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Application of Non-Rated Line Officer Attrition Levels and Career Field Stability

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APPLICATION OF NON-RATED LINE OFFICER

ATTRITION LEVELS AND CAREER FIELD STABILITY

THESIS

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Abstract

The Air Force monitors the strength of its active duty officer force and attempts to achieve the difficult challenge of employing a diversity of talent among career specialties and experience levels. This study completes two objectives, predicting future manning levels for 23 career fields, and providing a statistical framework to assess the stability of these fields.

The first part of the study applies regression and survival analysis to subpopulations within the active duty Air Force officer corps, and then aggregates them by year to forecast future personnel levels. Four career fields are considered, including Acquisitions (ACQ), Logistics (LOG), Support (SPT), and Non-Rated Operations (NRO). Based on the set of officers who commissioned within these career fields in 2014, this analysis predicts the number of personnel who will remain in each of these fields over the next 30 years. The rates depend on which factors have proven significant in each career field via a regression analysis and may include a combination of gender, commissioning source, prior enlisted service and/or Distinguished Graduate (DG) status at commissioning.

The second part of the study measures the stability of career fields through calculation and comparison of the mean and standard deviation values for the coefficients of variation. These results can be applied to decrease personnel management costs and enhance understanding of officer behavioral patterns, thereby improving the way that USAF leadership manages its personnel.

Dedication

This research is dedicated to my wonderful husband, our darling children, and my loving and supportive parents.

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I would like to thank my advisor, Dr. Raymond R. Hill for his encouragement, expertise and guidance in completing this research, and Lt Col JD Robbins, PhD, for his support and insight into this analysis. I would also like to express gratitude to my AFIT professors for excellent instruction, to my fellow students for frequent and enjoyable collaboration, and to Capt Alyssa Tetrault, whose kindness and friendship enabled me to persevere.

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APPLICATION OF NON-RATED LINE OFFICER

RETENTION LEVELS AND CAREER FIELD STABILITY

I. Introduction

1.1 Problem Background

1.1.1 Unique Qualities of the USAF

There are a number of studies conducted on employee retention in civilian populations. This previous research informs the current study but due to the unique demands and responsibilities placed upon today's military officers, it is crucial to study the military population directly. In this regard, some studies directly consider distinct military subpopulations, such as Gjurich [1] on Navy Surface Warfare Officers and Hall [2] on Army dentists. This research also delivers insight into the current work. However, the duties and stresses placed on military members differ significantly between branches, so the population of United States Air Force (USAF) officers is studied directly to best characterize the attrition behavior of this group.

The goal of this research is to use this information to positively impact USAF personnel management policies in ways that will decrease costs and enhance USAF leadership understanding of officer behavior patterns, thereby improving the way that USAF leadership manages its personnel.

To apply this analysis, it is important to understand the unique qualities of the USAF with respect to human resource organization and policy. Two unique qualities mentioned here are the force management constraints and the nature of typical career paths.

The structure and makeup of the USAF is subject to several constraints that increase the challenge of force management. Similar to many Defense and commercial organizations, the USAF aims to have sufficient variety among both rank and professional specialties. However, unlike these organizations, the maximum end strength is determined annually by Congress and the rank breakdown is limited by the Defense Officer Personnel Management Act (DOPMA) [3]. This act constrains the number of active duty officers serving in the field grade officer ranks (O-4 to O-6) at the end of any one year based on the total number of commissioned officers on active duty. These limits exclude most Reservists called to active duty (AD), General Officers, full-time National Guard, medical and dental officers, warrant officers, permanent professors at the service academies, and other subgroups [3] that compose relatively small proportions of the USAF population.

Because of these limits, when certain career fields exhibit higher than average attrition rates, that career field operates in a shortfall capacity. However, the USAF is constrained from planning for these events because they cannot acquire or promote extra personnel to safeguard against these potentially high future attrition rates due to the DOPMA limits. For example, if the USAF sees a problematic high level of attrition in Lt Cols in the Acquisition career field with 22 commissioned years of service (CYOS), they cannot simply increase the number of Majors in Acquisition to buffer against this problem because of the DOPMA limits.

Therefore, the USAF attempts to operate very closely to the DOPMA maximums and certain career fields undergo stress when their end strength is low [4]. This places high stress on overworked individual service members in those career fields as well as the senior leaders tasked with accomplishing their mission with fewer resources. This unique quality means that it is essential to carefully study attrition patterns and develop models to attempt to avoid these kinds of situations or at least decrease the frequency of their occurrence.

The second unique quality of the USAF that requires consideration is the nature of the near-singular career path to senior leader. With very few exceptions (e.g., medical corps, dental officers, and lawyers), all USAF officers start out at the lowest rank, Second Lieutenant. At current promotion rates, if someone enters active duty service by being commissioned in 2016, the earliest and most likely year they could be promoted to O-4 is 2026. If they are selected for promotion to Lt Col, then the most likely year they would promote (termed "in the promotion zone") is 2031. Finally, if they are selected for promotion to Col, then the most likely year they would promote "in the promotion zone" to Col is 2037.

This means that every year we have to make predictions about how many officers we need at each rank at field grade officer levels approximately 10-20 years in advance. It is extremely difficult to make these predictions because it is so far in advance and because it can be influenced by several things, to include the current number of worldwide conflicts the US is involved in (or plan to be involved in for the future), the state of technology (e.g., development of remotely piloted aircraft means changing needs for number of pilots), public opinion (negative view of military could pressure Congress to decrease end strength), the Department of Defense (DoD) budget that is set for a given year or expected for the future, and the political affiliations of the President and members of the House of Representatives and the Senate. These conditions are difficult to predict far in advance, so it is imperative that we fully understand the nature of officer retention behavior so we can optimize the portion of management of force strength that is in our control.

In addition to the difficulty of prediction so far in the future, the typical nature of the USAF officer career path means that a shortage of officers in any particular career field cannot easily be corrected since the USAF generally does not hire officers at any other level than Second Lieutenant. While at times the National Guard or USAF Reserve may be called upon to supplement the active duty force, this is not always an option in every career field or specialty area. This means that low commissioning levels in a particular career field in a given year or set of years could have ripple effects for up to 20 years in the future. Situations like this may require costly bonus offers or significant retraining expenses through crossflow programs.

Given these two qualities, we consider ways to improve personnel management policies with the USAF. The USAF invests considerable resources in training, educating, and mentoring its officers, so it is of significant benefit to understand attrition behavior. Since this information will be used to improve retention policies, it is critical to provide senior decision makers with evidence-based recommendations that come out of a scientific process.

1.1.2 USAF Commissioning Programs

Prior to reviewing the data, we hypothesized that for the first three to five years of active duty service after commissioning, retention would be close to 100%. This is because commissioned officers owe the Air Force an initial active duty service commitment from their training program. Typically, graduates of the US Air Force Academy owe five years of service, while Reserve Officer Training Corps (ROTC) and Officer Training School (OTS) graduates owe four years [5]. While active duty service commitments are not iron clad contracts, they are pretty close from the perspective of the service member. Consequently, retention in these early years is very close to 100%. Career field health analysts in AF/A1 verified this [6], confirming that on average, over all career fields, retention is approximately 98% within the first few years of commissioned service.

However, retention is not exactly 100% due to issues that did not come up during officer training but that were later realized after commissioning. This could range from previously undiscovered health issues that would preclude military service to disciplinary issues, such as failing a drug test or receiving a citation for driving under the influence of alcohol. Thus, the attrition rate is predictably lower for a few reasons.

First, the Air Force undertakes rigorous screening prior to accepting officer candidates. Applicants to OTS must have a career-relevant undergraduate or postgraduate degree, and be licensed and eligible to practice in their field. They apply to a selection board where their record is scrutinized for work experience, accomplishments, character, leadership ability, education, and grade point average. They undergo a thorough, in-person physical and mental screening evaluation. If accepted, candidates attend five weeks of officer training including academic preparation and intense physical conditioning [7].

The ROTC program includes a similarly rigorous application process and several additional requirements. Candidates must be in good academic standing and enrolled in an accredited four-year degree program that hosts or has a local agreement with an AFROTC detachment. Cadets must complete either a 3-year or 4-year program. The first 1-2 years (depending if the cadet enrolls as a freshman or sophomore) consists of 2-3 hours per week (in addition to the institution's degree requirements) of academic work, such as aerospace studies and leadership laboratory training. After completion of the initial General Military Course, cadets apply for the final two years of the program, termed the Professional Officer Course, and are evaluated for acceptance based on GPA, unit commander evaluation, standardized test scores, and performance during the General Military Course. If selected, they are tested in a demanding 24-day summer field training exercise, and then complete 4-5 hours per week of academic coursework and leadership laboratory training over the next two years before they are commissioned as officers [8].

United States Air Force Academy (USAFA) applicants are evaluated based on similar requirements to both OTS and ROTC, including character, leadership ability, academic performance, etc. They need to complete an in-person candidate interview, writing sample, physical fitness test, and medical evaluation. They must acquire an official nomination from a member of Congress or other approved nominating entity, and submit three teacher evaluations. Once admitted, cadets complete a four-year academic degree program plus several hours per week of military education and preparatory leadership training [9].

Summer programs over the first two years include basic cadet training, expeditionary, survival and evasion training, parachuting, soaring, navigation, and others. For the final two summers, cadets may take leadership roles running summer programs for first and second year cadets, earn their private pilot's license, work with a sponsor on scientific research, visit, and interact with an operational Air Force unit or complete other programs [9].

Candidates for all three commissioning programs are thoroughly vetted for the extremely high standards desired of military officers, including peak physical and mental health, leadership traits, and proven moral character. At any time during the OTS, ROTC or USAFA commissioning programs, cadets may and frequently are disenrolled for medical, disciplinary, or any other issues deemed noncompliant with military service. Thus, candidates are twice vetted, through application and their commissioning program, and thus relatively few new officers attrit during the first few years of commissioned service.

Additionally, unlike their counterparts in non-military occupations, service members generally lack the ability to separate due to their own personal preferences or decisions during their active duty service commitments. The decision to retain or separate generally remains with the Air Force, and the member lacks influence into this decision.

1.2 Research Scope

The objective of this research is to provide insight into retention behavior of active-duty USAF officers serving in four career fields: Acquisition, Non-Rated Operations, Logistics, and Support. It builds on Schofield's [10] work that created survival functions to predict attrition behavior over a typical officer's career. This research applies that theoretical framework to the active-duty USAF officer population with 0 CYOS in 2014 to predict how many officers will retain in the four aforementioned career fields over the next 30 years. It considers the current demographics of these subpopulations and categorizes each officer based on gender, commissioning source, DG status, and prior enlisted service. The number of officers that fit in each demographic combination is applied to their respective survival functions developed by Schofield to forecast personnel strength and analyze career field health over the next 30 years.

This research investigated the current approach to characterizing officer retention behavior and proposes new metrics and methods to better understand this behavior, model it more precisely, and provide improved predictions for specific groups of personnel aggregated by career field and years of military service. This information will help USAF leadership identify force structure problems earlier and develop policies to minimize the use of costly tools (e.g., bonuses, reductions in force, and force shaping) to right size the force.

This research focused on four career fields, Acquisitions, Logistics, Non-Rated Operations, and Support, and makes predictions on how many personnel will be serving in that career field for the next 30 years. Furthermore, it identifies a triage list of certain career fields with the most volatile attrition behavior and offers recommendations to adjust to and manage this unpredictability. Additionally, it recognizes a list of career fields with the most stable retention behavior and postulates what could potentially be causing this stability. It considers the current stress metrics used to describe the health of all career fields and proposes improved ones that better portray the health status of these fields.

1.3 Issues, Needs and Limitations

Data used in this study comes from MilPDS (Military Personnel Delivery System), which is the main database for all personnel data for the Total Force (Active Duty, Guard and Reserve) [11]. While this catalog of data is thorough and fairly accurate, there may exist some incorrect data entries or blank fields due to human entry error, lack of information or changes in the USAF (e.g., addition or removal of certain career fields) over time. To manage these errors and make the data usable for analysis, a SAS program reviews the data and resolves errors based on a set of assumptions before it is transferred over to Microsoft Excel for analysis [10].

A limitation to the research is that it is specifically designed to make predictions about unique career fields, and while general insights can be applied to other populations, the specific survival functions and metrics are not designed to be applied to other populations, either civilian or military. For example, factors that play a role in retention behavior may be different between career fields. Deployment schedules, work hours, operations tempo, stress levels, and other factors would lead to different survival functions so that one should not necessarily be applied to another. While general insights may be gleaned for attrition behavior, it is best when used specifically for the subpopulations studied.

1.4 Thesis Outline

Chapter 2 reviews the existing literature on both military and civilian personnel management. Chapter 3 gives an introduction to the MilPDS, the original source of the data. Chapter 4 describes the current methodology applied to predict retention rates. Chapter 5 discusses the analysis and findings in two sections. First, it provides survival functions predicting retention levels both on the aggregate level and on the individual career field levels for Acquisition, Non-Rated Operations, Logistics, and Support fields. Second, it suggests new metrics to measure the health and stability of Air Force Specialty Codes. Chapter 6 provides limitations, recommendations for follow-on research, and conclusions.

II. Literature Review

2.1 Introduction

The U.S. military is a volunteer force whose members sign on for specific periods of time, hopefully with the best of that force staying for a career (until retirement). In general, all military members start at the lowest ranks. Senior military leadership all started at the bottom. A viable military requires qualified leadership only attainable by those new members retaining in the military and progressing through the ranks. Naturally, personnel retention is important to the military.

Over the past few decades, numerous studies, analyses, and theses have investigated the costly issue of highly trained and skilled military members separating from service, which can lead to shortages at higher ranks and a smaller talent pool than desired from which to select the most senior officers.

Since the military utilizes a career model that grows leadership internally, rather than hiring externally, it is essential to understand the retention and attrition behavior of officers. In this chapter, we summarize germane literature that provides insight into the factors that affect this behavior.

Past research employs questionnaire data, personnel records, and other sources of official manpower data for military members. Analytical methods considered include numerous modeling techniques, such as multivariate logistic regression, survival analysis, classification trees, complex adaptive system simulation, discrete event simulation, and stocks and flows models, among others.

Manpower analysts examine the factors that influence retention decisions, including marital status, presence of dependents, belief in long-term opportunities within the military, specialized training, status of the civilian economy, the prospect for alternate employment, and others. Various studies examine significant factors influencing attrition and made recommendations to senior leadership on ways to retain high-quality personnel.

While studies of military populations are the primary focus of this literature review, a study of the government civilian population is found relevant and included as well. As this research extends that of Schofield [10], we start with a summary of her work.

2.2 Previous Military Manpower Research

Schofield uses a logistic regression model to establish the factors that predict retention for non-rated Air Force line officers. She finds that gender, number of years served as an enlisted member, and career field selection, as well as commissioning year, source, and honors status (termed "Distinguished Graduate" in the Air Force) were statistically significant regressors [10].

Schofield processes personnel data into cohorts grouped by years of service. Someone leaving the service is deemed a "failure" or a censored data point in reliability terms. Continuing with the analogy to reliability analysis, a survival function based on the cohort provides a model of personnel retention probability.

Schofield builds 99 distinctive survival functions and found that these methods are nearly as effective as the model currently utilized by the Air Force in managing personnel strength. Schofield recommends using her approach as an alternative to the current model [10].

Hall [2] studies Army dental officer retention as predicted by variables aside from salary. Data on 2,003 active-duty Army dental officers serving from September 1998 to July 2008 was used [2]. Survival analysis is performed to develop a predictive model that indicated whether Army dentists would stay on active duty past their initial service commitment. The research results help suggest that frequent and lengthy deployments combined with appealing prospects in the civilian dental industry were partly responsible for dental officers electing to separate. Hall's analysis finds that age, race, dependents, commissioning, professional specialty, and date of entering service (before or after 9/11) are the most significant independent variables in predicting retention [2].

Interestingly, Hall finds that deployments were not statistically significant, contrary to popular belief that frequent and length deployments motivates service members to separate. Hall also finds that those Army officers who had dependents, completed additional dental training, and joined the Army after 9/11 are more likely to stay in the military [2].

Gjurich [1] studies data on 5,438 Surface Warfare Officers in the grade O-3 who served in the US Navy between 1990 and 1998, and had completed their initial service commitment. The work focuses on US Navy personnel shortages where qualified, highly skilled people were exiting the military, negatively impacting force readiness and our national defense posture. Gjurich analyzes official personnel and questionnaire data and found that retention was positively correlated with having dependents, being commissioned from the Reserve Officer Training Corps (ROTC) program, and having pursued graduate education. His research is based on earlier work that found that financial factors were not a primary motivator of separation, but instead concerns about military drawdown and subsequent lack of long-term opportunities were significant factors in predicting attrition [1].

Gjurich recommends the US Navy predict officer retention using logistic regression and classification trees (the methods he used) as a more accurate predictor than the current method of extrapolation. He feels the Navy could benefit from the cost savings due to improved forecasting and prediction methods [1].

Zinner [12] studies a population of male, company-grade U.S. Marine Corps officers with one to seven years of service, using data from a 1992 DoD survey of military members and their spouses as well as official 1996 manpower retention data. Zinner uses a multivariate logistic regression model to predict retention after an initial service commitment and found that the variables that significantly impacted retention included commissioning source, job specialty, deployment, satisfaction with life in the Marine Corps, perception of drawdown, seeking a civilian job, belief that skills gained in the military would transfer to the civilian domain, and impact on spouse's career. Zinner also finds that more demanding jobs (such as combat arms officer) negatively impact retention, and officers who commissioned through ROTC are 28% more likely to stay on active duty than those who complete Officer Candidate School.

Zinner's results [12] do contrast with Hall's study on Army dentists [2]. Zinner found that officers who deployed to Operations Desert Shield or Desert Storm had a 10% decreased likelihood of staying on active duty than those who did not deploy. However, it can be hypothesized that a dentist might have a very different deployment experience and daily duties than would a typical Marine Corps officer, and this might account for the contrasting results [12].

Finally, Zinner considers that 71% of Marine Corps officers are married, and married officers are more likely to separate than are non-married officers. As a follow-on, approximately 70% of the married members stated that their spouses were influential in their decision to separate from the Marine Corps. To this end, he recommends that the Marine Corps stay committed to quality of life concerns for its service members and their families, as this affects readiness through retention and morale [12].

Gaupp [13] considers the issue of separation of US Air Force pilots who have completed a lengthy, costly training program, and the reasons that influence them to leave. Gaupp investigates both the external, environmental factors that motivate pilots to leave the US Air Force as well as the internal, personal interactions between pilots [13].

Gaupp's model, the Pilot Inventory Complex Adaptive System, includes both these internal and external factors to study how pilots change and adapt to their surroundings. He applies his complex adaptive system simulation to describe the long-term behavior of the agents (in this case, pilots). While his model cannot be used to predict the short-term actions of agents, its use is in considering personnel trends over longer periods of time [13].

Gaupp recommends that decision makers use this long-term information to create an environment where these highly skilled, valuable pilots are motivated to continue serving. Additionally, while his study only considered the aviation community, he maintains that the policies could have application across the Air Force population as a whole, although he recommends building a modified system for that purpose [13].

Castro and Huffman [14] study data on 289 US Army soldiers (both enlisted and junior officers) stationed in Germany or Italy between June 1999 and December 2000 to determine the effect of several factors on a soldier's decision to stay in the military [14]. They built a Chi Square Automatic Interaction Detection (CHAID) model that utilizes the variables of deployment, years of service, and job satisfaction. This model predicts a soldier's intentions with 62.3% accuracy [14]. They also create a multinomial logistic regression that used both work climate and operations tempo measures. Work climate includes "job satisfaction, job recognition, task significance, work intensity, job challenge, goal acceptance, job control, and soldier pride." Operations tempo includes daily and weekly hours worked, time spent in training or temporary duty status, quantity of deployments, and overload of work [14].

Castro and Huffman [14] are able to predict retention with an impressive 75.1% accuracy rate when their model includes work climate, operations tempo, and an interaction term with the product of these two variables. They recommend leadership consider these many indicators when considering force management policies.

Perry [15] studies official personnel data from 27,659 mid-grade US Marine Corps officers from Fiscal Year (FY) 1980 to FY 1999 to determine the influence that professional specialty, termed "primary military occupational specialty (PMOS)," held on retention and promotion. Logistic regression and Cox Proportional Hazard models are used to predict these effects in retention and promotion.

Perry [15] finds that those with a PMOS of pilot are more likely to stay in for ten years of service, while those with a PMOS other than infantry are less likely (than infantry members) to stay in for ten years. In the military, ten years is considered an important point in a service member's career because he/she is halfway to the 20 years of service required for a prestigious and financially rewarding military retirement.

2.3 Previous Civilian Personnel Research

In addition to military studies, there is significant literature on employee turnover in the civilian sector, particularly work that looks at retention and attrition behavior of US government civilians.

Parker and Marriott [16] propose a unique approach to manage force levels within the National Imagery and Mapping Agency (NIMA). They build a stocks and flows model to simulate personnel levels and their respective costs over time. The user specifies inputs such as retirement rates, bonuses, annual pay raises due to inflation, salaries, promotion rates, and other personnel aspects. Output includes multiple solution alternatives including recommended personnel levels, pay and benefits, attrition data, and more. The decision maker can review this output as well as a sensitivity analysis that allows them to see the effect of changes on model inputs and assumptions. The leadership can then identify projected personnel overages and shortages and select a strategy that optimizes hiring and downsizing policies accordingly. This approach utilizes system dynamics to identify the effect of different catalysts on force levels. Comparing different strategies via simulation allows a much lower cost than executing a strategy and taking data from a real-world system.

A method similar to Parker's and Marriott's could work with USAF officers since officers represent a similar population; NIMA has a large (9000+), highly specialized work force where both education and experience are critical to success [16], comparable to the population of USAF officers.

Conzen [17] studies official personnel data on US Naval Officers who were eligible to separate between 1992 and 1997. He creates maximum likelihood logistic regression and multivariate models to predict officer retention based on either a completely funded, graduate degree from the Naval Postgraduate School or a civilian school funded at least partially through a naval program. Conclusions from this study indicate that a funded degree did not have a significant effect on retention after ten years of service [17].

This insight regarding graduate degrees is applicable to US Air Force policy as well. Until recently, junior US Air Force officers were informally encouraged to get advanced degrees to “check a box” for their promotion board to Major [18]. This belief was aggrandized because Air Force Personnel Center published annual data with promotion rates based on graduate degree completion, and the promotion rates to O-4 (Major) were clearly higher for those who had completed a master’s degree.

To counter this perception, Welsh [18] initiated official guidance that until eligibility for promotion to O-6 (Colonel), advanced academic degrees (AADs) were not expected for line of the Air Force officers, and all supporting promotion documentation would no longer display AAD data. This was scheduled to go into effect for the promotion boards in Dec 2014 [18].

"Since job performance is the most important factor when evaluating an officer for promotion, the decision to delay completion of an advanced academic degree will not affect their ability to serve a full career in the Air Force" [19].

In a study conducted at the United States Military Academy, Dabkowski et al. [20]. utilize discrete event simulation to consider retention and attrition issues in the U.S. Army. They look at the overages commonly seen in the Company Grade Officer ranks and the shortages frequently seen in the O-4 (Major) and junior O-5 (Lieutenant Colonel) officer ranks. They propose three scenarios to represent different model assumptions. For each scenario, each officer receives a measure of aptitude termed “talent”, where talent is assumed to be a one-dimensional attribute measured as a combination of skills, knowledge, and behaviors. Talent is used to predict how well officers of different caliber may perform over a career [20].

The first scenario models a world where officers never personally elect to separate but only leave the service if they are not selected for promotion. While this is not realistic, it serves as a sufficient baseline. The second model assumes a constant rate of separation over time for officers, and the third model assumes that those officers who depart tend to be the more talented ones, since they have a higher opportunity cost and are more likely to be recruited by civilian employers. The authors hypothesize that the real world operates somewhere in between the second and third model [20].

Dabkowski et al. [20] find that many highly talented Lieutenant Colonels are leaving the service earlier than is most beneficial for the Army, leaving a smaller than desired population to consider for leadership ranks of Colonel and General Officer (O-7 to O-10). To help amend this problem, they recommend instituting programs to more aggressively recruit talented officers and keep them around and suggest moving the promotion board to Colonel earlier so that additional officers have the motivation of staying past the typical 20 year retirement point. The authors contend that both of these methods would help the Army recruit and retain higher quality officers [20].

Demirel [21] studies officer retention decisions using data on those who entered the service in the ten year period from 1985 and 1995. He studies attrition behavior of those who reached two distinctive points in a military member's career: completion of their initial service commitment and reaching ten years of service [21].

The former point is important because it is the first time the member has the option to separate after commissioning. The latter point is notable because a member is halfway toward retirement.

Demirel [21] builds logit regression models and discovers that commissioning source had a small impact on retention. He finds that graduates of one of the service academies (US Air Force Academy, US Military Academy, and US Naval Academy) are 3.1% less likely to stay beyond their initial active duty service commitment when compared to Reserve Officer Training Corps (ROTC) graduates [21].

Demirel notes that while the differences in retention between commissioning sources were not large, the cost between putting an officer candidate through each varied significantly [21]. While officer candidate school takes weeks to complete, service academy and ROTC scholarships cover candidates for years. In light of this cost difference and the current situation of reduced military budgets, he recommends that senior leadership consider redirecting allocations from costly service academy and ROTC programs to officer candidate schools in order to save funds [21].

All of the aforementioned studies, analyses, and theses provide valuable input as to the factors that characterize the attrition and retention behavior of military personnel. Their recommendations to leadership as well as proposals for future work provide relevant background to the current research.

III. Data Source - MilPDS

The data used in this research originates from MilPDS (Military Personnel Delivery System), which is the main database for all personnel data on the Total Force (including Active Duty, Guard and Reserve). MilPDS covers all official actions (e.g., accessions, reenlistments, separations, commissioning, medals, promotions, pay, and benefits) throughout a member's career [11]. It is considered a precise and up-to-date way to track USAF personnel careers. Because it is the way that members receive certain benefits (healthcare eligibility for children, life insurance policies, housing allowance changes upon moves) and ensure they are competitive for promotion (e.g., having accurate data and awards listed for promotion boards) members are motivated to check it for correctness on a regular basis and request updates if needed.

MilPDS interacts with numerous other Air Force systems but it is considered the source data and therefore the most accurate supply of data for personnel analysis. Although it is not perfect, it is a highly robust system that recently underwent a major modernization upgrade that improved its backup capability and ensured that it efficiently interacts with other software systems the Air Force uses [11].

The data used in this analysis is a set of Excel spreadsheets with the MilPDS records on Air Force officers in the Acquisitions, Logistics, Non-Rated Operations, and Support career fields from 2002-2015. It is provided by Air Force Manpower, Personnel and Services (AF/A1).

IV. Current Methodology

4.1 Sustainment Model

The current Sustainment model is to predict retention over the next 30 years builds unique functions, or sustainment lines, for each career field through a SAS program that runs a maxi-min flow optimization. It has the goal of maximizing the manning level of the career field with the lowest manning over the next 30 years. This program is based on the assumptions that for the next 25-30 years, there will be no changes in officer retention, crossflow, end strength, nor 5-year funded manning requirements [10]. While these are rather large assumptions, they help create the current sustainment model and overcome some of the difficulties of attempting to forecast up to 30 years in the future.

4.2 Stress Metrics

Current methodology to model attrition behavior has some issues that could be improved upon. Reporting of data relies overly on historical data, does not plan for variation, and does not work well with small populations.

One of the major stress metrics used to characterize a subpopulation within a career field is shown here. A unique rate is calculated for each combination of career field and number of years of active duty service. The value is called the Cumulative Continuation Rate (CCR) from X to Y, and used as the probability that an airman who begins year X will stay through year Y.

In some cases, CCR is a useful metric. In one instance, it cleanly illustrates the stark attrition pattern seen with relation to the current cliff-vesting retirement plan. For example, of those 61A (career field of scientific analyst) officers who completed 12 years of service, 79% of them went on to complete 19 years of service. However, among 61A officers who completed 20 years of service, only 50% went on to complete 22 years. The 61A CCR from 12-19 is 79%, and the 61A CCR from 20-22 is 50%.

At this time, the predominant factor that decision makers rely upon in order to predict future behavior is historical attrition rates. While historical data certainly provides insight, it is desirable to utilize additional information and methods to provide improved predictions.

Another issue with the current methodology of predicting retention estimates is that there is limited planning for variation even though some career fields exhibit large fluctuations in retention rates. When these considerable oscillations occur early on in an officer's career (say, in the first five years), the impact is magnified because these rates affect personnel strength in that career field and year group for the next 15+ years.

4.3 Additional Factors

A major factor in prediction of active duty attrition behavior is the current military retirement plan. At this time, completion of twenty years of active duty service is required to earn a valuable active-duty retirement pension and benefits, which starts as soon as the member retires. This "cliff-vesting" system has been a useful tool for the military to retain high quality officers. If a member departs active duty service before 20 years, they do not receive any pension or medical benefits beyond a few months of coverage. While retention behavior is variable in the earlier years (i.e., fewer than ten years), it tends to be predictable beyond ten years because members are getting closer to the twenty year "cliff". However, a new blended retirement system is expected to be introduced soon, which will allow members to leave active duty service with a limited pension and some benefits before twenty years of service [22]. If adopted as expected, this new benefit system will increase variability in retention behavior of those with greater than ten years of service, making it critical that officer attrition behavior is carefully studied and accurately modeled.

V. Results and Analysis

5.1 Introduction

This section includes results and analyses from both components of the research. The first part applies regression and survival analysis to subpopulations within the active duty Air Force officer corps, and then aggregates them by year to forecast future personnel levels in the Acquisitions (ACQ), Logistics (LOG), Support (SPT), and Non-Rated Operations (NRO) career fields. Based on the set of officers who commissioned within these career fields in 2014, this analysis predicts the number of personnel who will remain in each of these fields over the next 30 years. The rates depend on which factors are proven significant in each career field via a regression analysis and may include a combination of gender, commissioning source, prior enlisted service and/or DG.

The second part of the study measures the stability of career fields through calculation and comparison of the mean and standard deviation values for the coefficients of variation. These results can be applied to decrease personnel management costs and enhance understanding of officer behavioral patterns, thereby improving the way that USAF leadership manages its personnel.

5.2 Survival Functions

5.2.1 Background

The survival analysis portion of this work is a direct follow-on to that completed by Schofield [10]. She uses logistic regression to determine significant factors in retention prediction for USAF non-rated line officers and finds that all six factors she considered (year commissioned, source of commission, number of years served in enlisted force, career field, and DG at commissioning) are significant. She then analyzes the data using the Cox proportional hazards model to produce a set of regression equations within each of the four career fields. The explanatory variables consist of the respective subset of the aforementioned six factors that are proven significant to that particular career field's regression model, as listed in Table 1 [10].

Table 1. Factors Significant to a Career Field's Regression Model

Career Field	Significant Factors
ACQ	Commissioning Source, Prior Enlisted Service
LOG	Gender, Prior Enlisted Service, DG
NRO	Gender, Commissioning Source, Prior Enlisted Service, DG
SPT	Gender, DG

Each factor has between 2-5 levels, as seen in Table 2 below.

Table 2. Factor Levels

Gender	Commissioning Source	Prior Enlisted Service	DG
Male	Academy	0-2 years	Yes
Female	ROTC	3-4 years	No
	OTS	5-7 years	
		8-11 years	
		>11 years	

The coefficients derived from these regression equations are used as baseline covariates to calculate a survival function for each applicable combination of the significant factors. This lead to 99 survival functions that describe the retention behavior of their respective subpopulations [10]. Specifically, they detail the retention rate from one year to the next based on CYOS.

A sample survival function as well as its 95% confidence interval can be seen in Figure 1. In the NRO career field, four factors are significant (gender, commissioning source, prior enlisted service, DG), so all four are used to create various distinctive subpopulations based on the combinations of different levels of each of the four factors. For example, for non-prior enlisted, male Academy graduates who were not DG, and who are in the NRO career field, retention behavior is predicted as seen in Figure 1.

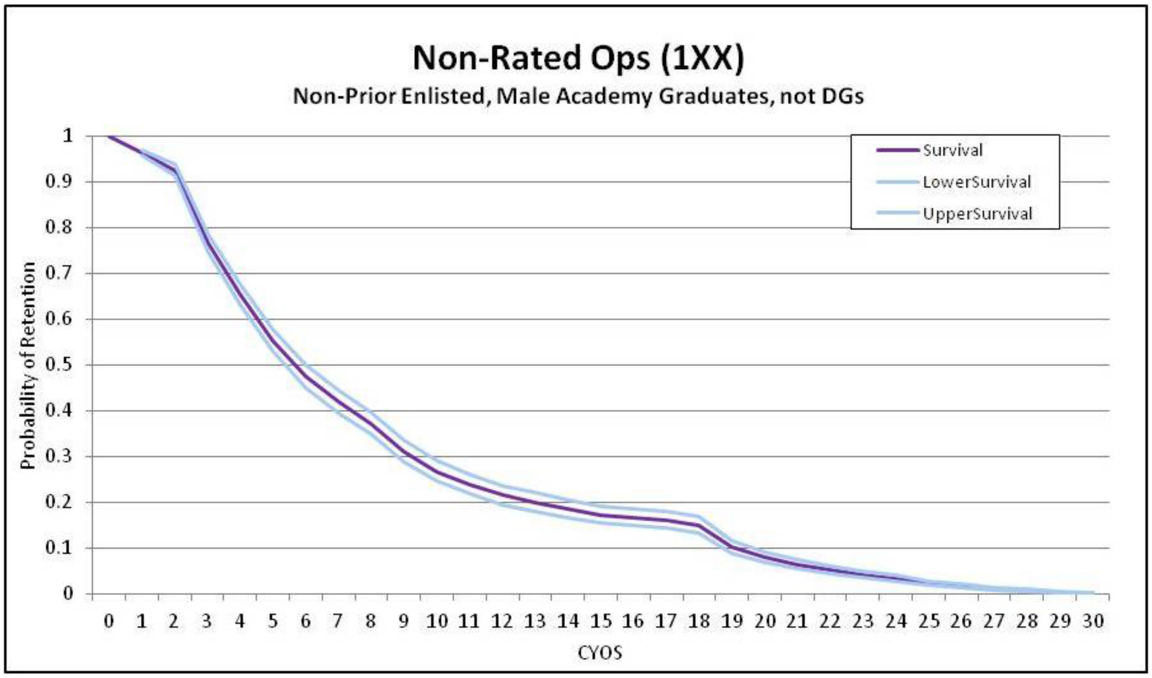

Figure 1. Non-Rated Operations Survival Function (Non-Prior Enlisted, Male Academy Graduates, Not DGs) [10]

The other 98 survival functions are calculated for each of their particular populations. While Schofield conducts the theoretical research on attrition, this analysis aims to apply that work to subpopulations within the current, real-world active duty Air Force officer corps. Four career fields are considered, including Acquisitions (ACQ), Logistics (LOG), Support (SPT), and Non-Rated Operations (NRO). Based on the set of officers who commissioned within these career fields in 2014, this analysis predicts the number of personnel who will remain in each of these fields over the next 30 years. The rates depend on the specific factors that are proven significant in each career field and may include a combination of gender, commissioning source, prior enlisted service, and/or DG status.

Each career field has various unique survival functions depending on which factors were significant. The number of potential survival functions for each career field depends on both the number of significant factors (Table 1) and the number of levels for each factor (Table 2). For example, in the NRO career field, the factors found significant to retention include gender (2 levels), commissioning source (3 levels), prior enlisted service (5 levels), and DG (2 levels). Therefore, the potential number of survival function is the product of these, i.e., 60 functions.

However, as Schofield notes [10], not all combinations of levels are feasible. For example, given that a person must be at least 17 years of age to enlist in the USAF [23] and applicants to USAFA must be 22 years or younger on July 1st of the year they enter the Academy [9], a USAFA graduate can have a maximum of six years of prior service, meaning there will be no combinations that include both the Academy factor and either one of the highest two factors within prior service, 8-11 years or >11 years.

Additionally, even if a combination is feasible, its survival curve may not be utilized if there are no personnel who commission in a given year who happen to fall within those categories [10]. For example, on average 16.7% of officers commissioned each year arrive from OTS [24]. Fewer than 10% of officers commissioning from any source in a given year achieve DG. Additionally, 20.2% of today’s officers are women [24]. Consequently, a combination that includes these factor levels with low percentages may have no officers for a particular year. Given that not all combinations of levels are feasible, and that some feasible combinations will not be applicable, the actual number of survival functions that are required for the 2014 population is listed in Table 3.

Table 3. Number of Survival Functions

Career Field	Possible Number of Survival Functions	Actual Number Survival Functions Utilized in 2014
ACQ	15	11
LOG	20	15
NRO	60	31
SPT	4	4

In order to actually use the survival functions on active duty force management, these curves must be applied to the respective populations that they represent, and then are aggregated to examine the population's behavior and personnel end strength. This will be investigated both at an overall, higher level (ACQ, LOG, NRO, and SPT combined) as well as down to the career field level.

5.2.2 Analysis

The data provided by AF/A1 stores personnel inventory counts for each unique combination of the factors considered, including gender, commissioning source, prior enlisted service and/or DG. Schofield completes a regression analysis that determines which of the factors were significant to different subsets of the population, so these are used to determine that 61 unique survival curves (of the potential 99 functions) would need to be utilized for the 2014 data.

We write the VBA program seen in Appendix A to bin the data and gather it into matrices for analysis depending on which factors were significant. We match each one of these 61 curves with the inventory counts at 0 CYOS to predict how many would retain in a given career field over the next 30 years. After multiplying these curves by the respective population counts that they represent, we aggregate them to display the survival curve for each of the four career fields considered, and then again for a total of all four career fields.

Aggregate Non-Rated Operations Survival Function

First we explore the aggregate perspective of the four career fields grouped together. The 2014 total weighted survival curve seen in Figure 2 is a prediction of how many officers will retain in the ACQ, LOG, NRO, and SPT career fields over the next 30 years. Of the 99 potential survival functions, 61 were both feasible and applicable to the 2014 population. Each of these 61 functions is multiplied by the proportion of the population they represent. For example, one population might be female LOG officers who were ROTC graduates, not DG, with 3-4 years prior enlisted service. The number of personnel who meet all these criteria and who commissioned in 2014 is multiplied against the 31 discrete points on the survival curve to see how that group would retain over the next 30 years. This is done for each of the 61 subpopulations and added together to see how the overall population performed.

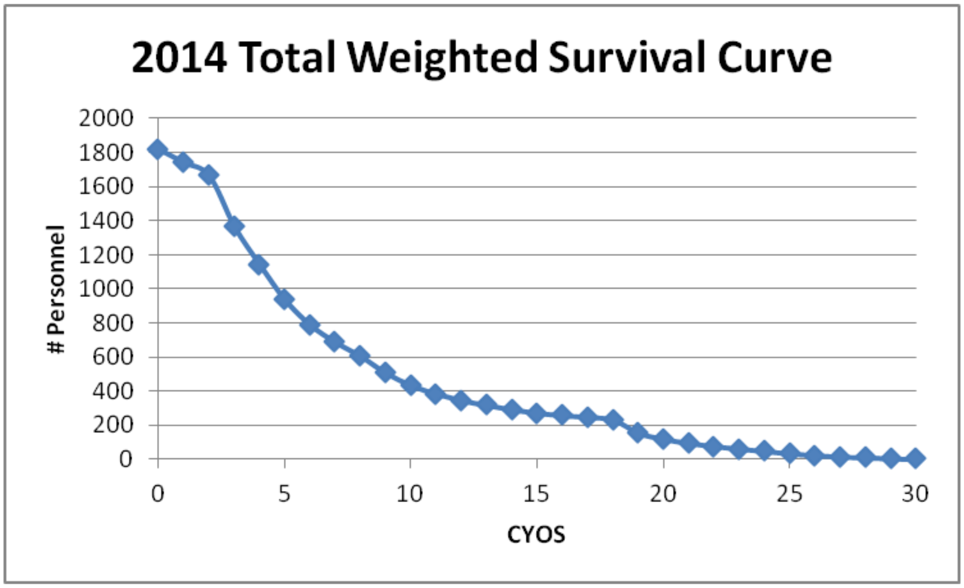

Figure 2. 2014 Aggregate Weighted Survival Curve

The intercept in Figure 2 is the 1,820 personnel who commissioned in 2014 (and therefore have completed 0 CYOS). The function is a series of discrete points connected by an interpolation that is included mainly for improved visualization. The interpolation is typically used in AF/A1 for aesthetic value [10].

Each discrete point on the curve represents the predicted number of personnel in the population considered who will retain to the next year. The slope of the line between any two contiguous data points represents the forecast number of people to attrit before reaching the CYOS of the higher value. For example, of the original 1,820 personnel at 0 CYOS, 1,742 (or 95.7% of the original personnel) are expected to remain to complete 1 CYOS. The slope between these two points is 78, representing the number who separated in this time period.

Of the original 1,820 who commissioned, 434 are expected to complete 10 CYOS, 118 are predicted to complete 20 CYOS, and only 2 are anticipated to complete

30 CYOS. This rapid decline in number of personnel is hypothesized to be due to myriad reasons. Potential causes include desire for geographic stability, alternate opportunities in civilian sector, obstacles to promotion and advancement within military, family situations that preclude the mobile military lifestyle and others.

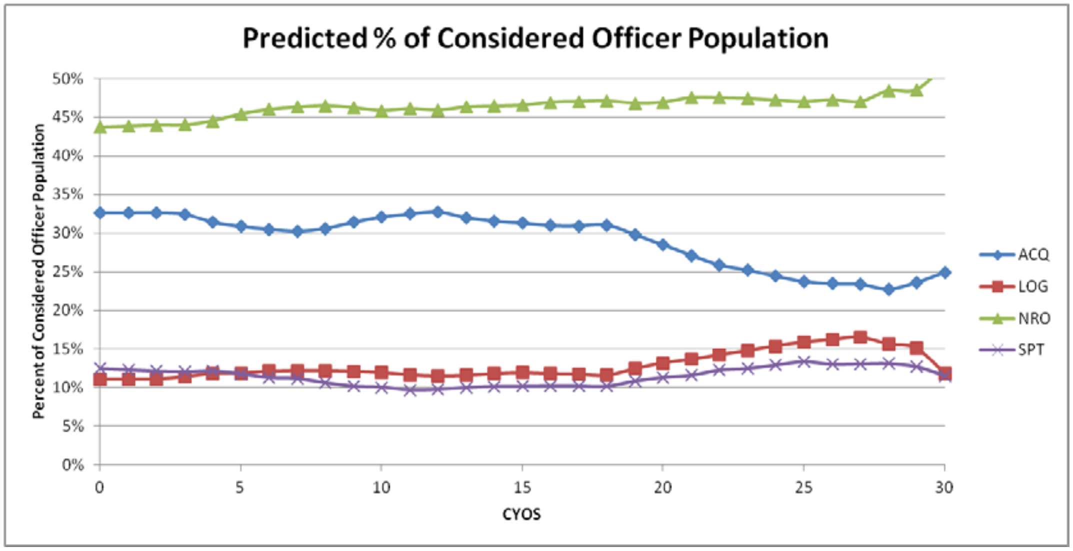

Figure 3. Predicted Percent Breakdown of Considered Officer Population

Figure 3 displays the predicted percent breakdown of the considered officer population (ACQ, LOG, NRO, and SPT) that will exist over the next 30 years. All four career fields stay relatively stable until 18 CYOS. At this point, as a percent of total, ACQ officers decline rapidly while ACQ and SPT officers exhibit a moderate increase and NRO officers are slightly amplified as well. The reasons behind this change are not clearly identified at this time. One potential reason could be limited opportunities for higher promotion in the ACQ field since the USAF employs an “up or out” system where members who are not promoted are typically soon required to leave the service. Another potential reason could be that prior enlisted ACQ personnel separate because their service before commissioning earns them a full military retirement before 20 CYOS.

One reason for the steady slope for all four career fields is that it is considered desirable to have a force structure that has sufficient representation from each of these segments. Still, there is a slight uptick at the higher end of the x-axis. At 28 CYOS, fewer than 10 personnel are still serving, so the retention rates at that end are skewed because each single person's decision to retain or separate has undue influence on the rate. Therefore the change in direction of the slope seen from 28-30 CYOS is insignificant.

Career Field Survival Functions

While the aggregate survival curve shows how the officer population behaves on a larger scale, it is useful to examine the actions of personnel in different career fields as well. Therefore, the weighted survival functions for each of the ACQ, LOG, NRO, and SPT career fields are analyzed individually.

ACQ Officers

ACQ includes officers who work in operations research, behavioral science, chemistry, physics/nuclear engineering, science, developmental engineering, acquisition management, contracting, and financial management. These officers compromise 32.6% of the total number of officers considered in this analysis. Regression results revealed that Commissioning Source and Prior Enlisted Service are significant factors that predicted retention. The population of 594 ACQ officers in 2014 with 0 CYOS required 11 of the potential 15 survival functions. Each of the applicable survival functions was weighted by its respective proportion of the ACQ population to produce the predicted ACQ end strength shown in Figure 4 below.

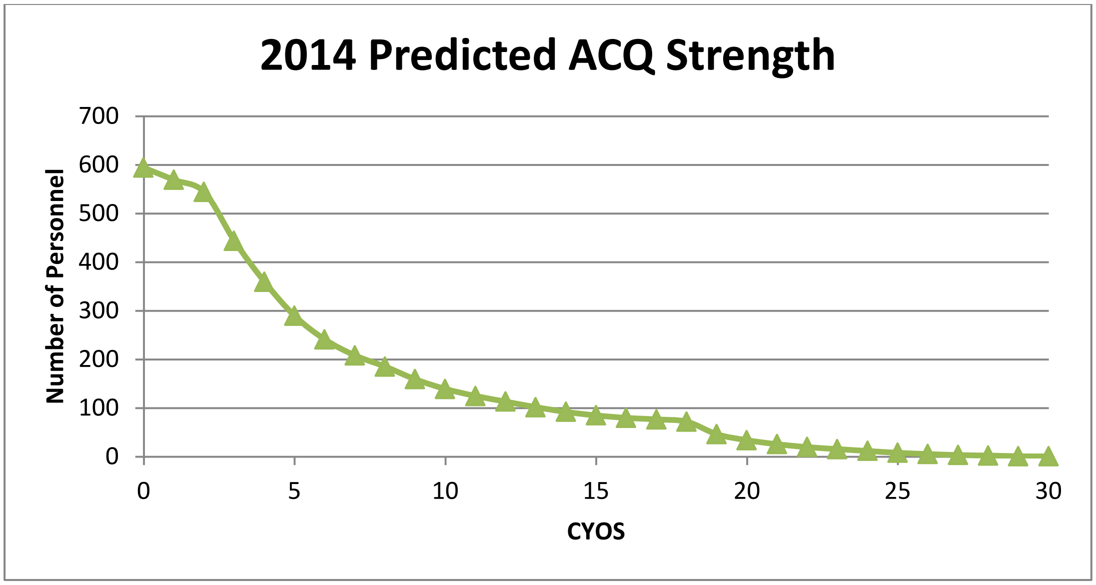

Figure 4. 2014 Predicted Acquisition Strength

Notably, a steep slope is seen between 4-10 CYOS, and then levels out after 10 CYOS. The high attrition rates around 5-6 CYOS can be attributed to the completion of service members' initial active duty service commitments (ADSC). Typically, graduates of the US Air Force Academy owe 5 years of service, while ROTC and OTS graduates owe 4 years. The model predicts that for those ACQ officers who have completed 4 CYOS, 19.5% will attrit before 5 CYOS. The curve levels out from 10-20 CYOS. This can be ascribed to completion of more than half the years of service required towards earning the prestigious and financially rewarding military retirement.

LOG Officers

The LOG career field includes officers with jobs in aircraft maintenance, munitions and missile maintenance, and logistic readiness officers. These officers compromise 11.2% of the officers considered in this analysis. Regression results revealed that Gender, Prior Enlisted Service, and DG are significant factors that predicted officer retention. The LOG population of 203 officers in 2014 with 0 CYOS requires 15 of the 20 possible survival functions. Each of the applicable survival functions is weighted by its respective proportion of the LOG population to produce the predicted LOG end strength shown in Figure 5 below.

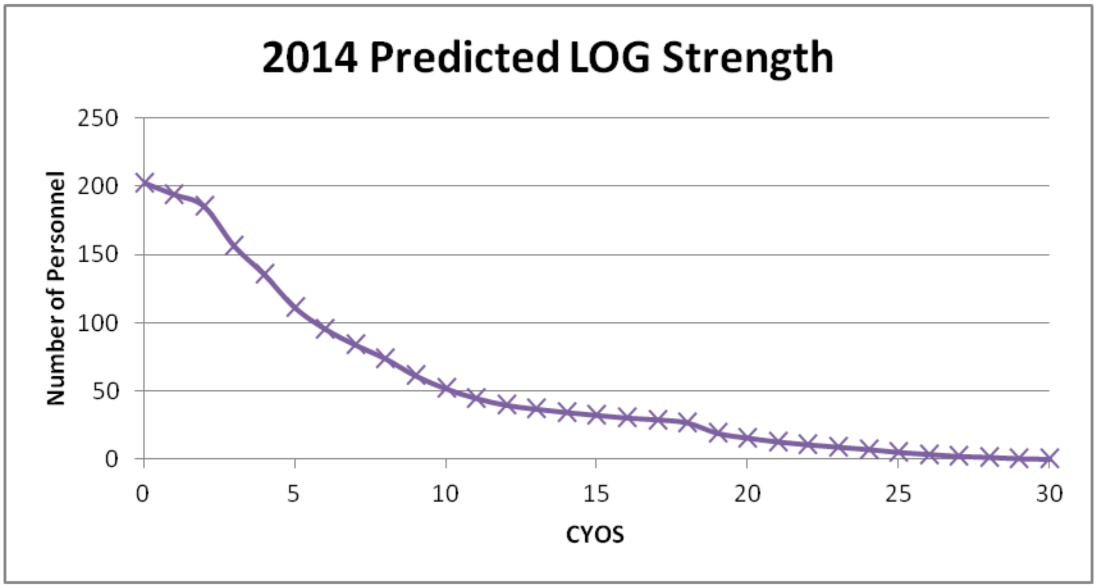

Figure 5. 2014 Predicted Logistics Strength

The chart displays high retention for 0-2 years, when members are newly commissioned and formally committed to a service obligation. However, similar to the ACQ population, a significant amount of attrition is seen near 5-6 CYOS when members complete their initial ADSC and have their first opportunity to separate. The model predicts that of those LOG officers who have completed 4 CYOS, 17.8% will separate prior to completing 5 CYOS. The curve levels out from 10-20 CYOS.

Although all four career fields studied had survival functions with similar shapes, LOG officers tended to have higher retention rates than the other three career fields studied, although only slightly so.

NRO Officers

The NRO career field includes officers who work in control and recovery, air liaison, airfield operations, space and missiles, intelligence, weather, and cyberspace operations. These officers compromise 43.7% of the total number of officers considered in this analysis. Regression results reveal that Gender, Commissioning Source, Prior Enlisted Service, and DG are significant factors that predicted retention. The population of 796 NRO officers in 2014 with 0 CYOS required 31 of the potential 60 survival functions. Each of the applicable survival functions is weighted by its respective proportion of the NRO population to produce the predicted NRO end strength shown in Figure 6 below.

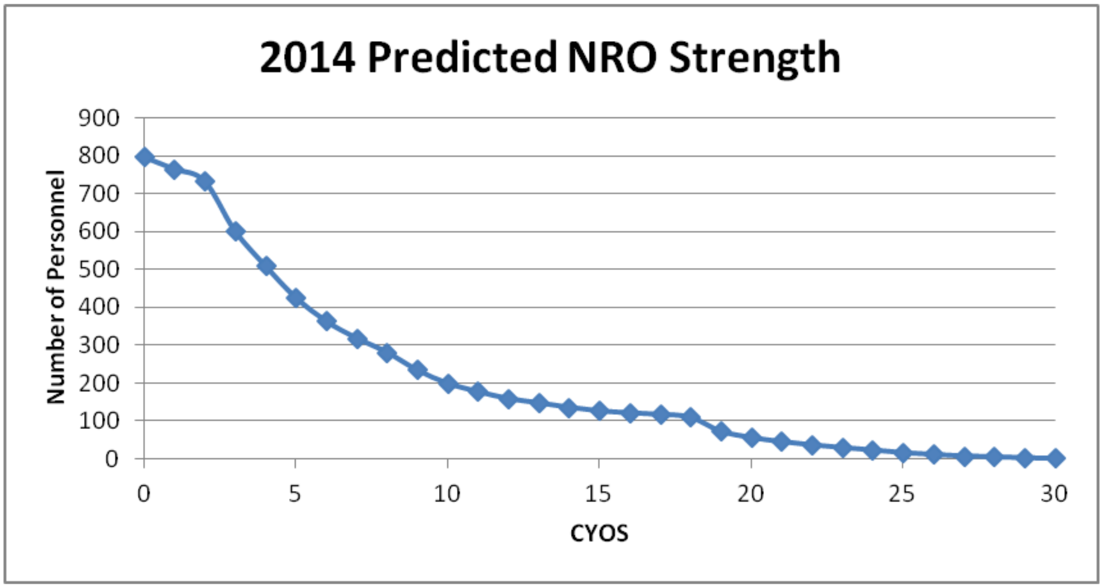

Figure 6. 2014 Predicted Non-Rated Operations Strength

As expected, NRO officers have low attrition during the period of their initial ADSC, and then attrition rises after that. The model predicts that of those NRO officers who have completed 4 CYOS, 16.4% will separate prior to completing 5 CYOS (i.e., the slope between 4-5 CYOS). The curve stays fairly flat from 10-18 CYOS and from 19-30 CYOS.

SPT Officers

The SPT career field includes officers who work in security forces, civil engineering, communications and information, band, public affairs, force support, and personnel.

These officers compromise 12.5% of the total number of officers considered in this analysis. Regression results show that Gender and DG are significant factors to predicted retention in this career field. The population of 227 SPT officers in 2014 with 0 CYOS required the use of all 4 of the potential SPT survival functions, which is not surprising as it is a large number of officers to categorize, and each significant factor (gender, DG) has only 2 levels. Each of the applicable survival functions is weighted by its respective proportion of the SPT population to produce the predicted SPT end strength shown in Figure 7 below.

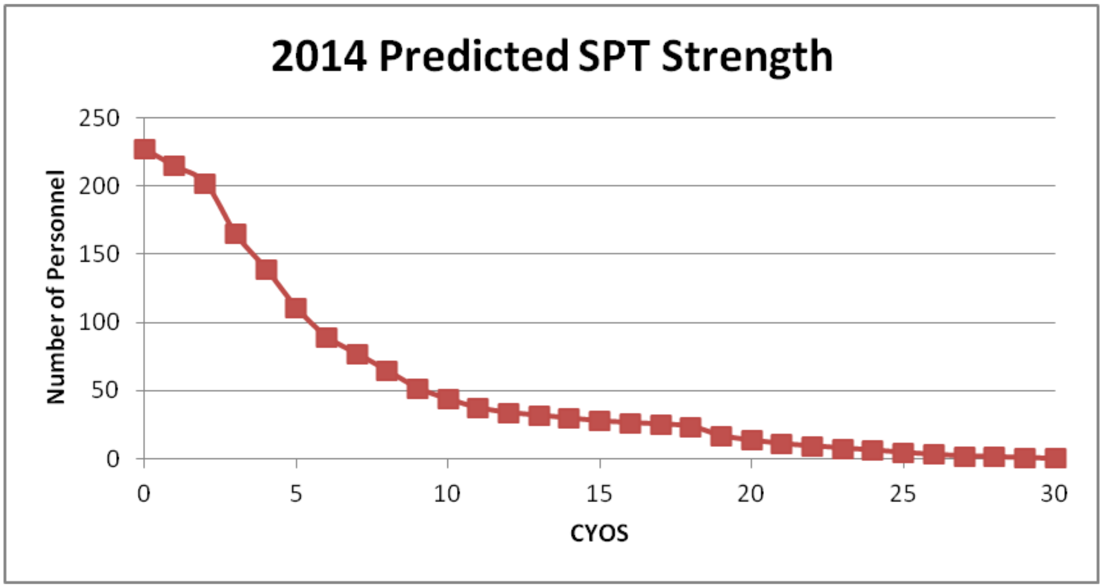

Figure 7. 2014 Predicted Support Strength

For 10 out of the first 11 years of service, the SPT career field has the highest attrition rates of the four fields considered. However, for the remaining years (12-30 CYOS), the SPT attrition rate is similar to that seen in the other career fields. Analogous to the other fields, SPT officers retain well as expected while completing their initial ADSC, and then retention declines as those commitments expire. The model predicts that of those SPT officers who have completed 4 CYOS, 20.5% will separate prior to completing 5 CYOS (i.e., the slope between 4-5 CYOS). The curve levels out from 10-20 CYOS.

5.3 Coefficient of Variation

5.3.1 Background

Statisticians need data statistics that are both accurate and useful to describe different populations. In this research, we recommend using the Coefficient of Variation as a new metric to compare the retention behavior of different career fields.

Standard deviation is considered as a potential metric because it measures the spread of a data set. A low standard deviation (near zero) indicates that the data is mostly homogenous with little variation; most of the data points are clustered near the mean. A high standard deviation signifies the data is more disparate, and the data points are more spread out, or farther from the mean.

While the measure of standard deviation can be a helpful tool to see the spread of personnel inventory within a single career field, its utility is limited when comparing the standard deviations of two or more career fields because the groupings have largely different base population sizes, as is the case with career field inventories.

When standard deviation is used to compare retention behavior, the career fields with the largest populations (with 2015 inventory ranging from 1,459 to 3,364 officers) have the highest standard deviation (27.3 to 42.6), and the career fields with the smallest populations (2015 inventory ranging from 19 to 247 officers) have the lowest standard deviations (0.7 to 2.7), as is expected. Therefore, standard deviation can only shed light when comparing different career fields if each is scaled by the population size it represents. Therefore, the coefficient of variation is recommended as an alternate metric to characterize career field health.

5.3.2 Analysis

The coefficient of variation displays its utility through this analysis. Division by the respective mean population standardizes the measure so career fields of different size can be compared.

It is defined as:

$$c_v = \frac{\sigma}{\mu}$$

where σ is the population standard deviation and μ is the population mean, both across 14 years of data from 2002-2015.

The data extracts provided by AF/A1 contain over 35,000 rows of personnel inventory data for each calendar year, CYOS and career field. We write a VBA program as seen in Appendix B to select out only the data fields desired for analysis, manipulate them into 23 matrices, each 29x14 (1-29 CYOS, and 14 years covered between 2002-2015), and then calculate data statistics for each CYOS and career field combination. This program is run for 23 career fields. While many statistics are analyzed and considered for utility, coefficient of variation is determined to be the most useful to personnel analysis.

The VBA code calculates and compares the coefficients of variation between each combination of CYOS and career field, leading to 696 total coefficients of variation. Each one represents a unique combination of each of 23 career fields and each CYOS from 1-29 years.

Next we took the average over 1-29 CYOS to get one mean c_v for each AFSC. Of the 23 individual career fields considered in the Acquisition, Logistics, Support and

Non-rated Operations career fields, those with the highest average coefficient of variation are listed in Table 4 below, from largest to smallest.

Table 4. Career Fields with Highest Mean Coefficient of Variation

AFSC		mean c_v
13L	Air Liasion Officer	29.8%
35B	Band	16.7%
13D	Control and Recovery	14.5%
35P	Public Affairs	14.1%
61C	Chemist	14.0%

High variation can cause high personnel management costs. Since the Air Force only promotes from within, in order to maintain stability at the higher ranks and grow leaders within every career field, the Air Force has to retrain (at a cost) and crossflow officers into those career fields with high attrition rates, high variation, and less stability.

This metric can be applied to conclude that in order to save money and promote stability, career fields with a high coefficient of variation should be monitored more closely by Career Field Managers.

High variation may be caused by a number of effects, including high crossflow into or out of that career field, low annual retention, offers of active duty service commitment waivers, or higher than average and/or repeated downsizing due to Force Shaping, Reduction in Force, or Temporary Early Retirement Authority programs, relative to other career fields.

Additionally, these career fields could be studied further to separate out characteristics unique to each individual career field that cause the large amount of variation. They could be investigated to determine if the high variation is caused by lack of long-term career prospects, absence of visible high-ranking officers in that field, high deployment rates, low quality of life, or any of the other myriad of reasons that are hypothesized to cause variation.

Further, the career fields with the lowest average coefficient of variation are listed below in Table 5, ordered from smallest to largest.

Table 5. Career Fields with Lowest Mean Coefficient of Variation

AFSC		mean c_v
14N	Intelligence	6.4%
15W	Weather	8.3%
17D	Cyberspace Operations	8.6%
62E	Developmental Engineer	8.7%
32E	Civil Engineer	8.7%

The metric can be applied in a similar manner with these different results. When compared to the other career fields considered, the listed career fields demonstrate the least amount of variation and it can be concluded that certain aspects of these fields may foster stability. Notably, Intelligence (14N) has the lowest average CV because it had consistently low variation for every year from 1-19 years.

One additional consideration is that every career field studied exhibited higher mean coefficients of variation after 20 years than they did before 20 years, which can be expected due to the nature of military retirement.

Both high and low variation could be due to causes by service members or by Air Force personnel management policies. Variation (or stability) initiated from the service members could be an indicator of members' perception of career advancement opportunities (or lack thereof), the quality and nature of their professional environment and the impact (either positive or negative) of their career on their family life. However, variation (or stability) triggered by personnel management policies could be caused by downsizing due to Force Shaping, Reduction in Force, or Temporary Early Retirement Authority programs, that are much higher or lower relative to other career fields. Additionally, force management policies could prevent members from crossflowing out of consistently undermanned career fields, and specific skill or experience requirements (e.g., a nuclear engineer degree) could prevent members from crossflowing into these career fields.

In addition to calculating a mean coefficient of variation for each career field, we looked at the standard deviation of the range of c_v values. The career fields where the c_v metric varies the most are listed below from greatest to least in Table 6.

Table 6. Career Fields with Highest Standard Deviation of Coefficient of Variation

AFSC		standard deviation of c_v
61C	Chemist	6.9%
61A	Operations Research Analyst	5.8%
13M	Airfield Operation	5.7%
64P	Contracting	5.6%
13D	Control and Recovery	5.2%

If the coefficient of variation of an AFSC can be thought of as a stability measure for a particular career field, then the standard deviation of c_v may be perceived as the variability of that stability measure. An AFSC that displays low stability (i.e., high mean c_v) and high variation within that stability (high standard deviation of c_v) will likely require active monitoring, persistent oversight, and perhaps frequent intervention to ensure that career field is properly manned.

On the other hand, an AFSC that exhibits both high stability (i.e., low mean c_v) and little variation in that stability (low standard deviation of c_v) will be one that requires less monitoring and oversight. It is perhaps one that requires fewer personnel actions such as retainment bonuses or force shaping initiatives in order to manage the career field health. The AFSCs with the lowest standard deviations of the coefficient of variation are listed below, ordered from smallest to greatest.

Table 7. Career Fields with Lowest Standard Deviation of Coefficient of Variation

AFSC		standard deviation of c_v
17D	Cyberspace Operations	2.0%
63A	Acquisition Manager	2.4%
15W	Weather	2.5%
13S	Space and Missile	2.6%
61B	Behavioral Science/Human Scientist	2.6%

Finally, we present the 95% confidence interval for the mean c_v as defined earlier. As noted in Table 4, Air Liaison Officer (13L) exhibits a mean coefficient of variation significantly higher than the other AFSCs. The remaining career fields fall into the range of a mean c_v of 6.4-16.7%.

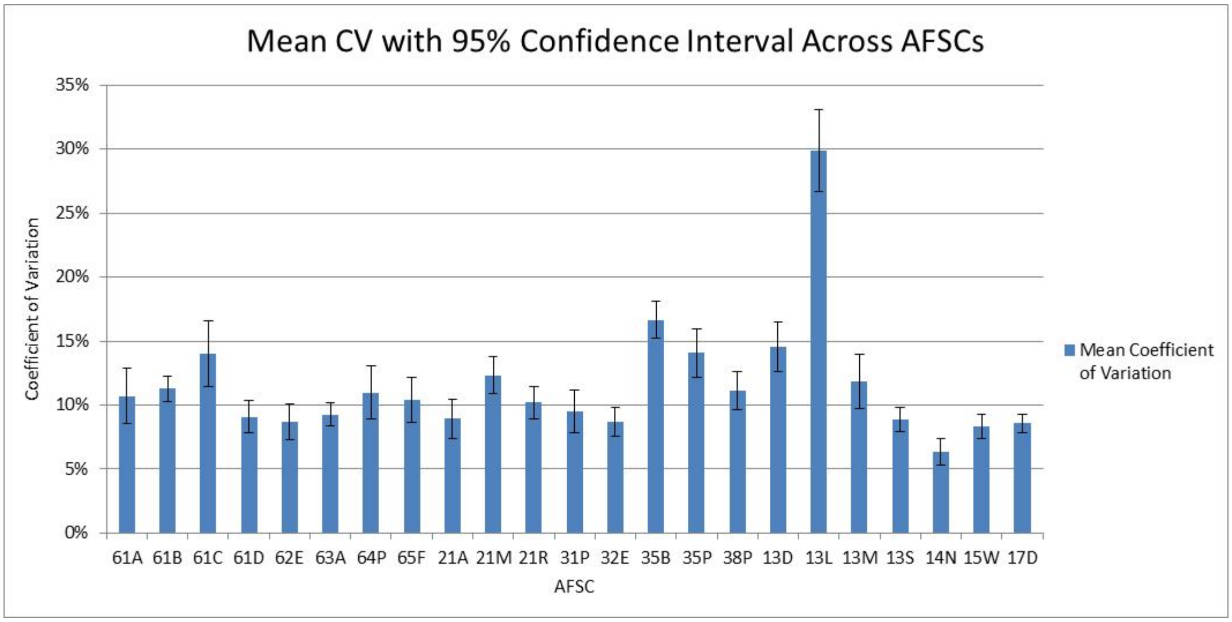

Figure 8. 95% Confidence Interval on Mean Coefficient of Variation Across AFSCs

The measures of mean and standard coefficient of variation suggested in this analysis can be used to better manage personnel levels in the Acquisition, Logistics, Non-rated Operations, and Support career fields.

VI. Conclusion

6.1 Limitations of Work

The goal of this work is to provide insight to decision makers and personnel management officers for a specific subpopulation. This study investigated officer retention behavior of the Acquisition, Logistics, Non-Rated Operations, and Support officer career fields within the U.S. Air Force. Each survival function applies directly to its respective career field and cannot necessarily be extrapolated to apply to other Air Force career fields. For example, there are significant differences in the operations tempo, deployment schedule, work environment and lifestyle aspects between healthcare professionals, rated personnel and the flying community, and the career fields studied. It can reasonably be assumed that these factors play a role in attrition behavior, and consequently the survival functions, metrics, observations, and analysis should not be generalized to career fields other than those studied.

6.2 Follow-On Research

Recommended additional research could include conducting regression and survival analysis for other Air Force subpopulations, such as rated officers, healthcare workers, enlisted personnel, or others.

Further research could include further study into the unique features of the career fields with high mean coefficients of variation to determine if there are aspects that can be controlled. On the contrary, a study of the Intelligence career field, i.e., the one with the lowest coefficient of variation, may provide valuable insight into if any policies, strategies or conditions could be duplicated to decrease variation in other career fields.

Another follow-on study could conduct an updated regression and survival analysis after the new military retirement system [25], proposed to go into effect in Jan 2018, has been around for a few years. The new system shifts away from the existing retirement plan that delivers a pension only after members complete 20 years of service, and offers benefits for those who separate before the 20-year point. This could have a notable impact on retention rates for those officers with between 10-20 commissioned years of service.

Additionally, future work could include utilizing a different method, such as simulation, to predict attrition behavior, and then comparing the results to this work for accuracy.

All of these opportunities could provide keen insight on retention behavior to manpower analysts and senior decision makers. Future characterization work in this field can provide valuable knowledge and have a positive impact on USAF personnel management policies.

6.3 Conclusion

Given that survival analysis provides transparency, ease of use, and relative accuracy, it offers a useful methodology to predict Air Force officer personnel strength in the given career fields.

Additionally, the coefficient of variation is a useful metric to identify those career fields where personnel levels are comparatively the most stable year to year, as well as those that are the most volatile. Those with high variation are likely to operate in a stressed, shortfall capacity more often due to lack of predictability, and they may benefit from additional monitoring.

Improved predictions of officer retention can help senior leadership identify force structure problems sooner and develop policies to minimize the use of costly tools such as bonuses, downsizing and early retirement options, to achieve the desired force levels. The ability to better understand retention behavior via accurate models and metrics can both save funds and help provide the optimal end strength.

Appendix A. VBA Code for Survival Analysis.

```
'Author: Maj Christine Zens

Option Explicit

Public Sub Survival_Numbers()
Dim Num_Functions As Integer
Dim myrow As Integer
Dim mycol As Integer
Dim popn As String
Dim i As Integer
Dim j As Integer
Dim k As Integer
Dim m As Integer
Dim lastentry As Integer
Dim q As Integer
Dim countcol As Integer

For m = 1 To 4
   Num_Functions = 0
   myrow = 2
   mycol = 13 'col M

   If m = 1 Then
   popn = "SURV_ACQ"
   lastentry = 585
   countcol = 38 'Col AL is 20144
   End If

   If m = 2 Then
   popn = "SURV_LOG"
   lastentry = 621
   countcol = 43 '"AQ is 2014"
   End If

   If m = 3 Then
   popn = "SURV_NRO"
   lastentry = 801
   countcol = 57 'CE is 2014
   End If

   If m = 4 Then
```

```
    popn = "SURV_SPT"
    lastentry = 125
    countcol = 27 'AA is 2014
    End If

    Sheets(popn).Activate
    Sheets(popn).Select

    For i = 2 To lastentry
        If Sheets(popn).Range("G" & i) = 0 Then
        Num_Functions = Num_Functions + 1
            mycol = mycol + 1

          Call Match_Counts_with_Survival_Curves(popn, lastentry, mycol, countcol)
        End If
    Next i

    Sheets(popn).Range("L1") = Num_Functions & " fxns"
    Sheets(popn).Range("M1") = "CYOS"

    For k = 2 To 32
    Sheets(popn).Range("M" & k) = k - 2
    Next k

    Sheets(popn).Range("M33") = 37 'last year (year 31)
    MsgBox popn & " Complete"
Next m

End Sub

Public Sub Count_People()
Dim myrow As Integer
Dim i As Integer
myrow = 2

Sheets("VALIDATION_COUNTS").Activate
Sheets("VALIDATION_COUNTS").Select

For i = 2 To 3280
    If Sheets("VALIDATION_COUNTS").Range("F" & i) = 0 Then
        Sheets("VALIDATION_COUNTS").Range("K" & myrow) =
Sheets("VALIDATION_COUNTS").Range("A" & i)
        Sheets("VALIDATION_COUNTS").Range("L" & myrow) =
Sheets("VALIDATION_COUNTS").Range("B" & i)
```

```
        Sheets("VALIDATION_COUNTS").Range("M" & myrow) =
Sheets("VALIDATION_COUNTS").Range("C" & i)
        Sheets("VALIDATION_COUNTS").Range("N" & myrow) =
Sheets("VALIDATION_COUNTS").Range("D" & i)
        Sheets("VALIDATION_COUNTS").Range("O" & myrow) =
Sheets("VALIDATION_COUNTS").Range("E" & i)
        Sheets("VALIDATION_COUNTS").Range("P" & myrow) =
Sheets("VALIDATION_COUNTS").Range("F" & i)
        Sheets("VALIDATION_COUNTS").Range("Q" & myrow) =
Sheets("VALIDATION_COUNTS").Range("G" & i)
        Sheets("VALIDATION_COUNTS").Range("R" & myrow) =
Sheets("VALIDATION_COUNTS").Range("H" & i)
        Sheets("VALIDATION_COUNTS").Range("S" & myrow) =
Sheets("VALIDATION_COUNTS").Range("I" & i)
        myrow = myrow + 1
    End If
Next i
End Sub

Public Sub Match_Counts_with_Survival_Curves(popn, lastentry, mycol, countcol)

Dim checkrow As Integer
Dim n As Integer
Dim p As Integer
Dim q As Integer
Dim count As Integer
Dim pplcount As Integer

checkrow = 2
count = 0

pplcount = 0

    For p = 2 To 35
        If Sheets(popn).Cells(1, mycol) = Sheets(popn).Cells(p, countcol + 1) Then
            pplcount = pplcount + Sheets(popn).Cells(p, countcol)
            count = count + 1
        End If
    Next p
    Sheets(popn).Cells(38, mycol) = pplcount
End Sub
```

Appendix B. VBA Code for Stress Metric Analysis.

```
'Author: Maj Christine Zens

Option Explicit

Dim CoreID()
Dim Current_Sheet As String
Dim CYOS As Long
Dim Count As Long
Dim Year As Long
Dim i As Long
Dim j As Long
Dim k, m, n, Test, p As Long
Dim CoreNew As String
Public Sub Main_Program()

'CoreID = Array("61A", "61B", "61C", "61D", "61S", "62E", "63A", "64P", "65F")
'ACQ...0 TO 8
'CoreID = Array("21A", "21M", "21R") 'LOG...0 TO 2
'CoreID = Array("31P", "32E", "35B", "35P", "38P") 'SPT...0 TO 4
'CoreID = Array("13D", "13M", "13S", "14N", "15W", "17D") 'NRO...0 TO 5
'CoreID = Array("61A", "61B", "61C", "61D", "61S", "62E", "63A", "64P", "65F",
"21A", "21M", "21R", "31P", "32E", "35B", "35P", "38P", "13D", "13M", "13S", "14N",
"15W", "17D")
'CoreID = Array("21M", "21R") 'LOG...0 TO 2

Sheets("CYOS Inv").Activate
Sheets("CYOS Inv").Select

For p = 0 To 23
Current_Sheet = CoreID(p)

Call Delete_Old_Sheets

Worksheets.Add.Name = Current_Sheet "this one works

Call Organize_Data
Call Get_Stats
Call Clean_Data_Statistics(Current_Sheet)
Call Summary

Next p
```

```
End Sub
Public Sub CV()
Dim t, u, stdev, mean As Long

Dim CoreID()

CoreID = Array("61A", "61B", "61C", "61D", "62E", "63A", "64P", "65F", "21A",
"21M", "21R", "31P", "32E", "35B", "35P", "38P", "13D", "13L", "13M", "13S", "14N",
"15W", "17D")

For t = 0 To 22

    Current_Sheet = CoreID(t)
    Sheets(Current_Sheet).Activate
    Sheets(Current_Sheet).Select
    Sheets(Current_Sheet).Range("AD1") = "CV"

    For u = 2 To 30
        If Sheets(Current_Sheet).Range("AC" & u) <> 0 Then
        mean = Sheets(Current_Sheet).Range("Q" & u)
        stdev = Sheets(Current_Sheet).Range("R" & u)
        Sheets(Current_Sheet).Range("AD" & u) = stdev / mean
        End If
    Next u

    Sheets(Current_Sheet).Range("AD2").Select
    Range(Selection, Selection.End(xlDown)).Select
    Selection.Copy
    Sheets("CV").Select
    Cells(2, t + 2).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

    Sheets("CV").Cells(1, t + 2) = Current_Sheet

Next t

End Sub

Public Sub Summary()
Dim r, s As Long

'Current_Sheet = "21M"
r = 0
```

```
s = 2
Do Until r = 1
        If Sheets("Summary").Cells(s, 1) = "" Then
            'Paste name of AFSC in first col
            Sheets("Summary").Cells(s, 1) = Current_Sheet
            'Paste statistics for that AFSC
            Sheets(Current_Sheet).Activate
            Sheets(Current_Sheet).Select

            Sheets(Current_Sheet).Range("Q32").Select
            Range(Selection, Selection.End(xlToRight)).Select
            Selection.Copy
            Sheets("Summary").Select

            Cells(s, 2).Select
            Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
                :=False, Transpose:=False
            Range("A1").Select
            r = 1

        End If
        s = s + 1
Loop

    Sheets("Summary").Range("B2").Select
    Sheets("Summary").Range(Selection, Selection.End(xlToRight)).Select
    Sheets("Summary").Range(Selection, Selection.End(xlDown)).Select
    Selection.NumberFormat = "0.0"
    Columns("B:N").Select
    Columns("B:N").EntireColumn.AutoFit

End Sub

Public Sub Delete_Old_Sheets()
         ' deletes old Sensitivity reports if they exist
Dim sht As Object

Application.DisplayAlerts = False
'MsgBox "About to delete old sheets", vbOKCancel

    For Each sht In Worksheets
    If sht.Name = Current_Sheet Then
    'MsgBox "Press OK to delete " & Current_Sheet & " and create new sheet",
vbOKCancel
    Sheets(Current_Sheet).Delete
```

```
End If
   Next
Application.DisplayAlerts = True

End Sub
Public Sub Organize_Data()

Sheets(Current_Sheet).Activate
Sheets(Current_Sheet).Select

'Put AFSC in A1
Sheets(Current_Sheet).Cells(1, 1) = Current_Sheet

'Put CYOS in first col
For j = 2 To 30
   Sheets(Current_Sheet).Range("A" & j) = j - 1
Next j

'Put years in first row
For k = 2 To 15
   Sheets(Current_Sheet).Cells(1, k) = k + 2000
Next k

'MsgBox "Years and CYOS done"
For i = 2 To 35057 '35057
   CoreNew = Sheets("CYOS Inv").Range("A" & i)
   CYOS = Sheets("CYOS Inv").Range("B" & i)
   Count = Sheets("CYOS Inv").Range("C" & i)
   Year = Sheets("CYOS Inv").Range("D" & i)

   'check for correct AFSC
   If Sheets("CYOS Inv").Range("A" & i) = Sheets(Current_Sheet).Cells(1, 1) Then
      'check for correct year
      For n = 2 To 15
         If Year = Sheets(Current_Sheet).Cells(1, n) Then 'it's correct column/year
            'check for correct CYOS
             For m = 2 To 30
                If CYOS = Sheets(Current_Sheet).Range("A" & m) Then
                   Sheets(Current_Sheet).Cells(CYOS + 1, n) = Count
                End If
             Next m
         End If
      Next n
   End If
Next i
```

```
End Sub


Public Sub Get_Stats()
'Current_Sheet = "6X"
'Current_CoreID = "61A"
Sheets(Current_Sheet).Activate
Sheets(Current_Sheet).Select

    Application.Run "ATPVBAEN.XLAM!Descr", ActiveSheet.Range("$A$2:$O$30"),
_
      ActiveSheet.Range("$A$32"), "R", True, True
End Sub

Public Sub Clean_Data_Statistics(Current_Sheet)
Dim lookcol As Long
Dim printcol As Long
Dim printrow As Long
'Dim Current_Sheet As String
Dim lowrow As Long
Dim lowcol As Long
Dim test1 As String
Dim MyCol As String
Dim q As Long

'Current_Sheet = "6X"
lowrow = 34
lowcol = 2

'print headings mean, std error, etc.
   For printcol = 17 To 29
      Sheets(Current_Sheet).Cells(1, printcol) = Sheets(Current_Sheet).Range("A" &
lowrow)
      lowrow = lowrow + 1
   Next printcol
 'MsgBox "Headings done"
   lowrow = 34
   For printrow = 2 To 30
     lowrow = 34
         For printcol = 17 To 29
            Sheets(Current_Sheet).Cells(printrow, printcol) =
Sheets(Current_Sheet).Cells(lowrow, lowcol)
            lowrow = lowrow + 1
         Next printcol
```

```
   lowcol = lowcol + 2
   Next printrow

Sheets(Current_Sheet).Range("A32:BF46") = ""
Sheets(Current_Sheet).Range("P32") = "Avg"

For q = 17 To 29
   MyCol = Sheets(Current_Sheet).Cells(32, q).Address '$AQ$32

   If q > 26 Then
   MyCol = Left(MyCol, 3)
   MyCol = Right(MyCol, 2)
   Else
   MyCol = Left(MyCol, 2)
   MyCol = Right(MyCol, 1)
   End If

   Sheets(Current_Sheet).Cells(32, q) = "=AVERAGE(" & MyCol & "2:" & MyCol &
"30)"
   Next q
   Sheets(Current_Sheet).Range("Q32").Select
   Range(Selection, Selection.End(xlToRight)).Select
   Selection.NumberFormat = "0.0"
End Sub
```

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14. ABSTRACT
The Air Force monitors the strength of its active duty officer force and attempts to achieve the difficult challenge of employing a diversity of talent among career specialties and experience levels. This study completes two objectives, predicting future manning levels for 23 career fields, and providing a statistical framework to assess the stability of these fields. The first part of the study applies regression and survival analysis to subpopulations within the active duty Air Force officer corps, and then aggregates them by year to forecast future personnel levels. Acquisitions (ACQ), Logistics (LOG), Support (SPT), and Non-Rated Operations (NRO) career fields are considered. Based on the set of officers who commissioned within these career fields in 2014, this analysis predicts the number of personnel who will remain in each of these fields over the next 30 years.
The second part of the study measures the stability of career fields through calculation and comparison of the mean and standard deviation values for the coefficients of variation. These results can be applied to decrease personnel management costs and enhance understanding of officer behavioral patterns, thereby improving the way that USAF leadership manages its personnel.

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