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RIGHTSIZING DOD INVENTORY: A CRITICAL LOOK AT EXCESSES, INCENTIVES AND CULTURAL CHANGE

by

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December 1999

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"Major Management Challenges and Program Risks: Department of Defense," (GAO/OCG-99-4, January 1999), the Government Accounting Office (GAO) reported that half of the Department of Defense's (DOD) $69.9 billion in inventory was either obsolete or rarely used. GAO then asserted that DOD would be able to reduce its inventory of secondary items and develop a culture of economic and efficient inventory management if DOD inventory management personnel were trained in modern commercial logistics practices. This thesis presents the position that high inventory levels can be the result of outdated performance measures and reward systems that often encourage holding high levels of inventory. Included is a description of performance measures used for Item Managers, Inventory Managers and unit commanders and their staffs as well as a discussion of other systemic factors that impact inventory levels and may result in excess inventories. In addition, this thesis suggests that some modern commercial logistics practices have been successfully implemented by DOD for certain commodities, while for others, it may not make sense to do so.

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ABSTRACT

In its report "Major Management Challenges and Program Risks: Department of Defense," (GAO/OCG-99-4, January 1999), the Government Accounting Office (GAO) reported that half of the Department of Defense's (DOD) $69.9 billion in inventory was either obsolete or rarely used. GAO then asserted that DOD would be able to reduce its inventory of secondary items and develop a culture of economic and efficient inventory management if DOD inventory management personnel were trained in modern commercial logistics practices. This thesis presents the position that high inventory levels can be the result of outdated performance measures and reward systems that often encourage holding high levels of inventory. Included is a description of performance measures used for Item Managers, Inventory Managers and unit commanders and their staffs as well as a discussion of other systemic factors that impact inventory levels and may result in excess inventories. In addition, this thesis suggests that some modern commercial logistics practices have been successfully implemented by DOD for certain commodities, while for others, it may not make sense to do so.

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I. INTRODUCTION

A. BACKGROUND

There has been a major revolution in inventory management practices in the private sector during the last ten years. Innovation and improved responsiveness, focused on customer satisfaction, have driven this trend. The importance of the additional enabler of use of information technology to improve asset visibility and real time tracking of inventory also cannot be overstated. Commercial business and logistics practices have reacted to increased competitive forces and adopted revolutionary technological and logistics process breakthroughs and improvements. A shift in the way businesses view inventory and its relationship to firm profitability has introduced a new set of performance measures and rewards focused on inventory reduction. Some results of this paradigm shift are: drastically reduced on-hand inventories; improved distribution systems; higher quality products and services; and healthier profitability for businesses that successfully make the shift. Meanwhile, military inventory management practices have often lagged behind the commercial sector, in part due the burdensome size and non-profit nature of the Department of Defense (DOD). However, force reductions, budget constraints and supporting infrastructure reductions require new approaches to streamlining the supply chain and reducing logistics and inventory

costs and to constantly explore new ideas and methods in order to increase effectiveness.

Traditionally, defense inventory management has been viewed as deficient from many sources; from taxpayers as an example of wasteful spending and from those within the military as inefficient and cumbersome. In December of 1990, the General Accounting Office (GAO) designated defense inventory management a high-risk area, labeling it as especially vulnerable to waste, fraud, abuse, and mismanagement. GAO believed there were significant weaknesses in "internal controls (procedures necessary to guard against waste, fraud, and abuse) and financial management systems (which are essential to promoting good management, preventing waste, and ensuring accountability)" [Ref 1, page 1]. Continued maintenance of high levels of excess inventory and inadequate systems for determining requirements for supplies were fundamental causes of inventory problems, and GAO believed correcting these problems was essential to safeguard scarce resources and ensure efficient and effective use on behalf of the American taxpayer. In short, GAO claimed DOD had wasted billions of dollars on excess supplies, burdened itself with the need to maintain them, and failed to acquire the tools or expertise to manage them effectively.

Since the late 1980s, DOD has experienced continuous budget scrutiny and reductions in funding as a result of the "Peace Dividend" (a reduction in funding of

thirty percent), and has taken steps to improve inventory management systems. However, GAO claims that DOD greatly lags the commercial sector in the execution of inventory reduction, and that adoption of these modern logistics practices (including supply-chain management) will quickly and greatly improve overall inventory management efficiency and effectiveness.

In the author's opinion, the GAO's assertion that training and implementation of commercial modern logistics practices will reduce excess inventory is only partially correct. Standardized training in modern logistics practices for all supply and logistics personnel (including maintenance personnel), exposing them to just-in-time inventory methods, direct vendor delivery and total asset visibility concepts would be beneficial. However, training alone will not reduce inventory levels. High inventory levels can be the result of military or civil service culture, performance measures, and a reward system that values holding these high levels of inventory. However, often there are legitimate reasons for DOD to hold inventory, and opinions differ as to what constitutes "excess" levels of inventory. An analysis of behaviors of managers within DOD's inventory system and the performance measures and rewards that propagate these behaviors can explain to a greater degree why the military has not kept pace with the private sector in inventory reduction in some regards. In addition, a discussion of internal factors that impede change is relevant, as well as a discussion of what modern logistics

inventory practices are being implemented within DOD and for which commodities and why.

B. SCOPE OF THESIS

The scope of this thesis is limited to the management of secondary items, an inventory category comprised of repair parts, replacement parts, clothing, subsistence items, medical supplies, and consumables such as fuel, paper products, and office supplies. Depot-level Reparables (DLR's) and associated factors such as repair cycle time are not addressed in this thesis.

First, this thesis provides a general overview of DOD's supply systems, then reviews its current performance measures and rewards systems in order to identify those aspects of these systems that promote carrying inventory in excess of demand. Additional causes of excess inventory and factors that impede change within the DOD inventory system are then discussed. Next, an analysis of modern commercial inventory management practices and their applicability to DOD will be reviewed. An analysis of which commercial best business practices are reasonable for DOD to use follows as well as an explanation of why certain inventory items are not best suited for commercial best business practices in the military environment and culture of the next century. Finally, the thesis will conclude with a Summary and Conclusions, and provide Recommendations applicable to DOD inventory systems.

C. RESEARCH QUESTIONS

This thesis attempts to answer the following questions: "What areas within the current DOD performance measurement and reward structure need to change, and how, in order to accomplish inventory reductions?," "Should the GAO continue to label DOD inventory as a high risk area?," "What factors impede change?," "What modern logistics inventory practices can be used by the military and for which commodities?," and "For which commodities are modern logistics inventory practices not applicable to the military and why?"

D. ORGANIZATION

There are five remaining chapters. Chapter II describes the administrative flow of the DOD supply system, discusses performance measures used for Item and Inventory Managers and users, and the behavioral impact of these measures on DOD inventory. Chapter III lists additional causes of excess inventory, focusing on the fundamental differences between commercial and DOD inventory management and systems. Chapter IV discusses factors that may impede change. Chapter V examines both existing and future possible uses of modern inventory management practices by DOD and discusses ways of implementing different performance measures and rewards while taking into account the limitations identified in Chapters III and IV. Chapter VI contains a summary of the thesis as well as conclusions and recommendations.

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II. PERFORMANCE MEASURES AND THEIR IMPACT ON DOD INVENTORY

The supply system currently in use in DOD evolved over many years and is designed to support high levels of combat readiness. Unlike the commercial sector, there has been limited awareness of the cost of holding high levels of inventory. The performance criteria against which personnel in the supply system are measured may have not changed enough to reflect the recent emphasis on efficiency through lower operating costs and less capital investment in inventory.

This chapter first provides a brief overview of the inventory and supply systems used in DOD, focusing mostly on the Defense Logistics Agency (DLA) and the U.S. Navy with a brief mention of the other military branches and the General Services Administration (GSA). Following this overview, there will be a discussion of the performance criteria against which Item Managers, Inventory Managers, and unit Commanding Officers, or "users," are measured. This chapter is intended to serve as a benchmark from which to improve the way performance is measured with the goal of increasing the efficiency with which the supply system operates.

A. THE WHOLESALE AND RETAIL SUPPLY CONCEPT

Just as the private sector supply system is divided into retail and wholesale levels, so too is the DOD supply system. Although the specific supply system

used by each branch of the Armed Forces is constructed differently, the Army, Navy, and Marine Corps use both wholesale and retail stock points. DLA and the Air Force use only wholesale. Examples of wholesale activities include DLA's Defense Supply Center Columbus, Ohio, and the Navy Inventory Control Point (ICP) in Mechanicsburg, Pennsylvania. Examples where wholesale material may be stored include DLA Defense Distribution Depots and Navy Fleet and Industrial Supply Centers (FISCs). An example of a retail activity is the Supply Department onboard a Navy destroyer or aircraft carrier.

Item Managers are located at wholesale-level activities. An Item Manager is assigned for each and every National Stock Number (NSN) item that a wholesale activity controls. Item Managers are typically assigned the control of many different items, and are responsible for procuring the item, selecting the stocking location, tracking the item's demand history, and arranging transportation of the item from the distribution center (or depot) to the user. They are also encouraged to arrange for direct vendor delivery whenever possible in order to reduce warehousing costs to the government. An individual item manager may be responsible for a few highly complex items or many simpler items.

Inventory Managers are located at retail activities. An Inventory Manager is responsible for managing all materials stored in a facility, regardless of NSN, much the same as occurs in a typical commercial store. High-demand items are

located at the retail level as well as at the wholesale level, in order to better support the needs of the user.

B. SUPPLY SYSTEMS

1. Defense Logistics Agency

The Defense Logistics Agency (DLA) is the DOD wholesale distributor for consumable materials used by the service branches and defense agencies. DLA is a Defense Working Capital Fund (DWCF) activity, meaning that it does not receive annual appropriations from Congress, but adds a surcharge to the cost of items "sold" to the services and other customers, to cover general, administrative and operating costs each year. DLA's supply entities are organized in three tiers across the country (and world): headquarters in Fort Belvoir, Virginia; Defense Supply Centers (where the Item Managers are located); and Defense Distribution Depots (where the stock is actually held).

DLA calls itself "The Warfighter's Logistics Combat Support Agency," [Ref. 2, web] tasked with providing supplies and services to America's military forces worldwide. Staffed by over 42,000 civilian and military personnel, DLA has offices in all fifty states and at least twenty-seven countries. DLA's annual throughput includes managing over four million consumable items, processing over thirty million distribution actions and administering nine hundred billion dollars worth of contracts. DLA is focused on five core missions: 1) material

acquirer/manager; 2) logistics information manager; 3) warehouser/ distributor; 4) document automator; and 5) contract manager. Repairables are managed by the individual services and DLA focuses on consumable, end-items.

DLA is comprised of two major subordinate commands, the Defense Contract Management Command (DCMC) and the Defense Logistics Support Command (DLSC). DCMC is the Department of Defense's (DOD) contract administration arm, responsible for the management and value-added administration of significant responsibilities such as administration of weapons system procurement and logistical support contracts issued by the services, defense agencies, and DLSC, but will not be addressed here.

DLSC is focused on providing logistical supplies and services in support of military missions; from hardware and repair parts to clothing, subsistence and medical support. From participating in training exercises to using customer-focused metrics to improve weapon systems support, DLSC's goal is optimal support and combat readiness. DLSC measures success in terms of reliability, consistency, logistics response time and weapon system mission capability rates. But DLSC also measures success in terms of customer prices, recognizing that saving money on logistics support translates into more resources for training and operational needs at the military service level. The scope of DLSC support includes [Ref. 2, web]:

1. Supplier of Parts, Material and Services – all food, fuel, medical supplies and clothing, 4.1 million consumable spare parts inventory (over 85 percent of the DOD total), $10 billion in inventory and $12 billion in annual sales, and management of a $9 billion national stockpile (war reserves).

2. Distributor/Warehouse Manager – all DOD wholesale inventories, throughput of over $106 billion in inventory and 31 million receipts and issues annually.

Reorganization of DLSC supply centers and responsibilities for various commodities is in progress. The Defense Supply Center (DSC) Columbus, Ohio, will be devoted to supplying items for land and sea weapon systems, DSC Philadelphia, Pennsylvania, will provide troop support and general commodity items, DSC Richmond, Virginia, will provide items for air, aviation and space support, and the Defense Energy Support Center will provide all forms of facility and mobility energy (fuels). In addition, the material storage and distribution functions are undergoing significant change, with consolidation of the Defense Distribution Center and twenty distribution depots.

Consumable Item Transfer. In 1989, Defense Management Report Decision (DMRD) 926, "Consolidation of Inventory Control Points," was released and recommended the transfer of all service managed consumable items (numbering over one million) to DLA. The DMRD maintained that DLA could manage the services' consumable items with fewer resources than required by the services, save money, and improve overall efficiency within DOD. The Deputy

Secretary of Defense for Readiness approved the initiative and the services and DLA developed a plan for transfer of management in two phases.

Phase 1 items (768,000 line items) started to transfer in August 1991, and included routine, less complex consumable supplies and spare parts. Phase 1 was completed in November of 1995. Phase 2 items remained under service management during Phase 1 because of their application criticality, end item uniqueness or until further evaluation of their intensive management requirements could be accomplished. DLA was able to enhance their weapon system support processes, and the first Phase 2 consumables began to transfer to DLA's management in January 1996. By the end of fiscal year 1997, an estimated 200,000 line items of Phase 2 consumable transfers were complete [Ref. 4, web].

2. General Services Administration

The General Services Administration (GSA) serves as a wholesale supplier to all federal agencies, including DOD. GSA's supply operations are fully self-supporting and offer such common use commodities as general office supplies (from pencils to furniture), leased space for government and DOD offices, as well as leases for many types of industrial and non-industrial vehicles and tools. GSA does not handle weapons systems or weapons systems support type items, so there is minimal overlap with DLA inventories.

3. U.S. Navy

The Naval Supply Systems Command (NAVSUP) provides direct operational support to naval forces worldwide and is responsible for the policies, procedures and business systems that govern the Navy supply system; in short, logistics support of material, services and information, provided when and where needed. In addition to assisting with the processing of DLA-managed material, NAVSUP manages and maintains a wholesale inventory of 383,000 line items valued at over $15 billion [Ref. 5, web]. These consist of mostly Navy unique depot-level repairables (DLRs) in support of ships, aircraft and associated weapons systems.

In coordination with DLA, NAVSUP determines spare part allowances and location decisions in order to provide maximum levels of readiness for the least inventory investment dollar. NAVSUP also performs initial outfitting in order to determine how many spare parts, provisions, and general use consumables that customers (ships, squadrons, shore and industrial activities) should maintain on hand to meet stated readiness and sustainability goals. Similarly to DLA, the general structure of NAVSUP is: headquarters in Mechanicsburg, Pennsylvania; Inventory Control Points (ICPs) at Mechanicsburg and Philadelphia (where the Item Managers are located); and Fleet and Industrial Supply Centers (where, along with customer storerooms, much of the DLR inventory is held).

At the activity level, the Navy separates its materials into "cognizance codes" based upon the wholesale activity that controls the item. Local "open" purchases are only authorized when an NSN item does not exist or is not available to fill the request in time for the command to meet a mission, such as an underway period. After determining that the desired item is in the stock system, the user places the requisition with the local Supply Response Section (SRS) at the command or activity. The SRS, which is located within a Supply Department, holds some stock of high demand items and fills the requisition from stock on hand if it is available. If not available, the requisition is forwarded to the Document Control Unit (DCU), also within the activity's Supply Department. The DCU is an expediting activity only and holds no stock. The DCU determines which wholesale activity controls the requested item and places the order with that activity. At small commands, such as a frigate, one or two persons within the Supply Department may perform both Supply Response and Document Control functions.

Normally the regional Fleet and Industrial Supply Center (FISC), a requisition processing and warehousing operation which holds inventory belonging to both DLA (consumables and repair parts) and the Navy ICP's (depot-level repairables), will process the requisition.

C. PERFORMANCE MEASURES FOR ITEM MANAGERS, INVENTORY MANAGERS AND USERS

1. Item Managers

Item Managers are located at the wholesale level of the federal supply system. DLA, GSA and each branch of the armed forces have Item Managers for the items they manage at the wholesale level. Commonly evaluated by how well they support the operating forces, their performance measures reflect this focus at the expense of other possible criteria, because failure to support tactical forces can have grave consequences. The point here is not to identify unethical behavior but to emphasize that incentives matter, and that performance measured is what naturally will be emphasized and focused on.

a. Performance Measures

The primary performance measure criterion is the Item Manager's fill rate, simply determined by dividing the number of orders filled by the total number of orders received. This is also often called the Supply Material Availability (SMA) rate, and is used to gauge how well the range (variety of items in stock) and depth (quantity of each item in stock) support requirements received. The second most common measurement is backorder age; how long an item has been on backorder, waiting to be filled, from the time the requisition is received. Backorder age is viewed as an excellent criterion to determine how well the

inventory is supporting customers. The Item Manager's goal is to both maximize the fill rate and minimize backorder age. Other criteria include: number of orders shipped and number of pounds shipped. Order fill rate and backorder age are among the most important factors for performance appraisals of Item Managers.

b. Impact on Inventory Levels

The performance measures listed above do not contribute to lowering inventory levels. To the contrary, the order fill rate criterion promotes keeping high inventories on hand to support as high an order fill rate as possible for Item Managers.

The second criterion, backorder age, may result in Item Managers canceling an order as soon as they determine that they are unable to fill the requisition quickly from on hand stock. This keeps the Item Manager's backorder ages low. However, lengthy backorder ages occur most frequently as a result of lack of availability from the manufacturer and long lead times, both of which are outside the Item Manager's control. The other criteria listed may result in slightly skewed behavior as well, such as; shipping many small orders and delaying a large order; often splitting large orders into many in order to increase the number of orders shipped; or even prioritizing shipments by weight instead of mission priority.

2. Inventory Managers

Inventory Managers are located at the retail level of each service branch's retail supply system, such as a Fleet and Industrial Supply Center (FISC) in the Navy and the Supply Department onboard a ship. Any supply activity below the wholesale level is considered retail.

a. Performance Measures

The performance measures for Inventory Managers are very similar to those of Item Managers, in that the primary focus is on material availability. Order fill rates and backlog ages are the primary criteria used to evaluate supply personnel at the retail level. Inventory Managers want material at the retail stock point or quickly obtainable when a request arrives, enabling them to keep order fill rates high and backorder ages low.

b. Impact on Inventory Levels

There is a significant amount of pressure on the retail level of supply from operational unit commanders to fill every requisition as soon as it arrives. The ability of the retail level to fill orders quickly has a direct impact on the readiness of combat units, the availability of the equipment the units use and the service branches' ability to support the service members. The consequences of inadequate logistics support can be significant, most notably mission failure and possibly loss of American and allied lives.

This emphasis motivates Inventory Managers to carry as close to their maximum stock levels as possible of as many items as possible. There is also a great temptation to try to carry small amounts of additional inventories of those items that the Inventory Manager (and unit commander served) believes may be needed in addition to requirements levels.

3. Users

"Users" are any command or unit who rely on the supply system for secondary item support. These include combat units as well as staff and administrative support commands.

a. Performance Measures

Commanders of combat units are evaluated based upon their readiness for battle. A thorough definition of readiness will include many factors, such as fully mission capable aircraft, material condition and availability of equipment, and personnel training.

When equipment is unavailable for use, the user wants it back in service right away. The user is inadvertently penalized when the wholesale activity is unable to obtain the required part. The expectation of the user's superiors and peers is that operational availability will be at or above what is minimally required. The user has the added pressure of being evaluated in relation to his peers' readiness levels.

b. Impact on Inventory Levels

Unit commanders have a very difficult job. Ultimately, they must perform military missions knowing that the lives of those they lead are highly dependent upon the quality and availability of the equipment and logistics elements that go with them. Users will hold the highest inventories possible, up to and perhaps even over requirements levels. Due to the impact of a lower than average or allowed operational availability in terms of performance appraisals from superiors and professional standing with peers, users may both petition their chain of command to increase requirements levels and pressure maintenance and supply personnel to order more material than allowed.

In addition, the potential exists for users to overstate their readiness capability and operational availability for exercises and operations. This may mask real systemic problems with the quality or performance of a weapon system or even the inability of the logistics pipeline designed to provide adequate spare parts support.

D. CHAPTER SUMMARY

The current DOD supply structure was designed to provide the highest levels of readiness for combat units and their support elements. This system was not designed to promote low inventory levels, and until recently inventory levels were not a major concern. The supply systems of DLA and each service, as well

as performance measures for Item Managers, Inventory Managers and end-item users are not currently structured to trade-off efficiency and/or value for readiness and associated material availability at any cost.

III. ADDITIONAL EXCESS INVENTORY CAUSES

A. INTRODUCTION

Performance measures and associated incentives of Item Managers, Inventory Managers and users are not solely the cause of DOD excess inventory. There are numerous significant and fundamental differences between how the military and commercial sectors conduct business, and a "cookie cutter" approach to applying commercial logistics "best business practices" to the DOD inventory management system cannot and will not result in the most efficient and, more importantly, most effective operation. Simply training in commercial practices and adopting them without understanding fundamental differences between commercial and military operations will not change or improve DOD inventory management culture. GAO agrees that application of all commercial practices is not warranted; DOD should adopt only proven "best business practices that enable the military departments to reduce inventory levels while improving the responsiveness of the supply system to user needs" [Ref. 6:p. 3]. This chapter points out additional causes and origins of excess inventory within DOD, which may not be present in the civilian sector.

B. DIFFERENCES BETWEEN COMMERCIAL AND DOD

1. Unstable Demand History and Unpredictable Forecasting

The military must maintain a constant state of readiness. No one can predict the location or concentration of forces required for the next war or other contingency. In addition, the duration or intensity of operations can be highly variable. Often, military missions are driven by national political objectives in response to global regional crises, and the objectives, not to mention the level of support required, can be moving targets. Attempting to estimate the level of effort required for the cacophony of potential scenarios and contingencies while looking backwards (based on past performance and scenarios) can prove futile. The additional responsibilities recently assigned to the military forces, such as peacekeeping and urban warfare, make it incredibly difficult to forecast future system and spare parts usage rates.

Consistently planned military exercises and training requirements coupled with "best guess" scenarios can be utilized to build inventory-sparing models to support reliability objectives of weapon systems. However, in military terms, the reliability (probability a system will perform satisfactorily for a given time under specified operating conditions) of a weapon system itself can vary significantly based upon usage and a variety of other factors such as the harshness of the operating environment. Many military weapon system components have

procurement lead times measured in months or even years, so without some sort of protection level (safety stock) to buffer both demand and lead time variability, the confidence level of logistical support to mission commanders may be difficult to elevate to a satisfactory level. Thus, when planning for any scenario, the prudent warfighter may request excess inventory in order to attempt to reduce one uncertainty, namely the adequacy of the supply of spare parts to support critical weapons systems.

In addition, weaknesses in forecasting inventory requirements and executing inventory procurement budgets contribute to supply sparing problems. Churn is a term used to describe the condition when unstable demand (among other factors) causes inventory levels to be continually revised and adjusted. Churn in inventory levels results from the introduction of new parts, replacement of old parts with improved versions, evolving experience with new parts, the upgrade of weapon systems, or funding shortfalls or plus-ups. Constant adjustment of the sparing requirements models can cause persistent shortfalls or excesses in spare parts levels.

2. Stockout Costs

Stockout costs in the commercial sector can be measured in terms of lost customers and lost business. In the military, a lost customer can literally mean lost service members or civilian casualties. A lack of spare parts support for critical

mission end-items can prove disastrous. It is not an overstatement to claim that stockout costs within DOD are very high, and this fact will justifiably drive inventory levels higher. Consumer (military user) confidence may be low, and again, the incentive for excess sparing can result.

3. Lack of Suitable Substitutes

National defense serves a public trust in carrying out our national security and military strategy. There is no substitute for national defense. Can the United States Marine Corps use anything other than a tank for mechanized ground assault? And if a tank is lost, is a replacement or newer version readily available on the commercial market? Many weapons systems, components, and equipment have been designed and manufactured to meet military specific needs, and often no demand or need exists for them on the open market. Hence, few commercial vendors desire to utilize their limited manufacturing and capital resources to compete for a specifically targeted market with little or no potential for expanding markets.

4. Lack of Competition

Detailed and cumbersome government procurement regulations may cause suppliers to choose not to do business with the U. S. Government. The withdrawal of potential suppliers reduces keen competition for improved military systems, hardware and support items. In addition, a manufacturer who wins a contract will

desire to make a single production run in order to reduce production and setup costs. Lot sizes will be large and less frequent, since the manufacturer will want to produce other products as well. Very few commercial activities contract with and produce for military activities exclusively. The end result may be contract requirements for large quantities of sparing inventories to be delivered and held by DOD activities.

C. CHAPTER SUMMARY

Incentives of inventory personnel are not the only causes which may make DOD activities increase inventory levels. Other factors include: unstable demand history and unpredictable forecasting; high stockout costs; lack of suitable substitutes; and lack of competition. These issues impact and may limit the ability and efforts of DOD to change from the current, often less than optimal inventory management procedures, to a more integrated and effective approach, objectively analyzing costs and benefits of inventory systems.

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IV. INTERNAL FACTORS THAT IMPEDE CHANGE

A. INTRODUCTION

Performance measures of supply personnel and the fundamental differences between commercial and DOD inventory process are not the only aspects that affect inventory levels in DOD. These issues and tendencies must be recognized and addressed as well, if efficient and effective inventory management is to become commonplace. This chapter discusses some of the additional issues and factors that impede the change process.

B. FACTORS

Factors internal to DOD are issues that DOD has some control over and have the authority to change. There are at least five significant factors internal to DOD that impact inventory management capability.

1. Definition of Excess

One impediment to change is the lack of a single definition of "excess" inventory. A heated debate is ongoing, fueled by GAO reports citing that DOD has excess inventory levels, although DOD does not have a set definition of "excess." For example, the Navy and DLA define excess inventory as the following [Ref. 6:p. 3]:

- NAVY: Any stock above a combination of war reserves, safety level, expected demand during administrative and production lead

times, economic order quantity (EOQ), and the reorder point, plus eight years of demand at current consumption rates.

- DLA: Any stock above six years demand at current consumption rates.

Note that DLA does not consider war reserves, safety stock, economic order quantity (EOQ), reorder point, or administrative and production lead times.

The argument can be made that because of the highly varied strategic and tactical mission requirements each service provides, a DOD-wide "joint" consensus on what constitutes too much inventory may not be arrived at. Despite not having a clear definition of excess, some of the primary reasons for current excess inventory levels are:

1. Weapons System Modifications: When a service purchases a weapon system, it may purchase the number of spare parts it expects will be needed over the anticipated life of the weapon system. However, as the system is modified, the spare parts may become obsolete and thus become excess and often unusable inventory. An associated problem with modifications is that spare parts for the improved weapon system may not yet be available in the logistics pipeline due to poor initial estimates of failure rates, resulting in a shortage of what you want and an excess of what you do not want, perpetuating mistrust in the supply system.

2. Base realignment and closures: Actions have unintended consequences. The "Rightsizing" of the armed forces has decreased demand for many items, resulting in significant levels of supply material no longer required by streamlined (consolidated, closed, decommissioned) activities, and this stock is transferred to and held at other installations. The transfer of inventory results in installations and activities holding inventory levels over their authorized allowances (often called requirements objectives or RO). Hence, excesses can result.

3. Support of Allies: In support of foreign military sales and various treaties, DOD retains some older versions of weapons systems and the associated repair parts needed for logistical support. These inventories are "excess" in terms of U.S. military needs, but are required to fulfil the Security Assistance Program (SAP) mission.

2. Focus on Immediate Results

A second culture-related impediment to change is the brief period of time that military personnel spend in a job or position. Throughout DOD, at every level, from the most junior to the most senior positions, an individual's performance is measured by what was accomplished during his or her tenure in a particular job or position. These performance appraisals support or undermine the possibility of the incumbent receiving future positions of increased responsibility and prestige.

In addition, significant anecdotal evidence supports the contention that the military culture suffers from a "Zero Defect" mentality, where any one sub-par fitness report or performance appraisal automatically eliminates promotion prospects. This mentality minimizes risk taking and the willingness to impart significant change or improvement. Efforts have been made to eliminate this mentality, as evidenced by the Secretary of the Navy, Richard Danzig's instructions to recent promotion boards not to automatically dismiss promotion candidates with blemishes on their records. He stated, "Your charge is to find the

best qualified officers. It is not to find the records that are the most immaculate" [Ref. 8].

Therefore, there is a tendency to focus on short-term, less risky projects that begin to pay off prior to the transfer of the initiator. Long-term projects with more lasting benefits (and where both risk and reward may be much greater) can be ignored if initial investments required are high and credit may go to a successor.

Awareness is the first step in combating this short-term, risk free mentality. Communicating strategic goals and vision throughout the military has improved in the last ten years. As the drawdown continues, military leaders need to objectively focus on streamlining products, processes and structure, with the goal of reinventing the military of the next century as a highly technical and efficient agent of change, supporting national military strategy and objectives. Individual military members need to be empowered and able to effect change.

3. Distrust of the Supply System

A third impediment is ongoing distrust in the reliability of the supply system, resulting in stockpiling and over-prioritizing of requests for spare parts and other secondary items. "Operating forces often do not have confidence in the ability of the supply system to support them, so they hoard items, and deliberately order more than they need" [Ref. 7:p. 13]. This distrust and the fact that a stockout can cost lives results in users occasionally placing a higher priority code on a

requisition than the item warrants, hoping it will result in faster receipt of the item. This practice can hide poor inventory management at the user level, mask actual sparing support requirements for weapon systems, and may result in another unit's readiness being degraded due to its inability to obtain the same item. However, the availability of secondary items is crucial to the readiness of combat and logistics support units not only at the individual level but for the aggregate effectiveness of all fighting forces.

4. Readiness Concerns

An additional factor affecting inventory management is the concern that readiness not be compromised for any reason. The philosophy of the current military supply system is predicated on high levels of combat readiness. It is unlikely this focus will change. The unresolved question of the future role of the military has a side effect of slowing significant change to the supply system pending a set direction for DOD as a whole. As such, DOD is wary about setting or changing priorities while it wrestles with this issue. Meanwhile, the supply system is constrained regarding how best to determine what to stock, how much to stock and the strategic placement of that stock.

5. Lack of Technology

Commercial firms have recognized that capital investment in information technology (IT) systems in order to enhance inventory management, provides an

edge against competitors in the customer service, cost of operations and profitability arenas. Unfortunately, DOD has often lagged far behind. For example, the Navy reported that during Fiscal Years 1996 – 1998, it had lost over $3 billion in in-transit inventory, including some classified and sensitive items such as aircraft guided missile launchers, military night vision devices, and communication equipment [Ref. 9:p. 1]. Often the items are not lost, but end-users are not always routinely reporting receipt of items and this prevents effective use of integrated accounting and logistics systems. And without effective follow-up to determine receipt or delivery to incorrect locations, these shipments may be written off as lost.

The optimal goal is an integrated real-time information technology program designed to link inventory information systems to improve asset visibility and provide inventory redistribution capability, more efficiently identifying and distributing assets. Such technology to support total asset visibility requires a large financial investment to develop and implement, as well as strategic "forward thinking" to field this capability not only individually service wide but at the DOD level as well. Fortunately, the services are making a significant effort to use and improve the Joint Total Asset Visibility (JTAV) initiative, since valuable benefits and outcomes can be obtained, such as limiting unnecessary buys, redistributing assets, reducing inventory and managing the pipeline more efficiently.

JTAV provides the capability for military services and DOD components at every level timely and accurate information on the location, movement, status and identity of equipment and supplies, facilitating improvements in the performance of DOD inventory and logistics practices. Visibility of assets in storage or as they flow from their origins through the long logistics pipeline to the warfighter is imperative. Without asset visibility, significant operational readiness degradation can occur. "When assets in the pipeline are not visible, they are difficult to manage. Property is lost, customers duplicate requisitions, superfluous material chokes the transportation system, and the cycle continues" [Ref. 10:Web]. With JTAV fully implemented, uncertainty in asset location and status diminishes. Inventory Managers can reduce total inventory and cost while improving response time and customer confidence in the supply system will improve. With JTAV, DOD has made great strides using information technology and web based applications to improve asset visibility and real-time transportation information.

C. CHAPTER SUMMARY

Additional DOD factors that impede change or improvement in inventory management capabilities include no common definition of excess inventory throughout the services, focus on immediate results, distrust of the supply system, readiness concerns, and lack of technology. However, significant efforts have been made to encourage more strategic long-term thinking by military personnel

and to utilize information technology (IT) to better provide asset visibility and improve customer confidence in the supply system.

V. USE OF MODERN LOGISTICS INVENTORY PRACTICES BY DOD AND ADDITIONAL PERFORMANCE MEASURES

A. INTRODUCTION AND DISCUSSION

As previously mentioned, innovation by the commercial sector in reducing product cycle time (from order to delivery) and use of just-in-time purchasing procedures have increased efficiency and profitability. In addition, outsourcing of many aspects of the logistics pipeline (purchase, storage, repair, and distribution) have proven effective at reducing overhead. DOD should strive to enhance military readiness while reducing peacetime investment in inventory. This can be accomplished by: buying commercial products (if applicable); adopting proven best commercial practices when warranted; and applying emerging technologies to improve the value of information such as asset and in-transit visibility, electronic data interchange (EDI), and electronic commerce (EC).

Many commodities used by DOD are also commonly used in the private sector. In addition, strategic planning for acquisition has undergone a shift from focusing on newly developed technology in support of weapons systems to surveillance of commercial markets for commercially available products to fill DOD requirements. Thus many of the previously mentioned obstacles (unstable demand history and unpredictable forecasting; high stockout costs; lack of suitable substitutes; and lack of competition) to reducing inventory may not apply.

However, DOD initiatives towards commercial logistics inventory practices should not be adopted without appropriate study; goals should be incorporated, development and testing of systems and procedures should be conducted and proven successful, and then funded first before implementation and fielding. One of the most egregious errors encountered by DOD while "Rightsizing" (reducing infrastructure and manning, utilizing new technologies to incorporate better business practices) is to project expected savings and efficiency goals and consequently reduce funding in advance of the actual savings or efficiencies gained.

The following is a discussion of what types of commodities used by DOD that commercial logistics practices are applicable to and for which commodities they may not be applicable to and reasons why.

1. Commodities Agreeable to Commercial Practices

The military services and DLA are experimenting with and successfully implementing Prime Vendor contracts, where commercial entities agree to deliver specified products within a small range of quantity and delivery schedule variability. The aim of Prime Vendor is to award contracts to commercial vendors who provide inventory directly to customers in time to meet their requirements, thus reducing the need for DOD inventories and resources. Commercial inventory practices for DOD are applicable to these commodities for a number of reasons;

most notably their common use by military and commercial customers, better demand predictability and forecasting, a variety of substitutes and availability, and a robust commercial market for these products in addition to the military market. Some examples of commodities where Prime Vendor is working successfully include subsistence (food) and medical supplies, including pharmaceuticals. Additional commodities where Prime Vendor may apply include tentage and textiles, wood products (bulk lumber) and industrial materials for housing repairs and minor construction and sheet metal. In addition, fleet automotive support may prove applicable to Prime Vendor sparing support if modifications to military vehicles are minimized. A market-oriented supply concept for these commodities enables military inventory and logistics systems to "marry" up to existing markets with existing commercial distribution channels. Leveraging existing private sector capabilities provides a best value approach toward commodities with common use in DOD and commercial businesses.

2. Commodities Not Agreeable to Commercial Practices

Spare parts support continues to challenge DOD Item and Inventory Managers. Forecasting future requirements and variability of demand history are the most significant hindrances that frustrate efforts to effectively and efficiently provide logistics inventory and sparing support. As previously noted, the unique and variable missions, environments, and operational parameters that military

hardware and personnel engage in can make effective sparing difficult, for commercial and DOD inventory managers alike. Prime Vendor and vendor managed inventory concepts for weapons system spare parts may yet prove valuable or effective if the challenges of effective sparing can be met.

B. ADDITIONAL PERFORMANCE MEASURES

As previously mentioned, readiness at any cost may place too high of a burden on funding objectives and the value (quality versus cost) of inventory management and readiness. However, DOD logistics customers are demanding improved performance in the areas of reliability, flexibility, and responsiveness. Additional performance measures which balance customer service, cost, readiness, and sustainability performance objectives should be investigated, and implemented where it makes sense, both militarily and financially.

C. CHAPTER SUMMARY

Many commodities used by DOD are also commonly used in the private sector. Therefore it make good business sense for DOD to adopt modern inventory practices when applicable. If military unique obstacles to more effective inventory management can be overcome, use of commercial systems and practices can meet military customer requirements and reduce the need for DOD inventories and resources.

VI. THESIS SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

The goal of this thesis was to identify and recommend those changes needed in the current incentive and reward structure that would support efficient and effective inventory management within DOD. First, the current DOD supply structure was discussed. The supply system is organized to provide the highest readiness levels possible for combatants and their support elements. Ongoing scrutiny has indicated that DOD's inventory management can be much more efficient. Current performance measures being used in the supply system center around order fill rates and backorder age. These performance measures may affect inventory practices by promoting high onhand inventory levels.

Additional excess inventory causes and fundamental differences between commercial and DOD inventory management practices were discussed, including unstable demand history and unpredictable forecasting, stockout costs, lack of suitable substitutes and lack of competition for DOD and inventory management. In addition, other factors that impede change within DOD inventory management include; no consistent definition of excess stock, often a focus on immediate results only, users and commanders distrust of the supply system, the concern not to compromise readiness at any cost, and the lack of effective technology to consistently provide both inventory asset and distribution in-transit availability.

Finally, the applicability and use of modern logistics practices by DOD was discussed, with a focus on what types of commodities modern logistics practices could be utilized on and what types were not readily susceptible to modern logistics practices.

B. CONCLUSIONS

The following are specific conclusions drawn from this study:

1. Cultural Changes in an Effort to Improve Performance of DOD Inventory Management Will Not Come Easily

Often rewards, expectations and existing policy hinder improvement efforts. All personnel associated with inventory management must adopt a more long-term strategic vision in order to proactively review the current logistics environment and suggest changes that utilize better inventory management systems and initiatives. In addition, uncertainty with respect to the future roles and missions of the U.S. military can cause inventory and sparing support to perform less than optimally. Excess inventory strains funding, confidence, the ability of managers and their staffs, and most importantly, threatens effective critical mission support.

2. Commercial Inventory Practices Should Be Used Where Practical

Applying proven commercial logistics practices to DOD inventory systems may result in a successful endeavor to challenge and defeat many significant inventory management difficulties and issues. The dynamic environment DOD

operates in today (profound changes in organizations, budgets, roles and missions, infra-structure, manpower), requires proactive logistics influence and inventory management systems which emphasize effective sparing support. Innovation and improved responsiveness, focused on customer satisfaction, from the private sector can be used in DOD inventory management where practical.

3. DOD's Use of Information Technology Will Improve Inventory Reduction Efforts

The use of Information Technology applications such as Joint Total Asset Visibility (JTAV) is an enabler for DOD to improve asset visibility, real time inventory tracking, and most importantly, to enhance consumer confidence in the military supply systems. However, without cultural change, the benefits of innovation are lost.

C. RECOMMENDATIONS

1. Review Performance Measures and Incentives for Supply Personnel and Future Roles of the Military

Emphasis on maximizing requisition order fill rate and minimizing back-orders is not sufficient. The supply systems of DLA and each service, as well as performance measures for supply personnel and end-item users should be more structured to balance inventory efficiency and value rather than readiness and associated material availability at any cost.

In addition, DOD and the National Military Strategy must better define the future roles and missions of the U.S. military. Without a clearer purpose or direction, DOD will be unable to determine the changes needed that will provide more effective inventory and logistical support.

2. Commercial Inventory Practices

DOD should continue to implement commercial logistics practices where actual savings will occur without significantly impacting operational readiness. Independent inventory and distribution systems may not be warranted when existing commercial products are utilized by both military and private sector markets.

3. Joint Total Asset Visibility (JTAV)

DOD should continue implementing information technology initiatives, fielding and integration in support of JTAV systems. JTAV is critical to the success of military inventory management, and is essential to restoring customer confidence and improving inventory management efficiency. Consistently providing both inventory asset and distribution in-transit availability information is critical to the warfighters at every level.

LIST OF REFERENCES

1. High Risk Series: Defense Inventory Management, United States General Accounting Office (GAO/HR-99-1, January 1999).

2. Defense Logistics Agency, "DLA Fact Sheet," [http://www.dla.mil/ public_ info/fact_sheet.html], November 1999.

3. Defense Logistics Support Command Homepage, [http://www.supply.dla. mil], December 1999.

4. Defense Logistics Support Command, "History of the Consumable Item Transfer," [http://www.supply.dla.mil], December 1999.

5. Naval Supply Systems Command, "The NAVSUP Claimancy," [http:// ldapl.fmso.navy.mil/corpinfo/custupdate98page2.html], May 1999.

6. General Accounting Office Report, *"Defense Inventory: Improved Management Framework Needed to Guide Navy Best Practice Initiatives,"* GAO/NSIAD-00-1, October 1999.

7. Kang, Keebom, *DOD Inventory Management Cultural Changes and Training in Commercial Practices*, Naval Postgraduate School, 1998.

8. Burlage, John, *Promotion Boards Looking More Kindly on Human Error*, Navy Times, 17 May 1999.

9. General Accounting Office Report, *"Defense Inventory: Navy's Procedures for Controlling In-Transit Items Are Not Being Followed,"* GAO/NSIAD-99-61, March 1999.

10. Joint Total Asset Visibility Office Homepage, "JTAV Strategic Plan," [http://www.acq.osd.mil/log/jtav/strat-plan/index.htm], January 1999.

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BIBLIOGRAPHY

Eltringham, Pete, CAPT, SC, USN Seminar Lecture: "Defense Logistics Agency: Supply Chain Integration with Emerging Technology," presented at the Naval Postgraduate School, Monterey, California, 13 November 1998.

Emahiser, James B., Assistant Deputy Undersecretary of Defense for Material and Distribution Management, prepared remarks, "Inventory Management Crucial to Mission Success," presented to the National Security, International Affairs and Criminal Justice Subcommittee, House Government Reform and Oversight Committee, 20 March 1997.

Ballou, Ronald, H., *Business Logistics Management*, 4th ed., Prentice Hall, 1999.

Blanchard, Benjamin S., *Logistics Engineering and Management*, 5th ed., Prentice Hall, 1998.

Kang, Keebom, *DOD Inventory Management Cultural Changes and Training in Commercial Practices*, Naval Postgraduate School, 1998.

Klapper, Larry S., *Supply Chain Management: A Recommended Performance Management Scorecard*, Logistics Management Institute, 1999.

Moore, Nancy, Y., *Material Distribution; Improving Support to Army Operations in Peace and War*, RAND, 1997.

Ramey, Timothy L, *Lean Logistics*, RAND, 1999.

Tersine, Richard J., *Principles of Inventory and Material Management*, 4th ed., Prentice Hall, 1994.

Zimmerman, Dennis, L., *Consolidation of DOD Inventory Control Points Under the Defense Logistics Agency; An Analysis of the Risks and Benefits*, Logistics Management Institute, 1997.

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