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THESIS

OPTIMIZING UNITED STATES COAST GUARD PREVENTION JUNIOR OFFICERS ASSIGNMENTS

by

Jose M. Rosario

December 2013

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13. ABSTRACT

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Currently, USCG officers are eligible for reassignment every three years for operational billets and every four years for staff billets. For AY13, the USCG decided to implement a more regional assignment process in order to reduce cost; we will be looking into how regional assignments will impact the professional development of USCG officers. The objective of this thesis is to find a balance between cost savings and the exposure that a junior officer must have in order to achieve the expertise needed for more senior positions later on in his or her career.

We explore the impact distance between duty stations can have in assignments for United States Coast Guard junior officers using a combinatorial optimization method called the Hungarian algorithm.

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OPTIMIZING UNITED STATES COAST GUARD PREVENTION JUNIOR OFFICERS ASSIGNMENTS

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For years, a diverse assignment history has been considered beneficial to the service and the member. Ideally, the Coast Guard would like members to experience different geographical locations throughout their careers. Although geographical diversity is still considered beneficial, the Coast Guard must find a way to provide geographical diversity at a lower cost.

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LIST OF ACRONYMS AND ABBREVIATIONS

ALCGOFF	all Coast Guard officers
AMIO	alien migrant interdiction operations
AO	assignment officer
ATON	aids to navigation
AY	assignment year
INCONUS	inside the continental United States
JCSP	Junior Command Screening Panel
LMR	living marine resources
MCESG	Marine Corps Embassy Security Group
MEP	marine environmental protection
O1	ensign
O2	lieutenant junior grade
O3	lieutenant
O4	lieutenant commander
O5	commander
OCS	Officer Candidate School
OCONUS	outside the continental United States
OLE	other law enforcement
PCS	permanent change of station
PWCS	ports, waterways, and coastal security
SAR	search and rescue
USCG	United States Coast Guard
USMC	United States Marine Corps
USN	United States Navy

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I. INTRODUCTION

A. UNITED STATES COAST GUARD

1. Brief History

Since its formation as the Revenue Cutter Service in 1790 as part of the U. S. Treasury Department, the United States Coast Guard (USCG) has acquired many missions. In 1832, assisting mariners in distress during the winter months became the responsibility of the Revenue Cutter Service, undertaking its first lifesaving mission. The USCG as we know it was formed in 1915 after merging with the Life Saving Service. Since its formation, three more agencies have merged with the U. S. Coast Guard: the U.S. Lighthouse Service, the Steamboat Inspection Service and the Bureau of Maritime Investigations. In 1967, the Coast Guard was moved from the Treasury Department to the Department of Transportation. On March 1, 2003, the USCG joined the newly created Department of Homeland Security, as a result of the September 11, 2001 terrorist attacks.

What started as a tax collection and enforcement agency has evolved into a multi-mission branch of the military with jurisdiction far beyond domestic waters. Today's Coast Guard has the following 11 statutory missions:

- Ports, Waterways, and Coastal Security (PWCS)
- Drug Interdiction
- Aids to Navigation (ATON)
- Search and Rescue (SAR)
- Living Marine Resources (LMR)
- Marine Safety
- Defense Readiness
- Alien Migrant Interdiction Operations (AMIO)
- Marine Environmental Protection (MEP)
- Polar Ice Breaking Operations
- Other law enforcement (OLE)

A workforce of nearly 59,000 active, reserve and civilian members of the United States Coast Guard accomplish the above listed missions.

B. OVERVIEW OF U.S. COAST GUARD JUNIOR OFFICER ASSIGNMENTS

Currently, USCG officers are eligible for reassignment every three years for operational billets and every four years for staff billets. Officers can be considered for reassignment before tour completion if an early rotation is requested or if the officer holds a rank higher than designated by the billet. The junior officer assignment process for a typical assignment year (AY) is as follows:

- The process starts with a 4-month career counseling and guidance period.
- E-Resume[1] due for Advance Education programs
- Special Assignments Shopping List[2] released to applicants
- Regular Shopping List released
- E-resume submission deadline for all officers Commanders and below for Special Assignments
- E-resume submission deadline for all Captains and below
- Junior Command Screening Panel (JCSP)
- All lieutenant commanders and OCONUS assignments completed
- Lieutenants and below assignments completed

Once all scheduled assignments are completed, the process starts all over again for officers transferring the following AY. In conjunction with the regular AY, Assignment Officers (AO) must also complete off-season assignments[3].

C. CONTRIBUTION OF THESIS

The purpose of this thesis is to find a more efficient and feasible way to complete assignments for USCG officers, specifically for the junior officers account: lieutenants (O3), lieutenants junior grade (O2) and ensigns (O1). Over the years assignment officers

[1] An E-Resume is the method used by applicants to convey to AOs their desire assignments.

[2] The Shopping List is the list of available jobs during the current AY.

[3] Off-season assignments include accessions programs, such as the USCG Academy, Officer Candidate School (OCS), and all other assignments outside the regular cycle.

have been issuing orders based on various performance factors. Although one of those factors was "needs of the service," fiscal needs did not play a big role into the assignments. For years, having a diverse assignment history has been considered beneficial to the service and the member. Ideally, the Coast Guard would like members to experience different geographical locations throughout their careers. Although geographical diversity is still considered beneficial, the Coast Guard must find a way to provide geographical diversity at a lower cost. Currently, the average permanent change of station (PCS) cost is around $25,000, with an average of 1000 junior officers transferred every year. Reducing PCS costs can easily be achieved by putting relocations on hold or by increasing the tour lengths. Although this might seem the most logical solution, it might not be the most beneficial in the long term, as freezing assignments and extending tour length can result in a lower than desired expertise in senior officers.

For AY13, the USCG decided to implement a more regional assignment process in order to reduce cost; we will be looking into how regional assignments will impact the professional development of USCG officers. The objective of this thesis is to find a balance between cost savings and the exposure that a junior officer must have in order to achieve the expertise needed for more senior positions later in his or her career.

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II. BACKGROUND AND RELATED WORK

A. ASSIGNMENTS AND CAREER PROGRESSION

The United States Coast Guard has over 200 units worldwide, those units are divided into nine Districts and USCG Headquarters (Figure 1). Districts are further divided into 35 Sectors or shore-based operational units. A group of 47 assignment officers (AO) are in charge of keeping all units staffed with the best candidate for each job. Thirty five AOs manage enlisted assignments accounts and 12 AOs manage officers' accounts. Officer accounts are divided by specialty and rank. For our purposes we will be mainly looking at the two prevention accounts. Prevention officers main duties include inspection of commercial vessels and facilities, maritime accidents and personnel investigations, and waterways management. These accounts are currently managed by two officers, one manages prevention assignments for commanders (O5s) and lieutenant commanders (O4s), the other one manages lieutenants, lieutenants junior grade and ensigns. Even though each AO has its own account, they must work closely to ensure that each billet is filled with the best candidate. Close coordination is imperative since in some cases O3s are needed to fill O4 positions.

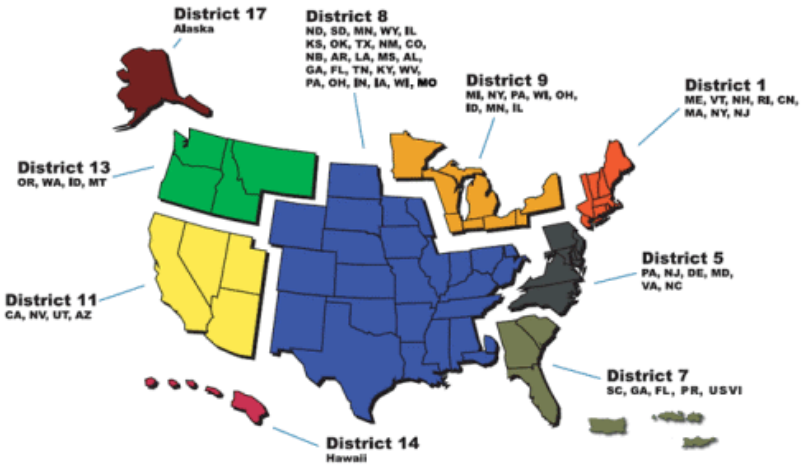

Figure 1. Map of USCG districts. All units outside the U.S. operate under of one of these districts or headquarters (from United States Coast Guard Auxiliary, 2008).

Assignment officers use the following 14 factors when completing assignments:

- Needs of the service
- Commanding officer's recommendation
- Performance history
- Member's desires
- Time at present unit
- Time in present geographic area
- Previous assignment history (isolated, ashore, afloat, outside the continental U.S. [OUTCONUS] and inside the continental U.S. [INCONUS])
- Advancement or promotion status and leadership potential
- Service remaining in original enlistment
- Qualifications
- Security clearance
- Service remaining before approved retirement date
- Willingness to obligate service for transfer
- Physical condition

As an officer, career planning should start at a very early stage. The process starts with a soon-to-be officer applying for a job upon commission. At that stage they must decide which career path to follow. If he or she decides to be a pilot, the appropriate steps must be taken for selection. If they decide to go the prevention officer route, they must start thinking which of the jobs available will be more beneficial for their career. Even if an officer is unsure about his or her career path, assignments must be carefully planned. When looking at assignment options, officers must try to achieve a balance between challenging leadership positions, operational and support assignments and education over the course of their careers. Basically, every officer must base his or her assignment desires on their goals.

After the establishment of the 35 sectors, the USCG has various assignment guides designed to assist officers with assignment decisions. They outline recommended assignments as an officer moves through the ranks (Figure 2). Within the Prevention field, officers must strive for an initial assignment that will afford the opportunity of

acquiring basic qualifications that will enhance their knowledge about the prevention field, such as a feeder port[4]. Feeder Ports provide new prevention officers with a myriad of training opportunities that are not frequently available in non-feeder ports; therefore, developing prevention knowledge at a non-feeder port can be more challenging. As officers progress in their career, it is highly recommended to seek staff or Out-of-Specialty assignments; these assignments will provide officers with a broader view of USCG and will make them more proficient in key leadership positions.

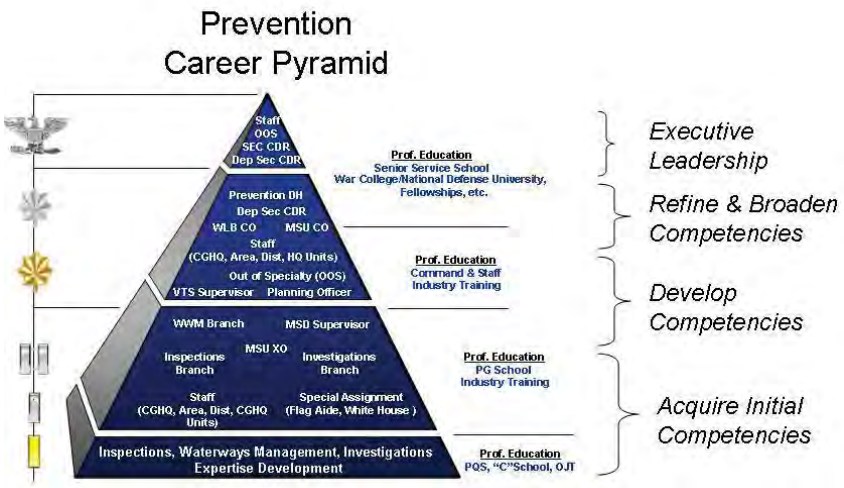

Figure 2. Career pyramid for prevention officer from O1 to O6 (from USCG, 2005).

B. COMPETENCIES

Due to the nature of the operations conducted by prevention officers there are dozens of qualifications that one can acquire. Some of these qualifications are limited to the region to which an officer is assigned due to the fact that some vessels operate mainly in certain regions. For example, it is nearly impossible to obtain the Foreign Passenger Vessel Examiner qualification if stationed in the Ninth District due the fact that there are not enough vessels in that region for officers to gain enough proficiency to conduct such examinations. But that does not mean officers are limited in the amount of qualifications one can achieve. The number of qualifications that one can achieve during an assignment

[4] Feeder Port is a USCG unit with enough workload that enables diverse prevention training opportunity.

is only limited by the level of performance of the member. High performing officers will seek qualifications beyond those expected from them to do the job. Those who go above and beyond will be compensated with more assignment opportunities.

On October 15, 2010, a law was passed requiring prevention officers to possess certain qualifications in order to fill prevention department head positions. The Coast Guard Authorization Act of 2010 requires a marine inspector qualification plus marine investigator or marine safety engineer qualification for all prevention department head positions. Such qualifications require years of experience and training, not to mention that in most cases there are various perquisite qualifications one has to obtain before such qualifications. As shown in Figure 2, prevention department head is a position that prevention officers should strive for, so it is important that officers stay on track when it comes to qualifications in order to be promoted to assignments of greater responsibility.

C. TRAVEL RESTRICTIONS

The USCG like all other federal agencies is facing fiscal reductions due to budgetary constraints that have been set government-wide. In order to keep providing much needed services and protection to taxpayers, the USCG needs to find ways to reduce costs in some areas and use those savings in more critical areas. On October 10, 2012, the USCG commandant announced, via distribution to All Coast Guard Officers (ALCGOFF), a mandatory reduction in all forms of travel to include PCS travel as part of the direction received from the White House Office of Management and Budget. As a result of this order, travel cost became part of the "needs of the service" assignment factor. For the AOs that means they have to pay more attention to the cost of filling all jobs during the assignment season than before. AOs can adhere to the commandant's orders by increasing the amount of no cost assignments, such as local transfers, fleet-ups[5] and extensions. For USCG officers, it means AOs can assign them to jobs within their current geographical region in order to reduce cost, which is contrary to the geographical diversity that has been encouraged in the past.

[5] Fleet-ups are job promotions within a unit.

D. RELATED WORK

Since the initiative to lower PCS cost by exercising more no-cost transfers is only a few months old, very little research has been done to determine the impact of such decisions on an officer once they reach more senior level. Fortunately, the U.S. Army, Marine Corps (USMC) and the Navy (USN) have previously worked on similar problems.

Loerch et al. (1996) approached assignment efficiency in Europe for Army personnel using an integer program. The program itself was not developed to provide a solution, but rather to provide decision makers with multiple options and its implications.

Tivnan (1998) developed a network model for enlisted personnel within the USMC that focused on assigning the best candidate to a job while reducing cost. The model addresses some of the same issues in the USCG, such as minimizing transfer cost within the continental U.S. without sacrificing the quality of the match.

Enoka (2011) designed an Excel-based tool that streamlined the assignment process for the Marine Corps Embassy Security Group (MCESG). This tool not only reduced the amount of time AOs were dedicating to completing assignments by 80%, but also improved the match quality.

The goal of this thesis is to use an approach similar to the one used by the USMC to improve the quality of the match for each prevention billet, while minimizing the distance between the departing and the receiving unit.

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III. THE ASSIGNMENT PROBLEM

A. INTRODUCTION

In assignment problems, we are trying to find an optimal solution to assigning *n* amount of personnel to *n* amount of jobs. The possibilities and its cost can be expressed with an *n x n* matrix, where every job is represented by a column and candidates are represented by rows. The cost of assigning the n^{th} candidate to the n^{th} job will be recorded in the corresponding cell. For these type of problems we have n^2 data points that we must consider in order to find a solution. Since a person assigned a job cannot be considered for any other jobs, we have *n!* possible solutions that we need to explore in order to find the optimal solution. Optimality can be measured in many ways. For example, it can be based on how much each person gets paid to do the job or in our case how many miles a person needs to travel to his new job. In the following section, we will discuss different methods that can be used to solve such problems.

B. METHOD OF SOLVING ASSIGNMENT PROBLEMS

1. Exhaustive Search

When dealing with simple assignment problems, exhaustive search is considered the most efficient method. Solving an assignment problem can be accomplished with just a pencil and paper or maybe a calculator. For example, we have three candidates to consider for each job and we want to minimize the total distance travel by candidates to their new jobs (Table 1). A problem like this has six possible solutions, which can be easily done using brute force.

	Washington, DC	Miami, FL	New York, NY
Candidate 1	100	200	300
Candidate 2	300	100	200
Candidate 3	200	300	100

Table 1. Miles each possible assignment will incur.

One possible solution is presented in Table 2. Here we assign Candidate 1 to the city that will incur the least mileage, Washington, DC. That will leave us with two options for Candidate 2 or 3, depending on who we allocate first. Say we decided to allocate Candidate 2 next, since we cannot assign him to Washington, then our options are Miami or New York. Out of the two options the most efficient choice is to assign him to Miami, so that will leave that last candidate with only one option, New York, for a total of 300 miles.

	Washington, DC	Miami, FL	New York, NY
Candidate 1	**100**	200	300
Candidate 2	300	**100**	200
Candidate 3	200	300	**100**

Table 2. Option One for candidates' assignment.

Another solution presented in Table 3, assigns Candidate 1 to Washington, Candidate 2 to New York and Candidate 3 to Miami for a total of 600 miles. This is twice as far as our first solution. If we try all six possibilities, we will see that our first solution is the most efficient way of assigning these three candidates based on the information given.

	Washington, DC	Miami, FL	New York, NY
Candidate 1	**100**	200	300
Candidate 2	300	100	**200**
Candidate 3	200	**300**	100

Table 3. Option Two for candidates' assignment.

Solving a problem of this size is fairly simple, but as the number of candidates and locations increase, so do the possibilities. If we add just one more candidate and one more job we will have 16 data points and 24 possibilities to consider. In this case the possibilities quadruple by just adding one more candidate and job. This method is not efficient when dealing with a large number of candidates and jobs.

2. Minimum-Cost Flow and Linear Programming

Assignment problems can also be solved using minimum cost flow models. We will demonstrate how this works using the data from Table 1. Assignment problems can be illustrated using bipartite directed graph (Figure 3) in which the nodes to the left are the candidates and the ones to the right represent the assignment locations. If the candidate is available and qualifies for the job, we will draw an edge from the candidate node to the job node. In order to create flow, we need to assign supply and demand. Since each candidate node represents one candidate, the supply of each candidate node is one and the same goes for the demand. The supply will be negative, indicating that a person must leave and the demand will be positive to indicate that a person needs to arrive. All edges will be labeled with the miles, lower bound and upper bound. In our case the lower bound will be zero and the upper will be one. Zero means the edge is not being used and one means it is.

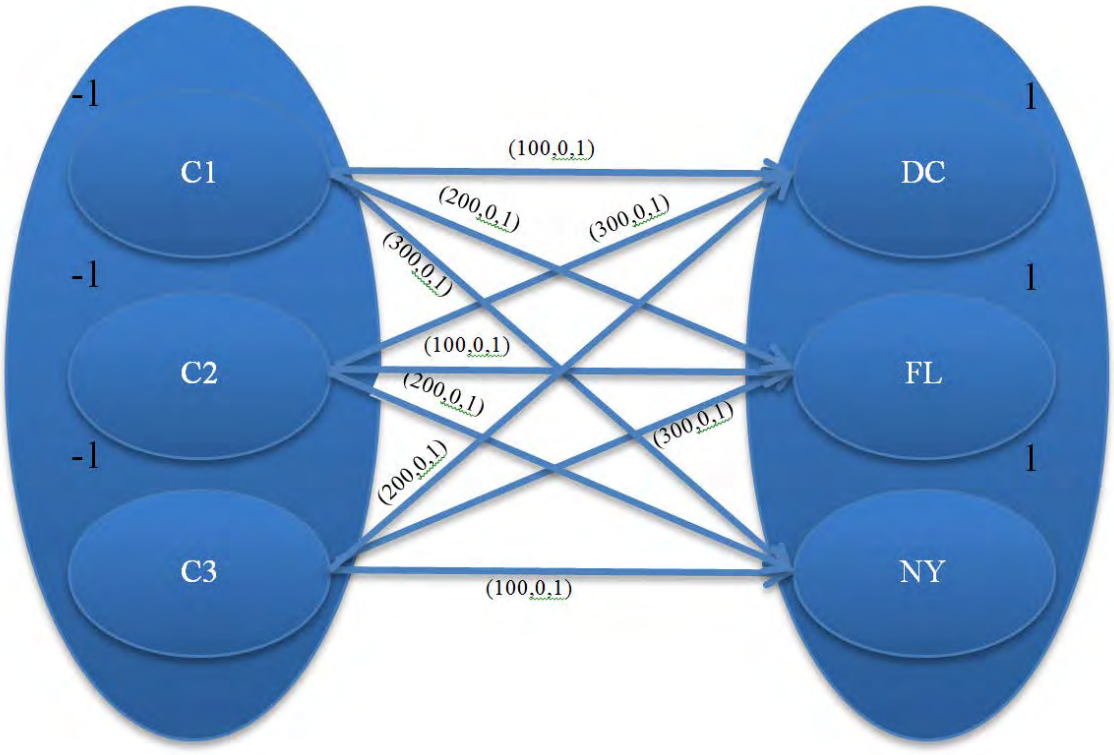

Figure 3. Bipartite graph illustrating assignment possibilities.

We can also formulate this problem into the linear program (Equation 1) commonly used to solve assignment problems given the sets $j \in J$ and $b \in B$, where j stands for junior officer and b for billet. In order to solve this problem we must consider the variable a_{jb} and the data m_{jb}. a_{jb} represents the decision to assign a junior officer j to a billet b. This variable will equal one for the junior officer j that was identified as the best candidate for billet b and zero otherwise. Then we have the cost m_{jb}, which in our case is the of amount miles a junior officer j must travel to its assigned billet b. We must also add two constraints to make sure only one person is assigned per billet. First, we limit the number of billets a person can fill by making the sum of all billets assigned to a person equal to one, then we limit the number of people that can be assigned to a billet by making the sum of all junior officers assigned to a billet equal to one. This is what is commonly known as the assignment problem in linear programming. Since it needs to explore how each candidate compares to every candidate for n^2 data points it has a run time of n^4.

$$\begin{aligned} \min_{m} & \sum_{(j,b)} a_{jb} m_{jb} \\ & s.t. \\ & \sum_{b} a_{jb} = 1, \forall j \\ & \sum_{j} a_{jb} = 1, \forall b \\ & a_{jb} \geq 0, \forall j, b \end{aligned} \tag{1}$$

3. Hungarian Method

The Hungarian method is a combinatorial optimization algorithm for solving this type of problem developed by Harold W. Kuhn in 1955. One thing that we need to keep in mind when implementing this algorithm is that adding or subtracting a constant to all the elements of any row or column does not change the outcome. To show how this algorithm works we will start by converting an assignment table into a cost matrix (Figure 4).

$$\begin{array}{c|ccc} & DC & FL & NY \\ C1 & 130 & 900 & 800 \\ C2 & 780 & 900 & 990 \\ C3 & 770 & 230 & 550 \end{array} \Rightarrow \begin{pmatrix} 130 & 900 & 800 \\ 780 & 900 & 990 \\ 770 & 230 & 550 \end{pmatrix}$$

Figure 4. Cost matrix.

The next step is to subtract the minimum cost of each row from each element in that row (Figure 5). After each step, we want to determine the minimum amount of lines that it will take to cross all zeros in the matrix. Optimality is achieved once the minimum numbers of lines required to cross all zeros is equal to *n*.

$$\begin{pmatrix} 130 & 900 & 800 \\ 780 & 900 & 990 \\ 770 & 230 & 550 \end{pmatrix} \Rightarrow \begin{pmatrix} 0 & 770 & 670 \\ 0 & 120 & 210 \\ 540 & 0 & 320 \end{pmatrix} \Rightarrow \begin{pmatrix} 0 & 770 & 670 \\ 0 & 120 & 210 \\ 540 & 0 & 320 \end{pmatrix}$$

Figure 5. Initial cost minus minimum row cost.

Since all zero entries can be cover with a minimum of two lines, we need to keep moving forward. Now, we are going to subtract the minimum column cost form each element of its column (Figure 6).

$$\begin{pmatrix} 0 & 770 & 670 \\ 0 & 120 & 210 \\ 540 & 0 & 320 \end{pmatrix} \Rightarrow \begin{pmatrix} 0 & 770 & 460 \\ 0 & 120 & 0 \\ 540 & 0 & 110 \end{pmatrix}$$

Figure 6. Minus minimum column cost.

Notice that there are multiple ways of covering all zero entries, but we need a minimum of three lines to accomplish it (Figure 7). This means we have found an optimal solution. The sum of the assignment must equal zero in order to be considered optimal.

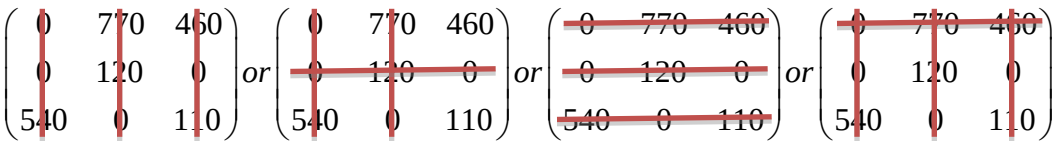

Figure 7. Four different ways to cover all zero entries.

Now we can check what the true cost of this assignment is using the values in our original cost matrix (Figure 8). The optimal assignment will be to assign Candidate 1 to Washington, DC; Candidate 2 to New York, NY and Candidate 3 to Miami, FL, with a cost of 1350 miles.

$$\begin{pmatrix} 0 & 770 & 460 \\ 0 & 120 & 0 \\ 540 & 0 & 110 \end{pmatrix} \Rightarrow \begin{pmatrix} 130 & 900 & 800 \\ 780 & 900 & 990 \\ 770 & 230 & 550 \end{pmatrix}$$

Figure 8. Optimal solution.

One way to demonstrate the efficiency of this method is by comparing it with the ones we previously discussed. Keep in mind that it takes six iterations to find a solution using brute force, $n!$, and if we use minimum cost flow it takes 81 iterations, n^4. We are going to use the data from the brute force example for this comparison (Figure 9).

$$\begin{pmatrix} 100 & 200 & 300 \\ 300 & 100 & 200 \\ 200 & 300 & 100 \end{pmatrix}$$

Figure 9. Assignment cost matrix.

By subtracting the lowest cost of each row from all the elements in that row we get the matrix below (Figure 10). We can cover all zero entries with three lines. Since the minimum number of lines equals n, we can say that the optimal assignment is Candidate 1 to Washington, DC; Candidate 2 to Miami, FL and Candidate 3 to New York, NY, with a cost value 300. Using this method we found an optimal solution in just one step, which translates to 27 iterations, n^3.

$$\begin{pmatrix} 0 & 100 & 200 \\ 200 & 0 & 100 \\ 100 & 200 & 0 \end{pmatrix} \Rightarrow \begin{pmatrix} 0 & 100 & 200 \\ 200 & 0 & 100 \\ 100 & 200 & 0 \end{pmatrix} \Rightarrow \begin{pmatrix} 100 & 200 & 300 \\ 300 & 100 & 200 \\ 200 & 300 & 100 \end{pmatrix}$$

Figure 10. Assignment cost matrix.

Figure 11 shows how each of these methods compare to each other when it comes to numbers of iterations that one needed to complete in order to obtain an optimal solution.

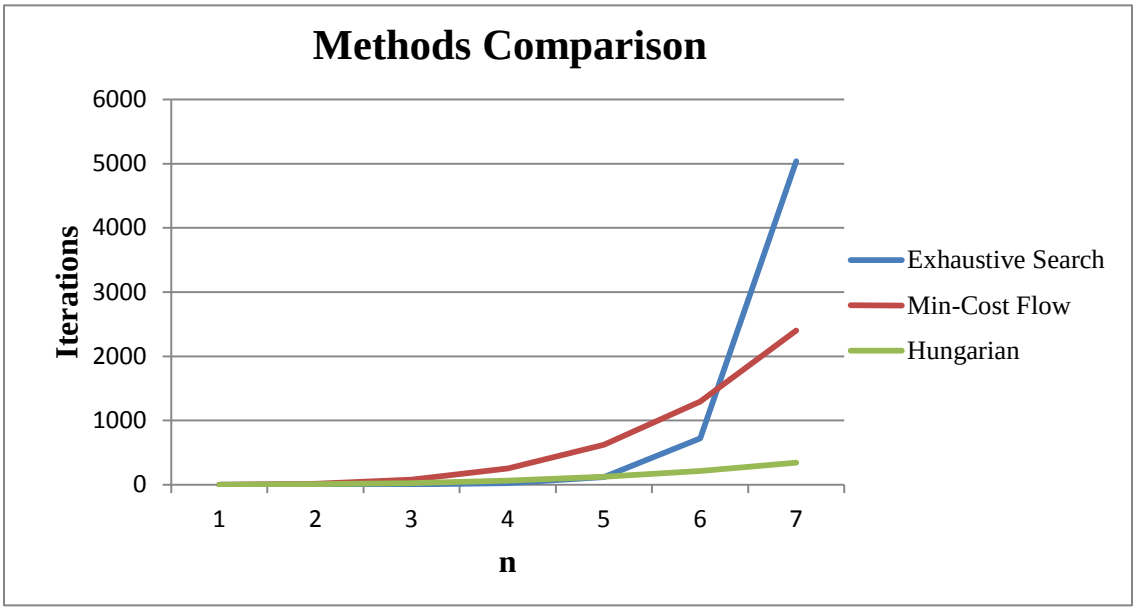

Figure 11. Iterations comparison between all three methods.

As you can see as *n* gets larger, the difference in iterations between methods is significant. Since our *n* will be large, we will use the Hungarian method to find an optimal solution to the assignment of junior officers.

C. ASSIGNMENT DATA

In order to provide the Coast Guard with the best quality of match for each billet during the regular and off-season assignments, detailers must carefully review and consider information from three main sources: the Coast Guard policies, the command's input and the member's data. Each of the sources provides the AOs with the vital

information needed to successfully match a candidate to a position in accordance with the 14 assignment factors presented earlier. Table 4 shows how in some instances more than one source can contribute to one factor. For example, AOs must compare the qualifications held by an officer with those mandated by the Coast Guard for certain billets and those qualifications desired by the receiving command in order to clearly access the qualification factor.

Source	Assignment Factors
USCG Policies and Command Input	Needs of the Service
Member's Data and Command Input	Commanding Officer's recommendation
Member's Data	Performance history
Member's Data	Member's desires
Member's Data	Time at present unit
Member's Data	Time in present geographic area
Member's Data	Previous assignment history
USCG Policies and Command Input	Advancement or promotion status and leadership potential
Member's Data	Service remaining
Member's Data, USCG Policies and Command Input	Qualifications
Member's Data	Security Clearance
Member's Data and USCG Policies	Service remaining before approved retirement date
Member's Data	Willingness to obligate service for transfer
Member's Data and USCG Policies	Physical condition

Table 4. Sources and assignment factors.

1. USCG Policies

There are certain USCG regulations that AOs must follow when filling certain jobs. For example, there are some qualifications that an officer must have in order to serve as Prevention Department Head. These are the minimum qualifications established by the commandant. Commands can further request other qualifications deemed necessary to successfully fulfill the duties required of that position. The Coast Guard has

specific guidance when it comes to prevention officers in positions such as commanding officers, executive officers, department heads, Chief of Inspections Division and Chief of Investigations Division.

2. Command's Input

Each receiving command is given the opportunity to provide the AO input regarding the ideal candidate for the job. The most common input provided by commands is the qualifications needed on top of those established by USCG policies and the possibility of a fleet-up or extension. Commands must provide justification on how such assignments will impact their operations and the benefits for the unit and the Coast Guard. AOs will take this input into account when filling positions, but are not required to abide by it, since these are just the desires of the receiving command. Instead of allowing a member to fleet-up, the detailer might deem it necessary to move the member to another location. They have that prerogative since they have a broader view of the needs of the service, not just the needs of that specific command.

3. Member's Data

This data provide the detailer with the greatest amount of information needed to proceed with the assignment process. This data can be divided in two subcategories:

a. Personal data: Includes name, gender, security clearance, rank, time of mandatory service remaining and special needs

b. Professional data: Includes date of rank, tour completion date, qualifications, assignment history, assignments preferences, performance history and member's career intentions

Once all the data are collected, the AO can proceed with the assignment process. This is when the AO compiles a list of candidates for every position. The initial list of candidates does not take into account the USCG policies and command's input, rather, this list is solely based on member's data. AOs will narrow the list of candidates based on the input received from the commands and Coast Guard Policy.

D. ASSIGNMENT VARIABLES

For the purpose of this thesis, we are going to use two variables, performance score and miles between current command and future command to determine an assignment score that we will compile into a table. It will be used to find an optimal assignment. We are going to encompass all applicable assignment factors within these two variables; both of these numbers will be in a scale from 0 to 1.

1. Assignment Score

For Assignment score we are going to use three main factors: Commanding officer's recommendation, performance history and qualifications. In Table 5 we will demonstrate how each member will be scored for each factor.

Assignment Factors	Label	Score
Commanding Officer's recommendation	*Rec*	1, if recommended and 0, otherwise.
Performance history	*Perf*	Between 0 and 1.
Qualifications	*Quals*	0, if Apprentice 0.5, if Journeyman 1, if Advanced

Table 5. Assignment factors and scoring.

Assignment score will be determined using Equation 2. Note that not all factors are taken into account in this formula. This score will provide us with a ranking for each officer based on the three factors that were selected. All other factors will play a role later when determining best candidates for the job.

$$\frac{Rec + Perf + Quals}{MaxScore} \tag{2}$$

2. Mileage Score

This score will be calculated using the actual distance from the member's current command to its possible future command and the maximum distance a member can drive between units within the continental United States (Equation 3).

$$Mileage\ Score = \frac{Actual\ Distance}{Max\ \ Distance} \tag{3}$$

An assignment score for every member as it relates to each job will be determined using Equation 4. Note that since we are a looking to reduce mileage, we are going to use one minus the Mileage Score. We will be weighting the performance and mileage score so we can adjust how much importance we want to give to each factor. The sum of the weights must be equal to one.

$$Assignment\ Score = \left(Weight_p \times Performance\ Score\right) + \left(Weight_m \times 1\text{-}Mileage\ Score\right) \tag{4}$$

Now that we can assign a score to every member for every job, we can use this information to figure out how the distance between locations impacts the assignment process for junior officers. In the following chapter, we are going to discuss all feasible solutions and its implications for the Coast Guard.

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IV. PREVENTION ASSIGNMENTS ANALYSIS

A. FEASIBLE SOLUTIONS

In this section, we are going to show the results of the different scenarios. Our scenarios are based on the weights of our two scores. In order to determine what our options are when it comes to this problem, we are going to compute assignment scores for every possible combination of performance weight and mileage weight for 46 prevention junior officers. These 46 billets and its incumbents were selected from the AY13 Lieutenant Shopping List (USCG, 2013a). The assignment data for all applicable billets was provided by the Special Assignments AO. For the purpose of this thesis, we are only going to use billets within the contiguous United States.

Since both the sum of performance weight and mileage weight needs to equal one, for every point we take from performance weight we need to add one to mileage weight. This method will produce 101 assignment score matrices, with 100 percent weight on performance and zero weight on mileage, to zero weight on performance and 100 percent on mileage. Once these matrices are produced, we are going to calculate the best possible solution for each using the Hungarian algorithm. Then, we are going to sum the amount of miles each member travels to their respective assignment for each scenario. We are going to compare all possible scenarios to determine our options.

After computing all 101 possible scenarios, we notice that we can group all scenarios in 10 different groups or ranges. As seen in Figure 12, we group them based on the total amount of miles traveled.

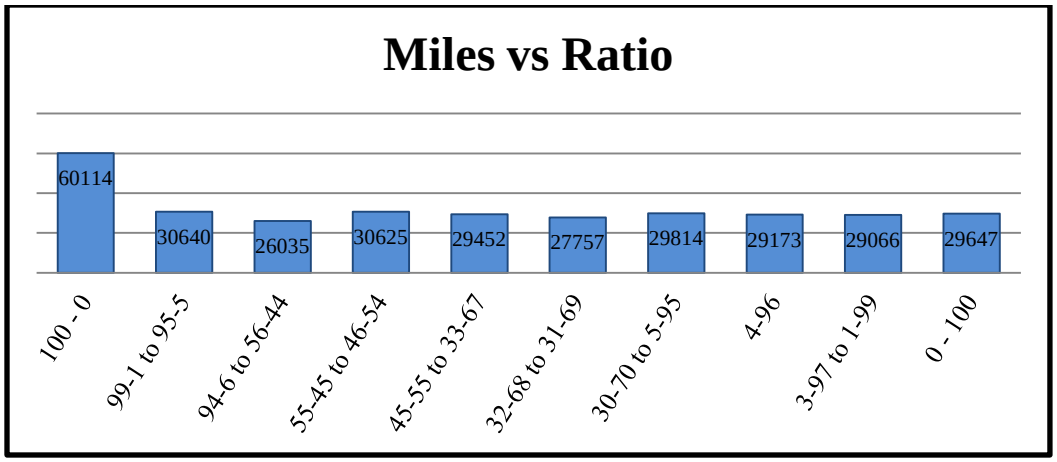

Figure 12. Miles versus ratio.

For example, the number of miles traveled when we assign a weight of 99 percent to the performance score stays the same as when we reduce the weight by one percent until 95 percent, for a total of 30,640 miles. But once we reduce it to 94 percent the mileage changes to 26,035 and stays at that level until the performance weight is reduced to 56 percent. All scenarios within each range produced the same solution, so we are going to further analyze each range to determine what will be an optimal ratio for prevention junior officers assignments. We are going to analyze these results based on the total amount of miles traveled in decreasing order. We compiled the results into Table 6, besides ratio and mileage we are going to also take into account untimely assignments and extensions. Untimely assignments are those that are not recommended by the AOs due to member's promotion status, previous assignments or time at present unit or geographical location. We have a column list the number of extensions to make sure there is a healthy number of officers rotating even though we are trying to reduce mileage. Historically, these type of assignments compromise between 23 to 28 percent of the total assignments (USCG, 2011a; USCG 2012; USCG 2013b). In our case, the percentage is between four and nine percent so we are only going to use it for reference.

Range	Ratio	Miles	Untimely Assignments	Extensions
1	100-0	60114	4	4
2	99-1 to 95-5	30642	4	3
3	55-45 to 46-54	30627	3	3
4	30-70 to 5-95	29816	4	2
5	45-55 to 33-67	29454	3	3
6	4-96	29174	4	2
7	0 - 100	29068	4	3
8	3-97 to 1-99	29068	4	3
9	32-68 to 31-69	27759	2	4
10	94-6 to 56-44	26037	2	4

Table 6. Assignment results sorted by total miles required.

All ranges provide savings when it comes to mileage and all ranges have untimely assignments as part of the optimal solution. In order to determine which of these ranges are feasible, we must look into the untimely assignments. Although these assignments are not normally recommended, sometimes there is justification for such assignments. For example, a low performing officer or an officer without the appropriate qualifications to fill positions of higher responsibility might get assigned to a billet of equal level of responsibility. This can also be the case for officers lacking the recommendation of their commanding officer, so just because all our scenarios have untimely assignments does not mean that all our scenarios are non-feasible. We recognized that not all junior officers progress at the same rate and that some will require more time at certain billets in order to obtain the level of expertise or leadership required for positions with greater responsibilities.

1. Range One – Baseline

In order to determine which solutions are feasible, we are going to take a closer look at all 10 ranges. Since we want to know how much weight can be given to mileage in order to reduce total distance without impacting career progression, we are going to use range one as our baseline. For Range One there is 100 percent of the weight on performance, which means we are not taking into account how far members need to travel to their new assignments. This assignment scenario results in a total 60,114 miles

traveled by all 46 junior officers and four untimely assignments. Those four assignments can be considered acceptable since all four members were missing a recommendation from their commanding officers for positions of higher responsibility. We can conclude that range one is feasible since all assignments are justified.

2. Range Two

From 99 to 95 percent weight on performance a total of 30,642 miles are required to complete this assignment scenario. This scenario also has four untimely assignments; three out of the four are members that also received untimely assignments in our baseline and the fourth one is also missing a commanding officer recommendation. All other assignments are in compliance with Coast Guard policy and guidance.

3. Range Three

In the 55 to 46 percentage range the untimely assignments are reduced to three and the mileage is now 30,627. Out of the three untimely assignments, two are missing the recommendation and the other one has an average recommendation and average level of qualifications. Based on those factors this can be considered a feasible solution.

4. Range Four

In Range Four, the level of untimely assignments stay at four, but one of them is a highly qualified individual with above average performance. Although mileage was reduced to 29,816, we can see that by giving 5 to 30 percent weight to performance, some high performing individuals can be affected.

5. Range Five

With the weight percentage between 33 and 45 for performance, we further reduce the mileage to 29,454. When it comes to untimely assignments we are down to three: the same high performing individual from Range Four, one with average qualifications and one without a commanding officers recommendation. Although untimely assignments are reduced, we will not consider this feasible since below average performers are receiving more beneficial assignments than the high performing ones.

6. Range Six

In this scenario mileage is still decreasing; now we are at 29,174 miles and the untimely assignments are back to four. We will deem this unfeasible since we will need to assign two average performers and one high performer to untimely assignments over people with lower performance in order to see this reduction of mileage. The fourth does not have a proper recommendation. Although the savings are significant when compared to our baseline, we clearly have other alternatives that will provide savings without impacting officers' career progression.

7. Ranges Seven and Eight

These two ranges provide the same results as range six when it comes to unfeasible assignments, but with a lower mileage, 29,068. We had to separate these two ranges because the Range Six ratio is between these two. Since the untimely results are the same as Range Six this range is also unfeasible.

8. Range Nine

At the 31 to 32 percent range for performance, we achieved the lowest level of untimely assignments, two; one high performer and one without the proper recommendation. In this case even though we have the high performer in an untimely assignment, it is worth considering since we have him slated for a major unit that can afford the possibility of fleeting-up to a position of higher responsibility depending on promotion status. At this level we have a mileage of 27,759.

9. Range Ten

Here we have the lowest mileage and the lowest amount of untimely assignments: 26,037 miles with two untimely assignments. Both untimely assignments are for members missing an adequate recommendation. The assignments that they are slated for are assignments that will provide more professional and leadership experience and will assist them in obtaining an adequate recommendation for future assignments.

As you can see there are numerous options available that can reduce the total amount of mileage traveled without compromising the career progression of prevention junior officers. In the next section we are going to discuss how efficient our options are. This will help determine which ratios are the most efficient.

B. ASSIGNMENT EFFICIENCY

Now that we have identified all feasible solutions, we are going to take a closer look to determine which ones reduce mileage with minimal impact to career progression. When we look at all solutions, we can see that some solutions can be declared unfeasible because they give preference to below average performers over high performing or average officers in order to reduce mileage. Therefore, we only have four ranges that we can consider feasible; two of them only assigned members without proper recommendation to untimely assignments. The other two ranges assigned only one average or high performing member to what can be consider untimely assignment, but depending on these members' promotion status this assignment can be beneficial. If a member has been selected for promotion, the AO can assign them to such units and the member can fleet-up to a position of higher responsibility before or soon after promotion within the unit.

As seen in Table 7, if we give a weight to the Assignment Score between 99 and 56 percent—Ranges Two and Ten—we can see savings of 49 or 44 percent respectively, without assigning average or high performing officers to untimely billets. If the opportunity exists to accommodate at least one average or high performing member at a unit with the possibility to fleet-up, we can reduce mileage by 49 or 46 percent—Ranges Three and Nine. Evidently, it is not necessary to put much emphasis on mileage to be able to obtain the best candidate for every billet without putting in jeopardy officers' careers or the expertise required of senior officers.

Range	Ratio	Miles	Savings (%)
1	100-0	60114	Baseline
2	99-1 to 95-5	30642	49
3	55-45 to 46-54	30627	49
4	30-70 to 5-95	29816	50
5	45-55 to 33-67	29454	49
6	4-96	29174	49
7	0 - 100	29068	49
8	3-97 to 1-99	29068	49
9	32-68 to 31-69	27759	46
10	94-6 to 56-44	26037	44

Table 7. Assignment savings compared to the baseline.

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V. CONCLUSIONS AND FUTURE WORK

A. CONCLUSIONS

Under the current fiscal situation the United States government is facing, every agency must find ways to cut costs in order to carry out its duties and comply with federal mandates. It is imperative that cost cutting is done in a responsible manner that will not hinder future operations and that was our goal during this study. We wanted to prove that savings can be achieved in the assignment process while maintaining the level of expertise required of prevention officers. Using the Hungarian method we were able to show that at least within the prevention junior officer assignments, savings can be achieved by factoring the distance a member must travel as part of the assignment decision. We understand that the assignment process is complex and very dynamic; therefore, we recommend further studies to be conducted to determine the feasibility of this model Coast Guard-wide.

B. FUTURE WORK

For the purpose of this thesis we looked only at prevention assignments for junior officers. Although this is one of the main assignment groups for Coast Guard officers, there are other groups that can further be used to demonstrate the impact distance can have on assignments. This can provide a more accurate picture, since often times officers are encouraged and allowed to fill billets outside their specialties in order to obtain a broader view of the Coast Guard. This is what the Coast Guard refers to as out-of-specialty assignments. If this method is used for all other specialties, it can help determine if this is a solution for all Coast Guard officers or if this will only work for certain specialties.

Another aspect that can be beneficial to consider is the implications this type of assignments can have over multiple AY. Since assignments are cyclical and for the most part availability of billets can be predicted a few years in advance, expanding this model over a few AY can provide more insight regarding how distance influences assignments over an officer's career. The result can be compared to the career assignments examples

provided in the *Prevention Officer Career Guide* (USCG, 2010). Using those models as baseline, one can determine if they can be achieved taking into account distance that a member needs to travel between assignments. A multiple AY study can further demonstrate if using distance as an assignment factor is a feasible long-term solution for the Coast Guard.

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