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DETERMINING PERSONNEL ACCESSION REQUIREMENTS FOR MEDICAL SERVICE CORPS HEALTH CARE ADMINISTRATORS USING A STEADY STATE ANALYSIS

by

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March 2006

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A Markov model was used to determine the optimal number of Medical Service Corps Health Care Administrator officers the Navy must access each year in order to maintain a desired end-strength. The Markov model identified the flow of Ensigns through Lieutenant Commanders using sixteen-year data. Five scenarios were analyzed to determine the most qualified method in determining accession levels. Optimization was achieved by changing with distribution of accessions sources and recruiting ranks. The solver scenario provided the alternative with the least amount of underage and overage when comparing the force structure to the predicted values. A four year historical review identified that if the current business practices will not allow for rank steady-states to be reached. A few significant characteristics were determined to influence retention at seven and ten year periods. The characteristic of primary concern, commissioning source, was determined to be significant. A survival analysis identified that the In-Service Procurement Program has a different survival function than other sources. Increased variations between the current force structure plan and the predicted Markov model outcomes suggest that greater efficiency could be obtained in future years. This Markov model can be used as a tool for accessioning to improving extended forecasts.

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DISCLAIMER

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I. INTRODUCTION

A. BACKGROUND

The attacks of September 11, 2001 brought recognition of the need to accelerate the transformation of the U.S. Navy in order to meet the challenges of the twenty-first century. This century has forced the U.S. government to put more resources into "guns" than "butter" as compared to historical requirements.[1] Prior to September 11, 2001, there were initiatives to "do more with less," which was the military's response to the way civilian enterprises are doing business. With the Global War on Terrorism (GWOT), the increased focus on "guns" requires the military to transform their business practices altogether. One way to ensure these resources are used in an efficient manner is to optimize the accessioning process. This thesis focuses on the Medical Service Corps (MSC) Health Care Administrator (HCA) accessioning process that the U.S. Navy Officer Community Manager (OCM) and planner prepare to meet these manpower and personnel transformation goals. Further, a Markov model will be used to identify the flow patterns of the MSC HCA officers from O-1 to O-4.

There are several manpower initiatives that are in keeping with Secretary Rumsfeld's "Transformation Plan" and the Chief of Naval Operations is leading the Navy through this endeavor. The attacks of September 11, 2001 accelerated the need to transform in order to meet the challenges of the twenty-first century. There were several focuses in Secretary Rumsfeld's plan that ranged from weapons capabilities to the efficiency of the service members that make them operate. Transformation is a continuous process that does not have an endpoint and it is meant to create or anticipate the future.[2] The overall objective of the transformation plan is to sustain American competitive advantage in warfare. New weapons systems and the state-of-the-art

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[1] Term used to reference the focus of financial resources. Guns = Military; Butter = Non-military.

[2] Defenselink Website: http://www.defenselink.mil/transformation/about_transformation.html; accessed on Feb 8, 2006.

technology are an important part of transformation, but the key to the process is the people involved. Most of the transformation is culturally based; therefore, it is the service members that drive this plan.

To meet the overall objective, the focus of manpower and personnel transformation starts with the recruiting process. It is essential to bring in only the optimal amount of individuals through the "right" commissioning sources to start this transformation process. It is the accession plan that lays out the future year recruiting goals, which are based on historical requirements and future targets.

There are many transformation initiatives that the Navy is directed to use; however, it is through the Sea Warrior initiative that manpower and personnel takes precedence. This major initiative focuses on "Manpower, Personnel, Training and Education (MPT&E)" and is one of the implementing initiatives of the Chief of Naval Operations' Sea Power 21 strategic vision for the 21st century.[3] Sea Warrior is geared to develop Sailors, who are highly skilled, powerfully motivated and optimally employed for mission success.[4] It is the Chief of Naval Operations' (CNO) guidance for 2006 that links the Sea Warrior initiative to transforming manpower applications.[5] Specifically, the CNO requests all naval activities to execute and integrate "Task Force Sea Warrior into the Manpower, Personnel, Training and Education (MPT&E) enterprise."[6]

From a training and education standpoint, Sea Warrior allows sailors to make career decisions while guiding them on a training path to meet their goals. This initiative also lets the service members see where they stand compared with other sailors and shows them what they need to do to advance. Sea Warrior can be accessed by any enlisted or officer personnel through the Navy Knowledge Online webpage. There is a five-part model, commonly known as the Five Vector Model that is the tool used to promote the Task Force Sea Warrior initiative. The five vectors are; professional

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[3] Navy Newsstand Website: http://www.news.navy.mil/search/display.asp?story_id=11472; accessed on January 26, 2006.

[4] Ibid.

[5] Admiral M.G. Mullen, 2006 Chief of Naval Operations Guidance, "Meeting the Challenge of a New Era," January 2006.

[6] Ibid.

development, personal development, professional military education and leadership, certifications and qualifications, and performance. The training and education is a focus on the individuals after they have been accessioned while the manpower and personnel concentrates on identifying the optimal number of personnel to get the job done. Even though it may seem minuscule to the work that happens after recruiting, manpower and personnel planning requires a lot of key players.

There are several key players in manpower that are part of the funding, requirements and authorization process. All of these key players are guided by several instructions; however, the one that is used most frequently is OPNAV 1000.16J, which is the Navy's Manual of Total Force Manpower Policies and Procedures. This instruction connects the roles of key players and references all the resources that assist in managing manpower in the Navy.

It is the manpower and personnel portion of this enterprise where the Markov model applications apply. Creating the highly skilled, powerfully motivated and optimally employed service members begins during the accessioning/recruiting process. It is up to the officer/enlisted community managers (OCM/ECM) to develop their accessioning/recruiting plans in such a way that favors efficient practices to bring in the best quality personnel. The Markov model is a great tool to use in this accessioning process as it predicts future manpower requirements and enables the OCM and planner to decide on the most efficient policy on accessioning.

The first of five key players in this process is the manpower "claimant", or the entity directly responsible for a particular command. The Medical Service Corps personnel most frequently fall under the Bureau of Medicine and Surgery (BUMED) as they are mostly attached to brick and mortar hospitals. It is the claimant's job to identify the requirements for the commands in their area of responsibility.

The Navy Manpower Analysis Center (NAVMAC) is responsible for determining requirements for afloat commands and monitors the Shore Manpower Requirements Determination Program (SPRDP) where claimants determine the requirements for shore commands.

The next key player is N80, which is a programming division of N8 and acts as the Navy's coordinator for the Planning, Programming, Budget and Execution (PPBE) process. N80 also acts as the review authority for programmed decisions that might come from manpower requirements both ashore and afloat.

Another key player, the Resource Sponsor, is the authority that funds the requirements for the manpower claimants. Finally, the Officer Community Manager is responsible for his or her community of officers and works with all the key players listed above to make the manpower requirements meet the target end strength or Officer Programmed Authorizations (OPA). It is up to the Officer Community Managers to find the most effective and efficient manpower accession plan that ensures the best mix of personnel in future years. Many of these accession plans are submitted using historical data with some attention being given to current attrition and continuation rates. One of the biggest challenges in aligning the accession plan for the Medical Service Corps with the transformation plan is to find the most efficient mix of officers (rank and specialty) to meet the dual military mission (war and peace) for each fiscal year. [7]

Accession planning for the Medical Service Corps, like other designators, is a job that concentrates on the actual officer inventory and OPA to further define the needs of the Medical Service Corps. It is essential to bring in the most efficient number of accessions each year because a bad year might cause future issues in the community. If the accessions are too low, this could affect the Medical Service Corps Health Care Administrators for 20 years as that cohort would be short of personnel during that duration and therefore very sensitive to attrition and retention. On the other hand, if there are too many accessions in a given year, this leads to a situation in which the Navy has too many personnel and cannot support those accessions for 20-year duration. Both of these potential problems must be considered when a fiscal year strength/accession plan is created.

It is essential for the Medical Service Corps Health Care Administrators accession requirements to be properly aligned with the CNO's Sea Warrior and other manpower based initiatives. Analyzing historical accession practices and comparing them to past

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[7] N13., "Community Management Training Brief"., Presented March 30, 2005.

end strength figures will enable the Medical Service Corps OCM to be better informed when making accessioning decisions. Using a Markov model will identify the steady state, or that state in which each pay-grade remains at the same end strength over time.

Finding the steady state for Medical Service Corps Health Care Administrators will allow for this assessment and assist in identifying the proper distribution of personnel and comparing it to the current condition or state of the corps. To refine this even more, it would also be beneficial to determine which accession sources have the highest retention rates or longevity. Finding the steady-state of the MSC HCA and their accession source survivability will assist the MSC Officer Community Manager in making decisions and developing the strength/accession plan for current and future years. In order to get to this point, however, it is also essential to understand the manpower process.

B. OBJECTIVES/PURPOSE

This thesis will use Markov modeling to develop a steady-state representation of the personnel progression within the Medical Service Corps specific to the Health Care Administrators subspecialty. The development of this model will provide an accurate depiction of accessioning needs as well as assist in answering the following questions:

- What is the steady-state of the MSC HCA officers from 0-1 to 0-4?
- When did each rank achieve a steady-state?
- Which accession source has the highest level of retention (two groups will be examined)?
- What is the prescribed amount of new officers to access given the MSC HCA's steady-state and survivability?
- What are the average attrition rates for the O-1, O-2, O-3 and O-4 pay-grades?
- What are the policy recommendations given the results?
- What other studies can be done to further investigate the accession sources and force structure of the MSC HCA's?

The purpose of this thesis it to determine the steady-state of the Medical Service Corps Health Care Administrators and compare them to the actual target end strength and accessioning numbers. Further, it will act as a tool to assist the officer community manager and planner in creating the most efficient accession plan. Moreover, it will assist in identifying the survivability of those officers enter the MSC through the In-service Procurement Program as compared to the other four accessioning sources.

C. SCOPE

The scope of this thesis includes: (1) an overview of the Medical Service Corps structure; (2) a summary of current business practices used for personnel forecasting in the Navy; (3) identification of policies that govern end-strength; (4) development of continuation rates by grade and years of service; (5) exploration of the impact of accession sources on continuation/retention rates at career decision points; (6) identification of the survivability of each accession source; and (7) development of a Markov Model incorporating the information detailed in the above items and a comparison of the steady-state to the current force structure.

This Markov model is developed for pay-grades of Ensign (0-1) to Lieutenant Commander (0-4), and excludes the pay-grades of Commander (0-5) through Captain (0-6). Promotion rates were obtained for these pay-grades using Defense Manpower Data Center (DMDC) and Bureau of Medicine Manpower Information System (BUMIS) data. Continuation rates are derived using the career progression of each officer to determine if he or she stayed in the same pay-grade, were promoted or left the Navy. This establishes the overall transition matrix for the Markov model. Logistic Regression is then used to identify significant retention rates at career decision points. If significant factors are identified, they are then used to adjust the transition matrix to obtain the most accurate depiction of MSC HCA continuation behavior. These logistic regression models focus on accession sources and are estimated to identify significant influences on retention. Finally, Cox Proportional Hazard regressions are used to determine the survivability of accessions entering the MSC through the In-service Procurement Program (IPP) compared with those entering through other commissioning sources.

D. ORGANIZATION OF STUDY

Chapter II presents an overview of the Medical Service Corps' established manpower authorizations and how policy affects accessioning decisions. It also takes a look at the accession sources for MSC HCA officers. A detailed table of authorized Medical Service Corps inventory and billets is included and the chapter addresses manning levels by specialty. In Chapter III, a literature review describes other studies of Markov modeling as it relates to manpower determination and also includes a Medical Service Corps level exploration of attrition. In addition, this chapter contains the results of a poll survey administered in the spring of 2005 by COMNAVCRIUTCOM that discussed attrition and retention for all four medical officers' designators. A look at the downsizing in the 1980's as it relates to the Medical Service Corps is also included in Chapter III. Chapter IV cover's the specific methodology and data used to determine the best transition matrix for the Markov modeling. This chapter also explains and demonstrates use of the Cox Proportional Hazards regression method of survival analysis to evaluate the efforts of the In-service Procurement Program. Chapter V provides the results of the Markov model, logistic regressions and survival analysis. Conclusions and policy recommendations as well as recommendations for further studies are included in Chapter VI.

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II. THE MEDICAL SERVICE CORPS

A. OVERVIEW

Naval Medicine provides high quality, efficient health care to about 700,000 active duty Navy and Marine Corps members and to approximately 2.6 million other active duty, retired and family members while supporting contingency, humanitarian and joint operations around the world. This is all due to the highly trained, devoted health care professionals all dedicated to accomplishing this mission (Ref 1: 2005 OCT 17). The Navy Medical Service Corps is an essential member of this team and its intricate role is described below:

> The Medical Service Corps is the most highly diversified Corps within the Navy Medical Department. An integral part of Navy medicine, the Medical Service Corps is comprised of a multidisciplinary team of commissioned naval officers in clinical, scientific, and administrative health care fields. The Medical Service Corps now has approximately 2,669 officers on active duty in the grades of Ensign to Rear Admiral. Health care scientists and clinical care specialists make up about 60 percent of the total Corps, serving in 22 different specialties, while health care administrators comprise the remaining 40 percent. Medical Service Corps officers serve in more than 250 Naval and medical commands throughout the world. About 65 percent serve in facilities delivering direct patient care and 35 percent serve in operational units, training and research commands, occupational and preventive medicine units, material and logistic support commands, and headquarters commands (Ref 2: 2005 OCT 17).

The Medical Service Corps (MSC) originated on 4 August 1947 with the passing of the Army-Navy Medical Service Corps Act. There were originally four sections in the MSC; Supply and Administration, Medical Allied Sciences, Optometry and Pharmacy. There are currently thirty-one subspecialties in the MSC and ten of them fall within the Health Care Administrator (HCA) section; General HCA, Patient Administration, Logistics, Information Systems, Medical Construction Liaison, Plans Operations Medical Intelligence (POMI), Manpower Management, Financial Management, Operations Research and Education & Training. Because the HCA group is more homogenous in their 10 occupations and make up almost half of the overall Medical Service Corps, they have been chosen as the subject for this study. The majority of accessions for HCAs are prior enlisted while the HCSs are typically accessed directly from the civilian population.[8] The retention rates tend to be slightly lower and the attrition rates slightly higher for HCAs than for HSCs because the typical prior enlisted officer is only required to serve at least 10 years before he or she can retire. Given that the majority of HCA officers come from enlisted ranks with at least 10 years prior service, the HCA retention rate dips after 10 years. On the other hand, those HCS officers who stay to 10 years typically make the career decision to stay to 20 years. (Ref 6, 1989 OCT)

To allow the reader to better understand the differences in manning and appreciate the fluctuations that occur even over small periods of time, two MSC Reports (Feb 05 and Oct 05), only eight months apart, are presented. The next two paragraphs explain the manpower figures from each of these reports.

The inventory of MSC officers as of 28 February 2005 was 2,572 with 1,061 of them being HCAs (Ref 3: 2005 OCT 11). During this period there were 2,583 total MSC billets authorized (BA), which put the overall MSC at a 99.6% manning level. The remaining 58% of the corps is made up of Health Care Scientists (HCS) and is broken down into 21 different subspecialties, each one having unique characteristics that separates them from the group. Table 1 lists the different subspecialties that make up the HCA and HCS groups.

The inventory of MSC officers as of 30 October 2005 was 2,493 with 1,008 being HCAs (Ref 18: 10 JAN 2006). During this period there were 2,571 total billets authorized, which put the overall MSC manning level at 97%. Table 1 below further details the manning levels, inventories, and billets authorized by specialty for MSC officers.

[8] A percentage breakdown of personnel brought into the Navy through accessioning sources is shown in more detail in Table 3.

Table 1. MSC REPORT as of 31 OCTOBER 2005[9]

SUBSP CODE	SUBSPECIALTY DESCRIPTION	INVENTORY	2XXX	=	NET INV	PERS IN TRAINING	BILLETS AUTH	TRAINING BILLETS	BILLETS AUTH	DELTA	MANNED
-	-	-	-		-	-	-			-	
1800	Health Care Adm	509	17	=	492	28	459	38	497	(5)	99%
1801	Patient Admin	105	3	=	102	0	69	4	73	29	140%
1802 & 3121	Mat'l Logist Mgt	78	1	=	79	2	69	2	71	8	111%
1803 & 6201	Info Systems	39	0	=	39	4	52	7	59	(20)	66%
1804	Med Construct Lia	17	0	=	17	0	19	0	19	(2)	89%
1805	Plans/Ops/Med Int	104	3	=	101	2	136	8	144	(43)	70%
3110	Financial Mgt	95	4	=	91	5	98	3	101	(10)	90%
3130	MPTA	33	3	=	30	7	36	4	40	(10)	75%
3150	Educ & Trng Mgt	17	0	=	17	0	22	2	24	(7)	71%
3211	Operation Research	11	0	=	11	3	8	2	10	1	110%
HCA Subtotal		**1,008**	**31**	=	**979**	**51**	**968**	**70**	**1,038**	**(59)**	**94%**
1810-11	Biochemistry	35	0	=	35	0	34	2	36	(1)	97%
1815-21	Microbiology	50	3	=	47	3	46	2	48	(1)	98%
1825/28	Radiation Health	81	0	=	81	6	66	8	74	7	109%
1835	Physiology	12	1	=	11	0	16	0	16	(5)	69%
1836	Aerospace Physio	93	3	=	90	15	74	17	91	(1)	99%
1840-43	Clinical Psych	119	0	=	119	19	120	13	133	(14)	89%
1844	Aerosp Exper Psych	31	1	=	30	4	31	1	32	(2)	94%
1845	Research Psych	21	0	=	21	1	18	0	18	3	117%
1850	Entomology	35	1	=	34	1	36	3	39	(5)	87%
1860	Environmental Hlth	85	0	=	85	3	82	3	85	0	100%
1861	Industrial Hygiene	132	1	=	131	9	116	13	129	2	102%
1862	Audiology	22	0	=	22	0	21	1	22	0	100%
1865	Medical Technology	82	2	=	80	5	75	7	82	(2)	98%
1870	Social Work	33	0	=	33	2	31	1	32	1	103%
1873	Physical Therapy	74	1	=	73	6	70	5	75	(2)	97%
1874	Occupation Therapy	23	0	=	23	1	20	1	21	2	110%
1876	Clinical Dietetics	39	2	=	37	2	34	2	36	1	103%
1880	Optometry	127	1	=	126	4	123	3	126	0	100%
1887/88	Pharmacy, General	141	2	=	139	7	129	7	136	3	102%
1892	Podiatry	22	0	=	22	1	21	2	23	(1)	96%
1893	Physician Assistant	228	1	=	227	7	191	5	196	31	116%
HCS subtotal		**1,485**	**19**	=	**1,466**	**96**	**1,354**	**96**	**1,450**	**16**	**101%**
	TPPH								30		
Total MSC Officers w/o 2xxx		**2,493**	**50**	=	**2,445**	**147**	**2,322**	**166**	**2,518**	**(73)**	**97.1%**
	2xxx billets								53		
Total MSC Officers		**2,493**		=					**2,571**	**(78)**	**97.0%**

FOOTNOTES:

1. SUBSP inventory captures all MSC officers with reported primary subspecialty code regardless of assignment.

3. FY06 Manpower Author (billets) based on October 2005 extract of TFMMS,
includes both coded and non-coded billets provided by Mrs. Arlene Reese M-12 (202) 762-3613.

4. 2XXX share as determined by BUPERS, PERS-N131M

5. DESIGN 2700 is not counted MSC (Director, MSC)

8. OPA number provided by BUPERS, PERS-N131M.

Table 1 represents one of several tools used in developing the accession plan. The Medical Service Corps report provides data for projected losses and gains as well as actual losses and gains and is completed on a quarterly basis. This allows the community

9 Source: Sonia Adams., October 2005 MSC Report

manager and planner to asses the attrition/retention behavior within the Medical Service Corps on a continual basis. Another function of this report is that it is referenced during a mid-year review. As such, it is used to compare the current OPA with the projected gains and losses and offers potential deviations of the accession plan depending on level or type of personnel changes experienced. This tool is managed by the Medical Service Corps planner.

B. ESTABLISHING MANPOWER AUTHORIZATIONS

1. Basic Manpower Requirements Process

The process by which manpower requirements turn into personnel assignments takes several important steps. While many of the steps are completed at the same time, it is Congress that ultimately approves manpower requirements based on the National Security Strategy. The program sponsor submits a requirement request to Congress for a desired level of manpower for each of their officer communities. The request is further submitted in the Planning, Programming and Budget Execution process, which is then submitted as part of the President's Budget. Based on the needs of the nation, the Officer Programmed Authorizations (OPA), or officer end strength, is determined in the budget and sent back to the program sponsors for action. OPA is the unqualified "space holder" used by the program sponsors to "buy" an authorization and the claimant to fill a billet. The officer community managers use the OPA as a guide to match actual authorizations to inventory.

There are several ways in which the Navy communicates these requirements and billets to each command depending on whether they are afloat or ashore. The Navy Manpower Analysis Center establishes afloat and ashore requirements via the Ship Manpower Document (SMD) and a Shore Manpower Requirements (SMR), respectively. The Activity Manpower Document (AMD) provides a qualitative and quantitative depiction of both ashore and afloat billets and requirements. This document lists the specific billets (quality) and manpower requirements (quantity) per activity. The "quantity" piece is taken from end strength and is reviewed three times a year. The "quality" piece is determined by the type of officer and skill set, which is further explained by subspecialty and/or an Additional Qualification Designation (AQD).

2. Accession Planning Process

The Chief of Naval Personnel (CNP) gives guidance to assist the MSC community manager in developing the annual accession plan. This plan is used to determine the recruiting goals for the upcoming fiscal year. The initial accession plans are completed two years ahead of time and are modified as changes are manifested during the review process. The MSC accession plan is constructed in a joint effort by the MSC officer community manager and planner. The MSC officer community manager is stationed at the Naval Personnel Command (NPC) and the MSC planner is stationed at the Bureau of Medicine and Surgery. This separate placement fosters a unique communication that allows them to develop the most efficient accession plan. The officer community manager has all the personnel resources at their disposal at BUPERS and NPC while the planner is in the center of Navy Medicine and has the resources available to them to address the needs to accomplish both war-specific and peace-time missions.

Before the accession plan is started by the officer community manager and planner, the promotion plan is completed. Once the promotion numbers are determined by pay-grade, both community manager and planner are able to identify the gaps in pay-grade for the upcoming year. The MSC planner then takes the promotion plan results and begins the accession planning process. The first step is done by taking the beginning inventory and projecting planned losses to identify other gaps in the personnel flow system. After taking the losses out of the inventory, the number of required gains is then identified. This can be adjusted either up or down depending on the target of end strength (OPA) or the specific billet authorizations. While adjusting for gains, the planner must consider the different accession sources to match the specific subspecialty losses and adjust them with proposed gains.

The only accession sources that bring in HCA officers are the following; Direct, Recall, Lateral Transfers, Health Services Collegiate Program (HSCP) and In-service Procurement Program (IPP). The majority of accessions come from the IPP, HSCP and

Direct programs. The accession plan is completed in the month of December for the fiscal year that falls two years away from the current year. In other words, the fiscal year 2007 plan is being worked on in December of 2005.

Upon completion of the accession plan, it is then submitted to CNP for approval. Once approved and a letter is drafted to guide MSC recruiting personnel in meeting the targets for the upcoming fiscal year. Due to the usual changes that occur to end strength during the year, a mid-year review is completed. If there are any changes to the accession plan as a result of the review, they must be approved by the officer community manager. (Ref 15: DEC 1996)

The most important tool for balancing the accessions is the Officer Programmed Authorizations (OPA), which is used as a guide to ensure inventory and requirements are as closely matched as possible. OPA is another representation of end strength and represents availability, or the lack there-of, in billets. It is the OPA that is used in concert with the Medical Service Corps report to balance the end strength with manpower billets.

C. POLICY CONSIDERATIONS

The Defense Officer Personnel Management Act (DOPMA) was an amendment from Congress to the United States Code Title 10 in November of 1980. The intention was to give direction for the management of the officer corps by "making uniform the provisions of law relating to the appointment, promotion, separation and retirement of regular commissioned officers of the Army, Navy, Air Force and Marine Corps." The establishment of this policy marked the first time that "uniform" laws would govern the original appointment of regular and reserve commissioned officers for all four military services. Moreover, it provided rules governing promotion and the standards for the mandatory separation and retirement of commissioned officers. (Ref 8: 1993 p. 1) This act laid the foundation of personnel strength planning.

There are four types of career flow structures commonly used by business entities. (Ref 4: 2005 NOV 2) The "up-or-out" policy is used by the military through DOPMA as a means to force attrition after two fail-to-selects. The other three flow structures are the "up-or-stay"; primarily used by public and private organizations as well as foreign militaries, "in-and-out"; also used in public/private organization, and "mixed". The main contributors to the military's up-or-out structure are accessioning and attrition (forced or natural), which determine the career flow structure in the military. Retention behavior is an important aspect of the process. The literature review in Chapter III addresses the specific attrition issues common to the Medical Service Corps.

Officer inventories in the control grades of O-4 to O-6 were established by DOPMA, which dictates promotion opportunities and specifies the flow points of the promotion process. DOPMA also reformed the system of active/reserve officer commissions and grade controls that were originally seen as a temporary measure to enable a peacetime military larger then the typical historical levels. (Ref 8: p. 7) Table 2 shows specific relationships in the times between each pay-grade as specified in DOPMA guidance.

As seen in Table 2, all of the O-1 officers automatically promote to O-2 in a minimum of eighteen months to two years based on DOPMA guidance. The six-month variance depends on how the service member's contract was written. To better understand Table 2, the first column refers to "promote to" and therefore the first row is filled with "n/a" entries because a person cannot get promoted "to" O-1. The column that depicts the average time in service provides a cumulative view of the total time taken to get to a particular pay-grade. Prior to April 2002, a promotion board for all officers in the O-2 pay-grade would have met for their promotion to O-3. As a result of an ALNAV note, there was a cancellation of all O-3 boards; therefore, the advancement for O-2's to O3 in now similar to the O-1 to O-2 promotion in that it is automatic.[10]

10 ALNAV Note., "Cancellation of the FY-03 Lieutenant Selection Boards"., R222028Z, APR 02.

Table 2. DOPMA List of Time Served Between Grades[11]

Promotion to:	Avg. Time in Service	Min. Time in Grade	Promotion % by Community	Active Duty Strength	Percent of Total Officers
O-1	n/a	n/a	n/a	7015	13.19%
O-2	2 Years	18 Months	100%	7831	14.72%
O-3	4 Years	2 Years	95-100%	17190	32.32%
O-4	9-11 Years	3 Years	70-90%	10396	19.55%
O-5	15-17 Years	3 Years	60-80%	7048	13.25%
O-6	21-23 Years	3 Years	40-60%	3490	6.56%
O-7	23-29 Years	3 Years	2-8%	107	0.20%

Congress is responsible for authorizing total officer strength levels and the personnel responsibilities of each military branch. One measure Congress uses as a tool to determine this strength level is looking at the historical relationship between the officer and enlisted personnel or the “enlisted-officer ratio.” Through DOPMA, Congress establishes the number of officers allowed in each field grade rank or more specifically, for those pay-grades above O-3. This officer grade distribution is published in the DOPMA grade table and varies as a function of total officer end-strength rather than as a fixed percentage of total “military end-strength”. In other words it does not account for enlisted personnel. (Ref 8: p. 7-8)

The instruction that acts as guidance for accession source requirements for the Medical Service Corps is OPNAVINST 1120.8. This instruction identifies those responsible in developing the accession plan and specific qualifications as well as requirements for each of the accession programs. Further, it goes into detail about the grade entry credit that is awarded to selected officers and provides a table to determine the specific level at which the officer will be appointed upon commissioning. This instruction is a tool used by the officer community manager when developing an accession plan.

[11] Source: David Schwind, “A Qualitative Analysis of Selection to Flag Rank in the United States Navy.” Master’s Thesis, Naval Postgraduate School, Monterey, CA. June 2004.

D. ACCESSION SOURCES

There are a total of five accession sources used to bring in Medical Service Corps Officers; however, only three are primary contributors. These three accession sources are; In-service Procurement Program (IPP), Health Services Collegiate Program (HSCP) and Direct. The other commissioning sources are the Inter-Service Transfers (IST) and Recalls. The exact numbers and percentages of accessions by source for the fiscal years 2004 and 2005 can be seen in Table 3. There were no officers brought into the Navy using the IST or Recall in 2004 and none using Recall in 2005. This is a reflection of the lack of use these two sources provide.

Since the HSCP and a portion of the IPP are the only training pipelines used in bringing new officers into the MSC it is sometimes difficult to gauge whether there might be losses due to training issues. The primary way to balance the inbound officers is through the open market via direct accessioning. Direct accessioning assists the MSC in making necessary adjustments during the year for any shortfalls of other programs.

Officers accessed into the MSC are brought in at different pay-grades depending on their level of schooling. If a service member applying for any of these programs has a Bachelor's, Masters or Doctorate degree, then he or she will be given the rank of Ensign, Lieutenant Junior Grade, and Lieutenant, respectively. Below, each program is discussed in detail.

Table 3. Accessioning Source Percentages for FY 2004 and FY 2004[12]

	IPP	Direct	HSCP	IST	Recall	Total
FY 2004						
#	25	16	16	0	0	57
%	44%	28%	28%	0%	0%	100%
FY 2005						
#	18	11	16	1	0	46
%	40%	24%	35%	1%	0%	100%

[12] Source: Information provided by Roshard Woolfolk., "Report of MSC gains by GCAT for FY 2004 and FY 2005", table drafted by author.

1. In-service Procurement Program

The In-service Procurement Program, or IPP, is becoming a more and more popular accession source in Navy Medicine. The reason for this popularity stems from the enlisted ranks and their ability to bridge over from being a Hospital Corpsman (currently other Navy ratings are included as well) and have the opportunity to receive a commission as a Naval Officer. Before 2001, this program brought in Health Care Administrators and Physician Assistants. Now it allows other Health Care Science specialties to bridge over from the enlisted ranks into the Medical Service Corps as well.

There is a board that meets each year to review several officer application packets. This board is composed of no less then three or no more then five senior MSC officers with one being no less the rank of Captain (Ref 7: 14 SEP 2005). These packets are screened to ensure that each candidate has the proper degrees and accreditations. They are also screened to ensure they provide three appraisals from officers stationed at or near their command. The Commanding Officer of the submitting member's command ranks the member when there is more then one submitting a package. The appraisals and ranking give the professional review board a good idea of the member's future capabilities as a commissioned officer. The package also includes a personal letter that is handwritten by each candidate and explains why he or she wants to become a Navy Officer. Each year there are changes to the instruction as the needs of the Navy change and to support the Sea Warrior initiative.

2. Health Services Collegiate Program

The Health Services Collegiate Program (HSCP) is a commissioning source that is a training pipeline. Individuals who are selected for this program are given a two-year scholarship to train for a designated health profession. Upon successful completion they are awarded a reserve officer commission in the active component as either a Nurse Corps, Medical Service Corps or Dental Corps officer (Ref 19: 1 AUG 2001).

3. Direct Accessions

Individuals who make up this pool of candidates typically have no prior military experience, and if selected must be able to have 20 years of service by age 62 for Regular Navy and age 60 if they are to receive an appointment into the Naval Reserve (Ref 7: 14

SEP 2005). Even though there are waivers that can be granted depending on manpower levels and critical needs, it is the goal of the Navy to keep the force as young as possible. Applicants must maintain the same qualifying degree as for the other programs and must also be appropriately accredited.

4. Inter-Service Transfers

Individuals who are accessed through this source come from other services, as well as the Navy. Depending on the designator the candidate held while in the service prior to being selected for this transfer, the entry grade credit table is used as a tool to determine at what level the candidate will be accessed into the Medical Service Corps (Ref 7: 14 SEP 2005). If the candidate is a Medical Service Corps officer in the transferring service, he or she will enter with the same rank according to the entry grade credit. If the candidate is not designated as a Medical Service Corps officer then he or she will not receive an even transfer of grade. For example, if an MSC officer from the Army transfers to the Navy, he or she will be given the entry grade credit of one year credit for every year they have been a commissioned officer. Moreover, if a Navy Line Officer is interested in a transfer into the Medical Service Corps, then he or she will only receive one-half of a year credit for each year of active commissioned service due to the fact that he or she maintains a non-MSC designator. This also applies to Reserve officers as they may also be transferred into the Medical Service Corps through this commissioning source (Ref 19: 1 AUG 2001).

5. Recalls

The use of voluntary recalls comes into effect when a necessary specialty is needed and human resources are not attainable by any other means. The use of recalls for Health Care Administrators is not as common as it is for the Health Care Scientist specialties. The recall population consists of those officers who still have an obligation to the service or fall within the fleet reserve after retirement. In order for these officers to be voluntary recalls, they must maintain the credentials and/or be practicing in the Medical Service Corps specialty of which they are being recalled (Ref 7: 2005 SEP 14). The officers who are recalled through this program retain the same rank that they held as reservists or upon their retirement.

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III. SELECTED REVIEW OF LITERATURE

A. OVERVIEW

This chapter reviews past studies to derive methodologies to assist in the current study. There are a limited number of studies directly related to Medical Service Corps' manpower and personnel. Further, there are only two studies that discuss Health Care Administrators as a group and only one of these had the MSC HCA group as a focus. Studies in this section are limited to Naval Postgraduate School manpower theses, Center for Naval Analysis (CNA) analyzes and a quick poll that was done by the Navy Recruiting Command (NAVCRUITCOM). Most of these studies were completed after 2000; however, a few were completed in the 90's.

Two studies that provide insight on the downsizing effects of the aggregate group of MSC officers completed in 1990 are reviewed. Only one study separated the HCAs from the HSCs. A quick poll, completed in March of 2005, provides information about influencers of leavening/staying in the MSC. These studies are reviewed to familiarize the reader with MSC attrition. Following the attrition studies, a basic description of Markov modeling is given and two Nurse Corps studies are reviewed for model estimations, variables, outcomes and methodology. Finally, those studies using survival analysis methodologies are reviewed. One of these studies is an actual MSC HCA focus on the IPP and Direct Procurement sources and the other two studies help build a better framework for the methodology used in this thesis.

B. ATTRITION

1. Historical Review

According to a Center for Naval Analysis study completed in 1989 by Michelle Dolfini (Ref 6, 1989 OCT), attrition and retention issues arose within the Medical Service Corps between 1983 and 1988. The purpose of this study was to determine if there was an actual manpower shortage by specifically examining Medical Service Corps accessions and retention. Attrition and retention were examined through the continuation rates at the aggregate community level in this study. Between FY84 and FY88, the continuation rates for both aggregate and community levels were maintained around 90 percent. The continuation rates for the Health Care Administrators during this period were relatively stable for the first 10 years of commissioned service and than declined thereafter. The Health Care Scientists followed a different retention behavior pattern as compared to the HCA's. If the HSC officers stayed in the service until the 10 year mark of commissioned service they typically made the long-term career decision to stay until the 20 year mark before there was a drop in the continuation rate. The difference in retention was mostly attributed to the prior-enlisted HCA community's ability to retire after 10 years of commissioned service. Since 90% retention was considered high during the time of the study, the solution suggested to deal with the shortage was to increase accessions. The study provided tables of average continuation rates as well as maintenance rates for future years; however, it did not discuss hiring strategies. This study also provided the personnel inventory for HCAs and HCSs during the 6 years of the study. It was determined that as of FY 89, the steady-state of the Medical Service Corps had not yet been achieved due to the fluctuations in attrition and retention. Two recommendations were made; one advised an increase in the already high continuation rates and the other recommended to adjusting and stabilizing the accessioning process. This thesis focuses on assisting in the second recommendation for HCA officers to adjust or stabilize the accessioning process.

2. Impacts of Force Reduction on Promotion

In 1990 a study was completed that estimated the results of an arbitrarily selected three percent reduction in Medical Service Corps officers over a five year period.[13] This thesis used an interactive model "Force" to analyze the force structure of the Medical Service Corps. Data for the years 1985 through 1989 were used to identify continuation and promotion rates as well as planned accessions. At the time of this study there was a total of 1,355 Health Care Administrators in the Medical Service Corps aggregate group of 2,665 total officers. Two scenarios were given; one was a view of the aggregate Medical Service Corps group and the other was limited to Health Care Administrators.

[13] Terri Butler, "The Impact of Force Reductions on Promotions in the Navy Medical Service Corps", Master's Thesis, Naval Postgraduate School, Monterey, Ca., 1990.

For the aggregate group, the results showed that allowing a three percent reduction in the accessions over a five year period created gaps in future inventories. Specifically, the gap was determined to be in the inventory at the promotion point for lieutenants to lieutenant commander. The suggestion was made to shift the promotion flow point to lieutenant commander from ten to nine years for the years 2000, 2001 and 2002. The decrease in inventory also affected the promotion flow points to commander and suggested a shift backwards from sixteen to fifteen years for the years 2006, 2007 and 2008. It was also found that there would be a junior officer reduction between the years of 1989 and 1995 of 58 to 51 percent, respectively. After this point, the numbers would increase, but only slowly. A future projection to the year 2000 showed an increase of only 53 percent. (Ref 16: DEC 1990)

A notable finding unrelated to the force reductions discovered in this study focuses on the potential growth in lieutenant commanders. The study was completed during a time when there were many lieutenants eligible for promotion to lieutenant commander, thus creating a sharp increase the inventory of lieutenant commanders. One way that was suggested to adjust for this was to slow the promotions to lieutenant commander during the years of the reductions (1991-1995). The study showed that slowing these promotions may bottleneck at the lieutenant commander level. (Ref 16: DEC 1990) If in fact there was a slowing of promotion and the bottleneck was manifested, then it was predicted that there would most likely be an increased attrition rate at the lieutenant level.

A critical assumption was made that Health Care Administrators would absorb the major portion of the reductions. It was noted that the actual reductions would probably not reach the level that were tested in this study. It was determined that, given these reductions, the HCA community would be severely short of officers at the lieutenant commander level by the year 2000. Even when all those lieutenants with nine and ten years were grouped together for promotion, this would still not provide a sufficient number of officers for the promotion zone. The study showed that there would be a shortage in the number of lieutenants at the nine and ten years of service mark for the years 2000 through 2004. Compared to the aggregate group of MSC officers, who were predicted to experience a three year shortage in inventory, HCA officers would not recover in their inventory levels. This is due to the HCA community's greater absorption of the three percent reduction in force. It was also determined that there would be similar shortages at the commander flow point level. If the commander vacancies were to remain constant at the 1985-1989 level, there would be a serious shortage of lieutenant commanders in the inventory at the sixteen year promotion flow point during the years 2006 through 2009. This would not allow an adequate size zone for those promoting to commander. (Ref 16: DEC 1990)

The analysis in the study further suggested that the three senior grades were increasing between the years of 1989 through 1995 from 42 to 49 percent. There was a suggestion that contracting some senior executive administrative positions would assist in reducing the force to meet future manpower demands.

As mentioned earlier, there was an overall reduction of three percent chosen for this study over a five year period. The HCA forecast over the years of 1990 through 1995 predicted a decline in numbers from 1,355 to 1,069. Given these figures, the "real" reduction for the HCA is twenty-one percent. (Ref 16: DEC 1990)

The current inventory level as of October 2005 is a total of 1,008 HCA officers in the Medical Service Corps aggregate group of 2,493. [14] As can be seen, the HCAs made up 51 percent of the total MSC group during the time of the study; however, they currently make up 40 percent of the total MSC population. This change in the HCA percentage represents an obvious change in policy that reduced the amount of HCA officers in future years after this study.

3. Medical Communities Quick Poll

The Navy Personnel, Research, Studies and Technologies from PERS-1 launched a quick poll to try and provide an understanding of the increased loss rate in the four medical communities. This quick poll was fielded to a select group of medical community officers starting on March 11, 2005. These officers were given five days to complete the poll and the last one was collected on March 23, 2005. Out of the 10,872

[14] Sonia Adams (MSC Planer) and Ms. Williams (Assistant Planner), October 2005 MSC Report (MSC Planner).

officers who were contacted, a total of 3,582 completed the survey for a 33% response rate. More specifically, the Medical, Dental, Medical Service and Nurse Corps had overall response rates of 34%, 34%, 38% and 25%, respectively (Ref 5: 2005 APR 6). The results were compared to a 2004 Navy Officer Survey since similar questions were used in both surveys. Comparing these groups identified differences between the two groups of officers in order to obtain a better understanding of the loss behavior.

In order to determine the key issues, focus groups were conducted for the Medical Officers of each community at the Naval Medical Center in Portsmouth, Virginia. The focus groups were asked a series of questions pertaining to attrition. The questions were derived from a 2003 Navy Personnel Survey and the 2004 Navy Officer Survey, while others were specifically developed to address career progression issues. These issues include communication, job satisfaction, career intentions, reasons for staying or leaving the Navy as well as incentives that might otherwise keep them in the service. Histograms were used to illustrate the results.

Overall results showed that the Medical Officers were less satisfied than the respondents to the 2004 Navy Officers survey. More specifically, the Dental and Medical Corps Officers were less satisfied than the Medical Service and Nurse Corps Officers. According to Newell (Ref 5: 2005 APR 6), other key results for this survey include:

- The number one factor influencing Medical Department Officers to leave the Navy is “Red Tape”.
- Mentoring is seen as important to a Navy career by all, but less then half were satisfied with their access to mentors in the Navy.
- While satisfied with current job assignment, Medical Department Officers report less satisfaction with career guidance received.
- Medical Department Officers were most satisfied with aspects of their Navy job, including responsibility, challenge, and feelings of accomplishment.

- Less optimism was found for promotion opportunities, with 51% reporting good promotion opportunity compared to a 75% found on the 2004 Navy Officers Survey.
- Approximately half of the Medical Department Officers believe that the Navy clearly communicates its goals and strategies for the future.
- Less then half of these Medical Officers were positive about their future in the Navy.
- Compared to the 2004 Navy Officer Survey, Medical Department Officers were less satisfied with the Navy and are less likely to report intention to continue in the Navy.
- Dental and Medical Corps were lower then Medical Service and Nurse Corps on all these items.

The actionable items that came out of this survey dealt with red tape, mentoring, communications, and promotions issues. It was suggested that the meaning behind the red tape needs to be better defined in order to address these issues. To attack the mentorship issue, programs would need to be pushed to the front of the medical communities and the representation of the Corps Chief's at Officer Indoctrination School (OIS) should continue.[15] The communications issue consisted of several action items. One was to establish alternative communication channels and another was that the Corps Chief's send a message to the survey participants. An additional item was to have periodic updates from the Corps Chief's offices posted on the internet and to also have those updates sent through email to the medical department officers. The last recommended action item for communication was to create some type of feed back mechanism for officers' concerns and dissatisfaction. The last suggestion about promotion was to educate officers about the promotion system so that they may design their careers to be more competitive. The final advice provided by this quick poll recommended better defining the career paths of these officers and addressing their

[15] Carol Newell, Kimberly Whittam, & Zannette Uriell., "CNP Quick Poll: Medical Communities," Slide Presentation.,Navy Personnel, Research, Studies, & Technology (PERS-1) 6 June 2005.

critical milestones. It was suggested that a handout at OIS could be given to the officers with a follow-on review with their boss at their first command. A follow-up quick poll was recommended for March 2006.

Overall, the MSC community is less likely to attrite than the other three communities. In other words, the MSC top ten influencers to leave were lower in percentage than those of the other three communities. This was true for the reasons to stay as well; however, they were the highest in percentage for these reasons when compared to the other three communities. A more detailed breakdown of MSC stay and leave influencers can be seen in Table 4.

Table 4. Top Ten Reasons "Why" MSC Officer Leave the Navy[16]

Top Ten Reasons to "Leave"	"Influenced to Leave" percentage	Top Ten Reasons to "Stay"	"Influenced to Stay" percentage
Red Tape	62%	Loyalty to Nation/Service	92%
Civilian Job Opportunities	52%	Medical/Dental Benefits	90%
Increased Use of Contractors/Civilians	47%	Patriotism	89%
Overall Time Spent Away From Home	46%	Retirment Benefits	89%
Impact of Being in the Navy on "Family"	43%	Other Benefits	84%
Impact of Being Deployed on "Family"	43%	Job Security	76%
Impact of Member's and Spouse's Career	40%	Career Assignments	76%
Increased Workload	39%	Current Job Satisfaction	71%
Morale in Community	39%	Access to Training Programs	69%
Increased Pressure to be More Productive	38%	Educational Benefits	69%

C. MARKOV MODELING IN THE MILITARY

1. Markov Model Assumptions

Like many manpower models used in the military, the Markov chain model of manpower mathematically describes how change takes place in a personnel system. Unlike other manpower models, the Markov model has no direct consideration of exogenous variables (i.e. demographic trends or changing unemployment rates).[17] Promotion rates are straight-forward because they are directed through policy; however,

[16] Source: Carol Newell, "CNP Quick Poll for Medical Communities", Power Point, April, 2005.

[17] Jeffery Kendall Sapp, "A Calculator Adaptation of the Markov Chain Model for Manpower Analysis." Master's Thesis, Naval Postgraduate School, Monterey, CA, June 1983.

it is hard to predict voluntary attrition rates. Since attrition and retention are not easy to predict, assumptions are made based on historical data, analytical judgment and prior experience. Therefore transition probabilities can either be based on an empirical analysis or on hypothetical assumptions. Historical rates are more likely to be better predictors of future behavior than hypothetical assumptions.

The empirical assumption breaks down even further into either a stochastic or deterministic approach. The stochastic approach examines each individual observation as part of the analysis and returns results that have upper and lower control boundaries instead of exact figures. For instance, the results for Ensigns after seven years might fall between fifty and sixty, but will typically not stay at any number in between. The deterministic approach relies on probabilities that will return results for the entire group. Instead of a figure that fluctuates over time, the deterministic approach will lock down on a steady-state figure and remain that way over time.

This thesis takes a deterministic approach due to the data available and has been modeled after the methodology used in a two prior Naval Postgraduate School theses dealing with Navy Nurse Corps.[18&19] Specifically, these theses take cohort data and track the number of personnel in each rank and years-of-service in that rank. Further, they identify the continuation, promotion or attrition rate used in the transition matrix to form a more precise depiction of personnel flow through the system. Both Nurse Corps theses are discussed later in this section.

The last breakdown of assumptions deals with either a “push” or “pull” ideology. It would be considered a “pull” if a service member was advanced to the next pay-grade only because there was a necessity to fill a vacancy. On the other hand, if the promotion is automatic as a result of some achievement or qualification, then it would be considered a “push”. In this case, a “pull” would relate more to officer promotions while a “push” is frequently associated with an enlisted promotion. Some feel that the promotion from O-1

[18] Glenn Deen & Glenn Buni,, “Development of a Steady State Model for Forecasting U.S. Navy Nurse Corps Personnel.” Master’s Thesis, Naval Postgraduate School, Monterey, CA, March 2004.

[19] Dan Kinstler & Ray Johnson,, “Developing a Markov Model to be used as a Force Shaping Tool for the Navy Nurse Corps.” Master’s Thesis, Naval Postgraduate School, Monterey, CA, March 2005.

to O-2 is considered a “push” as is the promotion from O-2 to O-3. However, promotion to higher pay-grades, i.e., O-4 and above is a “pull.” A “push” may also be caused by a demotion secondary to some deviant behavior or even by being kicked out of the system all together through a discharge.

2. Function of a Markov Analysis

There are several analytical instruments used in military manpower that assist in the creating manpower policies. Typically, these instruments use proper assessments and contribute to effective management of human resources to enhance the manpower system stability. One of these instruments relies on basic mathematical theories to determine effective manpower planning, system control and forecasting; the Markov Model. Markov analysis theory provides an excellent foundation for statistical and mathematical modeling to assist in the management of personnel systems. (Ref 17: JUN 1983)

More directly, if Markov modeling is routinely used as a personnel planner’s tool, it will assist the acquisition of the most efficient accessions mix. Without the use of a Markov model, it is hard to determine structural boundaries of manpower policies and future accession requirements. Some of these boundaries are created through funding or policy issues such as the number and pay-grade of those being accessed, the target end strength or Officer Programmed Authorizations (OPA), the limitations of promotions and its effects on recruitment. Using these boundaries, a Markov model can be used to forecast personnel accessioning and recruit the most efficient force. Further, it could identify the optimal number of applicants for the training pipeline and project attrition rates on specific accession sources.

The basic function of a Markov model is to determine the flow of personnel though the system and in that, identify what the steady state is for each group or pay-grade. This is done by identifying the number of personnel in the system at each pay-grade and how each of them transitions from one year to the next with regards to their pay-grade. There are three ways in which personnel can flow through the system. They will either stay at a pay-grade into the next year (continue), be advanced to the next pay-grade (promote) or get out (attrite). Demotion is also a method of flow; however, it is very rare and was not observed in the Markov Model data used in this study. Chapter IV will discuss in greater detail how the steady-state is determined.

3. Markov Modeling the Nurse Corps

The initial thesis that used Markov modeling to provide the Navy Nurse Corps with a tool to forecast recruiting goals was completed in March of 2004. In this thesis, the Nurse Corps (NC) was categorized by length of service and pay-grade.[20] The specific focus was on the junior officer's pay-grades O-1 to O-3 within eleven years of data provided by BUMIS. The transition matrix was derived from fiscal year data and was based on a three part personnel flow process. In this flow process, a NC officer could stay at the current pay-grade, promote to the next pay-grade or get out on the service. Backward movement or demotions were not allowed and even though there were O-4 and O-5 personnel in the data, they were left to flow through the system in order to create the best transition matrix. Logistic regression was used to investigate significant factors of staying in the NC at certain career decision points. The data used in this thesis were cohort files obtained from BUMIS and DMDC. There were two separate files created; one for the years 90' to 94' and the other for the years 96' to 98'. The results from the Markov model showed that the O-1's and O-2's reached their steady-state at the eight year mark while the O-3's do not reach their steady-state until the seventeen-years. When the NC goals were compared to the current accession plan, it was determined that there was a shortage of O-3's and an overabundance of O-1's. Even though the size of the NC was at its desired number, the prediction was for a very junior corps. (REF 9: MAR 2004)

Scenarios were developed to ascertain the best mix of accessions and to examine downsizing effects. Logistic regression results showed commissioning source played a role in retention. Recalls, Medical Enlisted Commissioning Program (MECP), and the Nurse Candidate Program were all significant in increasing the probability of staying in

[20] Gary Deen, & Glenn Buni,, "Development of a Steady State Model for Forecasting U.S. Navy Nurse Corps Personnel." Master's Thesis, Naval Postgraduate School, Monterey, CA, March 2004.

the NC as compared to the other sources. It was also found that males were most likely then females to stay in the NC and an increase in the education level decreases the probability of staying in the NC.[21]

A follow-on thesis specifically looked at how the NC would meet the challenge of accessing the appropriate number of nurses each year in order to maintain desired end strength. Logistic regression was used to determine significant “leave” and “promote” characteristics. These dependent variables were viewed at career points where officers were found to be either promoted to the next pay-grade or leave the service in large numbers, frequently as the result of DOPMA guidance on grades. The accession source was determined to be significant.[22] The Markov model was expanded in this thesis to include the O-4 pay-grade. The data used to develop the Markov model and estimate the logistic regressions were obtained from DMDC and BUMIS. Both files were merged for this study. The transition matrix was put together in similar fashion as the prior NC study. The model projected out from 2006 to 2009 and compared these results with the targeted end strength values during this same period. There were also several scenarios run to minimize the overage or underage found in the Markov analysis. This was achieved by changing the distribution of accretion sources as well as the distribution of the recruiting ranks. The optimal distribution of accession sources and rank were dependent on the acceptable deviation from the targets that had been pre-determined by the NC. It was unfortunate that this information was not provided and therefore a detailed recommendation for the best mix of accession sources and rank to reach end strength targets was not completed. The two-year projection did show that the NC’s current business practices would not produce large deviations in the near term. It was further determined that greater efficiency could be obtained in the out-years if there was

[21] Gary Deen, & Glenn Buni,, “Development of a Steady State Model for Forecasting U.S. Navy Nurse Corps Personnel.” Master’s Thesis, Naval Postgraduate School, Monterey, CA, March 2004.

[22] Dan Kinstler, & Ray Johnson., “Developing a Markov Model to be used as a Force Shaping Tool for the Navy Nurse Corps.” Master’s Thesis, Naval Postgraduate School, Monterey, CA, March 2005.

an increase in variation between the current force structure plan and the model's projections.[23] These theses serve as a basis for the current modeling effort. (REF 14: MAR 2005)

D. SURVIVAL ANALYSIS

Three studies are reviewed that analyze the survivability of officers. One of these studies focused on accession optimization and the other two identified survivability patterns. The first study is the only one that pertains to the Medical Service Corps (MSC) Health Care Administrators (HCA). The second and third studies provide an in-depth focus on survival analysis techniques. Although these do not relate to the MSC, they do provide the basic methodologies that can be adapted the Health Care Administrator community.

The first study used bivariate and multivariate analyses to estimate the factors that influence the "effectiveness" of MSC HCA In-service Procurement Program (IPP) and Direct Procurement (DP).[24] Data used in this study came from the Navy Officer Master File, Navy Officer Loss File, and the Navy Personnel Research and Development Center's officer Fitness Report File. These data sources were used to make comparisons of these officers by their commissioning source. Proportional "hazard" models were used to estimate the years of commissioned service the MSC HCA officers are expected to serve before retiring or being voluntary released from active duty. Logit models were used to evaluate the probability of being promoted and having higher than average fitness reports as a function of the procurement source. (Ref 24: DEC 1994)

The findings revealed that MSC HCAs with ten or more years of commissioned service tend to leave within a few years after becoming eligible to retire. Differences in education levels and early fitness report performance between officers accessed through

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[23] Dan Kinstler, & Ray Johnson., "Developing a Markov Model to be used as a Force Shaping Tool for the Navy Nurse Corps." Master's Thesis, Naval Postgraduate School, Monterey, CA, March 2005.

[24] DeAnn Farr, "Analysis of U.S. Navy Medical Service Corps Health Care Administrator Direct and In-service Procurement accession Programs," Master's Thesis, Naval Postgraduate School, Monterey, CA. December 1994.

IPP and DP were identified in the study. Based upon the results, it was recommended that a cost-benefit analysis be done to determine the optimal MSC HCA accession policy. (Ref 24: DEC 1994)

A second study analyzed the determinants of the survival of United States Marine Corps (USMC) officers and developed a methodology to optimize the accessions of prior and non-prior enlisted officers.[25] The data used to formulate the study came from the Marine Corps Officer Accession Career (MCOAC) file. The survival analysis was based on a Cox Proportions Hazards Model. The findings from this model showed that prior enlisted officers survived longer then their non-prior enlisted counterparts. In addition, it was found that commissioning age has a negative effect on the survival of officers. This means that every year added to the commissioning age of an officer results in a decrease in his or her survival.

In this study there was also a Markov model used that included vacancies. This model was created to determine the optimal percentage of prior and non-prior enlisted accessions for the USMC. It was determined in this study that there was a difference between the optimal and actual mix. The non-parametric model showed that the optimal percentage of prior enlisted officer accessions is 22.4% and the optimal percentage of non-prior enlisted officers is 77.6%. The actual percents for 1999 were 53.4 and 46.6 for prior and non-prior, respectively. (REF 23: MAR 05)

In the latest study completed in March of 2005, Korkmaz analyzed the survival patterns of Naval officers. The focus was on evaluating the factors that affect the longevity of officers with a more narrow focus on commissioning source. Data were created from the Navy Officer Data Card information and annual promotion board results for Naval officer cohorts who entering the service between 83' and 90'. Three SAS software survival analysis procedures were used to examine the factors that influence the survival of Naval officers (LIFETEST, LIFEREG and PHREG). The results indicated that commissioning source does in fact have a significant effect on the survival rates. It was also identified that females and African-Americans have significantly higher survival

[25] Phillip Hoglin, "Survival Analysis and Accession Optimization of Prior Enlisted United States Marine Corps Officers." Master's Thesis, Naval Postgraduate School, Monterey, CA., March 2004.

rates then males and whites, respectively.[26] Further it was determined that prior enlisted, older graduates from non-selective colleges have significantly higher survival rates that their counterparts. In a different view, the Surface Warfare, Fleet Support and Supply Corps officers were found to have a significantly lower survival rate then other officer communities. (REF 22: MAR 04)

This study also included an analysis of voluntary and involuntary separations. The findings of this analysis identified that the following had a significantly negative effect on "involuntary" separations and significantly positive effect on "voluntary" separations; commission age, being African-American, single with children, being commissioned from a NROTC contract program, bring prior enlisted, having a high GPA and designated in the "air" community.[27]

E. SUMMARY

The intention of this review was to discuss studies that deal directly with the methodology being used in this thesis and to provide insight into the MSC community. Although only a few of the studies deal with HCA officers or the aggregate group of MSCs, the basic methodologies can be adapted to study the MSC HCA community.

[26] Ibrahim Korkmaz, "Analysis of the Survival Patterns of United States Naval Officers." Master's Thesis, Naval Postgraduate School, Monterey, CA., March 2005.

[27] Ibrahim Korkmaz, "Analysis of the Survival Patterns of United States Naval Officers." Master's Thesis, Naval Postgraduate School, Monterey, CA., March 2005.

IV. METHODOLOGY

A. MARKOV MODEL FORMULATION

Once the decision to create a Markov Model was made it was essential to understand the type of information required. There are three options taken by the personnel in the Markov Model; stay at current rank, promote to next rank or get out of the service. Demotions were not allowed in the transition matrix. The ranks analyzed in the Markov model were Ensigns though Lieutenant Commanders (O-1 through O-4).

1. Data Set

There were two data bases used for this study; Bureau of Medicine Management Information System (BUMIS) and the Defense Manpower Data Center (DMDC). Specifically, the major contributor of data came from DMDC in Monterey, California. The mission at DMDC is summarized as follows:[28]

- Collect and maintain an archive of automated manpower, personnel, training, and financial data bases for the Department of Defense.
- Support the information requirements of the Office of the Undersecretary of Defense (OUSD) (P&R) and the other members of the DoD, manpower, personnel, and training communities with accurate, timely, and consistent data.
- Operate DoD-wide personnel programs and conduct research and analysis as directed by the OUSD.

The data was pulled using cohort files of all Medical Service Corps personnel over a seventeen year period (1988-2004). The data request included all Medical Service Corps personnel to include Health Care Scientist as well as the Health Care Administrators. Unfortunately, some of the data was not available at the specific level needed for this study. Specifically, DMDC uses Source of Commissioning to identify the appropriate route each officer used upon entering the service and the calendar year was used for promotions instead of fiscal years. DMDC's version of this variable was at the

[28] DMDC Website: http://www.dmdc.osd.mil/dmdc.html; accessed on January 12, 2006.

broad view and did not get into the depth needed to accurately separate the Health Care Administrators by their commissioning source. Upon further pursuit into a more specific account of commissioning sources, DMDC suggested the use of Health Manpower and Personnel Data System (HMPDS), which is a file sent to them on an annual basis. After research into the HMPDS files, it was determined that the ability to isolate the specific commissioning source was still not completely accurate; therefore, it was necessary to go to BUMIS directly.

The data received by BUMIS identified the commissioning source through a Source of Entry variable (SOE). Although this data was more specific then the other sources, there were still some matching issues. The In-service Procurement Program (IPP) was identified by a “10” and a “30” while most of the others were given a “40” for Direct, Recall, IST, and HSCP. In fact, there was not a code for the HSCP personnel. It was because of this that two groups were created within the data base instead of the five that existed. Since the isolation of the In-service Procurement Program personnel was easier to understand it was made into one group. All four others were grouped together, thus leaving two groups; “IPP” and “Others.”

This division also makes sense when considering the pool of candidates, since the IPP personnel are brought in specifically from the enlisted ranks while the other group typically is either directly from a civilian pool of candidates. This study will help isolate the differences in prior service officers and how they differ from those selected from the civilian population. This SOE date was merged with the DMDC data to create a Combined Data Base (CDB).

A “total years of service” variable was created to get a better understanding of the age of the corps. This variable was further used in the logistic regression models as this is a strong factor used in determining survivability. The construction of this variable was made based off of the “officer gain date” and date of separation or them still being in the service. In other words, their years of service were taken out to 2004 if they were still in the service.

After receiving the data from the sources it was essential to check for quality. With the use of Microsoft Excel "Auto-filter" function, the date was able to be isolated and checked efficiently. Expecting a DOPMA-like progression through the system of promotions with rank, year of rank and month of rank; the data was visually examined for discrepancies. A depiction of the partial promotion data can be seen in Figure 1.

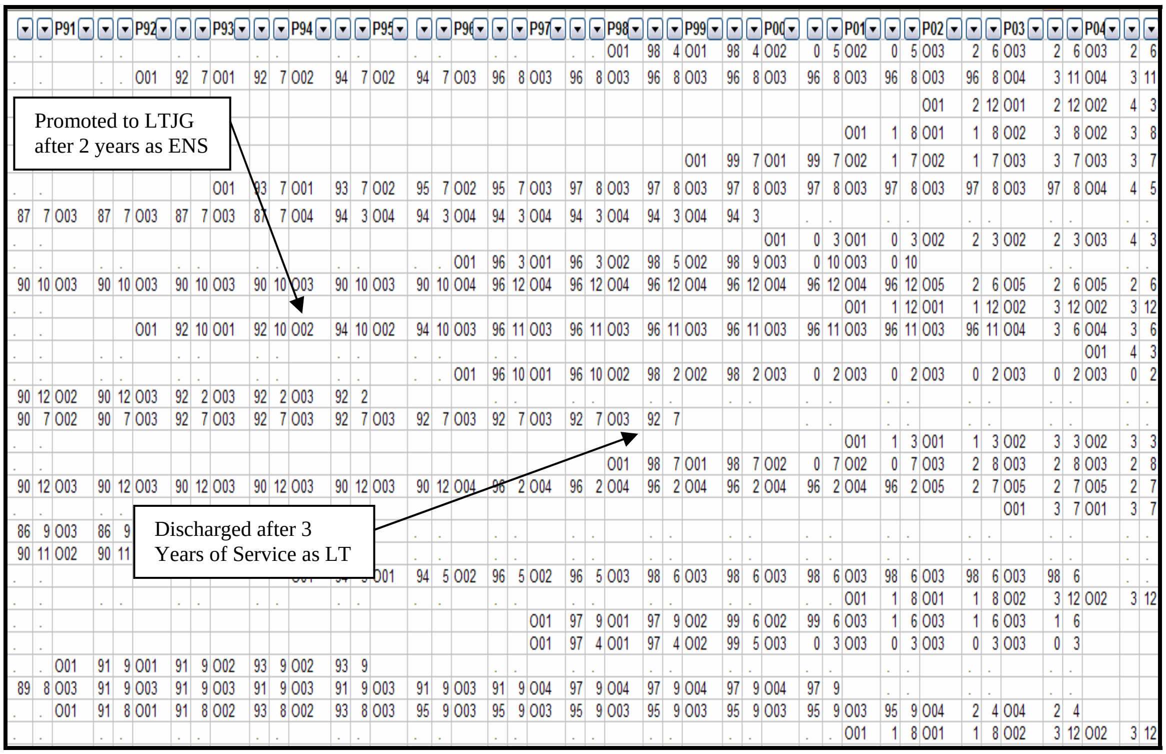

Figure 1. Partial Depiction of Promotion Data used in study[29]

The data was further separated to identify the exact number of available observations. First, all Health Care Scientists were separated from the data to isolate the Health Care Administrator specialties. Duplicate entries were then eliminated from the file and a line-by-line assessment was made to determine the completeness for each observation. If there were blanks discovered within an observation, it was further assessed to determine if other data within the same observation could be used to fill in the blank. For example, if there was some promotion information missing between two ranks of the same file, then the data was entered into the space that corresponded to the

[29] Source: Author.

before and after entry. Also, if an officer commission date was missing and there was existing promotion data available for that observation, then the initial date of rank for the first rank (Ensign in most cases) was used to fill in the date blank. For all those instances where there was no information available to fill in the blanks for the promotion, officer gain date and separation information, these observations were deleted from the data file. After several quality checks were made, there data was left with 1270 observations that represented the Medical Service Corps Health Care Administrators between the years 1988 to 2004.

2. Fiscal Year Matrices

The Markov Model developed in this study is designed to predict manpower stocks using the pay-grade and years of service over a seventeen-year period. The model used seventeen years of data to increase the number of observations. Under the constraints placed by DOPMA on promotion and decision flow points, some personnel can flow through the system up to O-5. The data was extracted in such a way that in year 1988 (first year of data) there were already people flowing into the system. This is why there were a few cases of personnel reaching the rank of Captain or O-6.

The primary transition matrix, as seen in Appendix B, was developed by combining data over all the seventeen calendar years. The matrix itself is broken down by pay-grade and years of service within that pay-grade. The rows represents the percentage of personnel at a particular rank and where they move "from" while the columns represent the "to" or where they go in a years time. Formulas were placed within the cells on the primary transition matrix to calculate the distribution of pay-grade and year of service for each calendar year. For example, the box in the primary transition matrix located at "row" ENS1 and "column" ENS2 has a value of .9816. This number was derived from taking all the first year Ensigns from the seventeen-year data and determining whether they advanced to a second-year ensign (ENS2), promoted, or discharged. This particular block states that there were a little over 98% of the Ensigns that stayed in the same rank. The other two white boxes with numbers in the same row represent promotion to LTJG and getting out of the service. All discharges are denoted in the last column. The very last column was created to check whether the rows add up to one. The percentage of those that stay, added to the percentage of those that promote and get out, must equal one, which is what takes place in the primary transition matrix.

3. Required Statistics

This section will discuss how probabilities of a change in grade were calculated as a function of years of service in a particular rank. From the Medical Service Corps data, the promotion year represented different actions that took place for each member. As shown in Figure 1, each person within the data has a representation of their status since they entered the service by pay-grade, year of promotion to pay-grade and the month that the promotion was awarded. For example, if there was an entry of O03 94 5 under the calendar year 2000, then this person has been a LT for 6 years and their date of rank was May of 1994.

a. Defining the Transition

In order to calculate transition probabilities, there must be a way to isolate each group by pay-grade and have an account for the individual's years of service within the pay-grade. The Microsoft Excel Auto-filter allowed for a pay-grade to be selected and the year that pay-grade was obtained. When this function was completed under a specific year it would isolate all those that were promoted to that pay-grade during that year. For instance, if O02 and 91' were selected in auto-filter in the column for year 91', then all those promoted to LTJG in 1991 would be observed. This function was completed for each year and pay-grade during the entire seventeen year period. This method was also used to identify the how personnel would flow through the system. For example, once the group was identified, LTJGs in 91', it could be determined if and when each member stayed at their current pay-grade, advanced to the next, or got out of the Navy.

Once these numbers are identified they are then put together to understand the flow behavior for each of the seventeen years. Since there were some LTJGs in 88' that were given that pay-grade in 87' or 86', these two years were also used to enhance the results. As shown in Figure 2, the numbers identified in the first step were placed in a table that contained each of the nineteen years (88'-04' + 87' and 86') as they pertained to one stage in a Medical Service Corps HCA officers flow through the system. Figure 2 is a representation of those LTs with six years of service in that pay-grade. The second column identified the year and the corresponding numbers signify those that stayed as a LT in their first year, those that were promoted to LCDR and those that got out of the Navy, respectively. More specifically, in 92' there were thirty-three that remained a LT, twenty-nine that were promoted to LCDR and seven that decided to get out of the Navy. This information was created for Ensign's with 1-3 years in pay-grade; Lieutenant Junior Grades with 1-4 years in pay-grade; Lieutenants with 1-9 years in pay-grade and Lieutenant Commanders with 1-9 years in pay-grade.

	YEAR	ENSIGN	LTJG	LT	LCDR	CDR	OUT
LT YR6	86			2	0		1
	87			3	1		
	88			0	2		
	89			1	0		
	90			14	11		1
	91			21	6		3
	92			33	29		7
	93			47	25		3
	94			46	14		4
	95			29	17		5
	96			52	10		
	97			30	6		
	98			30	0		6
	99						
	0						
	1						
	2						
	3						
	4						

Figure 2. Information Used to Determine Markov Model[30]

b. Stocks

Since a Markov model uses the current stock of personnel in the system to determine future states as part of the initial calculation, a table of current HCA inventory was created using the MSC Alpha Roster and can be viewed in its complete form in Appendix A. This roster was part of the OCT 05 MSC Report and was broken down by specialty and fiscal year (Ref 18: OCT 2005). As shown in Figure 3 as a partial

[30] Source: Author.

representation of Appendix A, there were twelve 1800E Ensigns in their second year in that pay-grade and eight in their first year at that pay-grade. This information was entered up until the pay-grade of LCDRs with nine years in pay-grade to match the transition matrix. These stock values were then entered into the first column and represented as "Stock at time zero."

ENSIGN	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05
1800E	20								12	8
1800T	8									8
1802V	1									1
3130T	1								1	
Total	30	0	0	0	0	0	0	0	13	17
LTJG	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05
1800E	23								3	20
1800P	65								40	25
1800T	2								2	
1801V	12								11	1
1802V	2									2
1803S	1								1	
1804V	1								1	
1805S	2								1	1
3110V	2								1	1
6201T	2								2	
Total	112	0	0	0	0	0	0	0	62	50

Figure 3. Ensign and Lieutenant Junior Grade Stocks as of October 2005[31]

c. Input

In order for the transition matrix to properly predict future years output it is essential to include the accessions that are brought in during those years. Since it is not a typical practice to access LCDRs into the Medical Service Corps Health Care Administration field, there were columns created for each pay-grade up to, but not to include, LCDR and protracted out to 2025, or twenty years into the future.

[31] Source: Author.

For pay-grades O-1 through O-3, there needs to be an input for the expected accessions. On a separate worksheet there was a space created for each pay-grade as it pertains to a future year. For instance, there is a place for O-1, O-2, and O-3 in rows that correspond to a specific "future" year column. Once these are identified and added into the matrix calculation at the point in which each of the pay-grades are in their first year, the personnel flow is complete and steady-states can be identified for each pay-grade.

When calculating personnel movements it is essential to use inputs that correspond to initial stock and the rates of the transition into each pay-grade. In Figure 4, the box for LTJG 1 was chosen to better understand this application. First there is a SUMPRODUCT calculation of the entire "Stock 0" and LTJG 1 columns and this is combined with a simple addition of the cell that represents new accessions for a specific year. Even though cell "D3" looks as though it would be used for each stock calculation over time this is not the case. In this study each stock calculation for every given year had its own cell of planned accessions for that given year. Figure 4 is a representation that was added to assist in the understanding of the input values relationship in the overall calculation and was not actually part of the study. A much more detailed look at the input sheet is given in Figure 5 as part of the summary output portion below.

fx =52+SUMPRODUCT(AN3:AN27,N3:N27)

K	L	M	N	O	P	AN	AO
						Stock 2002	Predicted 2003
	ENS2	ENS3	LTJG1	LTJG2	LTJG3	Stock T0	Stock T1
ENS1	0.9816		0.0184			31	14.00
ENS2		0.0241	0.9759			54	30.43
ENS3			1.0000			0	1.30
LTJG1				0.9708		103	=52+SUMPROD
LTJG2					0.0796	78	99.99
LTJG3						0	6.21
LTJG4						0	0.00
LT1						73	73.21
LT2						69	70.22
LT3						54	67.36
LT4						28	51.46
LT5						43	26.42
LT6						60	38.27
LT7						26	40.26
LT8						4	11.73
LT9						6	1.38
LCDR1						56	36.42
LCDR2						52	54.81
LCDR3						40	51.43
LCDR4						40	38.68
LCDR5						26	38.18
LCDR6						42	23.52
LCDR7						12	35.37
LCDR8						1	10.00
LCDR9						5	0.67
						903	***927***

Figure 4. Creating the Formula for the "Stock at Time One"[32]

d. Predicting Years Output

Once the personnel flow is identified and the annual accessions are inputted, it is the hope that the predicted years output would result in steady-states for each pay-grade. In order to set everything up in such a way that accurately depicts the personnel with respect to manpower requirements it is necessary to create pay-grade totals for each stock calculation. Doing this simple calculation allows for comparisons of current force structure as it relates to future target end strengths. This calculation is done by adding the total of each pay-grade over all years in rank for each of the stock columns.

[32] Source: Author.

As shown in Figure 4, the stock column calculations are completed one cell at a time and given a "$" in front of the column that refers to the transition matrix portion of the SUMPRODUCT calculation. It is the dollar symbol in Excel that locks down the reference point portion of the formula. When one formula is "pulled" across to other cells, the data that is attached to the dollar symbol remains the same. Putting a dollar symbol in front of the transition matrix column will allow the future stocks to reference the transition probability data within that column. Leaving the dollar sign out of the other portion of the SUMPRODUCT formula (stock zero column) will allow each future calculation to refer to the prior year's stock.

Once the cells are properly referenced and all of the pay-grades are totaled at the bottom by stock or future year, predicting future years output is the next step. Highlighting the cells in "Stock one" column, of which formulas were placed, and dragging them right across twenty cells will give the predicted years output for twenty years. This can also be done for the pay-grade totals. This drag technique allows for the steady-state to be assessed at two different places; through the stock columns and pay-grade totals. The steady-state can be identified when the number of the next years output is the same. It is at the point in which there is no change and the first occurrence of that number appears that marks the year that the steady-state is reached.

e. Summary Output

Once a steady-state has been determined, the policy and historical levels can be further analyzed. The target end strength is a representation of policy or historical figures while the predicted output is the result of a transition matrix calculation of stocks that produce the total number of personnel in each pay-grade. On the "Input Worksheet" shown in Figure 5, each cell contains references to target end strength and how these targets differ from the predicted year's output levels generated by the Markov model. The portion that identifies the "differences" has each cell linked to the transition matrix worksheet. The calculation for the difference in target end strength and predicted years output for Ensign is a simple subtraction. For example, if stock at time "one" produced seventy-three total Ensigns, regardless of years in rank as Ensign, while the policy or historical numbers for Ensigns has been determined to be seventy-seven, then there is a shortage or difference in Ensigns of four. Figure 5 is a direct representation of the input worksheet. The "accessions" are linked into the Markov model stock calculations while the "target end strength" represents the actual end strength determined by policy. The "difference" rows represent the differences between the actual Officer Programmed Authorizations end strength targets and those that have been predicted with using the Markov model.

A	B	C	D	E	F	G	H	I	J	K	L
Accessions											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	ENS	8	8	8	8	8	8	8	8	8	8
	LTJG	40	40	40	40	40	40	40	40	40	40
	LT	10	10	10	10	10	10	10	10	10	10
Target End Strength											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	ENS	43	43	41	39	37	37	37	37	37	37
	LTJG	154	154	149	143	139	139	139	139	139	139
	LT	383	377	372	368	364	364	364	364	364	364
	LCDR	261	259	255	253	252	252	252	252	252	252
Difference											
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	ENS	-18	-27	-25	-23	-21	-21	-21	-21	-21	-21
	LTJG	-48	-42	-42	-44	-41	-41	-41	-41	-41	-41
	LT	81	90	89	84	67	41	18	4	-3	-8
	LCDR	-55	-39	-19	-5	12	31	53	68	71	76

Figure 5. Input Worksheet to Determine the Difference in Future-Year Output[33]

To quality check the transition matrix a test preformed using historical data from fiscal years 2002 and 2003. Stock at time zero was replaced with actual 02' values taken from a report created by the MSC planner for fiscal year gains.[34] The theory behind the test was to push actual 02' figures through the transition matrix to identify the predicted output. Once these values were identified, a comparison to the actual 03' data

[33] Source: Author.

[34] Information provided by Roshard Woolfolk., "Report of MSC gains by GCAT for FY 2004 and FY 2005", January 2006.

was compared against the predicted values to determine the validity of the transition matrix given the historical data used in this study. A boundary variance of +- 10% was used to validate the data used in the transition matrix.

f. Base-Case Formulation

The OPA figures used in the base-case scenario were determined using the five-year forecast of total MSC officers in pay-grades O-1 through O-4. Using the 2003 alpha roster, the HCA percentages were determined by rank and these percentages were further used to separate the HCA officers from the HCS officers. These percentages were further used to fraction off the OPA "total MSC" figures given in the Officer Community Manager "Shell Plan" for FY 2006 –FY 2010.[35] The only commissioning source that provided the distribution by rank was IPP while the other four distributions was derived using past FY gains reports. The base-case scenario and all others in this study use the October 2005 MSC HCA stock figures in the Markov model for the "stock at time 0" calculations.

The accession figures are assumed to remain the same only because it is the most recent information available to assist in determining future accessions. This will also be the case for the pay-grade focused scenarios. The OPA is entered up to FY 2010 and then assumed to remain as the same figures of FY 2010 since the forecast ends at that time. The OPA figures will remain the same for all scenarios while the accessioning figures will be manipulated to determine the best mix of officers over time. All scenarios are tested with the understanding that in order for the accession results to be what they are, all other things must remain constant.

B. LOGISTIC REGRESSION

1. Data Set

The data used in this part of the study are the same as those used in the Markov modeling section. The Excel file containing both BUMIS and DMDC demographics and promotion history was converted into a SAS file for seventeen years of cohort data. The regression analysis addresses the retention of MSC HCA officers at certain year

[35] Roshard Woolfolk., "OCM Shell Plan containing FY 04 –FY 10 data." January 26, 2006.

milestones. The specific retention milestones that pertain to this study are the seven and ten year marks. The data for these two retention year milestones offer large enough sample sizes for regression analysis.

Models for these two retention milestones were chosen because of the data limitations, as well as, the significance of the ten-year retention fulfillment of IPP accessioned officers. In the preliminary examination of the data, the seven-year retention model was found to provide adequate information for analysis and was chosen because it provides a three-year comparison to the later model.

The data set covered the period of 1988 to 2004; however, the focus needed to be limited to those officers whose careers could be followed to the milestones used in the analysis. The original data set of 1,270 observations was divided into two groups; one that included only the 1988 observations (Group A, where n = 222), and another that incorporated all officers who entered in on or after 1989 (Group B, where n = 1048). Group B provided observations that identified officers entering the service and followed them through their careers. This study was further restricted to include only those officers who were promoted within two months of DOPMA's "average time in grade" (Group B restricted to n = 749).

The two models predict the behavior of the same group as they reach seven and ten years as MSC HCA officers. Of the 749 officers used in the seven-year model, 436 of them survived to seven years and 42 of them did not. The remaining 271 had less than seven years in the service and were still serving on active duty at the time the data collection ended; therefore they were unobservable. The ten-year model began with the 436 officers who had survived to seven years and followed them out to the ten-year mark to observe their retention. Of these, 293 people survived to ten years and 72 left the service before that mark. The remaining 71 were unobserved as they were still on active duty after the seven-year mark, but could not be followed to ten years because data collection ended prior to their tenth year of active service.

2. Sample Characteristics

Descriptive statistics for officers in the seven-year retention analysis can be seen in detail in Table 5. About 56% of the officers are IPP accessed, 19% are single, 25% are non-white and 24% are female. The average entry age was 25.8 with the lowest entry age being 20 and the highest being 36 years old.

Table 5. Descriptive Statistics for 7-Year Retention Model[36]

Variable	Mean or Proportion	Minimum	Maximum
In-Service Procurement Program (IPP)	.5637	0	1
AGE_AT_ENTRY	25.8088	20	36
SINGLE	.1887	0	1
NONWHITE	.2524	0	1
FEMALE	.2426	0	1

The descriptive statistics for the officers in the ten-year retention analysis can be observed in Table 6. There were slight differences between these officers and those in the seven-year analysis. A slightly higher percentage of officers in the ten-year retention analysis were accessed through IPP (56.3% verses 56.9%). The average age-at-entry was slightly lower (25.8 verses 25.05). The single officers had about the same representation in both seven and ten-year retention models. The non-white population represents a smaller part of the group that is measured with the ten-year retention model. Finally, female officers are represented at about the same level in both the seven and ten-year retention analyses.

Table 6. Descriptive Statistics for 10 Year Retention Model[37]

Variable	Mean or Porportion	Minimum	Maximum
In-Service Procurement Program (IPP)	.5691	0	1
AGE_AT_ENTRY	25.051	20	35
SINGLE	.1897	0	1
NONWHITE	.2186	0	1
FEMALE	.2411	0	1

[36] Source: Author.

[37] Ibid.

3. Preliminary Analysis

Before estimating the multivariate models preliminary analysis was conducted to better understand the retention behavior of the officers in the data set. Table 7 presents the results of a preliminary bivariate analysis of each explanatory variable's relationship to retention for Group B officers. Chi-square tests were conducted to identify significant associations between retention and the categorical explanatory variables. Since the AGE_AT_ENTRY variable is continuous, a "T" test was conducted to compare the average age for stayers and leavers. IPP officers have a significantly greater tendency to stay in the service then those who are commissioned through other sources. The married officers also show a significantly higher tendency to stay when compared to those who are single. The non-white HCA officers have a significantly greater tendency to remain in the service when compared to the white population. The female and male officers in the study have about the same likelihood of staying at 75% and 76%, respectively, a difference that is not significant.

Table 7. Explanatory Variables by STAY/LEAVE Status (Combined 7 and 10 Year Retention Groups)[38]

Variable	Stay Percentage	Leave Percentage	Pr>Chi-Square
IPP	78%	22%	.0274**
NON-IPP	72%	28%	
SINGLE	66%	34%	.0019**
MARRIED	78%	22%	
NONWHITE	82%	18%	.0016**
WHITE	72%	28%	
FEMALE	75%	25%	0.7157
MALE	76%	24%	
Variable	**Average "Stay" Age_at_Entry**	**Average "Leave" Age_at_Entry**	**Pr>:t:**
AGE_AT_ENTRY	27.24	25.21	<.0001***
*** .01 Level Significance ** .05 Level Significance			

4. Dependent Variables

Two dependent variables were created for the analysis. RET07 and RET10 are both binary variables that follow Group B (n = 749) through the sixteen year period. The

[38] Source: Author.

RET07 dependent variable measures all those observations that survive to the seven-year mark (RET07 = "1") and those who did not (RET07 = "0"). All those individuals who came into the service too late to be observed were assigned a "missing" code to denote "unobserved." The RET10 dependent variable was constructed using the same method.

5. Explanatory Variables

The explanatory variables listed in Table 5 were constructed from the data provided by DMDC/BUMIS. Table 8 gives a short description of each variable. All of the explanatory variables, except for AGE_AT_ENTRY, are binary. A more detailed description of these variables follows.

Table 8. Variable Descriptions[39]

Variable Name	Definition of Variable
RET07	1=Health Care Administrator officer was retained at 7 years, if not then =0 and if unable to reach 7 years due to entry date after 1997 then = missing.
RET10	1=Health Care Administrator officer was retained at 10 years, if not then =0 and if unable to reach 10 years due to entry date after 1994 then = missing.
IPP	1=Health Care Administrator officer commissioning source was In-service Procurement Program, =0 if one of the other four sources (HSCP, Recall, IST, or Direct)
AGE_AT_ENTRY	Age of officer upon entry into the Medical Service Corps as a Health Care Administrator.
SINGLE	1=Single, =0 if Married
NONWHITE	1=Race other then white, =0 if White.
FEMALE	1=Female, =0 if Male.

6. Variable Construction

Commissioning source is considered the "focus" variable for this analysis. There are five different types of commissioning sources that HCA officers use to enter the military and this study has broken them down into two groups due to data limitations. The first group represents all those who were prior enlisted and entered through the IPP source. The other group represents the remaining HSCP, Direct, IST and Recall sources.

[39] Source: Author.

The group of interest in this study is IPP because these officers represent the population that tend to leave/retire after ten years and are more homogeneous than the others.

Being binary, the NONWHITE, FEMALE and SINGLE explanatory variables were assigned a code of "1" if the officer was not white, female, or single, respectively. If an officer was white, male or married, respectively, then these variables were assigned a code of "0."

7. Multivariate Analysis

Figure 6 shows the empirical models and the functional form for both logistic regression analyses used in this study. Logistic regression was chosen for multivariate analysis because both of the dependent variables (RET07 and RET10) are binary and this regression method is appropriate for binary dependent variables. "P" is the probability that the dependent variable is equal to 1, "*e*" is the base of the natural log and "*a*" and "*b*" are the parameters of the model. The "X" represents the independent variables. The value of "*a*" yields "P" when "X" is zero and "*b*" adjusts how quickly the probability changes when changing "X." The value of "X" is not linear in relation to "P" and therefore the interpretation of the "*b*" is not straightforward. (REF 29: 11 MAR 2006)

Functional Form:

$$P = \frac{e^{a+bX}}{1 + e^{a+bX}}$$

Model #1:

RET07 = *f* (*IPP AGE_AT_ENTRY SINGLE NONWHITE FEMALE)*

Model #2:

RET10 = *f* (*IPP AGE_AT_ENTRY SINGLE NONWHITE FEMALE*)

Figure 6. Retention Models Used in Study[40]

[40] Source: Author.

8. Hypothesized Relationships

Table 9 provides the hypothesized effect on retention for the Group B officers for each explanatory variable. The reasoning behind each of the hypotheses identified in Table 7 is discussed below. Because HCA officers who are commissioned through the IPP are prior enlisted and only eligible for "officer" retirement pay after 10 years, it is expected that the IPP variable would be positively associated with retention when compared to the other four commissioning sources. HCA officers who join at an older age are expected to be less motivated to stay in the military; therefore, it would seem that the AGE_AT_ENTRY variable would be negatively associated with retention. This lack of motivation may be due to the decreased incentive to start a twenty-year career when they are older. When an HCA officer is single and without family responsibilities he or she will have more freedom to come and go as they please; therefore, the SINGLE variable is anticipated to be negatively associated with retention when compared to the married officers. The non-white officers are anticipated to have a higher retention because the military provides more job security for them when compared to their civilian opportunities. The gender variable "FEMALE" did not have a hypothesized sign as there is no clear reason why one gender would be retained longer than the other.

Table 9. Expected Signs for Explanatory Variables[41]

Explanatory Variable	Effect on Retention
IPP	"Positive"
AGE_AT_ENTRY	"Negative"
SINGLE	"Negative"
NONWHITE	"Positive"
FEMALE	"Unspecified"

[41] Source: Author.

C. SURVIVAL ANALYSIS

The analysis used in this thesis is meant to help understand significant factors that influence the survival of the MSC HCA officers. Historically, survival analysis methods were used to study death or failure of a product; however, they are also useful in the analysis of many events in different sciences. This methodology section discusses the survival analysis procedures in SAS software and explains the strengths and weaknesses of each procedure.

Survival Analysis is included in this study to provide the Officer Community Manager and planner with a better understanding of the overall effects of accession source on survival for MSC HCA officers. Further studies on this topic incorporating more demographic and economic data would provide a more complete view of influencers on the survival of MSC HCA officers with respect to commissioning source.

1. Data Set

The data set used in this analysis is the same as that used to create the transition matrix and for the logistic regression models. The only modification arose from the creation of separate variables to identify survival characteristics. The three variables that were created represented the time between an officer's first date of rank and the date he or she separated from the service. This "TIME" variable was created to depict the actual number of days the officers served in the military as officers. A second time variable, "TIME2," was created to represent the time between an officer's first date of rank and end of the data used. If there was no separation date, then he or she was considered to have "stayed" in the military; thus the variable "STAY" was created. When STAY is equal to "1", this indicates that the officer was in fact still in the service after the time the data ended.

To conduct a survival analysis, some data must be identified as "censored" in order to isolate the observations that survived through the entire cycle. When the variable "STAY" is equal to 1 an observation represents right sided censoring.

2. Survival Procedures

There are three commonly used SAS procedures that assist in determining the survival characteristics of a group. The LIFETEST procedure uses two methods for estimating survivor functions. The Kaplan-Meier method is more widely used and more suitable for smaller data sets, and there is the life-table or actuarial method that is most suitable for larger data sets. The Kaplan-Meier method is used for this analysis. The LIFETEST procedure tests the hypothesis that the survival function is identical for two or more groups. This method is used to identify survival differences by commissioning source.[42]

The LIFEREG procedure uses the maximum likelihood method to produce estimates of parametric regression models with censored survival data. Its competitor, the PHREG procedure has made the LIFEREG procedures almost disappear; however, there are things that the LIFEREG procedure does, which the PHREG can not. LIFEREG provides left and interval censoring while the PHREG procedure only allows for right censoring. The LIFEREG procedure can also provide information about the shape of the hazard function while the PHREG procedure gives nonparametric estimates of the survivor function. The weakest feature of the LIFEREG procedure is that it does not allow the use of time-dependent covariates.[43]

The PHREG procedure, known as the semi-parametric hazard model, combines the proportional hazards model and the maximum partial likelihood method. The biggest advantage to the PHREG procedure is that it can represent survival times without probability distributions and this is why it is labeled semi-parametric. Another advantage to this method is that it can incorporate time-dependent covariates. This procedure can also do other things such as allow for a stratified analysis and accommodate both continuous and discrete measurements of event times. It easily handles left truncation and it can be extended to non-proportional hazards. The main disadvantage to this procedure is that it can not test hypotheses with regards to the shape of the hazard function.

[42] Ibrahim Korkmaz, "Analysis of the Survival Patterns of United States Naval Officers." Master's Thesis, Naval Postgraduate School, Monterey, CA., March 2005.

[43] Ibid.

3. Summary

All three of the survival analysis procedures were used in this study to identify significant factors that influence survival within the MSCC HCA. The same data limitations experienced with the logistic regression that allowed for only a minimal number of explanatory variables also apply in estimating survival.

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V. RESULTS

A. MARKOV MODEL

The following sections provide the quantitative results of the Markov model. These results are based on scenarios developed to guide the Officer Community Manager and planner in identifying the most efficient accessioning policy; however, they do not represent current Medical Service Corps business practices and are only offered as suggestions for future accessioning. All scenarios are based off of the beginning stock of personnel for MSC HCA officers as of October 2005. Data taken from FY 2003 was used to determine HCA pay-grade percentages and these figures were further used to separate the HCS from the HCA officers when determining the future target end strength totals. These target end strength or OPA totals are based off of figures provided by BUMED.[44] These target end strength or OPA figures will also remain the same for all years of analysis since long term predictions are not available.

1. Model Validation

A Markov Model is only as good as the data used to derive the transition matrix. This section will discuss how the model validation test was performed and give historical trends of the past four years of accessioning to better understand the scenarios in the following sections.

a. Testing the Model

To validate this model, FY 2002 data was used to construct beginning stock values. These beginning stock values were provided by BUMED and developed from a Medical Service Corps alpha roster that included "date-of-rank," "subspecialty" and "rank" for each officer.[45] Using the "auto-filter" in Excel, each HCA subspecialty was selected for each rank while the FY date-of-rank was used to determine the time-in-grade for each rank. For example, when selecting all the Ensigns with the 1800E subspecialty, the date-of-rank could be easily observed for each of these officers. This

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[44] Roshard Woolfolk, Medical Communities Planner, "OCM FY07-FY10 Shell Plan." BUMED

[45] Roshard Woolfolk, Medical Communities Planner, "FY 2002 Alpha Roster." BUMED.

was further analyzed to determine their time-in-grade based on the FY2002 data. The stock for each subspecialty and rank up to LCDR was identified and can be seen in further detail in Appendix B.

Once the stock was determined for FY 2002, the same determination was made for the stock of FY 2003 using the same resource as before, but for the following year. The FY 2002 stock was further broken down to depict all ranks by their time-in-rank as seen in Figure 7. The "Predicted 2003" column shown in Figure 7 represents the Markov model results of the FY 2002 figures as they return predicted figures for FY 2003. Each row under the "Predicted 2003" column has a formula that relates back to the transition matrix for a calculation with the "Stock 2002" column. The highlighted portions of the "Predicted 2003" column include data provided by BUMED for MSC HCA gains for 2003 along with the appropriate formulas.[46] The input worksheet was not used during this test and the actual FY 2003 gains were entered in the appropriate first year pay-grade cells along with the transition matrix calculations. Since Ensigns do not have a prior rank, their first year cell does not contain this formula.

The summary box located at the bottom of Figure 7, displays the level of validation for this Markov model. As can be seen, the Markov model predicted the FY 2002 flow to FY 2003 actual stock with little difference. There was a 2%, 2%, 1% and 5% overage for Ensigns, Lieutenant Junior Grades, Lieutenants and Lieutenant Commanders, respectively. For a more holistic validation, the FY 2002 stock totaled to 903 and the actual stock for FY 2003 was 906 when the Markov model predicted a total of 927 for FY 2003. These calculations can be further seen in the darkened portion of Figure 7. This represents an overall overage for all MSC HCA officers O-1 to O-4 of 2.2%. Since all of the percentages fall below the boundary percentage of +- 10%, the validation in this test suggests that the transition matrix of the Markov model is a good representation of the MSC HCA flow between the O-1 and O-4 pay-grades.

46 Roshard Woolfolk., Medical Communities Planner, "FY 2003 Gains by gcat." BUMED. January 12, 2006.

Years-in-Rank	*Stock 2002*	*Predicted 2003*			
ENS1	31	14.00			
ENS2	54	30.43			
ENS3	0	1.30			
LTJG1	103	105.27			
LTJG2	78	99.99			
LTJG3	0	6.21			
LTJG4	0	0.00			
LT1	73	73.21			
LT2	69	70.22			
LT3	54	67.36			
LT4	28	51.46			
LT5	43	26.42	Total FY 2002	Total FY 2003	Predicted 2003
LT6	60	38.27	903.00	906.00	927.00
LT7	26	40.26	* 927-906=21 ** (1-(906/927))*100 = 2.2%		
LT8	4	11.73			
LT9	6	1.38			
LCDR1	56	36.42			
LCDR2	52	54.81			
LCDR3	40	51.43			
LCDR4	40	38.68			
LCDR5	26	38.18			
LCDR6	42	23.52			
LCDR7	12	35.37			
LCDR8	1	10.00			
LCDR9	5	0.67			
Total	*903*	*927*			
Summary Box	Stock 2002	2003 Predicted	2003 Actual	Difference	% Change
ENS	85	46	45	1	2%
LTJG	181	211	208	3	2%
LT	363	380	378	2	1%
LCDR	274	289	275	14	5%

Figure 7. Markov Model Validation[47]

b. Historical Trends in Accessions

Before scenarios can be analyzed, it is essential to understand the historical accessioning practices. These historical trends in accessioning figures represent an irregular mix and a steady-state will never be reached if business practices remain. The historical trends in accessioning shown in Figure 8 represent proof of the

[47] Source: Author.

irregular selections that have occurred during this past four-year process. These figures are illustrated here only to show the past business practices for comparison to future recommendations given the scenarios used in this chapter.

Accessioning plays a huge role in the manpower process. The accessions regulate the influx of the manpower process while attrition/retention regulates the outflow. It is difficult to control the "natural" attrition rate and even though there is some level of control in "forced" attrition, it is still the accessioning process that offers the most control to regulate personnel in the system. Understanding the past accession practices can assist in bringing the HCA officers to a steady-state and operate in a more efficient capacity.

While there has not been a consistent accession plan to date, this study examines four accession plans where the rates stay the same over time and one that only changes slightly; the solver scenario. This was felt to be beneficial because it enhanced the stability and ease during the planning stage. Identifying the steady state brings forth a consistent commissioning plan approach; therefore contributing to a more efficient process.

The data used to determine these MSC HCA accessions were four FY "gains-by-gcat" reports provided by BUMED.[48] Each report identified the "rank" and "subspecialty" and using the Excel "auto-filter," the HCS officers were separated from the HCA officers was enabled. The only figure available for FY 2002 was the "total" number of HCA officers. In order to get the most accurate account for ranks-specific figures during FY 2002, the averages of FY 2003 to FY 2005 were taken and applied to the FY 2002 total. After identifying the number of accessions for each FY by rank (FY 2003 – FY 2005), the fiscal year averages by rank was identified and is listed at the bottom of Figure 8. More specifically, this bottom row represents the averages of personnel accessed over the three year period of FY 2003 to FY 2005 and applied to the FY 2002 total. Figure 8 displays the detailed breakout of this calculation. As this figure represents, the sum of fiscal years 2003 to 2005 Ensign percentages were divided by

[48] Roshard Woolfolk, Medical Communities Planner, "FY 2002 – FY 2005 Gains by gcat." BUMED.

three to identify the average for Ensigns. This was done for each rank and then used with the FY 2002 accession "total" to further break out the ranks for that same year. As can be seen, the percentages that make up the FY 2002 ranks are the same as the average found in the bottom row. The column located under the "overall loss," and identified as "total," was only used to check the percentages over the three ranks to ensure they added to 100%. The most up-to-date accession plan (14 FEB 2006) only listed the IPP source by rank; therefore, the past averages method was used to determine the FY 2006 accessioning plan levels for the Direct and HSCP commissioning sources. The results of these past average calculations produced FY 2006 figures, which were used as accessioning requirements for the base-case.

SUM =SUM(B9:B11)/3

A	B	C	D	E	F	G
	ENS	LTJG	LT	Total	# Loss	% Decrease
2002	19	54	11	84		
2003	14	52	1	67	17	20%
2004	9	28	20	57	10	15%
2005	14	30	2	46	11	19%
				Overall Loss	38	45%
	ENS	LTJG	LT	Total		
2002	22.37%	63.98%	13.64%	100.00%		
2003	20.90%	77.61%	1.49%	100.00%		
2004	15.79%	49.12%	35.09%	100.00%		
2005	30.43%	65.22%	4.35%	100.00%		
Average	=SUM(B9:B1	63.98%	13.64%	100.00%		

Figure 8. Determining Historical Accessions[49]

Figure 8 also shows the level of loss by each fiscal year as well as the overall four year loss from FY 2002 to FY 2005. Column F in Figure 8 represents the number of accessions cut from the prior fiscal year. As can be seen by Figure 8, the accessioning practices seem unsteady and irregular. In FY 2002 and FY 2003, the number of Lieutenant Junior Grades is very close; however, the Lieutenants figures are very different. Identifying a trend using this data is somewhat difficult due to this inconsistent accessioning business practice. An interesting item that this data has

[49] Source: Author.

identified is the overall decrease in accession of 45% over the four years or three year accessioning cycles. This percentage was derived by dividing the total decrease (38) by the FY 2002 total (84). When this overall percentage decrease is dividing by the total number of cycles (3), a resulting annual percentage decrease of 15% is identified; therefore, there has been an average annual decrease in accessioning of 15% over the three year accessioning cycle. Figure 9 and Figure 10 depict the data represented in Figure 8 and assists in the understanding of historical accession business practices.

It is hard to pinpoint an exact reason as to why these numbers are falling so rapidly, but one can only assume that the drop is related to a couple of items. These items are either the rightsizing effects of transforming the force into a smaller but more efficient entity or the attrition/retention levels might be causing some bottlenecking in some of the ranks. For example, a lower attrition/higher retention would keep people in longer and therefore, there is less need to accession new officers.

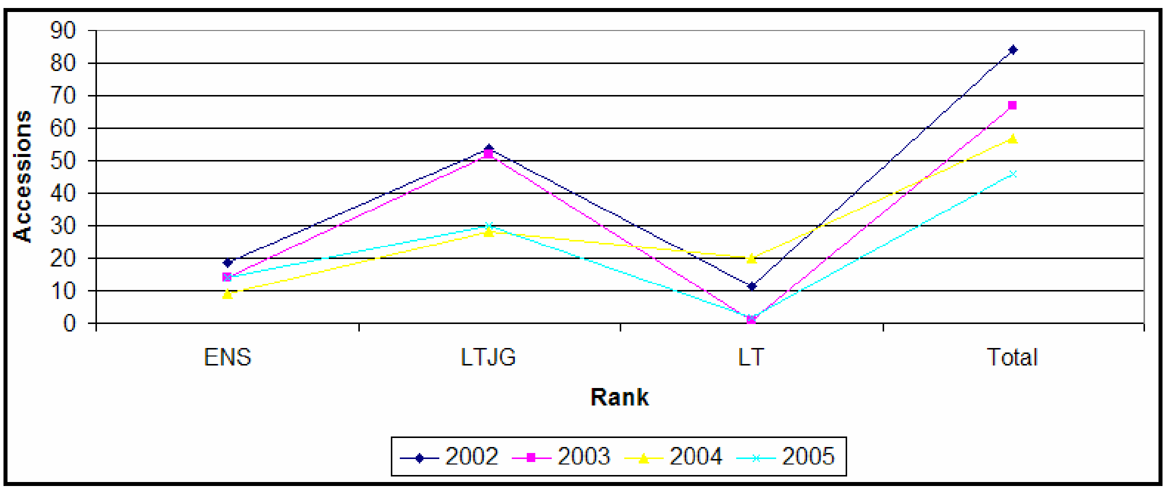

Figure 9. Fiscal Year Gains by Rank[50]

50 Source: Author.

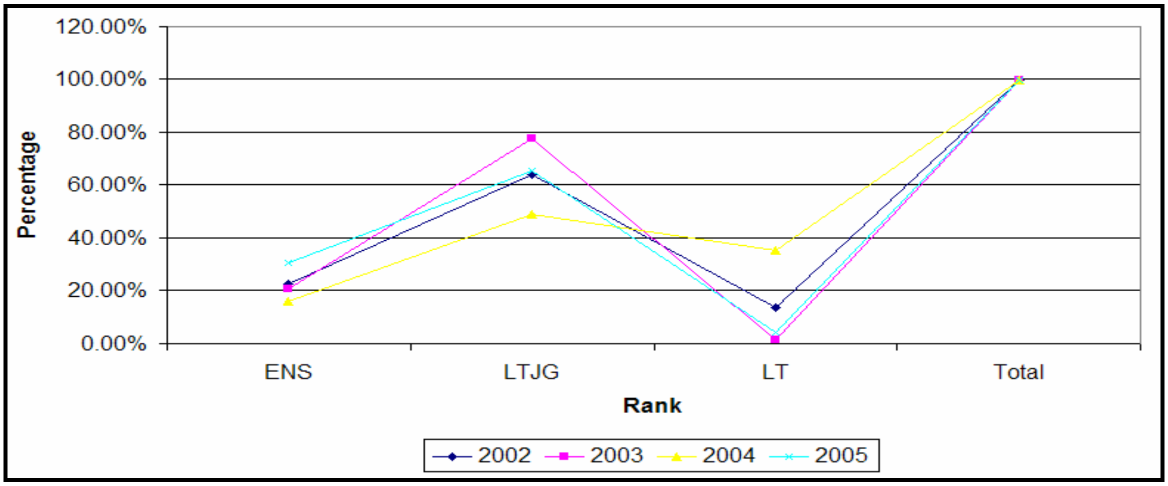

Figure 10. Fiscal Year Accessioning Percentage by Rank[51]

2. Scenarios

To identify the best policy recommendations it is important to test different accessioning scenarios within the Markov model and compare them to the base case for further analysis. In this section the base case is determined using the latest version of the FY 2006 accession plan and is compared to other pay-grade focused scenarios. The accession plan information is inputted into the transition matrix via the input worksheet shown in Figure 5 and the totals predicted by the Markov model are compared to the Officer Programmed Authorizations (OPA) end strength targets for MSC HCA officers. The idea is to find the scenario with the least amount of overage and underage.

a. Base Case Scenario

In contrast to the past four years, FY 2006 increases the number of accessions to 58 compared to the FY 2005 total of 46. This marks the first increase in accessions in the four-year period studied. Figure 5 in Chapter IV represents the base-case inputs for FY 2006 accessions and FY 2006 to FY 2010 OPA or "target end strength." Using the Markov Model, predicted end strength figures are derived. When these figures are subtracted from the forecasted end strength figures provided by the Officer Community Manager, a difference is obtained and can be graphed. Table 7 is a representation of the predicted values obtained from the Markov model using base-case

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[51] Source: Author.

accessioning figures and the resulting differences when compared to actual OPA figures. For readability, Table 10 was only taken out to ten years. The resulting differences were of primary concern while analyzing each scenario as they identify the overage and underage for each of the out-years. Adjusting the accessioning figures with each scenario will change the predicted figures, thus the differences will also change. For each scenario there will be a graph representation of these difference and they will be compared to the base-case results depicted in Figure 10 and Figure 11.

Table 10. Predicted Officer Programmed Authorizations vs Actual and Resulting Differences[52]

Predicted	Rank	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
	ENS	25	16	16	16	16	16	16	16	16	16
	LTJG	106	112	107	99	98	98	98	98	98	98
	LTJG	464	467	461	452	431	405	382	368	361	356
	LCDR	206	220	236	248	264	283	305	320	323	328
		-	-	-	-	-	-	-	-	-	-
Actual OPA	ENS	43	43	41	39	37	37	37	37	37	37
	LTJG	154	154	149	143	139	139	139	139	139	139
	LTJG	383	377	372	368	364	364	364	364	364	364
	LCDR	261	259	255	253	252	252	252	252	252	252
		=	=	=	=	=	=	=	=	=	=
Difference	ENS	-18	-27	-25	-23	-21	-21	-21	-21	-21	-21
	LTJG	-48	-42	-42	-44	-41	-41	-41	-41	-41	-41
	LTJG	81	90	89	84	67	41	18	4	-3	-8
	LCDR	-55	-39	-19	-5	12	31	53	68	71	76

52 Source: Author.

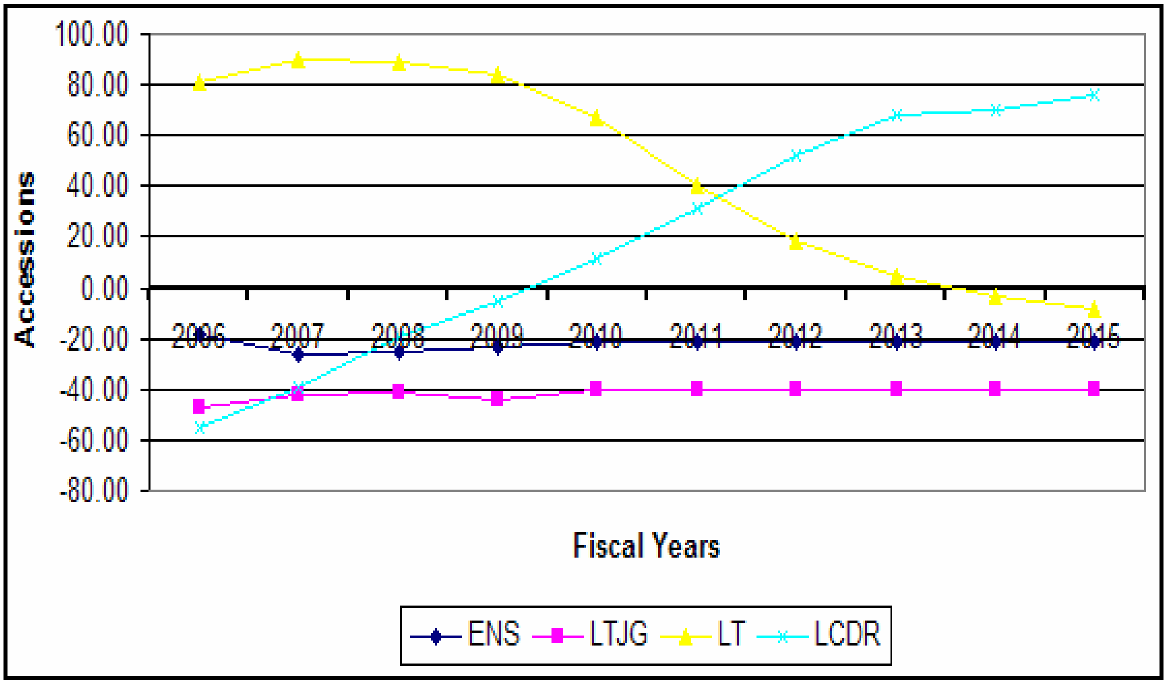

Figure 11. Base-Case Scenario Overage and Underage (Time = 10 years)[53]

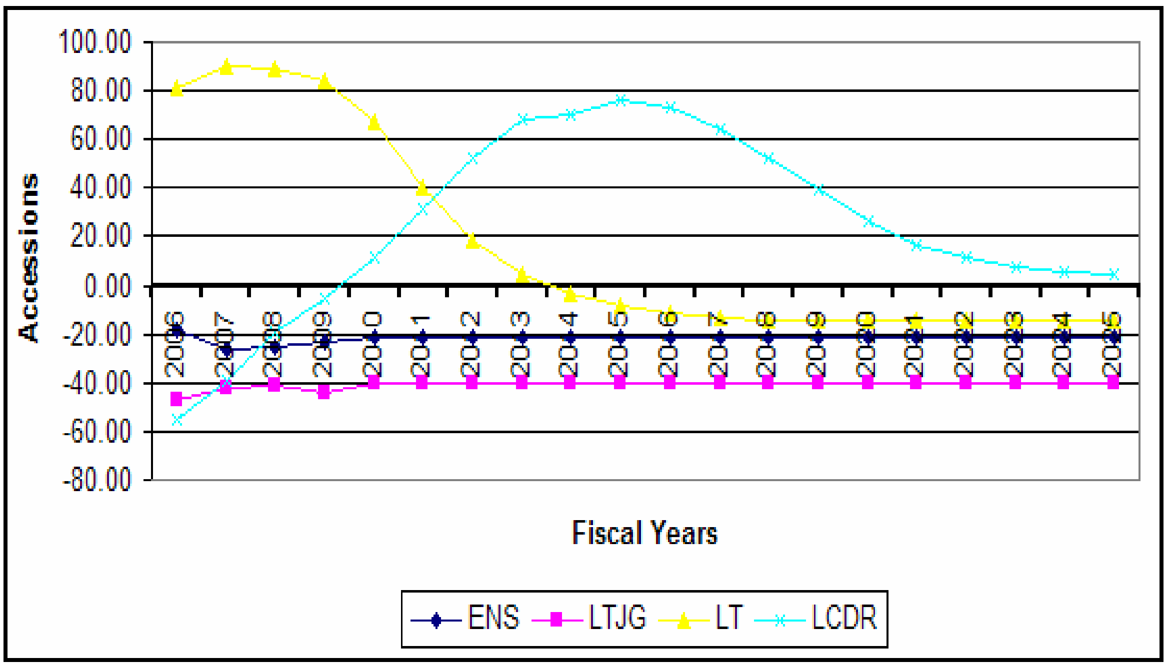

Figure 12. Base-Case Scenario Overage and Underage (Time = 20 Years)[54]

53 Source: Author.

54 Ibid.

b. Past Average Scenario

This scenario used using the averages derived from the past four-year accessioning plans. The results of these are compared to the base-case in Figure 13 and Figure 14 for the ten and twenty year timeframes, respectively. Even though there is a slight difference in accessions, the graph shows that there is not much of a difference between the two scenarios. Table 11 provides the actual differences between the base-case and past average scenarios. As can be seen, there is only a difference of 14 in the past average scenario when compared to the base-case. Still, this difference in comparison makes the past average scenario a better solution to accessioning as it lowers the total overage and underage to 66.

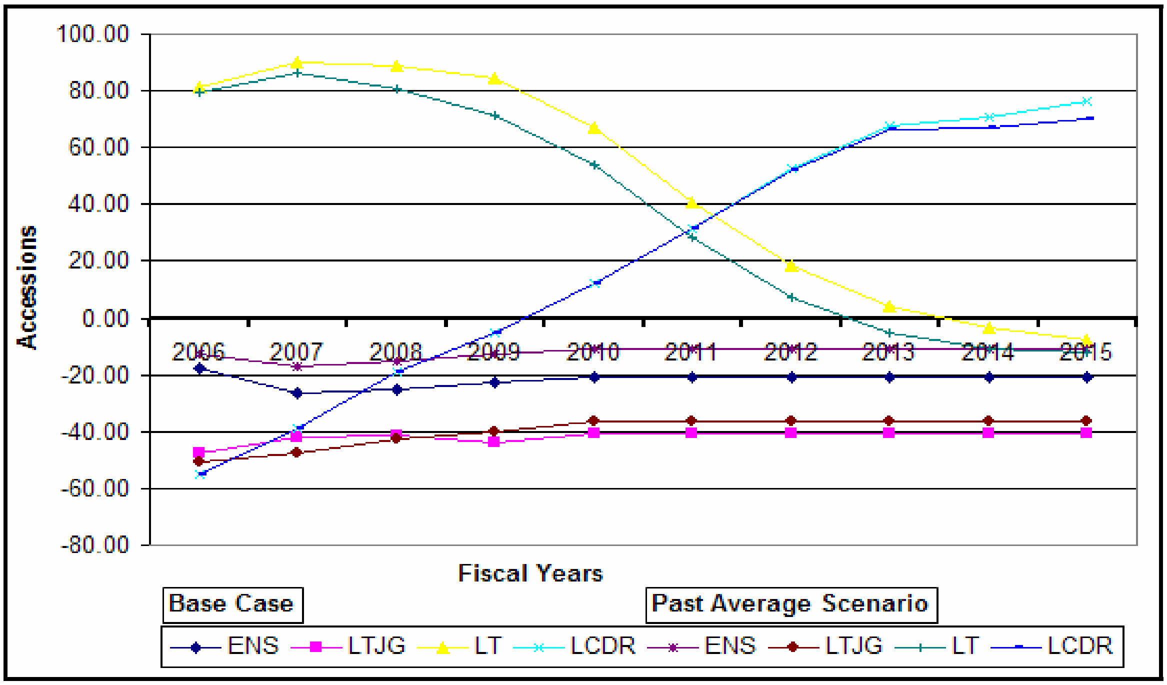

Figure 13. Past Average Scenario Overage and Underage Compared to the Base-Case (Time = 10 Years)[55]

55 Source: Author.

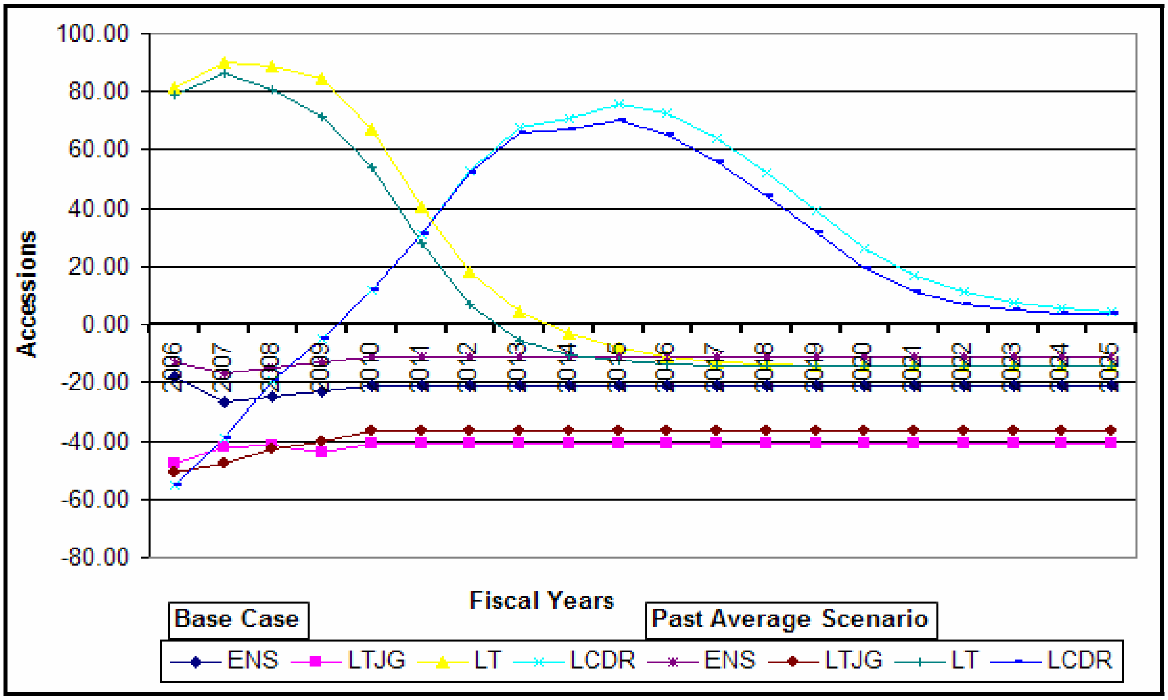

Figure 14. Past Average Scenario Overage and Underage Compared to Base Case (Time = 20 Years)[56]

Table 11. Past Average Overage and Underage Comparison (O-1 to O-4)[57]

Rank	Base Case	Averages	Difference
Ensign	-21	-11	10
Lieutenant Junior Grade	-41	-37	4
Lieutenant	-14	-14	0
Lieutenant Commander	4	4	0
Total Overage and Underage	80	66	14

c. *Pay-Grade Focused Scenarios*

This section discusses different scenarios that focus on the accessions of each junior officer pay-grade and compares predicted to actual end strength. Further, these results will be compared to the base-case overage and underage to identify the best accessioning options with the least amount of difference. The intention of these scenarios is to keep the overages and underage to a minimum and as close to zero as possible

56 Source: Author.

57 Ibid.

during “each” individual pay-grade. Unfortunately, changing one pay-grade will affect the entire group; this is why each pay-grade focused scenarios has a different outcome. Each pay-grade focused scenario brought that pay-grade to a zero level overage and underage. Once this was completed the other two ranks were then analyzed to identify their lowest resulting underage and underage to result in the best mix of accessioned officers. Since the FY 2006 accessioning plan calls for a recruiting of 58 officers, these scenarios stay within +/- 10 of that accessioning goal.

Starting with the O-1 focused scenario, the number of accessions that provided the closest steady-state mix was 19 Ensigns, 38 Lieutenant Junior Grades and 2 Lieutenants. This brings the accession total to 59. Bringing any more the 19 accessions through at the rank of Ensign would create an overage of +2 for every increase in accession at that same level. If there were 18 officers brought through at the rank of Ensign, then there would be an underage of 1 that would continue to fall at a -2 rate for every Ensign lost during an accessioning year.

Focusing on the Ensigns actually improves the future requirement levels for the other three ranks as compared to the base case scenario. Figure 15 shows ten year details of the O-1 focus and how it compares to the base case year. Notice that each base-case reference line is further away from the steady-state as compared to the O-1 focus. A twenty year depiction of the same data is shown in Figure 16 and illustrates the behavior of this type of accessioning practice. All ranks, except Lieutenant Commander, level out at about the same time; however, they have less overages or underage outcomes. Table 12 displays the comparison of overages and underage at the twenty-year time to the base-case. With the accession focused around the O-1 pay-grade results in minimizing the overage and underage by 22, 19, 4 and 2 for Ensigns, Lieutenant Junior Grades, Lieutenants and Lieutenant Commanders, respectively. The O-1 focus scenario brings the number of overage and underage from 80 to 39; an improvement of 41. Appendix F provides a more detailed depiction of the O-1 focused scenario accessioning plan and resulting overage and underage.

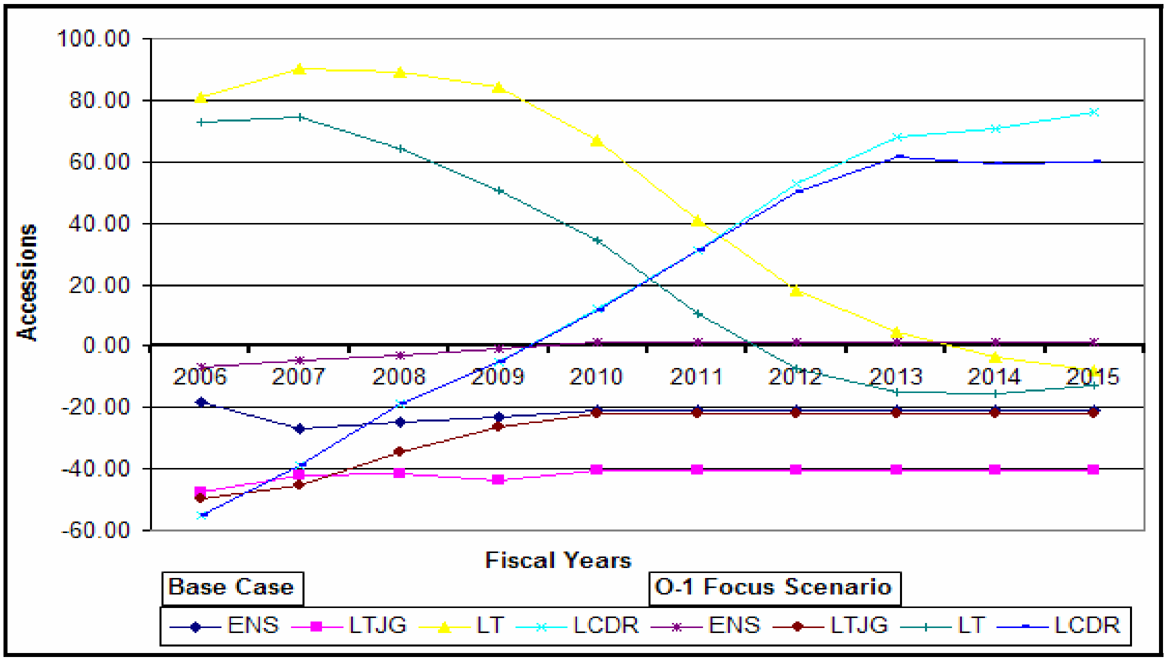

Figure 15. O-1 Focus Under and Overage Depiction Compared to Base Case (Time = 10 Years)[58]

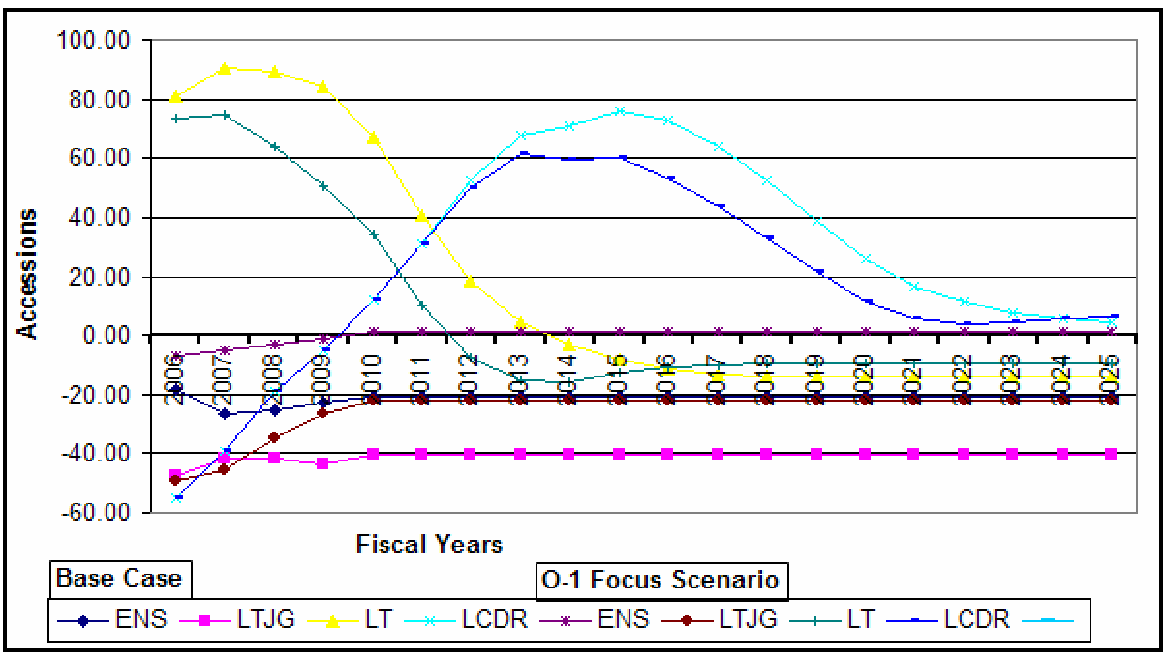

Figure 16. O-1 Focus Under and Overage Depiction as Compared to Base Case (Time = 20 Years)[59]

58 Source: Author.

59 Ibid.

Table 12. O-1 Focus Overage and Underage Comparison (O-1 to O-4)[60]

Rank	Base Case	O-1	Difference
Ensign	-21	1	22
Lieutenant Junior Grade	-41	-22	19
Lieutenant	-14	-10	4
Lieutenant Commander	4	6	2
Total Overage and Underage	80	39	41

When the focus is on the O-2 level pay-grade, the results are quite interesting. This scenario does not accession any O-3 because they are always over populated. The accessioning level for the ranks in the O-2 focus call for accessing 18 Ensigns, 50 Lieutenant Junior Grades and 0 Lieutenants. Adding or subtracting 1 Ensign, Lieutenant Junior Grade or Lieutenant with this mix of accessions adjusts other rank levels to a "less" desired state.

The results of this O-2 focused scenario leaves the junior officers at a highly desired level; however, the Lieutenants and Lieutenant Commanders are far above their levels compared to the base case. Figure 17 gives a representation of the O-2 level scenario over a ten-year period and compared the accessioning practices to the base-case. It is in Figure 18 that the O-2 focus scenario displays a much higher overage in Lieutenant and Lieutenant Commanders. Table 13 identifies the actual differences in overages and underage for the O-2 focused scenario as it is compared to the base-case at the twenty-year time. With the base-case underage being 80, this scenario surpasses the line and takes the accession levels up to an overage of 91. Even though the O-1 and O-2 pay-grades end up in a favorable steady-state, the O-3 and O-4 become overpopulated.

60 Source: Author.

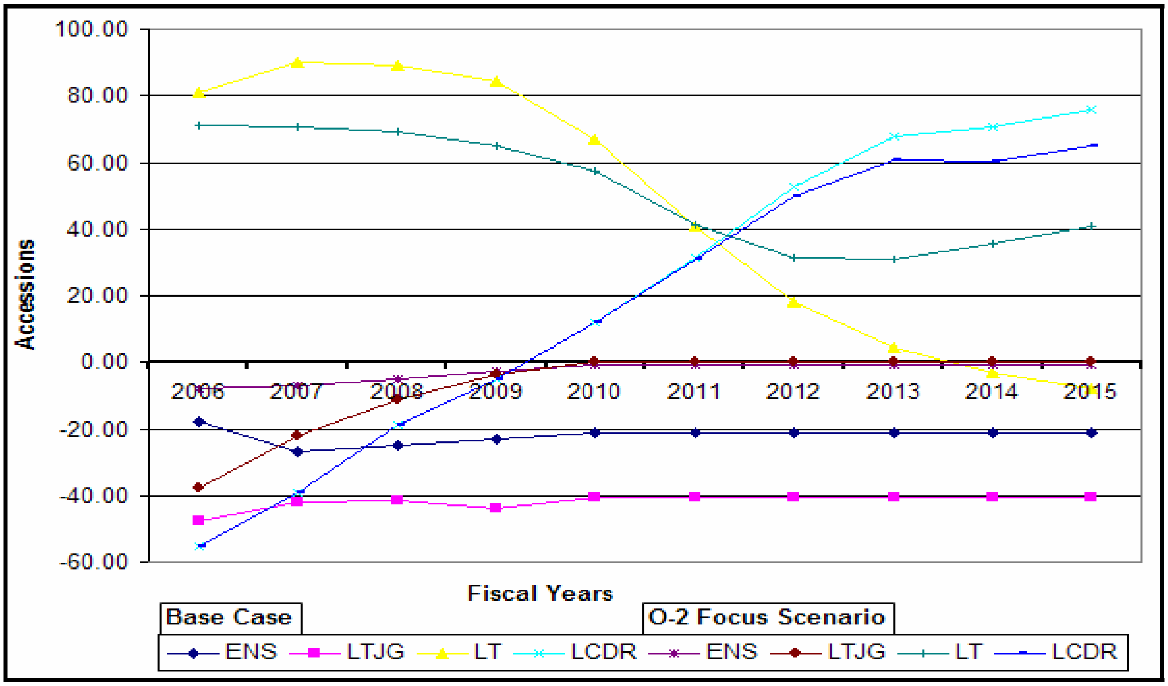

Figure 17. O-2 Focus Under and Overage Depiction as Compared to Base Case (Time = 10 years)[61]

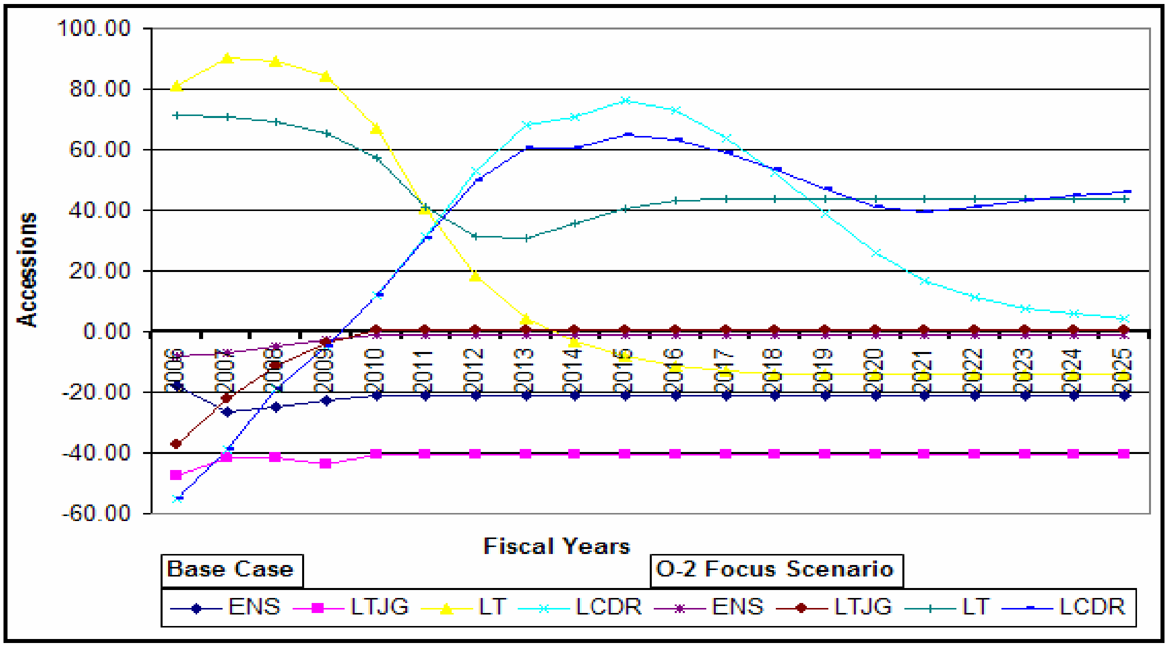

Figure 18. O-2 Focus Under and Overage Depiction as Compared to Base Case (Time = 20 Years)[62]

61 Source: Author.

62 Ibid.

Table 13. O-2 Focused Overage and Underage Comparison(O-1 to O-4)[63]

Rank	Base Case	O-2	Difference
Ensign	*-21*	*-1*	*20*
Lieutenant Junior Grade	*-41*	*0*	*41*
Lieutenant	*-14*	*44*	*58*
Lieutenant Commander	*4*	*46*	*42*
Total Overage and Underage	80	91	11

The last scenario is the focus on O-3 accessions. This turned out to be the most difficult to identify because the two prior pay-grades (O-1 & O-2) feed into the O-3 pay-grade. The O-3 focus was met resulting in accession of 15, 15 and 20 Ensigns, Lieutenant Junior Grades and Lieutenants, respectively. Again, any other adjustments outside of these figures skewed the results into a less desired outcome.

This scenario not only improved the O-3 pay-grade accessions, but it decreased the underage of O-1s as well. However, the other two pay-grades (O-2 & O-4) suffered. The O-2 pay-grade fell way below the desired level where it almost fell off the chart, literally. The O-4 pay-grade followed the same pattern as the base-case; it maintained about an 8 accession overage through time.

Figure 19 shows the ten-year outcome for the O-3 focused scenario and Figure 20 shows this same representation, only over twenty-years. Table 14 breaks out the actual comparison from the base-case to the O-3 focused scenario and provides outcomes presented at the twenty-year time. With the base case remaining at 80, this scenario focus resulted in an overall overage and underage of 78, an improvement of 2.

In each case of the scenarios, the desired level of the “difference” column in the tables is “0.” This would mean that there would be no overages and underage noted in the pay-grades and would represent a perfect outcome. Even though this would be nice to obtain, it is hardly plausible unless continuous monitoring of accessioning

63 Source: Author.

takes place using this method. Currently, the past accession business practices have been so irregular that this goal is impossible to reach unless there is a more uniform accessioning policy.

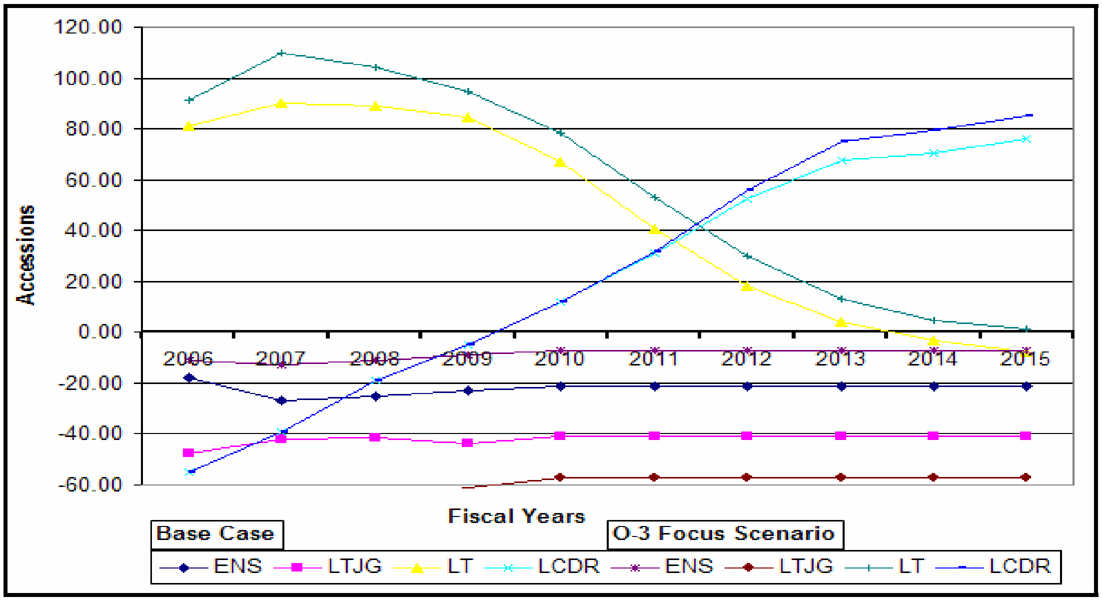

Figure 19. O-3 Focus Under and Overage Depiction as Compared to Base Case (Time = 10 Years)[64]

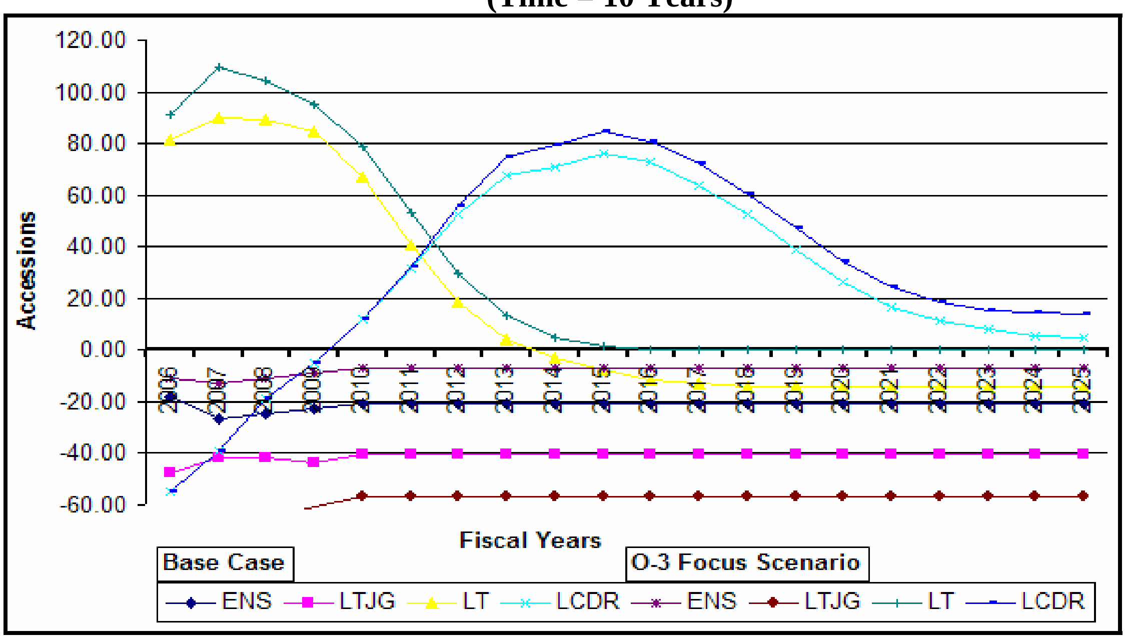

Figure 20. O-3 Focus Under and Overage Depiction as Compared to Base Case (Time = 20 Years)[65]

64 Source: Author.

65 Ibid.

Table 14. O-3 Focused Overage and Underage Comparison (O-1 to O-4)[66]

Rank	Base Case	O-3	Difference
Ensign	*-21*	*-7*	*14*
Lieutenant Junior Grade	*-41*	*-57*	*16*
Lieutenant	*-14*	*0*	*14*
Lieutenant Commander	*4*	*14*	*10*
Total Overage and Underage	80	78	2

d. Solver Scenario

There was one option to use solver to optimize the "badness" experienced between the actual OPA or target end strength and the predicted values. This was done by allowing solver to change the accession figures as integers and using the formula "SUMXMY2(Actual, Predicted)" as the objective function to minimize "badness." The constraint of a constant accession plan was relaxed, thereby allowing solver to access a different mix of individuals each year. It turns out that this scenario provided the best results. Figure 21 provides a detailed ten-year graph to compare the base-case to the solver results. For further analysis, Figure 22 provides a farther depiction of the same results up to the twenty-year mark. As can be seen, the twenty-year mark, represented at the end of the graph, identifies all the ranks very close together and near the "0" underage/overage line.

Unlike the pay-grade focused scenarios, this one has a different level of accessions for each year and requires no O-3s being accessed. Table 15 is a depiction of the "badness" as compared to the base-case. The base-case has an overall level of overage and underage of 80 while the solver method resulted in only 25. This is the best results seen with all five scenarios.

The accession recommendations for the solver solutions vary in numbers over the time covered and even though the "mix" of officers changes significantly, the total number of officers accessed only changes slightly on average. The accessioning solution for the solver scenario recommends an average mix 61 officers, which is only

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66 Source: Author.

three away from the current accessioning plan level. Appendix E provides a more detailed depiction of the solver scenario accessioning plan and resulting overage and underage.

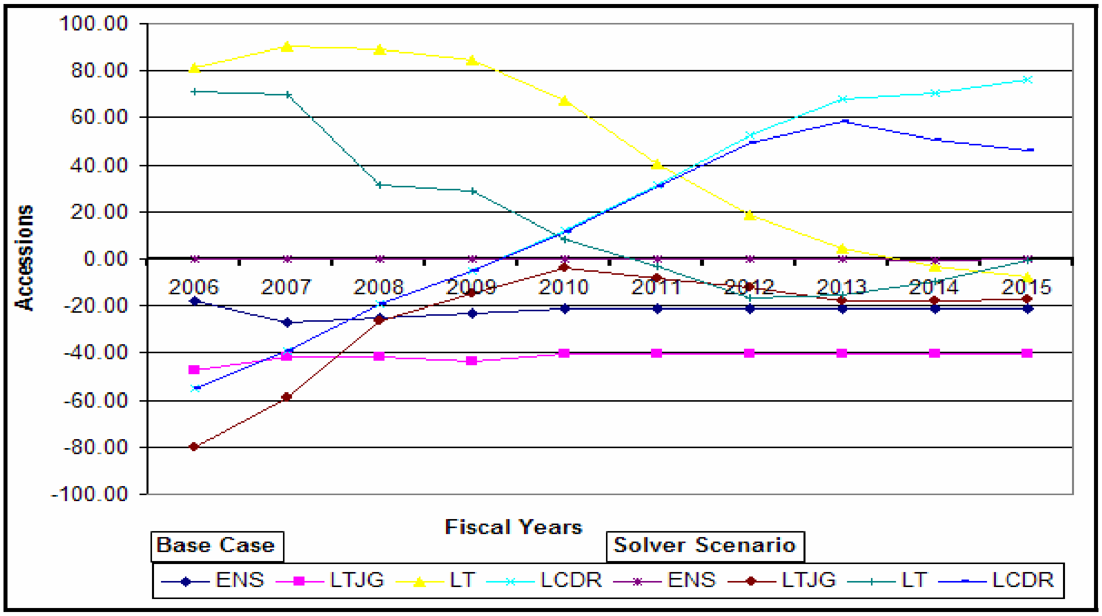

Figure 21. Solver Results for Underage and Overage as Compared to Base Case (Time = 10 Years)[67]

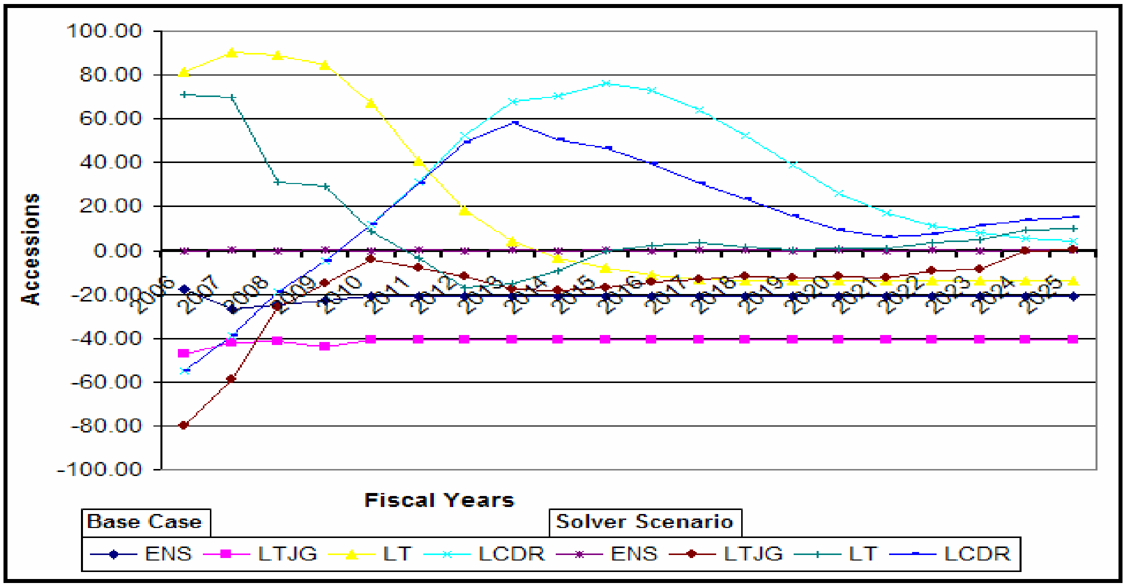

Figure 22. Solver Results for Underage and Overage as Compared To Base Case (Time = 20 Years)[68]

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67 Source: Author.

68 Ibid.

Table 15. Solver Results of Overage and Underage Comparison[69]

Rank	Base Case	Solver	Difference
Ensign	-21	0	21
Lieutenant Junior Grade	-41	0	41
Lieutenant	-14	10	24
Lieutenant Commander	4	15	11
Total Overage and Underage	80	25	55

3. Findings

a. Steady-State

The predictions used in this model were restricted to twenty years to set a plausible forecasting limit. Using the Markov model predictions, the steady-state was reached for Ensigns, Lieutenant Junior Grades and Lieutenants. The steady-states were reached at 3, 6, and 15 years for Ensigns, Lieutenant Junior Grades and Lieutenants, respectively. Given the length of time predicted, the Lieutenant Commanders came close to reaching a steady-state but fell short. After the twenty-year prediction, the steady-state was only one person away from being achieved in the Lieutenant Commander rank.

For each rank, there are steady-state figures that represent people at each time-in-rank. The base-case scenario results are shown here; however, the Markov model automatically generates these results for every scenario that is analyzed. Figure 23 provides the details of "actual" personnel levels experienced at each of the pay-grades at their steady-states. For example, at the point the steady-state is reached for Ensigns, there were 8 first year and 8 second year Ensigns. The zeros indicate that there were no three and four year Ensigns and Lieutenants, respectively.

69 Source: Author.

	ENSs	LTJGs	LTs
1 Year	8	48	56
2 Year	8	47	54
3 Year	0	4	53
4 Year	0	0	51
5 Year	0	0	48
6 Year	0	0	42
7 Year	0	0	28
8 Year	0	0	13
9 Year	0	0	4

Figure 23. Resulting Steady-State from Base Case Scenario[70]

b. Attrition Rates: Ranks O-1 to O-4

The attrition rates were identified through the transition matrix and can assist in determining the focus for accessioning. The attritions were obtained by taking the percentage of those that left the service for each rank and time-in-rank over the seventeen-year duration used to construct the transition matrix.

Table 16 represents the values that identified the percentage of personnel that got out of the service during specific times-in-rank. There is no way to further break down this data to identify "forced" or "natural" attrition characteristics using the Markov model. No attrition identified at any point in the Ensigns time-in-rank in this data set; therefore, the attrition rate is "0."

The results of the transition matrix based attrition analysis identified that the O-3s had the highest level of attrition. This makes sense as a lot of IPP accessed officers already have ten years of enlisted service in the Navy and are eligible for retirement when they are Lieutenants, if in fact they entered the officer ranks as an Ensign. Those officers commissioned using one of the other four sources tend to start out with no prior service and those that get past Lieutenant tend to continue on for higher ranks. This behavior can be seen in the lower attrition level for the O-4 level. The main purpose for including these rates in this study is to assist in understanding the population that contributed to the scenarios presented earlier in this chapter.

[70] Source: Author derived from Base Case accessioning mix of 8 ENSs, 40 LTJGs and 10 LTs over a period of fifteen years.

Table 16. Attrition Rates for O-1 to O-4 by Time-in-Rank[71]

Rank and Time-in-Rank	*Attrition Rate*
Ensign 1 Year	0.00%
Ensign 2 Year	0.00%
Ensign 3 Year	0.00%
ENS Average	**0.00%**
Lieutenant Junior Grade 1 Year	1.40%
Lieutenant Junior Grade 2 Year	1.50%
Lieutenant Junior Grade 3 Year	5.40%
Lieutenant Junior Grade 4 Year	0.00%
LTJG Average	**2.10%**
Lieutenant 1 Year	3.80%
Lieutenant 2 Year	2.40%
Lieutenant 3 Year	4.70%
Lieutenant 4 Year	4.90%
Lieutenant 5 Year	5.30%
Lieutenant 6 Year	6.50%
Lieutenant 7 Year	11.70%
Lieutenant 8 Year	25.90%
Lieutenant 9 Year	14.60%
LT Average	**8.90%**
Lieutenant Commander 1 Year	2.10%
Lieutenant Commander 2 Year	1.10%
Lieutenant Commander 3 Year	3.30%
Lieutenant Commander 4 Year	4.60%
Lieutenant Commander 5 Year	7.10%
Lieutenant Commander 6 Year	5.30%
Lieutenant Commander 7 Year	0.00%
Lieutenant Commander 8 Year	4.80%
Lieutenant Commander 9 Year	28.60%
LCDR Average	**6.30%**

B. LOGISTIC REGRESSION

Two logistic regressions are estimated in this study. One of these regressions estimated the impact of the explanatory variables on retention at the seven year point while the other focused on the ten-year point. This section presents the findings from these two regressions to assist in understanding the influences on retention.

[71] Source: Transition Matrix created by Author

1. Model Fit

The global null hypothesis for these regressions is that none of the explanatory variables assist in explaining the dependent variable and their beta coefficients are equal to "0." The alternative hypothesis is that at least one of the explanatory variables is not equal to "0", which means it does assist in explaining the dependent variable.

The "likelihood ratio" is used to determine if the global null hypothesis can be rejected and the alternative accepted. In the case of these two regressions, the likelihood ratio was .0003 for seven-year retention model and .0178 for the ten-year retention model. In both cases, the Chi-Squared probability associated with the likelihood ratio was less than .1000. The null hypothesis is rejected and the alternative hypothesis accepted that at least one of the explanatory variables help to explain retention to each milestone, though the level of significance indicates that the support of the alternative hypothesis is fairly weak.

The max-rescaled R^2 figure identifies how well the dependent variable is explained by the independent variables. The higher the max-rescaled R^2 value is the more explanatory power the model provides. The max-rescaled R^2 values for the two regressions were .0558 and .0430 for the seven and ten year retention models, respectively, indicating that the independent variables explain only about 6% and 4% of the influences on retention for the seven and ten year models, respectively.

2. Significant Findings

a. Retention at Seven Years

Three out of the five variables were found to be significant in the seven-year retention model as shown in Table 17. The "FEMALE" and "NONWHITE" explanatory variables were found to be very insignificant with p-values of .7265 and .4858, respectively. The analysis showed that being single is significant at all the usual levels and has a negative influence on seven-year retention, as hypothesized. This means that single officers are less likely to be retained to seven years, when compared to married officers, ceteris parabis. AGE_AT_ENTRY is significant at the .05 level and shows an expected negative effect on seven-year retention. This means that those officers who are commissioned when older are less likely to be retained to seven years, ceteris parabis. Finally, the procurement variable, IPP, is also significant at the .05 level and it has a positive effect on seven-year retention as expected. Those HCA officers who enter the service through the IPP are more likely to be retained to seven years than officers entering through other programs, with all other variables left constant.

Table 17. Logit Regression Model Statistics (Retention = 7 Years)[72]

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
In-Service Procurement Program (IPP)	**.6856 (.3607)**	**3.6130**	**.02865****
AGE_AT_ENTRY	**- .0678 (.0412)**	**2.7100**	**.04985****
SINGLE	**- 1.4845 (.3977)**	**13.9318**	**<.0001*****
NONWHITE	- .0150 (.4190)	.0013	.4858
FEMALE	.1469 (.4201)	.1223	.7265

- *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level
- IPP, AGE_AT_ENTRY, SINGLE and NONWHITE are measured with a one-tailed test.
- Female is measured with a two-tailed test.

Table 18 displays the partial effects of the significant explanatory variables in the seven-year logit retention model.

Table 18. Partial Effects For Significant Variables in Logit Retention Model (Retention = 7 Years)[73]

Variable	Partial Effect
IPP	**.04434****
AGE_AT_ENTRY	**-.00642****
SINGLE	**-.23368*****

** Significant at .05 Level *** Significant at all usual levels

[72] Source: Author.

[73] Ibid.

The partial effects in Table 18 are compared to the base case of a married non-white male who did not use the In-service Procurement Program to come into the service. The base-case used in this scenario has a predicted probability of being retained to seven years of 90.2 percent. The single officers are 23% less likely to be retained to seven years than the married officers. Those who entered in through the IPP are 4.4% more likely to be retained to seven years then those brought in by other sources. The partial effect of entry-age is only .6%, so for every one year increase in age at entry an officer is .6% less likely to retain to seven years.

b. Retention at Ten Years

Four out of the five explanatory variables were found to be significant in the ten-year retention model. Table 19 provides details about significance levels and identifies positive or negative effects on retention for each variable. All of the variables that were significant in the seven-year regression have the same signs in ten-year retention model; the only change is the significance levels for some variables.

The IPP variable dropped from a .05 significance level to a .10 level. The AGE_AT_ENTRY variable was the only variable that maintained the same significance level. The SINGLE variable dropped in significance. This variable was significant at all levels in the seven-year model but it is only significant at the .05 level in the ten-year retention model. The NONWHITE variable showed an increase in significance level and the coefficient changed from negative to positive in the ten-year model as compared to the seven-year model. This means that non-whites are more likely to retain past ten-years as compared to whites. Finally, the FEMALE variable was found to be insignificant in the ten-year model as it had been in the seven-year model.

Table 19. Logit Regression Model Statistics (Retention = 10 Years)[74]

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
In-Service Procurement Program (IPP)	**.4214 (.3022)**	**1.9447**	**.0816***
AGE_AT_ENTRY	**- .0622 (.0373)**	**2.7752**	**.0478****
SINGLE	**- .6976 (.3699)**	**3.5562**	**.0296****
NONWHITE	**.5726 (.4191)**	**1.8668**	**.0859***
FEMALE	- .1886 (.3623)	.2708	.6028

- *Significant at 10% level, **Significant at 5% level, ***Significant at 1% level
- IPP, AGE_AT_ENTRY, SINGLE and NONWHITE are measured with a one-tailed test.
- Female is measured with a two-tailed test.

Table 20 displays the partial effects of the explanatory variables in the ten-year logit retention model.

Table 20. Partial Effects For Significant Variables in Logit Retention Model (Retention = 10 Years)[75]

Variable	Partial Effect
IPP	.04408*
AGE_AT_ENTRY	-.01186**
SINGLE	-.09363**
NONWHITE	.10240*

*** Significant at .10 Level ** Significant at the .05 level**

The base case represented the same group of officers as the seven-year model with the only difference being that this is model measured ten-year retention. The base-case used in this scenario has a predicted probability of being retained to seven years of 77.2 percent. The effect of being an IPP officer did not differ much between the retention models; those who were commissioned through the IPP are still 4.4% more likely to be retained to ten years than those brought in by other sources. The single

[74] Source: Author.

[75] Ibid.

officers are 9.3% less likely to be retained to ten years than the married officers and represent a 14 percentage point decrease from the seven-year partial effect. The partial effect of entry-age is only 1.1% so for every one year increase in age-at-entry an officer is 1.1% less likely to be retained to seven years. This represents a difference of .05% from the seven-year partial effects. The non-white officer's probability of retention to ten-years is significantly greater than that of a white officer. These officers are 10.6% more likely to be retained to ten years than their white counterparts.

C. SURVIVAL ANALYSIS

A survival analysis was conducted to test the focus variable IPP to see if it was significant in determining survival. The PHREG, LIFEREG, and LIFETEST procedures in SAS software were used on the entire 749 observations in the MSC HCA group to determine survival patterns and to identify significant influences on survival. The analyses completed in this section use the dependent variable TIME2 (date of first rank – end-of-date; in days) and the censoring variable, STAY when it is equal to "1" to indicate staying beyond the end of data. This data set consisted of 184 censored observations of STAY. This section discusses the results of the three procedures used.

1. PHREG Procedure

The PHREG procedure has the same type of global null hypothesis that is used with logistic regression in that the null hypothesis tests whether all the betas are equal to "0." It was determined that the Chi-Square statistic was 18.33 for the likelihood ratio with an associated p-value of .0026. The null hypothesis is rejected and the alternative hypothesis accepted that at least one of the variables is not equal to "0" at all of the usual levels of significance.

The variables used in the logistic regression models were also used to determine significant influences on survival. Table 21 provides the parameter estimate and significance level for each of the variables used in the procedure. The IPP variable was very insignificant, indicating that IPP does not have a strong influence on the hazard function.

There was only one significant variable identified in the PHREG results. The SINGLE variable is significant at all levels which mean that single officers experience a 115.6% greater hazard of leaving than the married officers.

Table 21. Parameter Estimates for PHREG Procedure[76]

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square	Hazard Ratio
In-Service Procurement Program (IPP)	**-0.04235 0.15359**	**0.076**	**0.3913**	**0.959**
AGE_AT_ENTRY	**-0.00942 0.01861**	**0.2563**	**0.3063**	**0.991**
SINGLE	**0.76818 0.18616**	**17.0284**	**<.0001*** **	**2.156**
NONWHITE	**-0.12358 0.18259**	**0.4581**	**0.2492**	**0.884**
FEMALE	**-0.045 0.17362**	**0.0672**	**0.7955**	**0.956**
***Significant at 1% level				

2. LIFEREG Procedure

It is a bit more difficult to identify the global null hypothesis for this procedure than for others. In the case of the LIFEREG procedure, only a log likelihood value is provided and calculations are made from that figure to determine the significance level associated with the global null hypothesis. In order to find this value another model is estimated without the independent variables. This model produces another log likelihood value. The value for the full model had a log likelihood value of – 356.31 and the model with no independent variables returned a value of – 370.11. Taking twice the positive difference between the two values yields a chi-square value of 27.60. For five degrees of freedom (the number of covariates excluded from the basic model), the *p*-value for the

76 Source: Author.

difference in log likelihoods is less then .001. So the global null hypothesis can be rejected and the alternative hypothesis that at least one coefficient is not equal to zero can be accepted.

The results of the model can be found in Table 22 below. Only one significant variable was identified using this procedure. As with the PHREG procedure, the SINGLE variable was found to be significant at all the usual levels.

The numerical values of the coefficients are not very informative in the reported results; however, a simple calculation transforms the result for a more intuitive interpretation. The way in which the coefficient is interpreted also requires another calculation. For a binary variable such as SINGLE, if expected value is taken for its ß(beta) or $e^{ß,}$ the estimated ratio of the expected mean survival times for the two groups is identified.[77] Thus, the correct calculation is $100(e^{-.41244} - 1) = -33.80$. According to the model, being single is associated with a 33.8% decrease in expected time to stay in the service compared to a married officer, holding all other variables constant.

Table 22. Parameter Estimates for LIFEREG Procedure[78]

Variable	Parameter est. (s.e.)	Chi-Square	Pr>Chi-Square
In-Service Procurement Program (IPP)	0.01547 0.0694	0.0497	0.4118
AGE_AT_ENTRY	-0.00339 0.008	0.176	0.3374
SINGLE	-0.41244 0.0849	23.5704	<.0001***
NONWHITE	0.08073 0.0787	1.0521	0.1525
FEMALE	-0.0138 0.07497	0.034	0.8537

[77] Paul Allison, "Survival Analysis Using The SAS System: A Practical Guide," Cary, NC:SAS Institute Inc., 1995. p 65.

[78] Source: Author.

3. LIFETEST Procedure

The LIFETEST procedure provides a graphical representation of how two groups behave during a period of time. In order to produce the most informative outcomes for this procedure, three different time frames were analyzed using the same data. This study focused on the IPP variable and identified the survival function of both groups, where 1= IPP and 0= the other four commissioning sources. Figure 24 is a representation of the total data set over a ten-year time period. The differences in survival patterns were found to be insignificant (Log-Rank .3384, Wilcoxon .1183). This lack of significance may be due to the fact that these two groups, regardless of commissioning source, have at least a three-year commitment and do not have the option to leave before that time and they also closely follow the same pattern after the eleven-year timeframe. This consistency between both groups is illustrated at the very beginning and at the end of the curve. The difference seen between the five and ten year timeframes justified finer examination of the two groups. This approach isolates the time in which most IPP officers are less willing to leave as they are typically closer to retirement than those officers from the other commissioning source. This same incentive is not present for the other four groups.

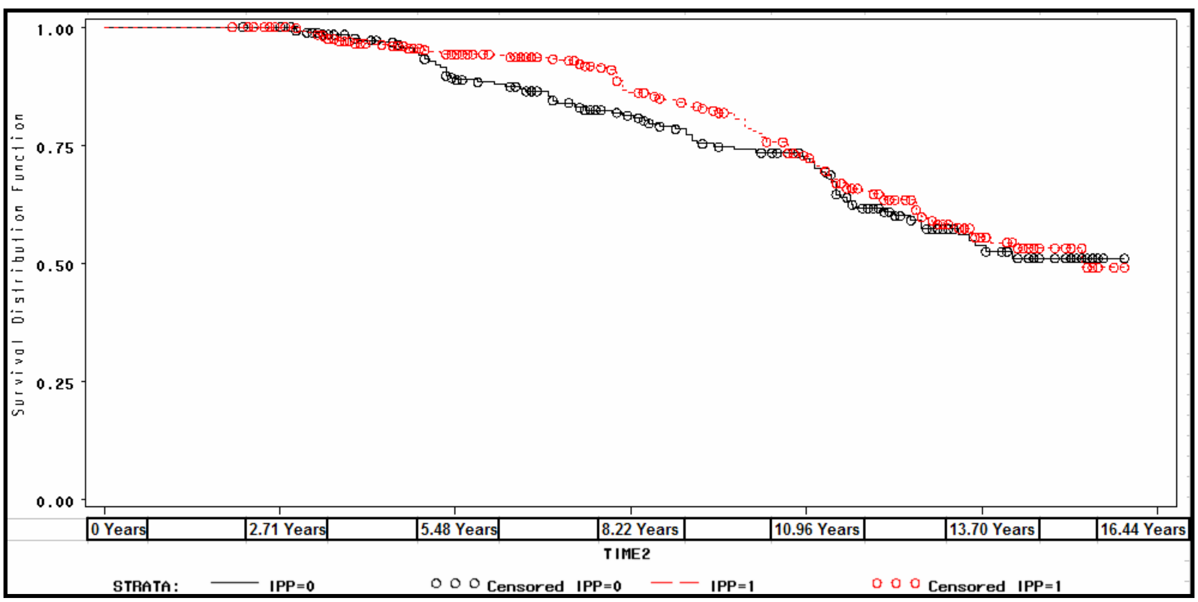

Figure 24. Commissioning Source Survival Functions (Time = 16.44 Years)[79]

79 Source: Author.

One set of survival curves focused on the one to eleven-year timeframe and the other focused only on the time of greatest separation; the five to eleven-year timeframe. The eleven-year graph and the five to eleven-year graph can be seen in Figures 25 and 26, respectively.

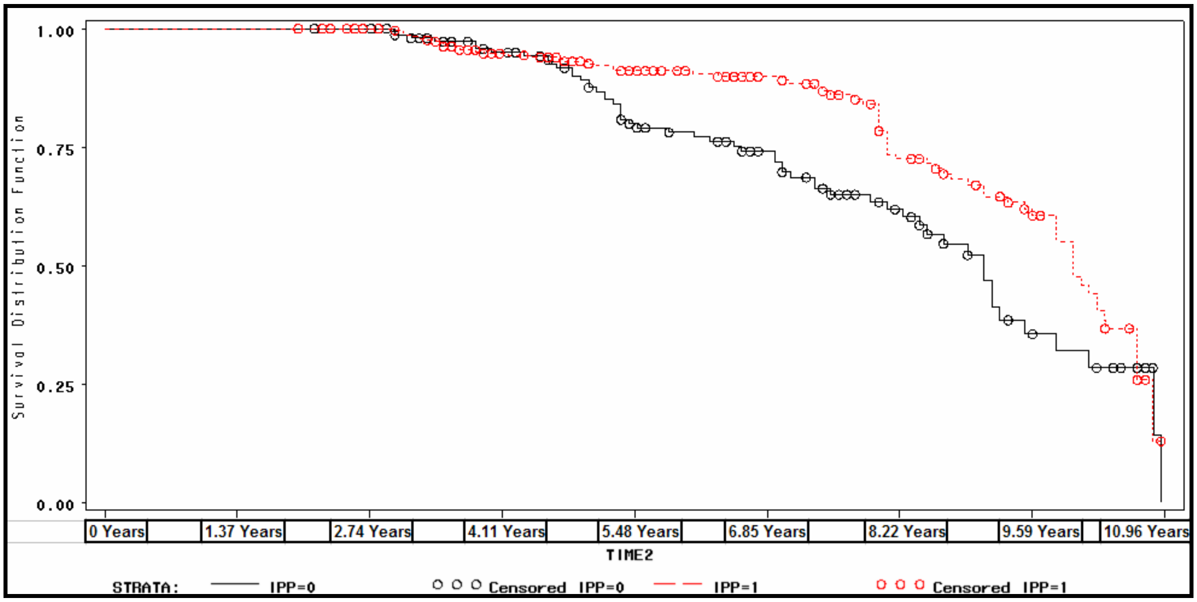

Figure 25. Commissioning Source Survival Functions (Time = 11 Years)[80]

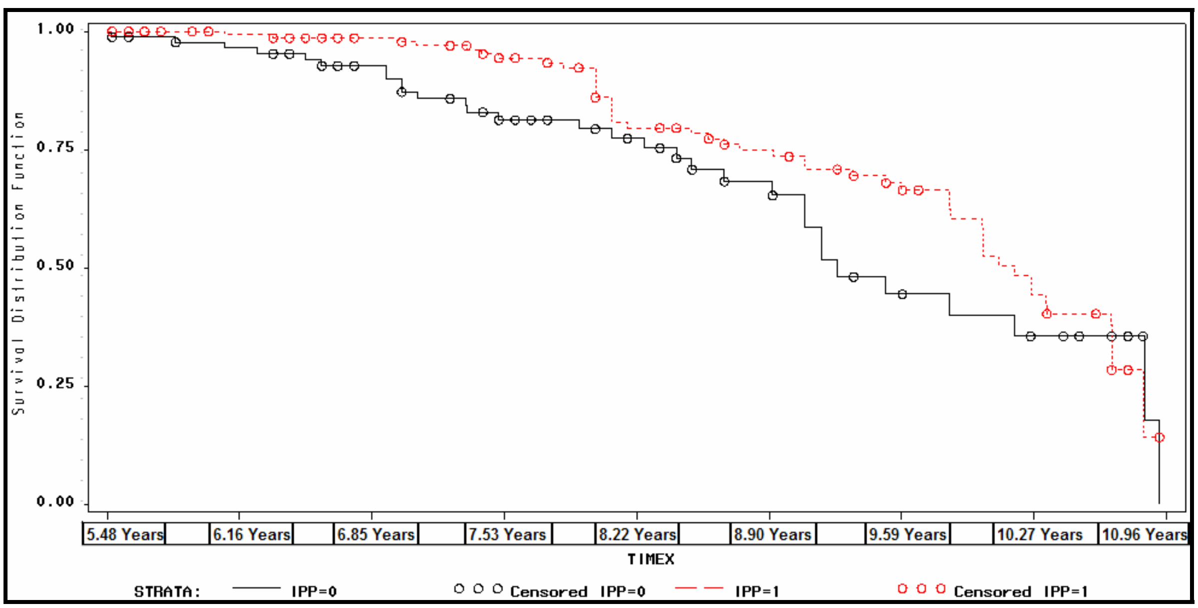

Figure 26. Commissioning Source Survival Functions (Time = 5.5 – 11 Years)[81]

80 Source: Author.

81 Ibid.

The eleven-year focus identified a significant difference between the two groups at all the usual levels with both Log-Rank and Wilcoxon statistics, their p-values being .0041 and .0030, respectively. These were identified using a two-tailed test used with all three graphs. So it can be said with confidence that the IPP commissioning source has a different survival function than the others up until the eleven-year mark, and they behave similarly thereafter.

The five to eleven year procedure also showed a significant difference but only at the .05 level with a p-value of .0104 for the Wilcoxon statistic. One item of interest this graph identifies is the 8.22 year point where the IPP curve comes very close to the other group's curve. One factor that could be influencing this is the eight-year retirement option that is sometimes given to prior-enlisted officers. The normal policy is that an officer must have at least ten years commissioned service to retire as an officer. Although infrequent, sometimes this is backed up to the eight year point. The eight-year policy is currently in effect until FY 2008.

D. SUMMARY

The Markov model, the regression models and the survival/hazard models all provide interesting results in regards to potential future actions that could improve the accessioning program for HCA officers. Five scenarios were tested using the Markov model. One of these focuses was on the historical averages of the past four accessioning plans. There were three scenarios that focused on the junior officer ranks, and the final one applied a solver application to minimize "badness." With the three junior officer pay-grades analyzed, it was the O-1 focus that provided the best results as it had the smallest difference between actual and predicted end strength of 39 at the twenty-year point. The solver scenario provided the best outcome as it brought the difference down to 25. With the base case resulting in an overall overage and underage of 80, these two scenarios clearly improve the current accessioning practice by over 50%.

The logistic regressions resulted in some significant findings that could assist in improving the retention of MSC HCA officers. The seven-year retention analysis results showed the IPP, AGE_AT_ENTRY and SINGLE variables all to be significant while the ten-year analysis included the same three and added the NONWHITE variable to the significant variables. The PHREG and LIFEREG SAS survival procedures both identified the SINGLE variable as being significant at all levels. The interpretation is that single officers tend to stay in the service for a shorter time as compared to their married counterparts, while all other variables remain constant. The LIFETEST procedure indicated that the IPP source had a significant effect on survival patterns and that this group survives longer than the group that is representative of the four other accessioning sources within the first eleven years of active service.

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VI. CONCLUSIONS

A. MARKOV MODEL

This thesis identifies scenarios in which it is possible to do better than current business practices. Four of the five scenarios result in a constant level of accessioning officers while one returned a variable accessioning plan. These scenarios provided plans for the improvement of the current accessioning process and the use on the Markov model can assist the OCM and planner to make these improvements for future years.

In two out of the five scenarios analyzed in the Markov model, which were an improvement in the ability to meet OPA targets, the one thing that remained consistent is that accessioning Lieutenants is a bad choice. One of these scenarios provides a "constant" accessioning solution while the other represents a "variable" accessioning solution. The base-case identified that the current recruitment level on Lieutenants is very high creating large overages for the Lieutenant Commanders while at the same time leaving the Ensigns and Lieutenant Junior Grades below their desired level. The last four years of accessions shows that the Lieutenants have been accessioned at a 13.6% average rate. Even though this is the lowest of the three accessions with regards to averages, the FY 2006 accession plan calls for an even larger amount and puts the Ensigns at the lowest accessed rank. If this type of business practice is continued then it will not be possible for the HCA community to attain its OPA targets.

The basis of the Markov model relies on the accuracy of the target end strength or Officer Programmed Authorization (OPA). In order to get the most accurate results from the Markov model, these figures need to be as accurate as possible. It is hard to predict the future requirements; however, with these figures being identified every five years, the OPA should allow the Officer Community Manager (OCM) and planner to sufficiently plan for accessions since these are only planned every two years. Using this Markov model will assist in bringing the MSC HCA to meeting OPA targets as long as it is used as a tool for planning each of the future accession plans.

B. LOGISTIC REGRESSION

The two logistic regression models estimated in this thesis provide some insight into the influences on retention at the seven and ten year milestones. In both models, the most significant influence is the officer's marital status. The Navy can address this retention influence through programs that support both married and single officers. Since single officers are less likely to be retained to seven-years, there might be an opportunity to identify why they leave and see if there are any potential programs that can be developed to keep them interested in remaining in the service.

The second most significant influence determined in the seven-year retention model is the IPP commissioning source. The reason behind this influence could be that IPP accessed officers are locked into a commitment of eight to ten years while officers from the other accession sources have less of an incentive to stay in the Navy as they are much further away from retirement. This could also explain why there is a lower level of significance for IPP found in the ten-year retention model than in the seven year model as many of the officers are able to retire at the ten-year mark. One way the Navy can address these concerns would be to find a way to increase the incentives to remain for those officers with less than ten years of service. If an incentive is offered to the other four commissioning sources, then it should be offered to the IPP accessed officers as well.

Another significant influence found on both seven and ten-year retention is entry age. The current upper age limit for officer commissioning is thirty-five. The significance of entry age is intuitive as it makes sense that as people age, they are less willing to remain in the service. This lower level of retention might be related to either the development of other interests or it may be that the physical requirements become tougher with age.

The final significant variable, minority race/ethnic group status, was significant only in the ten-year retention analysis. A non-white officer may not be as confident as a white officer that civilian job opportunities are readily available and therefore the job security in the military may be of greater importance. Maintaining an equal opportunity environment that stresses the benefits of diversity is essential.

C. SURVIVAL ANALYSIS

The survival analysis results supported the regression results. The PHREG and LIFEREG procedures determined that there is a higher likelihood for single officers to survive when compared to their married counterparts. The PHREG procedure indicated that single officers had a 116% greater hazard of leaving the service when compared to married officers. The LIFEREG procedure indicated that being single is associated with a 33.8% decrease in expected time to stay in the service compared to a married officer, holding all other variables constant.

The LIFETEST graphics procedure produced a survival curve for the IPP commissioning source and compared its survival function to the other sources. After considering three different time periods (5, 10 and 16 year), it was determined that the results for the ten-year period were the most significant. These results are similar to the results of the logistic regression models as they show that the survival pattern of the IPP group is different from the other commissioning sources up until the ten year period; after that the two groups maintain similar functions.

D. RECOMMENDATIONS

Given the results of the Markov model scenarios and logistic regressions, the recommendation is to have the OCM and planner use the Markov model application with solver as an accession planning tool to minimize the overage and underage. Updating the Markov model with each quarterly accessioning plan review to ensure it reflects the most accurate OPA will allow for the optimal mix of accessions and will eventually permit the MSC HCA officers to reach their OPA targets.

If retention fluctuates to a lower than optimal level, or lower than what was experienced in the Markov model, addressing and developing incentives for the single officer population might be an alternative. Since the Markov model addresses the in-flux of personnel into the system, creating programs to retain single officers longer might assist in controlling the flow of personnel out of the system.

E. SUMMARY

The intent of this thesis was to develop a Markov model to be used as a tool in the accessioning process so that the current accessioning business practice would shift the HCA accessions to best match their OPA targets. Isolating the HCA group of MSC officers allowed for a more specific emphasis on one homogeneous group. The opportunity to create a Markov model for the HCS group would provide the complete accessioning tool for the OCM and planner to use when determining the accession plan. There are many ways to determine accessions and with the OCM and planner positions being filled with different personnel every three years, a uniform tool would be most appropriate. The Markov model was created to act as that uniform tool so that the method of accessioning will become common place or part of the accessioning culture. This would create a lower learning curve for newly reporting OCMs and planners and should add efficiency to the process while granting more time to other tasks.

1. Lessons Learned

The search for accurate data was the longest and most time consuming portion of the thesis. The data were requested in April of 2005 from DMDC and the final product was not received until September 2005. After the data were received, several other quality assurance checks needed to be done to accurately depict the flow and characteristics of the MSC HCA officers. This process included deleting all duplicates names, using other data sources (BUMIS) to make the data more accurate and then checking cell-by-cell to ensure all the data were consistent. Although the process was very tedious, the Markov model validation test showed that the data did in fact closely resemble the actual flow of MCS HCA officers through the system.

This data issue suggests that researchers plan ahead and consider more than one source for data. A better data source for this type of study could be BUMIS or the Officer Community Manager and planner.

2. Recommendations for Future Studies

The primary recommendation for future study is to identify a Markov model for the MSC HSC group so that the OCM and planner have a tool for their entire community. This would require a similar data set that identifies the promotion history of each officer along with his or her commissioning base data and date of separation. Since the Markov model is based on of ranks and time-in-rank, it would be most beneficial to have the promotion date for each of the ranks.

Given the initial results of the regression and survival analysis, it seems that the behavior in terms of retention is different between the too accession sources. If this finding is borne out by more detailed regression studies, it will become necessary to adapt the Markov model to each accession source. Making a transition matrix for each accession source would further enhance the recruitment process.

It is also recommended that more detailed logistic regressions be estimated for the entire group of MSC officers to assist in understanding the influences on retention and also promotion. This study was not able to identify promotion effects due to data limitations. Since the primary focus was on the Markov model, the data that were finally obtained did not include the economic, demographic and career information that will be desired for a more complete analysis. It may also be beneficial to identify trends in the historical end-strength and determine what has influenced shifts in personnel between fiscal years.

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APPENDIX A

MSC HCA's Stock Breakdown as of 31 October 2005.[82]

ENSIGN	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Check
1800E	20								12	8	
1800T	8									8	
1802V	1									1	
3130T	1								1		
Total	30	0	0	0	0	0	0	0	13	17	0

LTJG	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Check
1800E	23								3	20	
1800P	65								40	25	
1800T	2								2		
1801V	12								11	1	
1802V	2									2	
1803S	1								1		
1804V	1								1		
1805S	2								1	1	
3110V	2								1	1	
6201T	2								2		
Total	112	0	0	0	0	0	0	0	62	50	0

LT	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Check
1800D	2				1		1				
1800E	54		1			5	8	5	11	24	
1800P	145			1	19	20	16	24	29	36	
1800T	10			1	1		2	1	1	4	
1801S	1					1					
1801V	54				3	9	8	8	16	10	
1802S	1				1						
1802V	38			1	1	4	5	4	9	14	
1803S	9				1	1	4		2	1	
1804S	1							1			
1804V	8				1			4	3		
1805P	1				1						
1805S	28			1	5	5	5	6	4	2	
1805T	1								1		

[82] Source: Created from OCT 2005 MSC Report "Alpha Roster" drafted by LT Sonia Adams and Ms. Williams.

MSC HCA's Stock Breakdown as of 31 October 2005 (Continued).[34]

LT Continued	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Check
3110P	6				2	3		1			
3110T	5					1	2			2	
3110V	31				4	5	6	8	6	2	
3121P	3			1			1		1		
3121T	3								2	1	
3130P	6			1		1	1	1	1	1	
3130S	1						1				
3130T	6						1	2	2	1	
3150P	5				1	2	1		1		
3211P	5			1	3	1					
3211T	2					1	1				
6201P	8				1	2			4	1	
6201T	2					1		1			
Total	436	0	1	7	45	62	63	66	93	99	0

LCDR	Total	FY97	FY98	FY99	FY00	FY01	FY02	FY03	FY04	FY05	Check
1800D	6		1			2	3				
1800E	6					1	1	2	1	1	
1800P	59	1	2	1	8	13	9	10	2	13	
1800T	8					3	2		3		
1801S	3					1			1	1	
1801V	15			2	6	1	2	1		3	
1802S	6				1		3	1	1		
1802V	9		1				3	2	1	2	
1803S	2						1	1			
1804S	1								1		
1804V	2								2		
1805E	1						1				
1805S	28				3	4	5	4	4	8	
3110P	8					3	1	3		1	
3110S	5			1	1	2				1	
3110V	10			1	1			1		7	
3121P	3				2		1				
3130P	7					1	3	1		2	
3130Q	2				1		1				
3130S	2						2				
3150P	8					1	1	1		5	
3211Q	1							1			
3211T	1								1		
6201P	7				3	1	2	1			
6201T	1							1			
Total	201	1	4	5	26	33	41	30	17	44	0

APPENDIX B

FY 2002 ENS & LTJG Stock by Subspecialty[83]

ENSIGN	Total	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	Check
1800E	62									35	27	
1800P	4									3	1	
1800T	7									6	1	
1801V	4									4		
1802V	4									4		
1803E	1										1	
3110V	3									2	1	
Total	85	0	0	0	0	0	0	0	0	54	31	0

LTJG	Total	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	Check
1800E	45									19	26	
1800P	87									36	51	
1800T	7									3	4	
1801V	8									3	5	
1802V	10									5	5	
1803P	2										2	
1803S	1									1		
1805S	1									1		
3110T	2									1	1	
3110V	15									9	6	
3121T	1										1	
6201T	2										2	
Total	181	0	0	0	0	0	0	0	0	78	103	0

[83] Source: Roshard Woolfolk, BUMED

FY 2002 LT Stock by Subspecialty

LT	Total	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	Check
1800D	3								1	2		
1800E	36		1		5	2	5	2	2	6	13	
1800P	134		1	1	5	14	14	9	29	31	30	
1800T	10					2				5	3	
1801S	6		1			2	1	1		1		
1801V	32		1		2	4	2	1	6	8	8	
1802S	6					1	1	3	1			
1802V	21				2	3	3	2	2	4	5	
1803S	9					2	2			1	4	
1804S	2				1	1						
1805S	22				5	7	1	2	4	2	1	
1805T	1								1			
3110P	5				1	3		1				
3110S	4			2		1	1					
3110T	7								3	4		
3110V	27			1	1	5	2	4	3	4	7	
3121P	6		1		1	1	2	1				
3130P	8		1		1	2	3	1				
3130S	2					1					1	
3130T	1										1	
3150P	5					2	3					
3150T	1						1					
3211P	2					1		1				
3211T	2					1			1			
6201P	8				2	4	1		1			
6201Q	1					1						
6201T	2						1			1		
Total	363	0	6	4	26	60	43	28	54	69	73	0

FY 2002 LCDR Stock by Subspecialty

LCDR	Total	FY93	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	Check
1800D	3					1				1	1	
1800E	11					2	2	2	2	1	2	
1800P	79	1			4	9	9	12	12	15	17	
1800T	13					3	1	1	2	3	3	
1801S	6		1		1	2		1		1		
1801V	26				1	3	2	4	5	8	3	
1802S	8					1	2	1	1	1	2	
1802V	7					1	1	1	1	1	2	
1803S	3					1		1		1		
1804S	4					1	1			1	1	
1805P	2						1	1				
1805S	33	1			5	4	2	5	6	4	6	
1805T	1										1	
3110P	14					2	1	2		4	5	
3110R	2	1				1						
3110S	21		1	1	1	2	3	3	4	5	1	
3110V	5							2		2	1	
3121P	4							1	2		1	
3130P	8					2		1	1	1	3	
3130Q	2					1			1			
3150P	9					3	1	1		2	2	
3150S	1					1						
3211P	3										3	
3211Q	2					2						
6201P	6								3	1	2	
6201T	1							1				
Total	274	3	2	1	12	42	26	40	40	52	56	0

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APPENDIX C

FY 2003 ENS and LTJG Stock by Subspecialty[84]

ENSIGN	Total	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	Check
1800E	31								19	12	
1800P	4								4		
1800T	2								1	1	
1801V	5								5		
1803E	1								1		
3110V	2								1	1	
Total	45	0	0	0	0	0	0	0	31	14	0

LTJG	Total	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	Check
1800E	50								17	33	
1800P	91								44	47	
1800T	7								4	3	
1801V	20								14	6	
1802V	18								9	9	
1803P	1								1		
1803S	2								1	1	
1803T	2								1	1	
3110T	2								1	1	
3110V	11								7	4	
3121T	1								1		
6201T	3									3	
Total	208	0	0	0	0	0	0	0	100	108	0

84 Source: Roshard Woolfolk, BUMED

FY 2003 LT Stock by Subspecialty

LT	Total	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	Check
1800D	3						1	2			
1800E	42	1		2	4	1	2	4	13	15	
1800P	137	1	3	9	13	9	26	25	19	32	
1800T	16				1		2	5	3	5	
1801S	3				1	1		1			
1801V	34		1	2	1	2	4	10	10	4	
1802S	5				1	3	1				
1802T	1								1		
1802V	24		1	1	3	3	2	4	4	6	
1803S	9			1	2			1	4	1	
1804S	2		1	1							
1805P	1						1				
1805S	16		1	3	2	1	3	2	1	3	
3110P	3					1	1	1			
3110S	3	1		1	1						
3110T	6						3	2		1	
3110V	38	1		4	2	4	4	5	7	11	
3121P	6	1			1	4					
3130P	7		1	1	3	1			1		
3130S	1								1		
3130T	2							1		1	
3150P	7	1		1	5						
3211P	2			1		1					
3211T	3						2	1			
6201P	5			2	1		1	1			
6201T	2				1			1			
Total	378	6	8	29	42	31	53	66	64	79	0

FY 2003 LCDR Stock by Subspecialty

LCDR	Total	FY95	FY96	FY97	FY98	FY99	FY00	FY01	FY02	FY03	Check
1800D	3				1			1	1		
1800E	8			1	2	2		1		2	
1800P	80	1	3	4	7	10	11	16	19	9	
1800T	11			1		2	1		5	2	
1801S	5	1		2		1		1			
1801V	28		1	3	2	4	6	8	2	2	
1802S	9	1		1	1	1	1	1	2	1	
1802V	10			1	1	1		1	3	3	
1803S	4			1		1		1		1	
1804S	3			1	1				1		
1805E	1								1		
1805P	1				1						
1805S	31	1	3	2	1	4	5	4	6	5	
3110P	16			2	1	2		4	4	3	
3110Q	1								1		
3110R	1	1									
3110S	19		1	2	3	2	5	5	1		
3110V	6					2		1	1	2	
3121P	5					1	2		1	1	
3130P	7			1		1	1	1	2	1	
3130Q	2						1		1		
3130S	2									2	
3150P	8			2	1	1		1	2	1	
3211P	1								1		
3211Q	1									1	
6201P	10					1	3	1	2	3	
6201T	2									2	
Total	275	5	8	24	22	36	36	47	56	41	0

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APPENDIX D

Transition Matrix of Medical Service Corps Health Care Administrators (Source: Author)

	ENS2	ENS3	LTJG1	LTJG2	LTJG3	LTJG4	LT1	LT2	LT3	LT4	LT5	LT6	LT7	LT8	LT9	LCDR1	LCDR2	LCDR3	LCDR4	LCDR5	LCDR6	LCDR7	LCDR8	LCDR9	CDR	OUT	CHECK
ENS1	0.9816		0.0184																							0.0000	1
ENS2		0.0241	0.9759																							0.0000	1
ENS3			1.0000																							0.0000	1
LTJG1				0.9708			0.0155																			0.0137	1
LTJG2					0.0796		0.9053																			0.0150	1
LTJG3						0.0109	0.9348																			0.0543	1
LTJG4							1.0000																			0.0000	1
LT1								0.9620								0.0000										0.0380	1
LT2									0.9763							0.0000										0.0237	1
LT3										0.9530						0.0000										0.0470	1
LT4											0.9434					0.0079										0.0487	1
LT5												0.8899				0.0569										0.0532	1
LT6													0.6710			0.2636										0.0654	1
LT7														0.4513		0.4318										0.1169	1
LT8															0.3453	0.3957										0.2590	1
LT9																0.8542										0.1458	1
LCDR1																	0.9787								0.0000	0.0213	1
LCDR2																		0.9891							0.0000	0.0109	1
LCDR3																			0.9670						0.0000	0.0330	1
LCDR4																				0.9545					0.0000	0.0455	1
LCDR5																					0.9048				0.0238	0.0714	1
LCDR6																						0.8421			0.1053	0.0526	1
LCDR7																							0.8333		0.1667	0.0000	1
LCDR8																								0.6667	0.2857	0.0476	1
LCDR9																								0.0000	0.7143	0.2857	1

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APPENDIX E

Solver Scenario Results (Source: Author)

Accessions

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	26	17	23	16	21	17	20	17	19	18	19	18	19	18	20	17	20	17	20	17
LTJG	8	54	27	54	38	50	38	43	39	43	42	44	44	43	44	43	47	44	54	45
LT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	33	71	50	70	59	66	58	60	58	61	61	62	63	60	63	60	66	61	74	62

Target End-Strength - OPA

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	43	43	41	39	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
LTJG	154	154	149	143	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139
LT	383	377	372	368	364	364	364	364	364	364	364	364	364	364	364	364	364	364	364	364
LCDR	261	259	255	253	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252

Difference

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LTJG	-80	-59	-26	-15	-4	-8	-12	-18	-18	-17	-14	-13	-12	-13	-12	-12	-9	-9	0	0
LT	71	70	31	29	8	-3	-17	-15	-9	-1	3	3	2	0	1	1	4	5	9	10
LCDR	-55	-39	-19	-5	12	31	49	58	51	46	39	30	24	16	9	6	7	11	14	15

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APPENDIX F

O-1 Focused Scenario Results (Source: Author)

Accessions

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
LTJG	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38
LT	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59

Target End Strength

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	43	43	41	39	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
LTJG	154	154	149	143	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139	139
LT	383	377	372	368	364	364	364	364	364	364	364	364	364	364	364	364	364	364	364	364
LCDR	261	259	255	253	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252	252

Difference

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
ENS	-7	-5	-3	-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
LTJG	-50	-46	-35	-26	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22	-22
LT	73	74	64	51	34	10	-8	-15	-16	-13	-11	-10	-10	-10	-10	-10	-10	-10	-10	-10
LCDR	-55	-39	-19	-5	12	31	50	62	60	60	53	44	33	22	12	6	4	5	6	6

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