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DETERMINING OUTSOURCING POTENTIAL FOR THE INVENTORY MANAGEMENT OF NAVY REPAIRABLES

by

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December, 1996

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**DETERMINING OUTSOURCING POTENTIAL FOR THE INVENTORY
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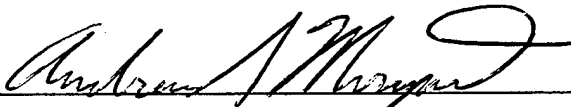
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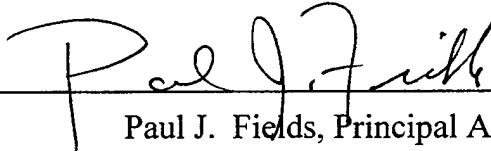
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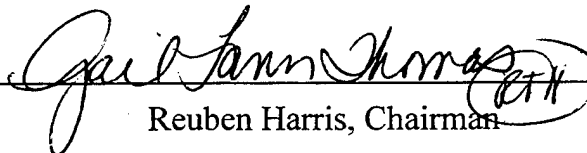
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ABSTRACT

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I. INTRODUCTION

For the purpose of this thesis, “outsourcing” refers to contracting with commercial activities to perform a function that is currently performed by DoD activities. DoD will maintain responsibility for and monitor the contractor’s performance. “Repairables” refers to items that are repaired by either DoD or commercial sources and re-issued to DoD activities. “Non-repairables” are items that are disposed of when they fail. Items are repaired for the following reasons: the item is less expensive to repair than replace, the item has a long procurement lead time, or the item is no longer procurable.

This thesis examines the potential to outsource the inventory management of the Navy’s repairable items to commercial companies. The costs of various degrees of commercial inventory management of repairables are developed and compared to the cost of organic management. This thesis focuses on the costs of inventory management of repairables as performed at the Inventory Control Point and does not address the military necessity of Navy versus commercial repair capability.

A. RESEARCH QUESTIONS

The following primary and secondary questions are examined in this thesis:

Primary Question: What is the potential for outsourcing the inventory management of Navy repairables?

Secondary Questions:

1. What are the costs and benefits for the Navy to manage repairable inventory items organically?
2. What are the costs and benefits for commercial sources to maintain the inventories of Navy repairables but not set inventory levels or conduct demand forecasts (partial outsourcing)?
3. What are the costs and benefits for commercial sources to fully manage Navy repairable items (total outsourcing)?
4. What are the criteria to determine if a repairable item should be managed commercially?

B. DISCUSSION

With the recent success of commercial inventory management of subsistence and medical items using "Prime Vendor" programs, the costs, benefits, and feasibility of outsourcing the management of all inventory items should be examined. The Navy Inventory Control Point (NAVICP) currently manages the inventory of 110,000 repairable line items at Mechanicsburg and 65,000 items at Philadelphia [Ref. 1]. Forty percent of these items are repaired by Navy shipyards and depots, and sixty percent are sent back to the vendor for repair. However, the entire inventory management function (forecasting, level setting, purchasing, repair scheduling, etc.) is conducted by the NAVICP.

Even though the management of repairable items is much more complicated than the initial programs with food and medical supplies which have obvious non-DoD markets, the

commercial manufacturers have much to offer in the field of inventory management of repairable items. For example, commercial manufacturers provide much of the data used to set the initial levels, predict failure rates, and estimate mean repair time. In most cases the commercial sources provide the Initial Supply Support (ISS) to new weapon systems until the Navy is ready to assume that responsibility. For these reasons and because of past successes, the NAVICP has started looking into the issue of outsourcing repairables inventory management. The following three alternatives are being considered: no outsourcing, partial outsourcing, or total outsourcing.

The cost of Navy management of repairable inventories is reviewed in this thesis. The emphasis in this area is to predict how much inventory management costs would change with outsourcing.

The NAVICP began prototyping the second alternative of partial outsourcing in September 1996. The prototype uses Commercial Asset Visibility (CAV) with the Hughes corporation. CAV is a software program that electronically links the commercial vendor to the NAVICP. The NAVICP will manage the inventory and have visibility of "A" condition items at Hughes. Requisitions can be referred directly to Hughes who will ship the item directly to the customer. This thesis compares and quantifies the cost savings of the prototype to the other alternatives for partial outsourcing.

The NAVICP recently received a proposal from Hughes Aircraft Company to completely outsource the inventory management and repair function for 23 items of the Ship Self Defense System MK 1. The basic guidelines for complete Direct Vendor Delivery (DVD) outsourcing are that the NAVICP pays a flat rate and demands a certain service level and delivery time be

maintained. The commercial company then sets the levels and manages the inventory. This thesis reviews the Hughes proposal and others to determine the benefits of complete outsourcing.

C. SCOPE

This thesis focuses on the three alternatives of outsourcing. First, complete Navy management of the inventory. Second, partial outsourcing, where the Navy manages the inventory levels and commercial vendors maintain the inventory. And finally, total outsourcing, where the Navy sets the service level requirement and the commercial vendor sets the inventory levels and maintains the inventory. The emphasis is on the costs and benefits of each alternative. The goal of this thesis is to develop a model to determine when outsourcing would be beneficial and what level should be considered.

This thesis does not include a detailed analysis of the cost to repair items commercially verses organically. This thesis also does not analyze the benefits and concerns of maintaining a core competency in repair capability. The research focused on the management of repairables inventory and not on Navy or commercial repair capability.

D. METHODOLOGY

This thesis begins with a review of previous outsourcing initiatives. The Prime Vendor programs with subsistence and medical items. The similarities and contrast between these items and Navy repairables is discussed. For this section, the research relied on reports and interviews from various DLA sources including the Defense Personnel Supply Center and the Defense Operations Research and Analysis Center.

The first outsourcing alternative, Navy management, is analyzed with a focus on how the Navy system works and how much it costs. Research in this area relied on NAVSUP Publication 553, "Inventory Management, A Basic Guide to Requirements Determination in the Navy," NAVICP and NAVSUP financial and organizational data in operating cost and surcharge calculation, and interviews with NAVICP personnel.

Research for the second alternative, partial outsourcing, relied on business cases developed by NAVICP, interviews with NAVICP personnel and vendors, proposals from vendors, and data from the current prototype with Hughes. This data results in a comparison of the costs and benefits of partial outsourcing.

Research for the third alternative, total outsourcing, relied on proposals from vendors, and interviews with vendors, NAVICP personnel, and consultants. This information leads to a costs and benefits analysis as well as a feasibility assessment of total outsourcing.

The information from the previous chapters is combined into a model that determines when and at what level outsourcing would be beneficial. Conclusions are drawn based on an objective analysis of the data.

II. REVIEW OF PREVIOUS OUTSOURCING INITIATIVES

To fully appreciate the analysis of outsourcing initiatives, a review of why DoD is considering changing its inventory policy is appropriate. The DoD has always managed an enormous inventory of material. This inventory is of course the target of much criticism by DoD and non-DoD sources. This chapter reviews the reasons for considering change and then reviews the initial outsourcing initiative, Prime Vendor.

A. REASONS FOR CHANGE

The primary reason DoD is criticized for its inventory is based on cost effectiveness due to size, not effectiveness of meeting the customers needs. The inventory at 77.5 billion dollars in 1993 is the largest in the world [Ref. 2]. The interest in analyzing and justifying the size is not new. The inventory grew by 60 billion dollars from 1980 to 1988 prompting the Chairman, Subcommittee on Governmental Affairs, to ask the GAO to examine DoD's logistic's practices [Ref. 3].

When the Soviet Union dissolved in the late 80's, the desire to realize a peace dividend by reducing DoD and its logistic support increased. The public began to openly criticize the Defense Department for "...having wasted tens of billions of dollars filling warehouses with stockpiles of items...things the military doesn't need and in some cases doesn't even know it has purchased" [Ref. 4]. GAO did not have to look far to find numerous examples of inventories which exceeded requirements. In one maintenance facility, GAO found a retail level inventory

sufficient to meet two years of demand backed up by another two years worth of wholesale level inventory. In another example, GAO reviewed 27 consumable items worth \$20 million and found quantities sufficient for 21 years of demand. Out of the \$27 million sample, items worth \$11 million were excess to DoD's needs. [Ref. 3] Even though many of the excess inventories are due to DoD downsizing and the resultant loss of demand, the fact that DoD has a large inventory with significant excess is not disputed by DoD.

The inventory management practices of DoD are also the source of much criticism. While commercial practices have changed significantly over the last 20 to 30 years, DoD has continued to use essentially the same method. DoD uses the Economic Order Quantity formula which was first published in 1915. An August 1993 GAO study of six successful commercial companies, *Defense Inventory, Applying Commercial Practices Should Help Reduce Supply Costs*, revealed that many academic logisticians and successful private companies believe this formula to be antiquated and undesirable. Many of the assumptions, especially the assumption of constant demand do not fit today's business operations. DoD's holding and ordering cost used to calculate the optimum order quantity are not current nor accurate and the procedure for calculating the obsolescence rate is not valid according to GAO. GAO then goes on to recommend some alternative methods: the Wagner-Whitin algorithm and the Silver-Meal heuristic models which minimize cost for varying demand items. However, GAO fails to mention that while the alternative methods work well with varying demand, the demand must be known and of course DoD's demand is not deterministic. Taken to the extreme, DoD would not maintain a "war reserve" if it knew when the war was to occur. [Ref. 5]

DoD is reviewing the Silver-Meal heuristic and other models in an effort to develop a forecasting model to accurately predict the varying demand. But, implementing a forecasting model which will work well on hundreds of thousands of line items may not be as easy or cost effective as GAO proposes. The August 1993 GAO report is very critical of DoD's methods, but does not offer a viable alternative model to calculate stocking levels and reorder points.

In studies on medical item management, subsistence, maintenance repair levels, purchasing practices and many more, GAO recommends testing commercial practices in the DoD. The primary means for changing the flawed culture in DoD is through updating the training programs to stress modern logistic concepts such as just-in-time and direct shipment [Ref. 5]. While GAO and other sources do acknowledge that DoD is moving in the right direction, GAO feels DoD has been inconsistent in applying commercial practices [Ref. 5].

On the positive side, DoD's inventory has decreased. From 1989 to 1993, the inventory decreased in value by \$11.2 billion [Ref. 2]. However, this decrease has not kept pace with the downsizing of operational forces. DoD basically concurs with all the GAO reports concerning the size and management practices of its inventory and understands the need to consider new alternative approaches. The most popular new alternative is the Prime Vendor (PV) concept.

B. PRIME VENDOR

Prime Vendor is successfully being tested or utilized for the inventory management of several DoD items. In this section, the Prime Vendor concept is reviewed and then two examples of Prime Vendor are discussed.

1. The Prime Vendor Concept

Basically, the Prime Vendor concept consist of contracting out the inventory management function to a regional vendor. The contract is centrally managed, normally by the Inventory Control Point that formerly managed the inventory, and is awarded for multiple years. Payment to the vendor is based on costs plus a fixed fee. The costs of the items are controlled by the contract and the fixed fee is based on a percent of the total value of items sold. The desired service level and delivery time frames are specified in the contract. Penalties and incentives can also be negotiated into the contract.

The vendor assumes all responsibility for setting inventory levels and meeting service level requirements. After the contract is awarded, the vendor is supplied with all of the demand data and forecasts available to the ICP. Inventory currently on hand at DoD can then be consumed or transferred to the vendor for distribution to customers. The contract should specify the means to provide the vendor with any future demand data such as projected surges in demand. The contract should also specify the degree to which the vendor is responsible for surge requirements. For example, some proposals only hold the vendor liable for a certain percent surge in demand. Any demand requirement above the specified percentage would not be subject to a penalty for late delivery.

For Prime Vendor to work effectively, an automated means to transmit demand requirements to the vendor is necessary. An efficient means to order material allows the vendor to meet quick response time requirements and maintain smaller inventories at the vendor and customer levels. In some cases, an automated method already exists in commercial industry and the vendor can expand capability to include DoD. In other cases a centralized DoD activity may

develop the automated method for use by DoD and the vendors. To make the transition to Prime Vendor painless to the fleet customers and avoid multiple requisitioning systems, the automated ordering system should be incorporated into the customer's current requisitioning system.

The goals of Prime Vendor are to reduce inventory, increase customer satisfaction, and reduce material prices. The DoD inventory system has multiple (two to four) layers of inventory. The suppliers maintain an inventory and sell to the ICPs who maintain a wholesale level of inventory at numerous depots across the country. The ICPs issue to either the customers or in some cases to an intermediate level (base warehouses of food, overseas allowance list, etc.) who then issue to the customers.

Under Prime Vendor, the wholesale and intermediate layers of inventory, with the possible exception of a war reserve level, are eliminated and the vendor issues directly to the customer. Customer satisfaction improves because the customer receives items direct from the vendor with a faster response time than under the current system. In many cases the products are better quality because they have not been sitting in the DoD inventory system, or the vendor offers a wider variety of commercially available products. And finally, because the inventory is smaller and less expensive to maintain, the prices of the items to the customer are less.

For Prime Vendor to be cost effective, the decrease in the cost recovery factor or surcharge under the current system must be greater than the fixed fee awarded to the vendor in the contract. The following examples of Medical Prime Vendor and Subsistence Prime Vendor should further explain how the goals of Prime Vendor are achieved.

2. Prime Vendor Examples

Many commodities are being considered for the Prime Vendor concept but the medical and subsistence transition to Prime Vendor are the first major prototypes. The Defense Personnel Support Center (DPSC) is the inventory control point for both medical and subsistence items. Under Prime Vendor, DPSC's responsibilities shifted from a wholesale level inventory manager to contract management of a commercial-based JIT inventory system. To better explain how Prime Vendor works and the potential benefits, this section focuses on the contract award and ordering process under Medical Prime Vendor and the effects on inventory levels and customer service under Subsistence Prime Vendor.

a. Medical Prime Vendor

In January 1993, Medical Prime Vendor (MPV) was created with the award of a five year, \$100 million contract to McKesson Corporation to supply prescription drugs to 11 hospitals near the Washington D.C. area [Ref. 7]. The Directorate of Medical Material, DPSC, awards and monitors the performance of vendors in 24 geographical regions across the United States, Asia, Europe, and Panama. Each region has two Prime Vendor contracts, one for pharmaceutical items and one for consumable medical and surgical supplies, that provide support to medical treatment facilities (MTFs) in their region. By the end of FY 1995, six medical and surgical contracts covering six regions and 20 pharmaceutical contracts covering 22 regions had been awarded [Ref. 8].

The first step in establishing the Prime Vendor contracts is to develop a Distribution and Pricing Agreement (DAPA) with pharmaceutical manufacturers. The DAPAs list all the items to be covered under the Prime Vendor contracts and establishes ceilings on

prices the manufacturers can charge. DPSC then contracts for a vendor using the competitive bid method. The contract will specify required delivery times (24 hour delivery six days a week), minimum fill rates (95 percent), procedures for informing customers of status (within 2 hours), procedures for emergency order delivery (within six hours), and procedures for contract payment [Ref. 9].

The contract with the vendor is a "modified requirements contract" which represents an agreement to purchase an approximate amount annually. The 26 Medical Prime Vendor contracts currently in place represent estimates of \$114 million purchases of medical and surgical items and \$908 million purchases in pharmaceuticals annually [Ref. 8]. The individual requirements are submitted by the MTFs.

The ordering procedure under Medical Prime Vendor is efficiently conducted through an automated means provided by the vendor. MTFs are required to obtain any item listed in a DAPA computer catalog from their vendor. The catalog contains the manufacturers and their prices. MTFs select the items they need from the catalog and place the order via electronic data interchange (EDI) to the vendor with an electronic copy to the payment activity, DPSC. The vendor then processes the order and sends an acknowledgment to the MTF and an invoice to DPSC via EDI. The vendor delivers the material within 24 hours to the MTF. MTFs are responsible for verifying daily the accuracy of the receipts to DPSC. DPSC then pays the vendor via electronic fund transfer and bills the MTFs, completing the paperless ordering process. [Ref. 9]

The major benefits of the Prime Vendor concept: reduced inventory, increased customer satisfaction, and reduced prices, have been achieved in Medical Prime Vendor

according to an audit conducted by the Inspector General in May 1996. Wholesale level inventories have decreased from \$333 million in March 1993 to \$206 million in September 1995. MTFs are maintaining smaller retail level inventories because they order in smaller quantities and more frequently from vendors that deliver faster and with more reliability. Of the 294 MTFs under Prime Vendor which were surveyed or visited, the Inspector General found that they were very satisfied with the vendor's service. Particularly satisfying to the MTFs were the broader range of items available, faster delivery times, and the electronic ordering and billing processes. Finally, the material purchased through Prime Vendor is generally less expensive than the same item purchased from the DoD central supply system. DPSC includes a 20 percent surcharge for all medical items. The Prime Vendor surcharge is from 4.5 to 7.5 percent for medical and surgical items and .25 to 1.9 percent for pharmaceutical items. The Prime Vendor surcharge includes the one percent DPSC fee and the vendor distribution fee that varies with each contract. [Ref. 8]

b. Subsistence Prime Vendor

The contract and ordering procedures for Subsistence Prime Vendor (SPV) are very similar to Medical Prime Vendor. The Defense Personnel Support Center (DPSC), located in Philadelphia, PA, purchases approximately 90 percent of the subsistence consumed by the Armed Forces [Ref. 10]. Founded in 1965 to centralize the function of subsistence purchases, DPSC has remained virtually unchanged despite many improvements in commercial food distribution. DPSC also provides food for overseas installations and numerous non-DoD customers.

The flow of subsistence under the current system is a four-tiered process. DPSC purchases subsistence from a variety of suppliers and stores the semiperishable food (dry and canned goods) in one of four depots, and perishable food (fresh and frozen fruits, vegetables and meat) in one of 21 Defense Subsistence Offices (DSO) located across the country. The main customers of DPSC are the base warehouses who maintain their own inventory and issue to the end-users (ships, dining facilities, etc.).

DoD inventories are large compared to demand, and stock turnover is consequently low. The DPSC inventory, worth in excess of \$132 million, can fill approximately 82 days of DoD demand. Base warehouses maintain enough inventory to meet approximately 45 days of demand at a monetary value in excess of \$200 million. The end-users maintain different amounts of inventory: Navy shore facilities maintain 32 days, Navy ships maintain 45 days, and Army dining facilities maintain 3 days. DPSC held items may stay in their warehouses for up to two years or more. The DPSC inventory turns over less than twice a year. [Ref. 10]

There are many inefficiencies which contribute to the excessively large inventories. There is no incentive for DPSC to become more efficient because defense activities must purchase from them unless the items are less expensive from other sources. They essentially enjoy a monopolistic market. DPSC uses long range forecasting to plan inventory levels due primarily to a 120 to 205 day procurement lead time. DPSC also requires the base warehouses to order 30 days in advance. [Ref. 10] In turn, base warehouses increase their inventory size because they feel DPSC is unreliable. Services in the same location often duplicate the base warehouse function because there is little or no coordination between them. Finally, DPSC does not maintain visibility of items in the base warehouses.

The cost of operating the current system is excessive and not entirely accounted for in the DPSC prices. DPSC uses a 16.6% (Fiscal Year 1993) surcharge to cover the cost of procuring and distributing food. The costs of operating the base warehouses and distribution to the end-users are not specifically recorded. DPSC spends approximately \$64 million each year to operate its depots and DSOs. [Ref. 10]

In response to another GAO report on DOD subsistence inventories, DLA conducted a test in fiscal year 1995 of the Prime Vendor method in a four state region (Alabama, Georgia, South Carolina, and Florida). They separated the area into five zones and awarded each zone a Prime Vendor contract. Subsistence Prime Vendor Interpreter (SPVI) software, the automated means to order and bill items via Prime Vendor, was developed by DPSC and used in 90 ordering locations. Prime Vendor was phased in from December 1994 to April 1995 to allow for SPVI installation and training. [Ref. 11]

The potential cost savings look very promising. DLA did not count as savings any reduction in personnel staffing or savings by eliminating any warehouses. The savings in the test were mainly from the one-time savings of \$18.7 million due to inventory reduction across all five zones. Even counting the entire cost of developing and installing SPVI, the test resulted in a net savings of \$12.1 million. [Ref. 11] The inventory reduction results from the reliance on the vendor and consequently the ability to lower base warehouse and eventually wholesale inventory levels. Because customers have confidence in quick deliveries with high fill rates from the vendors, they do not feel required to maintain high inventory levels themselves.

Transportation cost savings accounted for \$914,000 over a six month period. The transportation savings were calculated by the reduced amount of transportation required from the

DPSC wholesale level to the base warehouses. Because the vendor delivers directly to customers, DPSC had no transportation expense during the trial. The cost savings from the reduction in transportation cost from the base warehouses to customers were not included because information on historical cost was not available. [Ref. 11]

The Prime Vendor trial also reveals the potential for substantial savings in warehouse space, personnel, and other direct costs. The base warehouses which reduced their inventories during the trial realized a forty percent space reduction. Personnel requirements were reduced by over fifty percent, and other direct costs were reduced by 40 to 55 percent. [Ref. 12]

An interview with the customer service representative at Naval Station Mayport, Florida, revealed that the customers are also very pleased with Prime Vendor. The ships unanimously concur that "... the quality has improved 100%." The vendor in Mayport, Beaver Street Foods, increased the variety of items available to the ships by 25 percent, adding many customer desired commercial products. [Ref. 13] The delivery time was reduced from ten days to two days for fleet customers. In Mayport, only 2 of 175 deliveries were interrupted by the ship's schedule and the base support activity was able to take receipt of the items for a later delivery. [Ref. 14]

The Medical and Subsistence Prime Vendor implementations demonstrate that commercial management of DoD inventories is possible and in some cases provides reduced inventories, increased customer satisfaction, and reduced prices. Even though the savings and benefits may not yet be completely quantified, the outcomes of the Prime Vendor programs look promising. Repairables, however, are much more complicated to manage than items such as medicine and food which have enormous commercial markets, an established commercial

industry, and more constant and determinable demand. The next section reviews how the Navy manages repairable items and the costs associated with Navy management.

III. NAVY REPAIRABLE ITEM MANAGEMENT

Managing the inventory of repairable items is very complex and dynamic. This chapter describes how the Navy performs inventory management and at what financial cost. The Navy Inventory Control Point located at both Mechanicsburg and Philadelphia, Pennsylvania, manages over 175,00 repairable items [Ref. 1]. Repairable items are parts that can be economically repaired and returned to ready for issue condition (their original use). Consumable items are disposed of after they break. The following inventory management functions are discussed in this chapter and are considered applicable to outsourcing: new item support, the management information system utilized in inventory control, the Navy's inventory model for setting levels and order quantities, the ICP procurement process, and physical distribution.

In addition to inventory management the ICP also perform several "central" supply support tasks such as:

1. Cataloging (the collection and management of technical information),
2. Identification (properly identifying systems, equipment, and spares),
3. Standardization (effort to procure standardized weapons system),
4. Inspection (ensuring the accuracy of Navy stock inventories),
5. Quality Control (validating that procured material meets the highest standards), and
6. War Reserve Planning (planning for mobilization and item readiness) [Ref.15].

These tasks must be centrally performed for all Navy items. The associated costs of performing them are identified and separated from the costs of inventory functions which are outsourced.

The Navy surcharge is used in analyzing the costs of performing inventory management at an ICP. The surcharge is a percent mark-up on Navy managed items to cover the costs of operations. However, some functions are mission funded and therefore not covered by the surcharge. This research includes a review of these functions but does not consider them to be applicable to outsourcing inventory management since they must be performed centrally for all Navy repairables and not individually for each item.

A. THE NAVY INVENTORY MANAGEMENT SYSTEM

The tasks of the Navy Inventory Control Point (NAVICP) are not only widely varied but are also extremely complex. This section focuses only on the five tasks which the author considers to have partial or full outsourcing potential as inventory management functions. First, when new items are first introduced to the Navy support system they must receive special support until the normal supply channels are established. Second, the NAVICP operates a management information system including a mainframe software program, Uniform Inventory Control Program (UICP), which records demand, makes forecasts, and maintains inventory position data. Third, the NAVICP designs and runs inventory models. Fourth, the NAVICP operates a procurement process to maintain its inventory. And fifth, the Navy and DLA maintain the physical distribution functions of storing and moving material. These five functions are briefly reviewed to provide an understanding of how an ICP works so that when the research reviews outsourcing inventory management, the comparison of commercial and organic operations of the functions is clear.

1. New Item Support

New item support is divided into two categories: Interim Supply Support (ISS), and provisioning. New items are usually brought into the system via a new weapons systems acquisition program. The new programs are managed by the hardware systems commands who supervise the design and execution of the program. The ICP who has control over the item is involved from the beginning in planning the logistic support for the system. Interim Supply Support is the logistics support provided by the contractor when the system is first operational. Provisioning is the support provided by the ICP which covers logistics needs including cataloging identification, and initial wholesale system procurements until the normal supply channels are established.

The inventory management aspects of ISS and provisioning are similar and connected. Both ISS and provisioning determine inventory levels from estimates on failure rates and number of systems in use. The estimates are derived from design engineers' estimates, manufacturing estimates, historical data of like components, and any other available source of information. The program manager provides the estimate of units on-line and requiring support. Under ISS, the contractor provides the parts support using the above information. Under provisioning, the ICP provides the parts support picking up where the contractor left off and continuing until the normal supply channels are established. The ICP also uses the information from the hardware system command to plan for budgeting and time-phasing of procurements. The "central" supply support tasks are also performed during provisioning.

2. The Management Information System

Developed in August, 1965 by the Fleet Material Support Office (FMSO) which works for the Naval Supply System Command, UICP is the system of computer files and programs that the ICP uses to manage inventory items [Ref. 15]. As configuration manager, FMSO is responsible for the system design, ADP analysis, programming and documentation of UICP. The UICP is maintained on IBM mainframes located in Mechanicsburg, PA. Information on hundreds of thousands of line items is maintained in UICP files. The line items are grouped together in several categories to ease the operation of running programs.

The UICP gathers data for the inventory managers to utilize in setting levels and order quantities. The data collection has two primary forms, demand data and inventory position data. Demand data is fed into UICP from various stock points and end-users in the form of requisitions. The UICP is connected to all of its customers in real-time or near real-time. Many customers are on the same wide area network as UICP and continuously exchange information. Other customers, ships at sea for example, communicate one way via satellite to the UICP. Demand data also include expected demand programed into the UICP with Planned Program Requirements (PPRs). PPRs are input with data from the hardware systems command, fleet units, or any other source which can let the item manager know of a planned demand which could not be forecast based on historical data. The inventory position data is the flow of information that keeps UICP updated on the actual receipt and issue of parts. Updates to UICP are made daily by the stock points.

The UICP uses the demand data to forecast future demands. Data on actual usage is collected by quarter. The data is screened through a file to determine if it is within control limits.

The control limits vary but are normally within ± 2.5 to 3.75 standard deviations of the forecast. To prevent continuous and costly minor fluctuations in inventory levels (inventory churn), the NAVICP does not usually re-forecast demand if the actual demand data is within control limits. When required, the demand for future quarters is forecast with an exponential smoothing model using a smoothing constant of 0.4 for demand showing a trend and 0.2 for demand without a trend. [Ref. 15]

3. The NAVICP Inventory Models

The time proven Economic Order Quantity (EOQ) model is utilized by the NAVICP to determine order quantities and levels for both new procurements and carcass repairs, repair of damaged Navy owned repairables. The annual forecasted demand for an item minus the annual forecasted repair quantity determines the annual demand of new item procurements. Similarly, the annual forecasted demand minus the predicted number of items lost or damaged beyond repair determines the annual demand for item repairs. The holding cost rate is twenty-one percent, made up of 10 percent cost of money, 10 percent obsolescence rate, and one percent warehousing costs [Ref. 15]. The ordering cost includes the costs of contracting for new items and for repair. The NAVICP calculates an average figure for buys and repairs annually. The order levels are then determined by calculating the demand during lead time plus safety stock. The safety stock calculation uses an estimate of the cost of a stock out and a combination of the variability of the demand and lead times for both buys and repairs.

Determining order quantities and reorder points for repairables is very complex and unique to the DoD. A model must be used to calculate quantities of new items to purchase and a separate model to determine quantities of existing carcasses (broken items) to repair. The models

must be linked together to avoid a carcass constrained situation so the repair model does not recommend repairing more items than available. NAVSUP linked the two EOQ models together by integrating the calculation of reorder, repair, and safety stock levels. The integrated model basically uses a weighted average of lead times in the reorder and repair level calculations and a weighted average of the item cost in the safety stock level calculation.

The NAVICP subjects the model recommendation to numerous constraints in an effort to incorporate some of the constraints of reality into the EOQ assumptions. The EOQ model assumes that no quantity discounts exist. Quantity discounts do of course exist, but the vast amount of information that would have to be recorded on the hundreds of thousands of line items requires storage and computation support beyond the NAVICP's capability. To take advantage of the discounts and better manage the purchasing workload, the amount of the order quantity is constrained to not less than two quarters worth of demand [Ref. 16]. This constraint also corrects for errors caused by ignoring actual contractor order and set-up costs. The EOQ, utilizing a fixed item price, sometimes recommends ordering or repairing a quantity that is much smaller than what is profitable to the contractor. Conversely, the ceiling on the quantity ordered is also limited. NAVSUP constrains the maximum amount of an order to six quarters of demand and in some cases sets limits on the maximum reorder point in an effort to keep inventory levels down and reduce holding costs. [Ref. 15]

The EOQ assumes that demand is known and constant. Of course, demand is not constant and not deterministic. However, the item managers utilize the Planned Program Requirements information, trend analysis, and their experience to adjust EOQ recommendations

for probable changes in demand. The item manager's recommendation is screened against available funding and forwarded to the contracts and acquisition department.

Repair quantities are subjected to a Repair Scheduling program which groups requirements to enable depots and item managers to better schedule repair work. Item managers work closely with repair depots for active repair items to facilitate level workload planning.

4. The NAVICP Procurement Process

The NAVICP procurement process is subject to many government regulations intended to maximize equitable treatment of the vendors and the benefit to the Navy. These regulations often add much time and costs to the procurement effort. To establish a contract a statement of work must first be developed which lists the criteria for the vendor. Unless a sole source is desired and can be justified in accordance with the Federal Acquisition Regulations (FAR), the contract is advertised in a Request for Proposal. A source selection plan is developed to aid in selecting the best contractor. The formal source selection process reviews the submitted proposals and narrows the field by identifying proposals within the competitive range. After possible discussions with vendors in the range, a final selection is made and the Contracting Officer enters into negotiations with the chosen vendor and awards the contract. Of course, contracts can and are awarded for more than the purchase or repair of individual items. The funding for repairs differs with different items. Some items are funded in advance and the repairs are sent directly to the contractor by the item manager. Others must be contracted for separately and paid for at the completion of the work by the repair facility. Protests from vendors not selected in the contracting process can often delay the award of the contract.

5. The Physical Distribution Function

The inventory management of Navy repairables includes monitoring the inventory position at wholesale and retail levels and filling requisitions using all available inventory items and transportation assets as necessary. For the purpose of outsourcing Navy repairable inventory management, this research only analyzes the wholesale physical distribution functions. The Defense Logistics Agency manages the storage and most of the transportation of wholesale inventory items. The items are stored in warehouses across the country. Basically, the NAVICP determines how many items to retain in wholesale inventory and which depot to store them in. DLA then charges the Navy for the storage and transportation service. Storage facilities are all organically owned and operated. Transportation assets utilized in the continental United States are a mix of organic and commercial, but mostly commercial, carriers. Transportation outside the continental United States is not analyzed because the commercially managed repairables which are outsourced will be shipped to DoD transportation facilities which will fill these requirements.

B. THE NAVY INVENTORY MANAGEMENT COSTS

The costs of Navy operated inventory management functions is hidden in the complex funding structure for the Navy supply support system. The supply support functions are funded primarily through two mediums: mission funding and Defense Business Operations Fund (DBOF). In this section, the research breaks down the funding structure to identify the portion of DBOF funds which apply to inventory management functions that have outsourcing potential.

The result of the analysis serves as an estimate of the Navy's costs to perform inventory management which the research compares to the commercial costs in Chapter VI.

1. Mission Funded

Mission funding applies to funds which were appropriated by Congress. Mission funding accounts for approximately 41 percent of the costs to operate the Navy supply system [Ref. 17]. Most functions which receive appropriated funds also receive DBOF dollars. On average, the following functions receive 27 percent of their funds from appropriations and 73 percent from DBOF: personal property management, procurement (non-inventory), terminal operations, utilities, maintenance of real property, data processing (non-inventory), safety, and public works [Ref. 18]. Although these functions may partly be utilized in the support of inventory management activities, the amount of appropriated funds utilized in this effort is not significant.

2. DBOF Surcharge

The Defense Business Operating Fund is a revolving fund which the DoD supply system utilizes to maintain and manage its inventories. The fund is replenished through the use of a surcharge applied to the cost of items purchased by customers. In addition to pure inventory management functions, the surcharge also funds many other supply support activities. The amount of the surcharge is calculated from a forecasted Value of Annual Demand (VAD). The costs to operate DBOF funded activities is applied to the VAD to determine the surcharge percentage. Table 3.1 shows the breakdown of the fiscal year 1997 surcharge [Ref. 19].

Table 3.1 FY 1997 Surcharge (%)		
	Standard	Exchange
Material Replacement Factor	6.4 %	17.4 %
Procure/Rep Equalizing Factor	16.0	-18.9
<i>Cost of Operations</i>	<i>57.4</i>	<i>57.4</i>
ICP DMRD Savings	-7.7	-7.7
Net Operating Results	-4.4	-4.5
MTIS Benefit	-11.4	-2.2
Cash	4.1	4.1
Customer Rate Factor	-26.2	-26.2
Total Surcharge	34.2 %	17.2 %

The Material Replacement and Procure/Repair Equalizing factors take into account the differences in providing inventory management for items purchased new verses items repaired. The ICP DMRD Savings applies to savings from defense management Review Decision 971 for excess inventory which can be sold without replacement. The Net Operating Result is the refund for overcharging customers in fiscal year 1996. The Material Turned-In to Stock (MTIS) benefit represents the savings from excess material returned from customers. Cash is the cost of money. And the Customer Rate Factor corrects for changes in demand or item pricing errors in surcharge and VAD projections which occur two years in advance.

According to Table 3.1, a 34.2 percent surcharge will be applied to items for "standard" repairable requisitions, without a carcass turn-in, and 17.2 percent surcharge for requisitions with a carcass turn-in.

3. Inventory Management Cost Calculation

The Cost of Operations (Budget Project 91) is the key to determining what portion of the NAVSUP surcharge applies only to inventory management functions. However, the cost of operation includes numerous functions including: fuel operations, small and large purchases for customers, servmarts, service craft, terminal operations, port services, general and administrative costs, headquarters (NAVSUP) costs including non-inventory related costs, depreciation, etc. [Ref. 19]. Within these categories the portion which applies to inventory functions is not always easily separated from non-inventory costs.

Fortunately, the NAVICP Mechanicsburg has developed an estimate of the surcharge which should apply to consumable Non-Developmental Items (NDI) purchased using a just-in-time process. "NDI" refers to items which are developed commercially and available on commercial markets. NAVICP estimates a 15.2 percent surcharge should be applied to these items [Ref. 18]. In theory, the 15.2 percent represents the costs to fund all non-inventory functions and inventory functions which are not outsourced with NDI items (functions performed centrally at the ICPs). Subtracting this estimator from the fiscal year 1997 surcharge on new items results in an inventory management surcharge of 19 percent.

The soundness of this 19 percent inventory surcharge estimate can be verified in three ways. First, the cost data from fiscal year 1995 showed \$ 726 million or 66 percent of the total surcharge revenue was used on wholesale related material functions [Ref. 17]. Sixty-six percent of the fiscal year 1997 surcharge is 22.5 percent. Second, working backwards to confirm the validity of a 19 to 22 percent inventory surcharge results in an estimate of 40.2 percent of the costs of operations belonging to inventory functions. By summing a percentage of the cost of

operations and the other factors in Table 3.1 with the exception of the savings resulting from DMRD and MTIS (because these savings will exist whether or not the inventory functions are outsourced) and setting the summation equal to 19 percent, the resulting portion of operations costs applying to inventory management is calculated at 40.2 percent. Based on a comparison of the activities funded under cost of operations and realizing that some of those activities must remain “central” to NAVICP, the research considers 40.2 percent a conservative and valid estimate. Finally, the 19 percent estimate is lower than the lowest DLA ICP surcharge of 30.8 percent and lower than the Bell Helicopter surcharge of 23 percent. Because NAVICP items are on average more expensive than DLA consumables, this comparison also passes the reasonableness test.

However, the 19 percent inventory surcharge is only a rough estimate of the costs of inventory management, and applying the 19 percent surcharge to the projected “exchange” surcharge in Table 3.1 does not work. Consequently, the research only uses the estimate as a rough comparison when analyzing the outsourcing options in chapter six.

4. Variable verses Fixed Costs

In calculating a surcharge estimate to cover the costs of inventory management the issue of variable verses fixed costs must be addressed. Most of the cost involved in the operations of an ICP are fixed [Ref. 21]. In fact, the staffing of ICPs is not directly related to the demand or quantity of the items they manage. Therefore even if 19 percent of the cost of goods sold accurately reflects the costs of providing inventory management, the resulting savings in an ICP’s budget will most definitely be less. To illustrate this point, when the NAVICP transferred tens of thousands of consumable items to DLA ICPs under the Consumable Item Transfer

initiative, the NAVICP cost did not decrease nearly as much as the surcharge revenue it lost [Ref. 21]. Similarly, outsourcing to commercial sources may have the same effect on NAVICP.

For the purpose of the research, the effects of outsourcing are viewed in the long term. The goal is to determine theoretically whether or not there is benefit in having commercial sources provide inventory management services. In the long term all the cost can be considered to be variable.

IV. PARTIAL OUTSOURCING

Contracting the services of commercial companies to perform some of the inventory management functions, "partial outsourcing", is the first step away from complete Navy management. In this thesis, only the physical distribution function is considered for partial outsourcing. Physical distribution can easily be separated from the other functions in inventory management and is not specific or unique to DoD. Many commercial companies maintain inventories and have the ability to ship material to their customers. However, the management of items which are repaired and re-issued, "repairables", is unique to the DoD. To analyze the method and potential benefits of partial outsourcing, this chapter compares the operation and costs of the current system to the prototype being conducted with Hughes Technical Services Company in Long Beach, California.

A. CURRENT SYSTEM

As discussed in chapter three, the Defense Logistics Agency performs the physical distribution function for the Navy ICP and is reimbursed for its expenses. DLA tracks the number of service transactions provided to the Navy using their management information system and then bills for its services. The billing rate is based on an average cost per unit calculation. Until fiscal year 1996, DLA used a "composite rate" of \$ 29.71 to cover all of its services [Ref. 22]. The composite rate included services for receiving and storing an item or issuing and shipping an item regardless of the item's weight, size, duration of storage, or distance shipped. In fiscal year 1996, DLA implemented "discrete pricing" to better apply the real costs of

operating to the service each individual customer was receiving. Under discrete pricing, the Navy pays different rates for the various services and various sizes of items managed. For example, items are broken down into three size categories and different rates were calculated for receiving, local issues, non-local issues, and transshipments. Transshipments are issues originating in one DLA depot and processed through a second depot on the way to the customer. The average costs for receiving, storing, issuing, and transshipping a repairable is estimated at \$ 37.28 [Ref. 23]. This estimation is based on the average size and shipping destination of items repaired by Hughes. Physical distribution charges from DLA account for a substantial amount of the costs of managing the inventory. The total DLA reimbursable for fiscal year 1995 was \$ 118.5 million out of a \$ 296.2 million cost of operations [Ref. 24].

In addition to higher costs for physical distribution services, the current system also requires more processing time during the repair cycle. The current Repair Cycle Time (RCT) includes 44 days in which the material is not funded and unavailable for issue. Repair Cycle Time represents the total time that an item is in damaged, not ready for issue, status. RCT starts when the carcass is turned in and stops when the item is available for issue. Shipments of repaired items to the defense depots are coordinated by DoD inventory managers. The repaired items average 21 days awaiting shipment to a defense depot. The shipping time plus the receipt processing time at the defense depot storing the material is 23 days. [Ref. 23]

B. PARTIAL OUTSOURCING EXAMPLE

On 2 February 1996, Hughes Technical Services Company submitted an unsolicited proposal to the NAVICP basically proposing to perform the warehousing and shipping services

for all items Hughes repairs. By outsourcing the physical distribution function to Hughes, the Navy could bypass the DLA warehousing and shipping functions described above. The essential criterion in examining all outsourcing proposals are:

1. Does it work better?
2. Does it costs less?

This section examines these criterion compared to the current system and then Chapter VI compares the benefits of partial outsourcing to the alternatives discussed in Chapters III and V.

Under the Hughes prototype, Hughes would maintain the inventory of the items Hughes repairs in a bonded warehouse and ship directly to the customer. The proposal covers the inventory management of all items repaired by Hughes for a six month period. The demand level is estimated to be 450 items in six months based on a demand of 900 in 1995 [Ref. 25]. Requisitions for the material are sent via electronic data interface directly to Hughes from the NAVICP. Hughes would have the ability to ship items to customers directly from the repair facility, bypassing their own warehouse. Additionally, Hughes would install an emergent issue capacity by obtaining pager services to make their shipping operation available to the Navy seven days a week, twenty-four hours a day.

The inventory level is updated by Hughes via the Commercial Asset Visibility (CAV) software into the Uniform Inventory Control Program described in chapter three. Commercial Asset Visibility software enables certain commercial companies which conduct large amounts of business with the Navy access to the UICP. CAV improves the visibility of Navy-owned items and their status, whether they are ready for issue or undergoing repair. By keeping Hughes on

line with the NAVICP, the item managers at the ICP would have more visibility of the assets than they do under the current system.

When Hughes receives a requisition from the NAVICP, the material would be issued within 24 hours and the customer would receive the material on average five days after submitting the request [Ref. 23]. Shipments would transship through the Defense Depot which is in the continental United States and nearest the customer. For example, an issue from the Mini-ICP at Hughes to a ship in Norfolk would be shipped by Hughes to Defense Depot Norfolk Virginia. The status on the shipment would be updated by Hughes into the UICP and then to the customer much the same way it is done in the current system.

Hughes performs the physical distribution service at a lower rate than DLA. Hughes calculated its cost by estimating the total costs to establish and provide the service and then dividing that number by the estimated number of items processed. The per item costs to either store and ship the item or ship directly from repair to the customer is \$ 27.50 [Ref. 26]. No additional costs would be incurred by the NAVICP to monitor the program. There would be an additional order cost to add this service to the existing contract. However, if the prototype is successful, the physical distribution service could be included in the initial repair contracts. Hughes also does not normally operate its shipping facility on holidays or weekends. Consequently, there would be a one time non-recurring charge of \$218.43 for pager services so the NAVICP can contact Hughes for emergent issues [Ref. 26]. The costs of the pagers would be included with the first quarterly invoice.

The Mini-ICP prototype with Hughes is now operational. The physical distribution services of the Mini-ICP were amended to the original Hughes repair contract in September

1996. The first requisition was successfully sent electronically from UICP to Hughes on 26 September 1996. Hughes then shipped the material from their bonded warehouse directly to the customer in less than 24 hours. Now that the process of shipping direct from the vendor is proven possible, the NAVICP is working with the Raytheon Corporation to implement another Mini-ICP. The costs estimate from Raytheon is not yet available. [Ref. 1]

C. SAVINGS AND BENEFITS

Calculating the savings and benefits of partial outsourcing can easily be quantified while other savings result from qualitative approximations. The quantified savings result from the reduction in per unit item service rate and the reduction in the amount of lost material. The qualitative approximations of savings and benefits are harder to quantify or do not result in direct reductions in DoD budgets. These non-quantifiable advantages result from the potential benefits from inventory reductions due to reduced repair cycle time, improved inventory effectiveness, and reductions in backorder quantities.

The savings in rate reduction alone justify implementation of the partial outsourcing concept. Under Hughes inventory management, the Navy saves \$ 9.78 per item [Ref. 23]. This \$ 9.78 represents more than a 26 percent reduction in the costs of physical distribution functions. And as mentioned above the physical distribution costs of inventory management is substantial representing over 40 percent of the inventory management costs. For the Hughes prototype, the savings will only be \$ 8,802 per year because the demand is only estimated to be 900 items. However, if other companies could provide physical distribution services at similar rates, the savings would be enormous.

The other quantifiable savings are from the reduction in the amount of material lost.

From January 1995 to May 1996, 13 items from Hughes valued at \$ 56,000 were lost in the DLA and Navy supply system [Ref. 23]. This material value does not include the personnel and support structure in place to prevent and investigate losses. Full time employees are utilized at the stock points and inventory control points to track missing material and determine the reason for the discrepancy and the activity responsible for the loss. With the vendor shipping directly to the customer under partial outsourcing, these losses may be completely avoided and would certainly be reduced.

The major benefit from the Mini-ICP prototype with Hughes, the reduction in repair cycle time, is harder to quantify. The only portion of the repair cycle time which is funded and therefore used in the inventory level calculations is the repair turn around time (RTAT). RTAT is basically the time an item is in the process of being repaired. RTAT includes the time to calculate the repair quantity, contract for the repair service, ship the item to the repair depot, and for the depot to complete the repair. The cycle time in shipping and receiving the repaired item, 44 days for DLA and 5 days for Hughes, is not included in the inventory level calculations. Because the material is unavailable during this time, the effectiveness or fill rate declines. To quantify the value of the inventory in the repair cycle time, the value of a repair cycle day must first be calculated. If the repair cycle time outside of RTAT were funded, one day would represent \$ 1.6 million [Ref. 23]. This value is derived by spreading the value of the RTAT pipeline across the entire repair cycle time. Hughes' portion of the \$1.6 million is \$128,000 [Ref. 23]. This simply means that Hughes repair services account for approximately eight percent of the inventory in repair. For a 39 day reduction in repair cycle time, the value of the

inventory savings equals \$4.992 million [Ref. 23]. Although the actual level of inventory would not increase, the net effect of reducing cycle time would make \$4.992 million worth of inventory available to the customers. The effect of having this much inventory available would improve the effectiveness of the supply system. Backorders would be reduced and mission readiness would increase.

D. OTHER PARTIAL OUTSOURCING INITIATIVES

Partial outsourcing is not limited to the physical distribution function of "A" condition (ready-for-issue) material from commercial repair facilities. Conceptually, any part of the inventory management function could be outsourced. The Navy is reviewing the potential benefits of outsourcing any or all of the inventory management functions. Two more partial outsourcing initiatives of the physical distribution function currently being considered involve damaged items awaiting repair and newly produced items .

The NAVICP is also considering the potential savings of storing carcasses (damaged repairables not ready for issue) at the commercial repair facilities or at a third party logistics manager near the carcass collection point. The current process is to ship the carcasses not required for immediate repair to a NAVICP designated storage point which is a warehouse operated by DLA. When the carcasses are required for repair, DLA ships them to the designated repair depot. The savings in this initiative are similar to the Hughes Mini-ICP prototype. By avoiding the DLA physical distribution function, the Navy essentially avoids shipping the material twice.

In a study completed in May 1995 using the DLA composite rate, Resource Consultants, Incorporated, concluded that the Navy could save 10 to 20 dollars per carcass [Ref. 27]. RCI came up with three alternatives:

1. Revise repair contracts to include contractor storage of carcasses,
2. Use a third party logistics manager near the collection point to temporarily store the carcasses, or
3. Have the contractor who operates the Navy collection point store the carcasses.

Basically, instead of the current process of shipping, storing, shipping, and then repairing items, the RCI proposal recommends storing the material with a contractor either before or after it is shipped for repair. By using the alternative methods of carcass storage, outsourcing the physical distribution function of carcass inventory management, the Navy could save 270,000 to 540,000 dollars per year based on 1994 volume of carcass transactions. [Ref. 26]

The third area for the outsourcing of the physical distribution function for Navy repairables concerns new production items. Under the Hughes Mini-ICP prototype, physical distribution of repaired items is outsourced. Using the RCI proposal, the NAVICP is reviewing the potential benefits for outsourcing the physical distribution of damaged items. And finally, the NAVICP is also studying the potential to outsource the physical distribution of items newly produced by commercial companies. Outsourcing services for new items is the logical follow on to the Mini-ICP. And now that it is up and operating with Hughes, NAVICP is building a cost benefits analysis of expanding the production contracts with Hughes to include storing new items for shipment directly to customers. [Ref. 1]

This section only analyzed the option of partial outsourcing the physical distribution function since it is the easiest inventory management function to outsource because it can be separated from the other functions. The next chapter analyzes the operations and costs of total outsourcing of the entire inventory process.

V. TOTAL OUTSOURCING

Contracting the services of commercial companies to perform all of the inventory management functions, total outsourcing, is the most complex and riskiest alternative to maintaining the functions organically. Under the total outsourcing concept, the vendor basically maintains the inventory and undertakes all decisions and actions necessary to satisfy an effectiveness level (requisition fill rate) and delivery time frames as specified in their contract. The vendor performance is monitored by the NAVICP who also awards the contract.

There are numerous functions which the vendor can undertake to satisfy the outsourcing contract. However, as discussed in chapter three, there are several "central" functions such as cataloging, identifying, standardizing, and war reserve planning, which must be retained by the NAVICP. The purpose of this section is to examine the potential for commercial companies to perform the forecasting, level setting, repair and procurement quantity calculations, contracting, storing, issuing, and shipping functions of inventory management. Additionally, the companies should provide an automated means of transferring information to and from the current Navy information system. Information on demand projections which exists in UICP must be available to the companies and information on status of requisitions, effectiveness, and delivery times must be available to the NAVICP to monitor the performance of the contract.

There are several different means to establish a total outsourcing contract and to determine its cost structure. To analyze the potential benefits of total outsourcing, this chapter reviews the proposals for commercial sources to perform the inventory management function. Bell Helicopter submitted a proposal to manage the commercial items it now provides to DLA.

Hughes Aircraft designed a logistics support plan for the Ship Self Defense System (SSDS) which utilizes contractor managed inventories. And the NAVICP has drafted a statement of work for contractor management of the P-3 and S-3 radar systems inventory.

A. BELL HELICOPTER

The Defense Supply Center in Richmond (DSCR), a DLA inventory control point, is currently managing a contract with Bell Helicopter for the total outsourcing of inventory management responsibility for 941 line items [Ref. 28]. The DLA term for a contract that outsources inventory management is "corporate contract". DSCR managed the sole source contract with Bell Helicopter for the production of 941 line items, which were then managed by four different DLA inventory control points. Prior to the DLA outsourcing contract, Bell maintained an inventory of the 941 items for which they had a commercial customer base.

This section of the research analyzes how DLA's organic management of the 941 items compares to the effectiveness and costs of Bell Helicopter's management. Although the 941 items are not repairables, this contract demonstrates how the outsourcing of inventory management can work under very similar circumstances.

1. DLA's Management Operations and Costs

Under DLA management of the 941 items, a larger inventory is maintained relative to the level of demand, the cost of management is more costly, and less effective (lower fill rate) than Bell Helicopter's management. The total inventory of the items in fiscal year 1995 valued \$ 31,944,700 calculated using the Bell Helicopter prices [Ref. 29]. The inventory annual holding costs is determined by DLA as six percent of the item costs [Ref. 29]. This six percent holding

costs factor is too low to be considered realistic. According to Heizer and Render, authors of *Production and Operations Management*, “any holding costs factor lower than 15 percent should be suspect” [Ref. 30]. Additionally, GAO considers the DoD determination of holding costs factors to be inaccurate because DLA, Army, and Air Force ICPs do not base the obsolescence value on the expected remaining useful life of the items [Ref. 5]. The inventory was maintained by DLA to satisfy an annual demand of 7,831 total requisitions for a sales value of \$ 3,682,700 [Ref. 29].

The fill rate effectiveness improves with Bell Helicopter management and the lead time for out of stock items dramatically improves under total outsourcing. The effectiveness of DoD ICPs is measured by “supply management availability”, which is the percent of incoming requisitions that are filled. The goal is to fill a minimum of 85 percent with material that is in the wholesale stock system [Ref. 15]. DLA was exceeding the 85 percent goal while they managed the 941 items [Ref. 29]. However, DLA’s lead time to procure and make available new items is 483 days [Ref. 29]. The average lead time to fill an order with material that is available is nine days [Ref. 28].

DLA covers the costs of providing inventory management services by applying a mark-up or surcharge to the item cost for each requisition. Because the 941 items in this proposal are under the control of four ICPs they are subject to four different surcharges ranging from 30.8 percent to 46.3 percent in fiscal year 1995 [Ref. 29].

2. Bell Helicopter’s Management Operations and Costs

Under Bell Helicopter management, effectiveness and costs both improve. DLA awarded a one year corporate contract with four option years to Bell Helicopter for the performance of the

inventory management services in mid 1995. Bell Helicopter's supply availability is over 90 percent [Ref. 28]. The requisitions are passed to Bell Helicopter via electronic data interchange from the ICP in the same method as in the Hughes "partial outsourcing" example in Chapter IV. When Bell Helicopter receives a requisition from the DLA ICP, the material is issued and shipped and the customer receives the material on average eight days from the time of order [Ref. 28]. For items that are not immediately available, the average lead time for Bell Helicopter to fill the requirement is 90 days, and the average lead time to produce and make available new items is 211 days [Ref. 29]. Table 5.1 provides a comparison of DLA and Bell Helicopter performance times.

Table 5.1 Performance Comparison Measured in Days			
	Delivery Time	Fill Out-of-Stock Order	Procure New Items
DLA	9	150	483
Bell Helicopter	8	90	211
Improvement	1	60	272

Bell Helicopter already maintains an inventory of the 941 items and therefor has many advantages in combining inventories. Any increases in Bell Helicopter's holding cost of inventory or safety stock is funded by Bell Helicopter and not DoD. Because, Bell Helicopter has a substantial customer base already, it does not plan on increasing stock levels to meet DoD demand. The risk of maintaining the inventory is also assumed by Bell Helicopter. DoD does not own nor guarantee the purchase of inventory items. Additionally, Bell Helicopter takes custody of the current \$ 31.9 million DoD inventory. Bell Helicopter sells the inventory to

commercial customers when possible at a 23 percent mark-up and pass the profit on to DoD in the form of reduced costs [Ref. 29].

Bell Helicopter has an incentive to be effective. The corporate contract with Bell Helicopter is designed to offer incentives for higher effectiveness and quicker deliveries. When Bell Helicopter delivers direct to the customer or the nearest defense depot within eight days they receive a 23 percent mark-up on the costs of the item [Ref. 28].

3. Savings and Benefits

Outsourcing the inventory management functions to Bell Helicopter for 941 line items will result in a five year savings of \$12.3 million and improved service to DoD customers. The costs comparison shown in Table 5.2 calculates the five year net present value with a six percent discount rate. [Ref. 29]

Table 5.2 DLA and Bell Helicopter Costs Comparison (\$ Thousands)						
	NPV of Annual Demand	NPV Inventory Holding	One-Time Transfer	Less NPV of Retail Sales	Less NPV of Reduced Lead Time	Total Costs
DLA	\$ 22,675	\$ 8,073	\$ 0	\$ 0	\$ 0	\$ 30,748
Bell Helicopter	21,494	0	70	3,032	135	18,397
Savings						\$ 12,352

The net present value of annual demand is based on the historical sales volume over a twelve month period ending in 1994 and the assumption that the demand rate will be constant for the next five years. The DLA figures include the items price plus the appropriate DLA costs recovery rate for fiscal year 1995. The Bell Helicopter figures represent the item value plus a 6.7

percent costs recovery rate for DLA and a 23 percent costs recovery rate for Bell Helicopter.

DLA must charge 6.7 percent to cover the ICP administrative costs that will be incurred by DLA.

[Ref. 29]

The holding cost is based on six percent of the Bell Helicopter price of the on-hand inventory for five years. As discussed earlier, this six percent is probably too low an estimate and therefore the savings will be more than the DSCR study indicates. The one-time transfer cost is based on the DLA composite rate applied to transfer the on-hand inventory to Bell Helicopter plus a one percent administrative charge applied to the dollar value of the inventory transferred. The retail sales benefit is based on the amount of DoD inventory that Bell Helicopter thinks it can sell to commercial sources at a 23 percent mark-up over the next five years.

The lead time savings calculation is different than the method utilized in Chapter IV's example of partial outsourcing. In both calculations, the "lead time reduction" is identified as the time period representing the change or improvement in lead time between DoD and commercial sources. For the partial outsourcing example, the lead time savings calculation was based on the value of the inventory required to satisfy the projected demand during the lead time reduction. Under the Bell Helicopter proposal, the value of the lead time savings is calculated by determining the ordering costs necessary to purchase inventory to satisfy the demand which would have occurred during the lead time reduction. The cost of the DLA ICP's labor and non-labor procurement, supply, technical, and quality costs were divided over the length of the lead time to determine a daily value. The portion of this daily value which applies to Bell Helicopter is proportional to the percent of business they represent.

4. Conclusion

Under the Bell Helicopter outsourcing contract, DLA can offer better service at a reduced price to its customers. The savings gained by outsourcing the function to Bell Helicopter represent a 40 percent reduction in DoD's supply support costs for these 941 items. The lead time for item procurement improves by 56.3 percent. Effectiveness improves from 85 to 90 percent and the items are delivered one day earlier. [Ref. 29]

Because of the success with Bell Helicopter, the Defense Supply Center Richmond is expanding the number of its total outsourcing initiatives. DSCR plans to add 432 items to the Bell Helicopter contract [Ref. 28]. DSCR is also pursuing similar initiatives with eight or nine major manufacturers including Boeing, McDonnell Douglas, Lockheed-Martin, and Pratt and Whitney.

B. HUGHES AIRCRAFT COMPANY

Hughes Aircraft Company is developing the Ship Self Defense System (SSDS) MK 1 for installation on LSD 41 class ships. As part of the production contract Hughes was tasked with developing a "Just In Time" (JIT) support plan for SSDS parts. The Navy's goals of the JIT support plan are:

1. To eliminate or minimize spares buy-in costs to the Navy,
2. To provide on request delivery to a commercial freight carrier within 24 hours,
3. To eliminate or minimize storage costs for spares, and
4. To eliminate or minimize obsolescence associated with inventory. [Ref. 31]

In developing the support plan, Hughes has recognized from the beginning that the Navy

environment of SSDS support was not as conducive to JIT as the commercial environment.

There are three factors that make the Navy environment less conducive to JIT. First, the demand for SSDS parts is unstable. The demand rate is based on the item failure rate which is not completely predictable. Therefore, production schedules and delivery runs can not be linked to demand. The unstable demand factor necessitates holding a standing inventory. Second, uncertain delivery schedules and destinations prevent vendors from establishing links between order and delivery times making the transportation system less efficient. Finally, commercial vendors do not manage repairables. The vendors normally establish one way links for providing parts to customers. The Navy repairable system would require Hughes to manage a rotating pool of repairable items. [Ref. 31]

Regardless, Hughes has taken the steps to develop a JIT support plan which attempts to achieve the four goals listed above. The first step was to identify which of the SSDS parts would be covered by the plan. Only SSDS assemblies which are unique to SSDS have been considered. Many SSDS assemblies are used and supported in other established systems, mainly the Q70 display console and the TAC-4 computer system. Of the SSDS unique parts, only assemblies with "significant failure rates," replaceable on board ship, and subject to part obsolescence were identified as JIT candidates [Ref. 31]. A "significant failure rate" was used as a qualitative term to describe any component that may fail and to exclude those items which the vendor estimates will not fail. For example, Hughes uses a one million hour failure rate for cables which equates to over one hundred years because cables "do not fail" and therefore are not considered as candidates for the JIT support plan [Ref. 32]. Twenty-three items produced by

fifteen different companies were identified as candidates. Only two of the assemblies are manufactured by Hughes. [Ref. 31]

After identifying which parts would be in the JIT support plan, Hughes developed three support options:

1. Vendor-capitalized JIT support,
2. Pre-paid vendor support, and
3. Pre-paid third party JIT support.

The remainder of section B examines how the parts support would occur under each of the three options and then how SSDS support would be implemented. The costs of the three options were not determined because the plan was rejected with the mutual agreement of Hughes and NAVICP [Ref. 33]. Subsection 4 examines how the plan would have been implemented and subsection 5 discusses why it was rejected.

1. Vendor-capitalized JIT Support

Vendor-capitalized JIT support meets all of the four goals stated earlier. Under this option, the Navy does not fund any of the inventory but only pays for the items it demands, much like the Bell Helicopter example. The vendor maintains a level of inventory necessary to meet 95 percent of the demand and a shipping facility capable of shipping parts within 24 hours [Ref. 31]. The vendor also funds any holding costs and costs of obsolescence associated with the inventory.

According to Hughes, only vendors with large commercial customer bases who already maintain a standing inventory can utilize this option and make it costs effective for the Navy. Two vendors, who manufacture three of the twenty-three JIT assemblies, accepted the vendor-

capitalized JIT support option. Both of these vendors have a commercial customer base which allows them to spread the costs of inventory management across a large and stable demand. Therefore the incremental cost of adding another customer, the Navy, is negligible. The level of inventory would not have to be dramatically increased by the vendor, and because the demand is large and reasonably stable, the safety level would also not increase much.

Under this option, the vendors ship directly to the customer from a pre-existing shipping facility within 24 hours. When Navy owned items are damaged they are turned in to the Navy collection point much like the current system. The NAVICP which provides guidance for the collection point would ship directly to the vendor for storage and repair. The Navy would not necessarily receive new spares nor spares which were previously Navy owned when requisitioning an item.

The vendor who funds the inventory may not be the vendor who manufactures the item. In some cases, a vendor has indicated a desire to invest in the JIT spares pool and manage the inventory for the Navy and other customers. The possibility that another vendor may wish to manage the inventory should not affect the Navy's decision on whether or not to adopt this option. The identity of the vendor managing the inventory would be transparent to the Navy's support process and goals. The obvious assumption which follows is that the vendors desire to enter this business because they plan to make a profit by providing better and cheaper inventory management services than the Navy. This assumption is discussed in more detail in Chapter VI.

2. Pre-paid JIT Support

The second option, pre-paid JIT support, may achieve three of the four JIT goals. Pre-paid support works when the vendor has a storage and shipping facility with the capacity to

manage the SSDS items but does not currently maintain a standing inventory of those items. Nine of the twenty three items fit into this category. Because the vendor does not have a commercial customer base substantial enough to warrant a standing inventory, the vendor is normally not willing to assume the risk of investing in an inventory to fill Navy demand. Consequently, the Navy would be required to fund the purchase of the initial inventory. The vendor would then store the inventory in its facility and ship parts directly to customers within 24 hours of the request. The vendors would be responsible for funding any increases in inventory levels justified by an increasing demand [Ref. 32].

The Hughes support plan assumes that a savings would be realized under this option. The savings would supposedly result from the reduction in inventory holding and shipping costs. Hughes estimates that the vendors would charge an additional amount to cover their costs but that the costs would be low because existing vendor storage and shipping processes would be used. However, under the current system described in chapter three, existing DoD storage and shipping processes are also used. Chapter IV shows how a savings may result with the partial outsourcing concept. But the savings depend on how much the vendor charges for its services compared to the Navy's costs. Because Hughes did not determine the cost of this option, a savings can not be demonstrated.

3. Pre-paid Third Party JIT Support

Pre-paid third party JIT support would achieve the same goals and function similar to option two, pre-paid vendor JIT support. Of the twenty-three initial items, eleven items fit into this category of support. The only difference with option two is that the vendor making and repairing the SSDS item does not have or desire to use its storage and shipping capability to

provide inventory services. Therefore, NAVICP would contract with a third party vendor to provide storage, inventory control, and responsive shipping.

As discussed under option two, the potential for savings from pre-paid third party JIT support has not been demonstrated. The savings would depend on what the vendor charges for its services.

Interestingly, the two SSDS support items that Hughes manufactures are both in this category. Even though Hughes is currently providing the storage and shipping services for all the items it repairs under its Mini-ICP concept discussed in chapter four, Hughes does not have the capability to provide the inventory management services for these two items, since it does not currently maintain a 24 hour warehouse and shipping operation.

4. SSDS Support Implementation

To implement the JIT support plan, Hughes recommended utilizing all three options as described in subsections 1, 2, and 3 until a Hughes SSDS Support Center could be established [Ref. 31]. Whenever possible, Hughes recommends using option one. This option is believed to best achieve the Navy's four goals of JIT. To implement the support for the remaining twenty items in options two and three, the vendors should be contracted to provide the initial support which would later migrate to the SSDS Support Center.

The SSDS Support Center concept provides the Navy with a single point of contact for all SSDS support. Hughes would establish a closed loop tracking system and centralized inventory control for all items. The Support Center provides 24 hour service. Requisitions would be received by the Support Desk and directed to either the vendor maintaining the inventory for option one or the Hughes SSDS support facility. Items would then be shipped through a

common carrier, the mode of which would be determined by the priority of the requisition.

Hughes would then provide the feedback status to the Navy.

The SSDS Support Center would also manage the inventory of carcasses. Carcasses would be turned in to Navy collection points as in the current system. The collection point forwards the items to the Hughes Support Center which either maintains the stock of items or directs them to the vendor responsible for repair. For vendor capitalized spares under option one, the Navy would only pay the net price of the new item. Under pre-paid inventories, the carcass remains Navy owned material.

Fast Payment Procedure is recommended by Hughes to expedite payment for items received. Under the Fast Payment Procedure, the vendors will send their invoices to the NAVICP at the time of shipment. Ownership of the material transfers to the Navy when it reaches the common carrier. The Navy would then pay the invoice before the receipt is confirmed. Discrepant receipts must be identified to the vendor within six months.

The system Hughes plans to use for managing the inventory and tracking all transactions is the Property Accountability System (PAS). PAS is a widely utilized PC-based inventory and control tracking system. PAS would track the on-hand inventory levels of Hughes items, the levels at the vendors facilities, the levels anticipated from a vendor, and the quantity in shipment to the Navy. PAS, through the use of tracking tags on all items, also tracks the shipping status of all requisitions including all of the information from the carriers (date, time, delivery, destination, receipt confirmation, etc.). PAS would also serve to record demand data and the measures of effectiveness, (fill rates and on-time deliveries). [Ref. 31]

However, the software adaption to enable PAS to communicate with existing Navy systems is not available. SSDS support envisions that an automated link between the UICP and PAS would be developed if the SSDS support were adopted. Once a link is developed, requisitions could flow electronically for the UICP to PAS and status could flow back to the UICP. The system as it currently operates would require manual input at both ends.

5. SSDS Support Plan Rejection

As mentioned earlier, this SSDS support plan was not adopted with the mutual agreement of the Navy and Hughes based primarily on two reasons. First, Hughes does not want to risk the investment in an inventory with a low and unpredictable demand. For this low quantity of demand, the Navy does not want to support a JIT plan for which they have to fund the inventory. The level of initial buffer stock was determined using a Poisson distribution, a 95 percent fill rate, and an average replenishment time of 2.5 months [Ref. 31]. Second, Hughes believes that its cost in establishing a comprehensive inventory management service for only these few items would exceed the costs the Navy now incurs [Ref. 32]. Based on estimated failure rates, with SSDS installed on one ship in fiscal year 1996 the initial estimated demand is one spare every seven working days (at 260 working days per year). By 2002, when SSDS is installed on 37 ships, the demand will only be five spares per working day. [Ref. 31]

According to the NAVICP, the near future demand would be even lower than projected but the NAVICP will reconsider the plan when demand increases. NAVICP identified four of the twenty three items as already being supported through the Navy stock system. The demand projections will also decrease because the installation and production plans were scaled back. Instead of the previously planned seven ship installation by 1998, the installation plan slowed to

three ships in 1996, one in 1997, and none in 1998 [Ref. 34]. The NAVICP plans to reevaluate the JIT support concept for SSDS in fiscal year 1999 when demand increases.

In contrast to the Hughes support plan for low demand unique SSDS items, the NAVICP is conducting a total outsourcing JIT support plan for some SSDS items common to the TAC-4 computer system. Unlike the SSDS which is only planned for installation on 41 LSD class ships, the Navy utilizes hundreds of TAC-4s. The demand for this commercially available computer system is satisfied by Hewlett Packard (HP). HP performs the entire inventory function for 700 to 800 TAC-4 parts [Ref. 34]. NAVICP awarded the six year support contract to HP in January 1995 and only required that HP meet a specified delivery time. A costs comparison between the Navy and HP inventory management functions was not conducted. The primary justification for having HP provide the inventory support was that the items are state-of-the-art. The estimated high costs of obsolescence for commercially available high tech commodities prohibits the NAVICP from investing in its own inventory. Additionally, because HP already maintains an inventory and shipping function to support a wide customer base for the items, the costs for HP inventory management functions were assumed to be low. [Ref. 35]

C. P-3 AND S-3 RADAR SYSTEMS

The NAVICP has drafted a statement of work to outsource inventory management to vendors with a goal of improving availability and reliability of repair parts. The Creative Contracting Working Group, formed by NAVICP to explore initiatives in improving the way to do business with vendors, drafted the statement of work. The items being considered for outsourcing are the components of the AN/APS 115 and AN/APS-137 radar systems used on the

P-3 and S-3 aircraft. The group also contracted for logistics consulting services from Coopers and Lybrand to assist in some of the costs calculations which are discussed later in this section. The Contracting Working Group believes the real savings and benefits from outsourcing the inventory management function will result from improvement to reliability and availability resulting from commercial management [Ref. 36].

This proposal for outsourcing is different from the previous examples. First the vendor's responsibilities including required program improvements are more narrowly defined. Second, the method in which the vendor is paid for its services differs from previous examples. This proposal utilizes an hourly rate calculation to determine the value of the contract. And finally, the vendor has more incentive to improve its performance.

1. Vendor's Responsibilities

In this proposal like the Bell and Hughes examples, the required requisition fill rate and delivery time frames will be specified in the contract. The fill rate has not yet been determined by the NAVICP but will equal or exceed the current goal of 85 percent [Ref. 37]. The required delivery time frames would be 24 working hours for high priority requisitions and 96 working hours for all other requisitions [Ref. 38]. Working hours are defined as 0700 to 1700 Monday through Friday. The vendor would be encouraged to identify the requirements for providing 24 hour delivery outside specified working hours for critical requirements. Like previous examples, the vendor will maintain the inventory in a bonded warehouse and ship directly to customers in the continental United States and ship to a designated East or West coast DoD activity for deployed customers.

Unlike previous examples, in this proposal the contractor would be required to develop and implement a program to insure the improvement in availability and reliability of spares. The reliability would be measured by the spares' Mean Time Between Failure (MTBF). The contract would specify the required MTBF for each of the five years of the contract. The vendor would be given complete flexibility in the methods and procedures he desires to utilize. Modifications and engineering changes would be identified and incorporated by the vendor to assist in meeting the required goals.

Although the vendor has complete flexibility in managing the inventory, the initial level of new and repaired items in the rotatable pool would be agreed upon by both NAVICP and the vendor. This agreement would lessen some of the risk to Navy readiness in first adopting this proposal. After the contract is awarded, the vendor would make the decision to repair or replace items from the rotatable pool when an item is required.

The vendor must also develop and maintain a data base acceptable to the Navy. The data base must be able to communicate with Navy systems to send requisitions and receive inventory information. As a minimum, the vendor would maintain statistics on inventory levels, usage, TAT, MTBF, availability, and delivery times.

Finally, the vendor must establish and maintain a training and user support program. The vendor will brief aviators on how the direct vendor delivery (total outsourcing) concept will work. The vendor would be required to work with aviators on changes and possible improvements to best optimize and enhance system performance. The vendor would also brief organizational level maintenance personnel on techniques to improve current maintenance practices.

2. Method of Payment

The vendor will be paid for its inventory and repair services based on the flight hours utilized and a hourly rate calculation. First, NAVICP will estimate the number of flight hours for the aircraft for the entire year to determine the average monthly hours. Then the number of hours would be applied to an hourly rate which would be negotiated in the contract. The vendor would then bill the Navy each month based on the average monthly hours. At the end of a six month period, the Navy would obtain the actual flight hours flown from maintenance reports and apply a correction to the last monthly bill of the period. [Ref. 38]

Of course the crucial item in this form of payment is the hourly rate calculation. To determine whether or not the Navy is benefiting financially from outsourcing this function, the Navy must know its own hourly rate. The Creative Contracting Working Group acquired the services of Coopers and Lybrand to assist in determining the rate for the radar systems. Coopers and Lybrand are combining the wholesale and the intermediate level repair and inventory costs using a composite labor rate calculation developed and approved by NAVAIR. The wholesale costs is being determined adding the costs of the Navy services (surcharge), the costs of the DLA storage, and the costs of repairs [Ref. 39]. Coopers and Lybrand plan to be completed with the rate calculation by December 1996 [Ref. 37].

3. Incentives

The method of payment provides the largest incentive to the vendor to improve both the reliability and maintainability of the radar components. Because the vendor is paid on an hourly rate, which is negotiated in the contract, the vendor increases its profits by increasing the MTBF

of the spares and decreasing TAT. The improved performance of the spares and shorter repair time would decrease the vendor's inventory levels and therefore its costs.

The contract also includes penalties for not meeting with required measures of performance. If the contractor fails to meet the goals for availability, MTBF, or TAT, the flight hours paid would decrease. As the discrepancy in the vendor's performance increases so would the rate of decrease in the flight hours paid. For example, if TAT is within 10 days of the goal, flight hours would decrease by 0.5 hours for each day over the goal. If TAT is within 20 days of the goal, flights hours would decrease by one hour for each day over the goal. [Ref. 38]

VI. DETERMINING OUTSOURCING POTENTIAL

Using the analysis of inventory management under Navy and commercial sources in the three previous chapters, this chapter develops a model to determine the potential for outsourcing inventory management of Navy repairables. The research model utilizes five factors to gage the potential for outsourcing:

1. Performance capability of vendor,
2. Commercial customer base,
3. Stability and level of demand,
4. Existing physical distribution capability, and
5. Cost.

The model does not result in a quantified amount of savings or benefit from outsourcing verses Navy management of inventory items. The model also does not provide a clear-cut yes or no decision for outsourcing many items. The intention is to provide an indication of the potential for savings and benefits from outsourcing.

A. PERFORMANCE CAPABILITY OF VENDOR

The first and only critical success factor for determining outsourcing potential is the commercial company's ability to meet the performance criteria established by the Navy. The NAVICP establishes and disseminates the criteria in the request for proposal. The criteria depend on what services the ICP wants from the vendor. For example, the partial outsourcing of physical distribution functions to Hughes discussed in Chapter IV contains fewer services and

therefore less criteria than DSCR's for total outsourcing of inventory management to Bell Helicopter discussed in Chapter V.

Determining the reliability of a commercial profit oriented vendor should not be a cause for concern. The inventory experts at the NAVICP will participate in the source selection process to determine if the vendors performance estimates documented in the proposal are reliable. This process is in effect today at NAVICP and DSCR where outsourcing contracts are awarded and managed by the ICPs. The ICPs are effective in selecting commercial companies because they have been working at it throughout their history. If the ICP selects commercial companies with a high level of reliability to manufacture new parts and repair existing DoD parts, then the ICP can also select reliable companies to perform inventory functions.

B. COMMERCIAL CUSTOMER BASE

A factor which normally indicates potential for outsourcing is the existence of a commercial customer base. A customer base outside of DoD obviously removes much of the risk for the vendor. The increased level of demand allows the vendor to maintain smaller amounts of safety stock because it has the same effect as consolidating inventories. A wider customer base also allows the vendor to spread its fixed costs across the higher demand making the price to DoD more attractive.

However, a commercial customer base which exists when outsourcing is initially considered may not exist throughout the life cycle of the DoD system. Products generally become obsolete in the commercial market long before DoD stops using them. The average life cycle of a commercial product is five years compared to DoD systems which last 15 to 20 years

[Ref. 40]. Even with the threat of obsolescence, the existence of a commercial customer base will greatly increase the potential for vendors to provide inventory management support to DoD.

The potential for outsourcing benefits may still exist even without a commercial customer base. As discussed in Chapter V, DSCR is currently outsourcing inventory management of 941 line items to Bell Helicopter which maintains a large commercial customer base. DSCR is also pursuing outsourcing initiatives with other manufacturers including Boeing which does not maintain a large customer base for the items being reviewed [Ref. 28]. DSCR's approach is to consider all vendors regardless of the commercial customer base status. The potential benefits still exist if the contract contains the right incentives. Vendors who undertake greater risk require that more incentives be provided in the contract.

C. STABILITY AND LEVEL OF DEMAND

Another factor which decreases the vendor's risk and increases the potential benefits for outsourcing is the stability and level of demand. Stable demand allows the inventory manager to maintain less safety stock and therefore absorb lower holding costs. A high level of demand allows the inventory manager to spread its costs over more items, thus lowering the costs to the customer (DoD). The decreased risk from stable and high demand levels entice more vendors to participate in the inventory management functions. As shown by the examples in Chapter V, Hughes does not want to establish an inventory management capacity for the 23 SSDS items which have a low demand rate, i.e., only five requirements per day when installed on 37 ships by the year 2002 [Ref. 31]. However, the support for the TAC-4 with hundreds of installations is provided by Hewlett Packard with a benefit to both provider and customer [Ref. 35].

D. EXISTING PHYSICAL DISTRIBUTION CAPABILITY

A good indication of the potential benefits for a company to provide inventory management services is whether or not they currently provide the service to their other customers. It is easier to entice a vendor to expand his current operation to include DoD than it is to encourage it to develop a new capability. The existence of a current physical distribution system is also a good indication of the vendor's reliability in providing this service. In the Hughes SSDS example from Chapter V, vendors for 12 of the 23 items had existing physical distribution services and were willing to expand them to include DoD [Ref. 31].

The existence of the physical distribution capability is not a critical success factor for outsourcing. The option of having a third party provide the inventory functions for the vendor is a possibility. However, the potential savings and benefits when using a third party inventory manager would probably be less because the vendor does not have any incentive to decrease its amount of business. Under the total outsourcing plan, the vendors can be enticed to improve its product and inventory functions. With a third party, the inventory manager does not control the product.

E. COST

After screening an item against the first four factors, the cost of outsourcing should be compared to the cost of Navy management. The cost comparison for partial outsourcing is easily and accurately conducted. The cost comparison for total outsourcing provides a good estimate of potential savings but requires more qualitative analysis and is not as definitive as the partial outsourcing comparison.

The partial outsourcing cost comparison provides the potential savings with a high degree of certainty. DLA uses discrete pricing rates for the services it provides to the Navy. If the vendor can meet the performance criteria, the potential savings can easily be calculated by comparing rates and forecasted demand.

The total outsourcing comparison is not as simple. Chapter III developed an inventory surcharge estimate of 19 percent of the cost of the item. Applying this estimator to the cost proposed by the vendor provides a reasonable indicator of the potential savings from outsourcing. However, the NAVICP would continue to perform the central inventory management tasks discussed in Chapter III. Additionally, the savings may not be realized in the short term where most of the inventory management costs are fixed. For example, under the Consumable Item Transfer initiative, the NAVICP transferred thousands of line items to DLA ICPs for inventory management as shown in Table 6.1 [Ref. 41].

Table 6.1 Consumable Item Transfer					
	FY 91	FY 92	FY 93	FY 94	FY 95
Number of items transferred	17,188	102,719	170,582	239,424	255,657
Sales in \$ millions	21.6	103.5	170.7	133.7	257.7
Inventory changes in \$ millions	218.2	956.7	1605.5	2420.0	2645.5
End strength saved	0	0	212	207	96

As shown in Table 6.1, the changes in end strength do not correlate with the decrease in items managed. Despite the large number of transfers, the end strength did not decline until FY 93. Likewise, the decrease in inventory management cost at NAVICP did not match the decrease of the surcharge revenue from the items transferred [Ref. 21].

The value of the benefit resulting from reduced lead time must also be quantified. The author considers the method utilized in the partial outsourcing example to be the most accurate calculation of savings. In that example the value of the demand required to satisfy the demand during the change in lead time is calculated and counted as savings.

The cost comparison for total outsourcing also requires some qualitative judgement. The major benefits from outsourcing the inventory management functions which the author does not attempt to quantify are through improved availability and reliability of the items.

F. ANALYSIS OF MODEL RESULTS

A reasonable estimate of the potential for outsourcing can be achieved by analyzing the results of the model. All items managed at the NAVICP should be considered for outsourcing and run through the model. The only critical success factor in the model is vendor performance. If the NAVICP does not feel comfortable in the vendor's ability to meet a specified fill rate and delivery time, the outsourcing option should be rejected. The other four factors do not negate the possibility of outsourcing potential. However, all of the proposed and existing outsourcing programs that demonstrate potential benefit satisfy the vendor performance criteria and at least one of the remaining four factors. The outsourcing potential is indicated by the level of success an item manifests in each of the five factors.

The level of outsourcing which demonstrates a potential for success is easily determined. If a vendor demonstrates the capability to perform the physical distribution function at an equal or lower costs while also considering savings from reductions in lead time, partial outsourcing should be pursued. If a vendor demonstrates the capability to perform inventory management

functions and reasonably satisfies the remaining four factors, total outsourcing should be pursued.

The “reversibility” of a mistake in estimating the potential for outsourcing also weighs in favor of pursuing outsourcing initiatives under risk. As discussed in the cost comparison sections of the research, the changes in the NAVICP organization and funding would not immediately follow the establishment of an outsourcing initiative. Therefore, if a vendor is not performing at the desired level, the NAVICP should be able to resume inventory management responsibilities after contract termination or expiration.

VII. CONCLUSION AND RECOMMENDATIONS

The potential for outsourcing Navy repairables exists and must be considered by the NAVICP. There are many forces both internal and external to DoD which make outsourcing an issue. The most recent report to Congress on the roles and missions of the Armed Forces emphasizes the need for increased reliance on commercial activities through outsourcing . The report considers any government activity which does not rely on “specialized, defense-unique equipment” to be a prime candidate for outsourcing [Ref. 42].

Many DoD activities already have ongoing and successful outsourcing programs. In the 1995 DoD Logistics Strategic Plan, the Deputy Under Secretary of Defense (Logistics) calls for the expanded implementation of the Prime Vendor concept in various consumable commodities and identifies the need for further balancing the workload between the private and public sectors [Ref. 43].

The initial success in outsourcing the inventory management function to commercial sources involves consumable items (subsistence and medical) in established commercial markets with high and stable demand. However, the outsourcing of repairables is more complex and risky than low cost, high demand consumable items. Repairables are normally more unique to DoD than consumables and have a lower, less predictable demand. Regardless, the NAVICP has demonstrated that the inventory management function can be successfully outsourced if the conditions are right.

To find the right conditions, the author provides a comparison of the costs and method of Navy inventory management to commercial inventory management both in proposed and

existing programs. The Navy inventory management cost is derived from an analysis of the Navy surcharge. The author develops a 19 percent inventory surcharge estimate to use as a benchmark in the comparison to commercial costs.

From the comparison, the research develops a model to estimate the potential for outsourcing. The author compiles a list of factors which indicate the potential for success in outsourcing from an analysis of the established and proposed outsourcing initiatives of both consumable and repairable items.

All items managed by the NAVICP should be screened through the model. The degree to which the factors in the model are satisfied will indicate the potential benefit for outsourcing. The only critical factor in the model is the performance capability of the vendor. If the commercial factors can reasonably satisfy the model, outsourcing initiatives should be pursued.

A. RESEARCH QUESTIONS

1. What is the potential for outsourcing the inventory management of Navy repairables?

The inventory management of Navy repairables can be outsourced to the private sector. Many examples of outsourcing successes illustrate commercial industry's ability to perform the inventory management functions. The initial programs with medical and subsistence items resulted in reduced inventories, reduced lead time, and increased customer satisfaction. Under Bell Helicopter inventory management, DSCR improved response time at a lower cost. The program is so successful, DSCR is expanding Bell Helicopter's role and pursuing outsourcing initiatives with all of its vendors [Ref. 28]. The NAVICP has already demonstrated the potential

for outsourcing success by contracting with Hewlett Packard for the inventory management of over 700 TAC-4 computer line items. HP fills all requirements within a specified lead time and enables the Navy to effectively support this state-of-the-art equipment [Ref. 35].

2. What are the costs and benefits for the Navy to manage repairable inventory items organically?

The author estimates the cost for the Navy to perform the inventory management function at 19 percent of the item cost. The inventory surcharge represents only the cost of the inventory functions which are outsourced. The author derived the inventory surcharge estimate from an analysis of the Navy surcharge and the activities it supports. The inventory surcharge includes both variable and fixed costs.

The benefit of Navy inventory management is primarily control. By maintaining complete control over the levels, procurements, and distribution of repairable items, the Navy may experience less risk to operational readiness at a possibly higher cost.

3. What are the costs and benefits for commercial sources to maintain the inventories of Navy repairables but not set inventory levels or conduct demand forecasts?

The costs of partial outsourcing are provided by the vendor in the form of proposed rates for various physical distribution services. The proposed rates are easily compared to the discrete pricing rates that DLA charges the Navy for physical distribution services. In the partial outsourcing program now in effect with Hughes, the Navy saves \$ 9.78 per item representing more than a 26 percent reduction in the physical distribution costs [Ref.23].

The benefits from partial outsourcing are derived from lower charges, higher accountability, and faster response time. Physical distribution functions represent over 40 percent of the costs of inventory management [Ref. 24]. If other vendors can also provide a 26 percent reduction in costs, the savings could be significant. Because the repairables are handled fewer times, the accountability of items improves under partial outsourcing. Finally, the reduction in repair cycle time increases the availability of inventory. In the Hughes example, the cycle time decreased from 44 to 5 days making \$ 5 million worth of inventory available [Ref. 23].

4. What are the costs and benefits for commercial sources to fully manage Navy repairable items?

Like partial outsourcing, the costs for total outsourcing are also provided by the vendor. The Navy specifies the requirements for service, usually a minimum fill rate and maximum delivery time. The Navy compares the vendor's response to the 19 percent inventory surcharge to determine the potential for savings.

The benefit from total outsourcing inventory functions include more than the potential monetary savings. If vendors can be properly enticed to improve the reliability and availability of their product, operational readiness of DoD forces can improve. Outsourcing also enables the Navy to utilize state-of-the-art equipment without the high costs of obsolescence. Additionally, outsourcing provides more flexibility for DoD to match its support infrastructure to actual demand. The NAVICP can more easily award, monitor and end commercial service contracts than it can substantially adjust its own size and capability.

5. What are the criteria to determine if a repairable item should be managed commercially?

Based on an analysis of proposed and existing outsourcing programs, the author developed a model to gage the potential for outsourcing utilizing the following five factors:

1. Performance capability of vendor,
2. Commercial customer base,
3. Stability and level of demand,
4. Existing physical distribution capability, and
5. Cost.

The model provides a reasonable estimate of the potential for outsourcing. The only critical success factor in the model is vendor performance. The outsourcing potential is indicated by the level of success an item demonstrates in each of the five factors.

B. FURTHER RESEARCH

The author considers the model to be a rough estimator of outsourcing potential. More work must be done analyzing effects on operational readiness and Navy costs determination to more precisely quantify the results of an outsourcing analysis.

The author did not consider the possible effects on operational readiness by loosening direct control of inventory management functions. Although the author does not consider this to be a substantially negative issue for outsourcing, any concerns of a significant decline in operational readiness must be addressed.

The cost of Navy inventory management functions should be more clearly defined by additional research. The 19 percent inventory surcharge derived in Chapter III is used only as a “ballpark” figure for the comparison to commercial inventory cost. Although it may not be possible to calculate one cost rate which applies to all items, a more accurate idea of the costs to perform the various inventory functions is necessary. Additionally, costs must be more precisely differentiated between fixed and variable. Analysis as to how easily the variable and fixed cost could be decreased is also required.

With additional information on effects on operational readiness and Navy costs, the model will provide a more precisely quantified estimate of the potential benefit from outsourcing inventory management functions.

LIST OF REFERENCES

1. Interview between M. Black, Commander, USN, Naval Inventory Control Point, Mechanicsburg, Code 57, and author, 4 October 1996.
2. Government Accounting Office, *Defense Inventory, Changes in DoD's Inventory, 1989-93*, Report to the Chairman, Committee on Governmental Affairs, U.S. Senate, August 1994.
3. Government Accounting Office, *Commercial Practices, DoD Could Save Millions by Reducing Maintenance and Repair Inventories*, Report to the Chairman, Subcommittee on Oversight of Government Management, Committee on Governmental Affairs, U.S. Senate, June 1993.
4. Moore, M., "GAO: Military Doesn't Know That Enough is Enough," *Washington Post*, p.25, March 7, 1990.
5. Government Accounting Office, *Defense Inventory, Applying Commercial Practices Should Help Reduce Supply Costs*, Report to the Ranking Minority Member, Committee on Governmental Affairs, U.S. Senate, August 1993.
6. Government Accounting Office, *Organizational Culture, Use of Training to Help Change DoD Inventory management Culture*, Report to the Chairman, Committee on Governmental Affairs, U.S. Senate, August 1994.
7. White, K., *Adopting the Prime Vendor Program to Manage Marine Corps Authorized Medical/Dental Allowance Lists*, Master's Thesis, Naval Postgraduate School, Monterey California, December, 1994.
8. Office of the Inspector General, *Prime Vendor Support of Medical Supplies*, 7 May 1996.
9. Capano, A., *The Effects of the Department of Defense's Prime Vendor Program on Navy Medical Readiness*, Master's Thesis, Naval Postgraduate School, Monterey California, December 1994.
10. Government Accounting Office, *DoD Food Inventory*, Report to the Chairman, Subcommittee on Oversight of Government Management, Committee on Governmental Affairs, U.S. Senate, June 1993.
11. Defense Logistics Agency Operational Research Department, *Economic Analysis of the DoD Food Distribution Process*, Report DLA-95-A30326 for DoD Defense Logistics Agency, May 1995.

12. Interview between J. Bryant, Operations and Research Analysis for Defense Logistics Agency Operations Research Office, and author, February 1996.
13. Interview between V. Hope, Customer Service Officer, FISC Mayport, and author, 2 February 1996.
14. Interview between R. Faso, Chief, General Products Branch Food Service Business Unit Directorate of Subsistence, DPSC, and author, 6 February 1996.
15. McMasters, A., *"Inventory Management, A Basic Guide to Requirements Determination in the Navy,"* NAVSUP Publication 553, Government Printing Office, 3 January 1991.
16. Interview between A. Brennan, Naval Inventory Control Point, Philadelphia, Code 363.04, and author, 25 November 1996.
17. Naval Supply Systems Command, Presentation by Code 13 entitled "Perception...The Wholesale Surcharge," 1995.
18. Interview between K. Gadbois, Naval Supply Systems Command, Code 133E, and author, 26 September 1996.
19. Madden, M., Commander, USN, Commander Naval Supply Systems Command memo, "Minutes of the Fiscal Year 1997 NAVICP Mechanicsburg Price Update for DBOF Navy Managed Items," 5 August 1996.
20. Interview between R. Davis, Naval Inventory Control Point, Mechanicsburg, Code M013, and author, 23 September 1996.
21. Interview between M. Madden, Commander, USN, Naval Supply System Command, Code 133, and author, 2 October 1996.
22. Defense Distribution Region East, Presentation by Code 05 entitled "DLA Distribution Depot Rates", March 1996.
23. Black, M., CDR, Navy Inventory Control Point code 057, "Business Case Analysis on Mini-ICP Concept," 30 August 1996.
24. Navy Inventory Control Point, Mechanicsburg, Presentation by Code M01 entitled "Surcharges: A Perspective", 8 December 1993.
25. Tricoli, S., Manager, Hughes Technical Services Company, "Mini Inventory Control Point (MICP) Prototype Program - Cost Proposal," 2 February 1996.

26. Tricoli, S., Manager, Hughes Technical Services Company, "Mini-Inventory Control Point (MICP) Prototype Program - Cost Proposal, Proposal Update #1," 22 April 1996.
27. McGravran, S., Program Director, Resources Consultants, Inc, "RCI Study of Commercial Repair Process at SPCC," 9 May 1995.
28. Interview between J. Haynie, Captain, USAF, Defense Supply Center, Richmond, and author, 27 September 1996 .
29. Operations and Research and Systems Analysis Office, Defense General Supply Center, "Cost/Benefit Analysis for Bell Helicopter, Inc. Proposed Corporate Contract," September 1995.
30. Heizer, J., and Render B., *Production & Operations Management*, 4th ed, Prentice-Hall, Inc., 1996.
31. Castanedo, S.C., Hughes Aircraft Company, "Ship Self Defense System MK 1 Just In Time Support Plan," 18 January 1996.
32. Interview between M. Wong, Logistics Engineer, Hughes Aircraft Company, and author 9 October 1996.
33. Interview between G. Nesbit, Program Manager, Hughes Aircraft Company, and author, 3 October 1996.
34. Interview between J. Heltzel, Navy Inventory Control Point, Mechanicsburg, Code 059, and author, 15 October 1996.
35. Interview between J. Bailey, Navy Inventory Control Point, Mechanicsburg, Code 059, and author, 16 October 1996.
36. Interview between T. Trump, Navy Inventory Control Point, Mechanicsburg, Code 021, and author, 22 August 1996.
37. Interview between T. Kozier, Navy Inventory Control Point, Philadelphia, Code P002.2, and author, 16 September 1996.
38. NAVICP Creative Contracting Working Group, draft "Statement of Work, Direct Vendor Delivery Program," August 1996.
39. Coopers and Lybrand L.L.P., Presentation entitled "Direct Vendor Delivery Cost Analysis, Methodology Overview," September 1996.

40. Moore, P. "Overnight Combat Supply Delivery Not Unthinkable," *National Defense*, December 1995.
41. Interview between K. Gadbois, Naval Supply Systems Command, Code 133E, and author, 12 November 1996.
42. Department of Defense, Commission on Roles and Missions of the Armed Forces, "Directions for Defense," Advance Copy, 24 May 1995.
43. Kaminski, P., Office of the Deputy Under Secretary of Defense (Logistics), "Department of Defense Logistics Strategic Plan, Edition 1995," December 1994.

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