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**Analysis of Maintenance Manpower Structures  
for Land-based Naval Aircraft  
Using a Knowledge Value Added Approach**

**15 March 2009**

**by**

**Clinton L. Downing, LCDR, USN, and  
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**Naval Postgraduate School**

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Prepared for: Naval Postgraduate School, Monterey, California 93943



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# Abstract

In June of 2008, Lieutenant Commander Shane Tallant, Lieutenant Commander Scott Hedrick and Lieutenant Commander Michael Martin conducted thesis research titled *Analysis of Contractor Logistic Support for the P-8 Poseidon Aircraft*. Their manpower analysis showed a large percentage of costs related specifically to type-duty assignments. The objective of this thesis is to use a Knowledge Value Added analysis of the manpower structure of an existing operational aviation community in order to determine the most beneficial manpower structure for the maintenance personnel in that community. The methodology used during this research is applicable to any aviation community.

**Keywords:** Knowledge Value Added, type-duty, Navy standard workweek, maintenance manpower



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# Acknowledgements

The authors would like to thank the following people for their help in the completion of this project:

## **Clinton L. Downing's Acknowledgment:**

First and foremost, I would like to thank my beautiful high-school sweetheart and wife of 21 years, Lori, for her unwavering love and dedication. Throughout my naval career, she has been the glue that holds our family together and the rock I lean against when times are tough. It is only through her inspiration and unyielding support that I enjoy any degree of career success. For my children, Courtney, Kyle, Kaitlyn and Leah, I would like to thank you for your continued patience, understanding and love.

A special thank you is extended to LCDR Doug Huggins and the VQ-3 maintenance department for allowing us to use them as a model in this thesis. I would like to thank LT Jim McLaughlin and AVCM Matthew Richards for unselfishly giving their time during this endeavor. And, special appreciation is extended to AZ2 Vanderbilt for his expert understanding of the maintenance computer systems; his efforts greatly simplified our data-gathering efforts.

I would like to extend my most sincere appreciation to Glen Cook for taking the time to teach me the intricate details of the Knowledge Value Added approach, without which this thesis would merely be a doctrine review.

It is difficult to overstate my gratitude to our thesis advisor, Diana Petross. Since I've known her, she has demonstrated a genuine concern for the personal and professional development of her students. I am a better officer for having known her, and I sincerely appreciate her mentorship, guidance and enthusiasm.



To my thesis partner, Josh MacMurdo, thank you for all the hard work and for putting up with my regimented style. I know I can be difficult to work with; it was your insight, temperament and flexibility that made this project a success.

I am indebted to my many student colleagues for providing a stimulating academic environment in which to learn. I am particularly grateful for some of the close relationships that have developed while stationed here at the NPS, particularly those made with the international families. Thank you.

Last, but certainly not least, I would like to thank my parents, Mary and Clinton T. Downing, for their caring advice and unrelenting love and support.

### **Josh MacMurdo's Acknowledgment:**

I would like to take this opportunity to thank my thesis partner, Clint Downing, my advisors, Ms. Diane Petross and Mr. Glenn Cook, my family, and the “Pros from Dover” at VQ-3 (LT Jim Mclaughlin, AVCM Richards, AZ2 Vanderbuilt, and the entire VQ-3 maintenance team) for their insight into the workings of the Navy’s best maintenance department. A special thanks to all the AMDOs, LDOs, Warrants, Chiefs and blue shirt maintainers I’ve had the privilege to work with during my career so far—I owe them everything.



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Disclaimer: The views represented in this report are those of the author and do not reflect the official policy position of the Navy, the Department of Defense, or the Federal Government.



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# I. Introduction

## A. General

For over two hundred years, the United States Navy has deployed around the world in order to defend American interests abroad. The arduous nature of this sea duty has a negative effect on morale, motivation, safety, and performance. In an effort to improve the quality of life for the all-volunteer force, the Navy has developed and employed a type-duty assignment system that cycles sailors between sea duty and meaningful work ashore.

Balancing the needs of the Navy and those of the sailor is a daunting task, and several programs have been introduced in an attempt to get the right mix. Most recently, the Navy has employed the Sea Shore Flow program (SSF). The program is unique in that it tailors a 30-year career path for each individual enlisted rating. This benefits the sailor by providing a predictable career path, improved geographic stability and incentives for more time at sea. It also ensures that commands are manned at the right experience level. In the end, the goal of the SSF is to provide the best balance of sea and shore duty throughout a sailor's career (Navy Personnel Command, 2008).

The unfortunate consequence of any sea/shore program is that additional billets must be created in order to accommodate the shore rotation, resulting in higher community manpower requirements (160% for sailors on a 5/3 sea/shore rotation and 250% for those on a 2/3 rotation).<sup>1</sup>

As the US Navy attempts to reorganize its manpower structure to comply with fiscal constraints, it is important to recognize that cost is not the only metric that can be used to determine value. As the global economy sails through the Information

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<sup>1</sup> These figures were calculated using the ratio of total number of sailors to those on sea duty.



Age, trends are moving toward defining value more in terms of intellectual capital.

One view is that:

Knowledge has become the preeminent economic resource—more important than raw material; more important, often, than money. Considered as an economic output, information and knowledge are more important than automobiles, oil, steel, or any of the products of the Industrial Age. (Stewart, 1998, p. 1)

The stock market provides numerous examples of how this concept is in use today.

Microsoft has an estimated book value of approximately \$13-16 billion, yet it has a market capitalization of \$300-400 billion. This glaring differential represents the earning potential and the value of Microsoft's use of the knowledge embedded in its processes, technology, and people. However, when we look at a classic industrial-era company like Bethlehem Steel Co. (BS) we find a book value of \$1.2 billion while it had a market value of \$1.7 billion as of April 22, 1998. These values are very similar because the accounting and market valuations closely correlate to the physical, tangible asset values. (Housel & Bell, 2001, p. 40)

This example illustrates a convincing argument that the knowledge contained within an organization is a critical component of the value of that organization. Knowledge, therefore, is a principal metric for estimating value. If knowledge can be measured, it can be managed—providing decision-makers with insight and control over the real value of any enterprise organization.

## B. Background

A good case study within the military is the development of the P-8A Poseidon (Multi-mission Maritime Aircraft). In the mid-1980s, the United States Navy began looking for a replacement for the aging P-3 fleet that had been in service since 1961. In 1989, the Navy looked to build the P-7, a turbo-prop aircraft manufactured by Lockheed. The program quickly fell behind schedule and was plagued with cost overruns, so the Navy canceled the contract and opened a new competition for the P-3 replacement (“P-8 Poseidon,” 2009). On June 14, 2004, the Navy awarded a \$3.89 billion contract to a Boeing-led team for the acquisition of 108



multi-mission maritime aircraft (US Naval Air Systems Command, 2009). The new jet-powered aircraft is scheduled to begin replacing the aging P-3 fleet by the year 2013 (Boeing Defense, 2004).

**1. P-8 Poseidon**

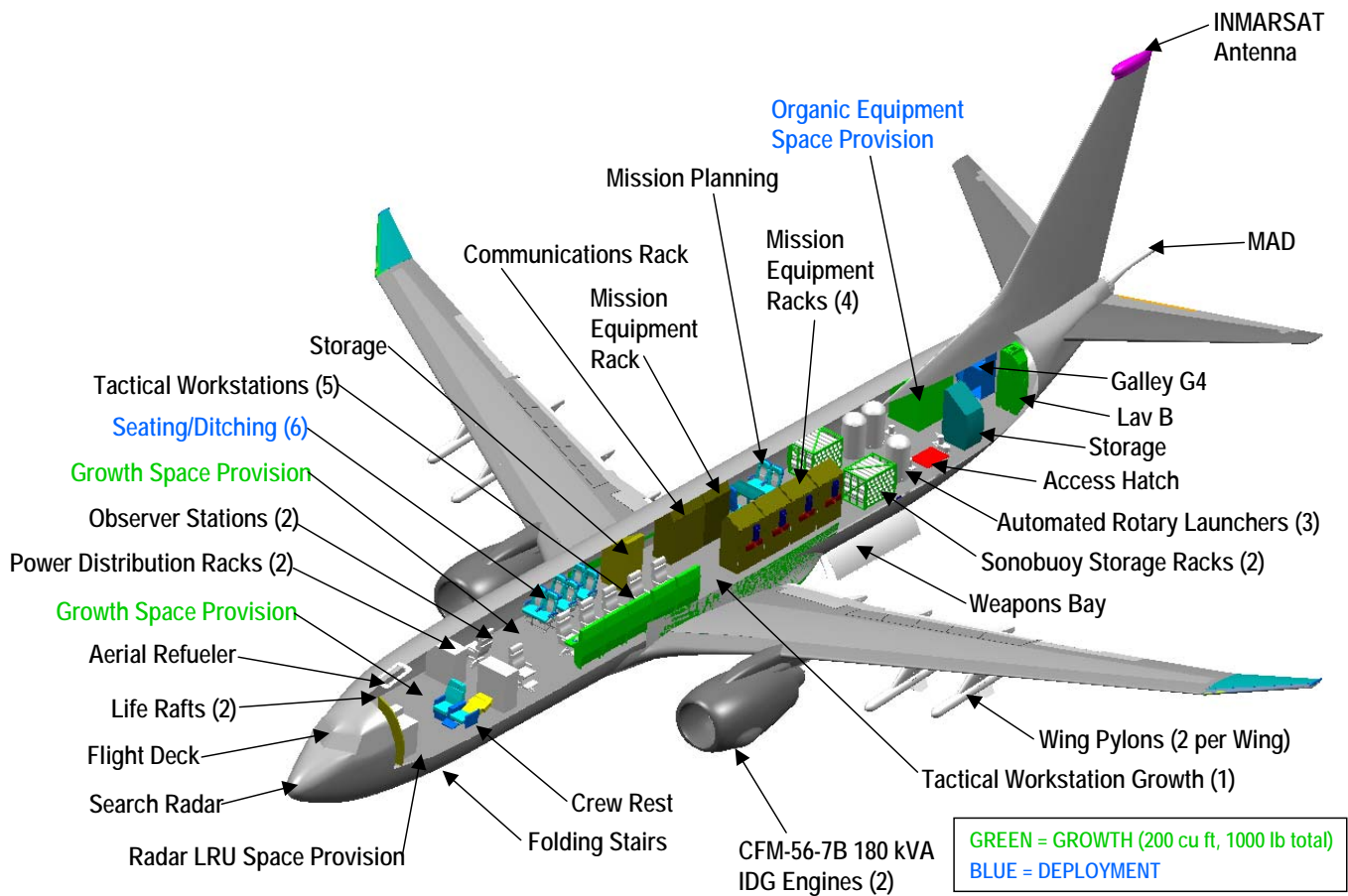
**a. Airframe**

The P-8A is being built on a modified Boeing 737-800 airframe that will utilize two high-bypass turbo fan jet engines and an open architecture mission system, allowing for improved flexibility and reduced long-term costs with the adaptation of next-generation sensors. According to the US Naval Air Systems Command (2009), some specific characteristics of the aircraft are:

- Length:** 129.5 feet
- Wingspan:** 124.5 feet
- Height:** 42.1 feet
- Weight:** Maximum Take-off Gross Weight: 188,200 pounds
- Speed:** 490 knots (564 mph)
- Range:** 1,200+ nautical miles with four hours on station
- Ceiling:** 41,000 ft
- Crew:** Nine

The airframe will have the ability to employ a diverse range of missiles, bombs, torpedoes, and mines, using an internal bay, four wing pylons and two centerline hard points.





**Figure 1. P8 Poseidon Planned Layout**  
(US Naval Air Systems Command, 2009)

**b. Missions**

The P-8A Poseidon was designed to be a truly multi-mission aircraft. Its dynamic mission set includes:

- Long-range, anti-submarine warfare,
- Anti-surface warfare, and
- Intelligence, surveillance and reconnaissance.



The mission system will be network ready—providing Link- 16, Internet Protocol, Common Data Link (CDL), and FORCEnet capabilities (US Naval Air Systems Command, 2009).

**c. Estimated Costs**

Initial estimates for the airframe, engines, armaments, electronics packages and ancillary equipment place the per-unit cost at \$159.9 million. If the Navy purchases all 108 units, the total flyaway cost is \$17.27 billion. These estimates are based on 2004 dollars and are not corrected for inflation (US Naval Air Systems Command, 2009).

**d. Manning/Manpower**

One of the more daunting tasks for a new project is to establish the proper manpower structure to support intended operations. The program office at Naval Air Systems Command (NAVAIR) is currently studying various manpower structures in an attempt to find the best value for the P-8A program. They identified three possible configurations and sponsored research at the Naval Postgraduate School (NPS) to assist in the determination of best value.

**2. Previous Thesis Work**

In June of 2008, Lieutenant Commander Shane Tallant, Lieutenant Commander Scott Hedrick and Lieutenant Commander Michael Martin conducted thesis research titled *Analysis of Contractor Logistic Support for the P-8 Poseidon Aircraft*.

**a. Purpose and Methodology**

The primary purpose of their research was to "assess the costs as an independent variable (CAIV) of the maintenance manpower of both the original equipment manufacturer (OEM) contractor logistics support (CLS)" (Tallant, Hedrick, & Martin, 2008, p. V). They accomplished this task by applying seven different costing tools to three independent models of Consolidated Maintenance Organization (CMO): purely organic, organic/CLS blend, and purely CLS option.



**b. Conclusions and Recommendations**

In the end, the NPS research team concluded that an Organic-CLS blend is the cheapest option for the Navy. They also concluded that this option is the most advantageous from an operational perspective (2008, pp. 89-90).

**c. Further Research**

One area of future research recommended by the NPS team stemmed from their manpower analysis. They proposed that:

A large percentage of cost related specifically to the need for a system of shore rotation. A study should be conducted to analyze if all 789 to 845 enlisted personnel need to be classified as "on sea duty." If a structure could be devised that offered an equitable distribution of work between sea and shore staffing, considerable cost savings could be realized. (2008, p. 91)

Type-duty assignment terms such as "sea-duty" and "shore-duty" are defined in the MILPERSMAN as follows:

Shore duty (Type Duty Code 1):

Duty performed in United States (U.S.) (including Hawaii and Anchorage, Alaska) land-based activities where members are not required to be absent from the corporate limits of their duty station in excess of 150 days per year.

Sea duty (Type Duty Code 2):

Type 2a: Duty performed in commissioned vessels and deployable squadrons home ported in the U.S. (including Hawaii and Alaska).

Type 2b: U.S. land-based activities and embarked staffs, which require members to operate away from their duty station in excess of 150 days per year.

For land-based naval aviation, the applicable type-duty assignments are type-duty code 1 and 2b. Type-duty assignments are used by the manning distribution system as a tool to improve the quality of life for the all-volunteer force, not as a basis for funding. Funding is based on manpower requirements derived from the application of the "Navy standard workweek" to the "total weekly work hours





required.”<sup>2</sup> For land-based naval aviation squadrons, the standard workweek has two categories: deployable and non-deployable. Therefore, the refined proposal asks the question: Can a cost savings be realized with an equitable billet distribution between deployable and non-deployable Navy standard workweeks?

### **3. Current Research**

This thesis will address the question using two different approaches. First, application of Navy doctrine will be used to determine the feasibility of the proposal. Then, a cutting-edge approach rooted in thermodynamics theory, called Knowledge Value Added (KVA), will be used to assign a value to different manpower structures based on deployable and non-deployable Navy standard workweeks. A comparison of the resulting derived values will provide some insight into the proposed question.

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<sup>2</sup> A more detailed discussion is presented in Chapter II of this thesis.



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## II. Doctrine

### A. General

The Navy employs a standardized approach when determining manpower requirements for naval activities. The process of determining actual community manpower requirements is a laborious task that takes teams of experts and vast amounts of time and research to complete. For the purpose of this thesis, a general overview of the process will be used. The methodology is based on the *Office of the Chief of Naval Operations Instruction (OPNAVINST) 1000.16K*, the governing document that provides policies and procedures required to develop, review, approve, implement and update manpower requirements and authorizations for all naval activities (Office of the Chief of Naval Operations, 2007).

### B. Methodology

The methodology for determining manpower requirements begins with the establishment of the Required Operational Capabilities (ROC) and Projected Operational Environment (POE). The ROC is prepared by mission and warfare sponsors and it details:

The capabilities required of ships & squadrons in various operational situations. The level of detail sets forth which weapons will be ready at varying degrees of readiness (e.g., perform anti-air warfare with full capability condition of readiness I (24hrs, General Quarters); partial capability in readiness condition III, (60 days, 8 hrs watch/day). (NPS Faculty, 2009)

The POE identifies:

The environment in which the ship or squadron is expected to operate, including the military climate (e.g., at sea, Wartime, capable of 60 days continuous operations at readiness Conditions I & III). (NPS Faculty, 2009)

Together, the ROC and POE identify a community's mission requirements and describe the specific operating environment in which the unit is expected to



operate. It is based on anticipated wartime tasking and projects the nature of deployment of the warfighting platform.

The *Navy Total Force Manpower Requirements Handbook*, referred to in 1000.16k, contains Navy staffing standards, which determine the total weekly work hours required to accomplish an activity's mission. By applying the appropriate Navy standard workweek, consistent with the ROC and POE, to the total weekly work hours, the unit can meet these manpower requirements. The "efficient use of resources" concept is then applied to ensure the unit's manpower reflects the minimum quantity and quality necessary to effectively and efficiently accomplish the activity's mission (Office of the Chief of Naval Operations, 2007, p. 2-2). Manpower requirements become authorized positions when supported by resources (i.e., funded). This, in turn, sends a demand signal to the distribution system for manning assignment to a unit (p. 1-2). Actual manning assignments are distributed across the entire force based on a fair share of current manning levels.

### C. Value

Within the doctrinal approach, cost to the government is applied in the authorization of manpower requirements. Once requirements are funded, total lifecycle costs for an activity or community can be estimated. As part of previous research, the Cost as an Independent Variable (CAIV) approach was used to determine the lifecycle value of maintenance manpower requirements for a Naval Aviation community. The authors of this thesis propose that the CAIV approach is consistent with manpower valuation from the naval enterprise standpoint but is not a comprehensive approach to valuation of manpower.



### III. Knowledge Value Added (KVA) Approach

#### A. General

Cost is one of many metrics that can be used to determine manpower value. However, as the global economy proceeds through the Information Age, the trend is to define value in terms of intellectual capital. Knowledge, therefore, is a principal metric for estimating manpower value.

Unfortunately, "there is no generally accepted single definition of knowledge. And there is no wide-spread agreement on the overall parameters of knowledge" (Housel & Bell, 2001, p. 12). One attempt at solving this dilemma is the Knowledge Value Added (KVA) approach. KVA is an analytical method, founded in thermodynamics complexity theory, which utilizes an algorithm to provide a performance ratio estimate. It views an organization as a portfolio of knowledge assets, assesses value of intellectual capital, defines a common unit of output and provides performance ratios for all core processes. These performance ratios are the principal outputs of the KVA process and are identified as Return on Knowledge (ROK).

An early use of this approach was to capture value added to systems that implement Information Technology (IT). The KVA process provides actionable information to decision-makers by capturing the difference in ROK between the "as-is" and "to-be" models. This difference in ROK represents the relative value (or benefit) of introducing the IT into a system. If the relative benefits justify the costs, then the decision-maker should implement the IT; if not, he/she should keep the as-is model.

At the core of the KVA approach is the portfolio of knowledge assets, defined as sub-processes. These sub-processes need not be IT driven, which allows for great versatility in the KVA application.



## B. Methodology

Given the flexibility intrinsic to the KVA approach, the methodology can take several different forms. The model proposed in this thesis was presented in a class taught by Mr. Glen Cook (2008), lecturer at the Naval Postgraduate School in Monterey, CA, from June-August, 2008. The authors of this thesis claim no credit in the KVA process or definitions, only in its application.

### 1. Getting Started

The first step is to map the organizational processes into sub-processes. This mandates a thorough understanding of the business processes within the organization and may necessitate comprehensive doctrine review and personal interviews to gain the necessary granularity. The second step is to choose the most realistic unit of time that can be used as a standard for data collection across all sub-processes.

### 2. Learning Audits

There are three types of learning audits that can be performed. Data collection for all three types of audits is not necessary; however, at least two audits must be performed for verification and credibility. An 80% or better correlation between the audits indicates that the data is valid. Once the data is considered valid, one learning audit is chosen for use in the KVA calculation.

#### a. Actual Learning Time (ALT)

ALT is an estimate of the actual time it takes to learn how to do a sub-process. It includes all formal classroom training, on-the-job training and hands-on apprenticeship work. Of particular note, ALT only documents the actual time spent learning (not the elapsed time). ALT is based on three principal assumptions:

- Learning time is the average time across all qualified people,
- Learning time is a measure of complexity, and
- Greater complexity means longer learning time.



Once validity requirements are met, a common practice in KVA analysis is to select ALT as the learning audit for future calculations.

**b. Nominal Learning Time (NLT)**

NLT is an allocation process that explains the knowledge allocation of a particular sub-process as a percentage of the whole process.

**c. Ordinal Learning Time (OLT)**

OLT is a numerical ranking of all sub-processes from the easiest to the hardest to learn (in terms of complexity).

**3. Number of People**

One critical element of the KVA methodology is to accurately account for the number of people involved in the completion of a sub-process. The following rules apply:

- Every sub-process can have more than one but must have at least one person.
- An individual can be represented in more than one sub-process.
- All people for a sub-process are assumed to be doing comparable work.
- If the work is not comparable, then identify it as an additional sub-process.

**4. Times Fired (K-fire)**

This is a measure of the number of times a process executes or knowledge is used to perform a step in a process. It is a cumulative value for all actors involved in performing a sub-process over a given timeframe.

**5. Percentage IT (%IT)**

The percent IT identifies how much of a sub-process is accomplished by IT. In many instances, this is an approximation.



## 6. Total Learning Time (TLT)

TLT corrects the chosen learning time to account for the percentage of the sub-process that is completed using IT. When IT has only a small influence in the sub-process, it is considered a minor additive and the TLT correction becomes:

$$TLT = ALT + (ALT * \% IT)$$

When IT takes a significant role in the sub-process, it is considered a knowledge enhancer and the TLT correction becomes:

$$TLT = \frac{ALT}{1 - \% IT}$$

## 7. Total Output

Total output is defined as the total amount of knowledge needed. It is a product of the TLT and times fired.

## 8. Actual Work Time (AWT)

Actual work time is the actual (average) time spent accomplishing a sub-process.

## 9. Total Input

Total input is a calculation based on the costs incurred while accomplishing the sub-process. This can be measured in units of time or money, as appropriate. In instances where money is the appropriate metric, total input is a product of the AWT, number of people, times fired and cost per unit time. In instances where time is the appropriate metric, total input is a product of AWT and number of people.





## C. Value

### 1. Return on Knowledge (ROK)

The principal metric for value in the KVA methodology is ROK. It is the ratio of the total output divided by the total input. The absolute value of ROK is generally irrelevant. Its usefulness is in comparison to the ROK of other sub-processes.

### 2. Percent Utilization (%U)

Another useful metric that is commonly used in a KVA analysis is the percent utilization. It is calculated by dividing the AWT by the number of hours available for work.



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## IV. KVA Application

### A. General

One practical use of the KVA approach is in naval manpower management decisions. As US military forces become more technically advanced, the intellectual capital required to operate and maintain these assets becomes more valuable. The KVA methodology provides a vehicle for capturing this value and provides insight beyond that of the CAIV approach. It is an outstanding tool for gaining clarity on manpower decisions. Specifically, the KVA methodology can be used to identify ROK (relative value) for different classifications of the deployability of an operational aviation community. This provides manpower managers additional insight into the value of different manpower structures, enhancing any cost-benefit analysis.

### B. Community Selection

The KVA methodology can apply to the maintenance manpower structure of any aviation community. A community that is in its infancy, such as the P-8, would be an excellent choice because they would benefit most from the results of a KVA analysis. It is possible to conduct research into the assignment of maintenance personnel by conducting a KVA analysis based on the approximations made in a mature Manpower Estimation Report (MER). Unfortunately, the P-8 MER will likely continue to undergo several significant revisions. Given the heavy reliance that the KVA approach has on manpower structure, any changes to the MER will make the analysis of little use to the P-8 manpower decision-makers.

The next best option is to choose an existing community that closely mirrors the mission and airframe of the P-8. Once the model is complete, it can be applied to the P-8 after the MER is solidified. The advantage of this approach is that it allows for the use of mature manning documents and historical maintenance data in the analysis, which will provide better results than an analysis driven by estimations. Unfortunately, no existing community exactly mirrors that of the P-8 in terms of



airframe and projected operational environment. A good analogue is the E-6 Mercury—a jet aircraft manufactured by the Boeing Company that primarily conducts missions over water and routinely deploys away from its main operating base.

## **1. Take Charge and Move Out (TACAMO)**

### **a. Mission**

The STRATCOMMWINGONE website describes TACAMO as:

A Navy Air Wing fully integrated on an Air Force base, carrying out a Navy mission in joint operations. Commander, Strategic Communications Wing One provides operational control and administrative support for Fleet Air Reconnaissance Squadrons Three, Four, Seven and various training units. The Navy's TACAMO community provides a survivable communications link between the national decision makers and the country's arsenal of strategic nuclear weapons. In other words, our 16 E-6B Mercury aircraft enable the President of the United States and the Secretary of Defense to directly contact submarines, bombers and missile silos protecting our national security through nuclear deterrence. (Commander, Strategic Communications Wing, 2009)

### **b. History**

The STRATCOMMWINGONE website also provides a clear history of TACAMO:

“Take Charge and Move Out!” In July 1963, Rear Adm. Bernard F. Roeder, Director of Naval Communications for the Chief of Naval Operations, used these words to task the development of a unique part of naval aviation. The nation needed a reliable strategic communications system between the President and other national command authorities with nuclear ballistic missile submarines. This system had to survive any hostile military action. The Navy created such a system, modifying a Marine Corps KC-130 Hercules transport aircraft with a Very Low Frequency radio transmitter capable of communicating with submerged missile submarines. This experiment was a success and TACAMO, with its "Take Charge and Move Out" mission, was born. Since then the three squadrons have flown over 28 years and 400,000 hours of safe missions.

The period following the end of the Cold War in 1989 brought revolutionary changes to the world and to TACAMO as well. The E-6A Mercury aircraft replaced the EC-130 Hercules that had provided 30 years of faithful service. TACAMO commands moved from six different homeports to a central



location: Tinker Air Force Base, Oklahoma. The result is a 25 percent reduction in operations and personnel expenses.

In years past, TACAMO provided communications capability only to submarines with ballistic missiles. Currently, TACAMO provides command and control capability for all three strategic platforms including submarines, bombers and land-based missile sites.

On Oct. 1, 1998, The U.S. Navy's fleet of E-6Bs replaced the EC-135 in performing the "Looking Glass" mission flown for over 29 years by the U.S. Air Force. This new mission allows the President and the Secretary of Defense direct command and control capability with America's strategic forces of ballistic nuclear missile submarines, intercontinental nuclear missiles, and strategic bombers. With the assumption of this new mission, a battle staff now flies with the TACAMO crew. (Commander, Strategic Communications Wing, 2009)

**c. E-6 Mercury Capabilities**

The E-6 Mercury was built on a modified Boeing 707-320 airframe that utilizes four high-bypass turbo fan jet engines. Some specific characteristics of the aircraft are (Commander, Strategic Communications Wing, 2009):

<b>Speed:</b>	.88 mach
<b>Max range:</b>	6,600 nm
<b>Endurance:</b>	16.2 hours
<b>w/refueling:</b>	72 hours
<b>Ceiling:</b>	42,000 feet
<b>Length:</b>	150 feet
<b>Wing span:</b>	148 feet
<b>Height:</b>	42 feet
<b>Weight:</b>	342,000 lbs. (max gross, take-off)





**Figure 2. E-6B Mercury**  
(Radecki, 2007)

C. Methodology

**1. Getting Started**

The TACAMO squadron manpower document (SQMD) provides a clean division of maintenance billets into functional areas called work centers (W/C). Each W/C is tasked with the performance of a unique set of maintenance actions on the aircraft and can be used as the maintenance sub-processes that are required in a KVA analysis.

Work performed on the aircraft by each W/C is captured on Maintenance Action Forms (MAF) and recorded in the Naval Aviation Logistics Command Management Information System (NALCOMIS)—an information management system that acts as a repository for maintenance data. Analysis of the data contained in NALCOMIS is critical in order to further understand the business processes used for maintenance on the E-6 Mercury. One year of maintenance data (January 2008-December 2008) was obtained from both operational TACAMO



squadrons (see Table 1). Since the difference in total maintenance hours and number of MAFs provided no insight into which data was more valid, one squadron was chosen at random for analysis. VQ-3 was selected to participate.

**Table 1. NALCOMIS Query Results**

	VQ-3	VQ-4
Total Maintenance hours	159,469	133,265
Total MAFs	13,915	20,833

A careful review of the MAF data revealed a discrepancy between the W/Cs identified in NALCOMIS and the SQMD. Specifically, NALCOMIS documented MAFs written against W/C 121: Reels, 340: Detachment Site A, 341: Detachment Site B, X20 and X30. These W/Cs do not exist in the SQMD. Likewise, there are some W/Cs identified in the SQMD (030: Maintenance Admin, 040: Quality Assurance, 050: Material Control and 05D: Tool Room) that are not recorded in NALCOMIS because these W/Cs did not complete any MAFs during the time period being studied.

This discrepancy exists because there is a difference between ideal and real manning distribution in the squadron. The ideal manning distribution would be in accordance with the programmed requirements as defined in the SQMD. Realistically, Commanding Officers are responsible for overall position management within their squadron and execute their prerogative, as authorized by *COMNAVAIRFORINST 4790.2a*, to distribute personnel within their command in a manner that “optimizes economy, productivity and organizational effectiveness” (Commander Naval Air Forces, 2008, p. 3-63). With regards to the KVA analysis, this results in an inability to effectively reconcile W/C NEC inventory against manpower NEC requirements. This presents a significant problem because NEC learning times are a major contributor to the ALT calculation and will have a significant impact on the resulting ROK. This is not the case with an ideal manning



distribution because the SQMD clearly identifies the NEC requirements for each W/C. Therefore, the KVA analysis must be based on the ideal manning distribution as defined in the SQMD. Subsequently, the definition of sub-processes should also follow the structure provided in the SQMD.

The drawback to using an ideal manning distribution is that it does not exactly mirror reality and requires some normalization of the NALCOMIS data in order to make it useable in the KVA analysis. Specifically:

- W/C 121 completed 928 MAFs and 7,765 maintenance man-hours. Since this W/C does not exist in the SQMD, these MAFs were assigned to W/C 120. The justification is that W/C 120 and 121 perform similar maintenance actions and are manned with personnel with similar rates, ranks, and NEC requirements.
- W/Cs 340 and 341 combined to complete 621 MAFs and 2,716 maintenance man-hours. These W/Cs act as miniature maintenance departments located at forward operating bases. Since these W/Cs do not exist in the SQMD, these MAFs were individually assigned to other W/Cs that perform similar maintenance actions and are manned with personnel with similar rates, ranks and NEC requirements.

The next, and much easier, step was to choose the most realistic unit of time that can be used as a standard for data collection across all sub-processes. Since all NALCOMIS data and NEC learning times were recorded in units of hours, this was an appropriate unit.

Two independent analyses were conducted. The first analysis is referred to as the “as-is” model and calculated the ROK and %U for a manpower structure based on a deployable Navy standard workweek. The second analysis, referred to as the “to-be” model, conducted the same calculations except the manpower structure was based on a non-deployable Navy standard workweek.

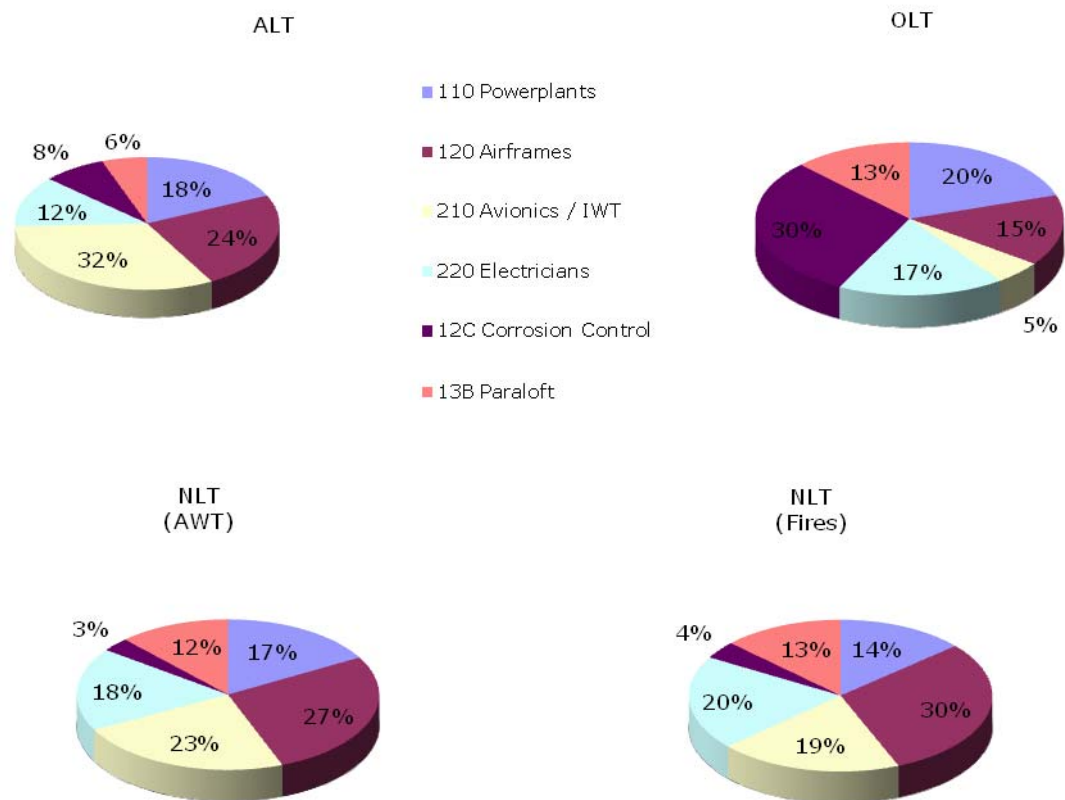
## **2. Learning Audits**

Sufficient data is available for all three types of audits. Figure 3 provides a visual representation of each learning audit. The correlation between ALT and NLT





is 81.7% and is considered valid for this analysis. ALT was selected as the learning audit in the KVA calculation.



**Figure 3. Learning Time Comparison**

**a. W/C Actual Learning Time (ALT)**

W/C ALT is derived by adding the total formal classroom time associated with meeting NEC requirements and the average time to complete the W/C hands-on apprentice, journeyman and master programs. Both the formal training and the hands-on program require independent calculations.

The W/C formal training time calculation is relatively simple and unbiased. The SQMD identifies primary and secondary NEC requirements for each individual billet. The Catalogue of Navy Training Courses (CANTARC) identifies the classroom time required to complete the formal training necessary to obtain a particular NEC.



The W/C formal training time is calculated by adding the classroom time required for all primary and secondary NECs for all billets assigned to the W/C.

The W/C hands-on program calculation is more complex and somewhat biased. TACAMO has adopted the Qualified and Proficient Technician (QPT) program as its hands-on program.

The QPT Program is in-service training for aviation units designed to encompass and standardize technical training and quantify maintenance proficiency levels across all aviation platforms. QPT enables unit leadership to compare [its] Total Force Readiness to its Mission Readiness, calculate the effectiveness and efficiency of training, and prioritize training funding requirements by providing measurable standards of proficiency. (Commander Naval Air Forces, 2008, p. 10-1)

The QPT program has three levels of certification: Qualified and Proficient Apprentice (QPA), Qualified and Proficient Journeyman (QPJ) and Qualified and Proficient Master (QPM). A maintenance technician's level of certification is associated with a pay grade and expected level of proficiency. The general doctrinal guidance is: QPA for E-4 and below, QPJ for E-5 and E-6, and QPM for E-7 and E-8.

Since the W/C ALT is defined in units of hours, and the QPT program does not explicitly identify learning-time requirements for each level of certification, a subjective approach was used to capture W/C hands-on learning time. Based on the best estimates from the Aircraft Maintenance Officer (VQ-3, 2009), the approximate relationship between level of certification and hours spent learning is:

- QPM ~ 800-1000 learning hours,
- QPJ ~ 700-800 learning hours, and
- QPA ~ 400-500 learning hours.

For use in the KVA analysis, the average estimated learning time was used for each QPT level of certification. The authors of this thesis acknowledge that this



subjective estimate adds a degree of inaccuracy into the KVA analysis. However, it is the best available solution and will not affect the conclusions drawn from the KVA analysis because the inaccuracy remains constant in the as-is and to-be models.

**b. W/C Nominal Learning Time (NLT)**

For this application, NLT represents learning in use, not learning in inventory. Two independent calculations were used to capture W/C NLT. The first method captured actual work performed by a W/C as a percentage of all work performed in the department. Actual-work-performed data is derived from the MAFs recorded in NALCOMIS. The second method captured the K-fires by a W/C as a percentage of all K-fires in the department. K-fires data is derived from the MAFs recorded in NALCOMIS.

**c. W/C Ordinal Learning Time (OLT)**

OLT is a subjective ranking of the W/Cs based on learning complexity and disregards differences in pay grade. This thesis relied on the experience and expertise of the Maintenance Master Chief and the Aviation Maintenance Officer. They each offered independent rankings that had a correlation of 100%.

**3. W/C Number of Sailors**

The KVA analysis used the manpower billets assigned to each W/C as identified in the SQMD. This was done primarily as a matter of consistency. However, use of this data does assume that actual manning is at the same level as the SQMD. The authors acknowledge that this assumption adds a degree of inaccuracy into the KVA analysis for two reasons. First, actual squadron manning levels are dependent on the fair-share distribution of manning inventory in the *Navy Manning Plan*. Second, actual manning distribution within the squadron is at the discretion of the Commanding Officer and is not necessarily in accordance with the SQMD. This assumption is justified because any inaccuracy in W/C manning levels will have no effect on the conclusions drawn from the KVA analysis because the inaccuracy remains constant in the as-is and to-be models.



#### 4. **W/C Times Fired (K-Fire)**

“Times fired” is the summation of all MAFs completed by a W/C during the period being studied. In order to preserve the integrity of the KVA analysis, any W/C that completed less than 1% of all squadron MAFs (<139) was excluded from the model due to insufficient data.

K-fire data on the remaining W/Cs was converted into times fired per hour. This calculation used the “productive workweek” (as defined in the *OPNAVINST 1000.16K*) for deployable and non-deployable aviation squadrons (60 hours for deployable squadrons and 33.38 hours for non-deployable) and a 48-week work-year (to account for standard four weeks annual leave).

#### 5. **Percentage IT (%IT)**

For the purposes of this KVA analysis, the %IT was assumed to be 10% for all W/Cs. A more accurate estimation could be determined by reviewing the Maintenance Requirement Cards for each MAF initiated over the period and by deriving an average for each W/C. The time required to gather this information does not justify the minor increase in accuracy, particularly since the %IT is a minor additive. This assumption is justified because any inaccuracy in %IT will have no effect on the conclusions drawn from the KVA analysis as long as the inaccuracy remains constant in the as-is and to-be models.

#### 6. **W/C Total Learning Time (TLT)**

W/C TLT was calculated by using the formula for IT as a minor additive.

$$TLT = ALT + (ALT * \% IT)$$

#### 7. **W/C Total Output**

This output was the product of TLT and K-Fire.

#### 8. **W/C Actual Work Time (AWT)**

W/C AWT was derived from NALCOMIS data by combining the maintenance hours of work performed by all members of a W/C.



## 9. Cost per Sailor

When determining manpower costs, NAVAIR 4.2 uses a flat rate, an annual standard of \$94,000 per sailor (Tuemler, 2007). For use in the KVA, this value was converted to cost per hour using 48 weeks per year (to account for annual leave) and the Navy standard workweek (as defined in *OPNAVINST 1000.16K*) for deployable and non-deployable, land-based aviation squadrons. This standard is a 60-hour workweek for deployable squadrons, 33.38-hour workweek for non-deployable units.

## 10. W/C Total Input

W/C total input was calculated using the product of W/C AWT, number of sailors, W/C K-fired per hour, and cost per sailor per hour.

## 11. W/C Return on Knowledge (ROK)

W/C ROK was calculated by dividing the W/C total output by the W/C total input. A reduction factor of 1000 was then applied in order to create a scale that was usable for analysis.

## 12. W/C Percent Utilization

W/C percent utilization was calculated by dividing the W/C AWT by the number of hours available for productive work.

## D. Assumptions and Limitations

### 1. Assumptions

- The learning times associated with QPT certification levels will not vary as a function of the Navy standard workweek. Thus, ALT remains constant for both the as-is and to-be models.
- Actual manning is at the same level as defined in the SQMD for both the as-is and to-be models.
- All available work time is dedicated only to aircraft maintenance.
- The %IT is 10% for all W/Cs.



- Annual cost of a sailor is constant (\$94,000).
- AWT is based on maintenance requirements of the aircraft and will not vary as a function of the Navy standard workweek.

## 2. Limitations

- The only non-subjective source of data available for input into the KVA is from NALCOMIS. This data only captures direct maintenance man-hours within the department. It does not capture the contribution made by management.

## E. Results

A summary and comparison of the KVA analysis results for both the as-is and to-be models is depicted in Table 2.

**Table 1. KVA Results Comparison**

	Deployable		Non-deployable		Difference	
	(As-is)		(To-be)			
	W/C ROK (ALT)	W/C % U (AWT)	W/C ROK (ALT)	W/C % U (AWT)	W/C ROK (ALT)	W/C % U (AWT)
110 Powerplants	21.64	40.3%	12.04	72.47%	-9.60	32.15%
120 Airframes	17.49	40.8%	9.73	73.40%	-7.76	32.56%
210 Avionics / IWT	28.26	53.1%	15.72	95.42%	-12.54	42.33%
220 Electricians	13.95	47.0%	7.76	84.44%	-6.19	37.46%
12C Corrosion Control	52.48	13.6%	29.20	24.49%	-23.29	10.86%
13B Paraloft	9.37	94.3%	5.21	169.45%	-4.16	75.18%

## F. Analysis

The KVA analysis had two weaknesses. First, although the KVA analysis did an excellent job of capturing the value of the actual work performed on VQ-3 aircraft, it failed to capture the value of management's contribution to aircraft maintenance. This is a known weakness of the KVA methodology and proved to be insignificant since the discrepancy was consistent between the as-is and to-be models.

The second shortfall was that the analysis did not include all work centers. This flaw also proved to be insignificant because the results obtained from the



remaining work centers had universal appeal. Specifically, the KVA analysis revealed that all of the W/Cs that were analyzed experienced a reduction in ROK of approximately 44% between the as-is and to-be model. This indicates that the as-is manpower structure is categorically more valuable to the maintenance department than that of the to-be model.

The percent utilization calculation produced some interesting results. Generally speaking, optimal W/C %U is between 60-80%. A %U greater than 80% is acceptable; however, it will likely have a negative impact on quality of life if sustained over long periods of time. Any %U greater than 100% indicates there are not enough manpower resources being applied to the W/C (Cook, 2008).

With the exception of the Paraloft, the %U for W/Cs in the as-is model is relatively low. This is the result of the assumption that all available work time is dedicated only to aircraft maintenance; yet, we know this is not true. For example, some W/C personnel are also aircrew and, as such, spend a portion of their work hours available flying the aircraft. This will necessarily drive down the %U.

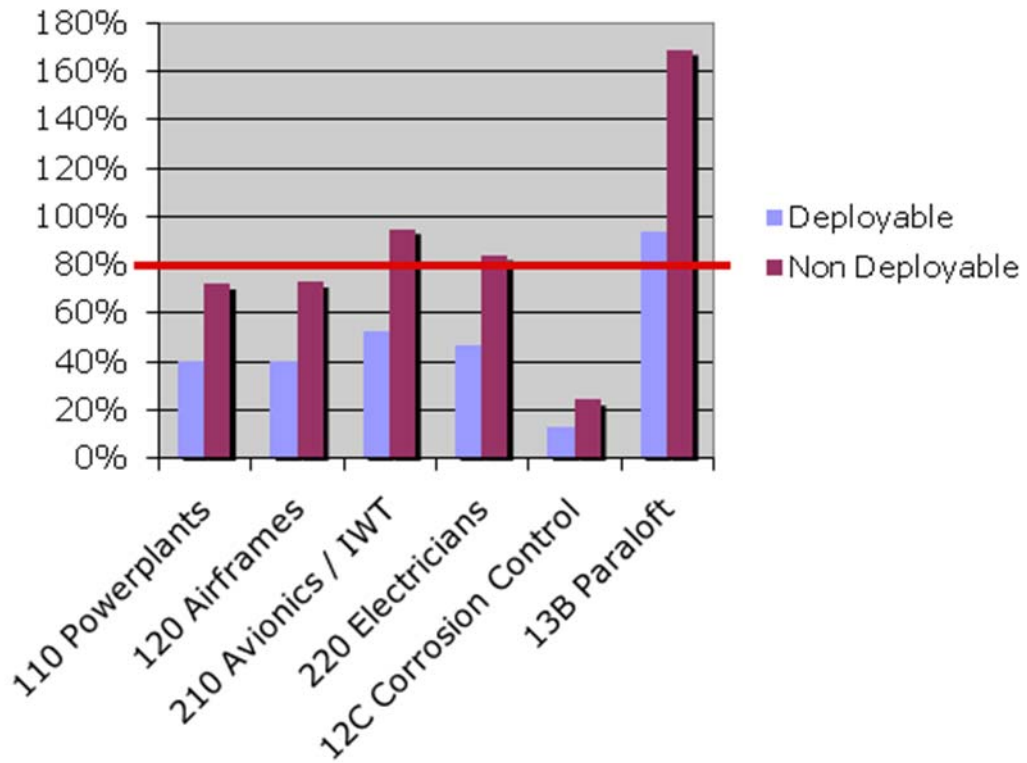
One item of concern stemming from the analysis is the %U of W/C 13B (Paraloft). In the as-is model, this W/C is operating near full capacity (94.3%). As mentioned previously, this level of loading will have a negative impact on quality of life, if sustained over long periods of time. Even more alarming, the %U for W/C 13B in the to-be is 169.45%. This is a clear indication that more manpower resources would be required if the non-deployable standard workweek were to be employed for this W/C. A 214% increase in manpower would be required to reduce the to-be %U below 80%. In fact, the manpower requirements for any W/C in the to-be model must be increased 180% in order to maintain the same %U as that of the as-is.<sup>3</sup>

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<sup>3</sup> Calculated using a ratio of the deployable and non-deployable Navy standard workweek (60hrs/33.38hrs~180%)







**Figure 4. Work Center Percent Utilization Comparison for As-is (Deployable) and To-be Model (Non-deployable)**





## V. Conclusions and Recommendations

### A. Conclusions

This thesis used two different approaches to address the question: can cost savings be realized with an equitable billet distribution between deployable and non-deployable Navy standard workweeks? The first analysis revealed that manpower costs are doctrinally bound to the Navy standard workweek, which is applied as a function of the ROC and POE. Using the doctrinal approach, the authors conclude that a cost savings cannot be realized without a corresponding change to the mission and operating environment of the aviation platform.

The second analysis using the KVA methodology proved to be a good supplement to the doctrinal approach. It provided additional insight into the business processes within the maintenance department of an aviation squadron. The KVA analysis demonstrated that (1) the maintenance department benefited categorically from use of the deployable Navy standard workweek, and (2) a significant increase in manpower resources would be required in order for any of the W/Cs to obtain a satisfactory level of utilization using a non-deployable standard workweek.

### B. Recommendations

Navy standard workweek assignments for any aviation community are bound by naval doctrine and driven by the ROC and POE. Since these are normally classified documents, specific recommendations concerning ROC/POE are beyond the scope of this thesis.

However, the KVA demonstrated that the deployable Navy standard workweek categorically resulted in a higher ROK—an average increase of 44%. Thus, we recommend that manpower planners use the deployable Navy standard workweek whenever possible.



### C. Areas for Future Research

Management Value Added (MVA) is another value-based approach that attempts to capture the contributions made by management. The KVA and MVA methodologies should be applied to the P-8 MER in order to gain clarity on the actual value of each work center. This could prove useful to P-8 manpower decision-makers as they determine which work centers should remain organic to the organization and which should become contractor logistic support.



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