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Tara L. Terry, Albert A. Robbert, John E. Boon, Jr., Perry Shameem Firoz,  
S. Craig Moore

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RAND Project AIR FORCE

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## Preface

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United States Air Force career field managers (CFMs) annually predict the number of billet vacancies that will require an officer who holds an advanced academic degree (AAD). The process requires CFMs to predict specific vacancies three to five years before they occur, which can be difficult and produces inaccuracies that can lead to a shortfall of officers qualified to fill positions that require an AAD or to an oversupply of officers with AADs, which unnecessarily increases Air Force costs.

RAND Project AIR FORCE examined the Air Force process for producing, allocating, and assigning officers with master's and doctorate degrees. This report presents findings on the extent to which the number of personnel who earned master's and doctorate degrees from fiscal years (FYs) 2000 through 2010 matched billet requirements in terms of degree level and academic specialty. It also provides a methodology for determining the required production level of officers who earn AADs and serves as a user's guide for the modeling tools that illustrate the methodology. These modeling tools will aid the Air Force Education Requirements Board (AFERB) in allocating quotas to career fields and academic institutions and should be used in conjunction with other important criteria, such as budgetary constraints and Air Force Chief of Staff priorities. Additionally, these modeling tools will aid CFMs in deciding which academic specialties are needed in the near future within their career field.

This work was sponsored by the Director, Force Development, Deputy Chief of Staff for Manpower, Personnel and Services, Headquarters United States Air Force (HQ USAF/A1D) and conducted within the Manpower, Personnel, and Training Program of RAND Project AIR FORCE as part of the fiscal year 2011 study "Enhancing Force Management and Development." The modeling tools described in this report can be obtained from the lead author upon request (contact Tara Terry at [tterry@rand.org](mailto:tterry@rand.org)).

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## Summary

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The United States Air Force's current process for producing advanced academic degrees (AADs) requires career field managers (CFMs) to predict specific AAD-coded billet vacancies three to five years before they occur and then submit these requirements to the Air Force Education Requirements Board (AFERB) to fill those projected vacancies. Based on the reported vacancies and other criteria (such as the Chief of Staff's priorities), the AFERB provides quota allocations;<sup>1</sup> any CFM requirements that do not receive a quota allocation become unfunded quota requirements. After an officer earns an AAD, the Air Force Personnel Center assigns the officer to an AAD-coded billet vacancy. The ideal result should be a 100 percent match rate between the Air Force-funded AADs earned by officers and the education requirements of the corresponding AAD billet vacancies, irrespective of the number of funded quota allocations allotted at the AFERB.

However, our analysis of 8,447 AAD assignments for officers who earned AADs from FY2000 through FY2010 shows that only 58 percent of officer assignments to master's degree billets and 33 percent of officer assignments to doctorate degree billets were made such that the officer's degree level and academic specialty matched the billet requirement. One reason for the low percentage of proper assignments is that the AAD assignment process does not deliberately match officers who have previously earned an AAD to unfunded quota requirements. Furthermore, our analysis points to a lower-than-desired utilization rate of officers who have earned Air Force-funded AADs.

Our analysis also shows that the career points at which personnel earn AADs are misaligned with the AAD billet grade structure. An analysis of FY2010 data shows that the number of personnel with Air Force-funded master's degrees falls short of requirements in early years of service, but exceed requirements by the sixth year of service. Similarly, the number of personnel with Air Force-funded PhDs falls short of requirements until the grade of O-5. The majority of Air Force-funded master's and doctorate degrees are earned by O-3s and mature O-4s, respectively, making the filling of lower-grade requirements for these degrees with personnel in the designated grades infeasible. This misalignment contributes to the difficulty of placing officers holding the right AADs into the proper AAD-coded billets.

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<sup>1</sup> A quota allocation provides tuition dollars and student man-years for an officer to volunteer to earn a specific AAD and ultimately fill the previously identified billet vacancy.

To aid the current AFERB process, RAND created modeling tools that use historically derived tenure in AAD-coded billets to estimate the required AAD production and to recommend an initial distribution of quota allocations to Air Force specialty codes (AFSCs) and academic institutions based on the number of AAD-coded billets on the unit manning document (UMD); these modeling tools are to be piloted in the FY14 AFERB. The models' outcomes corroborated the analysis and findings discussed above.

## Recommendations

While RAND's model estimates a gap between the number of quota allocations that should be funded annually and the actual number of funded quota allocations in recent years, it is unlikely that increased funding will become available to reduce that gap. Consequently, our recommendations focus on reducing the level of AAD production currently needed to meet requirements by more effectively using personnel with AADs. Our specific recommendations are as follows:

- **Modify the assignment process by placing a higher priority on matching personnel with AADs to AAD billets.** The Air Force can increase the return on its investment in graduate education by more deliberately matching officers who have earned AADs to unfunded quota allocations.
- **Examine whether the grade structure of AAD billets can be adjusted to better match the supply of personnel with AADs and/or fund AADs earlier in officers' careers.** Alignment of these two factors (grade requirements and when officers earn AADs) could allow for a higher utilization rate of Air Force-funded AADs and increased tenure in AAD positions.
- **Increase tenure in AAD billets after graduation to reduce the AAD production requirement.** The model results indicate that O-4s spend less time in AAD-coded billets versus other grades overall: 1.41 man-years in master's degree and 2.3 man-years in PhD positions, respectively, versus a minimum of 2.3 man-years in master's degree and 2.6 man-years in PhD positions in the other grades.



## Acknowledgments

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We'd like to thank several people in the Air Force for their direction and guidance in developing and conducting this research. Our sponsor, Mr. Daniel Sitterly (AF/A1D), was instrumental in providing us with periodic policy implications of our work as well as aspects of the AFERB to consider in creating the modeling tools and our recommendations. We'd also like to thank those in the AF/A1DLE (Education Development) office who have since moved to other positions but helped provide direction and contact information with regard to the participants in the advanced academic degree process, such as Capt Michael Sukach, Maj Ann Igl, and Maj Denise Emery. Mr. Martin Synger provided important budgetary information regarding the process and the limitations of the funding sources for advanced academic degrees. Lt Col Elizabeth Demmons and Dr. Vera McKethan were key proponents in providing the opportunity to pilot our modeling tools in the FY14 AFERB. Additionally, there are two people who spent many hours conversing with us, helping us understand the behind-the-scenes aspects of the AFERB process as well as the advanced academic degree process, which further strengthened our work: Air Force Acquisition, Science, Technology, and Engineering (SAF/AQR), Science and Engineering Functional Management Team Ms. Barbara Hunter and Chief of the Air University Registrar Support Branch Ms. Teresa Dearth.

We'd also like to thank several people at RAND, including William Canny, who helped conduct initial interviews regarding advanced academic degrees; Paul Emslie, who laid the ground work for the data processing that occurred in creating the modeling tools; and Sandra Petitjean for her quick work on improving the graphics contained in this document. We also thank Carl Rhodes and Lara Schmidt for the support and editing comments that greatly improved the quality of the document and, lastly, the reviewers, Paul Dreyer and Lisa Harrington, whose insights helped clarify our thinking and strengthen the document.



## Abbreviations

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AAD	advanced academic degree
ABD	all-but-dissertation
AFERB	Air Force Education Requirements Board
AFI	Air Force instruction
AFIT	Air Force Institute of Technology
AFROTC	Air Force Reserve Officer Training Corps
AFSC	Air Force specialty code
ASC	academic specialty code
AU	Air University
CFM	career field manager
EIG	earned-in grade
FY	fiscal year
MS	master's degree
MY	man-year
NPS	Naval Postgraduate School
PAF	RAND Project AIR FORCE
PhD	doctor of philosophy
PME	professional military education
SIG	served-in grade
TPS	Test Pilot School (United States Air Force)
UMD	unit manning document
USAFA	United States Air Force Academy
YOS	year of service



# 1. Introduction

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## The Current Advanced Academic Degree Process

The United States Air Force uses graduate education for dual purposes: to train officers to be critical thinkers and to fill functional requirements for advanced academic degree (AAD) requirements within the Air Force as well as requirements for new faculty. This report focuses on the functional and faculty requirements.

To meet these requirements, career field managers (CFMs) and Air Force academic institutions annually

- review all their authorizations (or billets) to determine whether an AAD requirement on the billet is still valid or whether an AAD requirement should be added to the billet
- determine AAD-coded billet vacancies for all valid AAD requirements that exist three to five years out
- submit the billet vacancies as requirements to the Air Force Education Requirements Board (AFERB) to fill those projected vacancies.

The AFERB meets annually to award quota allocations to career fields and academic institutions based on a number of criteria, including the current fiscal year (FY) monetary budget, the current FY student man-year budget,<sup>1</sup> and the Chief of Staff's top priorities.

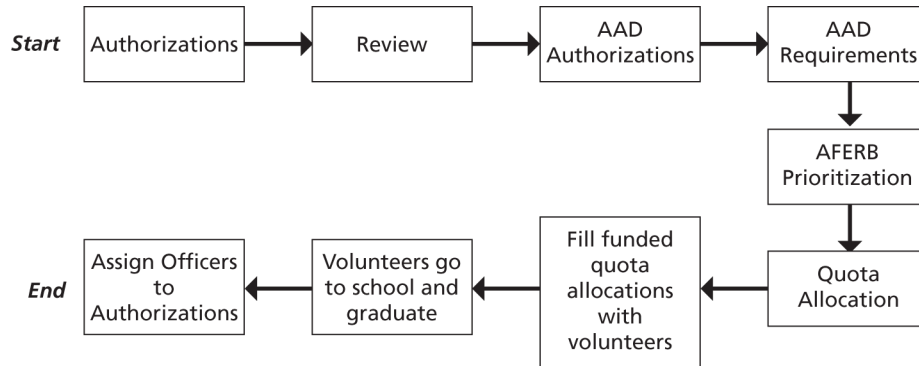
Once funded quota allocations are allotted, a call for volunteers is sent out to officers in each career field, and qualified volunteers are then selected to go to graduate school and earn an AAD with a specific degree level and academic specialty for each funded quota allocation.<sup>2</sup> After officers are chosen and earn the Air Force–needed AAD, they are required to pay back the Air Force by serving in an AAD-coded billet within two assignments following graduation, with assignments executed by the Air Force Personnel Center. Figure 1.1 presents a generalized depiction of the current AAD process.

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<sup>1</sup> The Air Force has a student man-year budget that constrains the aggregate number of years that officers are allowed to spend going to school.

<sup>2</sup> A call is not sent out when the projected vacancy occurs at an academic institution; instead, faculty are hand-selected to earn an AAD.

**Figure 1.1. As-Is AAD Process**



RAND A9846-As Is

## Research Objectives and Approach

The Air Force asked RAND Project AIR FORCE to review the current AAD process, which is widely viewed as problematic and inefficient, and recommend procedures to improve it. To understand the effectiveness of the current process, we first performed an analysis on the payback success rate as it relates to utilization of officers and an analysis of the number of officers who have earned AADs against the number of AAD-coded billets by year of service and grade. Secondly, we developed a methodology (through the use of modeling tools) for calculating required AAD production based on the number of AAD-coded billets and historical utilization of officers for each career field and academic institution. We propose the modeling tools be used to inform the AFERB quota allocation decisions and recommend a slight modification of the current AAD process to incorporate these modeling tools.

There are two kinds of users for the two modeling tools described in this report. The *AFERB model* is intended for use by the AFERB Working Group. The model outputs the number of officers to be sent to graduate school annually—in each career field and for each academic institution—by grade and degree level but not academic discipline. The *CFM model* is intended for use by career field managers (CFMs) or faculty management representatives at academic institutions. It provides an estimate of how a career field's or academic institution's funded quota allocations should be distributed across academic disciplines by grade and degree level.

## Report Organization

The following chapters describe in detail the data analysis performed and the Excel-based modeling tools. Chapter Two provides an overview of the data used in the analysis as well as the results of the payback analysis and the comparison of personnel with Air

Force-funded AADs to the number of AAD-coded billets. Chapter Three describes the two Excel spreadsheet models, their scope, levels of input and output, methodology and sources of data, and their uses and limitations. Chapter Three provides enough detail to enable a user to use the modeling tools, evaluate the results, and support distribution of funded quota allocations in the AFERB process (for the AFERB model) or aid in determining which academic specialties are needed in each career field/academic institution (for the CFM model). Finally, Chapter Four provides our conclusions and recommendations.





## 2. Outcomes of the Current AAD Process: Analysis of Officers Earning Advanced Academic Degrees, Billet Grade Structure, and Payback Rates

---

This chapter investigates the extent to which the current AAD process matches officers who have earned Air Force–funded AADs<sup>1</sup> with the education requirements of the corresponding AAD billet vacancies to determine whether the Air Force could increase the return on its investment in its graduate education program. Additionally, this chapter investigates the effect of the grade structure of AAD-coded billet requirements and the timing of officers earning AADs to assess whether the supply and the demand are in alignment. A poor match rate between earned AADs and billet requirements and/or misalignment between grade requirements and the year of service in which the AAD is earned could affect AAD production requirements and subsequent utilization of officers with AADs.

### Roughly Half of Air Force–Funded Advanced Academic Degrees Did Not Satisfy a Payback Requirement

According to Air Force Instruction (AFI) 36-2302,<sup>2</sup> “Graduates of the funded graduate education program will normally serve in an AAD position immediately following graduation, but must serve in an AAD position no later than the second tour following completion of the funded education.”

To measure payback as defined by AFI 36-2302, we used five years as a proxy for two tours of duty. Our dataset encompasses officers who earned an advanced academic degree in FY2000 through FY2006 and any positions held during our larger dataset window of FY2000–FY2010, which resulted in 3,181 officers who have earned AADs.<sup>3</sup> If an officer earned an AAD in FY2003, we examined all positions held by this officer in FY2003 through FY2007. We ended the earned AAD window at FY2006 so we would

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<sup>1</sup> We examined only AADs that corresponded to a funded quota allocation. We did not look at AADs that were self-funded.

<sup>2</sup> AFI 36-2302, *Professional Development (Advanced Academic Degrees and Professional Continuing Education)*, Washington, D.C.: Department of the Air Force, July 11, 2001.

<sup>3</sup> In our dataset, there were many officers who earned multiple Air Force–funded AADs, each of whom thus faced multiple payback requirements.

have a complete five-year job window on which to analyze each officer and AAD to determine whether the payback requirement was satisfied. If an officer served in an AAD-coded billet that matched the degree level of the AAD earned (MS billet for an earned master’s degree<sup>4</sup>) in the five-year window, we considered the payback requirement to have been met.<sup>5</sup>

As shown in Table 2.1, the surprising result was a 50 percent match rate—that is, 50 percent of officers who earned a specific Air Force–funded master’s degree did not fill AAD jobs in the five years following graduation.

**Table 2.1. Payback Percentage on Air Force–Funded AADs**

<b>Degree Level</b>	<b>Number of AAD Job Matches</b>	<b>Total Number of Distinct People and Degrees</b>	<b>% Payback</b>
MS	1,408	2,812	50%
PhD	298	369	81%
MS + PhD	1,706	3,181	54%

NOTE: MS = master’s degree.

Table 2.2 shows that many officer assignments are made without the correct degree level and academic specialty, irrespective of grade; only 58 percent of MS assignments and 33 percent of PhD assignments are made such that the degree level and academic specialty of the earned AAD match the AAD-coded requirements of the position. To look at assignment execution of AAD-coded billets more broadly, we dropped the five-year window requirement for this analysis; thus the data used in Table 2.2 comprise officers who earned an Air Force–funded AAD during FY2000–FY2010, and we considered only AAD positions that were held in or after the fiscal year in which the AAD was earned, ending in FY2010.

<sup>4</sup> In this report, we often follow the Air Force’s convention of using “MS” as an abbreviation for “master’s degree.” (Specifically, we use “MS” in tables and figures and when using the terms as an modifier in the text, and we spell out “master’s degree” as a noun in the text.)

<sup>5</sup> The Air Force’s payback definition doesn’t require the degree level to match that of the billet requirement—an officer earning an Air Force–funded master of business administration degree (MBA), for example, could satisfy the payback requirement if assigned to a PhD position in engineering. Nonetheless, it seemed an appropriate way to disaggregate the data, as officers who have earned PhDs are handled differently by the larger Air Force than officers who have earned master’s degrees in terms of career mentoring and tenure in positions.

**Table 2.2. Proper Assignment Percentage for Air Force–Funded AADs**

<b>Degree Level</b>	<b>Number of Assignments with Proper Degree Level and Academic Specialty Code (ASC)</b>	<b>Number of Assignments (Person-Job Pairs)</b>	<b>% Proper Assignments Made</b>
MS	1,205	2,077	58.0%
PhD	149	448	33.2%

One reason for the low percentage of proper assignments is the AAD assignment process. In recent years, of approximately 800 projected AAD billet vacancies, roughly 300 funded quota allocations were distributed. The assignment process does not deliberately match officers who already have the required degree to billet vacancies that *do not receive funded quota allocations at the AFERB*. More deliberately filling AAD-coded positions (specifically, unfunded quota requirements) with an officer who has earned an AAD will greatly increase the percentage of proper assignments made.

In addition to identifying the current match rate, this payback analysis points to a lower-than-desired rate of utilization of officers who have earned Air Force–funded AADs. As we will discuss later, higher utilization rates of officers with Air Force–funded AADs, as well as AADs earned through tuition assistance and other comparable programs, would lower the required AAD production estimated by the model.

### The Grade When Officers Earn AADs and AAD Grade Structure Requirements Are Misaligned

The analysis presented in this section addresses whether the aggregate inventory of officers with AADs is sufficient to fill the AAD requirements currently on unit manning documents (UMDs) based on degree level and grade.

We identified the year of service (YOS) in which officers first earn an AAD and split the degrees earned into two funding categories: Air Force–funded (through the AFERB process) or self-pay (through tuition assistance, night school, and other comparable programs) so that we could better understand the total supply of officers who have earned AADs. Figure 2.1 shows the ten-year average percentage of officers earning their first master’s degree in each YOS. Note that the majority of master’s degrees earned are self-pay. Also, Air Force–funded MS completions spike in the sixth year of service, whereas self-pay MS completions spike either in the sixth year of service or the ninth year of service (the ninth YOS coinciding with the historical timing of promotion consideration to O-4 in the tenth YOS). There is also another spike of officers earning their first master’s degree around the 14th year of service for both Air Force–funded and self-pay

master's degrees, which coincides with the historical timing of promotion consideration to O-5 around the 15th year of service.

**Figure 2.1. Year of Service in Which Master's Degree Is First Earned, FY2000–2010**

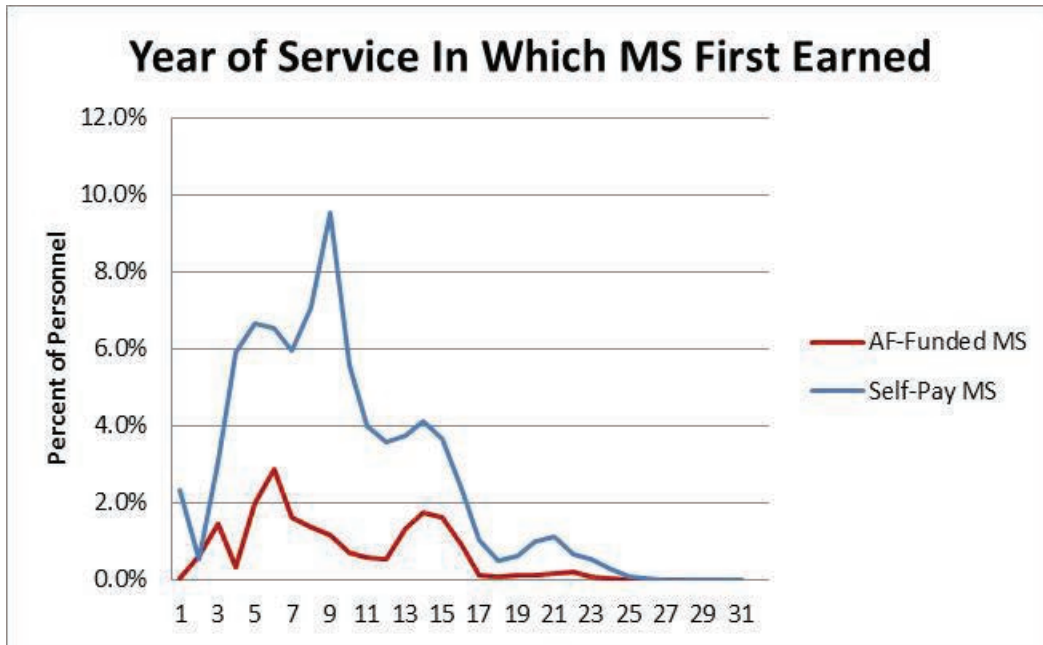
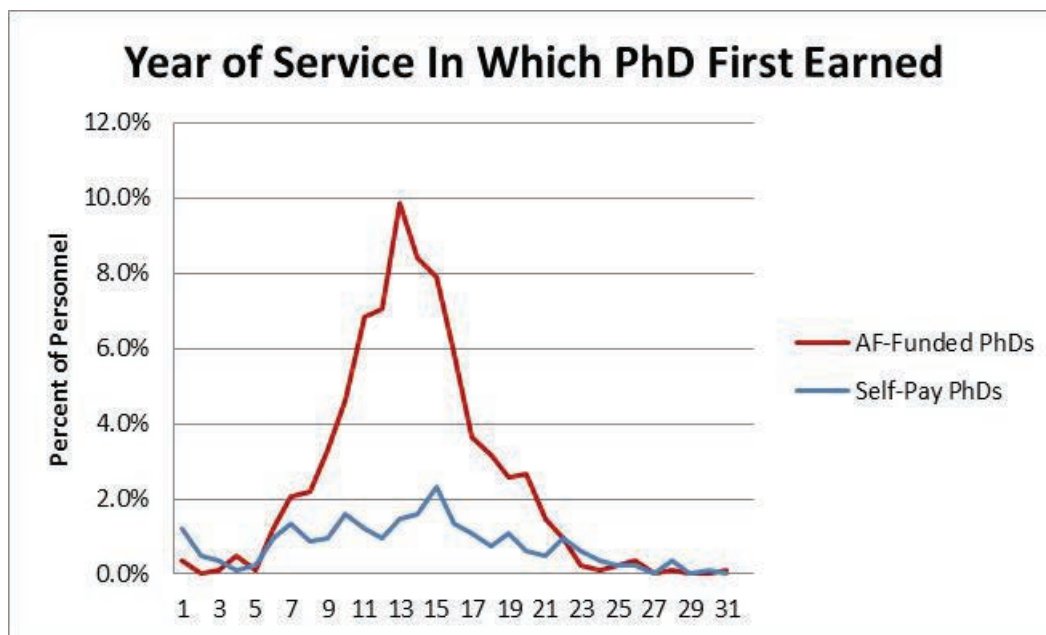


Figure 2.2 shows the ten-year average percentage of officers earning their first PhD in each YOS. Not surprisingly, very few PhDs are earned in the self-pay category. The peak years for earning a PhD are the 13th through 15th years of service, coinciding with the historical timing of promotion consideration to O-5.

Figure 2.2. Year of Service in Which PhD Is First Earned, FY2000–2010



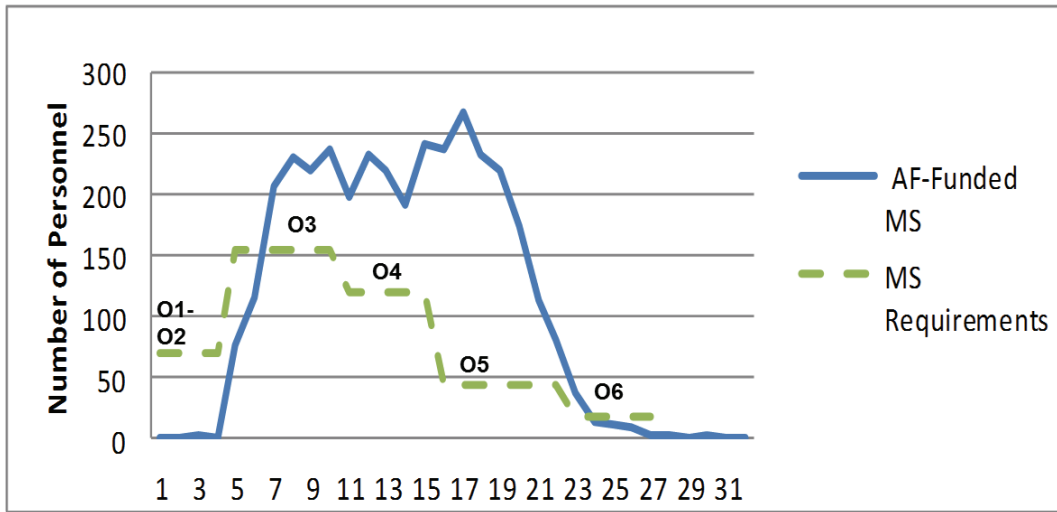
From Figures 2.1 and 2.2, completion of an AAD seems to correspond with promotion consideration to grades O-3 and O-4 for master’s degrees and O-4 and O-5 for PhDs, leaving very little time in the grade earned to serve in an AAD-coded billet.

Next, we compared the FY2010 inventory of active duty officers with Air Force–funded AADs to AAD-coded billets spread over the years of service typically held by an officer in each grade.<sup>6</sup> Figure 2.3 shows that the inventory of officers with Air Force–funded master’s degrees likely falls short of requirements in the early years of service (grades O-1/O-2<sup>7</sup>), but exceeds requirements after the sixth year of service. Similarly, Figure 2.4 shows that the number of officers with Air Force–funded PhDs falls short of PhD authorizations until the grade of O-5, where the number of PhD requirements drops dramatically.

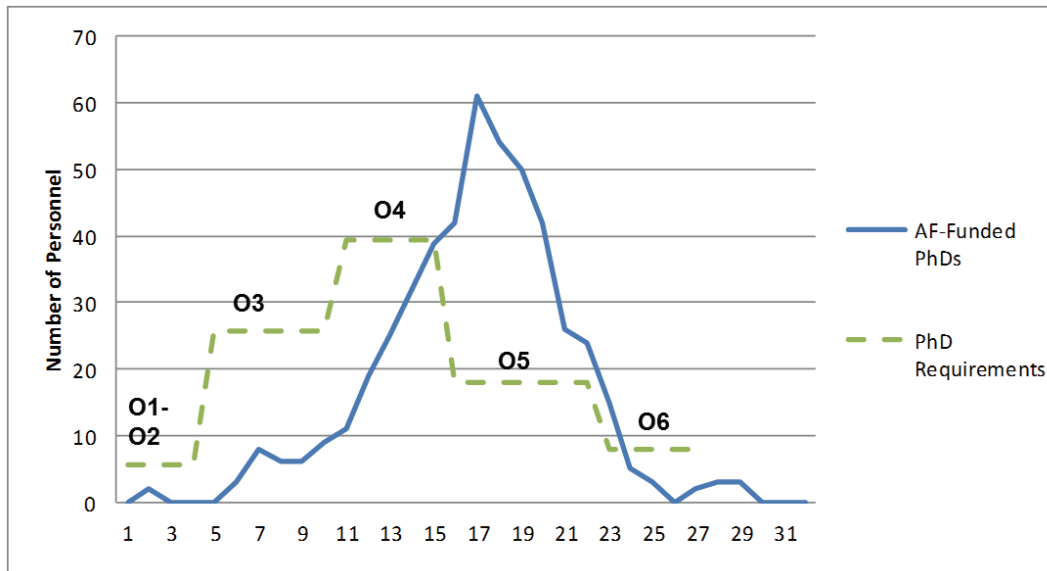
<sup>6</sup> For example, if there were 100 O-3 requirements and officers are typically O-3s from the fourth YOS through the ninth year of service, then the average number of O-3 AAD-coded billets for each O-3 YOS is 100/6, or approximately 16.7.

<sup>7</sup> Figure 2.3 underestimates the number of O-1/O-2 officers that have earned an AAD; this is due to personnel records often taking years to reflect graduate degree attainment.

**Figure 2.3. MS Inventory Versus Requirements, by Year of Service, FY2010**



**Figure 2.4. PhD Inventory Versus Requirements, by Year of Service, FY2010**



Figures 2.1–2.4 highlight a misalignment between the year of service in which officers earn AADs and the grade structure of AAD requirements, which leads to an inadequate supply of officers with the proper degrees in the appropriate grades. This misalignment likely accounts for much, and perhaps most, of our observed low payback and utilization rates.

Due to low utilization rates in lower grades, the model we will describe in the next chapter will estimate a higher AAD production requirement to meet the number of AAD-

coded billets on UMDs with personnel in the appropriate grades. Based on these outcomes, we suggest that the Air Force do the following:

- Send more O-2s to school to earn a master's degree by their promotion to O-3, enabling increased utilization and ensuring an adequate supply of O-3s with master's degrees to fill MS O-3 requirements.
- Send more O-3s and fewer O-4s to school to earn a PhD prior to promotion to O-4, enabling increased utilization and increasing the supply of O-3s and O-4s with PhDs to fill PhD O-3 and O-4 requirements.
- Consider redistributing the AAD authorizations to grades that match the population patterns.
- Perform a thorough job skills analysis of all AAD-coded billets, paying particular attention to O-1 and O-2 requirements, which are nearly impossible to fill unless the Air Force increases the number of commissioned second lieutenants (2nd Lts) who have already earned an AAD or fills some of these positions with civilians who can be hired with the required degree level and specialty.

The fourth recommendation would likely decrease the number of AAD-coded billets, whereas the first three recommendations allow for increased utilization of officers in the appropriate grades and ensure, in the aggregate sense, a proper supply of officers with AADs to fill AAD requirements.





### 3. AAD Production Requirements Model

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The purpose of this chapter is to present the findings from two Excel-based modeling tools that can strengthen the processes currently used to determine AAD production requirements and aid in quota allocation distribution to career fields and academic institutions. We briefly describe how the modeling tools fit into the current process, with slight modification, as well as the inputs into the models (data and how we characterized or grouped the data), some important data processing issues, and the model methodology. Lastly, we'll present the modeling results and our findings. The findings include a summary sheet containing aggregate production requirements for functional and faculty prep AAD production by degree level. Additionally, we created a rationing scheme, which allocates a constrained number of quotas to users in proportion to the estimated unconstrained requirement calculated by the model.

The AFERB modeling tool determines the AAD production requirement (i.e., the number of officers that should start graduate school each year) by Air Force specialty code (AFSC)/academic institution, degree level, and grade. The production requirement is calculated based on the number of AAD-coded billets currently on UMDs and the historical utilization of officers for each career field and academic institution. The AFERB model was designed to provide the AFERB Working Group with an analytical tool, backed by historical data, to help distribute quota allocations to career fields and academic institutions. The CFM model, the second modeling tool we created, was designed to help CFMs and faculty management representatives identify the AADs to be earned (by academic specialty) for the total funded quota allocations provided to them by the AFERB (by degree level). A summary sheet containing aggregate production requirements for functional and faculty prep AAD production is provided by degree level for use by the AFERB Working Group. Additionally, we created a rationing scheme, which allocates a constrained number of quotas to users in proportion to the estimated unconstrained requirement calculated by the model. The two models together can provide rigor and stability to the decisions resulting from the AFERB, standardize a quota allocation approach, and provide some transparency on quota allocation for AFERB attendees.

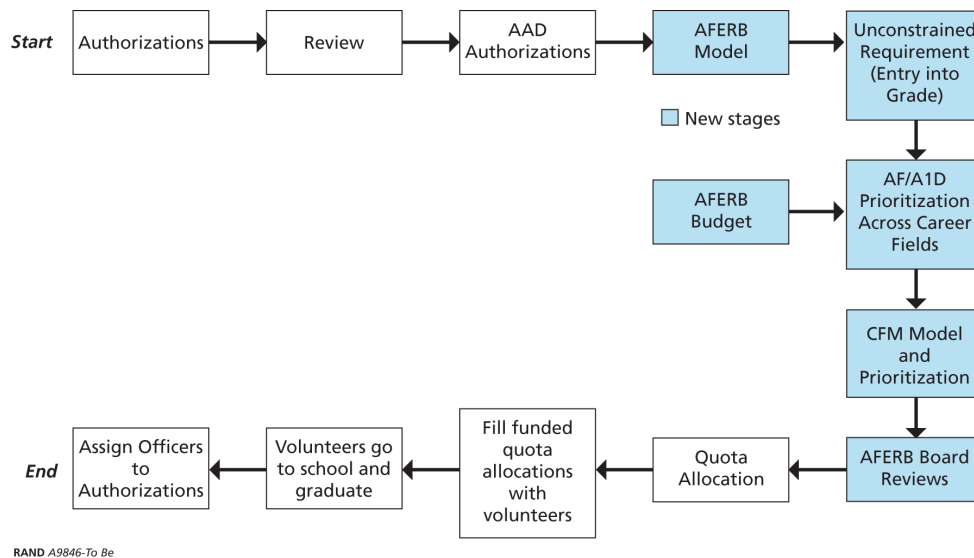
#### Recommended AAD Process

The current process requires CFMs to identify AAD-coded billet vacancies three to five years into the future, which can be hard to predict for many reasons, including retention

and intervening assignment actions. These projected billet vacancies are then submitted to the AFERB.

We propose modifying the current process (shown in Figure 1.1) to the process shown in Figure 3.1. The main difference between the current process and the recommended process, from an input perspective, is the use of validated AAD-coded billets on UMDs. The recommended approach also produces a steady-state AAD production target, which would allow the Air Force to yield a pool of AAD personnel that provides the greatest potential to match the pool of varying AAD billet requirements, given available funding.

**Figure 3.1. Recommended AAD Process**



## Data Used in the Modeling Tools

In this section, we provide the sources of our data, explain any assumptions we used to process the data, and discuss difficulties we faced in processing the data. As will be discussed in the methodology section, the modeling tool relies on an application of Little’s Theorem, which is simple in nature, but very useful; the complexity in the modeling tool resides in acquiring and processing the data in a meaningful manner so that we can use Little’s Theorem. This section addresses how that processing occurred.

### Data

We drew the data for our analysis, including the data discussed in Chapter Two, from officer master personnel files as well as manpower files provided by the Air Force

Personnel Center. We will discuss the data from two points of view: the AAD requirements dataset and the officer personnel dataset.

To determine the AAD-coded billets, we used a September 2010 Air Force manpower file provided to RAND by the Air Force Personnel Center, which contains a snapshot of all Air Force authorizations at that time. We narrowed down the authorization dataset to include AAD requirement information such as grade, degree level, academic specialty, and owner of the position. To ensure that we captured all faculty prep AAD requirements, we obtained a list of faculty prep AAD requirements by position number from each academic institution considered in the modeling tool (Air Force Institute of Technology [AFIT], Air University [AU], Naval Postgraduate School [NPS], United States Air Force Test Pilot School [TPS], and United States Air Force Academy [USAFA]). The following list summarizes a number of deletions made to refine the original data:

- All requirements pertaining to non-line AAD authorizations (Medical, Nursing, Dental, Chaplain, Judge Advocate Generals) were removed, as our modeling tools consider only requirements in line career fields, which is the AFERB's purview.
- Air Force Reserve Officer Training Corps (AFROTC) AAD positions were removed because AFROTC instructor positions, which require a master's degree with no specific academic specialty, are routinely filled from available inventories without the need for funded faculty prep AADs.
- Professional Military Education (PME) AAD authorizations were removed, as PME degrees are obtained through intermediary developmental education (IDE) or senior development education (SDE), so there is no reason to specifically educate officers to fill the handful of PME AAD authorizations.
- AAD authorizations for grades higher than O-6 were removed.

Acquiring the officer personnel information needed for the model required the merging of two datasets: (1) the historical information on each officer that contained education information as well as all positions held while on active duty, and (2) the AAD requirements dataset just described. To obtain the historical information on each officer, we used officer master personnel files provided by the Air Force Personnel Center. While our analysis concerns officers in AAD positions from FY2000 through FY2010, we obtained earlier personnel files dating back to 1989 to ensure that we captured all active duty officers during the FY2000–FY2010 time frame. We narrowed down the variables in the personnel files to include information such as primary duty AFSC, when AADs were earned (which could have been prior to commissioning) and by which method (Air Force–funded or self-pay), which AADs were earned (degree level and academic specialty), AAD positions held, and the FY in which the AAD position was held. We then merged the officer personnel dataset with the AAD requirements dataset to create a comprehensive data set containing 8,447 AAD assignments for active duty officers who earned AADs from FY2000 through FY2010. This comprehensive data set allows

comparison of earned AADs against AAD billet requirements, calculation of utilization rates, and a calculation of man-years served or tenure in AAD jobs (utilization and tenure rates will be discussed in the methodology section).

For consistency, much of the AAD requirements data deletion was also performed on the comprehensive data set:

- AFROTC positions held
- non-line officers as well as non-line positions
- PME degrees earned as well as PME AAD authorizations
- AAD authorizations for grades higher than O-6
- general officers serving in AAD positions.

### *Processing Academic Specialty Codes*

To provide an understanding for the difficulty faced when using and processing ASCs, we provide a brief explanation of the structure and meaning of an ASC and then provide recommendations for improved usage of ASCs. The list of ASCs contains more than 3,100 potential degrees that an officer could earn, and thus one of more than 3,100 degrees could be required in an AAD-coded position, making true determination of the appropriate ASC requirement a difficult task for a CFM.

An ASC is a four-character alphanumeric code, in which the first character represents the general area of study; the second character represents the major academic field (e.g., 4IYY represents electrical engineering); and the third and fourth characters represent specializations and subspecializations within an academic field, respectively. X, Y, and Z values in the ASC represent “other,” “not applicable,” and “unknown,” respectively, and are typically found in the last two characters, as discussed in AFI 36-2305, *Educational Classification and Coding Procedures* (2001). For example, 4ICB represents the subspecialization microwave tubes within the 4ICY specialization electronic circuits and devices within the academic field of electrical engineering. Table 3.1 outlines the general areas of study found with the list of ASCs.

**Table 3.1. General Area of Study Based on Academic Specialty Code**

<b>ASC</b>	<b>General Area of Study</b>
0YYY	Inter-Area Specialization
1YYY	Administration, Management, and Military Science
2YYY	Arts, Humanities, and Education
3YYY	Biological and Agricultural Sciences
4YYY	Engineering
5YYY	Law
6YYY	Mathematics
7YYY	Medical Sciences
8YYY	Physical Sciences
9YYY	Social Sciences

Analyzing the ASCs listed for degrees earned and AAD requirements, we discovered incorrect usage of ASCs—either more specialized than called for by the job or of the wrong specialization. We recommend that AAD requirements be stated in as general an ASC as possible to allow more officers to match the requirement (i.e., if the position requires an electrical engineer, then the specialty requirement should be 4IYY, not a specialization or subspecialization of electrical engineering unless absolutely necessary for mission completion in that position). However, degrees earned should be as specific as possible and in line with the officer’s education. There were several instances where an advanced academic degree was listed as YYYY, ZZZZ, or 0GY, which translate to “not applicable,” “unknown,” and “general studies,” which are not appropriate for graduate degrees.

Using the recommendation that AAD requirements list as general an ASC as possible, we converted all four-character ASCs into two- or three-character ASC requirements to facilitate more meaningful matches. All ASCs that begin with numeric characters 1–9 and some ASCs that begin with 0 (zero) were converted to two-character ASCs by concatenating the first two characters of the ASC with YY (e.g., 4ICB was converted to 4IYY, representing a need for an electrical engineer). Those ASCs that begin with 0Y were converted to a three-character ASC to allow for a specialization, since 0YYY represents inter-area specialization and is meaningless as a requirement. Thus, ASCs beginning with 0Y were converted to three-character ASCs by concatenating the first three characters of the ASC with a Y.

The last difficulty revolves around duplicate ASCs found in the list of more than 3,100 ASCs. For example, the broader field of biochemistry contains two subsections in

the list of ASCs that one could use for an officer earning a biochemistry degree, 0YBY and 8CCY. To address duplicates, we manually converted all duplicate ASCs found at the time of processing AAD requirements to one coherent set of ASCs.

### *Characterization of the Data*

The modeling we visualized for the AFERB process would indicate a steady-state production of AADs that, given historic or policy-driven utilization rates, would yield AAD inventories that matched AAD requirements. A key to this effort was to identify useful and practicable levels of data characterization for the modeling effort. The variables of interest (i.e., the variables by which requirements, inventories, and production could be characterized) are AFERB users (CFM or academic institution), degree level, method earned, and grade. With our payback analysis in mind, we also included a variable to represent whether there was a match between the earned AAD and AAD-coded billet requirement.

The first characterization of the data addresses the users of the AFERB process—CFMs and academic institutions. Functional requirements and faculty prep requirements are inherently different: functional requirements are specific to career fields, whereas faculty prep requirements are filled by officers from various career fields. Filling a faculty prep requirement requires CFMs to release an officer for the duration of the education and faculty prep assignment. Also, the nature of the AAD positions is different: Faculty prep requirements are teaching positions, whereas functional requirements can vary in purpose. The model acknowledges these differences by using career fields and academic institutions as a building block, with all officers categorized into career fields using their primary duty AFSCs; likewise, all AAD requirements and positions held were categorized by the career field or academic institution that owned the position, regardless of the AFSC of the officer residing in the position.

Another characterization of the data addresses degree level. As mentioned in Chapter Two, we felt that disaggregating the data into master's and doctorate degrees was necessary since officers who have earned PhDs are handled differently, in terms of career mentoring and tenure in positions, by the larger Air Force than officers who have earned master's degrees.

A third characterization of the data pertains to method earned. Again, the utilization of AADs greatly differs based on whether the AAD was Air Force-funded versus self-pay (paid for by the officer or funded with tuition assistance or other comparable programs). An Air Force-funded AAD being obtained by an officer is visible to the Air Force; the officer is using a student man-year, the officer's progress is being tracked by AU, and an estimated graduation date is available. Therefore, future assignment planning can occur. Additionally, this officer will have a payback commitment that must be

tracked as well. These pieces of information are unavailable for an officer earning a self-pay degree; the only visibility on self-pay degrees occurs once the self-pay degree has been earned. Thus, utilization is much higher when an Air Force–funded degree has been earned, and self-pay utilization seems coincidental at best.

The last characterization of the data concerns grade. Officers are positioned according to their rank and the grade of the billet. Thus, AAD requirements are categorized according to the grade requirement on the billet. Officers are categorized by the grade in which they earned an AAD (notated EIG, for earned-in grade). Lastly, AAD production is calculated in terms of the number of officers that should be sent to graduate school annually in each grade, with the assumption that an officer earns the AAD in the same grade in which they started graduate school.

In summary, the data are characterized by the five-tuple (user, match, degree level, method earned, grade). Table 3.2 contains a list of the AFERB users; any career fields not listed here had zero AAD-coded billets as of May 2010.

**Table 3.2. AFERB Users**

<b>Career Field/Academic Institution</b>	<b>Title</b>
11X	Pilots
12X	Combat Systems Officers
13A, 13S	Astronauts, Space and Missiles
13B	Air Battle Managers
13D	Control and Recovery
14N	Intel
15W	Weather
16F	Regional Affairs Strategist
16G	Air Force Operations Staff Officer
16P	Political-Military Affairs Strategist
16R	Planning and Programming
17X	Cyber Operations
21A	Aircraft Maintenance
21M	Munitions and Missile Maintenance
21R	Logistics Readiness
31P	Security Forces
32E	Civil Engineering
35X	Public Affairs
38F	Force Support
61X	Scientific/Research
62X	Developmental Engineering
63X	Acquisition
64P	Contracting
65X	Finance
71S	Special Investigations
AFIT	Air Force Institute of Technology
AU	Air University
NPS	Naval Postgraduate School
TPS	Test Pilot School
USAFA	U.S. Air Force Academy



### *Appropriate Aggregation of the Data*

We categorized all data using the five characterization variables discussed in the previous subsection. The result was that the intersection of all five variables produced a large number of very small cells—most of them containing too few observations from which to calculate any reliable rate information. To address the problematic small cells, we often had to aggregate to a higher level of data with a large enough population size in an effort to produce a more statistically reliable estimate. The first level of aggregation was to move from a specific user to all users. The second level of aggregation was to move from assignment matches to all AAD assignments (the comprehensive data set containing 8,447 observations). The general rule set is summarized as follows:

- If the (user, match, degree level, method earned, grade) cell contained 30 observations or more, then the data in this cell were used to calculate the rate.
- If the (user, match, degree level, method earned, grade) cell contained fewer than 30 observations and the (all users, match, degree level, method earned, grade) cell contained at least one observation, the rate was calculated based on the (all users, match, degree level, method earned, grade) cell.
- If the (all users, match, degree level, method earned, grade) cell contained zero observations, then the rate was calculated based on the (all users, all AAD assignments, degree level, method earned, grade) cell.

### Model Inputs

This section discusses the principal inputs to the calculations within the AFERB model; these inputs represent policy levers that can be adjusted by each user and, when appropriate, for each degree level and grade. The goal of the levers is to inform policy changes: for example, to determine the negative impact of a lower-than-desired graduation rate on AAD production or the positive impact of achieving higher utilization rates. The four policy levers are as follows:

- **Graduation rate:** We set the graduation rate at 100 percent as a default. We were unable to obtain data that would allow calculation of specific graduation rates.<sup>1</sup>
- **Percentage of AAD-coded billets to fill:** The percentage of billets to fill is also set, by default, at 100 percent, as validated requirements represent true needs that should be considered in the AFERB process.

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<sup>1</sup> Several AFERB participants voiced concerns that the PhD graduation rate was low (primarily due to failure to complete dissertations) and that Air Force–funded PhD education policy should be examined to improve the rate. Refinement of the rates used in the model, in conjunction with reviewing the utilization policy for all-but-dissertation (ABD) PhD candidates, is a topic worthy of additional attention by the Air Force.

- **Maximum number of officers, by grade, that should enter graduate school each year:** The maximum number of starts is currently set at 999, which is large enough to make this a non-binding constraint in the AAD production calculation; however, this feature is provided so that users can see the effect of limiting the number of officers sent to graduate school in each grade, by degree level, on the AAD production.
- **Target utilization rate by grade** (the proportion of officers holding AADs assigned to AAD billets in each grade): The target utilization rate is set at 100 percent, despite historical utilization at lower rates; we believe this is justified, as each officer must be assigned to a position, and most career field managers prefer an officer in the job without the proper AAD over the authorization sitting vacant.

## Methodology of the Modeling Tools: Application of Little's Theorem

This section broadly describes the methodology behind the model calculations, which relies on repeated application of Little's Theorem. The reader, upon completion of this section, should understand the basics of the calculations, how we relied on the ease and simplicity of Little's Theorem to calculate steady-state production rates based on AAD-coded billets and average man-years in AAD positions, and how to interpret the results of both the AFERB model and the CFM model. The appendix contains a section with formulas for those readers who are interested in the details of the model calculations. As this report is intended for policymakers and users alike, this report aims to demonstrate to the user that the methodology behind the model is sound, while providing policymakers with the ability to use the model and understand the results. This section first discusses Little's Theorem, from a high-level perspective, and how it can be used to calculate steady-state AAD production. Then we discuss the calculation of tenure in AAD positions and utilization rates, both necessary pieces to calculate AAD production, which leads into the AAD production calculation. From there we discuss the AFERB model, the rationing scheme provided on the summary sheets for the AFERB Working Group, and finally the CFM model.

The models rely on Little's Theorem, which states that, under steady-state conditions, the average number of items in a queuing system equals the average rate at which items arrive multiplied by the average time that an item spends in the system (Little, 1961). Let  $L$  equal the average number of items in the queuing system,  $\lambda$  equal the average number of items arriving per unit time, and  $W$  equal the average time in the system for an item; then Little's Theorem is the following equation:  $L = \lambda W$ . This notation translates into the following for use in our modeling tools:

- $L$  = the number of officers filling AAD-coded billets by AFSC/academic institution, degree level, and grade.

- $\lambda$  = AAD production, or the number of officers who should graduate annually and fill an AAD-coded billet, calculated by AFSC/academic institution, degree level, and earned-in grade.
- $W$  = tenure in AAD positions, or the average number of man-years an officer serves in an AAD-coded position, calculated by AFSC/academic institution, degree level, earned-in grade, and served-in grade.

Several assumptions are required to allow the above application of Little's Theorem: Toward the definition of  $L$ , we assume that the number of officers is equal to the number of AAD-coded billets, as that is the steady-state purpose of the model; toward the definition of  $\lambda$ , we assume that upon graduation the officer is assigned to an AAD-coded billet; and, lastly, dividing  $\lambda$  by a graduation rate allows us to arrive at the number of officers who should start graduate school annually.

### *Tenure in AAD Positions*

By the definitions given above, AAD production is dependent upon tenure in AAD positions, so we will first discuss how tenure in AAD positions is calculated. The method for computing the average number of man-years an officer serves in an AAD position can be viewed as the expected payout to the Air Force in terms of service in AAD jobs based upon earning an AAD in a particular grade. The computation accounts implicitly for promotions, losses, and non-utilization of officers (where the officers earned AAD does not match the AAD requirements of the position). The computation explicitly accounts for all service in positions requiring an AAD by grade and is normalized to the population size within that category/cell (user, match, degree level, method earned, grade). Officers who have separated are not available to serve in later grades and thus contribute zero man-years in future grades. Officers that are promoted are available to serve in future grades, but may not serve in AAD jobs, may serve in AAD jobs that do not match their degree earned, or may serve in AAD jobs that match their degree earned but the position grade does not align with the officer's rank.

### *Utilization Rates*

The utilization rate required for the modeling tools does not measure payback, but rather measures the likelihood that within an AFSC/academic institution an officer with an AAD is assigned to an AAD position where the officer's earned AAD matches the AAD requirements by degree level and two- or three-character ASC based on method earned and grade. This utilization rate is calculated based on the data set of 8,447 officers with AADs that served in AAD positions in the FY2000–2010 period.

### *AAD Production*

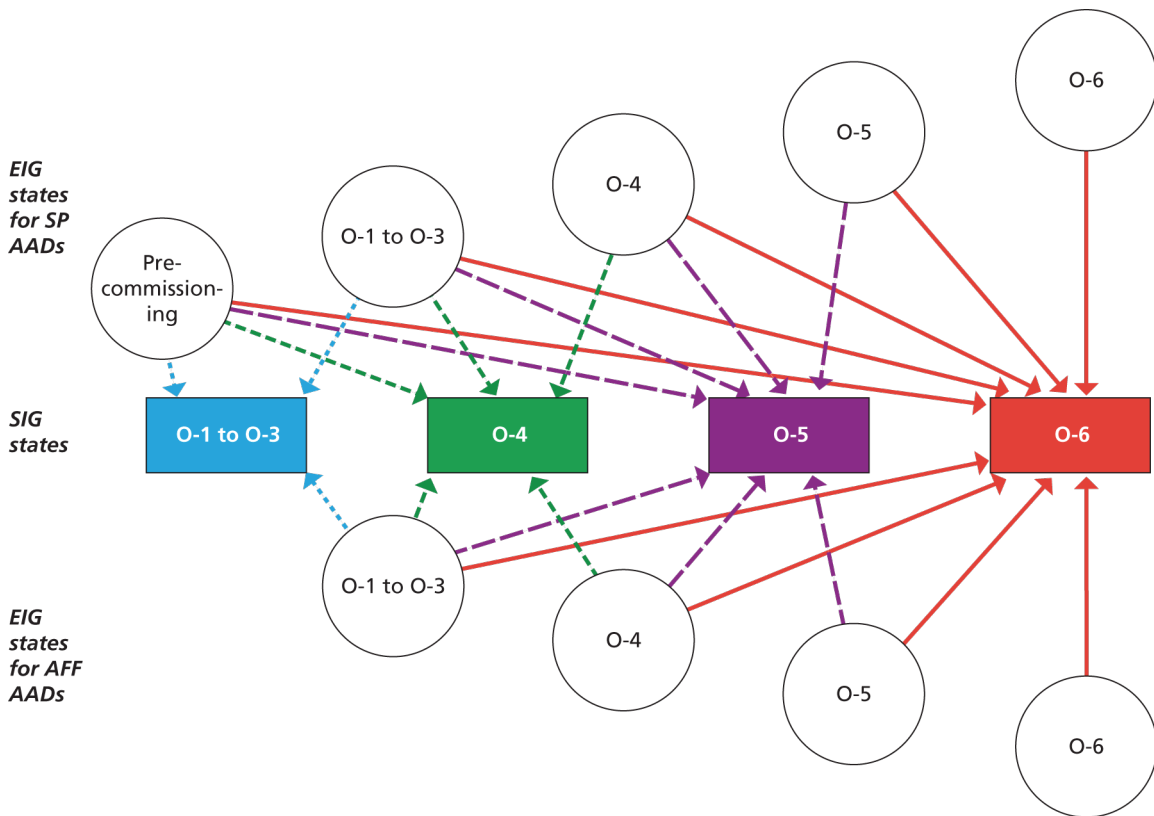
The calculation of AAD production is more complex than a straightforward application of Little's Theorem. We need to account for the various methods by which an officer can earn an AAD, in which grade the officer earns an AAD, and the grades in which the officer can serve in an AAD position after graduation. Using method earned, earned-in grade, and the grade in which the officer serves in an AAD position (notated SIG for served-in grade) as states in a flow model, Figure 3.2 displays the states that must be accounted for in the AAD production calculation.<sup>2</sup>

Capturing the effect of utilization and tenure in AAD positions is important as higher utilization rates and longer tenure in AAD positions both result in a decreased AAD production requirement in the higher grades. For instance, if officers who have earned an AAD as an O-1 to O-3 are utilized in grades O-1 to O-3 and also in O-4, then that would lower the production requirement for O-4. If officers stayed in AAD positions for an additional year, then that would reduce the AAD production requirement as well. Thus, the model calculations account for tenure in AAD positions and utilization rates by user, degree level, and grade based upon method earned and when the AAD was earned.

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<sup>2</sup> Although each arrow is theoretically possible, average man-year calculations, to be discussed later, show that officers are most utilized in the same grade that the AAD was earned.

**Figure 3.2. Flow Model for Served-in-Grade (SIG) States Based on Earned-in-Grade (EIG) and Method Earned—Self-Pay (SP) or Air Force–Funded (AFF)**



RAND A9846-AAD flow model

At this point, we have discussed all of the pieces that must come together to calculate AAD production: tenure in AAD positions, utilization rate, the four user-controlled levers (graduation rate, percentage of billets to fill, target utilization, and maximum number of new officers by grade to start graduate school), and the method earned for AADs based on the grade in which the AAD was earned and the grade in which the officer serves in an AAD position. While the remainder of this section will discuss the calculations at a more general level, the appendix contains a detailed description, with formulas included, for calculating AAD production for the MS steady-state unconstrained production.

To simplify the calculations, all data are converted to a common metric of man-years. Thus, AAD-coded billets are converted to the total number of man-years required to fill all AAD-coded billets with officers for a full year (labeled “Req MYs”); for example, to fill 125 O-1 to O-3 32E MS positions, we would need 125 man-years. The number of available man-years that officers contribute is simply the product of the number of officers and the average number of man-years spent in AAD positions (labeled Avail MYs) based upon when an officer earns a degree, when he or she served in an AAD

position, and the method earned. The goal is to start enough officers in graduate school such that when the graduation rate and utilization rate are taken into account, the number of required man-years is equal to the available man-years. Provided that the number of officers needed to start graduate school is less than the number of maximum starts per grade, the calculations result in Req MYs ≤ Avail MYs for each grade; if the max starts is less than the number of officers required, then Req MYs ≥ Avail MYs and results in a shortage. This general description provides the application of Little’s Theorem, which is that AAD production is equal to the number of AAD-coded billets (in terms of man-years) divided by the average man-years spent in AAD-coded positions. The calculations described above are identical for determining the number of Air Force–funded PhDs.

*The AFERB Model*

Figures 3.3 and 3.4 show the MS portion of the AFERB Model, which calculates the number of 32E (Civil Engineers) officers that should start graduate school annually to obtain an Air Force–funded master’s degree. Figure 3.4 shows the incorporation of 32E officers who have earned self-pay master’s degrees and their tenure in AAD positions as well as historical utilization. The number of man-years contributed from self-pay degrees is accounted for in the calculation of 32E MS production requirements, as discussed in connection the flow model presented in Figure 3.2.

**Figure 3.3. Screen Capture of 32E (Civil Engineering) MS Production Calculation**

NEW MS STEADY STATE SOLUTION																
Avg manyears per MS assignment	Grade in which an MS is earned					AFSC career field		_32E		Graduation Rate						
	01-03	04	05	06	Positions that req MS	01-03	125	100%								
	04	0.25	1.41	0.00		04	20	% of Billets to Fill								
	05	0.00	0.69	2.95		05	7	100%								
	06	0.00	0.02	0.16		06	3	100%								
							155									
Avail manyears given new degree earners	Grade in which an MS is earned					Req MYs	Avail MYs	Max Starts	Historical Utilization	Target Utilization	AFERB Recommendations (Steady State) New MS starts per year					
	01-03	53.04										125.00	125.00	999	57.1%	100.0%
	04	13.44	2.84									20.00	20.00	999	72.2%	100.0%
	05	0.12	1.97	1.47								7.00	7.00	999	40.9%	100.0%
	06	0.00	0.04	0.24	0.43							3.00	3.00	999	21.4%	100.0%
					155.00	155.00				57.79						

**Figure 3.4. Screen Capture of 32E (Civil Engineering) Contributions of Self-Pay MS Holders**

CONTRIBUTIONS BY SELF-PAY MS DEGREE HOLDERS									
Avg manyears per MS assignment	Grade in which an MS is earned								
	Comm	O1-O3	O4	O5	O6				
	O1-O3	2.26	1.95	0.41	0.00	0.00			
	O4	0.00	0.39	1.66	0.10	0.00			
	O5	0.00	0.07	0.73	1.55	0.00			
O6	0.00	0.00	0.09	1.26	3.01				
Avail manyears given new degree earners	Comm with an MS	Grade in which an MS is earned					Avail MYs	Historical Utilization	Target Utilization
		0.10	O1-O3	O4	O5	O6			
	O1-O3	0.23	4.50				3.46	38.4%	38.4%
	O4	0.00	1.78	1.70			2.54	55.3%	55.3%
	O5	0.00	0.31	1.24	0.20		0.56	30.2%	30.2%
O6	0.00	0.00	0.15	0.25	0.10	0.16	22.5%	22.5%	
						6.72			

The AFERB model results are to be interpreted as follows: Based on (1) the settings of the four user-controlled levers (graduation rate = 100 percent, percentage of billets to fill = 100 percent, target utilization = 100 percent for each grade, and maximum number of new officers by grade to start graduate school = 999) and (2) the average man-years per MS assignment, 32E should start 57.79 officers annually to have the inventory needed to fill 125 O-1–O-3, 20 O-4, 7 O-5, and 3 O-6 MS requirements. The steady-state production is an average annual rate, so ideally the 32E career field manager would send 58 officers to obtain master’s degrees for approximately four out of five years and 57 officers to obtain a master’s degree the fifth year.

***Rationing Scheme for AFERB Model***

We created a rationing scheme that distributes a constrained number of quota allocations to users in proportion to the estimated unconstrained requirement calculated by the model. We felt that a scheme like this was necessary given that the number of quota allocations provided by the AFERB in recent years has been significantly less than the requirements reported by the CFMs, resulting in potentially severe shortages. Many users felt the AFERB process lacks transparency, and they were unsure of the basis for distributing quota allocations; this rationing scheme should serve to standardize the approach used by the AFERB and should also allow all users to see their fair share of the constrained quota allocations.

Results obtained in the 30 AFERB model spreadsheets (25 functional sheets and 5 faculty prep sheets based on the AFERB users listed in Table 3.2) are carried over into a

summary sheet that provides a rationing scheme for distributing quota allocations when the number of quota allocations provided by the AFERB is less than the total unconstrained production requirement. Examples of the scheme are found in Figures 3.5 and 3.6, which provide screen captures of the functional MS portion and faculty prep PhD portion of the summary sheet, respectively. The totals at the bottom of the “Proportional New MS Starts” and “Proportional New PhD Starts” columns reflect the difference between the AFERB’s constraints and the unconstrained production required for that category. In Figures 3.5 and 3.6, the rows represent the functional and academic institutions’ shares of the total, which is based upon the weights indicated in Figure 3.7. To walk through the calculation for the “32E-CIVIL ENGINEERING” row in Figure 3.5, 155 is the total number of 32E FY2010 MS requirements (see red box in Figure 3.3 under “Positions that req MS”), 57.8 is the recommended steady-state AAD production (see red box in Figure 3.3 “AFERB Recommendations (Steady State) New MS starts per year”), 8.99% is the percentage of 32E MS model new starts to the aggregate number of MS model new starts (155/642.6), and 14.8 is the 32E proportion of the constrained number of quotas (164.5 \* 8.99%).

**Figure 3.5. Screen Capture of Functional MS Portion of Summary Sheet**

FUNCTIONAL MS	FY10 MS Req	MS Model New Starts	% of MS New Starts	Proportional New MS Starts
11-PILOT	46	18.9	2.94%	4.8
12-COMBAT SYSTEMS	24	10.6	1.65%	2.7
13A & 13S-SPACE & MISSILE OPERATIONS	40	16.1	2.50%	4.1
13B-AIR BATTLE MANAGER	2	0.7	0.10%	0.2
13D-CONTROL AND RECOVERY	2	0.9	0.14%	0.2
14-INTELLIGENCE	80	29.6	4.61%	7.6
15W-WEATHER	80	29.6	4.61%	7.6
16F-REGIONAL AFFAIRS STRATEGIST	40	16.4	2.56%	4.2
16G-AF OPERATIONS STAFF OFFICER	8	2.5	0.39%	0.6
16P-POLITICAL-MILITARY AFFAIRS STRATEGIST	44	15.9	2.48%	4.1
16R-PLANNING & PROGRAMMING	18	5.5	0.85%	1.4
17-CYBER OPERATIONS	98	30.1	4.69%	7.7
21A-LOGISTICS	19	5.1	0.80%	1.3
21M-MUNITIONS AND MISSILE MAINT	3	0.7	0.11%	0.2
21R-LOGISTICS READINESS	84	28.6	4.45%	7.3
31P-SECURITY FORCES	96	34.9	5.43%	8.9
32E-CIVIL ENGINEERING	155	57.8	8.99%	14.8
35-PUBLIC AFFAIRS	17	6.8	1.06%	1.7
38-FORCE SUPPORT	23	6.7	1.04%	1.7
61-SCIENTIFIC/RESEARCH	225	75.6	11.77%	19.4
62-DEV ENGINEER	443	167.6	26.08%	42.9
63 - ACQUISITION	79	27.0	4.20%	6.9
64 - CONTRACTING	75	22.7	3.53%	5.8
65-FINANCE	86	24.2	3.77%	6.2
71S-SPECIAL INVESTIGATIONS	28	8.0	1.25%	2.1
REGULAR UMD FUNDED	1815	642.6		164.5



**Figure 3.6. Screen Capture of Faculty Prep PhD Portion of Summary Sheet**

FACULTY PREP PHD	FY10 PhD Req	PhD Model New Starts	% of PhD New Starts	Proportional New PhD Starts
AFIT Faculty Prep	83	34.6	31.54%	17.7
AU Faculty Prep	23	8.8	8.06%	4.5
NPS Faculty Prep	0	0.0	0.00%	0.0
TPS Faculty Prep	3	1.3	1.19%	0.7
USAFA Faculty Prep	198	64.9	59.21%	33.2
FACULTY PREP OVERALL	307	109.7		56.2

In the upper left-hand of Figure 3.7, the user enters the number of quota allocations to be provided by the AFERB—330 in this example. Note that 330 quotas are less than 1002.52, the total number of recommended unconstrained new starts, as shown in the total box of the aggregate level gains column, which means that career fields and academic institutions will receive fewer quotas than are needed to maintain the proper inventory of officers with the right AADs. The aggregate level gains shown in Figure 3.7 are the totals for each category of the AAD production requirement estimated by the model.

The weight factors—the four yellow boxes—are left to the user’s discretion. The weighting factors were incorporated to allow any one of the four categories to have more importance than or weight relative to the other categories. Historically, the faculty prep categories have received about twice the number of quota allocations relative to their requirement size than the functional category; Figure 3.7 reflects this relative weighting. The last column in Figure 3.7 shows the quota allocation for each category and is a weighted-average calculation based on the number of constrained quotas (330), the weight factors, and the aggregate-level gains.

**Figure 3.7. Rationing Scheme for Distributing Constrained Quotas**

	Number of Funded Quotas Available	Weight factor for each category	Aggregate level gains	Quota allocation for each category (total=number of funded quotas available)
	330			
Faculty Prep MS		2	176.71	= 90.5
Faculty Prep PhD		2	109.65	= 56.2
Functional MS		1	642.59	= 164.5
Functional PhD		1	73.56	= 18.8
		Total 6	Total 1002.52	Total 330

Table 3.3 shows the impact of the weight factors on the distribution of constrained quotas to the four categories and compares the unconstrained quota totals to the quota distribution for three different weighting schemes.

**Table 3.3. Impact of Weighting Factors on Constrained Quota Distribution**

<b>Category and Degree Level</b>	<b>Unconstrained Quotas</b>	<b>Balanced Weights</b>	<b>Quotas</b>	<b>Faculty Emphasized Weights</b>	<b>Quotas</b>	<b>Faculty PhD Emphasized Weights</b>	<b>Quotas</b>
Faculty Prep MS	176.7	1	58.2	2	90.5	1	52.4
Faculty Prep PhD	109.7	1	36.1	2	56.2	2	65.1
Functional MS	642.6	1	211.5	1	164.5	1	190.7
Functional PhD	73.6	1	24.2	1	18.8	1	21.8
Total	1002.52	-	330	-	330	-	330

### *CFM Model*

The CFM model is designed to help CFMs distribute quota allocations from the AFERB Working Group across academic specialties. In the current process, requirements submitted to the AFERB are related to specific billets and, therefore, to specific AADs (by degree level and academic specialty). Thus, in the current process, the AFERB chooses the specific academic specialties that will be pursued within each career field and academic institution, irrespective of the needs or prioritization of requirements within the career field/academic institution. As discussed at the beginning of this chapter, given the low number of quota allocations relative to the number of requirements, we and many users of the AAD process (CFMs and academic institutions) prefer that users make a prioritized choice than to let the AFERB Working Group choose the specific academic specialties to be pursued. With this functionality in mind, the CFM model provides an initial, requirements-based distribution of quota allocations to academic specialties as a guide for CFMs, but allows CFMs to modify the recommended initial distribution. However, it's worth mentioning that CFMs would be constrained by funding and academic programs offered at AFIT, as civilian institutions cost tuition dollars in addition to man-years versus the man-year cost for attending AFIT.

The CFM model is another application of Little's Theorem, and it uses information from the appropriate AFERB model sheets as well as the summary sheet. Figure 3.8, as an example, shows a partial screen capture of the 62E (Developmental Engineers) CFM model for master's degrees; the PhD portion is identical. The "MS New Starts" and "MS New Starts by Grade" cells in the CFM model are linked to the unconstrained MS production contained in the corresponding AFERB 62E model sheet. The "Manyrs for EIG=SIG" are also linked to the average man-years per MS position data from the AFERB 62E model sheet. The "Proportional New Starts" cell is linked to the summary sheet and represents the share of the constrained quotas that 62E would receive given the

weight factors and 330 quota allocations total provided by the AFERB. The “Proportional MS New Starts by Grade” cell is equal to the MS new starts by grade divided by MS new starts and multiplied by the proportional new starts to obtain each grade’s proportional number of new starts.

**Figure 3.8. Screen Capture of Partial 62E CFM MS Model**

NEW MS STEADY STATE SOLUTION - ASC DETAIL																					
MS New Starts		Proportional New Starts		Requirements by ASC within this career field																	
167.60		42.91			OC	OG	OI	OS	OW	OYB	OYE	OYG	OYH	OYJ	OYK	OYL	OYM	OYN	OYO	OYR	
MS New Starts By Grade		Proportional MS New Starts by Grade		O1-O3	9	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	1
O1-O3	126.00		32.26	O4	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
O4	41.04		10.51	O5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O5	0.00		0.00	O6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
O6	0.56		0.14	Entries by AFSC, Grade, ASC																	
					OC	OG	OI	OS	OW	OYB	OYE	OYG	OYH	OYJ	OYK	OYL	OYM	OYN	OYO	OYR	
Manys for EIG=SIG				O1-O3	3.3	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
O1-O3	2.71			O4	1.4	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	
O4	1.41			O5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
O5	2.95			O6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
O6	5.93			Fair-share across ASCs																	
					OC	OG	OI	OS	OW	OYB	OYE	OYG	OYH	OYJ	OYK	OYL	OYM	OYN	OYO	OYR	
				O1-O3	0.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
				O4	0.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
				O5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				O6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

The first table on the right is only a partial list of the FY2010 62E MS academic specialties by two- or three-character ASC and grade because there are over 100 two- and three-character ASCs to calculate. The second table is an application of Little’s Theorem to calculate the unconstrained annual MS starts by 62E officers by two- or three-character ASC. The third table distributes the 62E career field’s proportional share of new starts (from the rationing scheme discussed above or from AFERB decisions).

Limitations of the CFM model result from a lack of data. The ideal CFM model would include a projected gap analysis, which requires knowing which officers are in the education pipeline along with an estimated time of graduation, starting date for a new position, and separation and reassignment rates by career field and grade. A projected gap analysis would allow the CFM model to project losses and reassignments from AAD positions three to five years out and to include officers currently in the education pipeline. It would then account for the influx of officers with AADs and the flow out of officers, and would then be able to pinpoint the academic specialties that should be earned based on projected billet vacancies. Currently, our model just calculates a fair share across academic specialties, since we have no information to provide a three- to five-year outlook.

## Model Results Indicate That Tenure in O-4 AAD Billets Is Quite Low

Although the major goal of this project was to create a model that could calculate the AAD production requirement, the data calculations highlighted an issue with tenure in AAD positions, one that ties into the findings from the analysis conducted in Chapter Two. In this section, we will discuss the results of tenure in AAD positions from an overall perspective (rather than a CFM or faculty management representative perspective) and their relevance to the recommendations discussed in Chapter Two.

Figures 3.9 and 3.10 show the average number of man-years spent in MS and PhD positions, respectively, depending upon when the AAD is earned (columns) and the authorized grade of the AAD-coded billet (rows).

**Figure 3.9. Overall Tenure in MS Billets**

		Grade in which an MS is earned			
		O1-03	O4	O5	O6
Avg manyears per MS assignment	O1-03	2.85	0.28	0.00	0.00
	O4	0.20	1.41	0.00	0.00
	O5	0.02	0.69	2.95	0.00
	O6	0.00	0.02	0.16	5.93

**Figure 3.10. Overall Tenure in PhD Billets**

		Grade in which a PhD is earned			
		O1-03	O4	O5	O6
Avg manyears per PhD assignment	O1-03	3.09	0.21	0.00	0.00
	O4	0.38	2.30	0.05	0.00
	O5	0.07	0.92	2.76	0.28
	O6	0.00	0.00	0.02	1.88

The average man-years per MS assignment for EIG/SIG = O-4/O-4 is 1.41, which is drastically lower than the comparable figure for PhD positions or for other grades where EIG = SIG. Although not as stark, the same is true for the average man-years in PhD assignments for EIG/SIG = O-4/O-4 (even though the situation is worse for colonels, there are significantly less PhD requirements at the O-6 level). These findings are supported by the analysis presented in Chapter Two, which shows that majors are earning AADs in their 13th through 15th year of service and typically serve in that grade only through year of service 15. As officers are typically majors for five years, there is little time to earn a graduate degree and serve in an AAD position before promotion to O-5, resulting in low tenure in O-4 AAD billets. Additionally, Figures 3.9 and 3.10 indicate a consistent behavior whereby officers who have earned AADs aren't utilized in future grades from when the AAD was earned. In fact, the small man-years per assignment

when SIG differs from EIG by one year is likely the result of being promoted while residing in a position and continuing to stay in that position after promotion.

Accordingly, we recommend sending more O-3s and fewer O-4s to AAD programs to enable increased utilization, increased tenure in O-4 positions, and increased inventory of O-3s and O-4s with Air Force–funded master’s and doctorate degrees. Furthermore, a redistribution of AAD authorizations (such as a “one grade up, one grade down” policy) of grades in alignment with the population would provide an opportunity to increase tenure in AAD positions. Although sending officers to graduate school earlier or a redistribution of AAD authorizations might allow increased utilization in higher grades, there are several reasons relating to officer development that hinder utilization—such as command opportunity; career-broadening jobs, such as joint staff experience; or regaining functional expertise if the officer has been in the academic setting for several years. These developmental opportunities often take higher priority in the assignment process once an AAD payback has been satisfied.



## 4. Conclusions and Recommendations

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The Excel-based modeling tools discussed in this report provide the AFERB Working Group and functional or academic institution users with initial recommendations for the number of graduate degrees that should be earned in the near future to satisfy AAD requirements based on historical information. As the recommended AAD production from the model is dependent upon, and sensitive to, tenure in AAD positions and historical utilization, we make the following recommendations to help improve the effectiveness of the AAD process, tenure and utilization rates, and the results from the modeling tools.

**To increase utilization and tenure, while ensuring the proper inventory levels of officers in lower grades having the proper graduate degrees, send newly promoted O-2s to graduate school to earn a master's degree and send more junior O-3s to graduate school to earn a PhD.** This would allow more man-years to be spent in AAD positions in the grades in which AADs are needed the most (O-3s for master's degrees and O-4s for PhDs). Increased tenure in AAD positions would lower the estimated AAD production requirement. However, it may be difficult for many reasons to send officers to school at the suggested timing; therefore, **a redistribution of grade requirements could also help to match available inventory to requirements.** This redistribution of grade requirements would likely be one outcome of a thorough job skills analysis. Another likely outcome of a job skills analysis would be a change in the number of AAD-coded billets.

The model is also sensitive to graduation rates. Note that a reduction from the current 100 percent setting would increase the model's estimated AAD production requirement. Therefore, **we recommended an analysis of graduation rates by AFSC and degree level.** In particular, this review should evaluate dissertation completion by PhD candidates and policies for utilizing ABD assets.

Utilization could be improved through refinement of the current list of ASCs. As mentioned previously, the current list of ASCs has many duplicate codes and structural issues. Additionally, many ASCs are not well defined. **A thorough analysis by a panel of experts could condense the list of ASCs and eliminate overspecification of the academic specialties in both officers' records and in individual billets.**

Lastly, **utilization could be improved if the assignment process placed a higher priority on matching personnel with AADs to AAD billets in order to increase the Air Force's return on its investment on graduate education.**





## Appendix: AAD Production Calculation Example

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An as example of how AAD production is calculated, consider the calculation for officers who earn a master's degree as an O-4. When this calculation is summed with the calculation for officers who earn master's degrees as O-1–O-3, O-5, and O-6, it provides the total number of officers who should be sent to graduate school annually to obtain a master's degree within the 32E career field.

Given the settings of the model (graduation rate = 100%, percentage of billets filled = 100%, target utilization for each grade = 100%, and maximum number of graduates to send to school in each grade = 999), the equation below describes how the number of O-4 officers that should start graduate school to obtain an Air Force–funded master's degree is calculated for any user of the AFERB model. In the formula, note that SP = self-pay, AFF = Air Force–funded, Req MYs = required man-years, Avail MYs = available man-years, Avg MYs = average man-years per AAD position held, and the grades in parentheses indicate EIG or SIG as appropriate.

$$\begin{aligned}
 & \text{AFF MS New Starts (O4)} = \\
 & \left( \frac{\left( \frac{\text{Req MYs (O4)} - \text{Avail MYs AFF (O1 - O3, O4)} - \text{Avail MYs SP (O4)}}{\text{Avg MYs AFF (O4, O4)}} \right)}{\text{Graduation Rate}} \right) \\
 & \text{-----} \\
 & \text{Target Utilization(O4)}
 \end{aligned}$$

Tenure in AAD positions is simply the average number of man-years spent in AAD-coded positions for each user, degree level, method earned, EIG, and SIG categorization; thus, *Avg MYs AFF (O4, O4)* is the total number of MYs served in O-4 positions for officers who earned Air Force–funded master's degrees as O-4s divided by the number of officers residing in MS O-4 billets for a particular user (career field or academic institution).

*Req MYs (O4)* equals the number of O-4 MS billets as it would take one officer to serve in the billet for one man-year to fill the position. *Avail MYs AFF (O1 - O3, O4)* is the product of the number of officers that earned a master's degree in grades O-1–O-3 and the average man-years that an officer in grade O-4 spends in an MS position given that the officer earned the degree in grades O-1–O-3. *Avail MYs SP (O4)* is the product

of utilization and the total number of man-years served in O-4 MS positions when the officers earned a self-pay master's degree, as explained in the equation below.

*Avail MYs SP (O4)*

*= Historical Utilization (O4)*

*\* (Avail MYs SP (Comm, O4) + Avail MYs SP(O1 – O3, O4)*

*+ (Avg MYs SP (O4, O4)*

*\* Number of Officers Earning SP MS as O4))*

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