Design of an Enlisted Assignment and Retention Marketplace

Gates., William R.; Hatch, William D., II
Monterey, California. Naval Postgraduate School

https://hdl.handle.net/10945/72643

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States.

Downloaded from NPS Archive: Calhoun
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

DESIGN OF AN ENLISTED ASSIGNMENT AND RETENTION MARKETPLACE

by

William R. Gates

William D. Hatch II

January 2024

Approved for public release. Distribution is unlimited.

Prepared for: BUPERS-34B. This research is supported by funding from the Naval Postgraduate School, Naval Research Program (PE 0605853N/2098). NRP Project ID: NPS-18-N314-A
THIS PAGE INTENTIONALLY LEFT BLANK
The Navy’s current enlisted distribution and career management originated with a conscripted force preparing for a Major Theatre cold war. Although it has been over 40 years since the volunteer force was implemented the policies and processes have lagged significantly. The Navy faces a significantly different demographic and a stronger economy, so the incentives to enlist and reenlist must evolve.

The Navy needs a market-based retention and assignment process capable of meeting the Navy’s job, career, and quality needs, while meeting the sailors’ individual desires, preferences, and aspirations. The traditional reenlistment and assignment processes address both retention and assignment, but they face significant risk for under- or over-estimating the retention incentive needed to meet end-strength goals, are inflexible, do not reward performance, and they include at least some less than voluntary assignments.

Focusing on the enlisted Aerographer’s Mate (AG) community, this research proposes five alternatives to introduce market-based mechanisms into the enlisted detailing process, specifically three alternative auctions designs, two-sided matching, and two-sided matching with money. A basic auction offers better precision in setting retention and assignment incentives at the minimum level necessary to achieve the desired outcome. Basic auctions can incorporate adjustments for past or projected sailor performance or to include individualized non-monetary incentives to further improve performance. However, they do not specifically address the one-to-one nature of the Navy’s assignment process. Two-sided matching is specifically designed to address the assignment problem, but not retention. Two-sided matching with money addresses retention and assignment. It is the alternative that best fits the Navy’s preferences for an enlisted detailing marketplace.
The report entitled “Design of an Enlisted Assignment and Retention Marketplace” was prepared for BUPERS 34-B and funded by the Naval Postgraduate School, Naval Research Program (PE 0605853N/2098).

Further distribution of all or part of this report is authorized.

This report was prepared by:

William R. Gates
Professor Emeritus

Reviewed by:

Raymond D. Jones, Chair
Department of Defense Management

Released by:

Kevin B. Smith
Vice Provost for Research
ABSTRACT

The Navy’s current enlisted distribution and career management originated with a conscripted force preparing for a Major Theatre cold war. Although it has been over 40 years since the volunteer force was implemented the policies and processes have lagged significantly. The Navy faces a significantly different demographic and a stronger economy, so the incentives to enlist and reenlist must evolve.

The Navy needs a market-based retention and assignment process capable of meeting the Navy’s job, career, and quality needs, while meeting the sailors’ individual desires, preferences, and aspirations. The traditional reenlistment and assignment processes address both retention and assignment, but they face significant risk for under- or over-estimating the retention incentive needed to meet end-strength goals, are inflexible, do not reward performance, and they include at least some less than voluntary assignments.

Focusing on the enlisted Aerographer’s Mate (AG) community, this research proposes five alternatives to introduce market-based mechanisms into the enlisted detailing process, specifically three alternative auction designs, two-sided matching, and two-sided matching with money. A basic auction offers better precision in setting retention and assignment incentives at the minimum level necessary to achieve the desired outcome. Basic auctions can incorporate adjustments for past or projected sailor performance or to include individualized non-monetary incentives to further improve performance. However, they do not specifically address the one-to-one nature of the Navy’s assignment process. Two-sided matching is specifically designed to address the assignment problem, but not retention. Two-sided matching with money addresses retention and assignment. It is the alternative that best fits the Navy’s preferences for an enlisted detailing marketplace.

Keywords: enlisted detailing, enlisted assignment, enlisted retention, market-based assignment
DESIGN OF AN ENLISTED ASSIGNMENT AND RETENTION MARKETPLACE

EXECUTIVE SUMMARY

The Navy’s current enlisted assignment and career management system is a combination of voluntary and involuntary elements. The assignment process often requires sailors to involuntarily accept orders, as the Navy matches a diverse set of Navy billets, differing in difficulty and attractiveness, with a variety of sailor preferences, backgrounds, and abilities. Reenlistment incentives are traditionally based on econometric models, rules-of-thumb, or other approaches intended to predict the bonus necessary to retain the right number of sailors by rank and career field, with few, if any, incentives that emphasize sailor quality. Furthermore, retention incentives lack the flexibility and responsiveness needed to address the constantly changing economic and national security environments.

The Navy needs a market-based retention and assignment process that can meet the Navy’s job, career, and quality needs, while also meeting the sailors’ individual desires, preferences, and aspirations. A more market-based process would have several key features:

- **Buyer/seller negotiation** – more opportunities for sailors and commands to directly or indirectly work out terms and conditions for jobs and enlistment contracts
- **Multiple/flexible options** – a greatly expanded set of options and opportunities available to sailors and commands
- **Changing prices and incentives** – commands and sailors can negotiate a wide range of monetary and non-monetary incentives as part of the assignment “package” to ensure the most qualified sailors fill all jobs
- **Voluntary choice** – probably the key element of a marketplace, brought about by the flexible incentives, options, and negotiation between sailors and commands

This research describes the current enlisted detailing process, the prospects for aligning service members’ End of Active Obligated Duty and their Planned Rotation Date and propose alternative courses of action (COAs) to introduce more market-based mechanisms into the enlisted assignment and retention processes. We specifically examine auctions and two-sided matching. The analysis identifies potential monetary and non-monetary incentives and approaches to allocating those incentives.

Considering the important influence that retention/assignment incentives exert on Navy talent-management objectives, it is essential to develop criteria to compare alternative courses of action (COAs). This analysis assesses alternative COAs against six performance metrics, originally developed by Coughlan and Gates (2010).
• Precision: assignment/retention incentives should accurately meet the intended talent-management objectives, including overall end-strength and distribution across specific assignments.

• Voluntary: assignment/retention incentives should be structured such that each service member willingly accepts the proposed assignment and perceives that compensation for the assignment is both satisfactory and fair.

• Flexible and Responsive: assignment/retention incentives should be flexible enough to adjust resources quickly and effectively in response to emerging issues, shifting priorities, and changing market conditions.

• Best Value: assignment/retention incentives should provide cost-effective solutions to address specific Navy needs while minimizing cost. Best value involves identifying the minimum cost incentive packages and target those qualified service members most willing to serve in the proposed assignment.

• Support Achievement: assignment/retention incentives should successfully compete for talent, reward performance, and recognize sailors’ contributions to the Navy’s mission.

• Practicality: practicality in retention and assignment programs addresses the ease of implementation for the Navy and ease of service member participation.

It is important to note that retention and assignment have traditionally involved two separate processes. Retention seeks to maintain the right number and quality of sailors by rank and occupation. The assignment process involves pairing sailors with billets or assignments in a “one-to-one matching” problem. Each sailor can match with at most one billet and vice versa. This makes assignment more complex than simple retention issues. As a result, comparisons of market-based COAs must evaluate their ability to address both retention and assignment issues.

This research examined six COAs. They are briefly described below.

• COA 1 – The current reenlistment and assignment programs.

• COA 2 – A basic auction design, modeled here as a uniform price, sealed bid, reverse auction with a single unit supply. Sailors would bid over the retention incentive required for them to supply their labor to the Navy, with the lowest bidders retained and paid the bonus requested by the first excluded bidder.

• COA 3 – A quality-adjusted discount (QUAD) action design, where “quality discounts” are given to the bids from high-performing sailors, effectively making them more likely to be retained in the auction. The discount is then added back to their retention incentive if they are retained, giving them a quality premium over the other retained sailors.

• COA 4 – A combinatorial auction where sailors can include both monetary and individualized packages of non-monetary incentives (NMIs) in their required retention incentive bids. In this auction design, sailors have an incentive to include
NMIs in their bids if the value they receive from them exceeds the Navy’s cost to provide them, reducing the Navy’s retention costs.

- **COA 5** – A basic two-sided matching process where sailors submit a rank-order preference list over the billets they are willing to accept, and commands submit similar rank-order lists over the sailors they prefer. An algorithm makes assignments based on these lists. The algorithm ensures the resulting assignments are stable; no participant is matched to an unacceptable partner and no two participants that are not matched would both prefer to be matched to one another than their partner identified through the process.

- **COA 6** – A two-sided matching with money process where sailors submit “bids” reflecting the minimum bonus required for any billet they would willingly fill, and the Navy (command) submits “offers” to qualified sailors reflecting the maximum bonus they would pay each sailor to fill each billet. An algorithm again makes assignments based on the sailors’ and Navy’s bids and offers, and the resulting assignments are stable.

The traditional retention and assignment processes face significant risk for under- or over-estimating the retention incentive needed to meet end-strength goals, is inflexible, and does not reward performance; the traditional assignment process includes at least some less than voluntary assignments. These concerns have generated interest in alternative market-based mechanisms including alternative auction designs and two-sided matching mechanisms.

A basic auction approach offers better precision in setting retention and assignment incentives at the exact minimum level necessary to achieve the desired outcome. This would allow these programs to be much more flexible and responsive to military needs at a significantly reduced cost. More sophisticated auction formats, customized to meet specific objectives (e.g., recognize performance or incorporate NMIs) offer the potential for even stronger performance improvement. While sophisticated auction formats add complexity, they also offer the potential for significantly greater cost savings and the ability to create incentives that efficiently and effectively support achievement and reward service member performance. (See also Coughlan & Gates, 2010).

One unaddressed auction-related issue is how sailors will respond if they have multiple opportunities to participate in an auction during the assignment process. If sailors are bidding on specific billets, a further concern recognizes that a sailor might be the low bidder for several billets in the auction COAs and the resulting assignments would depend on the rules the Navy adopts to resolve this issue (e.g., minimize auction payments, minimize overall retention and assignment costs, maximize some measure of either sailor or Navy value, or some combination of these factors). We have not explored the impact that different allocation rules might have on the sailor’s bidding strategies.

Two-sided matching can be modified to an enlisted detailing marketplace. It has the advantage of directly addressing the one-to-one matching problem that is not well addressed by an auction. However, it does not incorporate retention incentives or provide incentives for sailors to voluntarily accept hard-to-fill billets, which auctions can address. Further, as with auctions, we have not explored how sailors will respond if there are
multiple assignment windows. Will they submit short lists with just highly preferred assignments early in the assignment window, expanding their lists as they approach the end of their assignment window?

Two-sided matching has two related shortcomings; it does not provide retention incentives, as in an auction, and it does not reflect strength of preferences, but simply rank order preferences. Two-sided matching with money resolves these issues.

It is likely overly ambitious to move to such complicated COAs in the Navy’s first iteration of the enlisted detailing marketplace, though the Navy may want to consider these more complicated COAs as the enlisted detailing marketplace matures.

Each of the six COAs described above was informally graded for each of the six performance metrics, and each was discussed in terms of its ability to address the retention and assignment aspects of the enlisted detailing market place. These results are summarized in Table E1.

<table>
<thead>
<tr>
<th>COA</th>
<th>Traditional Retention &amp; Assignment</th>
<th>Precision</th>
<th>Voluntary</th>
<th>Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
<th>Retention</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA 1</td>
<td>Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>COA 2</td>
<td>Basic Auction</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Medium-High</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COA 3</td>
<td>QUAD Auction</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COA 4</td>
<td>CRAM Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium-High</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COA 5</td>
<td>Two-Sided Matching</td>
<td>Medium</td>
<td>High</td>
<td>Medium-Low</td>
<td>Medium</td>
<td>Medium-High</td>
<td>Medium</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>COA 6</td>
<td>Two-Sided Matching with Money</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

As expected, the traditional reenlistment and assignment processes address both retention and assignment, and are practical, reflecting that both the Navy and sailors are comfortable with how these processes currently work. However, they are less effective for precision (primarily retention incentives), voluntary (primarily the assignment process), flexible and responsive, best value, and support achievement.

Auctions are best suited to address retention issues and the basic auction preforms particularly well across the precision and flexibility and responsive metrics. The basic auction can be modified to incorporate adjustments for past or predicted future sailor performance (QUAD), individualized NMI packages (CRAM), or both. While leading to more complicated auction designs, these modifications would improve best value and support achievement. However, auctions cannot effectively address the one-to-one assignment process required in the enlisted detailing marketplace. Any particular sailor
might be the low bidder for several billets in the auction COAs and the resulting assignments would depend on the rules the Navy adopts to resolve this issue.

Two-sided matching is specifically designed to address the assignment problem and incorporates the Navy’s rank-order preferences over sailors and sailors’ rank-order preferences over billets. As such, it is voluntary and supports achievement. However, two-sided matching does not address retention. Further, it does not ensure that all billets will be filled, particularly hard-to-fill priority billets, or that all qualified sailors will receive an assignment. Finally, it is slightly less practical because it requires the Navy to express rank-order preferences over individual sailors or classes of sailors, possibly through a multi-attribute utility function.

Two-sided matching with money addresses the retention and priority billet issues by associating values to the Navy for filling particular billets with particular sailors, or classes of sailors. Navy values are integrated with sailor willingness to fill specific billets creating a market-based process that provides the best performance of all COAs across the six performance metrics while also addressing both retention and assignment concerns. Clearly, two-sided matching with money is the COA that best fits the Navy’s preferences for an enlisted detailing marketplace.

Finally, the Navy could combine COAs. For example, combining a quality adjusted auction with a combinatorial NMI auction (COAs 3 and 4) would create a combinatorial NMI auction with quality adjustment. This combination would increase the best value performance metric for the quality adjusted auction (COA 3) and increase the support achievement metric for the combinatorial NMI auction (COA 4). However, it would make the auction more complicated to implement and explain to enlisted sailors, reducing practicality.

Similarly, NMIs from COA 4 could be combined with two-sided matching with money (COA 6). This would increase the best value metric for two-sided matching with money by allowing sailors to substitute NMIs for some of their monetary incentive when the cost of the NMI is less than the reduction in the monetary incentive. However, it would again make the mechanism more complicated to implement and explain to enlisted sailors, reducing practicality.

REFERENCE

TABLE OF CONTENTS

EXECUTIVE SUMMARY ................................................................. vii
I. INTRODUCTION ...................................................................................1
   A. RESEARCH TASKS ................................................................. 1
   B. ASSUMPTIONS AND LIMITATIONS ................................... 2
II. BACKGROUND .......................................................................................... 3
   A. CURRENT MANDATE .......................................................... 3
   B. COMMUNITY MANAGEMENT .............................................. 4
   C. ENLISTED DISTRIBUTION AND VERIFICATION PROCESS ... 5
III. NAVY DISTRIBUTION PROCESS .......................................................... 7
   A. THE DISTRIBUTION TRIAD .................................................. 7
      1. Allocation ............................................................................... 7
      2. Manning Control .................................................................... 7
      3. Assignment ............................................................................. 8
   B. PROJECTED ROTATION DATE (PRD) ........................................... 8
      1. PRD Guidelines ....................................................................... 8
      2. Time on Station (TOS) ......................................................... 9
   C. EXPERATION OF ACTIVE OBLIGATED SERVICE (EAOS) ....... 10
   D. KNOWLEDGE MANAGEMENT AND INFORMATION PROCESS .. 10
      1. Funded Manpower Requirements ........................................ 10
      2. Navy Enlisted System (NES)/Enlisted Master File (EMF) ....... 10
      3. Enlisted Distribution Projection System (EDPROG) .............. 11
      4. Enlisted Personnel Requisition System (EPRES) ................. 11
      5. Enlisted Assignment Information System (EAIS)/Navy Single
         Integrated Personnel System (NSIPS) ..................................... 11
      6. Requisition (REQ) Listing/Career Management System-Interactive
         Detailing (CMS-ID) Process ..................................................... 11
      7. Rating Detailer .......................................................................... 12
      8. Orders Posting Module (OPM) ............................................... 12
      9. Orders ..................................................................................... 12
   E. CHAPTER SUMMARY ............................................................... 12
IV. ANALYSIS ............................................................................................... 13
   A. AEROGRAPHER MATE OCCUPATIONAL STANDARDS ......... 13
   B. AG COMMUNITY MANAGER ................................................... 14
      1. Community Management ..................................................... 14
   C. KEY ELEMENTS ........................................................................ 14
   D. ADDRESSING THE PROBLEM ............................................... 16
   E. OCCUPATIONALLY BASED STANDARDS FOR AG RATING ....... 17
   F. CHAPTER SUMMARY ............................................................... 18
V. MARKETPLACE COURSES OF ACTION WITHIN THE NAVY’S
   ASSIGNMENT SYSTEM ....................................................................... 19
   A. A MARKETPLACE FOR ENLISTED SAILOR RETENTION AND
      ASSIGNMENT ............................................................................. 20
LIST OF FIGURES

Figure 1. Enlisted Distribution Process ................................................................. 10
Figure 2. AG Community Management Model .................................................... 14
Figure 3. Priority of Key Elements .................................................................. 15
Figure 4. Key Elements in Process ................................................................... 16
Figure 5. AG Career Progression ...................................................................... 18
Figure 6. Varieties of Transaction Mechanisms ................................................ 20
Figure 7. NMI Cost vs. Value .......................................................................... 50
Figure 8. Non-monetary Incentives Portfolio ..................................................... 51
Figure 9. CRAM Overcomes Universal Package Weakness ............................... 53
LIST OF TABLES

Table E1.  Traditional, Auction-Based & Matching Retention & Assignment Programs  x  
Table 1.  Criteria for Preferred Reenlistment ................................................................. 17 
Table 2.  Effectiveness of Traditional Assignment and Retention Mechanism .......... 24 
Table 3.  Auction Design Characteristics ................................................................. 25 
Table 4.  Effectiveness of Traditional and Auction-Based Mechanisms ................. 34 
Table 5.  Effectiveness of Traditional, Auction-Based, and Matching Mechanisms ..... 42 
Table 6.  Effectiveness of Traditional, Auction-Based, Matching, and Matching with Money Mechanisms ................................................................. 44 
Table 7.  Comparative Effectiveness of Six Courses of Action .............................. 60
**LIST OF ACRONYMS AND ABBREVIATIONS**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG</td>
<td>Aerographer</td>
</tr>
<tr>
<td>AIP</td>
<td>Assignment Incentive Pay</td>
</tr>
<tr>
<td>AVAILs</td>
<td>Availability Report</td>
</tr>
<tr>
<td>B/A</td>
<td>Billets Authorized</td>
</tr>
<tr>
<td>CMS-ID</td>
<td>Career Management System-Interactive Detailing</td>
</tr>
<tr>
<td>CNO</td>
<td>Chief of Naval Operations</td>
</tr>
<tr>
<td>COA</td>
<td>Course of Action</td>
</tr>
<tr>
<td>CONUS</td>
<td>Continental United States</td>
</tr>
<tr>
<td>CRAM</td>
<td>Combinatorial Retention Auction Mechanism</td>
</tr>
<tr>
<td>DOD</td>
<td>Department of Defense</td>
</tr>
<tr>
<td>EAOS</td>
<td>Expiration of Active Obligated Service</td>
</tr>
<tr>
<td>EDVP</td>
<td>Enlisted Distribution Verification Process</td>
</tr>
<tr>
<td>FPSB</td>
<td>First-Price Sealed Bid Auction</td>
</tr>
<tr>
<td>MCA</td>
<td>Manning Control Authority</td>
</tr>
<tr>
<td>NPC</td>
<td>Naval Personnel Command</td>
</tr>
<tr>
<td>NEC</td>
<td>Navy Enlisted Classification</td>
</tr>
<tr>
<td>NMI</td>
<td>Nonmonetary Incentive</td>
</tr>
<tr>
<td>PRD</td>
<td>Projected Rotation Date</td>
</tr>
<tr>
<td>QRMC</td>
<td>Quadrennial Review of Military Compensation</td>
</tr>
<tr>
<td>QUAD</td>
<td>Quality-adjusted Discount Auction</td>
</tr>
<tr>
<td>SPSB</td>
<td>Second-Price Sealed Bid Auction</td>
</tr>
<tr>
<td>SWO</td>
<td>Surface Warfare Officers</td>
</tr>
<tr>
<td>TOS</td>
<td>Time On Station</td>
</tr>
<tr>
<td>UIC</td>
<td>Unit Identification Code</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

The Navy’s current enlisted assignment and career management system is a combination of conscription and voluntary processes, technology and policy.\(^1\) To make a major course change in how the assignment and placement process operates, the Navy is forward leaning by researching the notion of a new process titled “Enlisted Assignment and Retention Marketplace.” The marketplace process needs to meet the Navy’s manpower requirements and career needs while also meeting the desires, preferences, and aspirations of individual sailors. Some central planning and controls will be required to balance Navy jobs and a sailor’s career needs, but the desire is to match sailors to jobs through as much decentralized negotiation and communication as possible, similar to the processes at work in a private sector marketplace. Extensive past research has analyzed the enlisted assignment process within the Navy, across other services, and in the private sector. This research updates that work and provides courses of action (COAs) for a market-based assignment and retention process.

A. RESEARCH TASKS

This research identifies factors that determine assignment and placement by the United States Navy. The goal is to identify processes to improve the assignment and retention of enlisted personnel to support total force management while maintaining the Navy’s maritime superiority. Specific tasks include:

- Review and analyze the current enlisted assignment system
- Identify systems that capture the marketplace concept within the Navy’s manpower system
- Develop alternative COAs that introduce market-based mechanisms into enlisted assignment and retention processes
- Compare and contrast the COAs and provide recommendations

---

\(^1\) The material in this section was originally developed for an early draft of this report. It was later used as the basis for a separate report. See Hatch, W. (2023).
B. ASSUMPTIONS AND LIMITATIONS

The research focuses on sailors and assignment officers making decisions on second terms of enlistment, or greater. Specifically, paygrades E-5 to E-7. Therefore, it will not cover sailors leaving boot camp and in route to first tour or rate training. It examines second tour and beyond sailors.

The research will be analyzed through the lens of the Aerographer (AG) rating. The AG rating has an average rating inventory of 1035 enlisted personnel with a sea/shore rotation pattern of 36 months ashore and 36 months at sea. It includes an inventory of 900 distributable sailors and 135 non-distributable sailors in the individuals account.
II. BACKGROUND

A. CURRENT MANDATE²

The Navy has mandated that all sailors’ expiration of active obligated service (EAOS) and projected rotation date (PRD) match (Military.com, 2018). According to CAPT Vincent Segars, director, military Community Management, “There are currently more than 61,000 sailors whose EAOS is prior to their duty station tour length…. This misalignment causes unexpected gaps in manning, creating a demand signal for personnel replacement, that may be unnecessary if the sailor intends to obligate service” (Chief of Naval Personnel [CNP] Public Affairs, 1997, see also Chief of Naval Operations [CNO], 2017).

While retention is a voluntary decision, the options sailors have available are generally few and the reenlistment process is currently decoupled from the assignment process. The assignment process often requires sailors to involuntarily accept orders, as the Navy matches a diverse set of Navy billets, differing in difficulty and attractiveness, with a variety of sailor preferences, backgrounds, and abilities.

These elements are further influenced by the economic environment. It is increasingly difficult to entice young men and women to join the Navy when economic conditions are good. Similarly, it is difficult to maintain or improve retention in critical jobs once sailors meet their EAOS in a full employment economy.

To address Navy needs, the current assignment and retention process is strongly directed by Navy community managers and detailers using few of the incentives that might be found in a “marketplace” environment. The process should provide greater flexibility, negotiation, and voluntary choice. If the Navy were to simply adhere to sailor preferences, many important Navy jobs might go unfilled and sailor experience, skills, and standard career paths, would likely be misaligned. A market process capable of meeting Navy job requirements and career needs while also meeting the desires, preferences, and aspirations of individual sailors should be examined.

---

² The material in this section was originally developed for an early draft of this report. It was later used as the basis for a separate report. See Hatch, W. (2023).
The goal of a new process would be to match sailors to jobs through a more decentralized negotiation and communication medium similar to the processes at work in a private sector marketplace.

B. COMMUNITY MANAGEMENT

The Community Manager is “responsible for ‘cradle-to-grave’ monitoring and management of the health and welfare of our respective communities. We ensure that our cognizant ratings recruit and maintain required manpower, and that the manpower is correctly distributed throughout the enlisted paygrades as required by valid billets” (Navy Personnel Command [NPC], n.d.c.). As specified by the Navy Personnel Command (NPS, n.d.c.) the community managers’ duties include:

- Enlisted Women in Submarines
- High Year Tenure (HYT) Help Desk
- Develop recruiting requirements
- Establish A and C school requirements
- Work with warfare sponsors to ensure valid, executable billet requirements
- Set advancement quotas
- Set Career Waypoints-Reenlistment, PACT Designation, Active Conversion, Reserve Conversion or Transition between Components quotas
- Establish and monitor sea/shore flow. Establish and monitor career development
- Set Selective Reenlistment Bonus (SRB), Special Duty Assignment Pay (SDAP) and Enlistment Bonus (EB) levels
- Ensure rating Occupational Standards (OCCSTDS) are valid and current
- Ensure Navy Enlisted Classification Code (NEC) system is effective in training and detailing people to fill special skill billets
- Review Navy Training Plans (NTPs) and Manning documents for new or modernized systems to assess their impact on the enlisted structure, training pipeline and manpower distribution
- Analyze impact of proposed policy changes on a community
C. ENLISTED DISTRIBUTION AND VERIFICATION PROCESS

The Enlisted Distribution and Verification Process (EDVP) is directed by Bureau of Naval Personnel Instruction 1080.54, which defines procedures for the enlisted distribution and verification process (Department of the Navy [DON], 2023). This process is a recent change from the earlier Enlisted Distribution Verification Report. The EDVP is managed by commands in conjunction with the Navy Personnel Command (NPC). Sailors will be aligned to billets in the following order:

- Aligned based on the billet and sailor’s paygrade. If there are multiple sailors, the sailor with the longest time before their PRD is aligned first
- Aligned based on the billet pay band and the sailor’s pay band (supervisor, journeyman, and apprentice)
- If no billets are available within the pay band, sailors are then aligned to billets with lower pay bands
- If there are no lower pay band billets available, the sailor is aligned to excess (DON, 2023)
III. NAVY DISTRIBUTION PROCESS

A. THE DISTRIBUTION TRIAD

The distribution process has three components: Allocation, Manning Control, and Assignment (Hatch, 2023).³

1. Allocation

Allocation determines the share of the distributable inventory allocated across the four manning control authorities (MCAs): Atlantic and Pacific Fleets (both managed by Fleet Forces Command), Bureau of Naval Personnel, and the Reserve Forces. Allocation control occurs within the NPC and initially distributes billets by Chief of Naval Operations (CNO) priority to each of the four MCAs. Only the CNO can authorize priority 1 and 2 Manning designations. Priority 1 and 2 designations include:

Priority 1. Strategic assets to include activities that require focused manning to ensure commander’s mission attainment in support of national interest as outlined in the Navy Strategic Plan. Priority 1 designation must be limited to that portion of an activity absolutely critical to mission success.…

Priority 2. Essential assets to include activities that require additional manning attention for a set period of time to sustain specific ROC [Required Operational Capabilities] and POE [Projected Operational Environment], or MFT [Mission, Functions, and Tasks] responsibilities in support of CNO guidance. Priority 2 designation must be limited to that portion of an activity absolutely essential to the mission sustainment. (Chief of Naval Operations [CNO], 2019, pp. 8.11 – 8.12)

2. Manning Control

Manning control includes “manning” (quantity/quality/priority) and “placement” (communicating vacancies to the assignment control authorities within the NPC Enlisted Distribution Division, PERS-40). Each MCA bases requisition priorities on different criteria, including CNO priority 1 and 2 (the first requisitions to be filled), take-up month (current month through projected five months in the future), and employment.

³ The material in this section was originally developed for an early draft of this report. It was later used as the basis for a separate report. See Hatch, W. (2023).
Navy Personnel Command, Distribution Management, Personnel Allocations and Statistics (PERS-452) is the command advocate by Unit Identification Code (UIC) and the MCAs agent in the placement process. A UIC is a unique alpha-numeric code that identifies each activity across the Navy and Department of Defense (DOD). PERS-452 is the UIC’s advocate for validating enlisted personnel gains supporting readiness and identifying personnel inventory to be assigned by UIC. It is managed by four criteria:

- Monitor deployment readiness by UIC
- Process Enlisted Manning Inquiry Reports and Personnel Manning Assistance Reports submitted by the fleet to enhance the enlisted personnel readiness of deploying surface and aviation units and to keep the operational and administrative commanders advised of manning shortfalls and actions to resolve them.
- Manage the Career Management System-Interactive Detailing (CMS-ID), which advertises the available jobs (requisitions or billets) and assignment possibilities to enlisted sailors and is the foundation for billet based detailing and provide guidance and support the command’s EDVP.
- Work with commands to ensure NPC receives the most accurate enlisted demand signal possible

(Navy Personnel Command [NPC], n.d.b.)

3. Assignment

Enlisted rating detailers are charged with equitably distributing sailors to commands based on billets authorized (B/A) and the Navy Manning Plan via the CMS-ID. Detailers serve as advocates for a sailor’s best interests as determined by needs of the Navy, required career milestones, and personal preferences.

B. PROJECTED ROTATION DATE (PRD)

1. PRD Guidelines

According to the Naval Personnel Command MILPERSMAN 1306–104, CH-48 (Navy Personnel Command [NPC], 2014):

PRD determinations are based upon the following guidelines:

a. Distribution rates and Navy enlisted classification;

b. Spouse co-location tours, which are typically aligned with the member going to sea duty;
c. DoD area tours;

d. PRD is determined without regard to obligated service (OBLISERV), except for overseas tours;

e. PRDs will be established to reflect an accompanied tour for members with primary family members, or the all others tour for members who elect an unaccompanied tour;

f. PRDs are established as follows:

   (1) Continental United States (CONUS) - Month member reports to new duty station.

   (2) Outside continental United States - Month member departs CONUS.

   (3) Sea Duty (Type 2) - Based on full prescribed sea tour (PST) and sea shore flow enlisted career path outlined in reference (a).

g. For first-term members, see MILPERSMAN 1306-126.

2. Time on Station (TOS)

   TOS is similar to, but not the same as PRD. According to the Navy Personnel Command MILPERSMAN 1306-106, CH-67 (NPC, 2019):

   TOS is the period of time established for tours in specific geographic locations in the continental United States (CONUS), overseas, or at sea before executing a PCS transfer.

   a. TOS requirements are established to enhance operational readiness by stabilizing Service members in units in order to help reduce PCS costs and improve the quality of life by reducing personal or family turbulence….

   c. The TOS requirement for all assignments within CONUS is 36 months. The TOS requirement for overseas assignments is the applicable (unaccompanied or accompanied) Department of Defense (DoD) area tour for overseas locations…. TOS may be satisfied by one or more tours at the same permanent duty station or those in close proximity to each other.

   If two sailors in CONUS meet the assignment requirements, the sailor with the longest TOS will be considered for reassignment. (Department of Defense [DOD], 2019) (See also Chief of Naval Operations [CNO], 2018)
C. EXPIRATION OF ACTIVE OBLIGATED SERVICE (EAOS)

EAOS is “The date a Navy member completes the military service required by an enlistment contract, referred to as expiration of term of service by DoD” (CNO, 2018).

D. KNOWLEDGE MANAGEMENT AND INFORMATION PROCESS

The processes are identified one through nine and shown in Figure 1.

![Figure 1. Enlisted Distribution Process](image)

1. **Funded Manpower Requirements**

   Funded Manpower Requirements are the Navy’s foundation for developing an occupationally based personnel inventory. There are three components to funded manpower requirements, commonly called Billets Authorized (B/A):
   - A qualitative validated occupationally based workload (i.e., requirement by paygrade and rating)
   - Military Personnel Navy applied to the requirement
   - Congressionally approved end-strength applied to the requirement

2. **Navy Enlisted System (NES)/Enlisted Master File (EMF)**

   The Navy Enlisted System also known as the Enlisted Master File is the anthropolinguistic history or knowledge management repository of a service member’s recorded administrative history from entering to departing the Navy.
3. **Enlisted Distribution Projection System (EDPROG)**

The Navy’s Distribution Management (PERS-45) uses the Enlisted Distribution Projection System to generate allocation guidance. This system measures current strength versus current billets and projected strength versus billets. The results are passed to enlisted placement management within the Enlisted Distribution Division.

4. **Enlisted Personnel Requisition System (EPRES)**

There is a projected shortage if an activity’s projected manning in a particular rating and pay grade is less than authorized, and a requisition will be generated within the Enlisted Personnel Requisition System. Detailers pass the requisition information to the Requisition Posting Module within the Enlistment Assignment Information System.

5. **Enlisted Assignment Information System (EAIS)/Navy Single Integrated Personnel System (NSIPS)**

Navy commands and specific departments within the NPC must promptly and accurately submit availability reports, referred to as AVAILs. These reports represent personnel who are available for assignment or reassignment and are submitted using the Navy Standard Integrated Processing System. There are two types of availability reports:

- **Immediate**: Immediate. Used for Service members who are immediately available for transfer, including type duty disqualifications, assignment to or release from a humanitarian tour, school non-graduates, short-fused graduates, former officers, rating conversions, component changes, and brig or disciplinary assignment and releases. Immediate AVAIL report is also used for reassignment of pregnant Service members and Service members in a medical release status, including those going to or from limited duty (LIMDU) or physical evaluation board (PEB) status.

- **Non-immediate**: Used for Service members who will be available in the future for applicable reasons to include planned deactivation, decommissioning, change of homeport, and school graduates with a graduation date more than 21 days in the future. (NPC, 2018)


The Requisition Listing/Career Management System-Interactive Detailing is designed and used by sailors, command career counselors, and command personnel. The
Web-based system allows sailors to view available jobs and make their own applications or apply through their command career counselor (Department of the Navy [DON], 2016). CMS-ID billet-based detailing has an automatic alignment process which will align sailors to billets based on several factors:

- Rating
- Paygrade
- All NECs

An initial baseline of alignments is coordinated with the command activity manning manager (DON, 2016).

7. **Rating Detailer**

Enlisted detailers are charged with equitably distributing sailors to commands based on B/A and the Navy Manning Plan via the CMS-ID (Navy Personnel Command [NPC], n.d.a.). This ensures that detailers only send sailors to valid B/As.

8. **Orders Posting Module (OPM)**

Once all the decisions and considerations are made the detailer uses the Orders Posting Module within Enlisted Assignment Information System to issue the orders.

9. **Orders**

Orders identify the Billet Sequence Code which is the demand or space being filled in the new command. They also identify the PRD and EAOS. On an as required basis, orders authorize a change of station move and attend in route schools as necessary to fill the next duty assignment.

E. **CHAPTER SUMMARY**

This chapter identified the status quo priorities as set by Navy policy. Essentially the placement and assignment officers are advocates for commands and sailors, respectfully. The portion of the process that creates “Fit” and quality of life is the negotiation between Requisition Listing, CMS-ID and the Rating detailer.
IV. ANALYSIS

A. AEROGRAPHER MATE OCCUPATIONAL STANDARDS

The Aerographer (AG) rating was chosen to model the marketplace. The rating has an inventory of about 1050 sailors with a sea-shore rotation pattern of 36 months ashore and 36 months at-sea. The stability of these factors establishes a good base case to examine enlisted assignment and retention marketplace policy.

Aerographer’s Mates (AG) collect, measure, and analyze the elements of the physical environment (Land/Sea/Air/Space) and land/sea interface; synthesize a vast array of oceanographic, hydrographic, celestial, and meteorological data and in situ observations and measurements to produce forecasts and warnings in support of safety of flight, navigation, and naval/joint operations and missions; demonstrate expertise in METOC equipment and systems, Geospatial Information and Services (GIS), and tactical decision aids; combine knowledge of the operating environment with a thorough understanding of warfighting capabilities to assess and predict environmental impacts to friendly and enemy platforms, sensors, and weapon systems; develop actionable recommendations regarding tactics, techniques, and procedures that fully exploit environmental parameters, mitigate risk, and enable decision superiority across all warfighting areas and strategic and enabling capabilities; operate unmanned systems, small boats and expeditionary survey vehicles to collect meteorological, hydrographic and oceanographic data; and distribute data internally and externally to platforms and operational activities via communication devices, web-centric architecture, or on-scene in direct support of afloat units, fleet/joint staffs, or combatant/operational commanders. (Navy Personnel Command [NPC], January 2023, pp. AG-3)

The community has one direct NEC code. The Navy Personnel Command recently created a new NEC numbering system. The legacy NEC was 7412 and the new NEC is J00A Meteorological and Oceanographic Forecaster (see Appendices A and B; Navy Personnel Command [NPC], July 2023).

---

4 The material in this section was originally developed for an early draft of this report. It was later used as the basis for a separate report. See Hatch, W. (2023).
B. AG COMMUNITY MANAGER

1. Community Management

It is incumbent on the community manager, in conjunction with the rating detailer, to ensure B/A are sufficient to maintain a healthy sea-shore rotation and meet the AG community’s current and projected career management needs. The AG community has approximately 1035 B/A spread across sea duty, shore duty, and the individuals account. The individuals account consists of students and trainees, transients (changing stations), and patients, prisoners and holdees (personnel unavailable for medical or discipline reasons, or impending separation). This B/A supports a 36-month sea duty rotation, a 36-month shore duty rotation, plus approximately 15 percent in the individuals account (see Figure 2). The AG community manager is responsible for all three B/A categories.

![AG Community Management Model](image)

Figure 2. AG Community Management Model

C. KEY ELEMENTS

The analysis portion of the research identifies, but is not limited to, three key assignment priorities. These considerations directly support moving to a marketplace assignment model. These include Navy needs, sailors’ career needs, and sailors’ personnel preferences, in order of priority, as depicted in Figure 3 and replicated below.
Needs of the Navy

This is the primary consideration in each Sailor’s assignment and is taken into consideration prior to all other factors. These needs are met by filling a valid billet requirement with the best Sailor available. Billets advertised on MNA [MyNavy Assignment] are loaded as needs of the Navy assignments via the cognizant Manning Control Authority (MCA). There are two MCA’s (MCA-F) which controls most operation/deployable billets and (MCA-B) which controls most shore/training billets. Advertised billets on MNA are screened by the placement coordinator (who represents the command) and published in MNA for the detailer to fill.

Career Needs of the Individual

Detailers are mindful of selections in MNA to ensure each applicant’s career experience is taken into consideration. These different decision points include re-utilizing NEC’s, weighing different types to duty stations (developing a broad based Sailor), as well as choosing the right Sailor based on evaluation recommendations. Selecting Sailors using this criterion helps to develop Sailors who are capable of performing in key operational and non-operational environments.

Desires of the Individual

While every detailer strives to select Sailors for their number one preference in MNA, the needs of the Navy and desires of the Sailor don’t always align. The desires of the individual, although listed third, are extremely important. In this area, the morale of the Sailor and, in many instances, the family, are affected. (NPC, n.d.a.; see also Cheeseman, 2019)
D. ADDRESSING THE PROBLEM

Detailers fill assignment requirements in essentially the same manner as during conscription. Individual assignments are based primarily on the professional military qualifications required to productively perform the billet’s duties (CNO, 2018). The assignment and placement processes and culture may not be consistent with today’s volunteer force.

Sailors, command career counselors, and command personnel rely on requisition listing and CMS-ID in the assignment process. The web-based system allows sailors to view available jobs and submit applications or apply through their command career counselor shown in Figure 4.

![Diagram of assignment process]

Figure 4. Key Elements in Process

The term of enlistment or reenlistment in the active component (AC) includes terms lasting 2, 3, 4, 5, 6, or 8, years. Enlisted members are not allowed to reenlist for a period that expires before the end of their current enlistment. The flexibility in reenlistment terms should allow the Navy to align the sailors’ EAOS and PRD, supporting an enlisted assignment and retention marketplace. Specific criteria for sailors E-5 and above to reenlist are shown in Table 1.
Table 1. Criteria for Preferred Reenlistment. Adapted from NPC (2022)

<table>
<thead>
<tr>
<th>Reenlistment Point</th>
<th>Pay grades</th>
<th>Qualifying Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 8 years of service (YOS) AC/FTS personnel</td>
<td>E-3 and below</td>
<td>RE-R1 not applicable.</td>
</tr>
<tr>
<td>12 YOS RC personnel</td>
<td>E-4</td>
<td>Pass E-5 advancement exam. Have overall trait average 2.5 or above.</td>
</tr>
<tr>
<td></td>
<td>E-5 and above</td>
<td>Overall trait average of 3.0 or above. No performance mark below 2.0 in any trait.</td>
</tr>
<tr>
<td>8 to 20 YOS AC/FTS personnel</td>
<td>E-4 and below</td>
<td>RE-R1 not applicable.</td>
</tr>
<tr>
<td>12 to 20 YOS RC personnel, except FTS)</td>
<td>E-5</td>
<td>RE-R1 not applicable for AC or FTS E-5’s being separated due to HVT.</td>
</tr>
<tr>
<td>Beyond 20 YOS</td>
<td>E-6 and below</td>
<td>Overall trait average of 3.0 or above. No performance mark below 2.0 in any trait.</td>
</tr>
<tr>
<td></td>
<td>E-7 and above</td>
<td>No performance mark below 2.0 in any trait during 48 months immediately preceding reenlistment or EAOS/EOS.</td>
</tr>
</tbody>
</table>

E. OCCUPATIONALLY BASED STANDARDS FOR AG RATING

The career patterns and scope of rating found in Appendices A and B are at the core of the required Navy work for AG-rated sailors. The occupational standards for this rating (NPC, January 2023) are regularly evaluated and updated. They impact career development and promotion. The career pattern is depicted in Figure 5. Each concentric ring represents an additional body of knowledge. The body of knowledge is developed through experience and studying rate training manuals. It is confirmed through examinations that demonstrate readiness for promotion. The Navy refers to these knowledge, skills, and abilities as occupational standards, which are described in detail by the NPC (January 2023).
CHAPTER SUMMARY

This chapter identified the three key elements of the distribution process. The AG community was used as a notional community to examine key decision elements due to its CNO directed sea/shore rotation pattern of 36 months at sea followed by 36 months ashore. A sailor’s first opportunity to reenlistment is generally at the E-5 level, or above. When the AG’s sea/shore rotation pattern is modeled alongside a four-year active enlistment and four-year reserve contract, the sailor’s EAOS and PRD rarely match at the first reenlistment opportunity.

The Navy prioritizes assignment policy by means of the Military Personnel Manual using three key elements: needs of the Navy, career needs of the individual, and the sailors’ desires. Sailors’ reenlistments establish a new EAOS, which can extend for two to eight years. This decision can favor the Navy or the sailor depending on the community’s health. The Navy could align EAOS and PRD at this time to fully implement an enlisted detailing and retention marketplace.
V. MARKETPLACE COURSES OF ACTION WITHIN THE NAVY’S ASSIGNMENT SYSTEM

The Navy’s current enlisted assignment and career management system is a combination of voluntary and involuntary elements. While retention is a voluntary decision, the options available to sailors are generally few and the reenlistment process is currently decoupled from the assignment process. The assignment process often involves involuntary actions by the sailor, as the Navy attempts to match a diversity of jobs of differing difficulty and attractiveness to sailors with a variety of preferences, backgrounds, and skills. Reenlistment incentives have traditionally been predetermined, based on econometric models, rules-of-thumb, or other approaches intended to predict the exact bonus necessary to retain the right number of sailors by rank and career field, with few, if any, incentives that emphasize sailor quality. Retention incentives are publicized through military instructions and administrative messages and are relatively static once announced, lacking the flexibility and responsiveness needed to address constantly changing economic and national security environments (See also Coughlan & Gates, 1020).

To meet the Navy’s needs, the current assignment process is strongly directed by Navy detailers with few elements of a “marketplace” in which flexibility, negotiation, and voluntary choice are evident. If the Navy were to adhere more strictly to sailor preferences under the current system, many important Navy jobs would go unfilled and matching sailor experience/skills with jobs would not produce the career paths or job productivity required. Further, the current reenlistment process emphasizes quantity, not quality.

The Navy needs a market process that meets the Navy’s job, career, and quality needs, while also meeting the desires, preferences, and aspirations of individual sailors. Some central planning and controls will be required to balance sailor and Navy needs, but the desire is to match sailors to jobs through decentralized negotiation and communication similar to private sector marketplace processes.

A more market-based process would have the following key features:

- Buyer/seller negotiation – opportunities for sailors and commands to directly or indirectly work out terms and conditions for jobs and enlistment contracts
- Multiple/flexible options – a greatly expanded set of options and opportunities available to sailors and commands
- Changing prices and incentives – allow commands and sailors to negotiate a wide range of monetary and non-monetary incentives as part of the assignment “package” to ensure the most qualified sailors fill all jobs
- Voluntary choice – the key element of a marketplace, brought about by the flexible incentives, options, and negotiation between sailors and commands

This discussion will propose alternative courses of action (COAs) to introduce more market-based mechanisms into the enlisted assignment and retention processes, specifically auctions and two-sided matching. The analysis will identify potential monetary and non-monetary incentives and approaches to allocating those incentives.

A. A MARKETPLACE FOR ENLISTED SAILOR RETENTION AND ASSIGNMENT

A market involves institutions and procedures whereby buyers and sellers exchange goods and services. Markets rely on sellers offering their goods or services (including labor) in exchange for compensation from buyers (including employers). Markets allow tradeable items to be evaluated and then establish the prices of goods and services. A market may be deliberately created to enable voluntary exchanges of goods and services.

The nature of any market mechanism depends, in part, on the number of buyers versus sellers involved in the particular transaction, as depicted in Figure 6. Traditional price mechanisms typically set prices when there are many buyers and sellers. Negotiated prices are the norm when there is a single buyer and seller. Auctions or other exchange mechanisms (e.g., matching mechanisms) can be appropriate for setting prices when there is either a single seller and many buyers (forward auction) or a single buyer and several sellers (reverse auction).

![Varieties of Transaction Mechanisms](image)

Figure 6. Varieties of Transaction Mechanisms
ASSIGNMENT INCENTIVE PAY

Assignment incentive pay (AIP) offers an example of one Navy market-based program that applied auctions to the enlisted assignment process to encourage enlisted sailors to voluntarily accept hard-to-fill billets (Golding et al., 2002; Golding & Cox, 2003; Golfin et al., 2004). The U.S. Navy began offering AIP in June 2003. In this program, the Navy designated AIP eligible assignments (billets) and set a maximum monetary incentive for each billet, initially not to exceed $1,500 per month. Sailors accepting these hard-fill assignments received monthly incentive pay for the duration of their tour.

The AIP program was implemented using a modified sealed bid reverse auction format. Sailors (the sellers) interested in AIP-designated billets submit sealed bids, in $50 increments, for their chosen positions. A bid can start at $0 but can’t exceed the Navy-determined maximum incentive. After the auction closes, the Navy (the buyer) observes the bids and determines sailor assignments. The Navy selects the lowest–total-cost qualified sailor, where total cost includes the sailor’s AIP bid as well as any moving and/or training costs necessary for that particular sailor to fill the assignment. AIP significantly reduced the number of sailors receiving “involuntary” orders for hard-to-fill assignments, though such involuntary assignments were not eliminated (Coughlan & Gates, 2010).

We refer to AIP as a modified sealed bid reverse auction because the winning sailor is not selected based solely on the lowest submitted bid, which would be a traditional sealed bid reverse auction, but rather the selection is based on the sailor’s bid as well as other associated assignment costs. With this modification, sailors’ bids are likely to vary from the bidding strategies expected in a traditional reverse sealed bid auction. In particular, sailors with lower average assignment costs are likely to inflate their AIP bids relative to sailors with higher-than-average assignment costs (Nimon & Hall, 2005; Pinkston et al., 2005). Furthermore, sailors can bid on multiple jobs in an assignment auction; however, they can only win one post even if they are the low-cost qualified sailor for several posts. Thus, sailors have an incentive to overstate their required bonus to accept a particular post.

This early adoption of a market-based mechanism is informative for several reasons. It shows that the Navy is willing to implement reforms that mimic market incentives in talent-management applications. Early feedback on AIP from both sailors and commands was highly positive, demonstrating the potential value of market-based
mechanisms. At the same time, AIP demonstrates that the details of the mechanism design can affect bidding behavior. In other words, the devil is in the details and market-based mechanisms should be carefully designed and tested to avoid unwanted and unexpected behavior and results.

In addition, a sealed bid reverse auction is just one of many possible transaction mechanisms to implement an enlisted assignment and retention marketplace. There is an innumerable variety of distinct auction designs within the field of auction mechanisms. There are also a variety of matching mechanisms that have been implemented in several civilian sector applications. One must carefully select the mechanism design elements most appropriately fitting a particular talent-management application (Coughlan & Gates, 2010).

This research will compare different approaches to implementing an enlisted assignment and retention marketplace, alternative auctions and matching mechanisms, and discuss the pros and cons of the different COAs.

C. MEASURING THE PERFORMANCE OF ASSIGNMENT AND RETENTION PROGRAMS

Considering the important influence that retention/assignment incentives exert on Navy talent-management objectives, it is essential to develop criteria to compare alternative COAs (Coughlan & Gates, 2010). Precision is the most critical performance driver for these programs.

- **Precision**: assignment/retention incentives should accurately meet the intended talent-management objectives, including overall end-strength and distribution across specific assignments; an imprecise program can significantly “overshoot” or “undershoot” these targets.

The Quadrennial Review of Military Compensation (QRMC) was tasked by the U.S. Department of Defense to develop “agile and flexible compensation and benefit tools to optimize force management strategies of the uniformed services” (Undersecretary of Defense, 2008). In pursuit of this objective, the 2008 QRMC published four principles for evaluating military compensation programs. Adapting these four principles to assignment/retention incentives, we generate the following performance measures:

- **Voluntary**: assignment/retention incentives should be structured such that each service member willingly accepts the proposed assignment and perceives that

---

5 For a more detailed discussion see Coughlan & Gates (2010), pp. 509-17.
compensation for the assignment is both satisfactory and fair. In the reenlistment context, this principle implies that bonuses should be set at their market-clearing levels.

- **Flexible and Responsive**: assignment/retention incentives should be flexible enough to adjust resources quickly and effectively in response to emerging issues, shifting priorities, and changing market conditions.

- **Best Value**: assignment/retention incentives should provide cost-effective solutions to address specific Navy needs while minimizing cost. Best value involves at least three considerations: (a) targeting those qualified service members most willing to engage in the desired labor commitment (retention, separation, or transfer), (b) minimizing overpayment for those labor commitments, and (c) identifying the minimum cost incentive packages.

- **Support Achievement**: assignment/retention incentives should successfully compete for talent, reward exceptional performance, and recognize sailors’ contributions to the Navy’s mission. This recognizes that preferences in military force management are two-sided. Service members have different preferences for military service (and especially for different assignments), while the Navy prefers high-performers to low-performers.

In addition to the performance measures developed by the QMRC, we introduce a sixth measure:

- **Practicality**: Practicality in retention and assignment programs addresses the implementation ease for the Navy and participation ease for service members. The traditional retention and assignment programs are relatively easy for the services to implement and for service member participation. More market-oriented programs might be harder to participate in or implement.

The traditional reenlistment and assignment programs can be graded against these performance measures. The traditional programs are practical to implement yet face significant risk for under- or over-estimating the incentive needed to meet end-strength goals, especially in the current environment of global economic and political uncertainty (though the assignment process provides better precision). If the incentive is set too low, the Navy will not retain enough sailors to meet its end-strength targets. If the incentive is set too high, the Navy will incur unnecessary costs and may retain too many sailors, unless applications are capped at the desired end-strength target (in which case the Navy risks retaining a suboptimal group of sailors). Furthermore, all eligible sailors receive the same incentive, regardless of their individual incentive requirements or performance characteristics. This significantly overcompensates some sailors relative to their required incentive or performance level, and some high-quality sailors will not be retained, even
though the Navy might be willing to pay more to retain them. Finally, the retention process is voluntary, but the assignment process includes at least some less than voluntary assignments. Table 2 summarizes the performance measures for traditional reenlistment and assignment programs, referred to here as COA 1.

Table 2. Effectiveness of Traditional Assignment and Retention Mechanism

<table>
<thead>
<tr>
<th></th>
<th>Precision</th>
<th>Voluntary</th>
<th>Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA 1 Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

Concern over the performance of traditional retention and assignment programs has generated interest in alternative market-based mechanisms including alternative auction designs and two-sided matching mechanisms.

D. ALTERNATIVE AUCTION DESIGNS

An auction is a mechanism to allocate goods (or services) and establish prices for those exchanges via a bidding process. Hence, an auction is any mechanism that sets a transaction price through a competitive bidding process that determines the good(s) or service(s) sold, the seller(s), the buyer(s), and the transaction price. As described above, auctions are typically used when there is either a single seller and many buyers (a forward auction) or a single buyer and several sellers (a reverse auction). In the sailor retention context, the sailor is a single seller (of military service) and the buyers are the commands where the sailor might serve.

Furthermore, there are several distinct auction design features. One must carefully select the auction design elements that most appropriately fit the particular auction context. Table 3 depicts a few of the most important auction design considerations, highlighting in bold the design choices that are most appropriate for an enlisted assignment and retention marketplace. We will briefly describe each characteristic.

---

6 This section draws heavily on Coughlan & Gates (2010).
Table 3.  Auction Design Characteristics

<table>
<thead>
<tr>
<th>Forward (One Seller, Many Buyers)</th>
<th>Reverse (Many Sellers, One Buyer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Unit Demand</td>
<td>Multi-Unit Demand</td>
</tr>
<tr>
<td>Single-Unit Supply</td>
<td>Multi-Unit Supply</td>
</tr>
<tr>
<td>Single Item Bids</td>
<td>Combination Bids</td>
</tr>
<tr>
<td>Sequential Bid</td>
<td>Sealed Bid (Simultaneous)</td>
</tr>
<tr>
<td>First Price (Discriminatory)</td>
<td>Second Price (Uniform Price)</td>
</tr>
</tbody>
</table>

1. **Forward Versus Reverse Auctions**

In a forward auction, a single seller accepts bids from multiple potential buyers, while in a reverse auction a single buyer receives bids from multiple sellers. Military talent-management applications typically involve reverse auctions; the military is the single buyer of military service commitments (assignment, retention, separation, etc.) while the service members represent multiple sellers of service commitments. In reverse auctions, competition among bidders drives prices lower, with the winning bidder(s) submitting the lowest bid(s). Through competitive bidding, auctions can significantly improve precision and cost-effectiveness in setting assignment and retention bonuses by determining the exact market-clearing price that allows the Navy to precisely hit its assignment and retention targets.

2. **Single-Unit Versus Multiple-Unit Demand or Supply**

It is also important to distinguish between different supply and demand conditions. Each buyer in an auction may only require a single unit of the good or service being sold (single-unit demand) or each may require multiple units (multiple-unit demand). Similarly, each seller in an auction may have only a single unit of the good or service available (single-unit supply) or each may be selling multiple units (multiple-unit supply). In an assignment and retention application where specific billets are being filled, the Navy is the buyer. Demand could involve a single unit (billet) or multiple units (billets) depending on the retention target for that particular category of sailors. The sailors are the sellers, and they can only fill one assignment. Therefore, an enlisted retention auction can be characterized as involving a single- or multiple-unit demand and a single-unit supply.

There is a complication, as discussed later in this report, when an auction is extended to assignment applications. Each sailor can only fill one billet but may bid on
multiple assignments. If a sailor “wins” the auction for more than one assignment, the Navy will have to determine which assignment the sailor fills and which will go to higher-cost sailors. This could involve complex assignment calculations if several sailors win multiple auctions, and impacts rippling down through the second-place winners and possibly lower. This may also affect the sailor’s incentives and bidding behavior.

3. Single-Item Bids Versus Combination Bids

Another important auction design element comes into play whenever the lone buyer in a reverse auction can buy from any single seller either (a) a single unit with adjustable characteristics or (b) multiple units of the good or service (especially if those units are not identical). In such cases, a buyer’s valuation will often depend on the quantity of units being bought, and/or the specific characteristics of each unit; the price at which a seller is willing to sell will often depend on the specific characteristics of each unit and/or the quantity of units being sold.

In these scenarios, the auction design must decide whether to allow combination bids or to restrict bidding to single items alone. For most talent-management auctions, it is sufficient to accept bids only for single stand-alone items (e.g., a particular assignment). Thus, most of the auction applications explored here will assume that bidding service members each submit a single bid for a particular billet assignment.

4. Sequential Bid Versus Sealed Bid Auctions

Another auction design element concerns how bids are communicated; are bids observable to others while the auction remains open or are they sealed (unobservable to others) until the auction closes. In this design dimension, auctions are classified as either a “sequential bid” or “sealed bid” format.

In sequential bid auctions, bidders openly declare or otherwise publicly reveal their bids during the auction. In a sequential bid reverse auction, sellers would sequentially bid the price downward until all but the winning supplier(s) have been eliminated. In sealed bid auctions, participants submit a single undisclosed bid. All bids are opened simultaneously and the winner(s) declared.
Practicality in an enlisted assignment and retention marketplace strongly favors sealed bid over sequential bid auction designs. In any sequential bid auction, bidders (or their agents) must monitor ongoing price adjustments. There is no price-monitoring requirement in sealed bid auctions; bidders simply submit their one-time bids at any point during the prescribed bidding window. It is probably unreasonable to expect active bid monitoring in the military manpower context considering the geographic dispersion, limited connectivity, and overall operating tempo for active-duty service members.

5. First (or Discriminatory) Price Versus Second (or Uniform) Price Auctions

The lowest bidder wins in virtually all single-winner reverse auctions. A common variation among auctions, however, involves how the price paid to a winning seller is determined. Sealed bid single-winner auctions are most commonly separated into “first-price” auctions and “second-price” auctions.

In a first-price sealed bid (FPSB) auction, the transaction occurs at the price submitted by the winning bidder, which is—as the name implies—the first price that would be listed if bids were sorted in rank order (from lowest to highest in a reverse auction). Alternatively, the transaction occurs at the second-lowest price submitted in a second-price sealed bid (SPSB) reverse auction. In other words, the price paid or received in a second-price auction is equal to the bid of the “closest loser.”

The multiple-winner generalization of the first-price reverse auction is the discriminatory price auction (or simply discriminatory auction); each winning bidder receives whatever they bid (e.g., each sailor would receive the retention/assignment bonus they requested in their bid). In a discriminatory reverse auction with 10 winners, for example, the 10 lowest bidders would be the winning sellers and each would be paid the exact amount of their bid.

The multiple-winner generalization of the second-price reverse auction is the uniform price auction. Each winning bidder receives the amount of the “first-excluded”

---

8 An exception to this general statement is the case of matching or assignment auctions, in which each seller can be matched with only one buyer and/or vice versa. As discussed in this chapter, an individual sailor could be the lowest bidder for two or more different assignments but can only “win” one. Another sailor(s) who is (are) not the lowest bidder will “win” the other assignment(s).
bid, which is, as in the single-winner case, the bid submitted by the “closest loser.” In a uniform price sealed bid reverse auction with 10 winners, for example, the 10 lowest bidders would be the winning sellers and each winner would receive an amount equal to the 11th lowest bid (e.g., each sailor would receive the assignment/retention bonus requested by the 11th bidder). This multiple-winner auction format is called a uniform price auction because all winning bidders pay or receive the same uniform price.

6. **Bidding Behavior Under Alternative Pricing Rules**

Different pricing rules elicit different bidding strategies and potentially different auction outcomes. For simplicity, we focus on single-winner reverse auctions. However, all results easily generalize to the multiple-winner reverse auction context.

To illustrate, consider the situation faced by a sailor submitting a sealed bid for a billet that he or she values at exactly $500. In other words, the sailor would be willing to accept the assignment for any bonus of $500 or more, but the sailor would be unwilling to accept the assignment for a penny less than $500. The enjoyment or net benefit the sailor receives (or what economists call the sailor’s “surplus”) is equal to $B–$500 if the sailor receives a bonus equal to $B. What sealed bid should a sailor submit for a particular assignment? The answer depends on the auction’s pricing rules.

The answer is surprisingly simple in an SPSB auction: sailors should bid exactly their true minimum acceptable bonus, or $500 in the example above. Any bid above or below $500 in an SPSB auction will either have no effect on the auction’s outcome (i.e., the auction winner and the price paid will both be unchanged), or it will produce an auction outcome that is worse for the bidder than if she had instead bid exactly $500. If the sailor bids any amount below $500, for example, the only change that could possibly result is that sailor wins the assignment but ends up receiving a bonus less than $500, which is worse than losing the auction. If the sailor bids any amount above $500, the only change

---

9 Technically speaking, the broadest multiple-winner generalization of the second-price auction is known as the Vickrey auction, which involves a more complex price-determination algorithm. Each winning bidder pays the bid of the person who would have won that particular item if the actual winning bidder had not bid for that item. However, if each auction winner can buy or sell only one unit, as is the case in an enlisted assignment and retention marketplace where sailors can each sell only one labor commitment, the Vickrey auction becomes identical to the uniform price auction described here.

10 For a thorough yet accessible explanation of the results discussed in this section, see Klemperer (1999).

11 A thorough proof of this general result can be found elsewhere, e.g., Zimmerman (2008).
that could result is that the sailor does not win an auction that could have been won with a bid of $500 and misses the opportunity to receive a $500 bonus, or more.

Thus, in a SPSB auction, and its multi-winner generalization the uniform price auction, the sailors’ optimal strategy is always to submit a bid equal to their true valuation (the absolute minimum bonus they would willingly accept for the assignment being auctioned). The SPSB and uniform price auction mechanisms are “truth-revealing,” as sailors do best in these auctions by truthfully revealing the minimum bonus they are willing to accept. Moreover, experimental simulation of military force-management auctions using enlisted personnel indicates that bidders quickly recognize the optimality of such truthful bidding in these uniform price auctions (Bock, 2007).

Now suppose the same sailors are bidding for this same assignment in an FPSB auction. In an FPSB auction, the winning sailor receives a bonus equal to the amount they bid. Thus, sailors would not want to bid $500, their true minimum bonus, as this would guarantee zero net benefit ($B – $500 = $500 – $500 = 0). The optimal strategy in an FPSB auction is for sailors to bid some amount above their true minimum bonus for a particular assignment. How much should sailors “overbid?” The higher they bid, the higher the net benefit they receive if they win the auction ($B – $500), but the lower their probability of winning. Selecting a bid in an FPSB auction involves a tradeoff between the sailors’ chances to win the auction and their net benefit if they win. The amount sailors bid matters only if they actually win the auction, so they should bid as if they will be the winning bidder, which implies they should assume they are the bidder with the lowest required assignment bonus.

Identifying the optimal bidding strategy in an FPSB auction involves weighing how high sailors can bid and still win the assignment. The answer is that sailors can bid as high as the second lowest bid, which sailors can safely assume will be at or above the second lowest minimum bonus for the assignment. Thus, the optimal bidding strategy (technically, the “equilibrium” bidding strategy) in an FPSB auction is to bid what sailors expect the next lowest bonus would be if their required bonus for the assignment ($500) was the lowest among all sailors.
7. **Revenue or Cost Equivalence Under Alternative Pricing Rules**

One interesting and important implication of the above-described optimal bidding strategy is that, on average, sailors can expect to receive the same bonus whether the object is sold via FPSB or SPSB auction. The bonus in a second-price auction will be equal to the second-lowest bid. Because the optimal bidding strategy is to bid truthfully, this will also equal the second-lowest actual bonus requirement. The bonus will be equal to the absolute lowest bid under a first-price auction. According to the optimal bidding strategy, however, the lowest bidder in a first-price auction should bid the expected second-lowest required bonus. Under either the FPSB or SPSB auction format, the expected bid in a reverse auction is equal to the expected second-lowest valuation. In general, the expected revenue for the seller (sailors) under either auction format is the same (as is the expected cost to the buyer, or the Navy). This result is known as “revenue equivalence.”

Moreover, this revenue/cost equivalence result generalizes to far more complex auction designs. Particularly relevant for the military talent-management context, the equivalence result generalizes to auctions with multiple winners. Thus, whether the Navy uses FPSB or SPSB auctions for retention and assignment, the total cost to retain and assign the target number of service members will be similar under either auction format.\(^{12}\)

Triplett and Winters (2015) compared three pricing rules in an experimental setting, including sealed bid discriminatory price, sealed bid uniform price, and sequential bid uniform price. They found that the sealed bid discriminatory price auction outperformed the other pricing schemes across several dimensions. It was the most effective format from the Navy’s perspective, reducing the expected Navy cost by 5.1% over the sealed bid uniform price format and 10.1% over the sequential bid uniform price format. It was also more efficient in terms of identifying the sailor with the lowest required retention bonus. However, they also found there was a bidding learning curve. Participants refined their

---

\(^{12}\) The primary qualification to revenue/cost equivalence involves risk aversion. If bidders are risk averse (willing to sacrifice significant expected net benefit to reduce the risk of losing), they would be expected to bid below their actual estimate of the second-lowest value in a reverse FPSB auction, preferring to lower their bids slightly to increase their chances of winning a reverse auction. However, risk aversion does not affect the optimal bidding strategy in a SPSB auction. Thus, a FPSB auction (or the discriminatory auction in the case of multiple winners) may be slightly more cost-effective for the military compared to the SPSB (or uniform price) auction with risk-averse bidders. As the number of bidders increases, however, the impact of risk aversion in this comparison declines (because the estimated second-lowest bid becomes closer and closer to the lowest bid anyway). For further discussion see Coughlan & Gates (2010), pp. 525-28.
bidding behavior as they gained experience with the auction format (the experiments involved 10 rounds with each auction format). Regardless of the format selected, sailors will need information about bidding strategies and practice before participating in an enlisted detailing marketplace.

8. Incorporating Two-Sided Preferences in Retention Auctions

Virtually all existing military pay programs incorporate only one-sided preferences (the preferences of service members to reenlist, separate, etc.), treating all members of the same career field and rank as offering identical value to the military. To be fair, the same is true for all the auction mechanisms discussed to this point. The focus has been on retaining and assigning the target number of sailors at the lowest cost without focusing on whether the approach is selecting the “right” sailors within a given cohort.

In the retention context, for example, the reverse auction alternatives described above will retain the least expensive sailors. If the most valuable sailors within a given cohort have the best employment opportunities in the civilian sector, they may be among the more expensive to retain. Consequently, the “least cost” approach to assignment and reenlistment programs makes it difficult for the Navy to hold onto those sailors with the aptitude or skills making them valuable in the civilian sector as well.

Fortunately, however, the auction approach to talent-management is sufficiently robust to incorporate two-sided preferences by inserting different values into the auction mechanisms presented above for different service members within the same cohort. In assignment and reenlistment auction mechanisms, for example, two-sided preferences can be incorporated (especially using the uniform price auction approach) by assigning “extra credit” to service members who have earned certifications in critical skills, received commendations for their performance, or have simply been identified by senior-level commanders prior to the auction as being key contributors and more important to retain.

To illustrate, consider a specialty and rank cohort in which a select group of high-performing sailors are assessed to be worth $5,000 more to retain than the other members of their cohort (we leave it to policy makers to decide how such valuations could or should be determined). The high-performing sailors in this cohort would bid as before in an SPSB auction, submitting the minimum bonus amounts for which they would willingly accept an
assignment. However, this time the auction mechanism would treat the high-performing sailors as if their assignment cost was actually $5,000 less than the amount they bid.

With all bids collected and this “quality discount” given to the high-performing sailors, the auction mechanism identifies the set of least-cost sailors to assign and determines the first-excluded bid or cutoff bid as previously described (treating the high performers’ discounted bids the same way regular bids are treated in the basic auction). Winning “regular performers” would be assigned and receive a bonus equal to the cutoff bid. High performers would be retained if they submitted a bid less than $5,000 above the cutoff bid, and all retained high performers would receive a $5,000 bonus over the cutoff bid.

Incorporating this quality adjustment does not alter the “truth-revealing” nature of the uniform price auction mechanism. It remains the optimal strategy for sailors to bid their true minimum bonus requirement to accept an assignment, regardless of any quality adjustment that may be assigned (and whether this extra value is revealed prior to the auction). The versatility of force-management auctions allows for preferences on both sides of the market to be considered, with only minor “tweaking” of the auction mechanisms, as demonstrated by the quality-adjusted discount (QUAD) action design (White, 2010; Pearson, 2011; Nowell, 2012).

However, incorporating quality, or ideally projected quality for a future assignment, into an assignment and retention auction would require the Navy to measure sailor value and expected future value relative to different quality levels. While this recognizes and rewards sailor performance, it may decrease practicality.

9. Incorporating Nonmonetary Incentives Using a Combinatorial Auction

The traditional approach focusing exclusively on monetary incentives for assignment and retention may not be the most effective or efficient approach. Research has clearly shown that many sailors are highly motivated by certain nonmonetary incentives (NMIs), such as duty station of choice, geographic stability, sabbaticals, a compressed work week, etc. Moreover, surveys indicate that many sailors would forgo thousands or even tens of thousands of bonus money in exchange for such NMIs. Unfortunately, these same surveys reveal that a larger number of sailors (from 30 percent to more than 80
percent) consider a particular NMI to be essentially worthless and are unwilling to sacrifice even one dollar of bonus money in exchange for the incentive. (Denmond et al., 2007; Zimmerman, 2007; Coughlan & Gates, 2010; Hahn, 2010).

So how can NMIs be used as an assignment and retention inducement when each NMI is valued very highly by some but not valued at all by many or most? The answer is to use a retention auction allowing combination bids (discussed earlier in this chapter) to create personalized retention bonus packages that combine monetary and nonmonetary incentives. Incentives should be personalized such that sailors are offered a particular NMI as part of their retention bonus only if their bid for that NMI, in terms of the cash they are willing to give up, exceeds the Navy’s costs to provide. Preliminary field and simulation studies of such a mechanism, which we have titled the Combinatorial Retention Auction Mechanism (CRAM), suggest that retention costs could be reduced significantly (ranging from 5 percent to as high as 80 percent depending on NMI costs and Navy retention targets) relative to using monetary incentives alone.

As with quality adjustments, incorporating non-monetary incentives into a combinatorial auction may reduce practicality. Incorporating NMIs would require either estimating NMI costs or otherwise determining the number of sailors eligible to receive a particular NMI. Consider geographic stability for two or three tours, an often-mentioned NMI. While this may appear to reduce cost by reducing the sailors’ moving costs, it may impose other less obvious indirect costs. NMIs that reduce flexibility in the assignment process (geographic stability, location of choice, platform of choice, etc.) effectively constrain the assignment process. If the constraints have any significance, it reduces optimality of the resulting assignments by increasing costs or reducing the quality of fit for other sailors (Stitt, 2009).


Having investigated and evaluated the traditional approach to retention and assignment programs, a basic auction approach to such programs, and more sophisticated auction approaches, Table 4 provides a final “report card” for these alternative assignment and retention mechanisms. A basic auction approach offers better precision in setting retention and assignment incentives at the exact minimum level necessary to achieve the
desired outcome. This would allow these programs to be much more flexible and responsive to military needs at a reduced cost.

More sophisticated auction formats, customized to meet specific objectives (e.g., recognize performance, incorporate NMIs) offer the potential for even stronger performance improvement. While sophisticated auction formats add complexity, they also offer the potential for significantly greater cost savings and the ability to create incentives that efficiently and effectively support achievement and reward service member performance.

**Table 4. Effectiveness of Traditional and Auction-Based Mechanisms**

<table>
<thead>
<tr>
<th>COA</th>
<th>Traditional Retention &amp; Assignment</th>
<th>Precision</th>
<th>Voluntary</th>
<th>Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA 1</td>
<td>Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>COA 2</td>
<td>Basic Auction Approach</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Medium-High</td>
</tr>
<tr>
<td>COA 3</td>
<td>Quality Adjusted Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 4</td>
<td>Combinatorial NMI Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
</tbody>
</table>

One unaddressed auction-related issue is how sailors will respond if they have multiple opportunities to participate in an auction during the assignment process. Will they overstate their required bonus in early auctions, reducing their requests as they approach the end of their detailing window? This is a topic for further experimental research.

As a further concern, a particular sailor might be the low bidder for several billets in the auction COAs and the resulting assignments would depend on the rules the Navy adopts to resolve this issue (e.g., minimize auction payments, minimize overall assignment and retention costs, maximize some measure of either sailor or Navy value, or some combination of these factors). The rule adopted will affect the sailor’s bidding strategies, as illustrated with the AIP auction experiments. We have not explored the impact that different allocation rules might have on the sailor’s bidding strategies.
E. TWO-SIDED MATCHING MECHANISMS

Having discussed how different auction formats can meet different assignment and retention objectives, it is important to point out that the assignment process introduces a challenging consideration not well addressed by different auction formats. Pairing sailors with billets or assignments is a “one-to-one matching” problem. Each sailor can match with at most one billet and vice versa, which makes this talent-management problem distinct and more complex than simple retention issues.

The Navy’s Assignment Incentive Pay (AIP) program, discussed previously, attempts to use an auction approach while at the same time incorporating two-sided preferences. Sailors are not selected based solely on their bids in the auction, they are selected by a combination of their bid and other costs associated with filling the AIP billet (moving costs, training costs, etc.). This modification has likely affected the sailors’ bidding behavior. Sailors have a strong incentive to bid strategically, increasing their bids for assignments where they have low costs to fill the billet.

Experimental simulations of the current AIP program show that participants did recognize and respond to this incentive (Nimon & Hall, 2005, Pinkston et al., 2005). The experimental design resolved the assignment problem by choosing the set of assignments that maximized a sailor/billet score (a linear combination of sailor fit and bid, with better fit increasing the score and higher bids decreasing the score). As auction theory and these experiments suggest, the current AIP approach is an improvement in many ways over the previous involuntary assignment process, a mechanism specifically designed for one-to-one matching should offer even better performance.

1. The Two-Sided Matching Process

Roth (2002) described the evolving discipline of market design to solve market-related issues when he observed:

The economic environment evolves, but it is also designed. Entrepreneurs and managers, legislators and regulators, lawyers and judges, all get involved in the design of economic institutions. But in the 1990s, economists, particularly game theorists, started to take a very substantial role in design, especially in the design of markets. These developments suggest the shape of an emerging discipline of design economics, the part
of economics intended to further the design and maintenance of markets and
other economic institutions. (p.1341)

Roth (2008) specifically applies market design techniques to matching applications,
where participants on two different sides of a market are matched with one another. This
application dates back to work by Gale and Shapely (1962).13 Roth (2008) states:

Matching is one of the important functions of markets. Who gets which
jobs, which school places, who marries whom, these help shape lives and
careers.

Partly for this reason, a substantial literature has grown out of the
remarkable paper “College Admissions and the Stability of Marriage” that
David Gale and Lloyd Shapley published in The American Mathematical
Monthly in 1962 (henceforth GS). In that short and almost non-technical
paper they proposed a simple model of two-sided matching, in which men
and women (or students and colleges) each had preferences over individuals
to whom they might be matched in the other set. They proposed an
algorithm for finding a “stable” matching, in which no man or woman is
matched to an unacceptable mate, and no man and woman who are not
matched to each other would both prefer to be. (pp. 537–8)

2. The Matching Process

Matching markets can take one of two forms: one-to-one and many-to-one
matching. In one-to-one matching, participants on both sides of the market match at most
to one participant from the other side of the market. In many-to-one matching, multiple
participants on one side of the market match to one participant from the other side of the
market.

Gale and Shapley (1962) used the marriage “market” to illustrate one-to-one
matching. In their example, males and females represent the two sides of the market, and
each female (male) can match at most to one male (female). In many-to-one matching,
several participants from one side of the market can match to the same participant from the
other side of the market. College admissions is the common example, where the same
university admits several students. In both instances, the matching process is referred to as
“deferred acceptance.” All proposed matches are provisional as the process unfolds and are

---

13 For a more detailed discussion see Roth and Sotomayor, 1990
only formally “accepted” when the process concludes. A provisional match may be rejected at any time as the process moves forward.

In one-to-one matching, participants on both sides of the market rank their preferences from the other side of the market, from first to last choice, listing only those they consider acceptable matches; unacceptable partners are not ranked. One side of the market then “proposes” to their first choice on the other side. Continuing with the marriage market example, the process can begin with either males proposing to females or females proposing to males. In particular, each male (female) proposes to his (her) first-choice female (male). Females (males) reject any unacceptable proposals. Any female (male) receiving more than one acceptable proposal provisionally accepts her (his) preferred match and rejects the other proposals.

Rejected males (females) then propose to their next most preferred match. Again, females (males) reject unacceptable proposals and females (males) receiving multiple acceptable proposals provisionally accept their most preferred proposal and reject other proposals. The process continues until all males (females) have either been provisionally accepted by one female (male) or rejected by all females (males) on their list of acceptable matches. At that point, the proposals that females (males) have provisionally accepted are formally accepted. Note that this procedure can be centrally processed if males and females submit their rank order lists to a central authority; participants do not need to individually submit/reject offers.

Many-to-one matching follows a very similar process. Using the college admission example, students would start the process by applying to their first-choice college. Colleges only consider applicants they consider acceptable. Colleges receiving fewer acceptable applicants than their available slots provisionally place all acceptable applicants on their waiting list. Any college receiving more acceptable applications than slots available, provisionally places their most preferred students on their waiting list and rejects the other students. The process continues with rejected students applying to their next best choice, under-subscribed colleges provisionally placing acceptable applicants on their waiting lists and over-subscribed colleges provisionally placing their most preferred students on their waiting lists and rejecting all others. The process continues until every student is
provisionally placed on a waiting list or is rejected by all colleges they consider acceptable. At that point, the provisional waiting lists become formal acceptances.

Alternatively, the college admissions process can start with colleges accepting their top ranked students, up to the number of slots available. Students receiving more than one acceptance would provisionally commit to their highest ranked acceptance and reject the others. Schools receiving rejections would then accept their next most preferred students and students with more than one acceptance would provisionally commit to their most preferred acceptance. The process would end when all colleges have either received provisional commitments for all available slots or have been rejected by all students on their list. At that point, provisional commitments become formal acceptances. Again, this procedure can be centrally processed if students and colleges submit their rank order lists to a central authority; participants do not need to individually submit/reject offers.

3. Properties of Two-Sided Matching Outcomes

   a. Stability

   Both the one-to-one and the many-to-one cases produce stable outcomes. In one-to-one matching, stability implies that no participant is matched to an unacceptable partner and no two participants that are not matched would both prefer to be matched to one another than their partner identified through the process. In other words, no matched participant would prefer to be unmatched, and there is no pair of participants that would both willingly accept one another over their current partner, causing them to block the final matches and unravelling the outcome. In this sense, the matching outcome is stable and will not unravel (Roth, 1990; Roth & Sotomayor, 1990; Robards, 2001).

   Stability is very similar in the many-to-one matching context. There is no mutually beneficial paring outside of the match that would cause participants to block the final assignment and unravel the outcome. Furthermore, there is no subset of participants that can negotiate a better outcome for all members of their coalition (Roth, 1990, 2008; Roth & Sotomayor, 1990; Robards, 2001).

---

15 Roth (2008, pp. 554-55) provides a list of labor markets currently using a two-sided matching clearinghouse.
Roth (1991) examines seven different matching systems for physicians in the United Kingdom. He finds that stable systems persist while unstable systems tend to unravel as participants choose to negotiate matches outside of the central matching system. Board (1994) further finds that the success or failure of a matching system depends on both the number of unstable matches as well as the participants’ ability to identify mutually beneficial alternative matches.

b. **Optimality**

In both the one-to-one and the many-to-one cases, theory shows that the outcome favors the side that proposes. More specifically, Gale and Shapley (1962) show the outcome of the one-to-one (marriage) matching system is the optimal stable match for men (women) when men (women) propose. Optimal in this case implies that every male (female) is at least as happy with their match made through this process as in any other stable match, and at least one male (female) is unambiguously better off. While the outcome is not optimal for females (males) when males (females) propose, the matches are acceptable to all females (males); they would rather accept the match than remain unmatched.\(^\text{16}\)

c. **Truthful Revelation**

Considerable attention has been given to whether participants in these matching markets have incentives to falsify their preference rankings or is their best interest to submit truthful preference rankings. In general, the proposing side of the match cannot improve their outcome by falsifying their true preferences. At the same time, the participants receiving proposals can potentially improve their outcome by falsifying their preferences, but to manipulate the outcome successfully requires information that is hard to gather or unavailable (Dubbins & Freedman, 1981; Roth, 1991, 2008; Roth & Sotomayor, 1990; Robards 2001, 2011).

d. **Preference List Length and Participant Pool Size and Diversity**

Two factors likely to affect the quality of matches in a two-sided matching process include the length of the preference list (number of acceptable matches per participant) and the participant pool size (number of options for participants on both sides.

\(^{16}\) See also Roth (1990, 2008), Robards (2001, 2011).
of the market). Participants in a two-sided matching process can only be assigned to one another if they are ranked on one another’s list. The more options participants include on their list, the greater the probability they will be matched. Similarly, the greater the participant pool size and diversity, the greater the probability that participants will find an acceptable partner and be successfully matched. These expectations have been borne out by both simulation and actual experience (National Resident Matching Program, n.d.; Ng & Soh, 2001).

4. **Enlisted Detailing Applications of Two-Sided Matching**

Robards (2001, 2011) explored the application of two-sided matching to enlisted detailing applications. As Robards observed:

Approximately 294 detailers are responsible for managing the detailing process of a force that comprises 314,450 active duty sailors. In addition to sailors’ preferences over each command’s attributes, and the commands’ preferences over each sailor’s attributes, the detailers must consider eligibility criteria as well as numerous policies pertaining to the assignment of sailors. This creates an incredibly complex task whereby detailers must tradeoff the various preferences. Furthermore, because no standard procedure has been identified to assign sailors to commands in an optimizing manner, the quality of the assignments is largely dependent on the ability of detailers to mentally tradeoff sailors’ and commands’ preferences. (Robards, 2001, p. 69)

Robards (2011, pp. 97–136) notes that information overload is widely acknowledged to limit the ability of decision makers to make quality choices. He also notes that prior research has not considered assignment decisions. Assignment decisions are particularly complicated because decisions are interdependent; each assignment limits the remaining assignment options. Robards conducts a series of experiments examining decision quality in an assignment context. He finds that decision makers have a difficult time balancing the preferences across both sides of the market (i.e., they focus on position requirements to the detriment of the personnel). This supports the case for an algorithmic matching mechanism that appropriately balances preferences across participants. Two-sided matching is particularly appropriate because of its truth-revealing and stability properties.
Robards (2011) further explores two additional issues that are relevant for two-sided matching in the Navy’s enlisted assignment and retention process: the impact of determining preferences through a multi-attribute utility function and preference indifference. Robards explored using a multi-attribute utility function to represent the Navy’s preferences across sailors; individual sailors would determine their personal priority rankings. This is particularly relevant for an enlisted detailing application because both the gaining command and the Navy as a whole have assignment related preferences. Commands are likely to focus on the sailor’s ability to perform the required tasks while the Navy is also interested in broader aspects of career development.

The weights assigned different attributes in a multi-attribute utility function, including command versus Navy preferences, could be a Navy policy variable. Not surprisingly, Robards (2011) finds that the percentage of assignments that match a particular attribute increases as the weight assigned to that attribute increases. Viewing attribute weights as a Navy policy parameter allows the Navy to shape the workforce in ways that reflect the current environment and priorities. At the same time, developing the multi-attribute utility function would increase complexity for the Navy, reducing practicality.

Robards (2011) further observes that two-sided matching, as described above, relies on a strict preference ordering, with no indifference between alternatives. Two-sided matching requires a tie-breaking rule when there is indifference in the preference rankings, effectively converting the preference list to a strict rank ordering. Indifference would allow the Navy to determine the tie-breaking rule that provides the best assignments from a holistic perspective in an enlisted detailing application.

Robards (2011) finds that which and how many sailors are assigned to which billets depends on the tie-breaking rule. Using computational experiments, Robards explored the range of stable outcomes achieved through different tie-breaking rules. He then developed the set of dominant stable outcomes that includes assignments where it is impossible to either increase the number of sailors assigned without decreasing assignment quality (as measured by the multi-attribute utility function) or increase assignment quality without decreasing the number of sailors assigned. The Navy could then select their preferred outcome from the dominant set.

To summarize, two-sided matching can be modified to an enlisted detailing marketplace. It has the advantage of directly addressing the one-to-one matching problem that is not well addressed by an auction. However, it does not incorporate retention incentives or provide incentives for sailors to voluntarily accept hard to fill billets, which auctions can address. These results are summarized in Table 5 below. Further, as with auctions, we have not explored how sailors will respond if there are multiple assignment windows. Will they submit short lists with just highly preferred assignments early in the assignment window, expanding their lists as they approach the end of their assignment window? This is a topic for further experimental research.

Table 5. Effectiveness of Traditional, Auction-Based, and Matching Mechanisms

<table>
<thead>
<tr>
<th>COA</th>
<th>Mechanism</th>
<th>Precision</th>
<th>Voluntary Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA 1</td>
<td>Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>COA 2</td>
<td>Basic Auction Approach</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Medium-High</td>
</tr>
<tr>
<td>COA 3</td>
<td>Quality Adjusted Auction</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 4</td>
<td>Combinatorial NMI Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 5</td>
<td>Two-Sided Matching</td>
<td>Medium</td>
<td>High</td>
<td>Medium-Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>

F. TWO-SIDED MATCHING WITH MONEY

Two related shortcomings with two-sided matching are that it does not provide retention incentives, as in an auction, and it does not reflect strength of preferences, but simply rank order preferences. Kelso and Crawford (1982) were among the first to incorporate money into the matching process. This was further developed by Roth and Sotomayor (1990), among others. In a simplified description of this process, a producer attempting to fill several positions would announce wage offers across those positions. Prospective employees would “apply” to their most preferred position. If there is insufficient demand for certain positions, the producer would raise the compensation for the under-prescribed positions and prospective employees would adjust the applications.
correspondingly. This process continues until all positions are filled as needed. This process provides a stable outcome.

While this process incorporates retention incentives into the assignment process and addresses the one-to-one matching problem in the military assignments, it effectively treats prospective employees (sailors) as homogenous; it does not discriminate across differences in expected employee performance. Thus, it addresses some but not all of the shortcomings discussed for auctions and two-sided matching.

Homb (2006) and Tan (2006) explore a two-sided matching process with money in a military assignment context. In their mechanism, sailors submit “bids” for any available billet for which they are qualified and would willingly fill. Their bids reflect the minimum bonus required for them to fill that job. Similarly, the Navy (commands) submit “offers” to qualified sailors reflecting the maximum bonus they would pay each sailor to fill each available billet (offers for any particular billet can vary across sailors). These offers would be based on the same multi-attribute utility criteria discussed above, thereby reflecting sailors’ expected performance, other sailor characteristics, and Navy preferences, including billet priority.

The process can start with either the Navy making offers or the sailors’ submitting bids. Starting with the commands’ offers, each sailor is paid the Navy’s offer and provisionally assigned to the billet that offers them the greatest surplus value (the difference between the Navy’s offer and the sailor’s minimum required bid). If billets are over-prescribed, the offer from over-prescribed billets are reduced by a predetermined increment to all sailors. Sailors are then again provisionally assigned to the billets that provide them the greatest surplus. This process continues until the market clears and no billets are over-prescribed. At that point, assignments are finalized at the market-clearing prices. This process favors sailors and is thus called the sailor-optimal process. It also mimics a uniform price auction in that assignments are based on a price determined by the first excluded bidder (the point at which the last competing sailor either has a better alternative or no longer seeks an assignment). Finally, none of the unfilled billets has an offer for an unmatched sailor that exceeds the sailor’s minimum required bonus.

Alternatively, the process can begin paying sailors their bids, reflecting the minimum required bonus for sailors to fill each billet. Mirroring the process above, sailor
assignments are provisionally allocated to maximize the Navy’s surplus value (the difference between the Navy’s offer and the sailors’ bids). In this case, if billets are over-prescribed, all sailors’ bonuses for the over-prescribed billets are increased by a predetermined increment and sailors are again assigned to the billets that maximize the Navy’s surplus. This process continues until the market clears and no billets are over-prescribed. At that point, assignments are finalized at the market-clearing prices. This process favors the Navy and is thus called the Navy-optimal process. It also mimics a uniform price auction as explained above. Finally, as above, none of the unmatched sailors has a bid below an unfilled billet’s offer.

As with two-sided matching, the sailor-optimal model is truth-revealing for sailors. Their dominant strategy is to truthfully reveal the minimum bonus required for them to accept a particular assignment. In fact, Tan (2006) emphasizes that the only possible impact for sailor who deceptively raises their minimum acceptable bonus for a billet is to take themselves out of competition for the billet to the benefit of the sailor who receives that assignment. While truthful revelation is not the dominant strategy for the Navy in this case, they would need ex ante information on sailor preferences to manipulate their bids to their benefit. The Navy-optimal process is truth-revealing for the Navy; sailors would need information on the other sailors’ preferences to successfully manipulate their bids, so there is limited opportunity for bid-manipulation. Table 6 compares the performance of all COAs against the performance metrics.

Table 6. Effectiveness of Traditional, Auction-Based, Matching, and Matching with Money Mechanisms

<table>
<thead>
<tr>
<th>COA</th>
<th>Traditional Retention &amp; Assignment</th>
<th>Precision</th>
<th>Voluntary</th>
<th>Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
</tr>
</thead>
<tbody>
<tr>
<td>COA 1</td>
<td>Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>COA 2</td>
<td>Basic Auction Approach</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Medium-High</td>
</tr>
<tr>
<td>COA 3</td>
<td>Quality Adjusted Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 4</td>
<td>Combinatorial NMI Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 5</td>
<td>Two-Sided Matching</td>
<td>Medium</td>
<td>High</td>
<td>Medium-Low</td>
<td>Medium</td>
<td>Medium-High</td>
<td>Medium</td>
</tr>
<tr>
<td>COA 6</td>
<td>Two-Sided Matching with Money</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>
It should be noted that the Navy can combine some of these COAs. For example, combining a quality adjusted auction with a combinatorial NMI auction (COAs 3 and 4) would create a combinatorial NMI auction with quality adjustment. This combination would increase the best value performance metric for the quality adjusted auction (COA 3) and increase the support achievement metric for the combinatorial NMI auction (COA 4). However, it would make the auction more complicated to implement and explain to enlisted sailors, reducing practicality.

Similarly, NMIs from COA 4 could be combined with two-sided matching with money (COA 6). This would increase the best value metric for two-sided matching with money by allowing sailors to substitute NMIs for some of their monetary incentive when the cost of the NMI is less than the reduction in the monetary incentive. However, it would again make the mechanism more complicated to implement and explain to enlisted sailors, reducing practicality.

It is likely overly ambitious to move to such complicated COAs in the Navy’s first iteration of the enlisted assignment and retention marketplace, though the Navy may want to consider these more complicated COAs as the marketplace matures.
VI. SIMULATED PERFORMANCE OF ALTERNATIVE MARKET MECHANISMS

Ideally, one would directly compare the performance of each of the COAs described above. Unfortunately, this is difficult, particularly comparing the traditional assignment and retention process to either auctions or matching. For example, precision is the primary benefit a simple auction offers over traditional reenlistment incentives. While we can simulate an auction’s performance, we cannot simulate how reenlistment incentives would be set or assignments made in a traditional reenlistment process. Similarly, both of the two-sided matching COAs solve the one-to-one matching problem; assigning each sailor to just one billet and assigning just one sailor to each billet. However, any particular sailor might be the low bidder for several billets in the auction COAs and the resulting assignments would depend on the rules the Navy adopts to resolve this issue (e.g., minimize auction payments, minimize overall retention and assignment costs, maximize some measure of either sailor or Navy value, or some combination of these factors). We would need to know the Navy’s policy to compare the auction COAs to the matching COAs. However, we can compare the three auction COAs to one another, and the two matching COAs to one another.

A. SIMULATION RESULTS: BASIC AUCTION (COA 2) AND QUAD AUCTION (COA 3)

White (2010) was among the first to explore using a QUAD auction to set retention incentives. In the QUAD auction, sailors bid what they require to remain on active duty, as in a basic uniform price sealed bid retention auction. However, higher quality sailors have their bids reduced by some amount to reflect their presumably greater retention value. The Navy determines how to measure quality, what quality levels justify a discount, and the size of the discount (i.e., the quality-related increase in retention value). The Navy conceivably can identify several different quality levels and associated discount factors. The bids remain unchanged for sailors not meeting the Navy’s premium quality levels.

After applying the appropriate discount(s), the Navy identifies the set of sailors that minimizes total retention costs. Those sailors are retained, and the retention incentive is set equal to the first excluded bid (i.e., the lowest losing bid). Sailors not meeting the Navy’s
premium quality levels are paid this retention incentive. Premium quality sailors are paid this retention incentive plus the discount applied to their bid prior to the selection process. Because sailors are not retained if their bid is rejected, a sailor’s bid should accurately reflect their reservation value for remaining on active duty; the auction design is truth-revealing.

White (2010) demonstrates how the QUAD auction can increase the quality of retained sailors. He also shows that the uniform price QUAD auction can significantly reduce total retention costs compared to a standard uniform price auction. The discounted bids effectively increase the number of lower cost sailors in the auction, reducing the value of the first excluded bid compared to the standard auction. This reduces the retention incentive paid to all sailors not qualifying for the quality discount, potentially reducing overall retention costs.

The impact the QUAD auction has on both the quality of retained sailors and total retention costs depends on several factors, including the size of the quality discount(s), the number of eligible sailors, and the correlation between sailor quality and the sailor’s required retention incentive. If higher quality sailors are the most willing to remain on active duty (i.e., they tend to have the lowest bids in the retention auction), then the quality discount will increase the Navy’s retention costs and have a limited impact on the average quality of sailors retained. As the sailors submitting lower bids, higher quality sailors would be retained in the standard uniform price auction. This would correspond to a case where sailors with successful Navy careers have a predisposition to remain in the Navy.

Alternatively, if higher quality sailors are less willing to remain on active duty (i.e., have higher required retention incentives), the QUAD discount can have a significant impact on average quality of the sailors retained and may reduce retention costs. This would correspond to a case where sailors with successful Navy careers could also have successful civilian careers, increasing the opportunity cost of their military service. In this case, the impacts of the QAD auction depends on how the Navy sets quality thresholds and the size of the quality discount.

Several studies have attempted to examine the correlation between sailor quality and willingness to serve (required retention incentive) and simulated the performance of a QUAD auction based on survey data. These surveys gather sailor characteristics, career
milestones, and performance ratings from the survey participants that are proxies to measure sailor quality. They also ask what monetary bonuses they would require to remain on active duty. Nowell (2012) and Cassels (2016) examine quality and retention for surface warfare officers (SWOs), while Kelso (2014) and Williams (2015) focus on naval aviators. All authors find similar results. Based on the measures of quality adopted in their studies, there is no statistically significant correlation between quality and willingness to serve. Further, QUAD can increase the quality of the retained force but the impact on retention costs depends on the level of the quality thresholds and the size of the quality discounts.

The quality thresholds and the size of the quality discounts are both Navy policy variables, which do not have to be announced in advance. This enables the Navy to determine the appropriate tradeoff between cost and quality after learning the sailors’ assignment and retention incentive requirements. The lower the quality thresholds and the larger the quality discounts, the greater the Navy’s expense and the greater the impact on the quality of the retained force, and vice versa. The dominate strategy for sailors is to truthfully reveal their minimum assignment and retention incentive requirements in either a standard retention or QUAD auction so the Navy can determine its preferred quality threshold and quality discounts after receiving the sailors’ bids and balance these decisions across multiple ranks and career fields.

The QUAD auction clearly offers the Navy an opportunity to express a preference over sailors they consider high value. This allows the Navy to incorporate Navy preferences into an auction process without distorting the truthful revelation properties expected in a uniform price auction. However, as discussed earlier, individual sailors could potentially “win” multiple auctions. That would require the Navy to adopt assignment rules and the resulting assignments would depend on those rules the (e.g., minimize auction payments, minimize overall assignment and retention costs, maximize some measure of either sailor or billet value, or some combination of these factors). This could also affect bidding behavior depending on the assignment rule.

---

B. SIMULATION RESULTS: BASIC AUCTION (COA 2) AND COMBINATORIAL NMI AUCTION (COA 4)

Several studies have analyzed the performance of the combinatorial retention auction mechanism (CRAM) based on survey data from various Navy officer and enlisted communities. Most surveys followed a similar approach. Particular Navy communities were asked what monetary bonuses they require to remain on active duty. They were then asked how much of the monetary bonus they would give up to receive one or more of several NMIs identified in the survey. The first set of comparisons involved SWOs (Denmond et al., 2007) and both enlisted Fire Controlmen and Air Traffic Controllers (Zimmerman, 2008). These results are further summarized in Coughlan et al. (2011).

There are two ways to structure NMIs in a retention auction: a universal incentive package or personalized NMI packages that vary across sailors. The simplest way to incorporate NMIs is to offer a universal NMI package that provides all sailors a predetermined portfolio of NMIs and then conduct an auction over the cash bonus required in addition to the universal NMI package. To reduce costs relative to simple cash bonuses, the cash payments must be reduced sufficiently to cover the cost of providing the NMIs. In other words, the NMIs’ value to sailors must exceed the Navy’s NMI costs.

The main difficulty when designing a universal NMI package is determining what incentives to include. Because the NMIs are offered to all sailors, the Navy can potentially face a significant increase in cost by offering NMIs that cost more than they are valued by a majority of sailors. Assuming, for simplicity, that there is a downward sloping demand for a particular NMI (some sailors have higher values than others) and NMI costs are constant, this can be illustrated by Figure 7. The same story can be told with more complex value and cost functions, it would simply make the figure more complicated.

![Figure 7. NMI Cost vs. Value. Source: Coughlan et al. (2011, p. 73)](image-url)
As Coughlan et al. (2011) illustrate (Figure 8), “…if the demand curves shown represent valuations among retained sailors, it would be cost-effective to offer choices a and b. This is because total sailor value exceeds cost. Choices c and d, however, would result in a deficit. This is because total sailor value is less than total cost” (p. 73).

![Non-monetary Incentives Portfolio](image)

**Figure 8. Non-monetary Incentives Portfolio. Source: Coughlan et al. (2011, p. 73)**

Constructing the optimal universal NMI incentive package requires planners to discover the sailors’ values and Navy’s cost for prospective NMIs. Unfortunately, sailors have no incentive to truthfully reveal their NMI values if they know the information they provide will determine the package of NMIs that they will be offered. Further, it is difficult to measure the Navy’s costs to provide many NMIs, particularly before they know how many and which sailors will use the NMI.

Adding to this complication, surveys across different military communities, ranks, and years of service show that few if any NMIs have significant value for even 50% of the active-duty force, limiting the possibility for a cost-effective universal NMI package. Furthermore, approximately 80% of the surveyed service members expressed a significant positive value for at least one NMI, though that significant value is often limited to a small minority of the sailors surveyed. These NMIs would not be included in a universal NMI package, eliminating the possible efficiencies the Navy could gain by providing these NMIs to the subset of sailors who value them highly. (Coughlan et al., 2014)
Finally, the surveys also indicate that the value of an NMI package is not always the sum of the values for individual NMIs. Sometimes the NMI package is worth more than the sum of the individual NMI values, and sometimes it is worth less. And these super-additive and sub-additive properties vary across sailors for the same NMI package. In other words, sailors will view some combinations of NMIs as complements, others as substitutes, and still others as largely independent, and these views vary across sailors.

These complications suggest it would be more effective to offer individualized incentive packages through some form of a uniform price sealed bid combinatorial auction mechanism\(^\text{18}\) (Coughlan, et al., 2011; Denmond et al., 2007; Zimmerman, 2008). In one CRAM version, referred to as the “full-information-CRAM,” sailors reveal their NMI values for individual and combinations of NMIs. If the Navy knows the NMI costs, it can then determine the most effective NMI package for each sailor and hence the least expensive sailors is retained. Alternatively, the Navy can post a menu of NMIs (“menu-CRAM”) and their associated costs and allow the sailors to select the individualized set of NMIs that maximize their own value over cost (Coughlan, et. al., 2011).

In either CRAM version, retained sailors receive a particular NMI only if they express a value for the incentive that exceeds the Navy’s cost to provide it. Compared to the purely cash retention auction, the CRAM alternatives retain the same number of sailors but reduce the total cost to the Navy. In addition, CRAM potentially increases the sailors’ value. Each sailor’s value equals or exceeds their value under the cash only auction, but at a lower cost to the Navy; a true win-win situation. The menu-CRAM is more practical than the full-information-CRAM because the later would require sailors to state values for each individual NMI and each possible NMI combination, making it very information intensive.

Compared to the Universal Incentive Package, CRAM enables the Navy to capture the surplus represented by the green triangles in Figure 8 and eliminates the Navy’s potential waste associated with the red triangles under the universal incentive package.

\(^\text{18}\) CRAM is proposed as a uniform price sealed bid auction. As such, it retains the same incentive-compatible and truth-revealing properties of a uniform price auction as described above. The dominant strategy for participating sailors is to truthfully reveal the combination of NMIs and cash payment that is the minimum cost package of incentives required for them to remain on active duty. Detailed descriptions of the CRAM auction are provided in Coughlan, et al. (2011) and Zimmerman (2008).
CRAM further increases efficiency by capturing the surplus from incentives not offered under the universal incentive package, as represented by the blue triangles in Figure 9.

Simulations of the various retention mechanism alternatives were conducted using data from the SWO and Enlisted Retention Survey. In particular, three separate uniform price sealed bid reverse auction mechanisms were simulated: cash, universal incentives and CRAM (Coughlan et al., 2011). The universal and CRAM simulations require estimating NMI costs. In the absence of specific cost estimates for the various NMIs, costs projections were based on the value distributions from the surveys. In particular, Coughlan et al. assumed that the cost of each NMI fell between some lower bound cost and the respondents’ maximum submitted valuation.19

Coughlan et al. (2011) simulated the three auction mechanisms and compared their outcomes. CRAM clearly outperformed the monetary and universal incentive package auctions. The Navy’s cost savings from CRAM ranged from 6% – 42% over monetary incentives in the SWO survey and from 25% – 80% in the enlisted survey. The universal incentive package is simpler to implement than the CRAM auction, but it has a significant potential to be more expensive than either CRAM or simple cash auction.20 Further,

---

19 For more detail on these simulations see Coughlan, et al. (2011).
20 For discussions of other Navy communities see Cascardo & Kumar (2010), Levy (2010), Nowell (2012), Kelso (2014), Williams (2015), and Cassels (2016).
experimental analysis tested whether auction participants (sailors) bid as auction theory suggests (Hahn, 2010; Tiley, 2010). The results indicate that participants do bid as expected a majority of the time, even in fairly complex circumstances. With instruction, sailors will likely understand the auction process.

Another benefit of CRAM that cannot be quantified is the psychological benefits of choice. If sailors choose the benefits they prefer, they are more likely to recognize the true composition of their total rewards package and may also realize an increase in value by having a voice in their compensation. Allowing sailors to choose only those benefits that suit them, the Navy can eliminate the waste associated with unwanted benefits while empowering its service members (Coughlan & Gates, 2010).

C. SIMULATION RESULTS: TWO-SIDED MATCHING (COA 5)

Two-sided matching has been well studied, both theoretically (e.g., Roth & Sotomayor, 1990) and across a variety of civilian sector applications (e.g., Roth, 2008). One of the primary questions involving two-sided matching processes involves which side of the match should make the initial proposals. Theory shows that the stable outcome from the matching process favors the proposing side of the match. Furthermore, the optimal strategy for the proposing side of the match is to reveal their truthful preference rankings. The accepting side of the match can gain by manipulating their bids, though the information requirements to do so are formidable.

Roth and Peranson (1999) simulate the matching outcomes for the American resident physician market for both alternatives: student proposing and residency program proposing. Surprisingly, they find very few differences between the two approaches; less than 0.1 percent of the students were affected (Roth & Peranson, 1999, pg. 760). They attribute this small difference to the strong correlation between the preference lists for both sides of the market. Students appear to be ranking programs for which they are well qualified, and not programs for which they are poorly qualified, and vice versa. Ng & Soh (2001) found similar results in their simulations of the enlisted detailing process.

This illustrates the importance of expectations management. Sailors should know as much as possible about their qualification for alternative available billets, including Navy Enlisted Code (NEC), rank, sea-shore rotation, planned rotation date, etc. If there is
strong correlation between the sailors’ and commands’/Navy’s preferences, the sailor-optimal matching process will closely mirror the Navy-optimal process. When sailors propose, their optimal strategy is to reveal truthfully their rank-order preferences. There are opportunities for sailors to benefit from not ranking preferences truthfully when commands propose. Using the sailor-optimal approach, where sailors propose, would eliminate the benefit and motivation for sailors to game the system.

As Robards (2001, 2011) explains, beyond the sailor versus Navy-optimal matching process, there are several differences between the Navy’s assignment problem and many civilian sector applications of two-sided matching. For example, assignments in hierarchical organizations have to balance the preferences of the organization (the Navy) and its subordinate units (commands). Furthermore, there is no guarantee that all sailors will receive an assignment and there is no guarantee that all priority billets will be assigned a sailor. Billets will only be filled if they are included on a sailor’s preference list. If sailors do not list hard-to-fill but high-priority billets, they will not be filled. Similarly, lower performing sailors may not be matched if billets do not include them on their preference lists. Finally, the assignment process is a repeated process. Sailors and commands have more than one opportunity to find a match.

Ng & Soh (2001) used a simulation model with randomly generated sailors and billets to explore the impact of pool size (the number of sailors and billets included in the matching process) and preference list length (the number of ranked preferences) on matching process outcomes. Pool size can be increased by reducing the frequency of the assignment process (e.g., six-week intervals as opposed to two-week intervals). They find that it is important to increase both the size of the pool and the preference list length, as opposed to increasing only one or the other.

Increasing the pool size without increasing the preference list length may simply lead more sailors to list the same few preferred billets and more billets to rank the same few highly preferred sailors, particularly if preferences are highly correlated across sailors and commands. Increasing preference list lengths without increasing the pool of candidates simply forces sailors and billets to accept less preferred matches. Increasing both the pool size and preference list length increases the number of potential desirable partners (sailors and billets) and the number of alternative potential matches, particularly if preferences are
diversified and not highly correlated. Ng & Soh (2001) find that increasing both preference list lengths and the size of the pool increases both the quantity and average quality of the resulting matches.

Robards (2011) explores using multi-attribute decision analysis to integrate Navy and command preferences. Both the Navy and commands have utility (value) functions across different sailors. An overall score (ranking) over sailors can be developed by calculating a weighted average of the Navy’s and commands’ utilities. The Navy can emphasize Navy or command preferences, depending on the military environment, by varying the Navy and command preference weights. The relative weights could be treated as a variable in the matching process, comparing the matches resulting from different relative weights to find the Navy’s overall preferred outcome.

Robards (2011) suggests addressing hard-to-fill billets and lower performing sailors by placing constraints on the sailors’ and commands’ preference lists. This approach was adopted in the New York City high school matching process. In the New York City high school match, students are grouped into high, medium, and low performers based on their standardized English test scores. Schools are required to accept a portion of students from both the medium and low performing groups based on the percentage of student population making up each of these groups (Abdulkadiroğlu et al., 2005). They found that schools had different preferences over the lower performing students (e.g., GPA, attendance, and disciplinary records). The matching process allows schools to choose the lower performing students they feel they can best help.

Research has not yet addressed the behavioral effects of multiple assignment windows. One would expect sailors to list only their most preferred matches early in the process, increasing their preference lists to less preferred but acceptable assignments as the assignment window narrows, particularly if sailors will be assigned to unmatched, and presumably hard-to-fill, billets at the end of the process, or asked to leave active duty.

D. SIMULATION RESULTS: TWO-SIDED MATCHING WITH MONEY (COA 6)

As described above, two-sided matching with money addresses two shortcomings with two-sided matching: two-sided matching does not provide retention incentives, as in an auction, and it does not reflect strength of preferences, but simply rank-order
preferences. As such, there is no way for the Navy to incentivize sailors to accept critical hard-to-fill billets, or for the Navy to indicate its strength of preference (value) for one sailor over another to fill a billet. Two-sided matching with money allows sailors and the Navy/commands to express their relative values, providing a greater opportunity to increase overall value in the resulting assignments.

Tan (2006) simulated this process and found the results to be very promising. She examined both the sailor-optimal process and the Navy-optimal process. The overall system performance generated by the sailor-optimal and Navy-optimal models were comparable in terms of percent of sailors assigned, the percent of billets filled, and the percent of total surplus value captured by the matching process.\(^{21}\) Further, the process is stable in that no mutually beneficial match can take place among the unmatched sailors and billets.

Tan (2006) further found that the sailor-optimal model works to the advantage of sailors while the Navy-optimal model works in favor of the Navy, as expected. Sailors received about 75% of the total surplus in the sailor-optimal model; the Navy received about 25% of the total surplus. The results were reversed for the Navy-optimal model; the Navy received about 75% of the surplus while sailors received 25% of the surplus. This reflects the differences in the retention incentives paid in the two models. The retention incentives were approximately twice as high in the sailor-optimal model compared to the Navy-optimal model.

The sailor-optimal model is more expensive for the Navy but is more incentive compatible. Tan (2006) cautions that simulation models assume participants behave as theory predicts. Experiments should be conducted to verify actual behavior. In addition, as mentioned previously, each sailor and billet is eligible for several assignment iterations so a small number of unmatched sailors and billets in one iteration may not be a significant issue. A dynamic model can examine how many iterations it will take to ensure an acceptable probability that a particular sailor or billet is matched. As also mentioned earlier, that depends in part on the Navy’s rules regarding preference list lengths, etc. Further, it is

\(^{21}\) Total surplus value is the sum across matched sailor-billet pairs of the difference between the maximum the command is willing to pay the assigned sailor and the minimum the sailor requires to accept the assigned billet.
unclear, as with both auctions and two-sided matching, how sailors will respond with multiple assignment windows. Will they submit bids for just highly preferred assignments early in the assignment window, expanding their lists as they approach the end of their assignment window? This is a topic for further experimental research.
VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A market links buyers and sellers in a process to exchange goods and services. Markets rely on buyers (including employers) offering compensation for goods or services provided by sellers (including labor). A market allows tradeable goods and services to be valued and then establishes the terms of exchange (prices). The nature of any market transaction mechanism depends in part on the number of buyers versus sellers involved in the particular transaction.

The enlisted assignment and retention marketplace seeks to combine what the Navy has previously conducted as two separate processes: retaining sailors and assigning them to billets. The Navy seeks a market-based process that provides the following key features (Coughlan & Gates, 2010):

- Buyer/seller negotiation – more opportunities for sailors and commands to directly or indirectly work out terms and conditions for jobs and enlistment contracts
- Multiple/flexible options – a greatly expanded set of options and opportunities available to sailors and commands
- Changing prices and incentives – Commands and sailors can negotiate a wide range of monetary and non-monetary incentives as part of the assignment “package” to ensure the most qualified sailors fill all jobs
- Voluntary choice – probably the key element of a marketplace, brought about by the flexible incentives, options, and negotiation between sailors and commands

This enlisted detailing marketplace involves many sellers (sailors) seeking to provide military service and one buyer (the Navy) seeking to employ the right number of military service members. Furthermore, the enlisted detailing marketplace requires one-to-one matching; each sailor can only fill one billet and each billet can only accommodate one sailor. As such, the enlisted detailing marketplace requires a mechanism that both sets market-clearing prices and solves the Navy’s one-to-one enlisted assignment problem.

The discussion in this report has developed and discussed several COAs and compared them across a common set of six metrics. These metrics include (Coughlan & Gates, 2010):

- **Precision**: assignment/retention incentives should accurately meet the intended talent-management objectives, including overall end-strength and distribution across specific assignments; an imprecise program “overshoots” or “undershoots” these targets.
• **Voluntary**: assignment/retention incentives should be structured such that each service member willingly accepts the proposed assignment and perceives that compensation for the assignment is both satisfactory and fair.

• **Flexible and Responsive**: assignment/retention incentives should be flexible enough to adjust resources quickly and effectively in response to emerging issues, shifting priorities, and changing market conditions.

• **Best Value**: assignment/retention incentives should provide cost-effective solutions to address specific Navy needs while minimizing cost. Best value involves at least three considerations: (a) targeting those qualified service members most willing to engage in the desired labor commitment, (b) minimizing overpayment for these labor commitments, and (c) identifying the minimum cost incentive packages.

• **Support Achievement**: assignment/retention incentives should successfully compete for talent, reward exceptional performance, and recognize sailors’ contributions to the Navy’s mission.

• **Practicality**: addresses the ease of implementation for the Navy and ease of service member participation.

This research examined six COAs, including: traditional retention and assignment processes, a basic auction, a quality adjusted auction to account for past and expected future performance, a combinatorial auction that incorporates individualized packages of non-monetary incentives, two-sided matching, and two-sided matching with money. Each of these COAs was informally graded for each of the six performance metrics and each was discussed in terms of its ability to address the retention and assignment aspects of the enlisted detailing market place. These results are summarized in Table 7 below.

<table>
<thead>
<tr>
<th>COA</th>
<th>Precision</th>
<th>Voluntary</th>
<th>Flexible &amp; Responsive</th>
<th>Best Value</th>
<th>Support Achievement</th>
<th>Practicality</th>
<th>Retention</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Traditional Retention &amp; Assignment</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>Basic Auction</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>Medium-High</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>QUAD Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>CRAM Auction</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>Medium</td>
<td>X</td>
</tr>
<tr>
<td>5</td>
<td>Two-Sided Matching</td>
<td>Medium</td>
<td>High</td>
<td>Medium-Low</td>
<td>Medium</td>
<td>Medium-High</td>
<td>Medium</td>
<td>X</td>
</tr>
<tr>
<td>6</td>
<td>Two-Sided Matching with Money</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>X</td>
</tr>
</tbody>
</table>
As expected, the traditional reenlistment and assignment process addresses both retention and assignment and is practical reflecting that both the Navy and sailors are comfortable with how these processes currently work. However, they are less effective for precision (primarily retention incentives), voluntary (primarily the assignment process), flexible and responsive, best value, and support achievement.

Auctions are best suited to address retention issues and the basic auction preforms particularly well across the precision and flexibility and responsive metrics. The basic auction can be modified to incorporate adjustments for past or predicted future sailor performance (QUAD), individualized NMI packages (CRAM), or both. While leading to more complicated auction designs, these modifications would improve best value and support achievement. However, auctions cannot effectively address the one-to-one assignment process required in the enlisted detailing marketplace. A particular sailor might be the low bidder for several billets in the auction COAs and the resulting assignments would depend on the rules the Navy adopts to resolve this issue (e.g., minimize auction payments, minimize overall retention and assignment costs, maximize some measure of either sailor or Navy value, or some combination of these factors). The rule adopted will affect the sailor’s bidding strategies, which we have not explored.

Two-sided matching is specifically designed to address the assignment problem and incorporates the Navy’s rank-order preferences over sailors and sailors’ rank order preferences over billets. As such, it is voluntary and supports achievement. However, two-sided matching does not address retention. Further, it does not ensure that all billets will be filled, particularly hard-to-fill priority billets, or that all qualified sailors will receive an assignment. Finally, it is slightly less practical because it requires the Navy to express rank-order preferences over individual sailors or classes of sailors, possibly through a multi-attribute utility function.

Two-sided matching with money addresses the retention and priority billet issues by associating values to the Navy for filling particular billets with particular sailors, or classes of sailors. Navy values are integrated with sailor willingness to fill specific billets creating a market-based process that provides the best performance of all COAs across the six performance metrics, while also addressing both retention and assignment concerns.
Clearly, two-sided matching with money is the COA that best fits the Navy’s preferences for an enlisted assignment and retention marketplace.

A. FUTURE RESEARCH

There are at least two questions that deserve further research. The assignment and retention process can potentially span several assignment windows for any particular sailor. None of our prior research, or other academic research, has examined the impact this may have on sailors’ bidding strategies. Will they be more selective in the earlier rounds in the hopes of finding a “good deal” or will they prefer to know sooner rather than later their future assignment and retention incentive? This should be explored for any COA under consideration for future adoption.

For the three auction COAs, past research has both simulated the auction performance and experimentally examined how sailors can be expected to bid in these auctions. However, as described above, any particular sailor could win multiple auctions requiring the Navy to develop an assignment algorithm to assign winners to just one billet and replacing them with other sailors in the billets they won but will not fill. It is unclear how this assignment mechanism will affect bidding strategies, and this should be explored experimentally. Experimental results regarding the Navy’s AIP auction indicate that the impact on bidding behavior could be significant.
APPENDIX A: NAVY AG ENLISTED CLASSIFICATION

Navy Enlisted Occupational Standard for Aerographer’s Mate (AG)

Scope of Rating

Aerographer’s Mates (AG) collect, measure, and analyze the elements of the physical environment (Land/Sea/Air/Space) and land/sea interface; synthesize a vast array of oceanographic, hydrographic, celestial, and meteorological data and in situ observations and measurements to produce forecasts and warnings in support of safety of flight, navigation, and naval/joint operations and missions; demonstrate expertise in METOC equipment and systems, Geospatial Information and Services (GIS), and tactical decision aids; combine knowledge of the operating environment with a thorough understanding of warfighting capabilities to assess and predict environmental impacts to friendly and enemy platforms, sensors, and weapon systems; develop actionable recommendations regarding tactics, techniques, and procedures that fully exploit environmental parameters, mitigate risk, and enable decision superiority across all warfighting areas and strategic and enabling capabilities; operate unmanned systems, small boats and expeditionary survey vehicles to collect meteorological, hydrographic and oceanographic data; and distribute data internally and externally to platforms and operational activities via communication devices, web-centric architecture, or on-scene in direct support of afloat units, fleet/joint staffs, or combatant/operational commanders.

This Occupational Standard is to be incorporated in Volume I, Part B, of the Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards (NAVPERS 18068F) in Chapter 5. (NPC, January 2023)
CAREER PATTERN

AGCM

AGCS

AGC

AG1

AG2

AG3

AIRMAN
APPRENTICESHIP
APPENDIX B: REVISED NAVY AG ENLISTED CLASSIFICATION

JXXX – Information Warfare (Meteorology/ Oceanography) Community & Career Field

J00A – Meteorological and Oceanographic (METOC) Forecaster

Conducts a broad range of METOC forecasting activities to be performed in a wide variety of contexts in the generation of METOC products and operational recommendations. Assesses the impact of the elements of the physical environment (Land/Sea/Air/Space) and land/sea interface on both friendly and enemy platforms, sensors and weapon system performance, safety of flight and navigation, and naval/joint operations and missions. Evaluates numerical model performance to quantify the accuracy and reliability of future performance. Analyzes hydrographic features and elements on nautical/navigation charts and forecasts METOC conditions on Synoptic, Meso, and Micro scales. Analyzes side-scan, multi-beam, and single-beam sonar imageries. Collects and analyzes ocean bottom data using unmanned underwater vehicles. Creates climatological studies supporting Naval Warfare Planning. Produces forecasts and warnings. Characterizes the operating environment and recommends courses of action to enhance the warfighters’ ability to exploit the physical environment for successful mission accomplishment. Briefs forecasted METOC conditions in support of Warfare Operations (e.g. Anti-Submarine Warfare (ASW), Mine Warfare (MIW), Strike Warfare (STW), Navy Special Warfare (NSW)). Distributes data internally and externally to aircraft, ships, and shore activities via communication devices/web-centric architecture.

<table>
<thead>
<tr>
<th>Source Rating: AG</th>
<th>Billet Paygrades: E4-E6</th>
<th>Personnel Paygrades: E4-E6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course: Mandatory</td>
<td>CIN: C-420-2011</td>
<td>CDP: 390P</td>
</tr>
<tr>
<td>Sequence Code: 3</td>
<td>ESTB Date:</td>
<td>NR Ind: A</td>
</tr>
<tr>
<td>Component NEC:</td>
<td>Related NEC:</td>
<td>Legacy NEC Code: 7412</td>
</tr>
<tr>
<td>Primary Advisor:</td>
<td>Technical Advisor:</td>
<td>ECM: BUPERS-32</td>
</tr>
<tr>
<td>OPNAV N960</td>
<td>NAVMETOC</td>
<td></td>
</tr>
</tbody>
</table>

(NPC, July 2023, p. 79)
THIS PAGE INTENTIONALLY LEFT BLANK
LIST OF REFERENCES


MILITARY.COM. (Feb. 5, 2018). *Navy to synch rotation and separation dates.*


INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Office of Research and Innovation, Code 41
   Naval Postgraduate School
   Monterey, CA 93943