system. The component repair section of the NADEP operates according to a Master Production Schedule and material requirements are forecasted based on quarterly historical data.

*<u>Component usage is deterministic</u> because of the high rate of components inducted into the quarterly repair cycle and the more reliable mean-time-between failure rates associated with the avionic and hydraulic components. The historical data indicates that the mean-time-between failures rates determined for these components are in line with the repair requirement and there is a steady number of repairs each quarter.

*<u>Demand pattern is deterministic</u> when demand can be forecasted with little variation. Currently, there are three separate databases used to manage the inventory

function and they are managed by three separate personnel. The databases consist of the NADEP's North Island Material Management System (NIMMS) scheduling and bill of materials database, the FISC's Uniform Two (U2) inventory data base, and the KITs locally developed Kit usage tracking database. These databases are not linked together and, consequently, the demand predictions are not consistent with the material ordered for the prepositioned inventory. NADEP is responsible for documenting usage accurately and planning for requirements according to their production schedule while FISC is responsible for stocking the Focus Stores and Kits according to NADEP's production schedule. Because this function is accomplished from three separate points, duplications of orders occur as well as component usage tracking for historical data compilation is misrepresented. At present, there is only a 60% inventory turnover effectiveness and approximately 47% of the components are in either the Awaiting Parts or Condition "G" status. [Ref. 23-26]

Therefore, under the demand criteria for JIT, two out of three elements are present at the component repair level to indicate potential for JIT. The demand/supply forecasting element is, however, not accurate enough for a JIT system to be effective. A JIT system could be possible if the inventory and production scheduling process were streamlined to reduce the variance between the forecasted demand for material requirements and the inventory ordered to fulfill those requirements. Hence, the potential of JIT exists with respect to deterministic production scheduling and usage rates associated with the two components but is hampered by the variance in demand forecasting. [Ref. 23-25]

There is a potential to implement a JIT system but here are obstacles. Namely, these obstacles include transitioning the Kiting process into a Kanban resupply system and forecasting demand with little variance for each rework function. The essential qualification for moving towards an effective JIT inventory management system is the ability to track and forecast requirements with minimal variance. Conclusions and recommendations regarding the potential for JIT in the Navy are provided in the following chapter.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The goal of this research was to determine the potential for a Just-In-Time inventory management system in the Navy. The JIT philosophy maintains that lower levels of inventory in conjunction with a commitment to continual improvement of quality can reduce waste and inefficiencies. A major benefit associated with this philosophy is an increase in the quality of supply support and potential reduction in inventory costs. In today's era of force reduction and fewer resources, the Navy is searching for ways to achieve greater levels of efficiency while maintaining readiness. Therefore, this study has attempted to identify those naval organizations that might exhibit potential for a JIT inventory management system.

The research effort provided information involving the following steps:

*A description of the key concepts of the JIT management philosophy specifically exploring the goals, major principles, and benefits of a JIT system to determine the applicability of JIT within the Navy.

*An examination of current Navy inventories categorizing the various inventories in use and identifying the value they provide to the end user.

*A categorization of Navy organizations was established and certain aspects of their resupply functions were analyzed to determine the appropriate inventory management system. A comparison was made of the Navy inventory management system to the elements of a JIT resupply system and an assessment was made to determine eligibility of Navy operations for a JIT inventory management system.

*A case study was conducted of NADEP North Island since it exhibited potential for JIT applicability based on the criteria identified in steps one and three.

Just-In-Time represents continual improvement to obtain performance excellence in the operations of an inventory system.

To recognize the potential for JIT in the Navy, an understanding of the Navy supply and material management programs is required. Navy inventories are established and maintained to support peacetime operations and to provide an adequate supply of war reserve material. During peacetime operations, the Navy maintains three levels of inventories in conjunction with the three levels of maintenance.

To effectively manage these inventories in support of operations, the supply system incorporates its knowledge of the customers' technical requirements into lists known as Allowance Parts Lists (APLs). An APL is a tailored listing of the required repair or spare parts each customer needs to stock locally. These tailored listings which describe the consumer level of inventory for the various organizations are further categorized into afloat and ashore activities. In general, afloat units are loaded with sufficient supplies to assure a prescribed period of self-sufficiency and to permit maximum retaliation when necessary. Shore bases are used to supply the operating forces as circumstances require.

Based on mission requirements, there are certain conditions that exist specific to Navy facilities, either afloat or ashore, which lend themselves to either a traditional or possible JIT inventory management system. Afloat activities exist in an environment where the operation changes frequently and unpredictable usage and failure rates of components and equipment is an issue. Therefore, in this operating environment a traditional inventory resupply system is appropriate.

Shore activities primarily have to respond to the needs of the afloat units in a myriad of mission requirements and therefore experience unpredictability in equipment repair needs associated with the operating units. Hence, these activities require a traditional inventory management system as well. There are, however, environments where operations are more predictable such as the industrial-based activities which operate under an established production schedule.

The NADEP North Island represents such an environment since its operations are based on a production schedule. However, even though the number and type of aircraft due for depot maintenance repair can be anticipated, the predicted schedule can be impacted by several elements. Those elements consist of deferred maintenance issues, varying degree of component degradation, budget constraints, and emergency situations that arise. Therefore, for the major rework programs, a traditional inventory management system is necessary.

Although, the major rework programs experience production schedule variation, there are certain components that exhibit reliable failure rates and steady flow induction to the repair cycle thereby facilitating demand forecasting. The avionic and hydraulic component repair section exhibit these qualities. Since demand forecasting is critical to JIT system, these components demonstrate eligibility for a JIT inventory management.

B. CONCLUSION

Certain criteria for the supplier, delivery and demand patterns must exist if a JIT system is to be successful. The supplier, delivery and demand capabilities of NADEP North Island were analyzed to determine if there exists potential for a JIT system in parts of its inventory management.

First, since FISC is the supplier for the internal repair activity of the NADEP, the JIT supplier criteria is met with respect to location, administrative control, and responsiveness. However, one cautionary observation is the limited flexibility of FISC to acquire military- specific material from only DLA whose turn-around time for delivery is an average of 30 days. This fact has the potential to impede a JIT process.

Secondly, the ability for FISC to provide frequent delivery in small lot sizes is provided through the Focus Stores and Kiting Initiative for two components. (Not all of the rework programs at the NADEP can be provided through Kiting.) However, the Kits are maintained at the Focus stores and require the artisan to obtain and return the Kits as used. The replenishment process of inventorying items and restocking Kits is accomplished manually which increases the delivery time. As of yet, a Kanban signaling system for restock of Kits is not in place which would facilitate the resupply system and decrease delivery time. Additionally, not all parts are used from the Kits each time resulting in excess material. Therefore, the ability to deliver in frequent small lots, as with the Kiting initiative, demonstrates the potential for a JIT system, but the process has not evolved to the point of delivering the right amount at the right time directly to the production line.

Finally, in order to accomplish an effective JIT resupply system, the demand for material requirements must be forecasted for with little variance. This would require a predetermined production schedule, such as NADEP's master production schedule, and an accurate forecast for material usage and demand. Currently, the effectiveness in the match between inventory planning and production scheduling is approximately 60%. Part of this is a result of a segregated automation system that is responsible for scheduling and material requirements planning. There are three separate systems used to accomplish similar tasks but they are not linked together which results in misrepresentation of data. Hence, the NADEP and FISC have the capability to track and forecast but would require a more accurate method of forecasting and planning if a JIT system is to be applied.

C. RECOMMENDATIONS

The case study has identified potential for a JIT resupply system within the component section of the NADEP. To move towards a true JIT system, the following recommendations for further study are provided:

*Determine the impact of FAR regulations on the effectiveness of supplier and supply availability.

*Analyze the forecasting process for material requirements determination in conjunction with production scheduling.

*Analyze the information and database management system to determine the potential for production forecasting and material management interface.

*Determine the requirements for a Kanban resupply signaling system for the Kiting project and establish measures of effectiveness.

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