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Identifying the Cost of Non-monetary Incentives (ICONIC)

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December 2009

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13. ABSTRACT

There is growing research that explores using an array of non-monetary incentives (NMIs) to attract and retain quality Sailors. Non-monetary incentives used in this paper are: homeport choice, billet choice, platform choice and geographic stability. This research experiments with the cost of non-monetary incentives for potential reenlistment by using a linear programming assignment optimization model. The ICONIC (Identifying the Cost of Non-monetary Incentives) model was developed as a proof-of-concept mechanism to identify the cost for non-monetary incentives.

Forty-five Sailors and sixty billets was the sample size used to test the assignment model. Forty-one different scenarios were run with 50 percent weight on both Navy preferences and Sailor preferences that included a variety of NMI offerings. The same forty-one scenarios were run with 100 percent weight on Navy preference and 0 percent weight on Sailor preferences, and vice versa, for a total of one-hundred twenty-three different scenarios. The number of NMIs offered in each scenario was incremented as follows: five, ten, fifteen, twenty-five, and thirty-five. PCS, training, and fit costs were used to calculate the cost of the NMIs.

In general, the more emphasis placed on the Navy's cost, Sailor value decreased. Conversely, Sailor value goes up when cost is ignored. Moreover, the Sailor fit of a particular billet increases when cost is ignored. The key component of the objective function was to minimize the Navy's cost and increase value to the Sailor. In general, the model's results proved successful and showed a logical connection between the philosophical idea of how cost might behave as the number of NMIs offered increases and the heuristic assignment methodology.

This proof-of-concept will continue to revolutionize the most economical way to attract and retain Sailors.

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IDENTIFYING THE COST OF NON-MONETARY INCENTIVES (ICONIC)

Ryan D. Stitt, Civilian

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS IN DEFENSE ANALYSIS

from the

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December 2009

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LIST OF ACRONYMS AND ABBREVIATIONS

AC	Navy Air Traffic Controllers
AG	Aerographer Mates
COTS	Commercial Off-the-shelf
CNA	Center for Naval Analysis
CNP	Center for National Policy
CRAM	Combinatorial Retention Auction Mechanism
DoN	Department of the Navy
FC	Navy Fire Controlman
GAO	Government Accountability Office
ICONIC	Identifying the Costs of Non-monetary Incentives
JFTR	Joint Federal Travel Regulation
MS	Microsoft
NEC	Navy Enlisted Classification
NMI	Non-monetary incentive
OCONUS	Overseas Continental United States
PCS	Permanent Change of Station
SDIP	Sea Duty Incentive Pay
SRB	Selective Reenlistment Bonus
SWO	Surface Warfare Officer
TAD	Temporary Additional Duty

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I. INTRODUCTION

A. BACKGROUND

The Department of the Navy (DoN) needs flexible forms of compensation for its enlisted Sailors. One of the starting points is to determine if the current compensation policy is effective in retaining enlisted Sailors. A Center for Naval Analysis (CNA) study suggested that "changes in both Navy technology and civilian labor markets are going to require profound changes in the way the Navy recruits, trains, and compensates enlisted personnel."[1] While monetary compensation plays a role in Sailor retention, non-monetary incentives could prove to be attractive to reduce attrition rates.

In any public or private institution, compensation packages are designed to advance and achieve the organization's goals. The strength of a compensation package is measured by its ability to attract and retain a workforce with mission-critical skill sets. Moreover, a solid combination of incentives will evenly distribute the work, motivate the workforce, and maintain pay equity. Of course, to do this at the lowest possible cost is challenging. Attracting and retaining employees in mission-critical areas can be difficult, but the Navy recognizes the importance to pay-out additional money for lower blue-collar positions (e.g., network administrators and electronic technicians).

The alignment of employees' natural self-interests with the organization's objectives is motivated by other means of encouragement. A well-structured incentive system will motivate employees to achieve and exceed performance targets and lower attrition rates. Although many people prefer monetary compensation, at least up to a

[1] Martha E. Koopman, Steve Cylke, Heidi W. Golding, Michael L. Hansen, Thomas Husted. *Compensation Strategy for the Future Force*. Center for Naval Analyses, September 2000.

point, money is not the only thing that people value. "As a matter of fact, non-monetary rewards often are greatly valued by employees and, in some cases, they place a smaller financial burden on the firm."[2]

The Navy has historically had trouble meeting its retention targets and the programs to retain the current manning level are not effective. The Navy is facing macro pressures to both become a more efficient organization and retain qualified Sailors to sustain readiness and accomplish its operational missions. The current system relies on re-enlistment and retention bonuses to meet its end-strength targets. In 2004, the Navy studied the number of selected reserve personnel needed to support the active force in meeting current and future mission requirements. The Government Accountability Office (GAO) recommended that the Navy establish guidance for ongoing and future workforce reviews to ensure resources are allocated cost effectively and provide the best mix of reserve and active duty personnel.[3]

The Navy also faces future technological advances and budget constraints that combine to produce a new platform with reduced manning levels. This could reduce maintenance, move workload from sea duty to shore rotations due to new information technology, and increase the use of trainers and more commercial off-the-shelf (COTS) technology. Ultimately, the Navy needs to provide a range of distribution incentives to better meet the goal of allocating people across billets. The Navy needs more flexibility in its compensation system as it moves forward in a dynamic economy and needs to adjust appropriately to changing conditions.

There is growing research that explores using an array of non-monetary incentives (NMIs) to attract and retain quality Sailors. Non-monetary compensation might include: homeport choice, billet choice, platform choice and geographic stability. This research

[2] Kenneth A. Merchant, Wim A. Van Der Stede. *Management Control Systems*. London: Pearson Prentice Hall, Second Ed., 2007.

[3] U.S. Government Accountability Office, Washington, D.C. "Force Structure: Assessments of Navy Reserve Manpower Requirements Need to Consider the Most Cost-effective Mix of Active and Reserve Manpower to Meet Mission Needs," October 2005, http://www.gao.gov/new.items/d06125.pdf . (Accessed: September 28, 2008).

estimates the cost of non-monetary incentives for potential reenlistment incentives by using a linear programming assignment optimization model.

B. PURPOSE

The purpose of this research is to estimate the costs attached to offering non-monetary benefits to enlisted Sailors. Capturing the actual cost of non-monetary compensation would support a more robust cost-effectiveness analysis for the Navy. Specifically, the use of a linear programming assignment optimization model might help determine the cost impacts of proposed non-monetary reenlistment incentives, and those imposing constraints on the assignment process in particular. Current simulation models analyzing non-monetary incentives assume a somewhat arbitrary fixed linear cost. This proof-of-concept project attempts to estimate those costs thorough an optimization model called "ICONIC" (Identifying the Costs of Non-monetary Incentives) and determine if there are non-linear trends as usage increases.

C. RESEARCH QUESTIONS

1. Primary Research Question

What is the cost of those non-monetary incentives that restrict Sailor assignments in the Navy's Sailor detailing process?

2. Secondary Research Questions

a. What priorities guide detailer decisions in the assignment process?

b. Will the optimization model provide a method to find the cost of non-monetary incentives?

c. How effective is the model as additional NMI constraints are imposed on the detailer's decisions?

d. How does this model compare/contrast to other similar assignment models?

D. LIMITATIONS OF STUDY

This study focused on identifying the cost of non-monetary incentives for U.S. Navy Sailor reenlistments; specifically platform choice, billet choice, geographic stability, and homeport choice. The findings, however, may serve as a springboard for identifying the costs of other NMIs and for other DoD Components.

E. ORGANIZATION OF STUDY

Chapter II describes different modeling decisions and their outcomes using Linear Programming. This section also looks at the scope and methodology behind using an optimization model, provides a brief background of the Department of Navy community that was investigated, and describes the motivation behind this paper. Last, this chapter will summarize comparative methodologies similar to this study.

Chapter III presents the model's data and data collected from the Navy Air Traffic Controllers (ACs) and Fire Controlman (FCs) survey.[4] This chapter also introduces the associated data that helped identify the cost of NMIs.

Chapter IV shows the model's specifications and an overall view of how the model was designed in Microsoft Excel. Also, this chapter reveals the cost of offering stand-alone NMIs versus offering multiple NMIs, and looks at trends from the model's output.

Chapter V draws final conclusions from the information presented, and recommends topics for future research.

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[4] Brooke Zimmerman, "Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM)," Master's thesis, Naval Postgraduate School, 2008.

II. MODELING DECISIONS AND OUTCOMES

A. MOTIVATION

This research project is motivated by the recruitment and retention issues facing U.S. Navy personnel managers as they compete in an increasingly difficult labor market. This study is a component of a broader stream of research to develop a retention mechanism that optimally combines monetary and non-monetary incentives (NMIs). A linear programming assignment model, called Identifying the Cost of Non-monetary Incentives (ICONIC), will be used to identify the actual cost of non-monetary incentives. The ICONIC model will find a heuristic answer that approximates the optimal solution and most cost-effective means of putting a Sailor in the right place based on their preferences. The model examines the effects of imposing restrictions on those assignments to reflect NMIs such as home porting and geographic stability. Detailers have to make many decisions before a Sailor is relocated and this research will examine those decisions and attempt quantify the effects of these restrictions with a constrained optimization model.

1. Retention Mechanisms

This research is just one of many on-going elements of Drs. Pete Coughlan and William Gates' investigation into the opportunity costs of retention decisions, cash bonuses, and NMIs for retaining Sailors. The exploration of alternative retention mechanisms is potentially very powerful, and potentially easier to analyze by limiting attention to specific levels of effort.[5] Some of the mechanisms that could be used to incentivize reenlistment can be very costly.

[5] William R. Gates and Peter J. Coughlan. "Mechanism Design for Defense Management: A Research Agenda and Representative Illustration." Presentation at the Monterey Bay Aquarium, Monterey Bay, California, November 20, 2008.

A 2004 Center for National Policy (CNP) poll of Surface Warfare Officer (SWOs) was used to gather their opinions on monetary incentives as retention tool; one finding is shown in Figure 1.

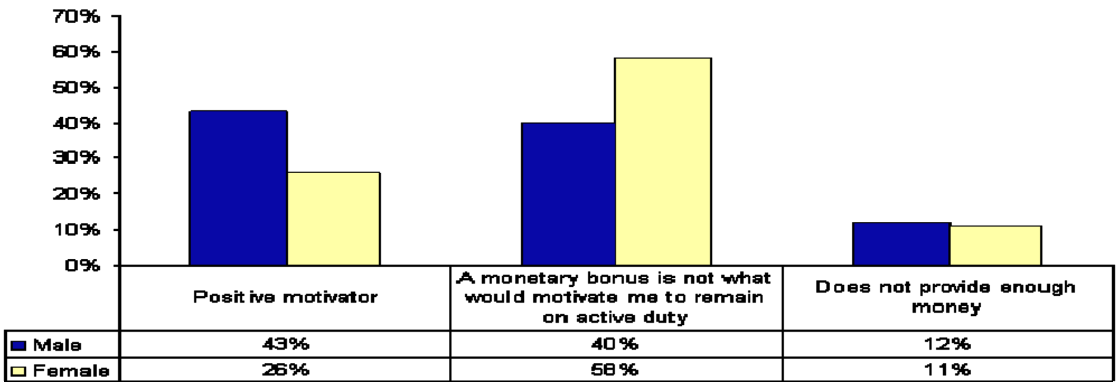

Figure 1. Monetary Incentives as a Retention Tool (From Peter Coughlan and Bill Gates. *Mechanism Design for Defense Management*, Nov. 20, 2008)

NMIs could prove to be cost-effective if the value of the incentive is greater than the cost for a sufficient number of service members. Figure 2 shows the cost versus the value of NMIs. Offering an NMI can be particularly cost effective if it is only offered to those for whom value exceeds cost, and to none of those Sailors where cost exceeds value.

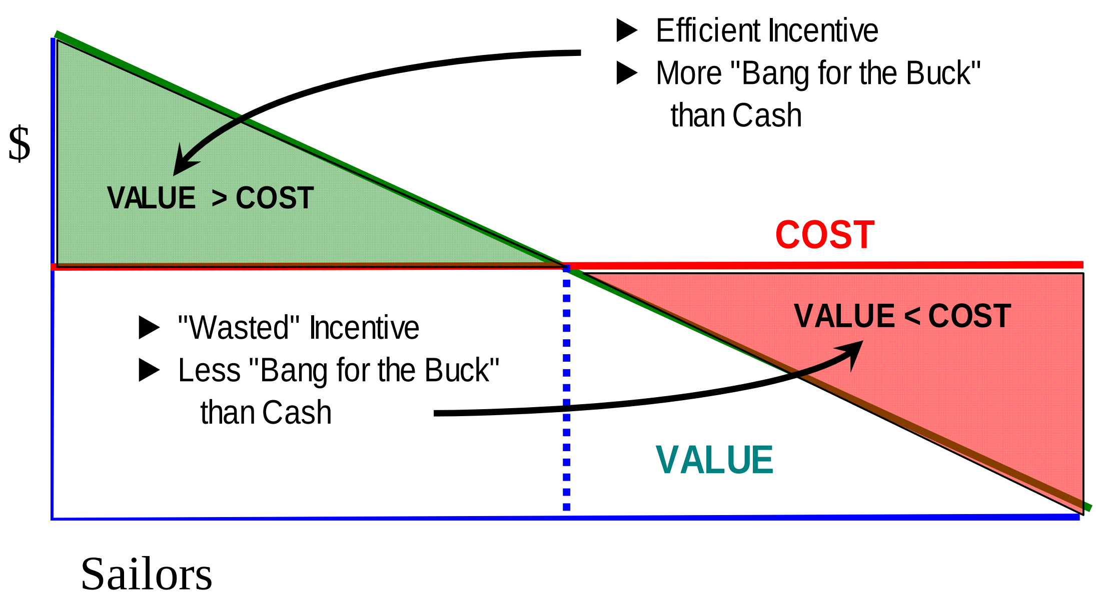

Figure 2. Non-monetary Incentives: Cost vs. Value (From Coughlan and Gates, 2008)

Using a reverse combinatorial auction might assist in retaining the required number of service members. In a reverse auction, there are many sellers and just one buyer; the winner is the seller who bids the lowest price, or with multiple winners the sellers with the lowest bids. In a second-price reverse auction, the winner actually pays the second lowest bid (first excluded bid with multiple winners). With a second price reverse auction, the dominant bidding strategy is to bid one's true minimum required price. Thus, the idea behind a reverse auction is to drive down the price of the purchase to the lowest level that satisfies the buyers demand.

If Sailors are offered the opportunity to choose a package of incentives in place of a cash bonus, will the Navy successfully retain those individuals for less cost?[6] The methodology behind a reverse combinatorial auction is to offer a "list" of retention incentives.[7] The concept behind the Combinatorial Retention Auction Mechanism (CRAM) is a package bid. Service members will submit a bid for their minimum required monetary retention bonus and the amount by which they would reduce this monetary bonus if they receive different NMIs or combinations of NMIs. The retainees (i.e., the "winners") ultimately receive retention packages involving a cash bonus and non-monetary incentives.[8] The Navy's cost for the retention bonus is equalized across all retainees, and equal to the cost of the first excluded bid.

The reverse auction mechanism was examined in a second thesis project by Lieutenant Brooke Zimmerman, who considered two specific Navy communities: the Air Traffic Controllers (ACs) and the Fire Controlman (FCs). The drawback to these earlier analyses is that both studies estimated the cost of the non-monetary benefits from the distribution of sailor values and assumed NMI costs were constant. This research will attempt to estimate a Navy cost for the non-monetary incentives, hence providing a more robust representation of the net benefits from offering a combination of monetary and non-monetary incentives.

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[6] Constance M. Denmond, Derek N. Johnson, Chavius G. Lewis and Christopher R. Zegley. *Combinatorial Auction Theory Appplied to Selection of Surface Warfare Officer Rentention Incentives*. MBA Professional Report, Naval Postgraduate School, 2007.

[7] Ibid.

[8] Pete Coughlan and Bill Gates. *Mechanism Design for Defense Management*. November 20, 2008.

B. SCOPE AND METHODOLGY

Inevitably, NMIs do have costs. While NMIs will have tremendous advantages for the reenlisted Sailor, if the cost of the NMI is not identified, then cost-effectiveness will be hard to measure. A mathematical representation of the (ICONIC) model was created using a linear programming (LP) assignment model in Microsoft Excel. In solving this LP model, an appropriate objective function from the detailer's perspective will be imperative to finding a realistic optimal solution(s).

1. The AC and FC Community

Before discussing the ICONIC model and its application, it is perhaps instructive to describe briefly the Navy community data used from Lieutenant Brooke Zimmerman's study: Air Traffic Controllers (ACs) and the Fire Controlman (FCs). This may help readers identify with the assignment of these Sailors to particular billets and the potential role that non-monetary benefits will play for these and other Navy communities. Navy Air Traffic Controllers (ACs) perform duties similar to civilian air traffic controllers. They are responsible for controlling and directing air traffic at airfields and on aircraft carriers. Fire Controlman (FCs) operate weapon systems on-board surface combatant ships. Typical duties for FCs include maintaining digital computer equipment, routinely inspecting, testing, aligning and repairing computers and associated data equipment, and running performance tests on Navy combat systems.

C. LINEAR PROGRAMMING

1. Definition and Applications

"Linear programming (LP) helps with resource allocation decisions."[9] There are many different types of linear programming models (e.g., Network Flow and Product Mix). They all seek to maximize or minimize some functional relationship, which is commonly referred to as the objective function. Some examples of Network Flow and

[9] Nagraj Balakrishnan, Barry Render and Ralph M. Stair. *Managerial Decision Modeling with Spreadsheets*. 2nd ed. (Upper Saddle River: Pearson Prentice Hall, 2007), 25–30.

Product Mix problems include food blending, inventory management, portfolio and finance management, resource allocation for human and machine resources and planning advertising campaigns. Some of the most common objective functions are: minimize cost, maximize output, profit, revenue, etc.

Management decisions play an important role when trying to make the most effective use of resources. In any resource allocation situation, managers are constantly seeking the most efficient, or optimal choice. "The most widely used decision modeling technique to help managers in this decision process is called mathematical programming."[10] In fact, mathematical programming is a form of basic algebra where real world decisions are described mathematically in the form of a model. Often times, when a management problem is defined there can be an infinite number of solutions.

Any problem having numerical decision variables and an objective function to be maximized or minimized is called an optimization problem. If there are constraints, the problem is called constrained optimization. Linear programs are constrained optimization problems that have certain special characteristics: the objective function and the constraints must be linear functions. One of the cautions about a linear programming model is that all model data is not known with certainty, which is often not the case. Sensitivity analyses can be performed to overcome the uncertain elements in the model.

The development of a linear programming model can be described in different steps: (1) Formulation, (2) Solution, and (3) Interpretation.[11] In the first step, the goal is to be sure that the set of mathematical equations adequately represent the specific management decision. Solving the problem in Microsoft Excel is the proposed method to find a solution from the mathematical expressions for the objective and constraints. It is important to understand that this discussion will refer to the LP solution as *an* optimal solution rather than *the* optimal solution because the ICONIC model may have more than one optimal solution (i.e., more than one solution that provides the same optimal value

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[10] Nagraj Balakrishnan, Barry Render and Ralph M. Stair. Managerial Decision Modeling with Spreadsheets. (Pearson Prentice Hall, Second Ed. 2007), 25–30.

11 Ibid.

for the objective function). Assuming that that mathematical expression is correct and is successfully solved using Microsoft Excel, results will subsequently be interpreted.

One linear programming problem with a special structure that is frequently used in the operations research literature is called the transportation problem. A common problem of this nature seeks to minimize the shipping cost between the manufacturer warehouses and retailers. "The objective of the company is to ship units from the warehouse to the retailer such that (a) no more units leave a warehouse than there are in stock, (b) the demands of the retailers are satisfied, and (c) the total shipping cost is minimized."[12] This is important to understand because the assignment model is a special case of the transportation problem. A way to describe the assignment problem is finding the shortest path algorithm; assigning one Sailor to one billet that best meets the objective function, i.e., satisfies the detailer's objective and the Sailor's needs.

Regardless of the size and complexity, the goal of solving a LP model is to devise an algorithm that mathematically represents an objective function and optimize the objective given a number of constraints. A seemingly fruitful approach to identifying the cost of non-monetary incentives is through an assignment model where certain NMIs can be represented as constraints in the assignment problem (e.g., homeport of choice, geographic stability, etc.).

2. The Assignment Model

"The assignment method, also known as Flood's technique or the Hungarian method of assignment, provides a much more efficient method of solving assignment problems."[13] The assignment method is also known as the weighted bipartite matching problem.[14] One way to think about the assignment model is with the concept of economic opportunity loss: that is, the value of the next best alternative sacrificed as the

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[12] Horst A. Eislet, Giorgio Pederoli and Carl-Louis Sandblom. *Continuous Optimization Models*. Operations Research: Theory, Techniques, Applications. Walter de Gruyter & Co., 1987.

[13] Richard I. Levin, Charles A. Kirkpatrick and David S. Rubin. *Quantative Approaches to Management*. New York: McGraw-Hill, 1982.

[14] G.L. Nemhauser, A.H.G.Rinnooy Kan and M.J. Todd. *Optimization.* Amsterdam: Elsevier Science Pub. Co., 1989.

result of making a decision. The best possible outcome in assigning one Sailor to one billet would involve an opportunity cost of zero. This research will seek to identify optimal assignments, and analyze the properties of the optimal outcome as constraints representing NMIs are increased.

The assignment model is a special case of linear programming that is the best way to assign ‘n’ persons to ‘m’ jobs, assuming that the “desirability” of assigning Sailor ‘i’ to job ‘j’ is d_{ij}. “Researches have suggested numerous algorithms for solving the assignment problem. Several of these algorithms apply, either implicitly or explicitly, the successive shortest path algorithm for the minimum cost flow problem.”[15]

3. The ICONIC Application

The ICONIC model should identify the most efficient mix of Sailors to billets and identify the cost of the NMIs. The challenges that this project might encounter include: identifying the appropriate objective function; including the most important assignment criteria from the detailer’s point of view; and the model’s effectiveness as constraints are added. One possibility, at the conclusion of this study, will be to determine if this model could represent small- and large-scale Sailor populations.

Conditions are constantly changing in real world situations; sensitivity analysis involves examining the optimal solution under changes in the values of input parameters.

D. COMPARATIVE METHODOLOGIES

Linear programming models can be problematic because real-world conditions are not always easy to formulate. Multiplicity, richness, and vagueness exist in the real world, and it can be difficult to replicate these relationships mathematically. In this research, the attempt to place a quantitative value (cost) on a non-monetary incentive has not yet been tested. Moreover, it is easier to quantify objectives such as “maximize profit” or “minimize cost,” but more dubious objectives, such as the one proposed here

[15] G.L. Nemhauser, A.H.G.Rinnooy Kan and M.J. Todd. *Optimization.* Amsterdam: Elsevier Science Pub. Co., 1989.

(mathematically representing the detailers' objective functions to identify the cost of non-monetary values), if not well-represented, can be misleading.

Other questionable objectives, such as "achieve competitive superiority" or "provide the best service to the community" have been modeled before, but for these objectives, "surrogate criteria" have to be determined that substitute for the objective while still being closely related to the goal.[16]

Linear programming models could have secondary implications as well. For example, maximizing profits in the short run may suggest increasing prices for some goods, but there could be long term effects to the business: increase in manpower, additional equipment purchases, shrinking market shares, slow growth, etc.[17] Maximizing long run profits might require a completely different market strategy. In the public sector, (e.g., Department of the Navy) identifying the cost of non-monetary benefits will be handled by setting the objective function to reflect the detailers' mindsets and decisions.

1. Tangential Topics/Examples

Most of the real-world assignment problems specifically answer a business question; for example planning transportation or distribution networks, and usually involve real cost data and product quantities that seek to minimize or maximize an easily-quantifiable objective function. The impediments in this research were trying to model a topic that is tangential in nature to real-world problem being modeled. It is like trying to predict a company's stock price, based on qualitative characteristics like cash flow, the company's bond rating, or the significance of meeting analysts' quarterly expectations. Research revealed problems that used a number of weights to define or determine the outcome of a subjective multi-attribute objective function (this is also known as Multi-Attribute Utility Analysis (MAUA)). In one example, a real-estate firm used weights on the characteristics of a certain property to secure a business transaction.

[16] Horst A. Eislet, Giorgio Pederoli and Carl-Louis Sandblom. *Continuous Optimization Models*. Berlin: W. de Gruyter, 1987.

[17] Ibid.

In one sense, this is a ground breaking endeavor. Understanding the importance of other types of models and examples might provide insight into the author's attempt to explore the cost of non-monetary incentives. Below are a few examples of tangential topics.

a. Inspection Optimization Model

The Environmental Protection Agency (EPA) developed a linear programming model designed for a state air-pollution control inspections program called an "Inspection Optimization Model" (IOM). It was a joint project between the Stationary Source Compliance Division and Statistical Policy Branch of the EPA. The EPA had divided air pollution sources into two main categories: mobile sources and stationary sources. With too few inspectors and too many sources to inspect, the EPA had a difficult time responding to the worst violators, but would frequently send investigators to the areas of less concern; the process was very inefficient. Thus, the EPA designed a quantitative approach that efficiently allocated inspectors to categories of stationary sources of air pollution within the given budgetary and policy constraints so that the most damaging violators are identified. [18]

The model's primary goal was to provide a planning tool for distributing resources. The major conceptual assumption of the model was that air quality will improve as a result of compliance with EPA guidelines. Moreover, the IOM would improve the effectiveness of the inspection program and more violators would be identified, thereby increasing compliance.

b. Heuristic Network-Flow Model

The timeshare vacation industry is a significant player in travel accommodations for people who want to vacation in a nice home-away-from-home, rather than visiting the same resort year after year. This opportunity is provided by timeshare exchanges that focus on the timeshare exchange fair. The series of events

[18] Jerzy A. Filar, Donna J. Nickerson and Phillip N. Ross. "Inspection Optimization Model." *Socio-Economic Planning Sciences* 28, issue 3 (1994): 137–146.

between owners and vacationers determines various aspects of how the exchange fair functions, and introduces a better optimized way of executing exchanges.[19] In this case, a network flow model was developed as a platform for illustrating the tradeoffs between optimal solutions of the exchange fair and the multi-objective optimization involving which vacationer gets "what" and "when." "The timeshare exchange problem is an assignment problem where the available intervals (unit-resort-weeks) are assigned to intervals requested in order to maximize weighted utility of the trader."[20]

c. Audit Staff Assignment Model

In this case, audit personnel are assigned to audit reports within the limitations of an audit office to meet the economic objectives of this office. Not only does a linear programming model maximize the audit office's economic objective, but it will also provide useful information such as: (1) schedule training requirements, (2) which members should work additional hours, (3) from which clients additional work should be sought, (4) whether to add audit clients when the office is running at capacity, (5) how vulnerable the office is to loss due to error in assignments.[21] The audit office seeks to maximize the mixture of monetary and non-monetary benefits, and the problem for staff assignment is to identify and quantify that mixture.

E. CHAPTER SUMMARY

Many of the problems that the Navy faces with low retention and Sailor dissatisfaction, in part, is caused by a distribution system that has inadequate incentives to balance the Navy's needs with the Sailor's preferences.[22] Consequently, the Navy must rely on a combination of things: non-monetary incentives to entice volunteers to

[19] Anton Ovchinnikov. "Timeshare Exchange Fair (A) and (B)." *Darden School of Business, University of Virginia Publishing*, Case UVA-QA-0709, (2007). https://store.darden.virginia.edu/business-case-study/timeshare-exchange-fair-a-107 (Accessed November 2008).

[20] Ibid.

[21] Edward L. Summers. "The Audit Staff Assignment Problem: A Linear Programming Analysis." *The Accounting Review* 47 (1972): 443-453.

[22] Martha E. Koopman, Steve Cylke, Heidi W. Golding, Michael L. Hansen, Thomas Husted. *Compensation Strategy for the Future Force*. Center for Naval Analyses, September 2000.

either move or remain in difficult-to-fill billets, frequent moves between good and bad assignments, and other special pays that can distort the environment and amenities that the next assignment offers.[23]

The primary objective of this work is to produce reasonable estimates and/or characterizations of the costs associated with offering certain NMIs to enlisted Sailors. The variance in per unit costs, such as NMIs offered to smaller or larger percentage of a particular Sailor specialty, is one component to the model's focus. This research attempts to take the assignment model and explore the possibility of finding a quantitative solution to a heuristic modeling approach. The objective function is to minimize the weighted average of the Navy's cost minus the Sailors' value, where the weights reflect the relative priorities detailers attach to Navy needs versus sailor preferences.

Finding an optimum solution to this question can be complex and assigning costs to non-monetary incentives can be problematic. The optimal solution to identifying the cost of non-monetary incentives is only as good as the model's input and overall design. The next chapter will introduce the ICONIC model's data and structure.

[23] Martha E. Koopman, Steve Cylke, Heidi W. Golding, Michael L. Hansen, Thomas Husted. *Compensation Strategy for the Future Force*. Center for Naval Analyses, September 2000.

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III. MODEL DATA

A. INTRODUCTION

The general approach to collecting the required data for the assignment model had many components. The ICONIC assignment matrix includes forty-five Sailors and sixty billets. This data represents the normal distribution of assignments per detailer in an assignment window as found by LCDRs Richard Shlegel.[24] The three Navy cost components factored into the model are: Permanent Change of Station (PCS) or moving costs, training costs and pay grade mismatch costs (or fit costs). Each cost component was assigned a value for each Sailor, based on the sailor's and billet's comparative characteristics (location, skills and pay grade). The basis of the linear programming model was to create a utility function for each Sailor in each billet. The utility function was developed, in part, with the help of two Navy detailers that identified detailing and funding priorities.

B. BILLET TYPE OF CHOICE

Lieutenant Brooke Zimmerman's survey of six-hundred and one enlisted Sailors showed that billet *type* of choice has more value than billet of choice.[25] *Billet type* of choice involves skill requirements, or Navy Enlisted Classification (NEC), and is independent of Homeport or Platform of choice. On the other hand, *billet* of choice includes Homeport and Platform type of choice; billet of choice is not used as one of the model's constraints. The ICONIC model characterizes billet type as NEC and randomly assigns choices based on probabilities of sailor preferences within the relevant population (E4-E6). About 20 percent of sailors prefer the same NEC, whereas 80 percent prefer a

[24] Richard J. Schlegel. An Activity Based Costing Analysis of the Department of the Navy's Enlisted Detailing Process. Master's thesis, Naval Postgraduate School, 2000.

[25] Brooke Zimmerman. Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM). Master's thesis, Naval Postgraduate School, 2008.

different NEC.[26] During an interview, one detailer stated that billet type usually means NEC, however there are times it does not correspond to NEC. Billet type; can refer to the pay grade of a billet (e.g., E4). Random designation of billet type of choice affects cost estimates associated with this NMI, but does not affect cost estimates for other NMIs.

C. PCS COSTS

To calculate the average PCS costs, the author obtained the most recent table from the Joint Federal Travel Regulation (JFTR) to find the weight allowance (in pounds) broken down by Sailor rank. Three moving companies were contacted (Allied, North American Van Lines and Mayflower) to gather estimated moving costs in two-thousand-pound increments. Each estimate was for a two- to three-bedroom living area. Overseas (OCONUS) miles were not estimated. A thirty-six month tour was used as the basic range that a Sailor would spend at one assignment. For each year's experience the enlisted Sailor has in his pay grade, a multiplier was used to calculate the total PCS cost to include the Sailor's dependent status. PCS costs were generated between all regions in the model (San Diego, Seattle, Norfolk, and Jacksonville). Mileage between airports was used to estimate the total PCS move, based on dependent status and the associated weight allowance for E4s-E6s.

PCS cost varies across assignments for each Sailor, and corresponds to the specific cost of moving each particular Sailor from his/her current billet to the assigned billet. PCS costs increased with each NMI, because they will often require that the Sailor who is assigned to a billet must PCS from a more distant location than would be required if the NMI was not offered.

D. TRAINING COSTS

A training cost is incurred whenever a Sailor is assigned to an NEC which is not his/her current NEC. Training costs include both school house costs, temporary lodging

[26] Brooke Zimmerman. Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM). Master's thesis, Naval Postgraduate School, 2008.

and *per diem* costs, and the sailor's salary and benefits while in training, Identifying potential training costs for a particular Sailor assignment is not easy. There is no research that estimates a training cost associated with a specific assignment. If a Sailor is assigned to a billet for which they do not have the requested NEC, the training cost required to ensure operational readiness at the next assignment is almost impossible to measure on a general basis. To address this issue, and provide a training cost for the ICONIC model, the author sought out training costs. Specific types of training were analyzed, along with dollar cost estimates for various pay grades. The model assumed two weeks of training for each pay grade, but the model is designed so this can be varied as a fraction of a month. Total training cost can increase with any of the NMIs modeled here if the number of Sailors assigned to new NECs increases when offering the NMI.

E. FIT COST

The Sailor and billet sample modeled here only includes pay grades E4 to E6. For the purposes of this model, the linear program does not include E3s or E7s to E9s. The rationale for including only E4s-E6s was two-fold: (1) to allow for "one-up, one-down" assignments and (2) to reflect actual detailing practice. In one interview with the author, it was revealed that one-up, one-down type assignments are possible, sometimes at the Commanding Officer's direction.[27] For example, an E4 can be assigned to a billet designated for an E5 and vice versa. It is also true that that a single detailer is only responsible assigning E4s, E5s, and E6s within a particular community. In some cases, where the community has a larger number of enlisted Sailors, there might be two or three detailers within these pay grades to handle the sheer volume of assignments. One-up and one-down assignments involve opportunity costs.

An increase in pay grade mismatches could occur with each of the NMIs modeled here, because assignment restrictions to satisfy NMI constraints sometimes require that more Sailors be assigned to billets with a higher or lower designated pay grade than would be the case if the NMI was not offered.[28] If an E5 is assigned to a billet

[27] Jill Handley. Interview with the author, January 2009.

[28] From: Pete Coughlan Research Notes. August 20, 2009.

designated for an E4, the Navy is essentially paying too much in salary to fill that billet, which could be costly and a poor use of talent. On the other hand, if the Navy assigns an E4 to a billet designated for an E5, the sailor may be under-qualified and the Navy bears an opportunity cost of value lost to the job. Since the value of an E5 relative to an E4 is reflected in their salary differences, the cost of such mismatches corresponds to this salary difference.[29] Thus, the cost to the Navy from assigning an E4 to an E5 billet (E5 to an E4 billet) is equal in amount to the salary difference between an E5 and E4 for the length of the assignment. The same is true for an E5 (E6) assigned to a billet designated for an E6 (E5).

F. SAILOR PREFERENCES

Random numbers were generated for each Sailor and each NMI (uniform between zero and one). This determined their rank relative to the range of NMI values found in Lieutenant Brooke Zimmerman's thesis work. Sailors have a preferred Homeport, Platform type, and Billet type, but some Sailors feel more strongly about these preferences than others. For example, while a majority of Sailors surveyed by LT Zimmerman assigned virtually zero value to choice of Platform type, 10 percent of the population valued this incentive at $10,000 or more.[30] Thus, Sailor valuation of these NMIs varies significantly in the model (rather than simply assigning the same "value" to any Sailor who receives Geographic Stability or Billet choice).

The model recognizes those Sailors who assign the highest value to an NMI should be the ones who receive the NMI. In particular, the ICONIC model does not force any Sailor to receive an NMI. Instead, if the assignment model, for example, provides Platform type to ten out of forty-five Sailors, then this NMI is given to the ten Sailors who have the highest valuation for platform type.

[29] From: Pete Coughlan Research Notes. August 20, 2009.

[30] Brooke Zimmerman. Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM). Master's thesis, Naval Postgraduate School, 2008.

The ICONIC model captures the Sailor's values in three distinct scenarios (discussed in Chapter IV). The purpose of these scenarios was to illustrate the trend in cost versus Sailor valuation.

G. OBJECTIVE FUNCTION

Every element of the detailer's objective function was specified in dollar terms. In particular, subject to the constraints (discussed in Chapter IV), the ICOINC model seeks to make the assignments which minimize:

$$\sum_{\text{Sailor 1}}^{\text{Sailor N}} \left[\left(\text{Navy Cost}\right) - \beta \left(\text{Sailor Utility}\right) \right]$$

where:

Navy cost = PCS cost + training cost + fit cost (pay grade mismatch cost)

Sailor utility = $\sum_{\text{NMI 1}}^{\text{NMI 4}} \left[\text{V(NMI)} \times \text{I(NMI)} \right]$

V(NMI) = *Average* Sailor valuation for that NMI[31]

- For homeport of choice, I(NMI) = 1 if Sailor was assigned to the homeport of his choice (whether or not this was given to him as an NMI) & I(NMI) = 0 otherwise
- For platform type of choice, I(NMI) = 1 if Sailor was assigned to the platform type of his choice (whether or not this was given to him as an NMI) & I(NMI) = 0 otherwise
- For billet type of choice, I(NMI) = 1 if Sailor was assigned to the billet type of his choice (whether or not this was given to him as an NMI) & I(NMI) = 0 otherwise
- For geographic stability, I(NMI) = 1 if Sailor was assigned to his *current* homeport (whether or not this was given to him as an NMI) & I(NMI) = 0 otherwise

The ICONIC model uses average Sailor valuation for each NMI rather than each Sailor's actual valuation for that particular NMI. There is no "incentive compatible" or "truth revealing" way for a detailer to honestly know how much each Sailor values

[31] Brooke Zimmerman. "Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM)." Master's thesis, Naval Postgraduate School, 2008.

Geographic Stability or his/her particular Homeport, Platform type, or Billet type of choice.[32] It is probably not feasible for the detailer to infer the true NMI valuations by communicating with Sailors during the detailing process because Sailors will likely overstate their true value to have a better chance of receiving the NMI. It is not unreasonable, however, for the detailer to have some idea how much Geographic Stability or Homeport, Platform type, or Billet type of choice is generally worth to the Sailor population the detailer is assigning. Therefore, the model considers the average valuation for each NMI within the detailer's community.

[32] From: Pete Coughlan Research Notes. August 20, 2009

IV. ICONIC MODEL AND RESULTS

A. INTRODUCTION

The basic idea behind the model's design was to use the costs identified in Chapter III to calculate the cost for offering NMIs. The objective function minimizes Navy cost minus the aggregate Sailor value. The linear program was set-up as an assignment model and solved with Premium Solver, an add-in to Microsoft Excel (MS). The add-in is necessary because the standard MS solver could not solve an LP problem with the number of decision variables used in this research.

The research recognizes the countless combinations that could be used to calculate the cost of NMIs. The research focused on a robust set of combinations to see if the model works as intended (reference Appendix I). Three distinct scenarios will be discussed in depth in this chapter. The three scenarios will be referred to as 50% Navy/50% Sailor, 0% Navy/100% Sailor and 100% Navy/0% Sailor. Each scenario placed the respective percentage weight on Navy costs and Sailor values in the selecting Sailor assignments. For simplicity purposes, the author will use the abbreviations shown in Table 1 throughout the remainder of this paper.

50% Navy/50% Sailor	=	50/50
0% Navy/100% Sailor	=	0/100
100% Navy/0% Sailor	=	100/0

Table 1: Abbreviations used for ICONIC's assignments

1. How It Works

PCS costs were first collected for E4s-E6s (costs varied if the Sailor had dependents). Assignments were grouped into four geographic regions in the continental United States (overseas assignments were not considered in this proof of concept model): continental US – east coast (CEC; e.g., Norfolk, VA); continental US – gulf coast (CGC;

e.g., Jacksonville, FL); continental US – north west (CNW; e.g., Bremerton, WA); and continental US – south west (CSW; e.g., San Diego, CA); PCS costs were estimated, by region (i.e., CEC, CGC, CNW, and CSW) according to the location of the Sailor and the vacant position. Training costs were estimated, based on a two-week training period if required to obtain a matching NEC. Salary differentials were used to reflect the potential value lost/opportunity cost for one-up or one-down assignment.

The second step was to create a forty-five by sixty matrix that indicates the Navy's total cost by Sailor and billet, that aggregates PCS, training, and fit costs. For example, in Figure 3, Sailor 4 (listed in the left-hand column) has a total cost of $6,928 if assigned to billet 7 (listed in the top row).

Billets

Sailors

Total Navy Cost	1	2	3	4	5	6	7	8
1	$ 2,560	$ -	$ 2,560	$ 2,560	$ 2,560	$ -	$ -	$ 2,560
2	$ 2,560	$ 2,560	$ 2,560	$ 2,560	$ 2,560	$ 2,560	$ 2,560	$ 2,560
3	$ 2,560	$ 2,560	$ -	$ -	$ 2,560	$ 2,560	$ 2,560	$ 2,560
4	$ 6,928	$ 6,928	$ 4,368	$ 4,368	$ 6,928	$ 6,928	$ 6,928	$ 6,928
5	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928
6	$ 6,928	$ 6,928	$ 4,368	$ 4,368	$ 6,928	$ 6,928	$ 6,928	$ 6,928
7	$ 6,928	$ 6,928	$ 4,368	$ 4,368	$ 6,928	$ 6,928	$ 6,928	$ 6,928
8	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928	$ 6,928
9	$ 10,428	$ 10,428	$ 7,868	$ 7,868	$ 10,428	$ 10,428	$ 10,428	$ 10,428
10	$ 10,428	$ 7,868	$ 10,428	$ 10,428	$ 10,428	$ 7,868	$ 7,868	$ 10,428
11	$ 9,686	$ 7,126	$ 9,686	$ 9,686	$ 9,686	$ 7,126	$ 7,126	$ 9,686

Figure 3. Total Navy Cost

The third step was to create an average Sailor value for Homeport, Platform, Billet, and Geographic Stability. Random uniform variables between zero and one were generated for the forty-five Sailors and four NMIs. This process allowed the author to approximate a dollar value for each Sailor for a particular NMI using Zimmerman's value distribution.[33] For assignment purposes, the detailer was modeled as knowing the average sailor value for each NMI as opposed to the sailor's actual value. NMI values help the detailer make an assignment based on the Sailors' preferences. For example, in Figure 4, the value for Sailor 4 (left-hand column) from billet 5 (top row) is $6,358.

[33] Brooke Zimmerman. Integrating Monetary and Non-monetary Reenlistment Incentives Utilizing the Combinatorial Retention Auction Mechanism (CRAM). Master's thesis, Naval Postgraduate School, 2008.

	1	2	3	4	5	6	7	8
Region	CEC	CEC	CEC	CEC	CEC	CEC	CEC	CEC
NEC	7607	7612	7614	7614	7607	7612	7612	7607
Grade	4	4	4	4	4	4	4	4
Paltform	Other 2	CVN	CVN	CVN	CVN	Other 2	MCS	LHA/LHD
Average Homeport	1	2	3	4	5	6	7	8
1	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358
2	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358	$ 6,358
5	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
7	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Figure 4. Homeport Opportunity Cost for Sailors 1–7 in Billets 1–8

The fourth step was to determine which Sailors are eligible for which billets, based on awarded NMIs. For example, if Sailor 2 is guaranteed homeport of choice and chooses an assignment in Jacksonville, FL (CGC) and billet 2 is not located in the Gulf Coast, then the binary variable in the feasible assignment table will be zero, precluding this assignment. On the other hand, if the Sailor is guaranteed a billet in Norfolk, VA (CEC) and the billet is located in the East Coast, the then the binary variable in the feasible assignment table will be one, allowing this assignment. Table 2 shows the binary decision for allowable and precluded assignments.

1	=	Allowable Assignment
0	=	Precluded Assignment

Table 2: Feasible Assignment Binary Decision Variables

In Figure 5, for example, Sailor 3 is ineligible for billet 4 (do not fill); Sailor 9 can be assigned to billet 6 (fill).

0	1	2	3	4	5	6	7
Region	CEC	CEC	CEC	CEC	CEC	CEC	CEC
NEC	7607	7612	7614	7614	7607	7612	7612
Grade	4	4	4	4	4	4	4
Paltform	Other 2	CVN	CVN	CVN	CVN	Other 2	MCS

Homeport	1	2	3	4	5	6	7
1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1
3	0	0	0	0	0	0	0
4	1	1	1	1	1	1	1
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	1	1	1	1	1	1	1
10	0	0	0	0	0	0	0

Figure 5. Feasible Assignment Binary Variables for Homeport

The fifth step was to incorporate the Navy's "one-up, one-down" policy for assignments. A one was given to feasible assignments based on pay grade (e.g., an E5 assigned to an E6 position) and a zero if the match is not possible (e.g., an E4 assigned to an E6 position), reference Table 2.

Last, Premium Solver (a MS Excel add-in) was used to sum the PCS, fit and training costs associated with each NMI as well as the Sailors' values for each assignment. ICONIC's objective function was to minimize the Navy's assignment costs minus the Sailors' value. Sailors that did not get an assignment were allotted a cost of one hundred thousand dollars; this enabled Solver to leave some sailors unassigned, but ensured Solver would make any feasible assignments, regardless of the Navy's cost or the sailor's value, before leaving a sailor unassigned. Future research could examine the impact of reducing this unfilled assignment penalty, allowing the Navy to be more selective in deciding which sailors to assign and which to leave unassigned and shifted to the next detailing window.

2. Constraints

There are three constraints for each binary forty-five by sixty assignment matrix. The constraints ensure that all Sailors are assigned to no more than one billet and that each billet was assigned no more than one sailor. The assignment matrix depicts each sailor across a row and each billet down a column. If a cell in the matrix has a value of one, the sailor in the corresponding row is assigned to the billet in the corresponding column; if the cell has a value of zero, the sailor is not assigned to that billet. The final column in the assignment matrix represents the decision to leave the sailor unassigned in this detailing window. The relevant constraints on the assignment matrix are as follows:

- The sum of all the values for each Sailor (across a row) has to equal one (including the delayed assignment decision)
- The sum of all the values for each billet (down a column) has to be less than or equal to one (not all billets are filled)
- Sailors can only receive feasible assignments (assignments that satisfy one-up/one-down restrictions and satisfy any NMIs awarded)

B. ESTIMATING THE COST OF STAND ALONE NMIS

The model was first run with no NMIs. This provides a baseline cost to compare the costs incurred when NMIs are offered to increasing numbers of service members. As an illustration, Figure 6 shows the baseline average Navy cost per assigned Sailor with no NMIs, as well as the costs when five, ten, fifteen, twenty-five, and thirty-five service members are offered Homeport of choice, with a 50/50 weighting between Navy costs and service member preferences.

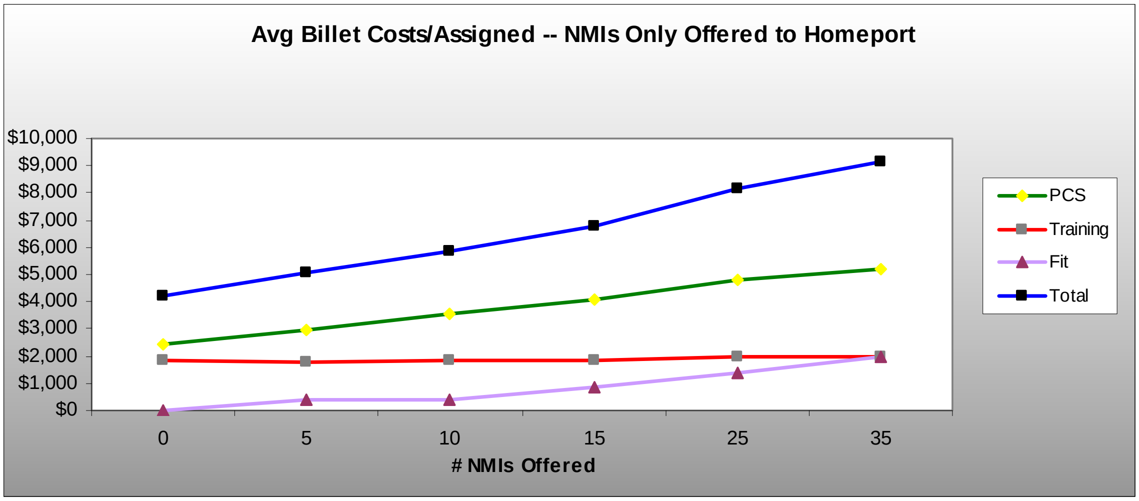

Figure 6. Average Navy Assignment Cost Versus Homeport NMI (50/50 weights)

There is an upward-sloping trend as the number of service members offered Homeport of choice increases. This makes sense, because the value to the Sailor is going up, but so is the cost to the Navy. The baseline average billet costs are shown in Table 3.

	50%/50%	100%/0%	0%/100%
Baseline Cost	$4,216	$3,110	$14,955

Table 3: Baseline Cost Offering No NMIs

C. ESTIMATING THE COST OF MULTIPLE NMIs

The same procedures were used as with offering stand-alone NMIs to analyze the effects of offering multiple NMIs. As an illustration, Figure 7 shows an example of the average assignment costs with increasing numbers of Sailors offered Homeport and Platform, for 100/0 weights on Navy costs and Sailor preferences. In this analysis, each NMI is offered to the Sailors who have the highest value for that NMI. As a result, some Sailors may receive one NMI or the other, some may receive both, and others receive no NMIs.

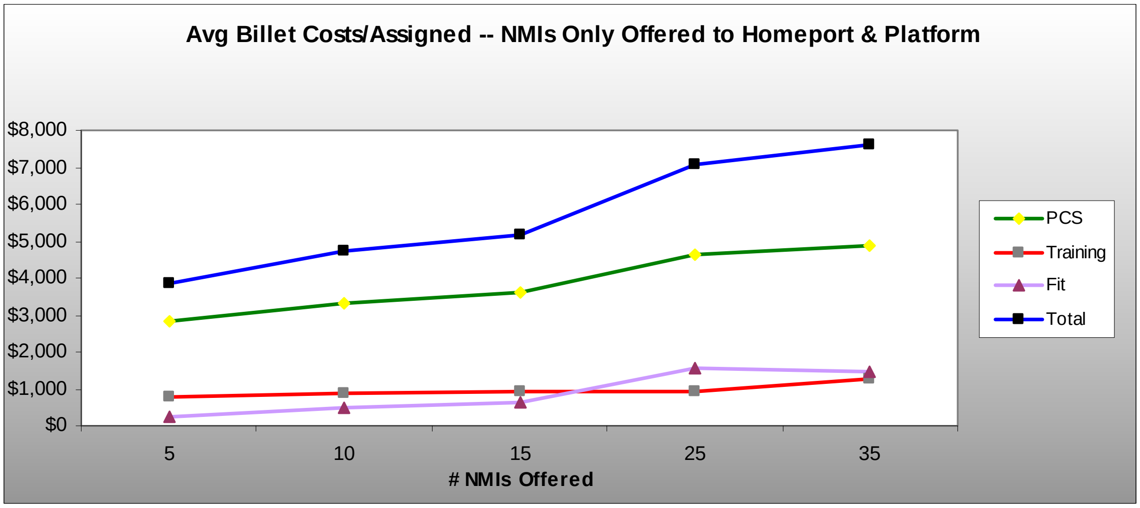

Figure 7. NMIs Only Offered to Homeport and Platform–100% Navy/0% Sailor

D. TRENDS AND OBSERVATIONS

Before discussing the trends and observations from this model, it is important to emphasize that this research is largely a proof-of-concept. The analysis examines several different scenarios (relative weights on Navy costs and Sailor preferences as well as different numbers and combinations of NMIS offered), but it only examines one sample of billets and sailors and one distribution of sailor NMI values. As a result, the following discussion should be considered preliminary and simply illustrative of the results we can expect after running the model with different sailor and billet characterizations and different NMI value distributions. Future research will incorporate *Monte Carlo* simulation into the LP model developed here, leading to a more robust set of results. The intent here is to verify this proof-of-concept model and summarize the preliminary results.

In general, across all the different combinations of NMIs offered (reference Appendix I, J, and K) the average billet costs for 0/100 are three times higher than the other two scenarios: 50/50 and 100/0. Moreover, the NMI value for 0/100 is twice as high as the value for 100/0. This makes sense; if the Navy has no regard for cost and puts all priority on Sailor preferences, one would expect the Sailors to have their preferred assignment choice regardless of cost, which would ultimately cost more and increase

Sailor value. These Navy cost and Sailor value trends indicate that the ICONIC model is working intuitively. In summary, with more emphasis placed on cost, total NMI value and total average billet costs decrease.

1. 50% Navy / 50% Sailor

In this scenario, the average billet total costs for all combinations of NMIs is generally linear (constant marginal cost to offering an additional NMI) until fifteen or more NMIs are offered (33% of total sailors to be assigned); the slope of the curve starts to increase (increasing marginal cost) as the number of NMIs exceeds 15. This increasing marginal cost generally reflects increasing fit costs (increasing one-up/one-down assignments). There is an increase in fit costs for all combinations of NMIs or stand-alone NMIs when fifteen or more NMIs are offered. For NMIs that include Homeport, either alone or in combination, there an increase in PCS cost; without Homeport, the PCS cost is essentially linear. Training costs remain essentially constant regardless of the number or combination of NMIs offered. Except when Homeport is offered, assignment cost is flat for fewer than fifteen NMIs. (See Appendix C)

In general, average Sailor values for all NMIs, regardless of the number of NMIs offered, is relatively constant and between twelve thousand and thirteen thousand dollars (see Appendix D). Homeport, either alone or in combination with other NMIs, is the only NMI that shows an increase in average sailor value after fifteen or more Sailors are offered the homeport NMI.

2. 100% Navy / 0% Sailor

When the Navy places all priority on Navy cost in making Sailor assignments, NMIs can potentially have a big impact on both Navy costs and Sailor Values. Average total billet cost doubles after fifteen or more NMIs are offered, except for the stand alone Platform NMI, which shows a linear trend in cost (see Appendix E). For example, PCS costs double from the baseline cost of two thousand three hundred seventeen dollars with no NMIs offered to five thousand two hundred fourteen dollars with thirty-five Sailors offered choice of Homeport only. This pattern is true for any combinations of NMIs that include Homeport. This makes sense because the Navy is controlling cost and hence PCS costs; as more Sailors are offered the Homeport NMI, cost should increase rapidly.

With the Navy placing all priority on minimizing costs, Sailor value increases at least slightly, primarily for the specific NMIs offered. NMIs involving Billet and Homeport have the strongest increasing trend in total NMI value (see Appendix F). This probably reflects the heavy constraints the model places on filling the least expensive assignment with the Navy placing 100 percent emphasis on cost.

3. 0% Navy / 100% Sailor

In this scenario, there is no emphasis on cost and the Navy gives all priority to Sailor preferences; average billet costs remain flat for all combinations of NMIs, except for those involving Geographic Stability (see Appendix G). This result is expected and again tends to validate the ICONIC model. If the Navy gives all priority to satisfying Sailor preferences, there is little impact on assignments if the Navy offers Sailors guaranteed NMIs. The one exception is geographic stability, which shows slightly decreasing average total billet costs after five or more Sailors are offered this NMI. The decrease in average total costs is driven by a decrease in average PCS costs; when Geographic Stability is offered, average PCS cost actually goes down because the sailors offered Geographic Stability are retained in their current location. Fit costs actually increase after fifteen or more sailors are offered geographic stability because it becomes harder to match pay grades as fewer people able to move. This is not true in any other scenario for 0/100. Figures 8 and 9 illustrate the impact of Geographic Stability.

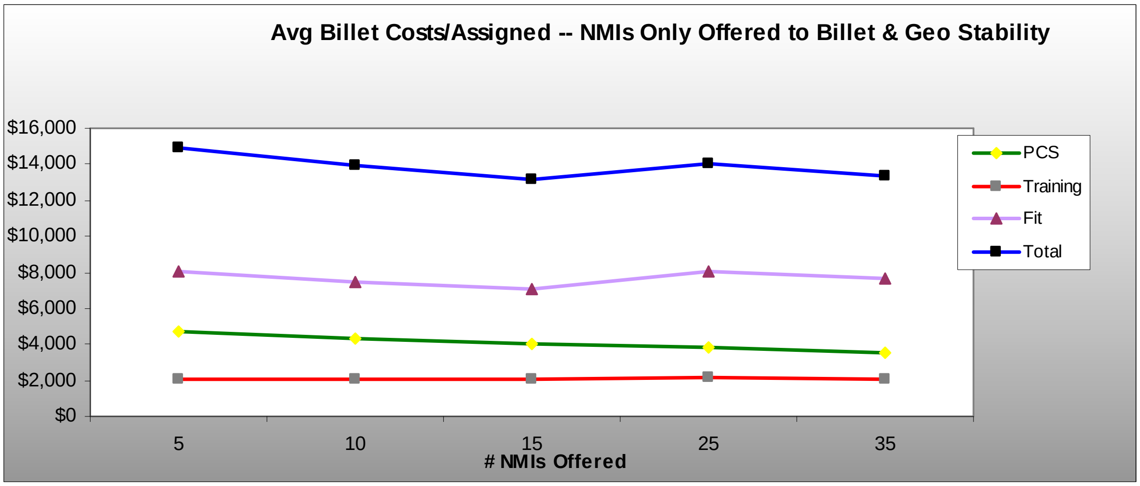

Figure 8. Average Billet Costs–NMIs Offered to Billet and Geographic Stability

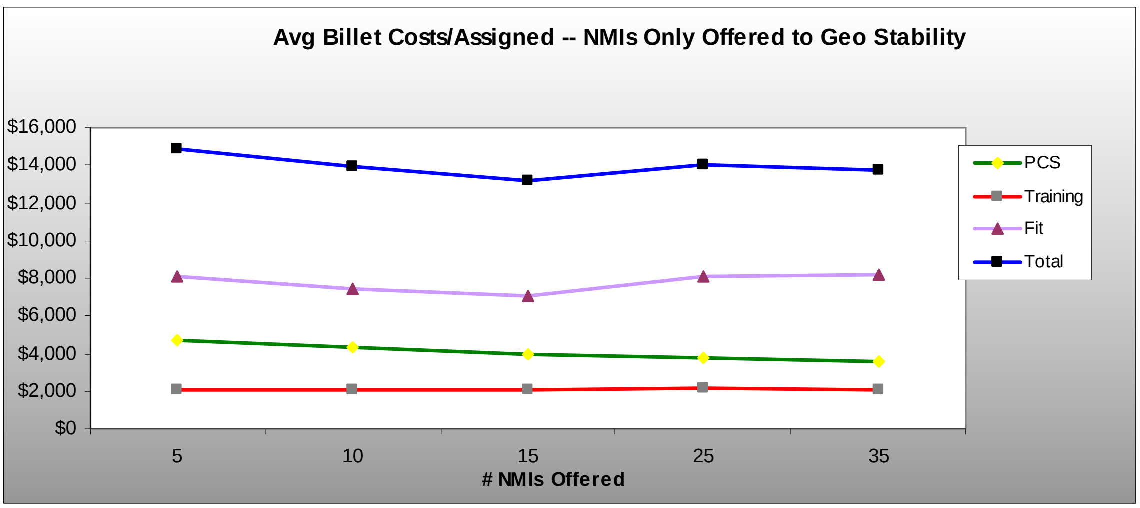

Figure 9. Average Billet Costs–NMIs Offered to Geographic Stability

Sailor value is also relatively constant in the 0/100 scenario; again, if the Navy places all priority on Sailor preferences when making assignments, guaranteed NMIs offer little value. In fact, in some cases offering too many NMIs may preclude the ability to match Sailor preferences in other dimensions; total value may actually show a slightly decreasing trend (See Appendix H). Additional model runs are needed to verify if these slight trends have any statistical significance.

V. CONCLUSION

A. SUMMARY OF RESULTS

1. Research Questions and Answers

Question: What is the cost of non-monetary incentives that impose restrictions on Sailor assignments in the Navy's Sailor detailing process?

Answer: The cost of NMIs varies depending on how much weight is placed on the Navy's financial implications versus Sailor preferences. In general, the stand alone NMI costs offering five NMIs are shown in Table 4.

NMIs	50%/50%	100%/0%	0%/100%
Homeport	$5,097	$3,856	$14,918
Platform	$4,216	$3,110	$14,706
Billet Choice	$4,216	$3,193	$14,955
Geographic Stability	$4,227	$3,110	$14,902

Table 4: Stand-alone NMI Cost: Five Sailors

The difference in total cost (shown in Table 4) between offering five NMIs and zero NMIs represents the marginal cost. Table 5 illustrates the model's marginal cost.

NMIs	50%/50%	100%/0%	0%/100%
Homeport	$881	$746	-$37
Platform	$0	$0	-$249
Billet Choice	$0	$83	$0
Geographic Stability	$11	$0	-$53

Table 5: Marginal Cost

Question: What priorities guide detailer decisions in the assignment process?

Answer: Detailers are faced with a constrained budget and must live within these fiscal constraints. PCS cost is the prominent component that erodes the detailer's budget.

Question: Will the optimization model provide a method to find the cost of non-monetary incentives?

Answer: The proof-of-concept ICONIC assignment model appears to be working as expected. The model is designed for a thirty-six month assignment, but does not depend critically on the duration that a Sailor will spend at each duty station. When excess NMIs are offered, the model prevents solver from assigning Sailors.

Question: How effective is the model as additional NMI constraints are imposed on the detailer's decisions?

Answer: Premium Solver did an excellent job of adapting to the constraints that the author put on the model as discussed in Chapter 4.A.2. However, as the number of NMI constraints increases, more Sailors are left unassigned.

Question: How does this model compare/contrast to other similar assignment models?

Answer: In some regards there are unknowns about how robust the assignment is compared to other studies. The author's research did find other investigations looking at similar issues.

B. CONCLUSION

As it stands, the proof-of-concept assignment model appears to working as expected. In concept, if cost is no factor, Sailor valuation goes up and adding NMIs will have little effect. If cost savings is emphasized, sailor value is lower and Sailor value goes up as additional NMIs are added.. The results of the model show these trends. The mathematical formulation and objective function presented in this paper reflects many modifications and simplifications that were required to make a workable model. Consequently, it is important to emphasize that the goal of this research is simply to demonstrate a proof-of-concept model to analyze the cost of non-monetary incentives enlisted assignments in the U.S. Navy.

As the present version of the model illustrates, identifying the cost of non-monetary incentives will only be as good as the model's inputs. That is, if the model's parameters are grossly inaccurate, or its constraints badly specified, then its output could have little meaning. On the other hand, "bad" or counter-intuitive output can be used to detect inaccurate assumptions about the model's parameters and/or constraints which, in turn, should help troubleshoot these elements.

C. RECOMMENDATIONS

1. Increased Scale of Research

The model is designed in such a way that it could be used for more Sailors and additional billets. There are limitations however, with the use of the Premium Solver add-in to Microsoft Excel. This research primarily addressed one particular community.

Extended research would be beneficial for other enlisted communities like for squadrons or aviators, or even Fleet Concentration areas.

There are many ways in which even the current model could be made more sophisticated and thereby improved. The current results reflect the relative costs incorporated into this model, particularly the opportunity costs associated with the one-up, one-down Navy assignment policy and the cost imposed on unfilled billets. It is recommended that the same model be used with different costs for these policy-related variables to explore the impacts of alternative relative preferences.

Similarly, there many more combinations in which NMIs could be offered in the basic model and different percent emphases on Navy costs versus Sailor preferences. These alternative specifications should be explored further.

The use of Monte Carlo simulation would also make the model more robust and help explore alternative specifications. Random sampling from probability distributions would make the model more "dynamic" in the sense that its parameters could be varied to determine the statistical significance of the model's results.

2. Increased Scope of Research

As the ICONIC model becomes more robust, the results from this model can be integrated into retention mechanisms that combine monetary and non-monetary incentives. Individualized incentive packages that reflect service member's specific preferences and circumstances will greatly increase quality of life and reduce the Navy's retention costs. Understanding NMIs costs is an important step to exploiting these retention tools. As this research progresses, it is important to incorporate this cost analysis into the Navy's Sailor retention programs.

APPENDIX A: DETAILER INTERVIEW

I am conducting this interview in support of my MBA Project research for the Naval Postgraduate School. My MBA project topic supports a proof-of-concept to identify the cost of non-monetary incentives. My primary purpose is to identify the cost of non-monetary benefits with the use of a linear programming assignment optimization model. Interview results are confidential and unclassified. Results will be used for academic analysis only.

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APPENDIX B: DETAILER QUESTIONNAIRE

Section I

- Detailer priorities when making assignments (sea/shore rotation, PCS costs, NEC utilization, Sailor career advancement (training), etc.)

1. If a Sailor was put into a billet that was less qualified than a more desirable candidate, do you have an estimate of what the average cost would be to train the less qualified Sailor?
2. What is the present average PCS cost per Sailor broken down by rank?
3. Besides PCS Costs and training costs, are there other costs that are associated with moving/placing a Sailor into their next assignment?
4. I am looking at developing an assignment model and exploring the impact of what PCS Costs and training costs (and other costs not mentioned) that would have on the Navy; more specifically, in your opinion do you think operational readiness would suffer as a result?
5. What implications do you foresee if you had to place a Sailor into a position that was less qualified? What costs would be attributable to that decision?
6. One aspect in the assignment model will be the weights of certain characteristics. For example, if it costs the Navy zero dollars to have a Sailor stay in a geographic location that would be a “5”, if it cost the Navy less than $500 (or some value), that would get a “4”, and so on. Is there a range or a distribution of costs that you have for the different types of placement costs?
7. Are there other OCONUS costs that are taken into consideration when a Sailor takes there next assignment?
8. We think, initially, it would save the Navy money to offer geographic stability to Sailors. But a certain number (of Sailors), the system would place too many constraints on the detailers. At what number (of Sailors) do you anticipate it would become infeasible to offer geographic stability to a Sailor? (This would probably have to be broken down by rank, rate and NEC).

9. The assignment model must optimize readiness and stability for both afloat and ashore activities. Secondly, the assignment system must provide equal opportunity for personnel to serve in their desired duty. At what point in your decision making will the command's preference make you change your mind? For example, on average the command billet's preference is usually happy with their 4th choice and down i.e. 3rd, 2nd, 1st.

10. Detailer decisions, primarily subjective, may not always result in the best match for the Navy and/or the Sailor. Detailers must consider numerous, often changing, policies and procedures promulgated by the DoD, CNO, MCA, and CNPC when matching personnel to billets. Also, detailers are sensitive to these preferences but must ultimately fulfill the Navy's immediate job priorities. Some commands been forced to receive less qualified Sailors to avoid vacancies in key positions, reducing mission effectiveness, How do you weigh the command's and Sailor's preferences for a position?

11. Sailors today expect fast answers and quick explanations for why they were not selected for the first-choice job or what their next career-enhancing move should be. Do you think that this would slow down the decision making process if you had other incentives to offer and have to explain them?

12. In this assignment model, at some point detailers might be forced to pay higher PCS costs based on the decision that were previously made/promised to other Sailors, is there a range of PCS costs that you are willing to accept?

13. The same would be true for Training costs, at what point would you recall a promise made to one Sailor if the projected training cost was too high for the less desirable Sailor?

Section II

- How would non-monetary incentives affect your job (particularly geographic stability and homeport)?

1. Since you deal with a range of enlistees (i.e., different pay types), would it matter what non-monetary incentive (e.g., homeport, geographic stability) you would give a particular Sailor?

2. Which do you think would be easier to manage: Choice of homeport or geographic stability? Could you manage both?
3. How would the cost/feasibility differ by pay grade? (E–6s are more specialized and there are les of them then E–3s, for example).
4. It seems as though some Sailors would rather separate from the Navy rather than accept undesirable orders, do you think would a non-monetary incentive like homeport is a great enough incentive to retain that Sailor?

Section III

- General opinion regarding the effectiveness in offering non-monetary incentives.

1. I am working on trying to identify the costs associated with non-monetary benefits, based on your experience, do you think offering a non-monetary incentive would be more attractive than money?
2. Ideally, I want to mathematically represent a detailer's decision in an optimization model that assigns one Sailor to one billet. Do you currently use any optimization or linear programming models that influence your decision making?
3. In general, are detailers are concerned about constituents' satisfaction and take necessary steps to ensure repeated success?

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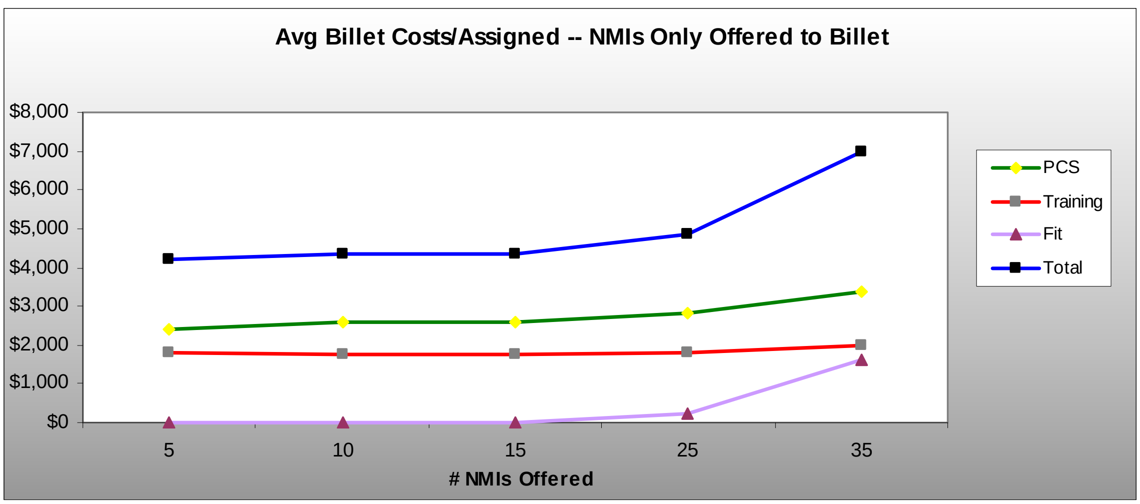
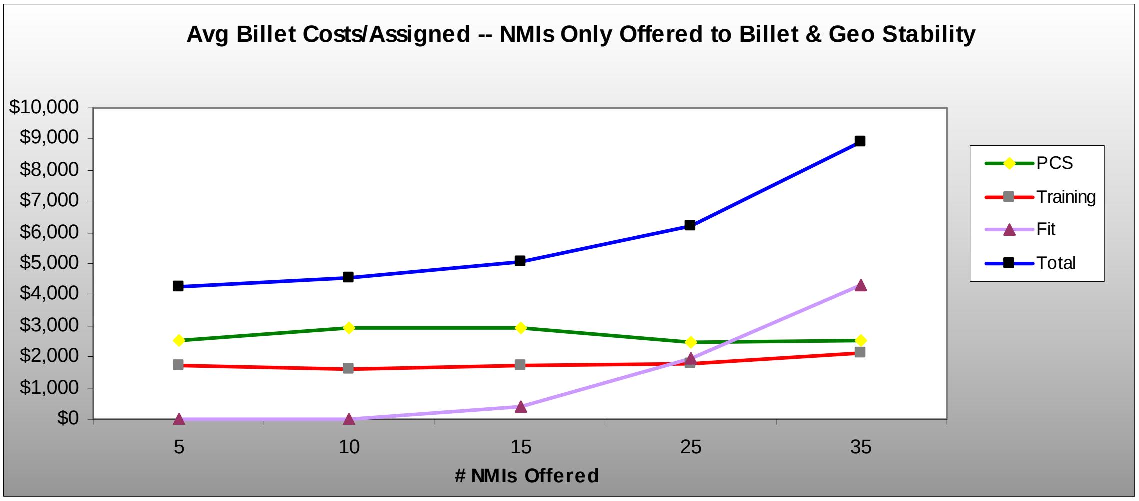
APPENDIX C: AVERAGE BILLET COSTS/ASSIGNED FOR 50% NAVY AND 50% SAILOR

For illustration purposes, Appendices C, D, E, F, G, and H show ICONIC's graphical results. Appendices C, E, and F show average billet costs/assigned by PCS, Training and Fit costs for 50 percent Navy/50 percent Sailor, 100 percent Navy/0 percent Sailor, and 0 Navy/100 percent Sailor, respectively.

Appendices D, F, and H show average Sailor values/assigned by Homeport, Platform, Billet and Geographic Stability for 50 percent Navy/50 percent Sailor, 100 percent Navy/0 percent Sailor, and 0 percent Navy/100 percent Sailor respectively.

The X axis shows the number of NMIs given ranging from five, ten, fifteen, twenty-five, and thirty-five Sailors. The Y axis shows the average cost per assigned Sailor in dollars.

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$6,000
$5,000
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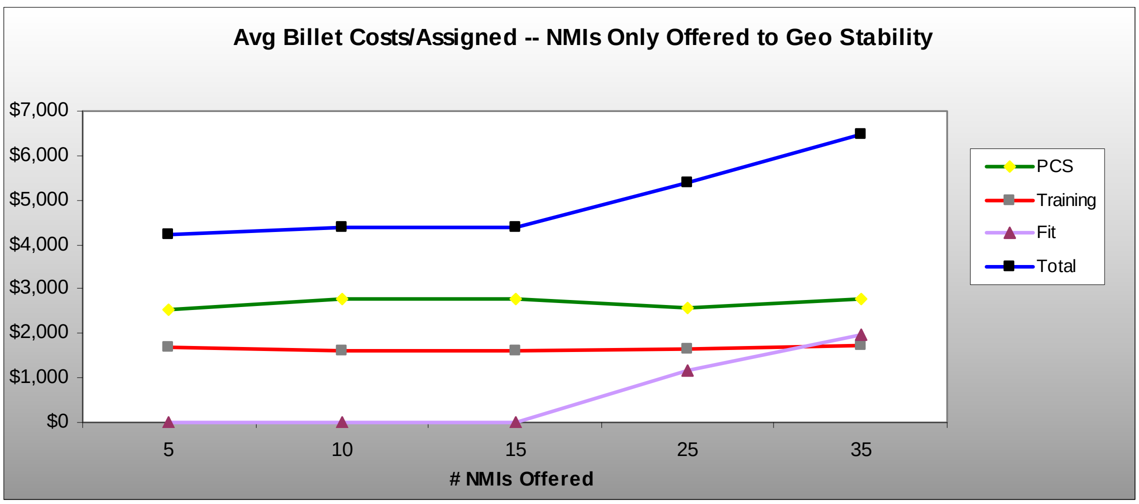
PCS
Training
Fit
Total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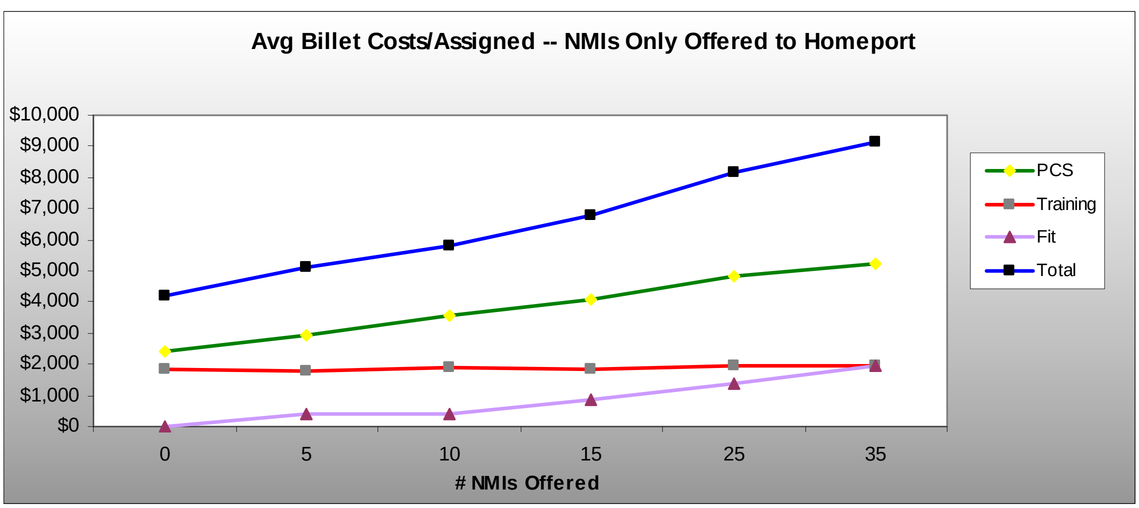
NMIs Offered
PCS
Training
Fit
Total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$6,000
$5,000
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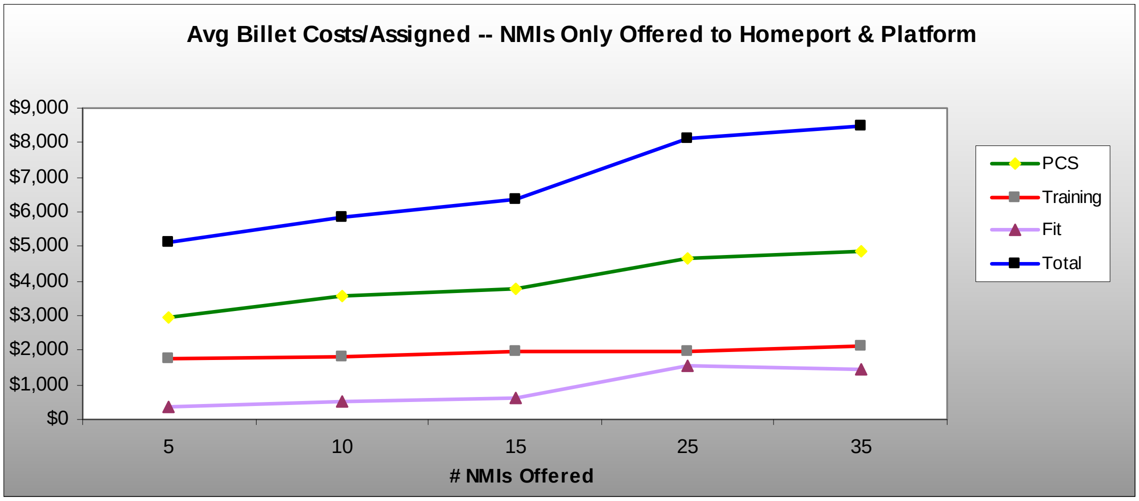
PCS
Training
Fit
Total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$6,000
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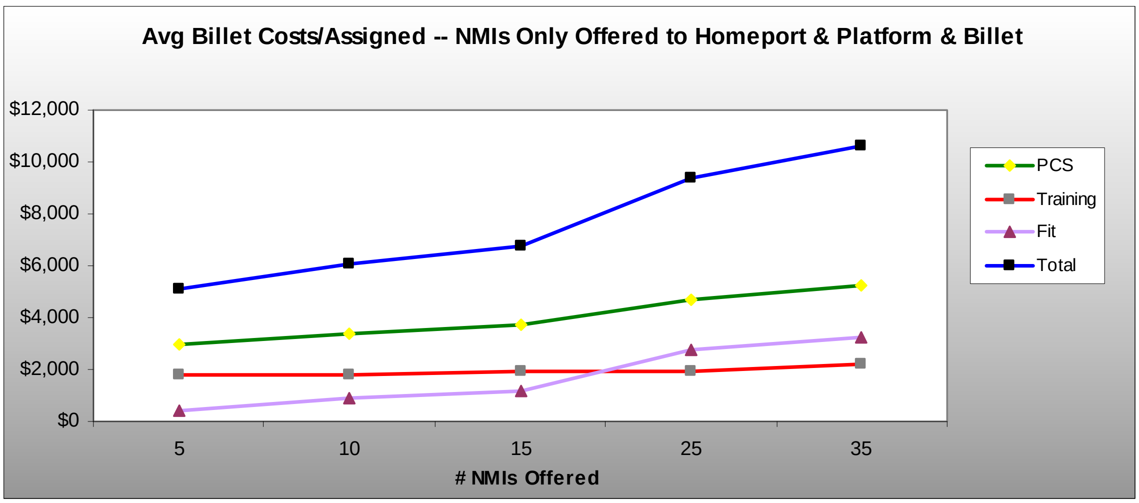
PCS
Training
Fit
Total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PCS
Training
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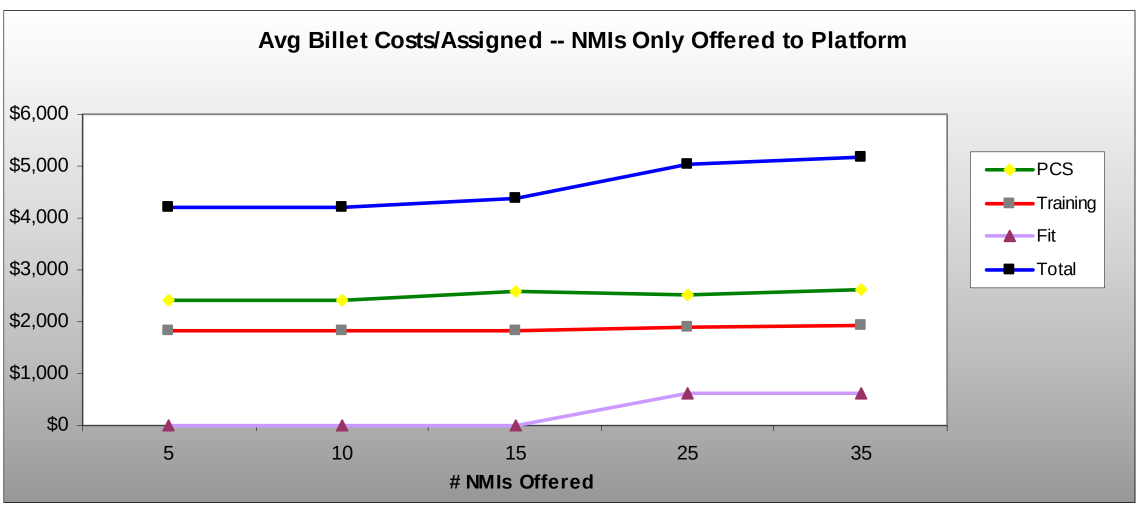
Total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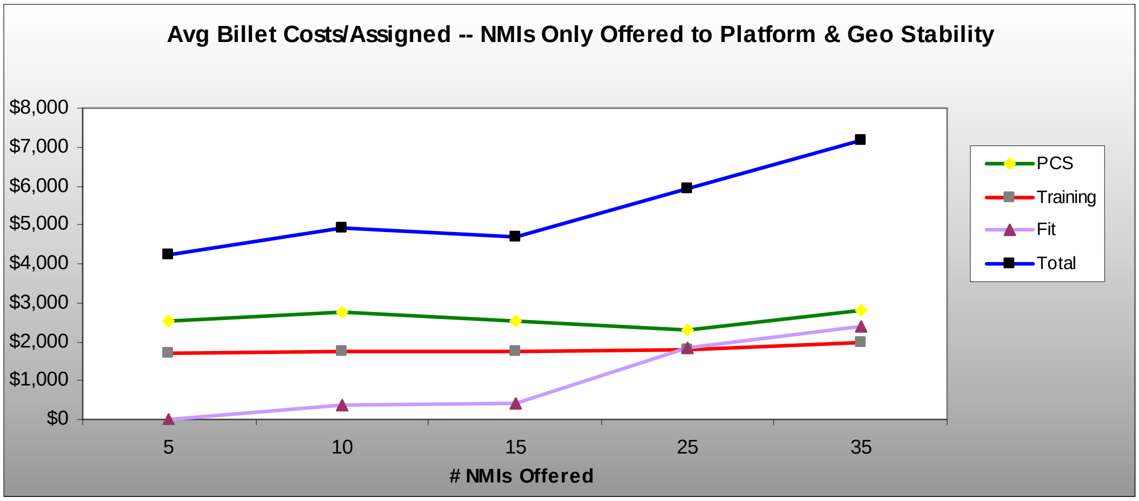
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$1,000
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NMIs Offered
PCS
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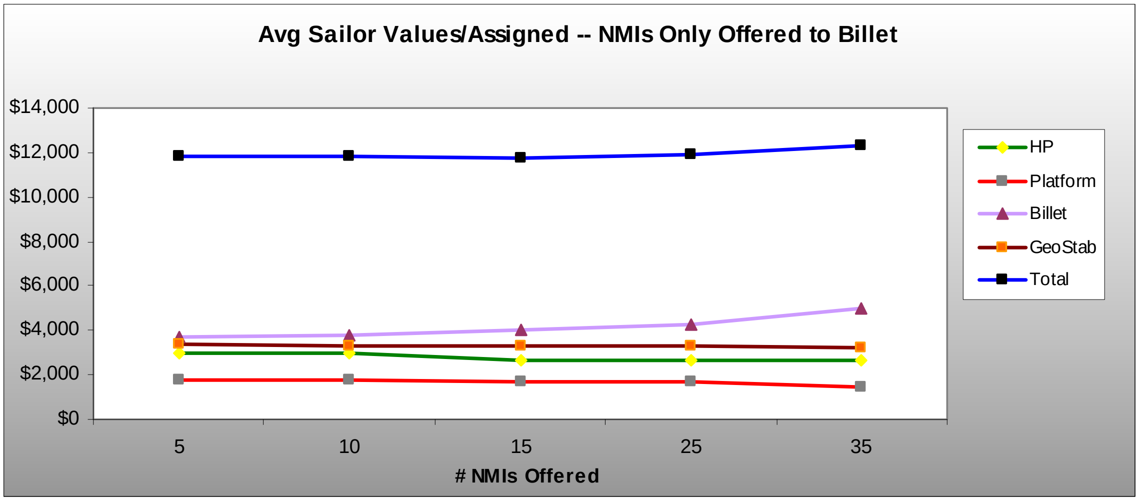
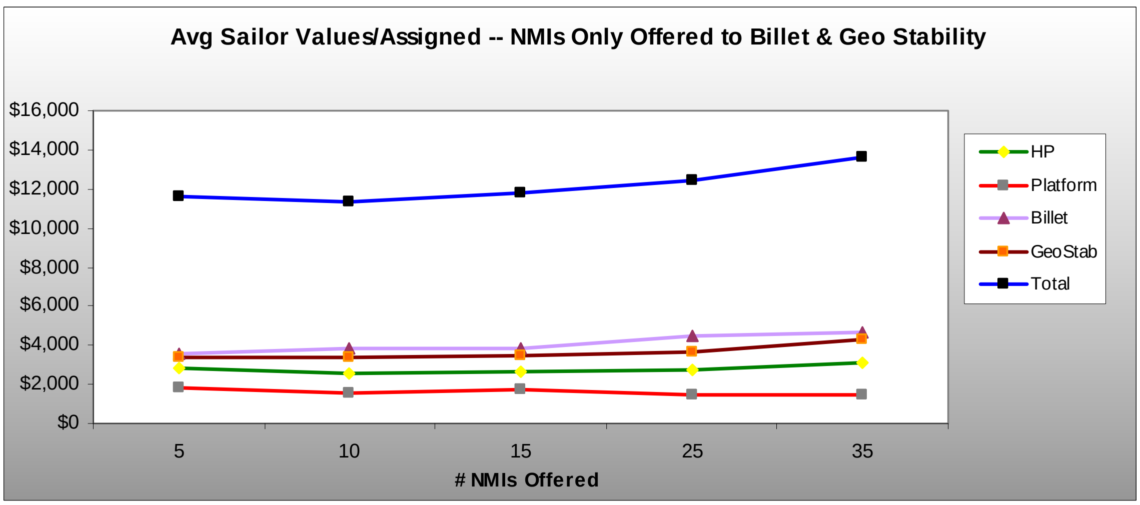
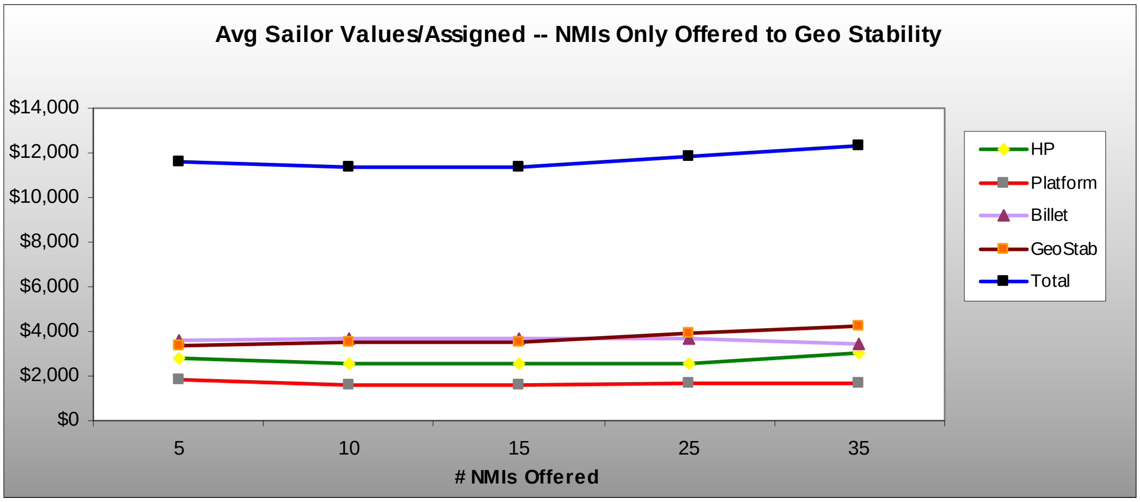
Total

APPENDIX D: AVERAGE SAILOR VALUES/ASSIGNED FOR 50% NAVY AND 50% SAILOR



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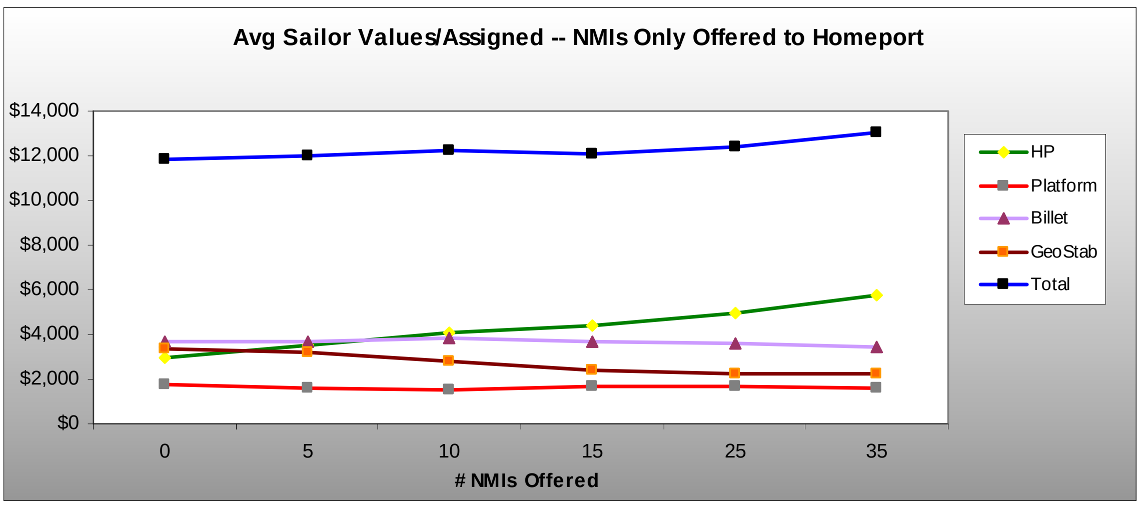
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NMIs Offered
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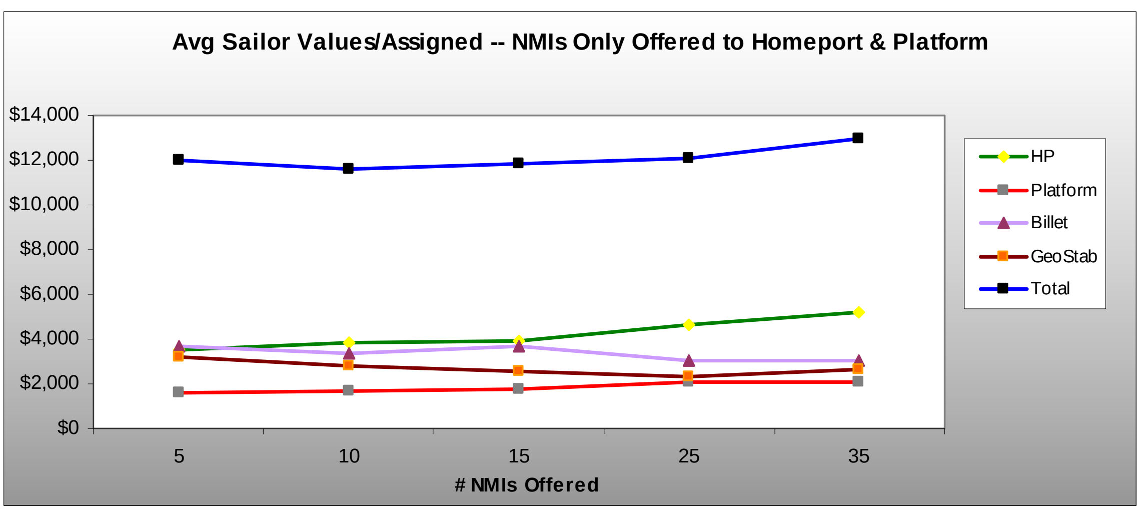
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NMIs Offered
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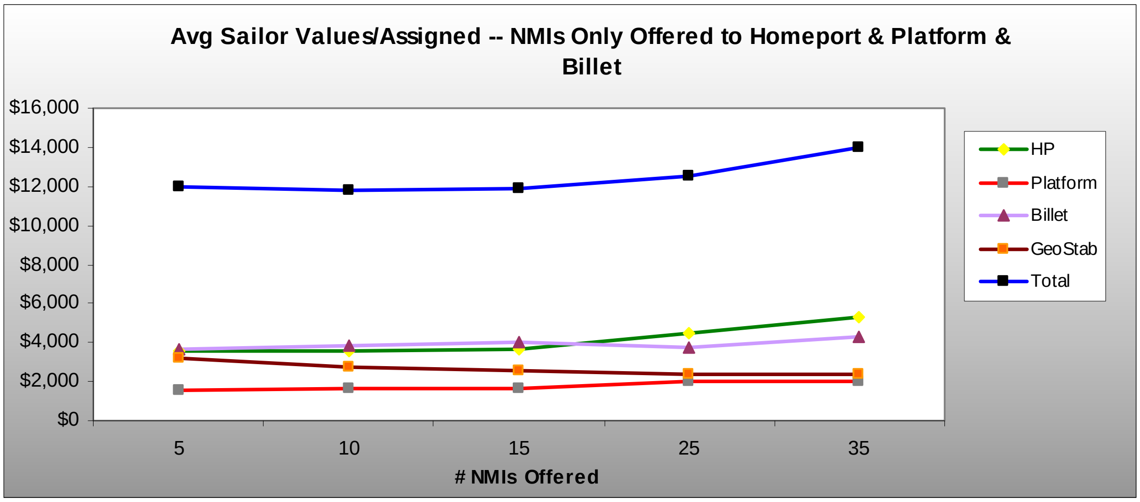
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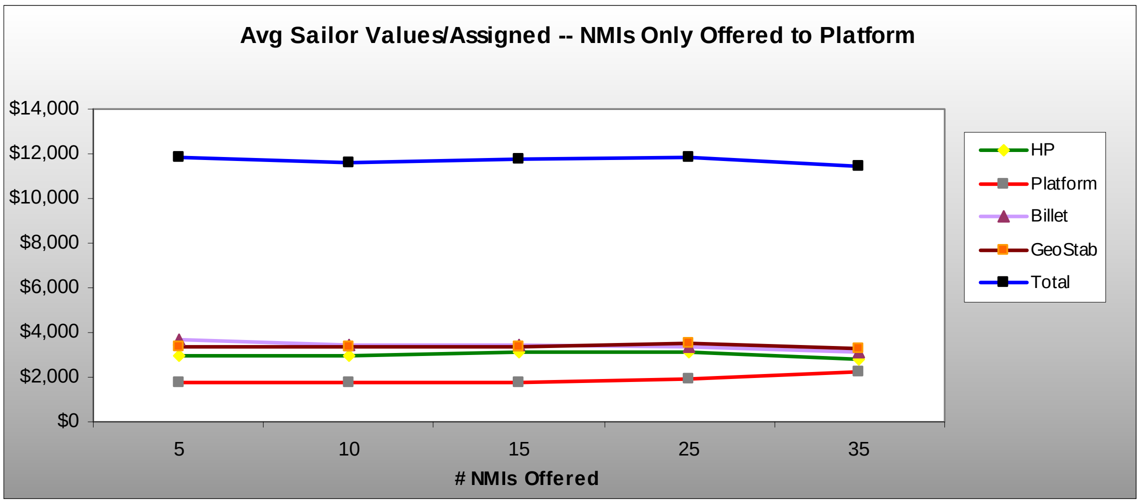
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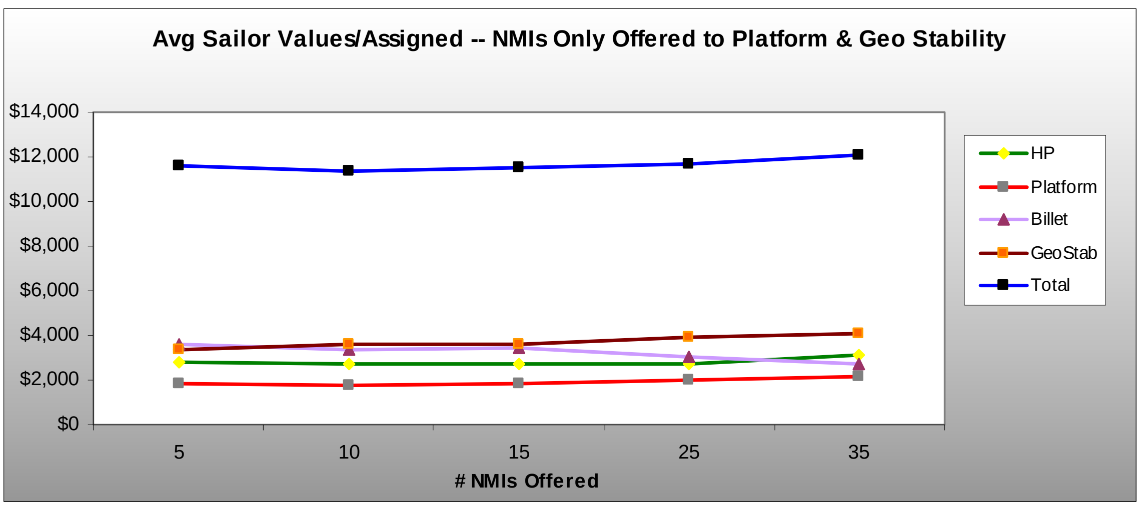
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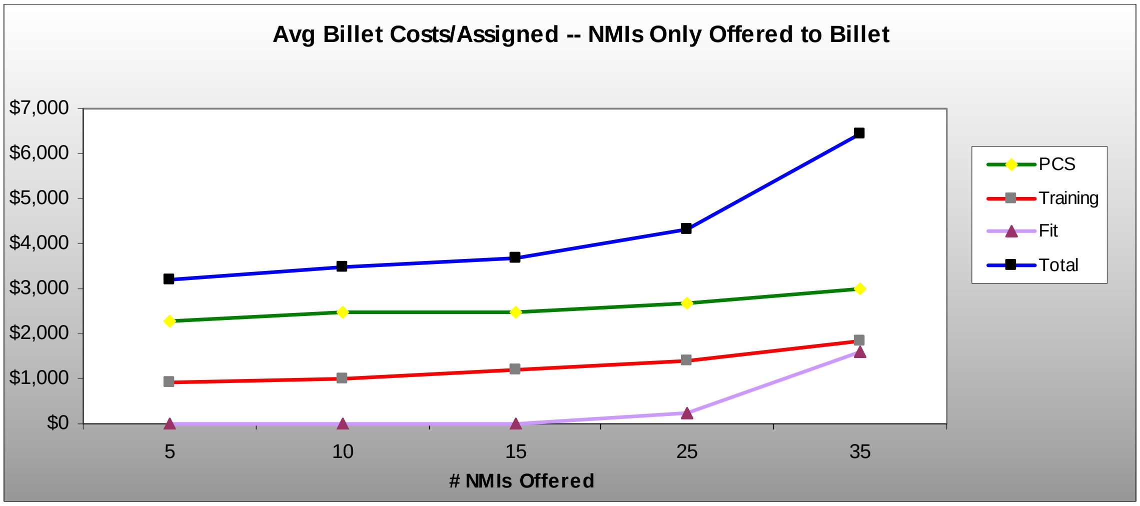
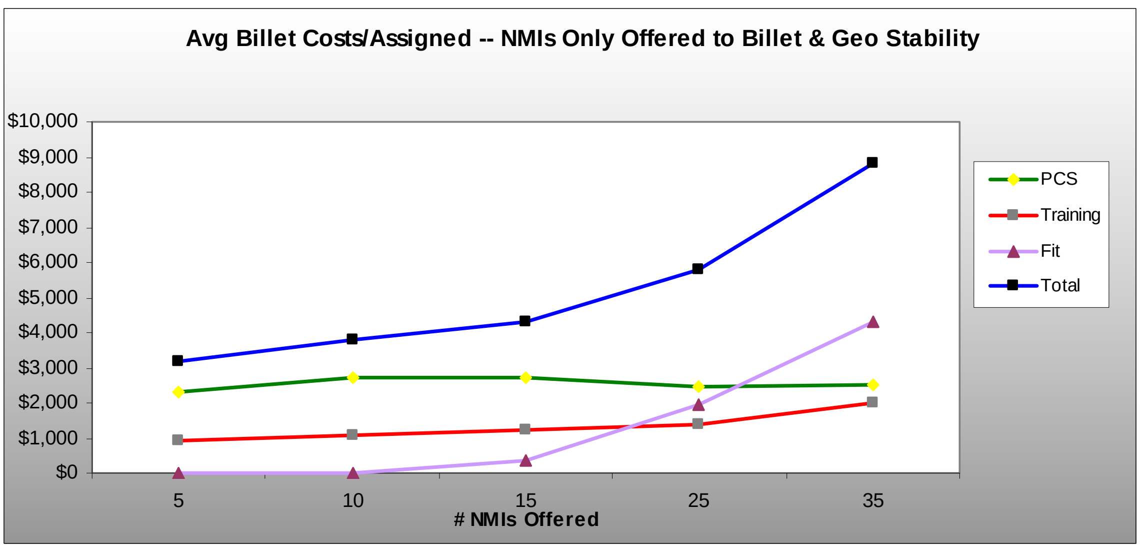
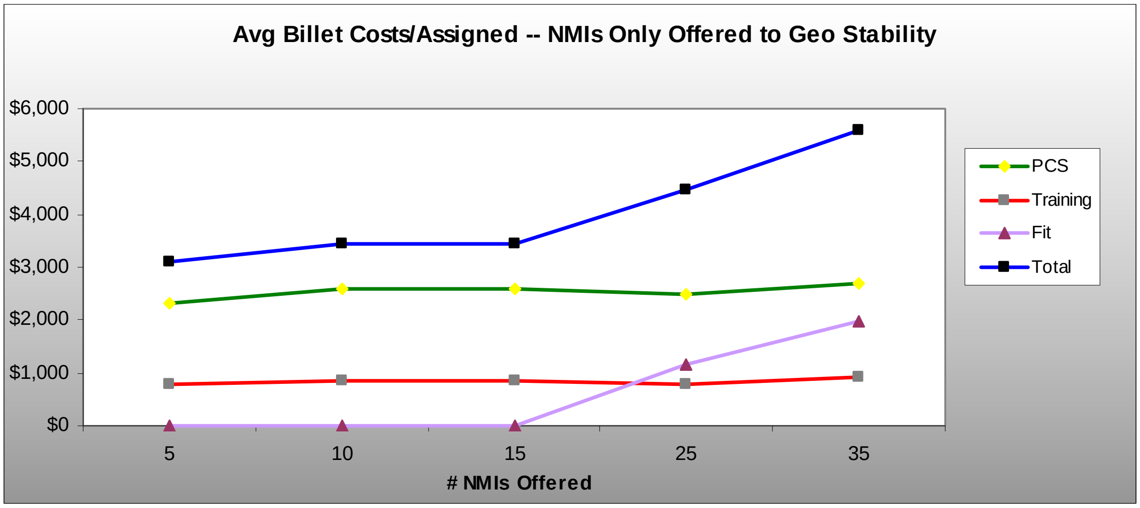
APPENDIX E: AVERAGE BILLET COSTS/ASSIGNED FOR 100% NAVY AND 0% SAILOR



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PCS
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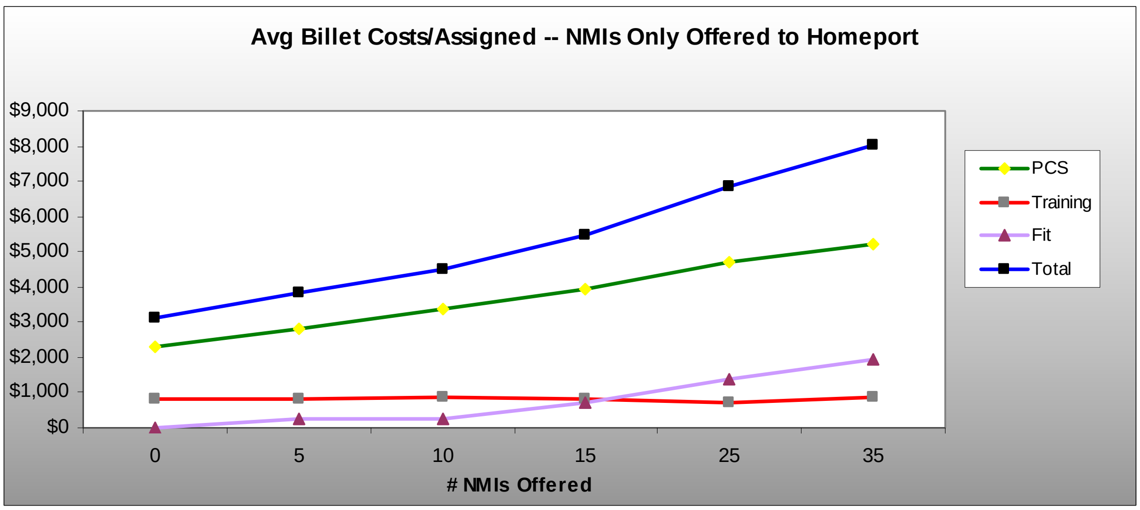
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PCS
Training
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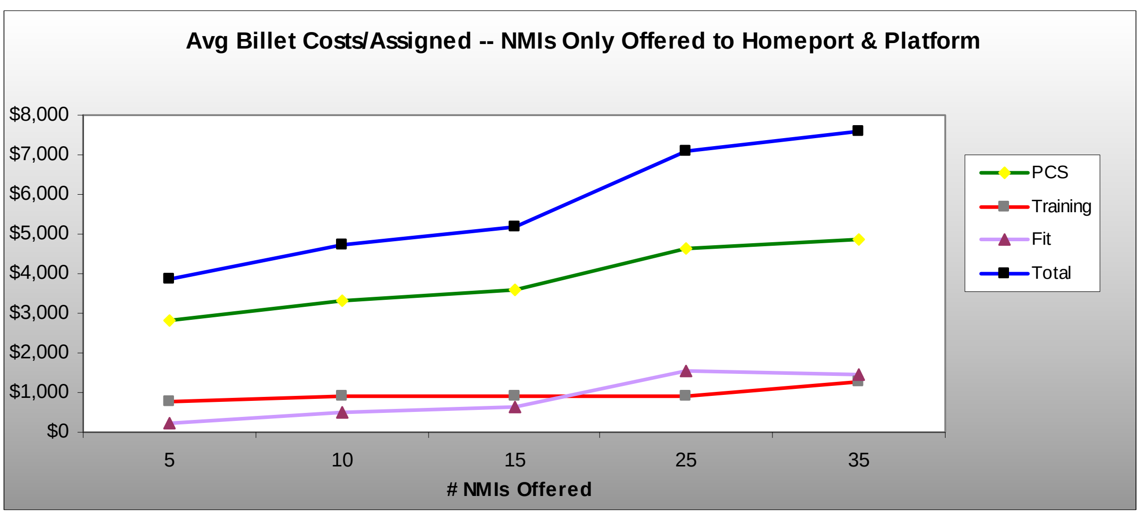
Total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PCS
Training
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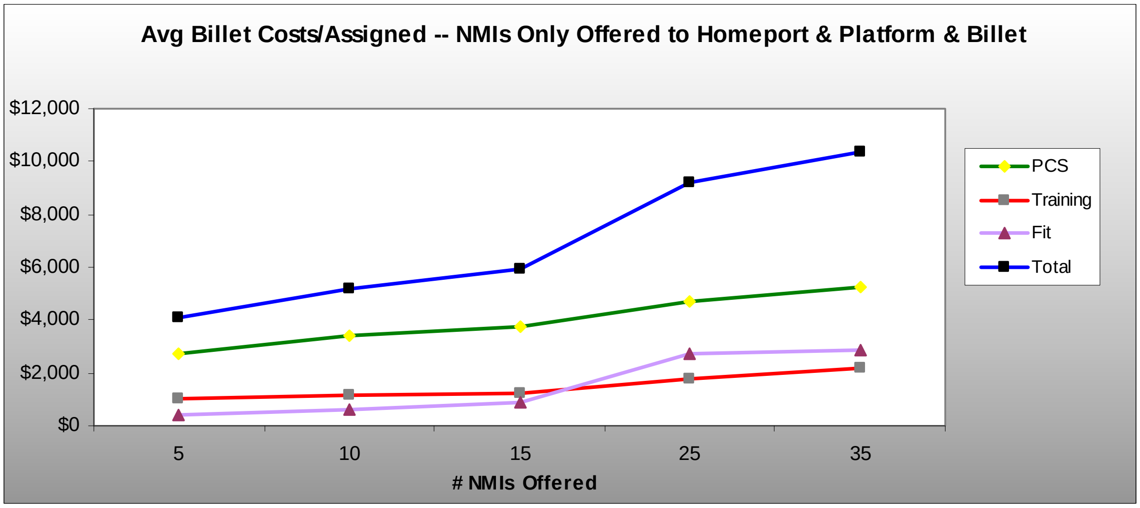
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PCS
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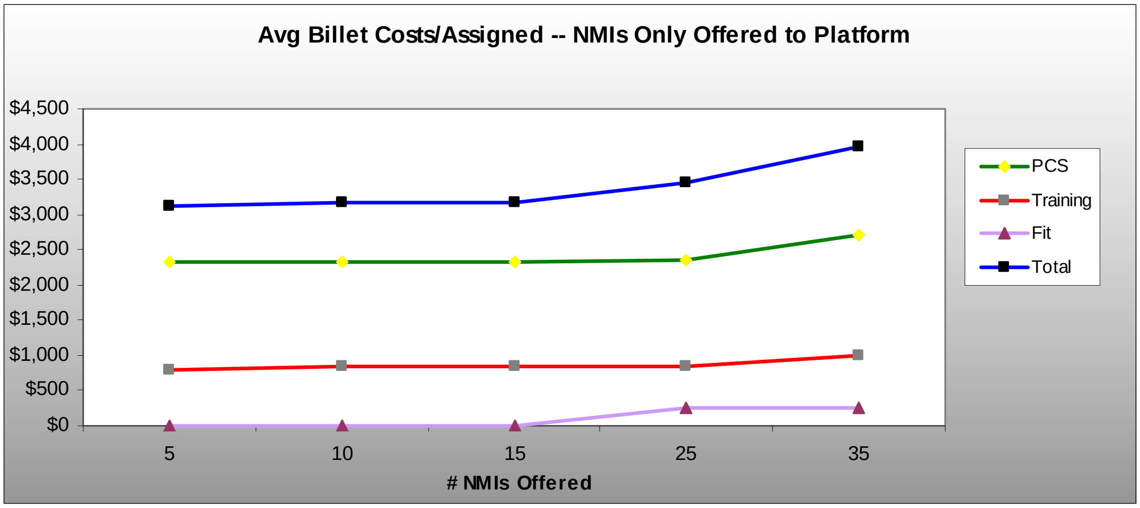
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Training
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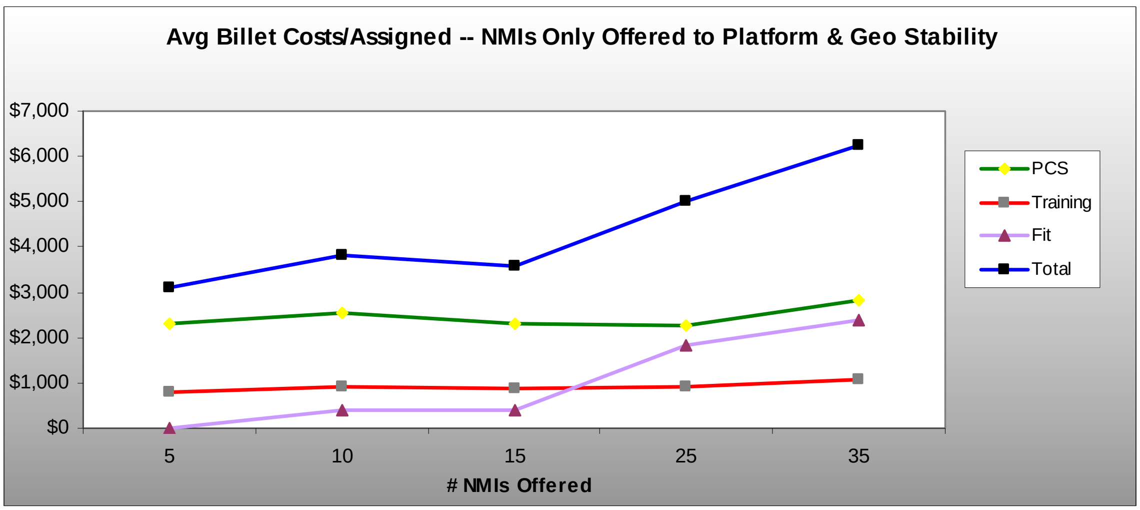
Total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NMIs Offered
PCS
Training
Fit
Total

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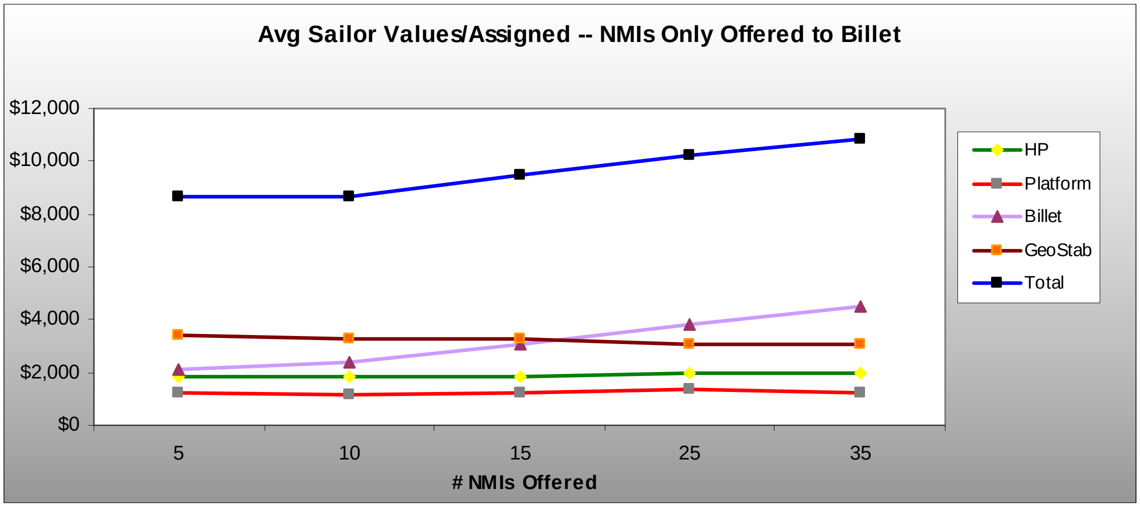
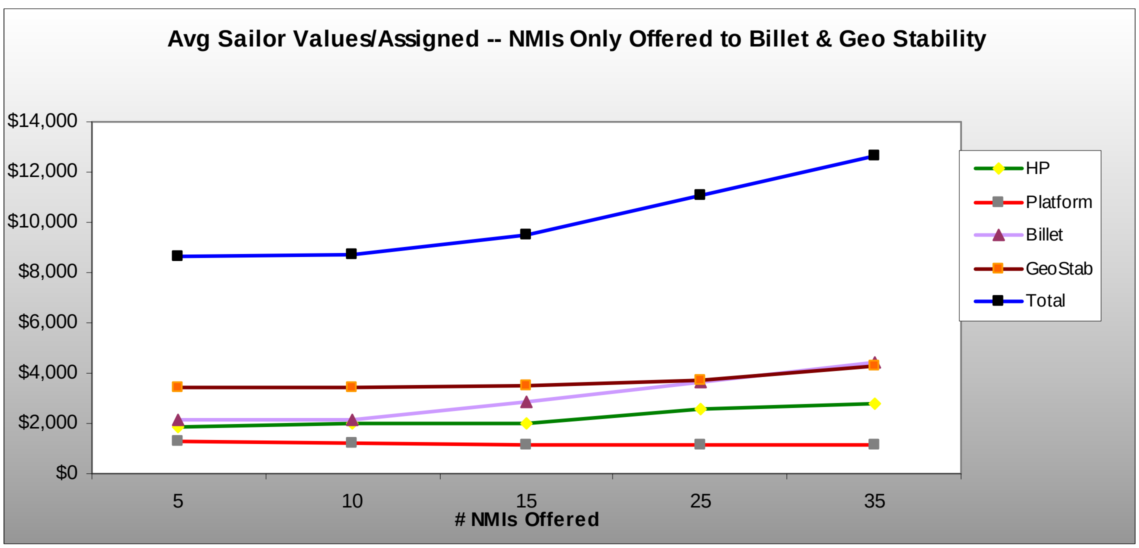
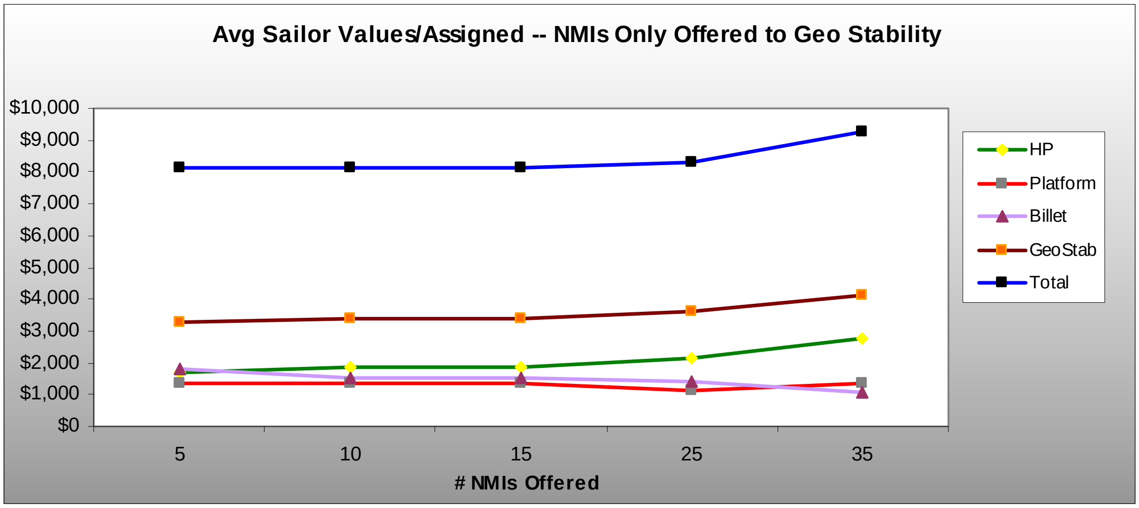
APPENDIX F: AVERAGE SAILOR VALUES/ASSIGNED FOR 100% NAVY AND 0% SAILOR



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$6,000
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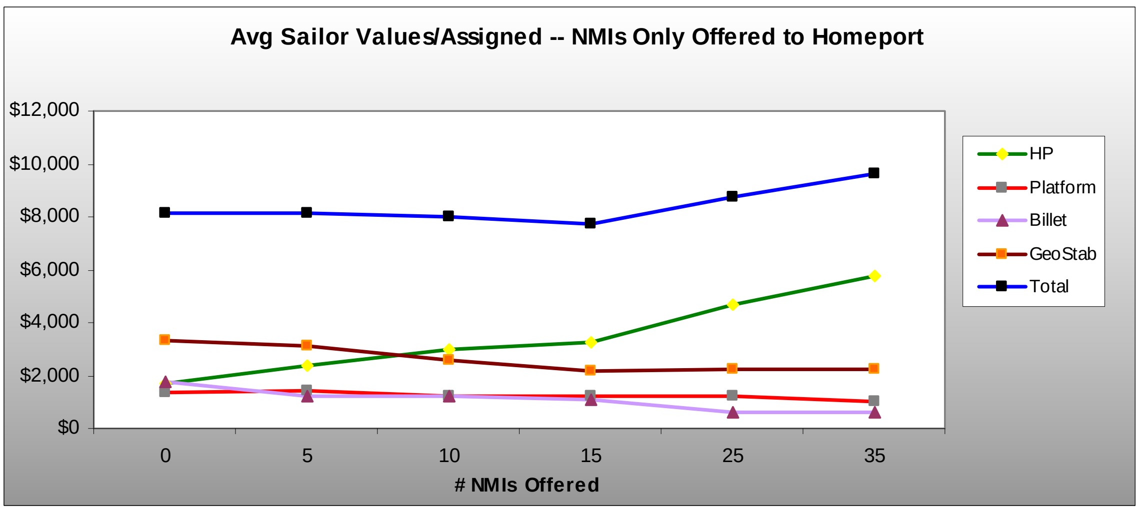
Platform
Billet
GeoStab
Total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NMIs Offered
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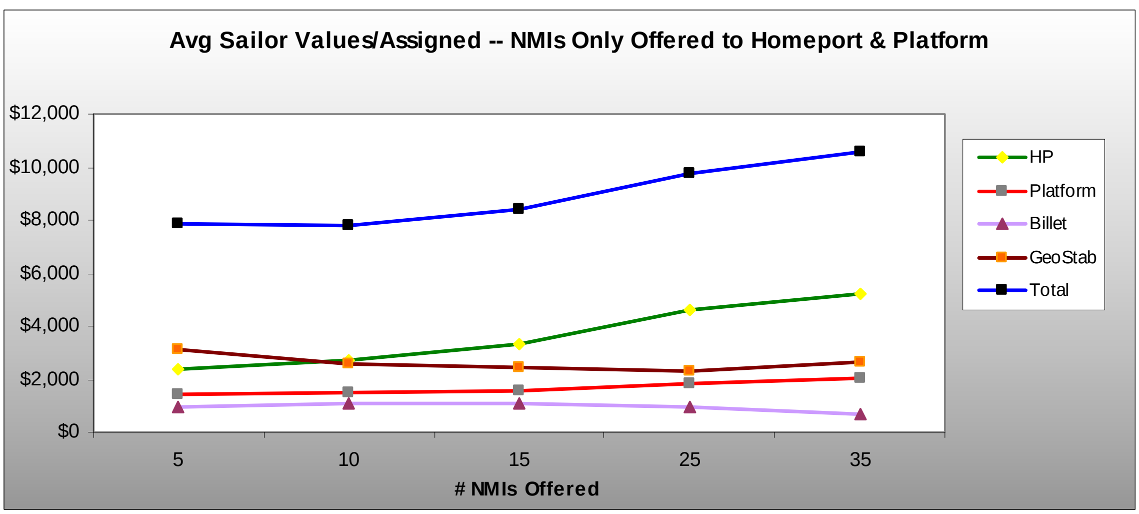
Platform
Billet
GeoStab
Total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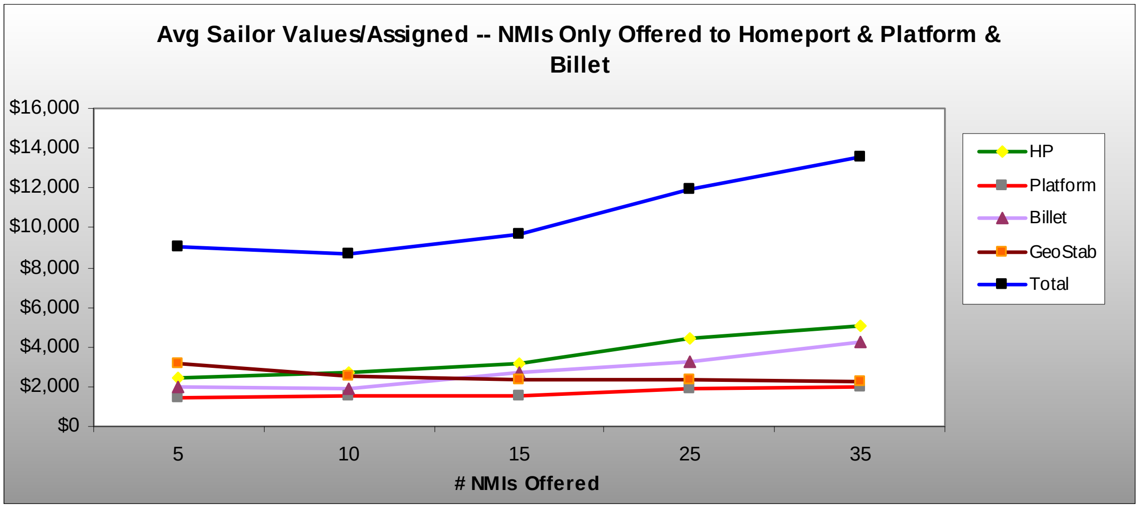
NMIs Offered
HP
Platform
Billet
GeoStab
Total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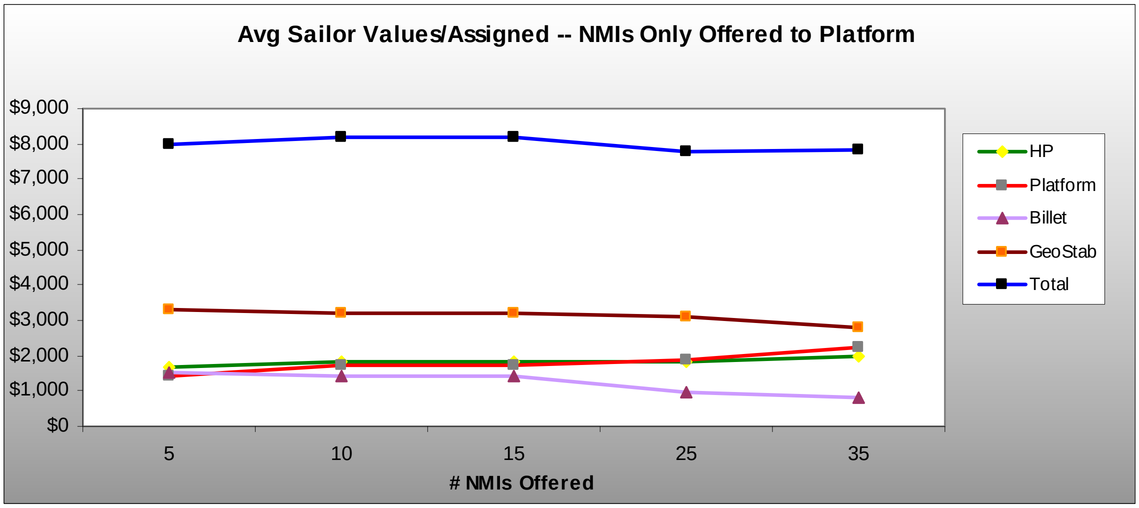
NMIs Offered
HP
Platform
Billet
GeoStab
Total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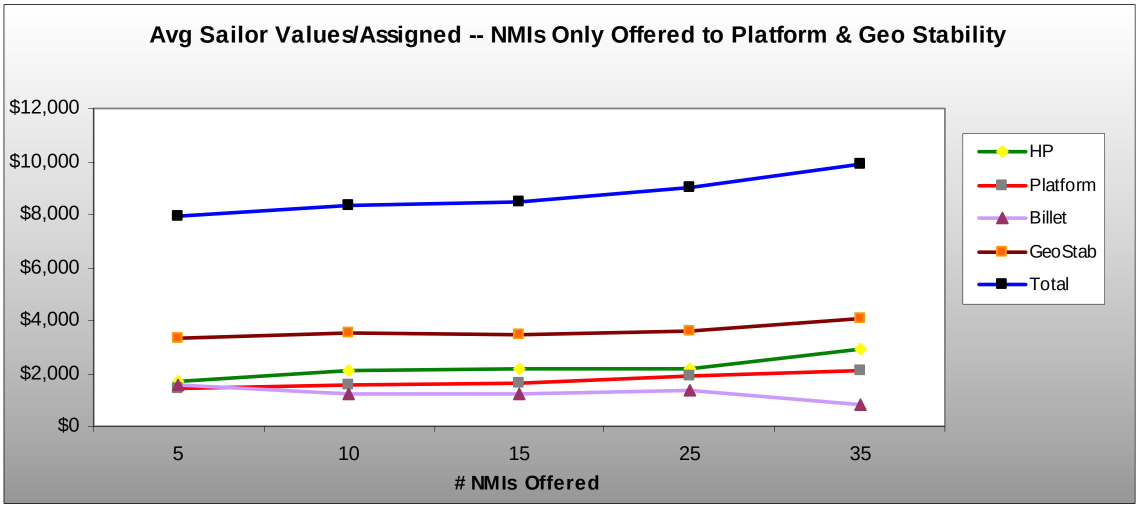
NMIs Offered
HP
Platform
Billet
GeoStab
Total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10
15
25
35
NMIs Offered
HP
Platform
Billet
GeoStab
Total

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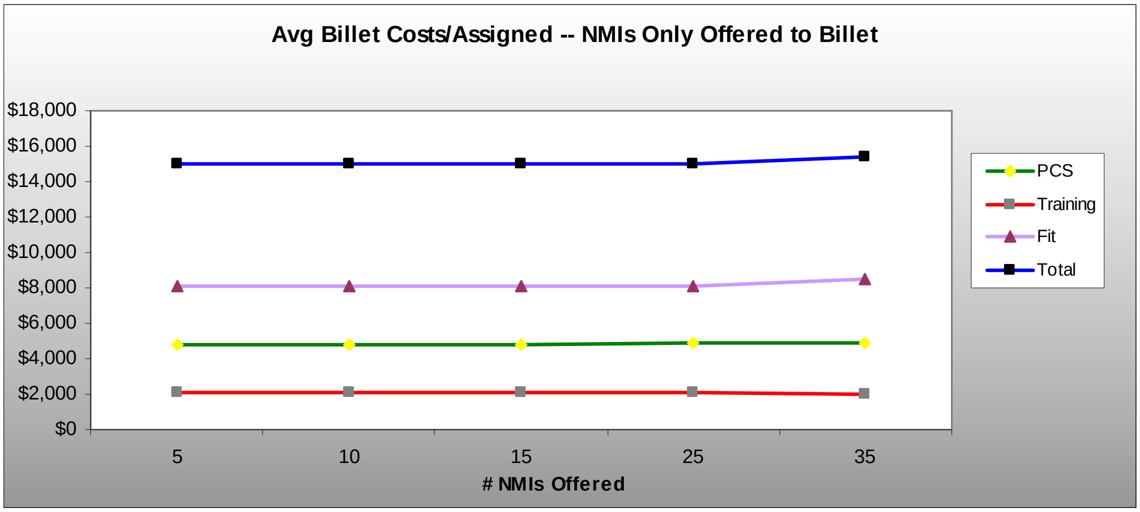
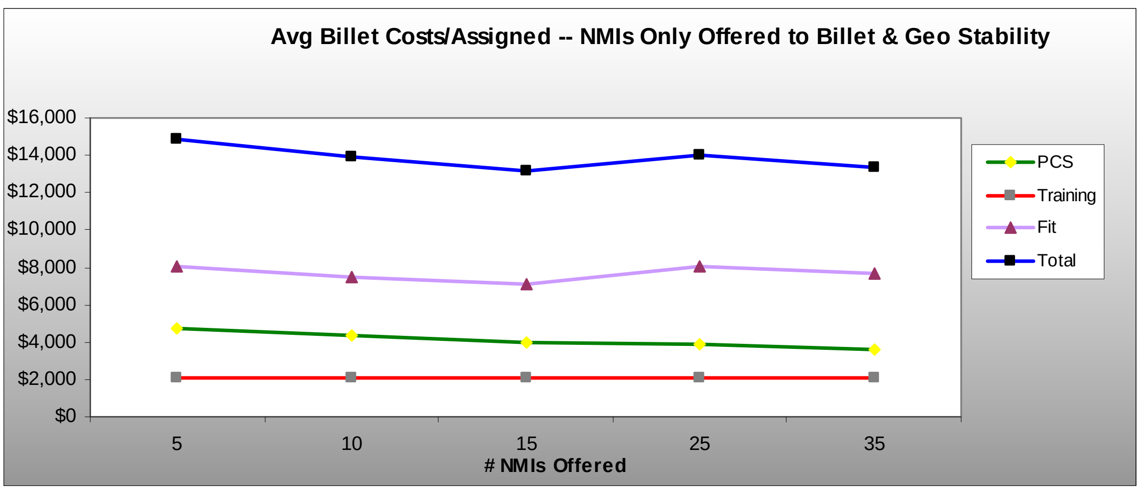
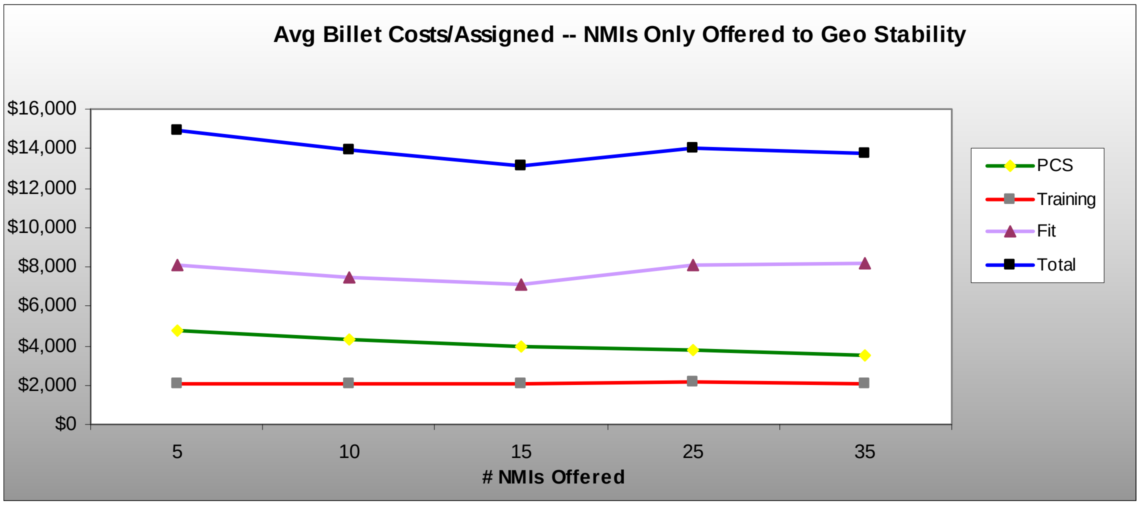
APPENDIX G: AVERAGE BILLET COSTS/ASSIGNED FOR 0% NAVY AND 100% SAILOR



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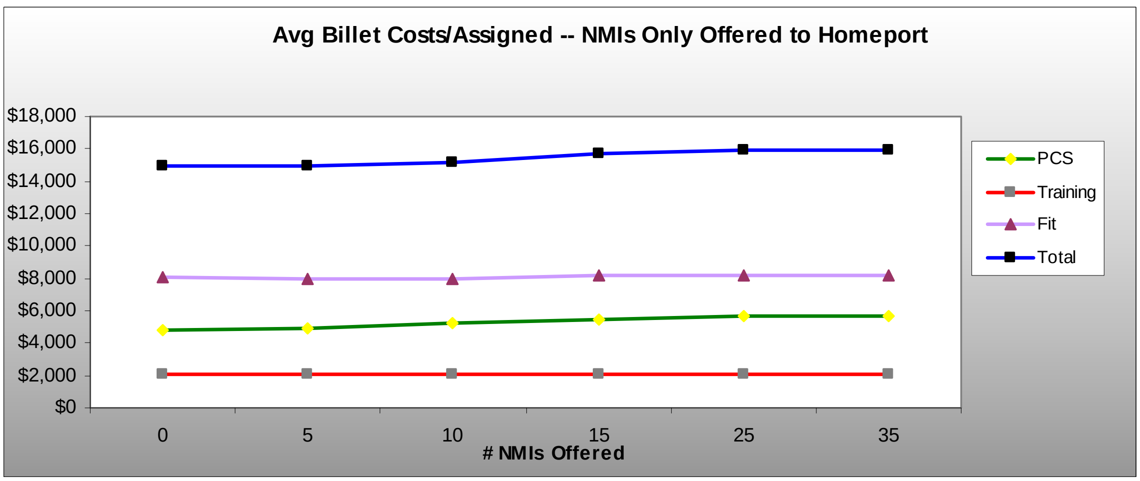
PCS
Training
Fit
Total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25
35
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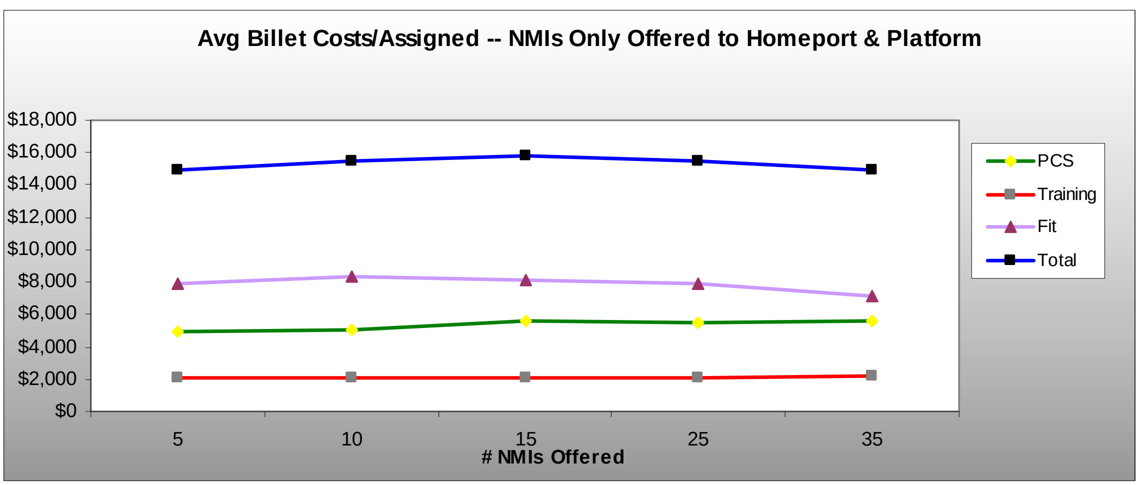
PCS
Training
Fit
Total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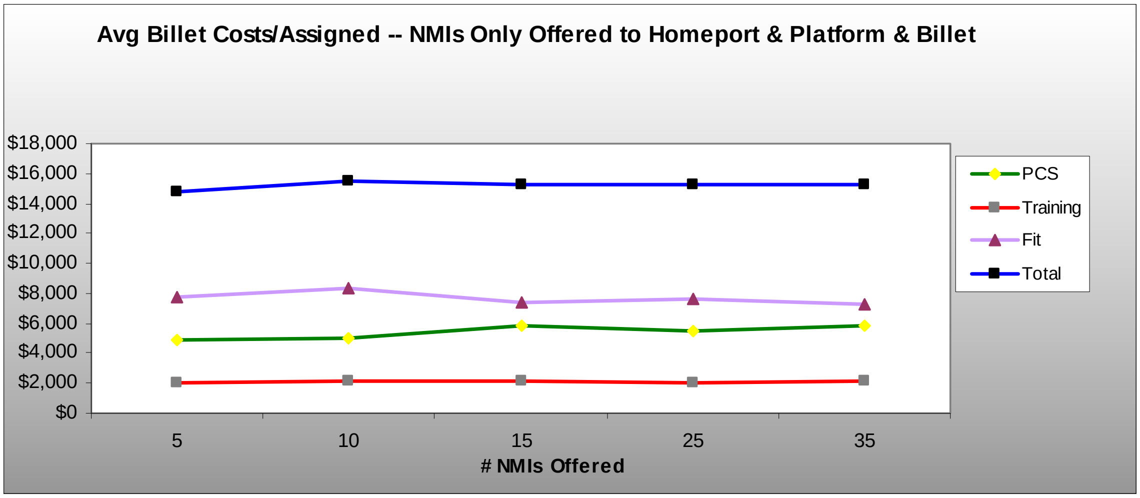
35
NMIs Offered
PCS
Training
Fit
Total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$12,000
$10,000
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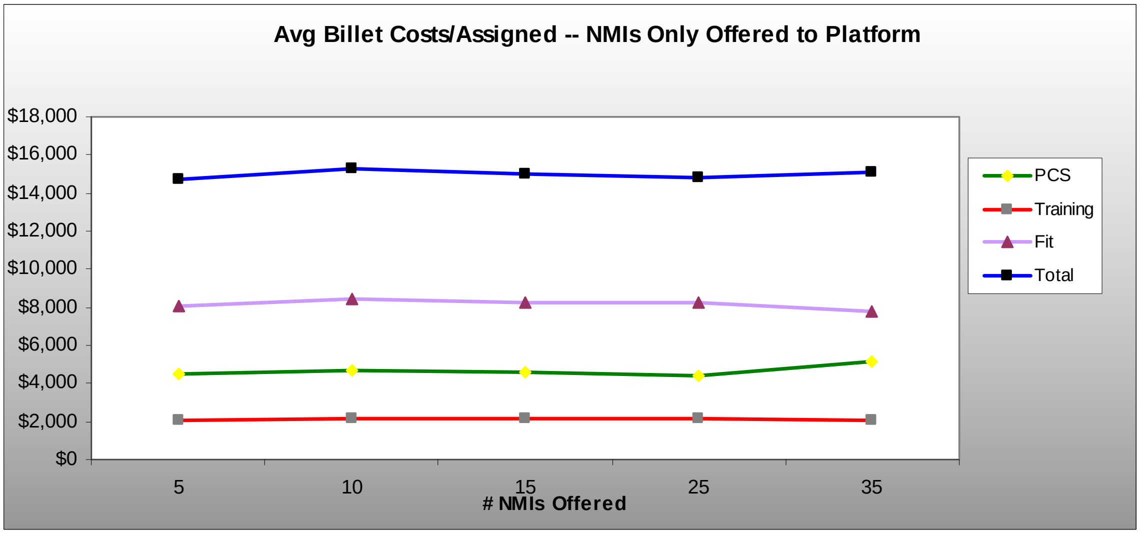
PCS
Training
Fit
Total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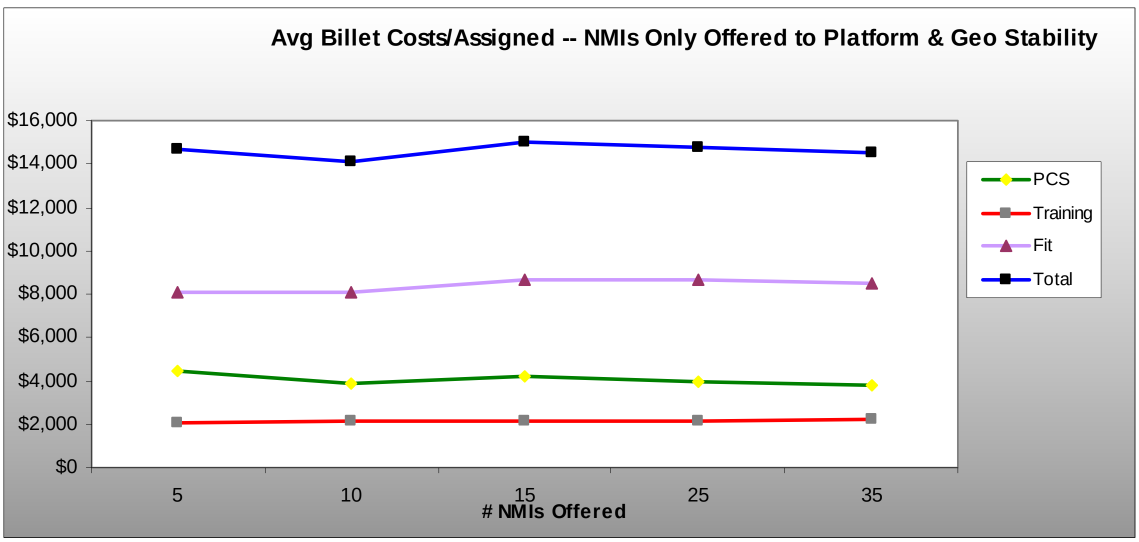
35
NMIs Offered
PCS
Training
Fit
Total


Avg Billet Costs/Assigned -- NMIs Only Offered to Platform & Geo Stability
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$8,000
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$4,000
$2,000
$0
5
10
15
25
35
NMIs Offered
PCS
Training
Fit
Total

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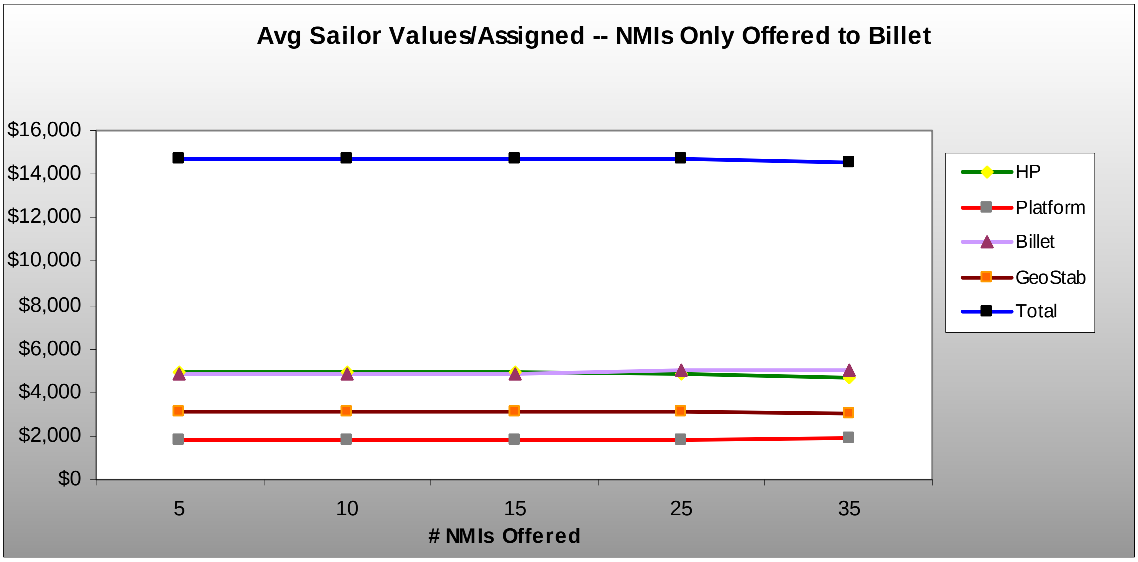
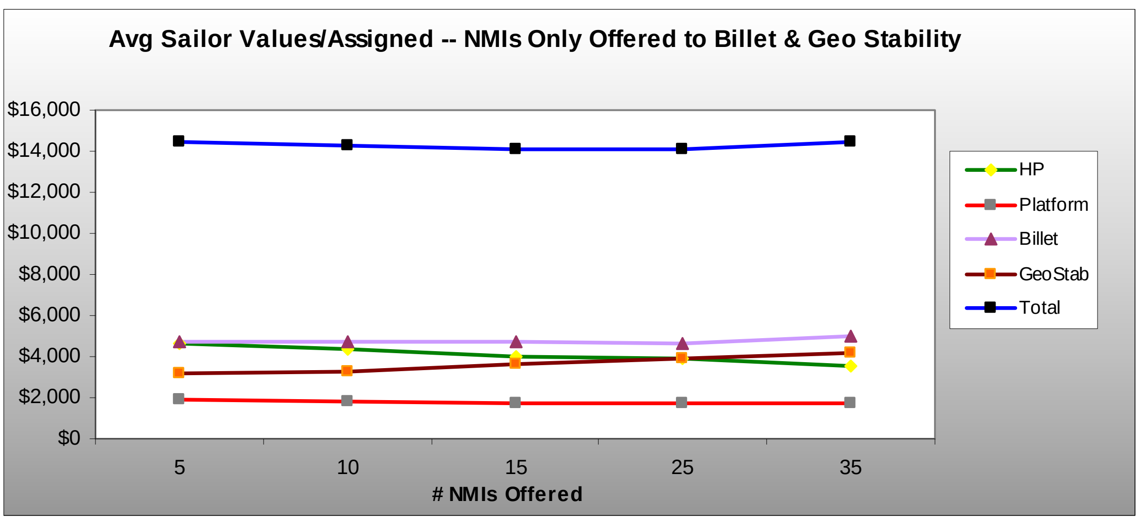
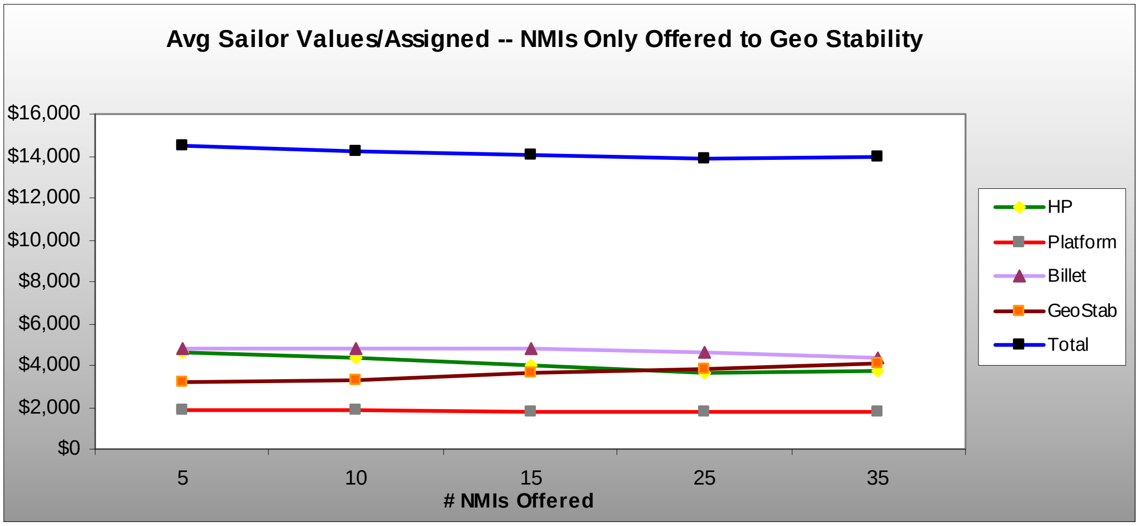
APPENDIX H: AVERAGE SAILOR VALUES/ASSIGNED FOR 0% NAVY AND 100% SAILOR



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25
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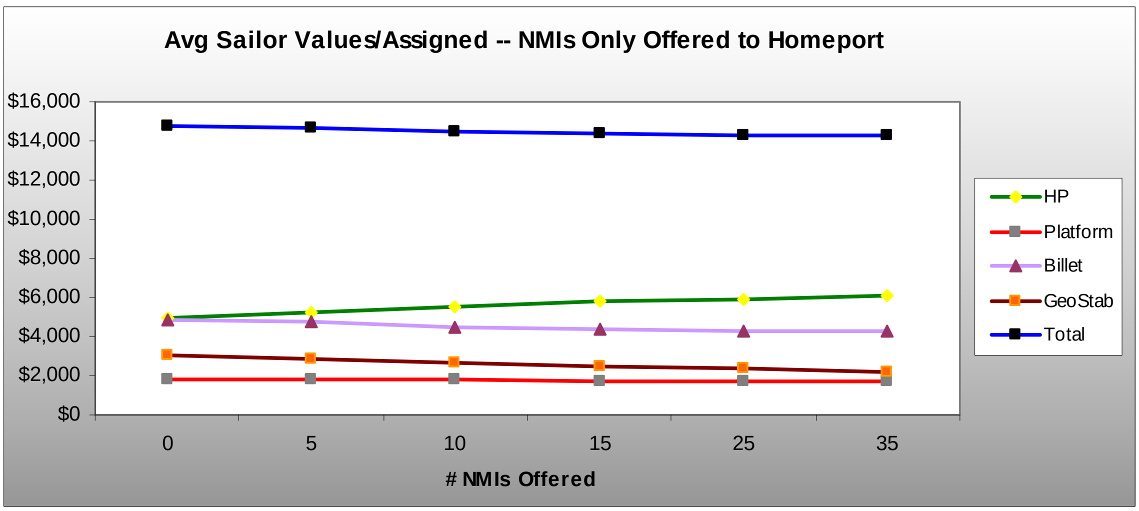
NMIs Offered
HP
Platform
Billet
GeoStab
Total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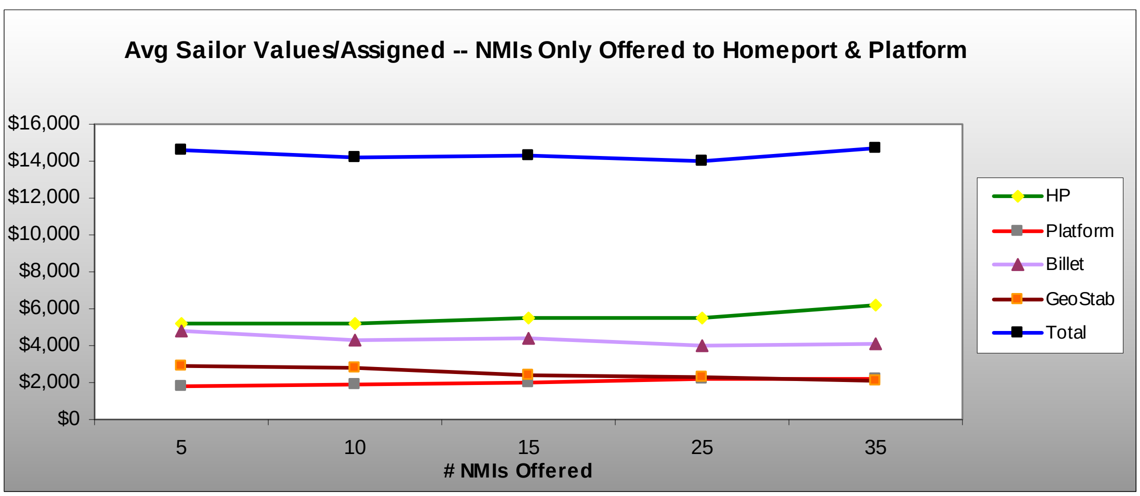
NMIs Offered
HP
Platform
Billet
GeoStab
Total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$8,000
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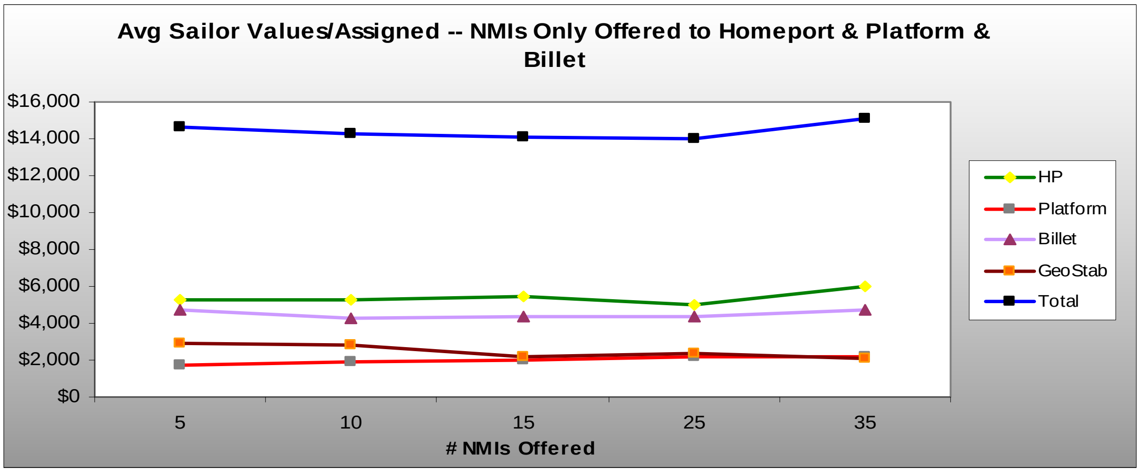
NMIs Offered
HP
Platform
Billet
GeoStab
Total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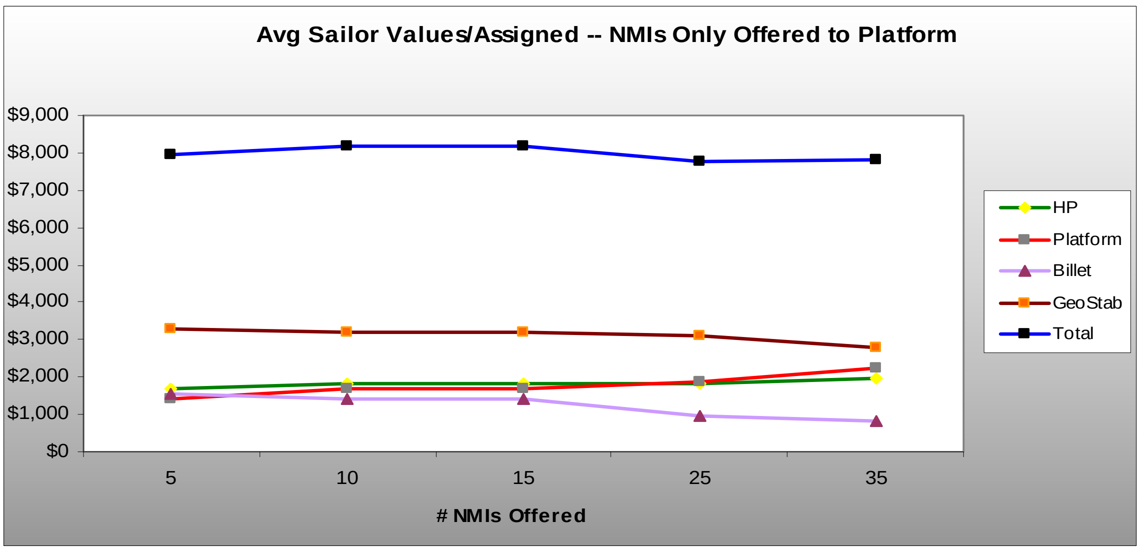
Platform
Billet
GeoStab
Total


Avg Sailor Values/Assigned -- NMIs Only Offered to Platform
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10
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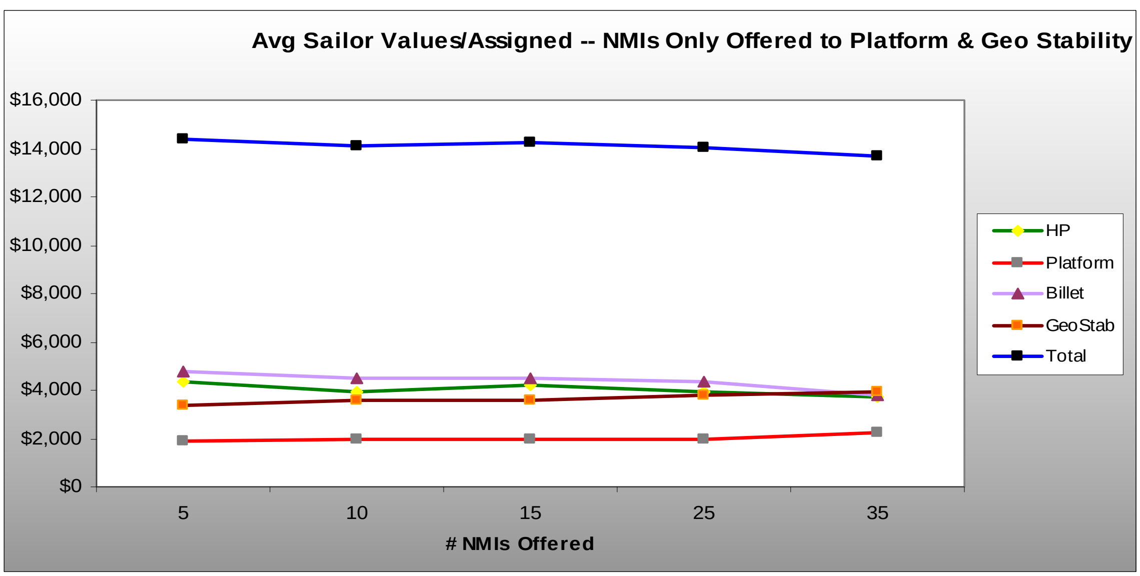
25
35
NMIs Offered
HP
Platform
Billet
GeoStab
Total


Avg Sailor Values/Assigned -- NMIs Only Offered to Platform & Geo Stability
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$8,000
$6,000
$4,000
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$0
5
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NMIs Offered
HP
Platform
Billet
GeoStab
Total

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APPENDIX I: DATA FOR AVERAGE BILLET COSTS AND AVERAGE SAILOR VALUES FOR 50% NAVY AND 50% SAILOR

		Average Billet Costs/Assigned					Average Sailor Values/Assigned				
NMIs Offered		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet	5	$2,402	$1,814	$0	$4,216	5	$2,967	$1,766	$3,690	$3,398	$11,821
Billet	10	$2,577	$1,757	$0	$4,334	10	$2,967	$1,766	$3,809	$3,295	$11,837
Billet	15	$2,582	$1,757	$0	$4,339	15	$2,684	$1,709	$4,048	$3,295	$11,735
Billet	25	$2,811	$1,810	$247	$4,868	25	$2,684	$1,652	$4,286	$3,295	$11,916
Billet	35	$3,377	$1,981	$1,619	$6,977	35	$2,684	$1,424	$5,000	$3,192	$12,300
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet/Geo Stab	5	$2,520	$1,707	$0	$4,227	5	$2,826	$1,823	$3,571	$3,398	$11,617
Billet/Geo Stab	10	$2,958	$1,606	$0	$4,564	10	$2,543	$1,595	$3,809	$3,398	$11,345
Billet/Geo Stab	15	$2,939	$1,707	$384	$5,029	15	$2,684	$1,766	$3,809	$3,500	$11,760
Billet/Geo Stab	25	$2,477	$1,797	$1,935	$6,209	25	$2,746	$1,456	$4,505	$3,685	$12,392
Billet/Geo Stab	35	$2,511	$2,109	$4,304	$8,923	35	$3,101	$1,500	$4,704	$4,294	$13,599
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Geo Stab	5	$2,520	$1,707	$0	$4,227	5	$2,826	$1,823	$3,571	$3,398	$11,617
Geo Stab	10	$2,783	$1,606	$0	$4,390	10	$2,543	$1,595	$3,690	$3,500	$11,329
Geo Stab	15	$2,783	$1,606	$0	$4,390	15	$2,543	$1,595	$3,690	$3,500	$11,329
Geo Stab	25	$2,566	$1,656	$1,151	$5,374	25	$2,543	$1,709	$3,690	$3,912	$11,855
Geo Stab	35	$2,769	$1,742	$1,962	$6,474	35	$3,035	$1,689	$3,409	$4,212	$12,345
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP	0	$2,402	$1,814	$0	$4,216	0	$2,967	$1,766	$3,690	$3,398	$11,821
HP	5	$2,950	$1,763	$384	$5,097	5	$3,532	$1,595	$3,690	$3,192	$12,009
HP	10	$3,569	$1,874	$384	$5,826	10	$4,097	$1,538	$3,809	$2,780	$12,224
HP	15	$4,061	$1,864	$878	$6,802	15	$4,380	$1,652	$3,690	$2,368	$12,090
HP	25	$4,811	$1,975	$1,398	$8,184	25	$4,945	$1,652	$3,571	$2,265	$12,433
HP	35	$5,214	$1,968	$1,962	$9,145	35	$5,780	$1,631	$3,409	$2,211	$13,031
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat	5	$2,950	$1,763	$384	$5,097	5	$3,532	$1,595	$3,690	$3,192	$12,009
HP/Plat	10	$3,562	$1,810	$494	$5,866	10	$3,815	$1,709	$3,333	$2,780	$11,637
HP/Plat	15	$3,768	$1,961	$645	$6,374	15	$3,902	$1,748	$3,653	$2,527	$11,829
HP/Plat	25	$4,630	$1,961	$1,543	$8,133	25	$4,624	$2,097	$3,044	$2,317	$12,081
HP/Plat	35	$4,871	$2,146	$1,456	$8,472	35	$5,217	$2,103	$3,022	$2,613	$12,955
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat/Billet	5	$2,950	$1,763	$384	$5,097	5	$3,532	$1,595	$3,690	$3,192	$12,009
HP/Plat/Billet	10	$3,405	$1,810	$878	$6,093	10	$3,532	$1,652	$3,809	$2,780	$11,773
HP/Plat/Billet	15	$3,740	$1,903	$1,150	$6,793	15	$3,613	$1,689	$4,018	$2,527	$11,847
HP/Plat/Billet	25	$4,687	$1,950	$2,756	$9,393	25	$4,436	$2,027	$3,737	$2,370	$12,570
HP/Plat/Billet	35	$5,226	$2,190	$3,209	$10,625	35	$5,268	$2,050	$4,286	$2,383	$13,987
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat	5	$2,402	$1,814	$0	$4,216	5	$2,967	$1,766	$3,690	$3,398	$11,821
Plat	10	$2,402	$1,814	$0	$4,216	10	$2,967	$1,766	$3,452	$3,398	$11,583
Plat	15	$2,576	$1,814	$0	$4,389	15	$3,108	$1,766	$3,452	$3,398	$11,724
Plat	25	$2,509	$1,910	$631	$5,050	25	$3,108	$1,936	$3,333	$3,500	$11,879
Plat	35	$2,617	$1,917	$631	$5,165	35	$2,826	$2,221	$3,095	$3,295	$11,437
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat/Geo Stab	5	$2,520	$1,707	$0	$4,227	5	$2,826	$1,823	$3,571	$3,398	$11,617
Plat/Geo Stab	10	$2,764	$1,757	$384	$4,904	10	$2,684	$1,766	$3,333	$3,603	$11,387
Plat/Geo Stab	15	$2,550	$1,738	$392	$4,681	15	$2,746	$1,806	$3,409	$3,580	$11,540
Plat/Geo Stab	25	$2,315	$1,786	$1,823	$5,924	25	$2,746	$1,981	$3,044	$3,896	$11,666
Plat/Geo Stab	35	$2,808	$1,987	$2,377	$7,172	35	$3,101	$2,188	$2,744	$4,068	$12,101

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APPENDIX J: DATA FOR AVERAGE BILLET COSTS AND AVERAGE SAILOR VALUES FOR 100% NAVY AND 0% SAILOR

		Average Billet Costs/Assigned					Average Sailor Values/Assigned				
NMIs Offered		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet	5	$2,289	$904	$0	$3,193	5	$1,837	$1,253	$2,143	$3,398	$8,630
Billet	10	$2,464	$1,004	$0	$3,468	10	$1,837	$1,139	$2,381	$3,295	$8,651
Billet	15	$2,464	$1,218	$0	$3,682	15	$1,837	$1,253	$3,095	$3,295	$9,480
Billet	25	$2,667	$1,389	$247	$4,302	25	$1,978	$1,367	$3,809	$3,089	$10,243
Billet	35	$2,987	$1,824	$1,619	$6,430	35	$1,978	$1,253	$4,524	$3,089	$10,843
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet/Geo Stab	5	$2,289	$904	$0	$3,193	5	$1,837	$1,253	$2,143	$3,398	$8,630
Billet/Geo Stab	10	$2,742	$1,061	$0	$3,802	10	$1,978	$1,196	$2,143	$3,398	$8,714
Billet/Geo Stab	15	$2,703	$1,225	$384	$4,312	15	$1,978	$1,139	$2,857	$3,500	$9,475
Billet/Geo Stab	25	$2,464	$1,410	$1,935	$5,809	25	$2,601	$1,165	$3,653	$3,685	$11,104
Billet/Geo Stab	35	$2,511	$1,991	$4,304	$8,806	35	$2,791	$1,125	$4,442	$4,294	$12,653
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Geo Stab	5	$2,317	$793	$0	$3,110	5	$1,695	$1,367	$1,786	$3,295	$8,143
Geo Stab	10	$2,595	$850	$0	$3,445	10	$1,837	$1,367	$1,548	$3,398	$8,149
Geo Stab	15	$2,595	$850	$0	$3,445	15	$1,837	$1,367	$1,548	$3,398	$8,149
Geo Stab	25	$2,505	$800	$1,151	$4,456	25	$2,119	$1,139	$1,429	$3,603	$8,290
Geo Stab	35	$2,691	$924	$1,962	$5,578	35	$2,746	$1,340	$1,096	$4,107	$9,288
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP	0	$2,317	$793	$0	$3,110	0	$1,695	$1,367	$1,786	$3,295	$8,143
HP	5	$2,817	$793	$247	$3,856	5	$2,402	$1,424	$1,190	$3,089	$8,105
HP	10	$3,359	$893	$247	$4,499	10	$2,967	$1,253	$1,190	$2,574	$7,984
HP	15	$3,915	$793	$741	$5,449	15	$3,250	$1,253	$1,071	$2,162	$7,736
HP	25	$4,717	$739	$1,398	$6,855	25	$4,663	$1,253	$595	$2,265	$8,776
HP	35	$5,214	$862	$1,962	$8,039	35	$5,780	$1,049	$609	$2,211	$9,648
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat	5	$2,817	$793	$247	$3,856	5	$2,402	$1,424	$952	$3,089	$7,867
HP/Plat	10	$3,331	$893	$494	$4,718	10	$2,684	$1,481	$1,071	$2,574	$7,811
HP/Plat	15	$3,613	$920	$645	$5,178	15	$3,324	$1,573	$1,096	$2,422	$8,414
HP/Plat	25	$4,630	$917	$1,543	$7,090	25	$4,624	$1,864	$974	$2,317	$9,779
HP/Plat	35	$4,871	$1,273	$1,456	$7,600	35	$5,217	$2,037	$687	$2,613	$10,554
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat/Billet	5	$2,732	$1,004	$384	$4,119	5	$2,402	$1,424	$2,024	$3,192	$9,041
HP/Plat/Billet	10	$3,426	$1,154	$631	$5,211	10	$2,684	$1,538	$1,905	$2,574	$8,701
HP/Plat/Billet	15	$3,763	$1,249	$898	$5,910	15	$3,179	$1,515	$2,679	$2,317	$9,689
HP/Plat/Billet	25	$4,687	$1,789	$2,756	$9,231	25	$4,436	$1,907	$3,239	$2,370	$11,953
HP/Plat/Billet	35	$5,262	$2,190	$2,892	$10,343	35	$5,086	$1,977	$4,286	$2,250	$13,599
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat	5	$2,317	$793	$0	$3,110	5	$1,695	$1,424	$1,548	$3,295	$7,962
Plat	10	$2,324	$843	$0	$3,167	10	$1,837	$1,709	$1,429	$3,192	$8,166
Plat	15	$2,324	$843	$0	$3,167	15	$1,837	$1,709	$1,429	$3,192	$8,166
Plat	25	$2,359	$843	$247	$3,449	25	$1,837	$1,880	$952	$3,089	$7,757
Plat	35	$2,704	$1,007	$247	$3,958	35	$1,978	$2,221	$833	$2,780	$7,812
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat/Geo Stab	5	$2,317	$793	$0	$3,110	5	$1,695	$1,424	$1,548	$3,295	$7,962
Plat/Geo Stab	10	$2,535	$907	$384	$3,826	10	$2,119	$1,538	$1,190	$3,500	$8,348
Plat/Geo Stab	15	$2,316	$869	$392	$3,578	15	$2,168	$1,631	$1,218	$3,475	$8,491
Plat/Geo Stab	25	$2,285	$920	$1,823	$5,028	25	$2,168	$1,922	$1,339	$3,580	$9,009
Plat/Geo Stab	35	$2,808	$1,062	$2,377	$6,246	35	$2,946	$2,125	$784	$4,068	$9,924

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APPENDIX K: DATA FOR AVERAGE BILLET COSTS AND AVERAGE SAILOR VALUES FOR 0% NAVY AND 100% SAILOR

		Average Billet Costs/Assigned					Average Sailor Values/Assigned				
NMIs Offered		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet	5	$4,781	$2,085	$8,089	$14,955	5	$4,945	$1,823	$4,881	$3,089	$14,737
Billet	10	$4,781	$2,085	$8,089	$14,955	10	$4,945	$1,823	$4,881	$3,089	$14,737
Billet	15	$4,781	$2,085	$8,089	$14,955	15	$4,945	$1,823	$4,881	$3,089	$14,737
Billet	25	$4,857	$2,085	$8,089	$15,032	25	$4,804	$1,823	$5,000	$3,089	$14,715
Billet	35	$4,889	$2,035	$8,473	$15,397	35	$4,663	$1,880	$5,000	$2,986	$14,528
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Billet/Geo Stab	5	$4,727	$2,085	$8,089	$14,902	5	$4,663	$1,880	$4,762	$3,192	$14,495
Billet/Geo Stab	10	$4,353	$2,085	$7,458	$13,896	10	$4,380	$1,823	$4,762	$3,295	$14,259
Billet/Geo Stab	15	$4,020	$2,085	$7,075	$13,180	15	$3,956	$1,766	$4,762	$3,603	$14,087
Billet/Geo Stab	25	$3,851	$2,126	$8,020	$13,997	25	$3,902	$1,689	$4,627	$3,896	$14,113
Billet/Geo Stab	35	$3,582	$2,109	$7,644	$13,334	35	$3,567	$1,750	$4,965	$4,181	$14,463
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Geo Stab	5	$4,727	$2,085	$8,089	$14,902	5	$4,663	$1,880	$4,762	$3,192	$14,495
Geo Stab	10	$4,353	$2,085	$7,458	$13,896	10	$4,380	$1,823	$4,762	$3,295	$14,259
Geo Stab	15	$3,992	$2,085	$7,075	$13,152	15	$3,956	$1,766	$4,762	$3,603	$14,087
Geo Stab	25	$3,766	$2,135	$8,089	$13,990	25	$3,674	$1,766	$4,643	$3,809	$13,891
Geo Stab	35	$3,545	$2,067	$8,160	$13,773	35	$3,757	$1,748	$4,383	$4,107	$13,994
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP	0	$4,781	$2,085	$8,089	$14,955	0	$4,945	$1,823	$4,881	$3,089	$14,737
HP	5	$4,934	$2,031	$7,952	$14,918	5	$5,228	$1,766	$4,762	$2,883	$14,638
HP	10	$5,204	$2,031	$7,952	$15,188	10	$5,510	$1,766	$4,524	$2,677	$14,476
HP	15	$5,426	$2,085	$8,226	$15,737	15	$5,793	$1,709	$4,405	$2,471	$14,377
HP	25	$5,651	$2,085	$8,226	$15,962	25	$5,934	$1,709	$4,286	$2,368	$14,296
HP	35	$5,684	$2,081	$8,133	$15,899	35	$6,069	$1,748	$4,261	$2,211	$14,289
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat	5	$4,934	$2,031	$7,952	$14,918	5	$5,228	$1,766	$4,762	$2,883	$14,638
HP/Plat	10	$5,053	$2,135	$8,336	$15,524	10	$5,228	$1,936	$4,286	$2,780	$14,230
HP/Plat	15	$5,551	$2,129	$8,133	$15,813	15	$5,491	$1,981	$4,383	$2,422	$14,276
HP/Plat	25	$5,498	$2,128	$7,881	$15,508	25	$5,491	$2,155	$4,018	$2,317	$13,981
HP/Plat	35	$5,639	$2,154	$7,150	$14,944	35	$6,195	$2,234	$4,121	$2,138	$14,688
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
HP/Plat/Geo Stab	5	$4,934	$2,085	$7,705	$14,724	5	$5,228	$1,766	$4,762	$2,883	$14,638
HP/Plat/Geo Stab	10	$5,053	$2,135	$8,336	$15,524	10	$5,228	$1,936	$4,286	$2,780	$14,230
HP/Plat/Geo Stab	15	$5,813	$2,129	$7,348	$15,290	15	$5,491	$2,039	$4,383	$2,211	$14,124
HP/Plat/Geo Stab	25	$5,507	$2,066	$7,634	$15,207	25	$5,027	$2,205	$4,360	$2,370	$13,963
HP/Plat/Geo Stab	35	$5,833	$2,130	$7,298	$15,261	35	$5,995	$2,197	$4,745	$2,118	$15,054
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat	5	$4,532	$2,085	$8,089	$14,706	5	$4,663	$1,823	$4,881	$3,295	$14,661
Plat	10	$4,684	$2,135	$8,473	$15,292	10	$4,804	$1,880	$4,762	$3,192	$14,637
Plat	15	$4,608	$2,135	$8,226	$14,969	15	$4,804	$1,993	$4,643	$3,192	$14,632
Plat	25	$4,408	$2,135	$8,226	$14,769	25	$4,663	$2,050	$4,524	$3,295	$14,531
Plat	35	$5,162	$2,082	$7,816	$15,059	35	$4,945	$2,278	$4,167	$2,780	$14,170
		PCS	Training	Fit	Total		HP	Platform	Billet	GeoStab	Total
Plat/Geo Stab	5	$4,478	$2,085	$8,089	$14,652	5	$4,380	$1,880	$4,762	$3,398	$14,419
Plat/Geo Stab	10	$3,903	$2,135	$8,089	$14,128	10	$3,956	$1,993	$4,524	$3,603	$14,077
Plat/Geo Stab	15	$4,181	$2,126	$8,666	$14,972	15	$4,191	$1,981	$4,505	$3,580	$14,256
Plat/Geo Stab	25	$3,949	$2,126	$8,666	$14,740	25	$3,902	$1,981	$4,383	$3,791	$14,056
Plat/Geo Stab	35	$3,831	$2,226	$8,486	$14,543	35	$3,722	$2,250	$3,789	$3,955	$13,716

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