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Implementing Propensity to Stay into Scholarship Allocation Decisions

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Implementing Propensity to Stay into Scholarship Allocation Decisions

Schiefer

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Thank you for your assistance

Research Report No. AU-ARI-90-5

Implementing Propensity to Stay into Scholarship Allocation Decisions

by

Michael A. Schiefer, Lt Col, USAF
Research Fellow
Airpower Research Institute

Air University Press
Maxwell Air Force Base, Alabama 36112-5532

March 1991

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Foreword

Lt Col Michael A. Schiefer began this research project with a narrowly focused topic: to illuminate ways the Air Force Reserve Officer Training Corps (AFROTC) might alter its scholarship allocation process to consider each applicant's long-term propensity to stay in the military. He has thoroughly and quantitatively documented AFROTC implementation options to include impacts, costs, and benefits.

In the course of this effort, additional AFROTC analysis needs became apparent. Colonel Schiefer identifies these needs. He also provides estimates of their impacts on AFROTC planning and budgeting. Finally, he suggests solutions.

DENNIS M. DREW, Col, USAF
Director
Airpower Research Institute

About the Author

Lt Col Michael A. Schiefer

Lt Col Michael A. Schiefer completed this study while assigned to the Airpower Research Institute (ARI), Air University Center for Aerospace Doctrine, Research, and Education (AUCADRE) at Maxwell Air Force Base (AFB), Alabama. In 1973 Colonel Schiefer graduated from the United States Air Force Academy with a bachelor of science degree in mathematics. His first assignment after graduation was at Kirtland AFB, New Mexico, at the Air Force Weapons Laboratory, where he modeled nuclear shock wave effects on reentry vehicle trajectories. Between 1976 and 1979 at the US Air Force School of Aerospace Medicine, he programmed a numerically controlled milling machine to manufacture a variety of medical research hardware. He earned a master's degree in operations research at the Air Force Institute of Technology in 1979 and worked until 1983 at Headquarters Air Training Command (ATC) designing and producing a variety of control and feedback tools for Air Force technical training managers. He earned a doctoral degree at the University of Texas at Austin in 1986. Until 1989, he was chief of the Enlisted Analysis Branch, Deputy Chief of Staff for Personnel, Headquarters USAF, the Pentagon. In 1989 the commander of ATC selected him to be a research fellow at ARI and concurrently attend Air War College. Colonel Schiefer is presently assigned to Headquarters ATC. He has a son, Matthew.

Preface

In June 1989 a special study group commissioned by the Air Training Command (ATC) commander, Lt Gen Robert C. Oaks, reported it had developed analytical techniques to predict an individual's propensity to stay (PTS) in the Air Force. The ultimate objective of the study was to begin bringing people into the Air Force who would be more likely to remain for the long term, thereby easing pilot and engineering retention problems. In March of 1989 Headquarters ATC directed this researcher to investigate how PTS information might be infused into Air Force Reserve Officer Training Corps (AFROTC) scholarship allocation decisions. The Oaks special study group suggested an optimization approach. While that approach is conceptually appealing, this report concludes that the benefits of such an implementation approach would not justify the costs. This study offers objective and subjective alternatives that complement current AFROTC selection procedures.

In the course of my research, I concluded that AFROTC has other pressing analysis requirements. AFROTC needs a dynamic model to estimate policy impacts on production and outlays. Such a model requires improved estimates of scholarship student persistence (continuation) rates. AFROTC also needs to refine the technique it uses to forecast tuition inflation rates. Finally, scholarship managers need to immediately begin capturing data on cadets who lose their scholarships.

I would like to thank Dr Karl Magyar, research adviser, and Dr Richard Bailey, editor, from AUCADRE for their valuable suggestions to improve this manuscript. Lt Col Manfred Koczur, also from AUCADRE, kept me above water administratively. Majors Rob Gaston, Mark Lewis, and Fred Fisher, and Capt Mitchell Norton spent a great deal of their time educating me on the AFROTC scholarship allocation system.

Finally, I am indebted to Brig Gen John J. Salvadore, Brig Gen Jeffrey T. Ellis, and Col J. R. Pond for providing resources and for encouraging their staffs to listen to what I had to say.

Michael A. Schiefer

MICHAEL A. SCHIEFER, Lt Col, USAF
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Chapter 1

Introduction

The Air Force has three primary organizations that train and screen individuals who wish to become commissioned officers: the United States Air Force Academy (USAFA), located in Colorado Springs, Colorado; the Officer Training School (OTS) in San Antonio, Texas; and the Air Force Reserve Officer Training Corps (AFROTC) at Maxwell AFB, Alabama, with detachments located on nearly 150 college campuses. AFROTC and OTS are subordinate organizations of the Air Training Command (ATC). The Air Force does not accept all applicants for officer training. Each officer training organization subjectively and objectively considers a variety of information to select applicants. In 1989 the commander of ATC directed AFROTC and OTS to consider in their selection processes a recently developed predictor of an individual's propensity to stay (PTS) in the Air Force. Subsequently, Headquarters Air Force Recruiting Service, Officer Accessions, directed this researcher to investigate methods AFROTC might use to implement PTS information into its officer candidate selection process.

Background

The Air Force has experienced chronic pilot and occasional engineer retention problems. Pilot losses create readiness and economic concerns because of the years and millions of training dollars needed to replace each pilot who leaves the Air Force. Airline hiring and Air Force salaries and management practices are some postcommissioning factors that influence pilot retention rates. If precommissioning factors such as childhood experiences also influence pilot retention, then, some pilots will be more predisposed to an Air Force career than others. In 1988 the ATC commander, Lt Gen Robert C. Oaks, charged a study group to investigate whether precommissioning attributes could be identified for individuals with a high propensity to stay in the Air Force. Since ATC selects, trains, and commissions most Air Force officers through AFROTC and OTS, the command might increase officer retention through its candidate selection policies. On 1 June 1989 the Oaks study group reported in its "Keeper Study" that retention probability was "distinctly higher" for officers with any of the following precommissioning characteristics:

- attended a moderate-cost college (as opposed to a high-cost college)
- had military parents
- moved frequently as children

- grew up in the south-central United States
- joined the Air Force for security (instead of training)
- had younger siblings.[1]

No characteristic alone was statistically significant enough to predict retention. Therefore, the Oaks study group used combinations of these characteristics with other information to predict retention. The group used stepwise linear regression techniques to build models to predict PTS for each of the 21 groups shown in figure 1.[2] The number of officers studied in each cell is indicated. At the time of the study, some of these officers were still on active duty, and others had separated from the Air Force. The officers studied were grouped into different cells to isolate any year-of-commission effect which might influence retention behavior. For example, the 1964–74 cells contained officers who may have joined the Air Force to avoid service in the Army during the Vietnam War. The 1981–84 cells contained pilots who were still serving their initial training commitments and were therefore not eligible to voluntarily separate from the Air Force. Officers were also grouped to isolate source-of-commission effects: USAFA, Officer Training School with no prior enlisted service (OTS NPS), Officer Training School with prior enlisted service (OTS PRIOR), and AFROTC.

Finally, the study made a distinction between pilots and nonpilots because the economic incentives to leave the Air Force are generally greater

		USAFA	OTS NPS	OTS PRIOR	AFROTC
1965–1974	PILOT	744	811	49	867
	NON-PILOT	767	735	231	962
1975–1980	PILOT	440	263	113	465
	NON-PILOT	476	280	203	530
1981–1984	PILOT	213	195	5	217
	NON-PILOT	238	237	73	295

Source: Officer Selection "Can We Select to Retain?" (Randolph AFB, Tex.: Officer Selection Study Group, Headquarters Air Training Command, 1989).

Figure 1. Keeper Study Officer Population

for pilots.[3] The study group considered some cells too small to analyze (cells not analyzed are indicated by shading). From a group of about 500 potential predictor variables, a computer program selected for each cell those variables that best predicted actual officer retention. The study group felt the resulting regression equations adequately modeled retention behavior and decided to use the results for the 1975–80 cells to estimate PTS for future officer candidates.

This study does not critique the findings or methodology of the Keeper Study. Some valid propensity-to-stay measures are assumed, and this work in no way depends on the Keeper project. This study examines ways AFROTC might implement PTS information in its scholarship program and estimates the impacts, costs, and benefits of various implementation options.

Officer Candidate Testing

The Air Force currently uses the Air Force Officer Qualifying Test (AFOQT) and the Scholastic Aptitude Test (SAT) to predict success in training.[4] The AFOQT measures candidate aptitudes for officer precommissioning and postcommissioning training. Various AFOQT versions have been used since 1951 to screen officer training applicants. Two features distinguish the Keeper Study factors from the AFOQT. First, the Keeper Study predicts long-term retention. The time horizon is much greater than that of the AFOQT, which predicts success in training. Second, much of the Keeper Study predictor data are biographical, encompassing information about each applicant's childhood, family, motivation, employment history, high school and college activities, life events, and precommissioning flying interests. Although distinctive, screening with biographical data does have a precedent. Between 1951 and 1981 the Air Force considered biographical data to score the AFOQT. However, in 1982 the test's biographical section was deleted. There is no official explanation for this change in the AFOQT.[5]

The Leadership Effectiveness Assessment Profile (LEAP), a related research effort being funded by the Air Force Human Resources Laboratory, aims to assess an individual's potential for leadership and management, predisposition toward commitment to the Air Force as an institution, and ability to function well in team situations. LEAP will also be biographical-survey based. Results are expected to be available for Air Force implementation by 1993.[6]

Comments

The recent decision by the Air Force to increase the active duty service commitment for pilot training to 10 years may reduce interest in PTS research.[7] This decision aims to ease the pilot retention problem. However, it seems that the Air Force would always be better served by pilots who do not feel indentured. Hence, hiring pilots with a high PTS is still a valid objective. Finally, while this study focuses narrowly on PTS, it is also a model approach to determine the impacts of other factors currently used in Air Force officer selection systems.

Chapter 2 provides background information on AFROTC selection factors. Understanding chapters 3 and 4 requires training in simulation, statistics, or operations research. However, conclusions to be drawn from these sections are clearly stated.

Notes

1. The Oaks special study group reported its findings in a report commonly called the "Keeper Study" within ATC. The actual report title is *Officer Selection, "Can We Select to Retain?"* (Randolph AFB, Tex.: Officer Selection Study Group, Headquarters ATC, 1989).

2. The regression technique is widely used to find the best mathematical fit of a response variable to a set of predictor variables. Cause and effect is not implied. However, this conclusion is often drawn. Linear regression limits the relationship between response and predictor to certain mathematically tractable forms. Stepwise linear regression selects from a group of possible predictors those that best fit the response data. Stepwise regression is sometimes criticized because it relies on a computer to search (without preconceptions) for a good mathematical relationship. Critics argue that researchers ought to have prior reasons to believe a response is related to a predictor variable.

3. Enlisted Air Force members with college degrees may enter the officer ranks through OTS. These individuals may retire after 20 years of military service, and to retire at their officer grades, they must have at least 10 years of commissioned service. Officers with prior enlisted service have higher retention rates in the first 10 years of commissioned service because they are closer to retirement eligibility.

4. The Air Force Officer Qualifying Test (AFOQT) consists of 16 subtests that are used in different combinations to form five composite scores: pilot, navigator-technical, academic aptitude, verbal, and quantitative. These composites are used to predict success in different training programs.

5. One principal told the author that the change was in response to pressure from an organization which felt the biographical portion of the AFOQT was discriminatory against blacks.

6. Tom Watson, "Leadership Effectiveness Assessment Profile," point paper (Brooks AFB, Tex.: Air Force Human Resources Laboratory, undated).

7. The Air Force requires that individuals sign an agreement to remain in the Air Force for a specified period of time after receiving some types of training. The length of time is called the active duty service commitment (ADSC). The ADSC ensures that the Air Force realizes a fair return on its training investments. In March 1990 the Air Force announced that the ADSC for pilot training would increase from seven to 10 years for those entering training after 1 October 1991.

Chapter 2

Current AFROTC Scholarship Allocation System

The AFROTC commissioning program seeks to produce the right numbers and kinds of officers at the right time within budget constraints. Production goals are established by Headquarters USAF/DPPP (Deputy Chief of Staff, Personnel, Directorate of Personnel Programs, Force Programs Division) in consultation with all commissioning sources. For fiscal year 1992, the AFROTC production goal is about 2,100 line and 100 nonline (e.g., doctors, nurses, lawyers) officers.[1] This chapter discusses the mechanisms AFROTC uses to achieve its goals. Before discussing these controls, I want readers to understand the standard AFROTC course of instruction.

AFROTC Military Course of Instruction

Currently, about 150 colleges and universities have AFROTC detachments. Individuals earn an Air Force commission through AFROTC in one of two ways. Figure 2 illustrates the usual AFROTC life cycle, which is a four-year sequence of instruction and evaluation.[2]

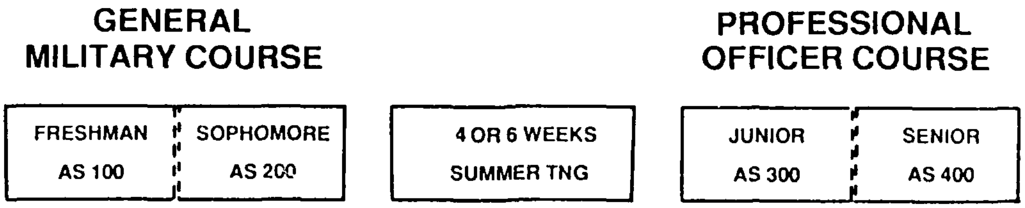

Figure 2. AFROTC Life Cycle

The General Military Course (GMC), which essentially is open to all students who hope to earn an Air Force commission, consists of the freshman-level Aerospace (AS) 100 class and the sophomore-level AS 200 class. Cadets spend one classroom hour each week on military studies and one hour each week on training. During the summer, between the sophomore and junior years, selected cadets attend four weeks of basic field training at an Air Force base. These cadets then enter the Professional Officer Course (POC), which is composed of the junior-level AS 300 class and the senior-level AS 400 class. Classroom contact hours increase to three hours each week with a fourth hour devoted to training.[3]

The second road to an AFROTC commission is a two-year program that consists of the POC. This option requires each student to attend two additional weeks of summer training between the sophomore and junior years as a substitute for the GMC.

Right Numbers, Right Kinds

There may be more cadets enrolled in the GMC than the Air Force ultimately will need. Consequently, entry into the POC (junior year of instruction) is not automatic; rather, it is contingent on the Air Force's forecast needs at the time of graduation. These needs are stated in terms of AFROTC production in the following categories:

- Pilot (one-third to be technical majors)
- Engineer (by major)
- Navigator (one-third to be technical majors)
- Scientific-Technical (by major)
- Missile (one-third to be technical majors)
- Nontechnical
- Nonrated Operations[4]

The mechanism used to control which cadets enter the POC is the Weighted Professional Officer Course Selection System (WPSS). This selection process originates at the AFROTC detachment and initially assigns each cadet a quality index score (QIS) in the latter part of the sophomore year. This score is based on a number of factors, including the Air Force Officer Qualifying Test (AFOQT), physical qualifications, and leadership and military aptitude ratings by the detachment commander and other officers. Boards composed of Headquarters AFROTC officers offer cadets entry into the POC based on, among other things, the quality index score, cadet production category preferences, college grade point average (GPA), academic major, AFOQT, and projected Air Force requirements. Since there is a minimum quality index score required, a cadet can be prevented from entering the POC at the detachment level. Selectees may enter the POC and the Obligated Reserve Section the first day of their junior year. At this point, a cadet is obligated to complete college and to begin four years of active duty upon graduation. The Air Force has a number of recoupment options if a cadet fails to complete school or the AFROTC program.[5]

While the WPSS can limit the number of cadets who enter the POC, it does not help ensure that the minimally required numbers and kinds will be available for screening. Consequently, AFROTC uses two scholarship programs to attract certain hard-to-fill production categories. In fiscal year 1990 the Air Force will have approximately 5,400 cadets on scholarship (freshmen, sophomores, juniors, and seniors). Approximately one-half of the officers who enter the program through AFROTC receive some sort of Air Force scholarship to pay for books, tuition, and fees for between two and four years (some scholarship students receive no funding for part or all of their freshman and sophomore years).[6]

Four-Year Scholarship Program

Some Air Force specialties require specific academic preparation—usually an engineering or a scientific degree. Historically, the Air Force Academy does not produce enough technical officers to meet Air Force needs, and the OTS does not attract sufficient high-quality, technically educated individuals.[7] To fill this void, AFROTC offers four-year scholarships to high-quality students to study specific disciplines. Approximately 15,000 individuals apply for the four-year scholarships each year. The Air Force offers scholarships to about 2,400 applicants, and 900 to 1,200 individuals actually accept the scholarships and enter the freshman class. About 99 percent of these scholarships are awarded to technical majors.[8]

Selection Process Timing and Criteria

Four-year scholarships are typically offered to high school seniors. AFROTC accepts applications from June through November for college entries the following September. Each applicant is rank ordered by a board of officers assigned to AFROTC detachments. About one-third of an applicant's score is based on high school studies. Specific items of interest are Scholastic Aptitude Test (SAT) scores (minimum 1,000 total, 500 mathematics, 450 verbal), American College Test (ACT) scores (minimum 23 composite, 20 mathematics, 19 English), grade point average (minimum 2.5 on a 4.0 scale), class rank (minimum top 25 percent), and classes taken. Together, these items indicate an applicant's ability to complete college-level work. About one-third of an applicant's board score is based on extracurricular activities in high school to get a measure of leadership potential as an officer. The final one-third of the score is based on appraisals of the applicant by an Air Force officer and high school teachers and counselors.[9]

Students apply and compete for scholarships according to academic discipline. Competition is keen in some disciplines. In others, most applicants who meet minimum standards are offered a scholarship. Those receiving four-year scholarships are classified into a production category in the latter part of their sophomore year through the WPSS. Figure 3 illustrates the life cycle of four-year scholarship recipients.

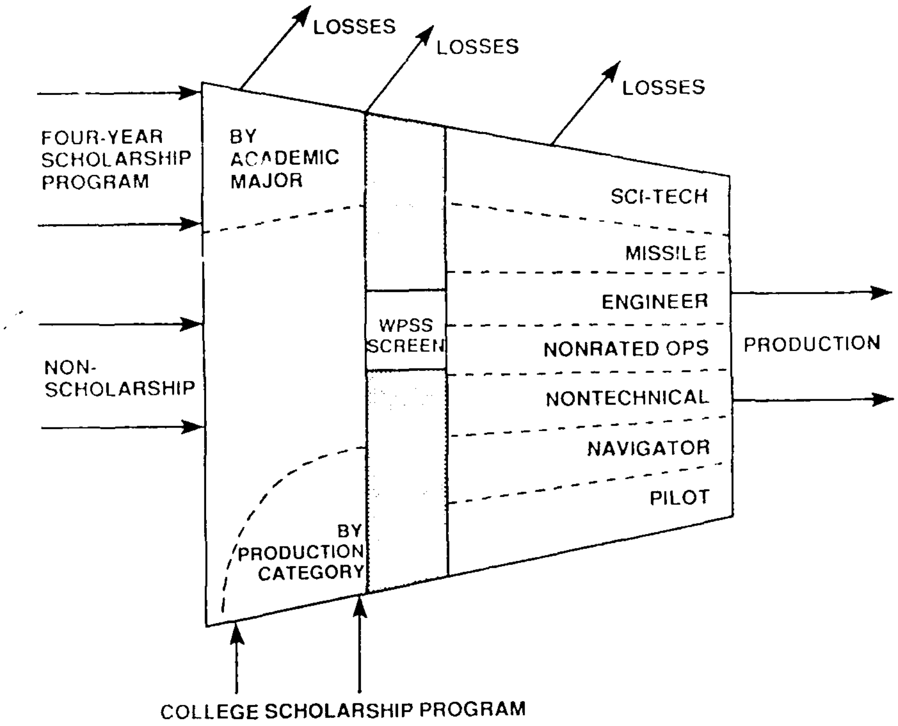

Figure 3. AFROTC Student Flows

Scholarship Types

There are four major award categories in the Four-Year Scholarship Program (FYSP). If there is an AFROTC detachment at a university, and a Type I four-year scholarship recipient can get accepted at that school, the Air Force pays for books, tuition, and fees, regardless of the cost. Type II four-year scholarships pay up to a dollar ceiling. For the 1990–91 school year, the Air Force plans for Type I awards to comprise about 20 percent of the FYSP. The annual Type II ceiling will be $8,000. For those with suspect academic ability, AFROTC offers Type II three-and-one-half-year guaranteed and three-year guaranteed scholarships. These scholarships are awarded after the student exceeds a specified minimum academic performance in college for either one semester (for the three-and-one-half-year scholarship) or two semesters (for the three-year scholarship).[10]

Student Obligations

Students who receive financial aid under this program enlist in the Obligated Reserve Section at the start of their sophomore year. These cadets agree to finish school and serve four years of active duty or be subject to Air Force recoupment action.[11]

Uncertainties

Several factors complicate FYSP management. When these scholarships are offered, the AFROTC objective is to produce required numbers by category four years hence. One uncertainty is that historically only about 50 percent of awardees ultimately will accept their scholarships. AFROTC is in direct competition with the Air Force Academy, other military services, and other funding sources for these students.[12] Therefore, it is not likely that the desired number of students by academic major will accept scholarships. Some majors may be overrepresented, while others may be underrepresented. A second source of uncertainty is that some scholarship recipients do not know which university they will attend. This uncertainty complicates budget management and also complicates predicting probability of graduation, as schools have different attrition rates. Hence, meeting production goals within cost constraints with the FYSP alone is difficult. A final problem is that production requirements for four years in the future are only estimates and will likely change. To deal with the uncertainty inherent in the FYSP, AFROTC uses the College Scholarship Program (CSP) to make midcourse adjustments.[13]

College Scholarship Program

The CSP augments the four-year scholarship program to produce officers subject to numbers, types, budgets, and other constraints. Figure 3 illustrates that the CSP makes awards to individuals who are already in college. Roughly 50 percent of AFROTC scholarships fall into this category, with about 1,000 awards given to 2,000 applicants annually.[14]

The CSP has several attractive features. This program has less uncertainty than the FYSP. Since the applicant's school and major are known, costs are more predictable. There is a student track record of collegiate academic performance. Since awards are for less than four years, the CSP costs less on a per capita basis. Finally, the Air Force has a better estimate of requirements, as students are closer to graduation. These advantages lead one to believe that the Air Force should place all its resources in the CSP. However, the CSP does not make 100 percent of the AFROTC awards, because it is not sufficiently attractive to students in some technical majors or to students attending the highest quality schools (as measured by cost). As these individuals are already in college, they have found some form of financial aid and are closer to realizing starting civilian salaries which exceed a second lieutenant's pay. Consequently, the Air Force is not as attractive financially.[15]

Selection Process

College scholarship applicants are rank ordered through a board process. About one-fourth of an applicant's score is awarded for academic potential as measured by the SAT, ACT, or academic aptitude score on the AFOQT. About one-third of the score is based on academic performance as measured by college GPA and course difficulty. The remainder of the score is based on AFROTC Form 36, AFROTC Scholarship Nomination. This form contains an applicant's appraisal based on an interview with an AFROTC officer, an applicant's statement of desire for a commission, a list of extracurricular activities, previous employment, academic major, race, and sex. Unlike the FYSP, college scholarships are awarded by production category (e.g., pilot, navigator). Although 85 percent of the CSP recipients have technical majors, prerequisite academic majors exist only for engineering and scientific-technical production categories.[16]

Obligation

Recipients of financial assistance under the CSP enter the Obligated Reserve Section at the time financial aid begins or on the first day of their sophomore year, whichever is later.[17]

Right Time

Graduates from the Air Force Academy and OTS enter active duty upon graduation. This is not the case for AFROTC graduates. The Air Force may wait up to 12 months after graduation before bringing AFROTC graduates on active duty (if at all).[18] This gives the Air Force latitude in two respects. First, since college graduation dates do not align with the start of the government's fiscal year, AFROTC graduates can be brought on active duty in one of two fiscal years. This gives the Air Force flexibility in meeting end-of-year strength objectives (end strength). Second, AFROTC graduates give Air Force programmers flexibility in meeting Military Personnel Account (MPA) constraints. An individual who comes on to active duty on 1 August will have to be paid for two months in that fiscal year and will have to be counted against end strength. However, if the Air Force waits until 1 October to bring the individual on active duty, the AFROTC graduate will not count or cost in the previous fiscal year's budget. The difference between bringing all AFROTC cadets on active duty at graduation as opposed to 12 months later is about a one-time $50-million decision:

$$2{,}500 \text{ 2Lt/year} \times \$20{,}000\text{/2Lt/year} = \$50\text{M}.$$

Only a portion of this could be saved by adjusting accession timing.

Right Cost—AFROTC Scholarship Budget

The AFROTC scholarship budget is calculated from the current year's average cost per scholarship (adjusted for inflation) multiplied times the number of scholarships awarded. For academic year 1988–89, the average cost per student was $5,559.[19] Under certain conditions, this approach is statistically sound because there are large numbers of scholarships awarded (5,400 in effect for academic year 1989–90). When large numbers are involved, actual average costs are likely to be near historical average costs. This approach requires few changes in the scholarship programs from one year to the next. Students must attend schools in the same tuition category. All schools must inflate their costs similarly. The dollar ceiling on low-cost schools must change at the inflation rate. The ratio of students in high-cost and low-cost schools must remain constant. To the extent that these things do not happen, the AFROTC scholarship budget will not match expenditures. (Chapter 4 contains estimates on how much outlays can be expected to differ from the budget.)

Other Constraints

In addition to meeting production goals, other potential AFROTC considerations might be managed through the scholarship program. If there were any particular group the Air Force could not get in sufficient numbers, scholarships might be used as an incentive. For example, scholarships might be used to attract blacks, hispanics, and white females. Another issue is detachment viability. By law, if an AFROTC unit has fewer than 17 cadets in the junior class for four consecutive years, the detachment must be closed. The scholarship program could be used to manage detachment viability.

Propensity-to-Stay Considerations

Current AFROTC policy is to award scholarships to applicants with the highest input quality. No study has determined the validity of these measures to predict success as an officer, although some of them do predict success in training. As discussed in chapter 1, the Keeper Study reports success in predicting retention. Propensity to stay could be incorporated into the AFROTC WPSS or scholarship award processes if there were chronic retention problems with a particular group.

Remarks

The primary goal of the AFROTC commissioning program is to produce the right numbers and kinds of officers at the right time within budget constraints. The Four-Year Scholarship Program attracts desired academic majors to AFROTC. The principal shortcoming of the four-year program is its uncertainty. The College Scholarship Program allows midcourse adjustments. AFROTC uses the Weighted Professional Officer Course Selection System to make final adjustments before cadets enter their junior year. At the present time, exercising these three controls is a complex, labor-intensive process. The next chapter presents an approach that could aid AFROTC managers in system control.

Notes

1. Maj Rob Gaston, Registrar, Selections Division (AFROTC/RRU), multiple interviews with author, Maxwell AFB, Ala., August 1989–April 1990.

2. Unless otherwise indicated, all figures and tables in this document are the work of the author.

3. Maj Mark Lewis, AFROTC/RRU, multiple interviews with author, August 1989 April 1990.

4. Ibid.

5. Maj Fred Fisher, AFROTC/RRU, multiple interviews with author, August 1989-April 1990.

6. Lewis interview.

7. Quality is nebulous. Air Force officers have different abilities. However, the personnel system does not have a good way to measure differences in officer output. Consequently, persons responsible for officer accessions use measurable indicators of input quality to differentiate between applicants. High AFOQT, GPA, SAT or ACT scores, high class rank, and participation in extracurricular activities or athletics are considered desirable. While there is evidence that these measures do predict success in training, the link to on-the job performance has not been established.

8. Lewis interview.

9. Ibid.

10. AFROTC Regulation 53-7, *College Scholarship Programs*, 1 January 1989, 15.

11. Ibid., 6.

12. The Air Force Academy and AFROTC do not coordinate their scholarship offers. Both organizations try to attract the best high school students. Individuals who receive offers from both face a dilemma. The academy is more attractive financially, in essence providing room, board, and tuition. It also provides unique training opportunities. AFROTC is attractive because it allows scholarship recipients a wide range of choices in universities. There is also greater personal freedom associated with attending a civilian university.

13. Gaston interview.

14. Ibid.

15. Ibid.

16. Ibid.

17. Ibid.

18. Lewis interview. The Keeper Study reports that the longer an AFROTC graduate waits before coming on active duty, the lower the probability of long term retention in the Air Force. AFROTC officials have long suspected this and question the wisdom of producing officers through OTS while AFROTC graduates wait to enter active duty.

19. Gaston interview.

Chapter 3

Integrating Propensity to Stay into the AFROTC Commissioning Program

The Air Force does not want all officer accessions to stay in the service until retirement.[1] Any commissioning effort to alter retention rates, either higher or lower, must consider projected manning in each production category. With this caveat, AFROTC could incorporate propensity-to-stay (PTS) information at three decision points: when awarding four-year scholarships (FYSP), when awarding scholarships to those already enrolled in College Scholarship Program (CSP), and when screening applicants for the Weighted Professional Officer Course Selection System (WPSS). The PTS information is useful only when true decisions are made. If there were too few applicants for a scholarship and AFROTC selected all applicants meeting minimum qualifications, PTS probably would not change any decisions. However, when applications exceed allocations, PTS could make a difference.

Implementation Options

For each of the three decision points, AFROTC has at least four implementation options, ranging from a slight alteration to an extensive revision of current scholarship applicant selection procedures.

Option One—Objective

Under this option, PTS impacts would be completely objective. Board members, who today subjectively rate applicants, would not see raw PTS information. PTS would influence allocations in a way which would be transparent to decision makers, either by embedding the information in another measure or by objectively adding points to an applicant's board score. The main advantage this approach offers is that PTS impacts could be both estimated and controlled. At the present time, AFROTC does not employ an indicator in a completely objective manner.

Option Two—Subjective

Under this option, decision makers would have access to each applicant's PTS information and, within wide bounds, act on it subjectively. This is the option board members use today for most other quality indicators.

Option Three—Combination

Option three is a combination of options one and two. It shows PTS information to board members and also requires an objective impact. This option ensures that PTS has some minimum impact while allowing extreme scores to carry disproportional weight in the allocation decision. AFROTC currently handles a few indicators in this manner.

Option Four—Optimization

The first three options require little modification to current AFROTC selection processes. Option four is different. It is an optimization option that not only allows PTS to influence individual allocations, it also affords AFROTC other management opportunities. This option requires boards to divide an applicant pool into three groups. Individuals who were so outstanding by current standards that they would receive an allocation no matter what their PTS might be would comprise group one. Group three would contain people of such low quality by current standards that they would not receive an allocation no matter what their PTS. Group two would be "gray-zone" individuals. While some would be better than others by current measures, the differences would not be so great that other factors should not influence the allocation decision. The objective would be to select from the gray zone a subset that had higher PTSs. The selection would also simultaneously satisfy other AFROTC constraints, such as total production goals, budget limits, minority production goals, engineering production goals, or detachment viability.

Weighted Professional Officer Course Selection System

Suppose the Air Force has determined that pilot retention is too low and should be altered by training different types of people. At the present time, AFROTC pilot allocations are made through the WPSS. When making these allocations, WPSS boards primarily consider two measures: a cadet's quality index score (QIS) and the AFOQT pilot component.[2] Figure 4 shows pilot allocation award probability as a function of QIS and pilot AFOQT. These data are for nonscholarship cadets considered in fiscal year 1989 for fiscal year 1991 college graduation. All data are for applicants with pilot as their first preference. Small cells are not displayed. For example, 56 cadets appeared with a QIS in the 80–89 range and with a pilot score in the 71–80 range. Of these, 44, or 79 percent, received pilot allocations.

Figure 4 reveals several things. First, if the pilot score is held constant, pilot allocation probability generally increases with higher QIS (reading from left to right within a row). Second, if QIS is held constant, allocation probability increases with higher pilot score (reading from top to bottom in a column). As would be expected when dealing with data, exceptions exist

AFROTC QIS

AFOQT PILOT	60-69	70-79	80-89	90-99	100-109
31-40		0/11 .00	1/10 .10		
41-50	3/12 .25	15/35 .43	13/26 .50		
51-60	5/12 .42	30/56 .54	28/43 .65	11/15 .73	
61-70	8/17 .47	45/70 .64	64/85 .75	12/14 .86	
71-80	5/9 .56	21/31 .68	44/56 .79	19/24 .79	
81-90		16/20 .80	30/40 .75	17/24 .71	
91-100			14/19 .74	6/12 .50	9/10 .90

Figure 4. Pilot Allocation Probabilities

to these generalizations. A third observation is that the highest allocation probability seems to be in the .8 to .9 range. Within a cell in figure 4, where all applicants have about the same QIS and pilot score, how is it that some are selected? The answer is generally found within the QIS, which is a composite of other measures. If any one component is strikingly low, a cadet might not get an allocation. For example, a low GPA might cause rejection (see chapter 2 for QIS elements).

WPSS boards begin their work in February. All allocations are not usually made during the first board meeting. Rather, the process is iterative. Based on Air Force requirements and individual preferences and qualifications, AFROTC offers some applicants allocations. Not all cadets are offered their first choice. For example, electrical engineers on AFROTC scholarships usually won't receive a first-choice pilot allocation. They normally receive electrical engineering allocations. As requirements change, and cadets accept or reject WPSS allocations, additional boards may be convened over a period of months. Cadets not offered an allocation on one board are carried over and reconsidered on subsequent boards.[3]

How can PTS information be integrated into the WPSS? Four general ways already have been mentioned to integrate PTS into the allocation process. Each option is now discussed in detail.

Option One—Objective

PTS could be incorporated into QIS without showing the PTS component to board members. Currently, the maximum QIS is 124. If PTS were incorporated into a QIS with a 10-percent weight, then 12.4 would be the maximum PTS points.

Figure 5 gives some insight into one PTS point-awarding subtlety. Listed along each matrix top are some possible original QISs that range from zero to 124. Along the left side of the matrix are some possible PTS awards. The matrix entries reflect the change from the original QIS that would result from awarding PTS points under two different methods. Under method one, the maximum QIS would remain 124, with up to 12.4 points awarded for PTS. In method two, up to 14 points would be added to current QISs: 14/(124 + 14) = 10 percent. The two methods produce different results. For example, under method one, an individual with an original QIS of 85, who received 6.2 PTS points, would see a –2.3 change in the QIS for a new QIS of 82.7. Under this implementation, one conclusion springs forth immediately: PTS points tend to help those with low original QISs and hurt those with high QISs (read left to right within a row). Reading within a column, the difference between awarding zero and 12.4 points is always 12.4. Thus, an original QIS of 65 would transform into the range (65 – 6.5, 65 + 5.9) = (58.5, 70.9) and (70.9 – 58.5 = 12.4). The most change an individual would see in the QIS would be 12.4. Depending on where an individual was in figure 4, ±.05 points would be about the probability that receiving a pilot allocation would change (where 1.00 is selection with

METHOD 1

PTS POINTS	ORIGINAL QIS 0	65	85	105	124
0	0	–6.5	–8.5	–10.5	–12.4
6.2	6.2	–.3	–2.3	–4.3	–6.2
12.4	12.4	5.9	3.9	1.9	0

METHOD 2

PTS POINTS	ORIGINAL QIS 0	65	85	105	124
0	0	0	0	0	0
7	7	7	7	7	7
14	14	14	14	14	14

Figure 5. PTS-Induced Change in QIS

certainty and 0.00 is nonselection). Method two would produce about the same change of magnitude except that the PTS impact would be independent of the original QIS. Hence, under option one, PTS would have only a marginal effect.

An issue that must be addressed is the propensity-to-stay point distribution plan as a function of PTS. If screening out individuals with a low PTS is the goal, AFROTC could achieve maximum effect by awarding zero points for a low PTS and nearly 14 points (under method two) for all other PTSs. Likewise, maximum advantage could be given to those with a high PTS by awarding them 14 points while giving everyone else zero points. A more traditional distribution would award seven points for a midrange PTS and zero or 14 points for PTS extremes. It may also be the case that different distributions should be used for different production categories. For example, if there were a production category with retention rates that were too high, a low PTS might be desirable.

Option Two—Subjective

A PTS measure could be shown to board members without being incorporated into the QIS. Requiring no change to current QIS calculations, this option would be easy to implement. Board members could be advised about the appropriate PTS weights. However, this option produces higher uncertainty about PTS impacts. Some board members may reject PTS validity and place no weight on it. Others might take the opposite extreme. One may speculate that under this option, PTS would mirror other QIS components that are available to the board. A particular component may be heavily weighted, particularly if extremely low. For example, suppose two cadets have exactly the same pilot score and QIS. One has a low GPA, which is compensated for by a detachment commander's high rating. The other has nominal QIS components. The cadet with the low GPA is less likely to receive an allocation. In this example, a low GPA drove the allocation decision. Similarly, extreme PTSs might carry great weight, all other things being equal. If the Air Force wants to improve retention in a production category, a low PTS might cause rejection under the WPSS. Ironically, while AFROTC might be less likely to offer a pilot allocation to a cadet with a low PTS, it might be more likely to offer the same cadet an allocation in a production category with retention considered too high. Hence, under option two, PTS potentially has more impact than option one for those with extreme scores.

Option Three—Combination

Propensity to stay could be treated like most other quality index score components. It could both contribute to QIS and be available to the board. This option would not eliminate the potential for great weight on extreme scores. However, it would ensure that PTS carried some weight. As in option one, some adjustment to current procedures would be required.

Option Four—Optimization

This option would require board members to separate applicants into three groups without considering PTS. Group one would be high-quality applicants who would receive an allocation regardless of their PTS. Group two would be gray-zone, intermediate-quality applicants, any of whom would be acceptable. Group three would be unacceptable applicants, regardless of their PTS. Assuming that group one's size is less than total allocations, then a group two subset could be selected using classic operations research optimization techniques. This case is a zero-to-one integer programming problem (again WPSS pilot allocations). The following equations define requirements and objectives for pilot production. These equations do not apply to other production categories.

Objective: To Maximize

$$\Sigma_i \, p_{3i} * p_{4i} * PTS_i * x_i$$

where Σ_i means the sum for all gray-zone pilot applicants.

p_{3i} means the probability that applicant i will complete the third (junior) year. Ideally, this probability or persistence would be estimated at least as a function of academic major and school.

p_{4i} is the fourth (senior) year completion probability.

PTS_i means the propensity to stay in years for gray-zone applicant i (PTS points here correspond directly to PTS).

x_i is a decision variable (representing applicant i) which an optimization program will set equal to zero if no allocation or one for an allocation.

* means multiply. Thus, $PTS_i * x_i$ equals PTS_i or zero.

The following constraints govern pilot allocation:

Production

$\Sigma_i \, p_{3i} * p_{4i} * x_i \geq$ pilot production goal for gray-zone applicants.

Minority

$\Sigma_j \, p_{3j} * p_{4j} * x_j \geq$ minority pilot goal for gray-zone applicants where index j denotes minorities (j's are a subset of i's).

Engineer

$\Sigma_k\ p_{3k} * p_{4k} * x_k \geq$ pilot-engineer goal for gray-zone applicants where index k denotes engineers (k's are a subset of i's).

Budget

$\Sigma_i\ c_{3i} * x_i \leq$ gray-zone pilot budget share junior year

where c_{3i} means the cost that applicant i will incur in the third (junior) year. Ideally, this cost would be at least a function of school and inflation.

$\Sigma_i\ c_{4i} * p_{3i} * x_i \leq$ gray-zone pilot budget share senior year

where c_{4i} means the cost that applicant i will incur in the fourth (senior) year.

Example

Suppose a WPSS board met and split a pilot applicant pool into three parts. Table 1 lists group two or gray-zone characteristics. (All data are notional. The PTS points for this example simply reflect the expected years the individual will remain in the Air Force.) Suppose that AFROTC wanted to satisfy the following conditions:

Production	$\geq$ 3.5 (expected production of at least 3.5 people)
Race	$\geq$ 1.0 (produce at least one minority)
Engineers	$\geq$ 2.0 (produce at least two engineers)
$Budget_3$	$\leq$ \$30,000 (spend less than \$30K in the junior year)
$Budget_4$	$\leq$ \$30,000 (spend less than \$30K in the senior year).

How should AFROTC select applicants to satisfy these conditions while it maximizes total PTS?

TABLE 1

Notional Data

NAME	*QIS*	*PILOT AFOQT*	*PERSIST $YEAR_3$*	*COST $YEAR_3$*	*PERSIST $YEAR_4$*	*COST $YEAR_4$*	*MINORITY*	*ENGINEER*	*PTS*
A	72	68	.98	\$ 8100	.99	\$ 8500			12 6
B*	88	56	.88	4200	.90	4300		YES	10 7
C*	70	59	.86	5600	.88	5900	YES	YES	9 9
D*	62	78	.98	5100	.98	5300			9.8

TABLE 1 (cont'd)

NAME	*QIS*	*PILOT AFOQT*	*PERSIST YEAR3*	*COST YEAR3*	*PERSIST YEAR4*	*COST YEAR4*	*MINORITY*	*ENGINEER*	*PTS*
E	75	56	.94	$15000	.96	$16000	YES		9.4
F	82	49	.85	5800	.86	6100		YES	9.0
G*	77	61	.93	4700	.94	5000			8.7
H	88	56	.85	5400	.90	5500	YES	YES	8.6
I*	69	65	.84	3000	.86	3100		YES	8.6
J*	70	70	.94	4300	.97	4500			8.5
K	87	50	.88	7200	.91	7600		YES	8.2
L	79	70	.88	12000	.90	12700	YES		8.0
M	73	54	.83	8100	.85	8300		YES	7.8
N	86	52	.92	5000	.94	5350			7.5
O	62	78	.96	5600	.97	7000	YES		7.3
P	89	52	.80	8100	.85	8500		YES	7.1
Q*	72	60	.98	3000	.98	3100	YES		7.0
R	72	70	.95	4300	.96	4500			7.0
S	65	80	.85	8100	.90	8500		YES	7.0
T	87	57	.85	15000	.88	16000	YES	YES	7.0

If AFROTC selected B, C, D, G, I, J, and Q, the following would be expected:

Production	=	6.0
Race	=	2.5
Engineer	=	2.3
$Budget_3$	=	$29,900
$Budget_4$	=	$28,570
Total PTS	=	53.7

A zero-to-one integer programming optimization code made these selections. In general, it selected those with higher PTSs. An individual not selected generally had a high cost or a low PTS. Selecting any other applicant set would result in a violation of a constraint or a lower total PTS. As the solution indicates, the original budget constraints are not consistent with production goals. AFROTC would probably want to impose additional constraints. For example, some minimum production from high-cost schools might be desired. Maximum production levels should probably be set. School viability might be a concern. It is possible to overconstrain the problem so that no solution is possible. This is also useful information since impossible goals ought not be sought.

This problem formulation was kept small and simple for illustration purposes. Some complexities have been ignored. This problem could probably be solved manually. However, as constraint and applicant numbers grow, computer assistance becomes essential.

Option four gives great weight to PTS for those in the gray zone. It is a major modification to the current system. The main advantage this approach offers is that it permits AFROTC to consider PTS while it satisfies other necessary constraints. The disadvantage is that some work would have to be done to write software and to implement the new system. Chapter 4 has additional information on the implementation of option four.

College Scholarship Program

A panel of three professors of aerospace studies (PAS) reviews each College Scholarship Program application. (A PAS is an Air Force colonel or lieutenant colonel who commands an AFROTC detachment.) Each officer subjectively assigns each record a score of from zero to 100. Each member assigns up to 24 points to each record to indicate academic potential. The AFOQT academic aptitude component score and/or ACT/SAT scores influence these points. Up to 33 points are awarded for academic performance. Board members consider college GPA, AFROTC grades, and course difficulty. The final 43 points are based on AFROTC Form 36, which contains a number of data fields and personal comments including the QIS and the AFOQT scores. Board members may weigh each Form 36 item as they wish, although historically the PAS and applicant comments are the most important. The board members' scores yield a maximum possible score of 300. Boards are held three times during the year, depending on the scholarship type. Figure 6 illustrates the frequency with which the February 1989 board awarded various scores.[4] For example, 88 applicants

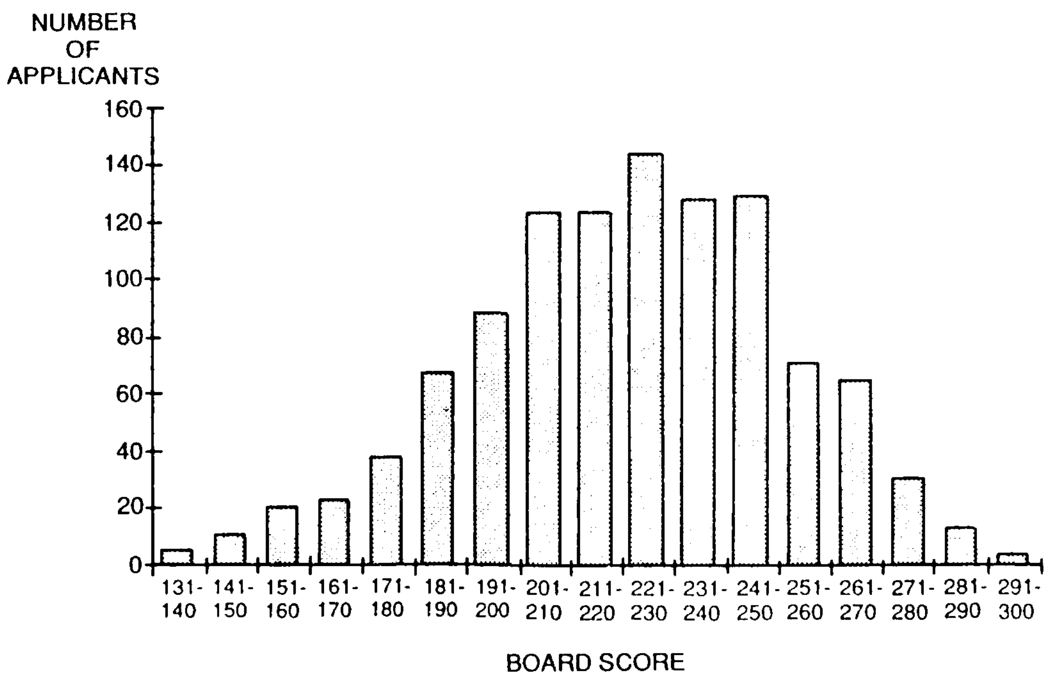

Figure 6. February 1989 CSP Board Results

received a score in the 191–200 range. The relatively high density of scores in the 200–250 range has important implications for various PTS implementation option impacts. This importance stems from the AFROTC policy of awarding scholarships based on board rank. When awarding 50 scholarships, AFROTC selects the 50 top-ranking applicants. For the February 1989 board, a small change in score for an individual in the 200–250 range would change relative rank much more than the same change in score for an individual in the 291–300 range.

Option One—Objective

Under this option, PTS points would be objectively added to board scores without showing the PTS component to board members. Using the method two approach discussed previously, AFROTC could add up to 33 PTS points to an applicant's board score—33/(300 + 33) = 10 percent. It could distribute these PTS points in many ways. Each distribution method would produce different results. AFROTC must anticipate these impacts before it selects a distribution plan. Figure 7 illustrates four potential plans.

The triangular distribution reflects one way raw PTS information could be transformed into points. The average applicant would receive one-half the maximum possible PTS points (33/2 in this case). Few applicants would have very high or very low PTS points. Finally, the highest PTS score frequency would be near the midrange.

Under the uniform distribution plan, AFROTC would give the average applicant one-half the maximum possible PTS points. In this case, score frequency would be the same over the entire range. There would be as many high scores as low and as midrange.

The "Help High PTS" distribution would award maximum PTS points to those with the top 25 percent raw scores and no points to all others. Hence, PTS points would help only those with the highest PTSs.

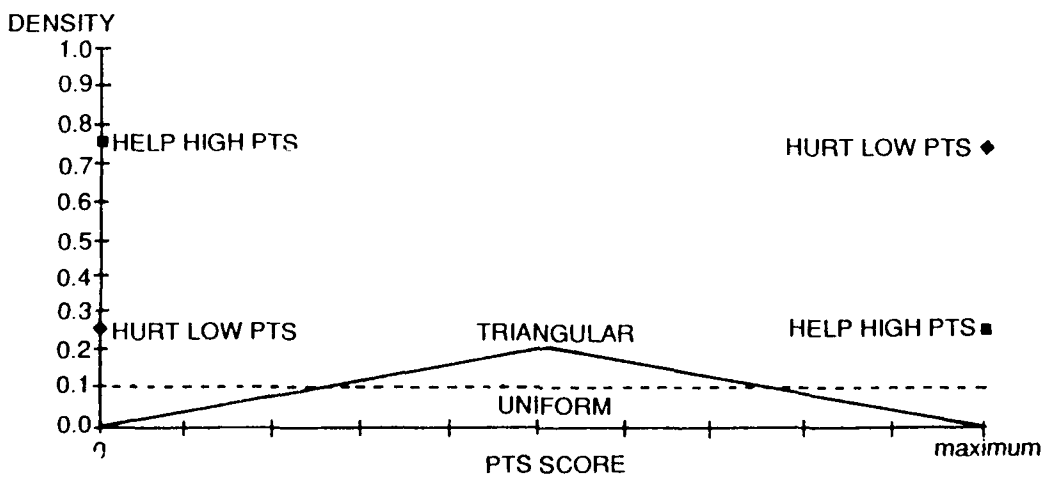

Figure 7. PTS Distribution Plans

The "Hurt Low PTS" distribution would award maximum points to the top 75 percent of the raw scores. The lower 25 percent would receive no points and thus would be hurt relative to the others.

This study used Monte Carlo simulation to estimate the impact of awarding PTS points by these four distributions. The simulation process consisted of the following sequence:

1. Randomly select a sample of 100 board scores from the figure 6 distribution. Determine each score's rank within the 100 board scores.
2. For each of these 100 scores, randomly assign PTS points according to figure 7 distribution. Calculate (New Score = Old Score + PTS) for each of the 100 board scores.
3. Determine each score's new rank within the 100.
4. For the selected distribution, perform steps 1–3 with 20 different random number streams.
5. For the remaining three distributions, repeat steps 1–4 with the same 20 random number streams.[5]

Figure 8 illustrates one impact of awarding PTS points with these four distributions. Horizontal axis for figure 8 represents original individual ranks in 10 percent increments (since the sample size is 100, each individual represents 1 percent). The vertical axis is the average absolute rank change (any change is considered positive) due to awarding PTS points under the various distributions. For example, under triangular distribution, the rank of those in the original bottom 10 changed by an average of just over two. As observers would expect, under the same distribution, the average rank change for those originally in the middle was greater—almost eight. More difficult to anticipate are the between-distribution differences. Recall that all four options place a 10-percent weight on PTS (up to 33

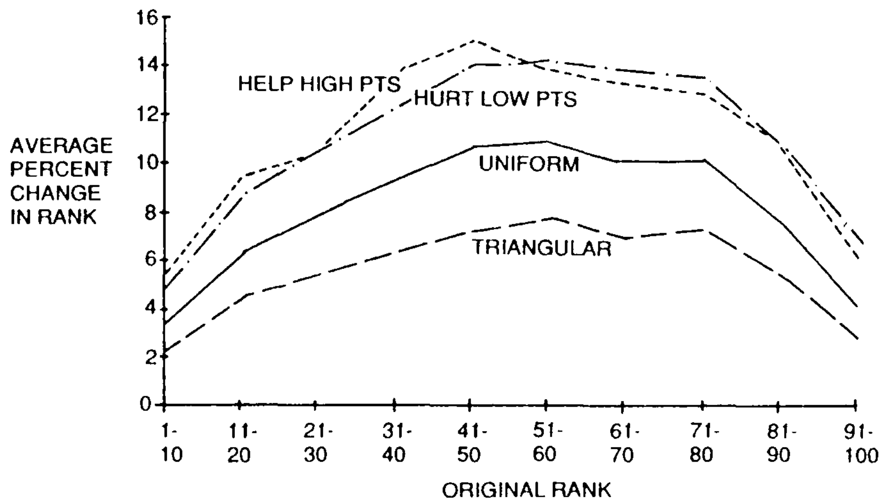

Figure 8. Average Impact on CSP Rank

points). The point is that a 10-percent weight can mean many different things. The specific distribution selected for awarding PTS points should depend on the desired impact. All these example distributions have at least one desirable feature: those with original low or high ranks changed the least. Hence, those selected first under the current system would still likely be selected. Those least likely to be selected originally are still least likely to be selected. Most turbulence occurs in the area where it is most difficult to distinguish between individuals.

On the surface, there appears to be little difference in impact between the "Help High PTS" and "Hurt Low PTS" distributions. Figure 9 illustrates that by another measure, there is indeed a difference. The horizontal axis is the same as in figure 8. The vertical axis lists the average maximum rank changes for the various distributions. For example, for the 20 triangular distribution simulations, the average maximum change in rank for those in the bottom 10 is about seven. The "Help High PTS" distribution impact becomes clearer. For those few with a high original rank who receive 33 PTS points, there is nowhere to go, and the maximum rank change is low. However, those few with a low or middle rank who receive 33 PTS points are able to move up in rank past many other individuals.

The "Hurt Low PTS" distribution interpretation is similar. For those few with original high ranks who receive no PTS points, there is a long way to fall. For those originally ranked low who receive no PTS points, things can't get much worse. Since most low rankers receive 33 PTS points, their relative position changes little. A reason one might elect to "Hurt Low" as opposed to "Help High" is that it might be easier to identify those who are likely to leave than those who are likely to stay.

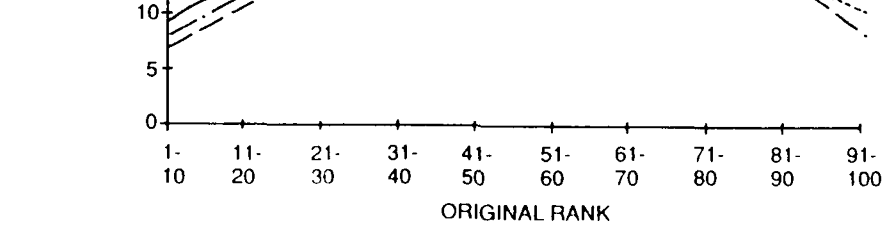

Figure 9. Maximum Impact on CSP Rank

Having said all this, it turns out that for many production categories, propensity-to-stay points under any distribution would not influence College Scholarship Program decisions. Figure 10 illustrates the electrical engineering subset from figure 6. In this situation, PTS would not have changed scholarship award decisions. All electrical engineer applicants who met minimum qualifications were selected. This pattern is typical for electrical engineers because Air Force needs exceed the number of interested applicants. A consistent exception to this pattern is aerospace engineering, where applicants exceed needs. For scholarships which do not require a scientific or technical major, applicants greatly exceed requirements.[6]

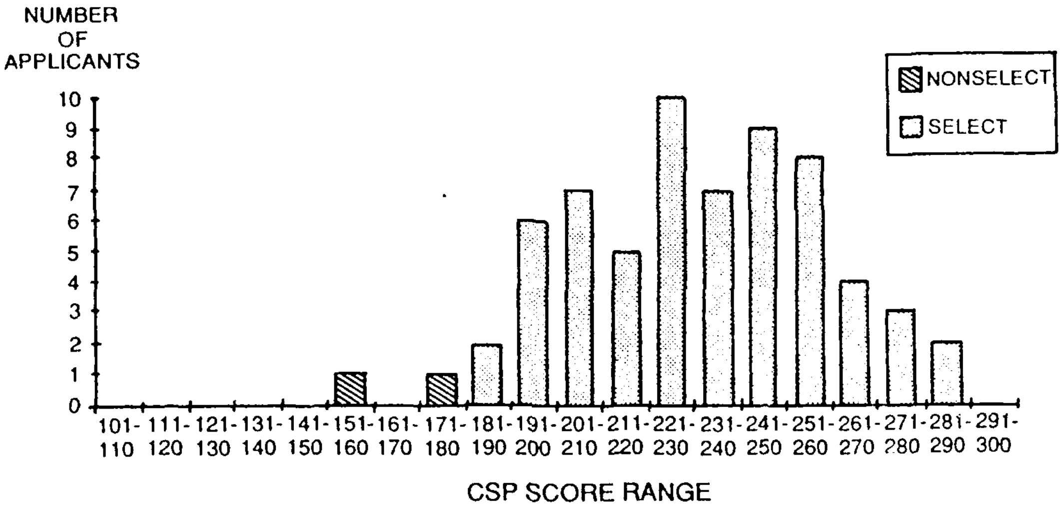

Figure 10. Three-Year Electrical Engineering Applicants (February 1989 Board)

Option Two—Subjective

There are two ways CSP selection boards could use PTS information subjectively. First, each board member's maximum score could remain at 100 points. The 43 points currently based on AFROTC Form 36 could reflect the PAS's judgment about PTS (method one). The alternative would be to permit each board member to award up to 11 additional points for PTS (method two). This is explained by the following equation: $11/(100 + 11) = 10$ percent. Again, under method one, PTS tends to hurt those with original high scores and help those with low scores. Under method two, the PTS effect is independent of the original board score. Under method one, PTS could carry a 43-percent weight in extreme cases. Under method two, the most weight PTS could carry would be 10 percent.

Option Three—Combination

Although an applicant's quality index score is seen by PASs on Form 36, the measure doesn't carry great weight in CSP selections. Thus, a QIS modification similar to the one discussed under the Weighted Professional Officer Course Selection System would have very little impact for the College Scholarship Program. (If the QIS were modified for WPSS purposes, it would necessarily be modified for CSP purposes.) If up to 11 objective points were allowed for PTS (method one), and PTS were also allowed to influence the 43 subjective points, the most weight PTS could carry would be 48.6 percent. This is explained by the following equation: $(11 + 43)/(100 + 11) = 48.6$ percent. Again, the impact on any individual would depend on original rank.

Option Four—Optimization

Figure 11 shows an aerospace engineering subpopulation in which applicants typically exceeded requirements. It also reflects the AFROTC policy of selecting the highest quality cadets as measured by their CSP score. This is a reasonable policy. However, the situation presents an ideal opportunity to use the PTS information. There are about 20 nonselects with a CSP score over 191. All these individuals meet minimum requirements as measured by electrical engineering standards (see figure 10). If the Air Force had a retention problem with aerospace engineers, then the AFROTC might want to select applicants in the 191–220 range with high PTSs over applicants with higher CSP scores and low PTSs. Of course, the qualified applicant excess presents other opportunities to AFROTC. Again, the obstacles to an optimization approach are data development and building the optimization infrastructure.

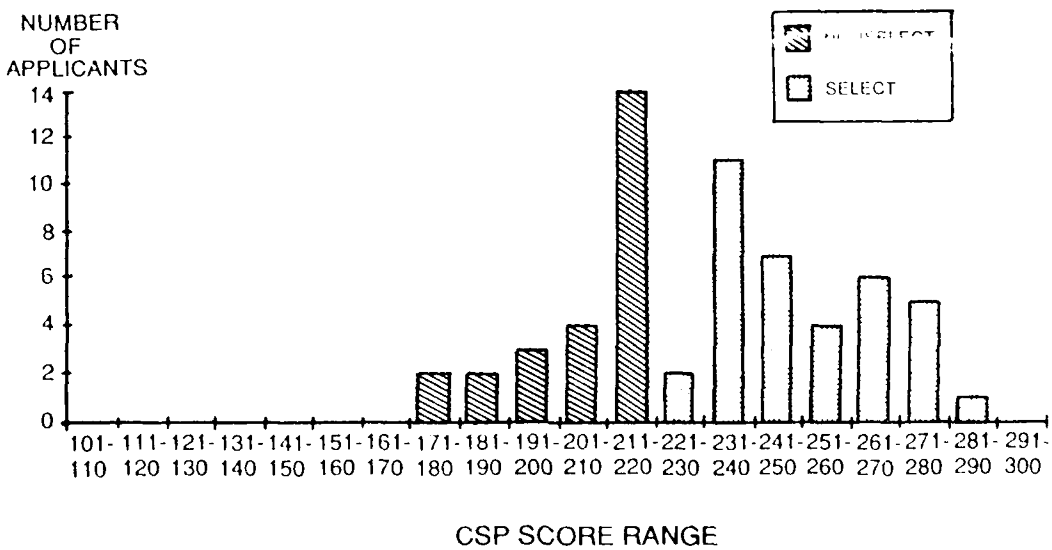

Figure 11. Three-Year Aerospace Engineering Applicants (February 1989 Board)

Four-Year Scholarship Program

A PAS panel of three reviews each Four-Year Scholarship Program application. Each officer subjectively assigns each record a score of from zero to 100. Each member assigns up to 14 points for academic potential based on high school GPA, class rank, and course work. Up to 43 points are awarded for extracurricular activities. Up to 43 points are also awarded based on personal applicant appraisals made by an Air Force officer and by high school teachers and counselors. In addition to the possible 300 subjective points awarded by the board, up to 70 points are awarded objectively on the basis of the SAT/ACT score.[7]

Boards meet starting in the fall. Individuals not selected on one board are not carried to the next board. Figure 12 graphs score frequencies for the FYSP board held in December 1989. This board had four panels. Each panel reviewed an equal number of applications that were drawn from all scholarship categories. To correct for scoring differences between panels, the board interleaved applicants into a single rank-ordered list. The number one ranked individuals from the four panels ranged from first to fourth on the composite list. The individuals ranked second from the panels, ranged from fifth to eighth on the composite list, and so on. After the composite list was formed, AFROTC managers started at the top and offered scholarships based on each applicant's first or second academic major preference. If there were no scholarships remaining for either preference, the individual was bypassed for someone further down the list.[8]

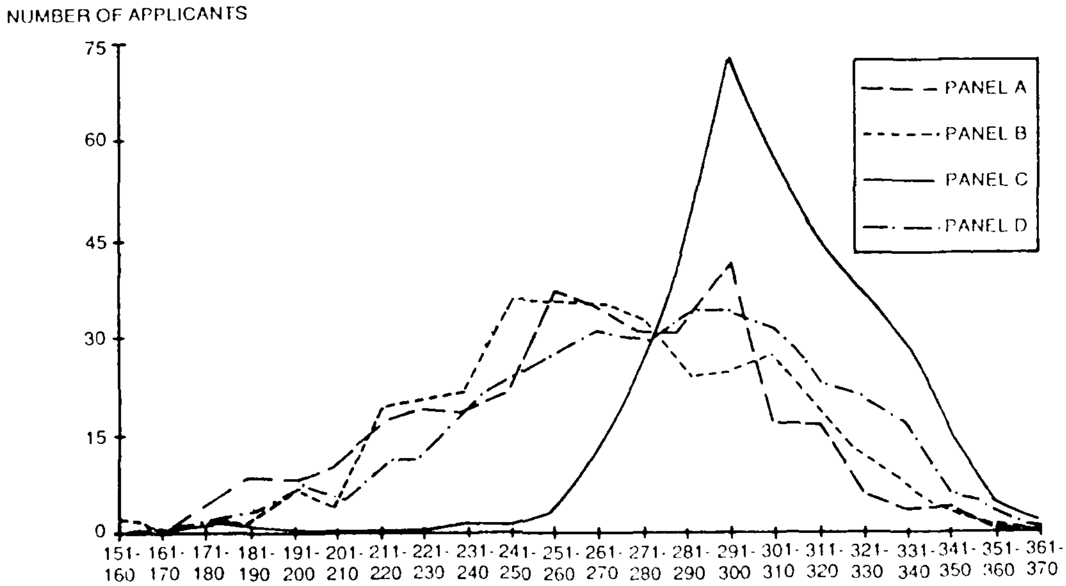

Figure 12. December 1989 FYSP Board Results

Option One—Objective

The analysis parallels the CSP option one analysis. Figures 13 and 14 summarize results. The main difference is that under method two, up to 42 points would be awarded for PTS. The equation used to research this conclusion is: 42/(370 + 42) = 10 percent. These results are quite similar to CSP findings in both patterns and magnitudes.

The problem is that the original PTS study used college experiences to predict PTS. Since FYSP applicants are still in high school, these predictors would not be available. Therefore, the PTS regression work would have to be reaccomplished before PTS could be used in the FYSP. Perhaps, it will not be possible to predict PTS without college experience information.

Option Two—Subjective

The four-year scholarship program selection boards could use PTS information subjectively in two ways. First, each board member's maximum score could remain at 100 points. The 43 point^ currently based on personal appraisal could reflect the PAS's judgment about PTS (method one). Again, under method one, PTS tends to hurt those with original high scores and help those with low scores. In this case, PTS could carry a weight between zero and 35 percent. This conclusion is derived by using the following equation: (3*43)/370.

The alternative would be to permit each board member to award up to 14 = (42/3) additional points for PTS (method two). Under method two, assuming *that PTS inform ition would not influence* the 43 subjective points, the PTS effect would be independent of the original board score.

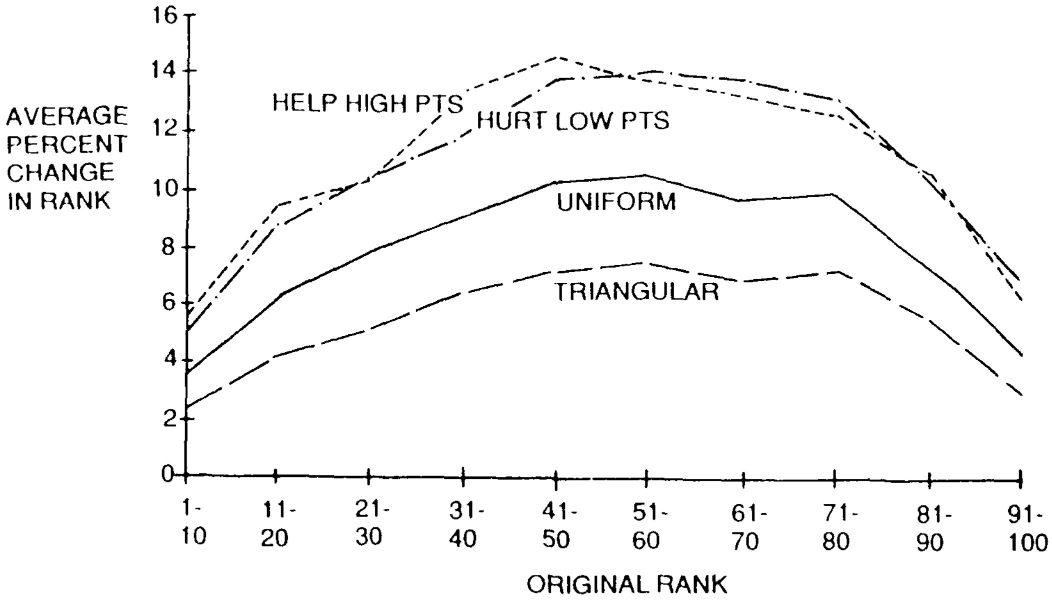

Figure 13. Average Impact on FYSP Rank

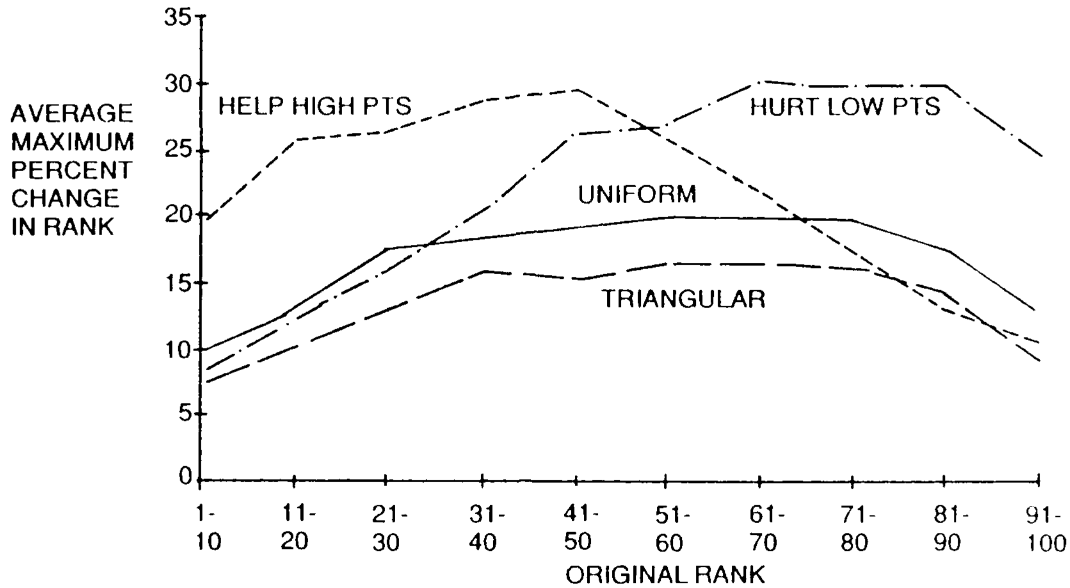

Figure 14. Maximum Impact on FYSP Rank

One might argue that this is too strong an assumption. Under method two, the most weight PTS could carry would be 10 percent.

Option Three—Combination

If PTS were given up to 14 points (method one) and also allowed to influence the 43 subjective points, the most weight PTS could carry would be 41.5 percent. The formula for this equation is: 3*(14 + 43)/(412). However, this would be an extreme case.

Option Four—Optimization

Unlike the CSP case, FYSP applicants exceed requirements in most categories. Therefore, PTS could influence most selection decisions. Again, qualified applicant excesses present other opportunities to AFROTC but for a price.

Conclusion

AFROTC has at least four options and three decision points to incorporate PTS information into its selection process. Three options mirror traditional AFROTC objective or subjective approaches. These three options would be conceptually easy to implement. The fourth is an optimization approach that would allow AFROTC to better satisfy operational constraints. Trying to assess PTS impacts is not straightforward. A variety of effects is possible depending on implementation methods and point distribution plans. Chapter 4 addresses other issues that must be considered before any PTS implementation, including costs and benefits.

Notes

1. This force management philosophy is driven by the military mission. Fighting wars requires a young and vigorous force. To achieve a youthful, aggressive force, the military has an up-or-out promotion system that limits the number of officers who may be promoted and that also limits the tenure of those who are not promoted.

2. Maj Fred Fisher, Registrar, Selections Division (AFROTC/RRU), multiple interviews with author, August 1989–April 1990.

3. Ibid.

4. Maj Rob Gaston, AFROTC/RRU, multiple interviews with author, August 1989–April 1990.

5. Using the same streams is a variance reduction technique that will produce a more accurate picture of the differences between PTS distribution options.

6. Gaston interview.

7. Maj Mark Lewis, AFROTC/RRU, multiple interviews with author, August 1989–April 1990.

8. Ibid.

Chapter 4

Implementation Issues—Option Four (Optimization)

In addition to resolving PTS impact questions raised in chapter 3, AFROTC must consider other issues before it implements option four. The outlay control benefit must be weighed against implementation costs. The AFROTC scholarship selection system is geared toward production, not outlay control. FYSP allocations are based on academic major and board rank. Currently, AFROTC has no way to learn which school applicants will attend, and it must rely on historical averages to estimate what the FYSP will cost. For most production categories, the CSP selects either most or a few of the applicants. Consequently, it is not feasible to alter outlays by changing selection decisions. Finally, the WPSS is a production control system that does not directly impact scholarship outlays. Unless some fundamental policy changes permit AFROTC to control scholarship expenditures more directly, a change to pursue option four makes little sense. It is not even clear that AFROTC needs to manage scholarship outlays on an individual basis.

Budget Benefits

AFROTC manages its scholarship dollars by using annual average costs. In constant dollars, the average annual cost per scholarship for academic year 1991 is expected to remain at the 1990 level. After adjusting for inflation, AFROTC estimated next year's total scholarship cost to be this year's average cost multiplied by total scholarships. One source of error in this approach is that approximately 40 percent of next year's scholarship recipients will be different from this year's. Graduation and attrition cause this turnover. New recipients may attend different schools or have different majors. AFROTC can estimate how much outlay uncertainty results from student turnover. Figure 15 shows scholarship distribution by cost for fiscal year 1989 with mean and variance (μ, σ^2) = ($5,559, $13,237,195).

To demonstrate turnover-induced uncertainty, the author randomly drew the costs for 5,100 scholarships from the figure 15 distribution.[1] The author then calculated total cost for these 5,100 scholarships as S_1. Next, 2,040 scholarships (40 percent of the 5,100) were randomly replaced to simulate student turnover. The total cost for the new 5,100 scholarships was then calculated as S_2. S_1 minus S_2 is the constant dollar difference

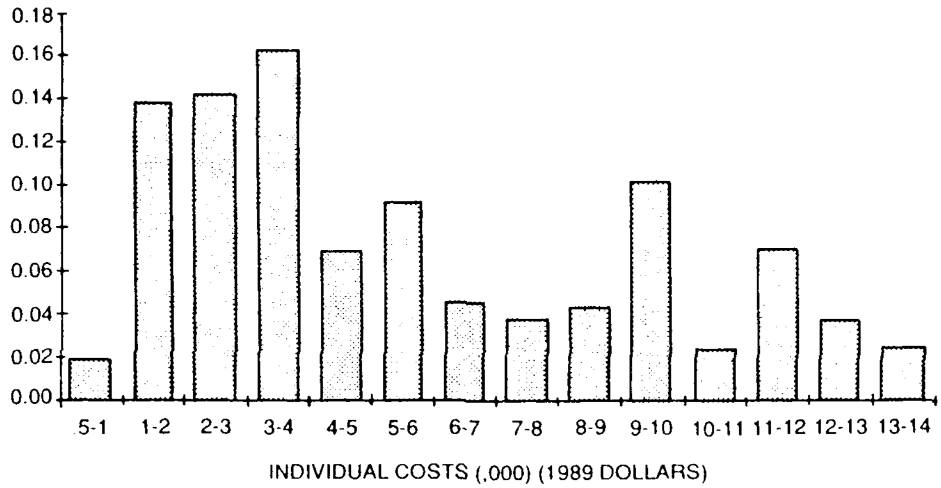

Figure 15. Fiscal Year 1989 Scholarship Cost Distribution

between years due to turnover. Figure 16 shows 60 between-year S_1 minus S_2 differences. The sample standard deviation is \$214,307. This means, in constant dollars, that about 68 percent of the time the difference between sequential-year costs can be estimated within ±\$214,307 of each other, and that 95 percent of the time, the difference can be estimated within ±\$428,614 (2*\$214,307). These bounds require that S_1 minus S_2 be *normally distributed.*[2] In this case, an equivalent process to the one just described, let S_1 and S_2 each be the sum of .40*5,100 = 2,040 random draws from the figure 15 distribution. According to the central limit theorem, S_1 and S_2 are normally distributed. The mean and the variance of S_1 and S_2 are

(2,040*\$5,559, 2,040*\$13,237,195).

The difference S_1 minus S_2 is also approximately a normal distribution with mean and variance

(\$0, 4,080*\$13,237,195).

One standard deviation is \$232,396. Thus, the figure 16 sample standard deviation is close to the calculated standard deviation.

Figure 17 shows bounds on turnover-induced variations for a range of scholarship programs. These one (68 percent) and two (95 percent) standard deviation intervals were estimated from the figure 15 discrete distribution. The important point is that at current scholarship levels, the constant-dollar difference between the budget and outlays should rarely exceed \$.5 million because of student turnover.

Another potential error source in the AFROTC budget is the estimation of tuition inflation from one year to the next. The fiscal year 1990 scholarship budget was \$30.427 million. If the inflation estimate for the fiscal year

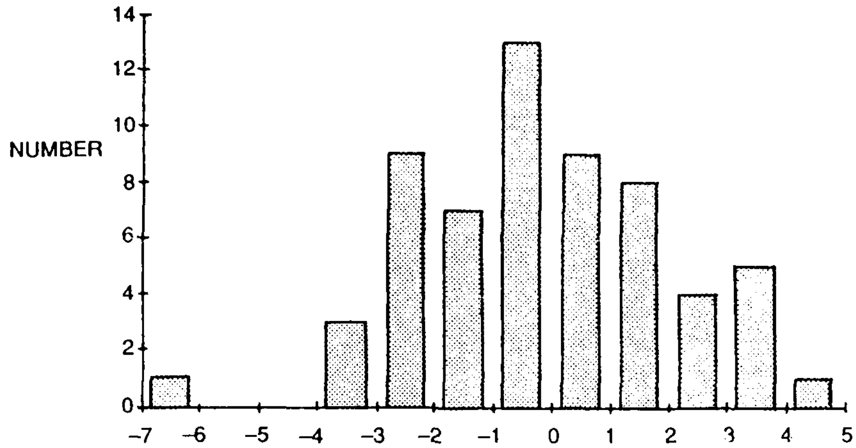

Figure 16. Between-Year Total Cost Variations (in hundreds of thousands of FY 1989 constant dollars)

1991 budget were in error by 1 percentage point, there would have been a $300,000 discrepancy. Thus, a 2-percentage point margin of error in the inflation estimate has an impact that exceeds 95 percent of the problems caused by turnover. In recent years, tuition-inflation rates have ranged from 5 to 7 percent. Hence, predicting inflation as the current rate would not have resulted in more than a 2-percentage point margin of error.

A final factor in the mismatch between budget and outlays is the numerical difference between actual and planned scholarship students. In fiscal year 1989, the average scholarship cost $5,559, and there were 5,400

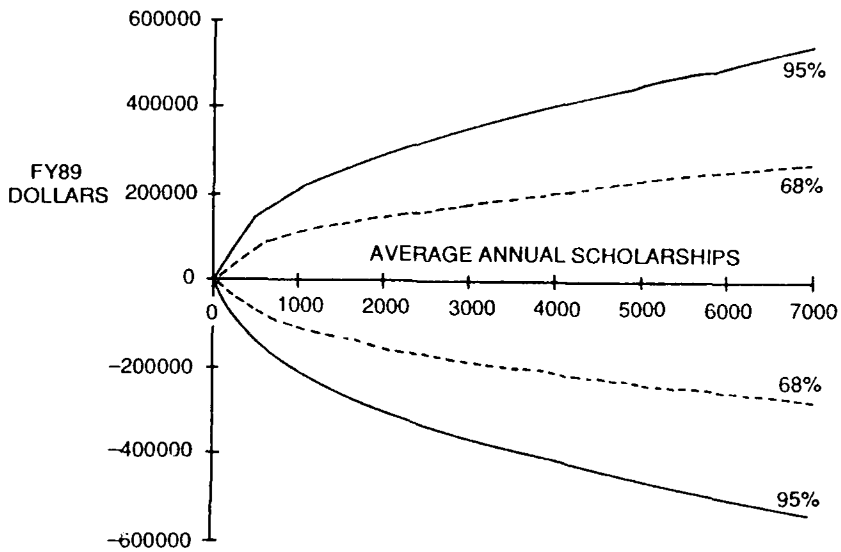

Figure 17. Turnover-Induced Scholarship Outlay Uncertainty

planned scholarship students. A 2-percent margin of error in scholarship students (108) would have meant a $600,000 discrepancy.

Clearly, AFROTC must have planned student numbers on scholarship. The combined effects of student turnover and inflation prediction error should not have caused more than a $1-million discrepancy in fiscal year 1989. While option four may permit better turnover effect control, AFROTC is unsure if any benefit is worth the cost. To manage outlays, AFROTC would find it easier and more beneficial to focus analysis efforts on forecasting inflation and controlling the number of cadets on scholarship.

Implementation Costs

If AFROTC decides to implement option four, it would have to develop and maintain computer software. This cannot be done without incurring some costs, and these costs must be weighed against benefits. This section sizes the problem and estimates implementation costs. A related issue is who would do the work. To understand these implementation issues, AFROTC must examine option four's operational implications.

Ideally, option four would be used to help make all gray-zone allocations once each year. Considering all applicants simultaneously permits maximum flexibility in the WPSS, CSP, and FYSP allocation decisions. When the applicant pool is large, it is easier to satisfy allocation constraints. However, it is not practical to make all allocations at one time because of the administrative burden associated with awarding scholarships. Having a limited staff makes it economical to spread the administrative effort across the year. Another shortcoming of a single allocation is that production goals change throughout the year. By spreading out allocation decisions, current AFROTC policies allow more ability to react to changing requirements. Most importantly, allocation decisions must correspond to when individuals make personal decisions. Therefore, any contemplated optimization should initially be tied to current AFROTC allocation timing. This would require AFROTC managers to establish suboptimal constraints.

The option four discussion in chapter 3 referred to gray-zone production and budget constraints. From where would these numbers come? AFROTC allocation managers would have to generate these numbers based on the current pipeline state and the best future production requirement estimates. Understanding how managers might go about this task requires a brief introduction to steady-state and dynamic models.

Steady-State Models

The scholarship program buys quality. In theory, AFROTC managers should meet production goals at minimum cost subject to quality constraints. However, quality goals do not exist.[3] Minimum quality standards do exist, but the Air Force would not want everyone to be minimally qualified. How much is enough? This question cannot be answered. In practice, the Air Force maximizes quality subject to budget constraints.

One relevant issue is, on average, how many scholarships are awarded to meet constant production targets. For the purpose of this discussion, a steady state is what would happen if everything remained the same every year. At issue is whether the AFROTC production pieces theoretically fit together. Figure 18 illustrates the basic idea. Given persistence rates (p_i), various numbers and types of scholarship students ($\mathbf{S_j}$), and nonscholarship students ($\mathbf{N_j}$), AFROTC can estimate steady-state production **G** and losses $\mathbf{L_j}$. (Figure 18 oversimplifies, since it does not account for different production categories.) For example, $\mathbf{S_4}$ entries will produce $\mathbf{S_4}$*p_1*p_2*p_3*p_4*p_5*p_6*p_7*p_8 graduates in four years, $\mathbf{N_2}$ entries will produce $\mathbf{N_2}$*p_5*p_6*p_7*p_8 graduates in two years, and so on. Clearly, many $\mathbf{S_j}$, $\mathbf{N_j}$ combinations will produce **G** graduates per year. Have AFROTC managers selected one of them? Is it, by some measure, the best way? These are two questions which can be addressed with a steady-state model. An additional steady-state model benefit is that it can give managers insights into the direction an organization might go to achieve stability which, in turn, translates into efficiency and simplicity.

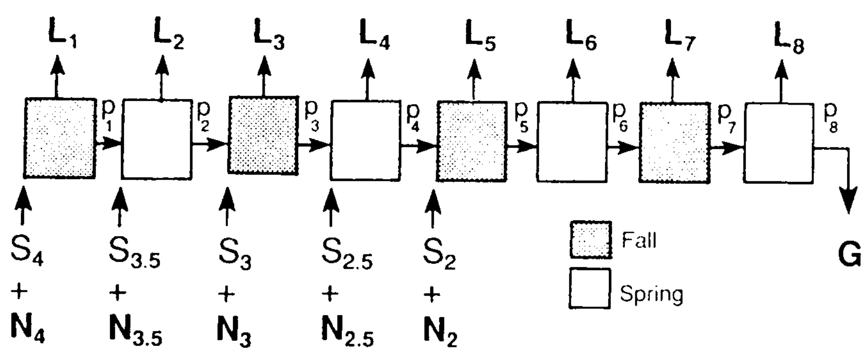

Figure 18. AFROTC Pipeline Steady-State Model

Dynamic Models

The Air Force and AFROTC rarely find themselves in a steady-state environment. Change is the rule. AFROTC must have a dynamic model to manage change. The model would start with the current production pipeline state and estimate future states, which could result from management decisions. Notionally, such a model would look like the figure 18 model except that the p_i's, $\mathbf{S_j}$'s, $\mathbf{N_j}$'s, $\mathbf{L_i}$'s, and total production **G** change over time. The S_j's and N_j's are under AFROTC control. However, the p_i's are not controllable. Therefore, accurate p_i estimation is essential to forecasting future production system states.

Setting AFROTC Production Goals

The original issue was how AFROTC managers would set gray-zone production and cost targets. The process consists of four steps.

1. Use a steady-state model to determine if average production goals can be achieved within budget and availability constraints. If so, set policy on the relative FYSP and CSP production contributions.
2. Use dynamic tools to help determine specific courses of action for the current year—how many scholarships to award in each category and how much money these scholarships should cost.
3. Identify, at each allocation board, select individuals in each production category who are so outstanding that PTS does not influence the decision.
4. Determine how many individuals are required from the gray zone to satisfy remaining production goals.

Size and Frequency of Problem

Again, an option four integer programming (IP) optimization code would be exercised each time an allocation board convened. This would occur about 10 times each year. After each board sorted applicants into three groups, it would take about a week's work to make gray-zone selections. AFROTC may have to investigate "what if" questions. Allocating six weeks' work per year would bring total operational requirements to four months' work per year.[4]

The largest applicant pool is from the FYSP. About 5,000 applicants are considered per board with 800 selections. There should probably be three gray-zone members for each allocation made. If 200 gray-zone allocations are required, the total zone size should be about 600. It would be conservative to estimate that 1,000 decision variables (gray-zone applicants) would be an upper bound for this problem. The constraint number would be less than 50 if AFROTC did not have widespread viability concerns. This is no small integer programming problem. If it proves to be too difficult to solve, as some IP problems are, heuristic approaches might produce acceptable solutions[5] and should probably be pursued first.

Software/Hardware

One cheap and quick way to get integer programming software is to purchase it commercially. However, AFROTC must first consider a number of things. The software must run on available hardware, or other hardware must be purchased to support the software. Clearly, the hardware/software decision must be made jointly. This particular problem is substantial and requires more than the average personal computer. Large integer programming problems are computationally expensive and require fast computers. Air Training Command leases a technically attractive commercial integer programming package from the SAS Institute. This SAS package resides on an IBM mainframe at Randolph AFB, Texas. AFROTC has recently purchased a powerful minicomputer that would be available for this project in early 1991. Again, appropriate IP software would have to be acquired for this machine.

It would take about one month's work to research integer state-of-the-art programming and to evaluate commercial codes. If an appropriate commercial code can't be found, AFROTC should develop a code in-house that is tailored to AFROTC's needs. It would take about two months' work to develop an IP code in-house. Once obtained, an acceptable IP code requires little maintenance.

Preprocessor

A second software decision consideration is that it must be possible to write a preprocessor for the IP code. A preprocessor converts raw data, such as that found in table 3, into the format the optimization code requires. For small problems, this task can be accomplished manually, but for large problems, computer assistance in the form of a preprocessor is essential. Some commercial codes have intrinsic preprocessors that cannot be adapted to this problem. It could take four months' work to develop PTS preprocessors. Different preprocessors would be required for the Four-Year Scholarship Program, the College Scholarship Program, and the Weighted Professional Officer Course Selection System problems. These preprocessors would require maintenance as AFROTC policy and environment change—about every three months.

Data Maintenance

Option four requires two basic data types: information about individuals and information about schools. Required information about individuals already flows to AFROTC data maintainers. AFROTC must extract information about schools from information about groups of individuals.

Most personnel policy models are rate driven (p_i). These rates change over time and must be reestimated, at least annually. A specific data need is for persistence rates as functions of academic major, academic semester, and academic institution. About three months' work is required to develop the software to estimate persistence rates. Another two months' work would be required for annual maintenance.

Analysis Support

Writing option four software would not be a one-time effort. A number of things require changes to the software an organization uses. This is particularly true for policy models. It is not practical to build models that anticipate all possible policy questions. Consequently, policy models evolve over time. For example, AFROTC might want to add, delete, or change constraints. At least three ATC organizations could develop and maintain AFROTC software.

AFROTC

AFROTC has a strong interest in internally maintaining any software it uses. Every commander wants to explore sensitive issues without external scrutiny.[6] Additionally, owning the analysis assets would permit AFROTC to set priorities internally. However, to undertake support responsibility, AFROTC would have to develop an analysis presence.

Recruiting Service, Officer Accessions

Recruiting service (RS) has functional responsibility for officer accessions. It therefore has a legitimate interest in any PTS effort. RS has a small analysis shop at Randolph AFB, Texas, that could provide support to AFROTC. However, the effort could consume 25 percent of the RS analysis work force. AFROTC might be less than enthusiastic about RS involvement in internal AFROTC issues. Geographic separation from the AFROTC headquarters located at Maxwell AFB, Alabama, causes an additional complication. Close interaction between analyst and end user would be essential to develop the optimization option.

Command Analysis Division

The ATC Command Analysis Division also has a small analysis shop. In theory, this group is the centralized analysis function responsible for providing assistance to all other ATC organizations. However, developing PTS option four would also be a major drain on resources. Since this group has less direct interest in officer accessions than the recruiting service, it might be more acceptable to AFROTC. This group is also located at Randolph AFB and would have the same problems associated with geographic separation.

Time Estimates

Table 2 summarizes time estimates for option four development and maintenance. These are only estimates. It probably wouldn't take more than one work year to develop option four. Annual maintenance would vary between six and nine months.

TABLE 2

Time Estimates

Activity	*Development (Months)*	*Annual Maintenance (Months)*
PTS Operations	0	4
Software/Hardware	3	0
Preprocessor	4	3
Data	3	2
Total	10	9

Conclusion

A decision to implement option four must weigh costs against benefits. The prime motivation for pursuing the optimization option is improved control of scholarship outlays. By managing scholarship turnover, option four would bring outlays $500,000 closer to the $30-million scholarship budget. The analysis cost to the Air Force would be about $50,000 per year. Chapter 5 draws conclusions on whether this level of effort might yield greater benefits if applied differently.

Notes

1. Raw data provided by AFROTC/RRU.
2. Normal distributions are commonly referred to as "bell-shaped curves."
3. There is no proven linkage between traditional measures of input quality and officer performance. Therefore, Headquarters US Air Force cannot establish input quality goals for AFROTC.
4. This chapter's time estimates are based on the author's 20 years of experience in building and maintaining simulation models.
5. A heuristic approach produces near optimal results with techniques that are usually simpler and faster than standard approaches.
6. Viability and minority problems are two sensitive AFROTC issues. Premature congressional interest in an issue can be vexing.

Chapter 5

Summary and Recommendations

Table 3 lists obstacles to and courses of action to achieve major AFROTC objectives. This chapter outlines specific actions AFROTC needs to take to better realize its objectives. As will be discussed in greater detail, some courses of action achieve a single objective while others achieve multiple objectives.

TABLE 3

AFROTC Objectives, Obstacles, and Courses of Action

Objectives	*Obstacles*	*Courses of Action*
– To produce – – Right kind – – Right number – – Right time	– Unknown or changing persistence rates	– Control production and outlays – – Comprehensive optimization approach
– To meet budget	– Turnover-induced uncertainty – Tuition inflation uncertainty – Scholarship population uncertainty	– Improve production forecasting and adjust budgets to projected outlays – – Dynamic model
– To consider propensity to stay	– Implementation	– Objective or subjective PTS approach
– To reduce costs	– Reluctance to dismiss	– Identify future losses sooner – – Develop loss data

Reduce Costs

Approximately 30 percent of AFROTC tuition dollars is spent on cadets who ultimately lose their scholarships. In 1990 this loss will amount to about $10 million. One way to reduce costs is to improve applicant screening so that fewer scholarship recipients will ultimately lose them. The same production could be achieved with fewer dollars. This strategy requires AFROTC to improve existing screening mechanisms or to develop new ones. A second way to reduce costs is to identify and eliminate future scholarship losers sooner. For every 100 losses eliminated from AFROTC a year sooner, the Air Force would save $500,000.

AFROTC needs pertinent scholarship loss data to implement cost-saving measures. In the past, AFROTC has not retained data on students who lost their scholarships. Without historical data, it is difficult to estimate analytically the probability that a particular cadet will graduate. In the absence of compelling evidence that an individual was a poor scholarship risk, some professors of aerospace studies have been reluctant to recommend elimination of scholarship students.[1]

By one measure, eliminating marginal students earlier is preferable to altering screening techniques. Table 4 lists the relative contribution to total scholarship losses by each class.

TABLE 4

AFROTC Steady-State Scholarship Losses

	Freshman	*Sophomore*	*Junior*	*Senior*
Percent of Losses	35	20	30	15
Percent of Dollar Loss	20	20	30	30

Although freshmen account for 35 percent of all losses, they only generate about 20 percent of the dollar losses. Seniors account for 15 percent of total losses, but they cause about 30 percent of annual dollar losses.[2] The explanation for this paradox is that freshman losses have received only one or two semesters of scholarship dollars while senior losses have been on scholarship from three to eight semesters. It might be possible to predict which seniors (or juniors) will ultimately lose their scholarships based on freshman and sophomore academic performance. Since most scholarship students are engineering and science majors, their future performance might be indicated by grades in freshman calculus and the so-called separator class required early in most technical programs.[3] Sufficient scholarship loss data help to examine the strength of these two indicators. However, before any data collection begins, specific data requirements must be determined. At a minimum, data should contain recipient's name, social security number (SSN), scholarship activation date, scholarship loss date, reason for scholarship loss, AFROTC screening scores, name of university, and transcript. Preliminary analysis could rely on a single year's data. It is probably not necessary for professors of aerospace studies to wait for analysis results. After the sophomore year, the marginal recipient's professors can probably estimate accurately whether that individual will graduate.

AFROTC should begin to collect scholarship loss data immediately. Since being able to project losses is not sufficient to reduce costs, AFROTC should also begin to install incentives for professors of aerospace studies to temper concern for their cadets with cost considerations. The decision to remove students from scholarship status should be made during the WPSS. If a scholarship student's only problem is academic, entrance into the Professional Officer Corps (POC) should be granted on a nonscholarship status. Except for reducing costs, one can argue that little else would change. It is likely the individual would accept entry into the POC in a nonscholarship, nontechnical production category. Poor grades have already reduced the individual's employment opportunities in the private sector. Having lost a scholarship that was tied to an academic major, the individual would be free to change to a more suitable major. Since the Air Force Military Personnel Center (AFMPC) does not usually place marginal academic performers into technical jobs, the ultimate person-job match would not change.[4] Finally, tougher scholarship policies would be an incentive for higher academic performance on the part of all scholarship students.

Propensity to Stay

Figure 19 summarizes major propensity-to-stay (PTS) implementation findings. The main attraction of an objective implementation is predictable results. A variety of implementation plans are possible depending on the specific goals of decision makers. The most attractive opportunity for an objective implementation is to alter the quality index score used in the Weighted Professional Officer Course Selection System. Since the College Scholarship Program tends to be an all-or-none selection process, depending on the production category, PTS would have little real impact on any decision. Although PTS has the potential to influence Four-Year Scholarship Program decisions, there is no current PTS instrument to evaluate high school seniors, since the original PTS regression models use college experiences for predictor variables. If new regression equations are developed without college experience information, predictive power may fall to unacceptable levels.

A main attraction of a subjective approach to PTS is implementation ease. Administratively, AFROTC only needs to show selection boards additional information. The drawback is that the weight placed on PTS will vary from board to board. The Officer Accession Analysis Division of Headquarters Recruiting Service (RSC) is working with AFROTC to assess the impact of PTS in a subjective implementation environment.[5] Findings should be available in the summer of 1990. The shortcomings to an objective PTS implementation in the CSP and FYSP also are present for the subjective case.

At the present time, any effort to use the PTS to influence AFROTC decisions should be focused in the WPSS. If AFROTC production goals fall, and CSP applicants subsequently exceed requirements in most categories, the PTS could influence decisions. If additional research yields good models for high school seniors, the PTS could become part of the FYSP selection process.

	WPSS	CSP	FYSP
OBJECTIVE predictable impacts	• DMs must specify objectives • 10% weight can mean many things • 10% weight alters chance of getting pilot allocation by about [illegible]	• DMs must specify objectives • 10% weight can mean many things • Greatest impacts on midranks • Limited applicability	• DMs must specify objectives • 10% weight can mean many things • Greatest impacts on midranks • Regression issue
SUBJECTIVE easiest to implement	RSC STUDY	X	?

Figure 19. PTS Implementation Summary

Meet Budget

Three obstacles cause AFROTC scholarship outlays to deviate from the budget. Even with perfect knowledge of tuition inflation and persistence rates, a 40-percent annual turnover for those on scholarship causes an outlay-budget deviation simply because students attend different universities. At a $5,000-scholarship level, the magnitude of the deviation should rarely exceed $500,000 annually. This deviation is not completely controllable and can be reduced only by changing AFROTC policies to force university-student mix expectations.

The spending deviation caused by a 2-percentage point error in the tuition inflation forecast exceeds the magnitude of the turnover problem. The current AFROTC practice is to estimate what tuition inflation is for the current year and then to use that rate to plan for the future. While universities may not publish tuition rates with sufficient lead times to meet AFROTC planning needs, an estimate of the coming year's tuition rates must exist. Professors of aerospace studies should be in the best position to obtain this information for AFROTC planning purposes.

Errors in forecast persistence rates will also result in a difference between outlays and budget. For a $5,000 scholarship program and an average annual scholarship cost of $5,600, a 2-percentage point error would cause about a $560,000 problem (a deviation of 100 students from the plan). At the present time, AFROTC persistence rate estimates are dated, and calculation methods need to be refined.

AFROTC needs to improve its capability to forecast what it will spend and produce under various policies. Three specific requirements stand out. First, AFROTC needs better forecasts of tuition inflation. Headquarters AFROTC might encourage professors of aerospace studies to develop university contacts to obtain the best possible information. However, the probability that professors of aerospace studies would be successful appears to be low. Therefore, initial investigations might be limited to a few universities with a large AFROTC presence.

Second, AFROTC needs to improve its persistence rate estimation methodology. The approach is conceptually straightforward. At the start of the academic year, social security numbers are retrieved from all scholarship students. At the end of the year, social security numbers of the remaining students are obtained once again. The ending population, divided by the starting population, is the persistence rate. Policy decisions occasionally cause some cadets to abnormally lose or keep scholarships. These cadets must be tracked by their social security numbers, which can be used to adjust or "normalize" starting and ending scholarship populations. For example, an abnormal loss during the year would be added to the ending scholarship population for persistence rate calculations. This is a low-risk effort, and it should be pursued without delay.

The third task is to build a dynamic model that would serve as the analytical tool for improved outlay and production forecasting. This is a no-risk project, but its utility will be limited by the quality of inflation and persistence estimates.

Production

AFROTC managers could use the dynamic model described in the previous section to adjust scholarship programs to satisfy externally imposed production goals and budget ceilings. The adjustment process would be principally a trial-and-error matter, requiring AFROTC to try different combinations of scholarship award programs to achieve desired results. In theory, AFROTC should be able to use operations research methods to simultaneously satisfy production goals, meet budget constraints, and select students with a high propensity to stay. In fact, the original goal of this research was to build such a tool. Figure 20 illustrates the basic process. A selection board would divide an applicant pool into three groups: the "yes" group of high-quality applicants to be selected regardless of their PTS; the "no" group of low-quality candidates to be rejected regardless of their PTS; and the "gray" group, whose members are of acceptable and approximately equal quality. After the selection board divides the applicant pool, it can use a dynamic model to forecast the production and outlay implications of selecting the yes group. The board can then rely on a

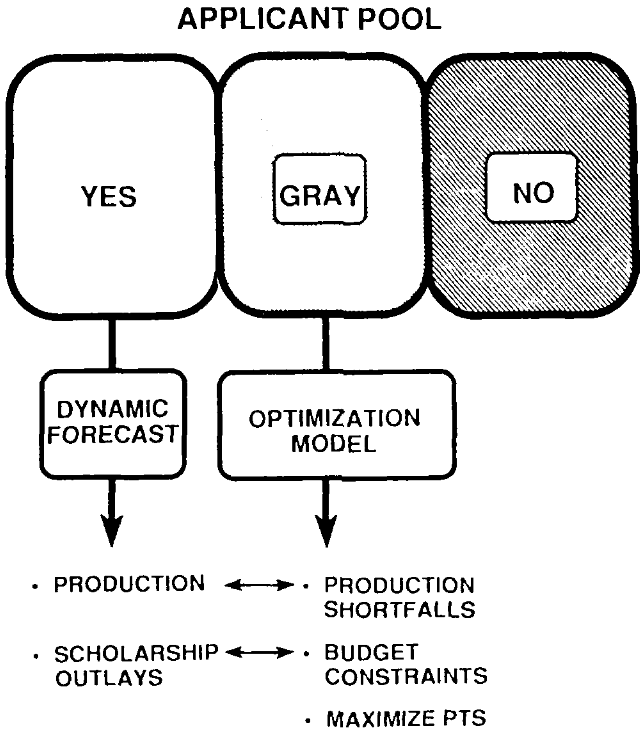

Figure 20. Notional Production Control System

zero-to-one integer programming model to select from the gray group high-PTS students who would also meet production goals and budget constraints. In making its selections, the IP would consider each applicant's PTS, projected tuition cost, and persistence rate (itself a function of semester, major, and university). The main attraction of the optimization approach is that AFROTC would increase its control over production and outlays. Unfortunately, the attractiveness of this approach fades when one considers the details of the current AFROTC system. Figure 21 summarizes the difficulty of an optimization approach. The main problem arises in trying to control outlays. Future scholarship expenditures cannot be controlled through the WPSS since scholarship decisions are not made at that time. Although scholarship decisions are made in the CSP, the program tends to select all or a few of the applicants, depending on the production category. Consequently, it is not possible to change outlays by selecting some applicants and not others. The FYSP offers great opportunity to impact outlays. Unfortunately, scholarships are awarded before an individual's tuition requirements are known, again making it impossible to control outlays.

In addition to offering limited outlay control, optimization requires stable production goals. In the current strength reduction environment, AFROTC finds it difficult to predict AFROTC officer production requirements four

	WPSS	CSP	FYSP
OPTIMIZATION other opportunities	• WPSS doesn't drive scholarship outlays • Other production forecast options • Great PTS weight for "gray-zone" applicants	• Applicant-scholarship mismatch problem • Other production forecast options • PTS carries little weight	• College (tuition) unknown, regression • Turnover-induced budget uncertainty less than $.5M/year • Analysis cost: $50K/year

Figure 21. Optimization Shortcomings

years hence. Similarly, optimization also requires stable scholarship budgets, again unlikely for the next few years. Finally, optimization requires accurate persistence and tuition inflation rates. Clearly, an optimization approach to implementing PTS, meeting production goals, and satisfying budget constraints is premature. AFROTC has a number of higher-priority analysis requirements.

Summary

This study has examined PTS implementation options. Opportunities to implement these options occur while awarding scholarships and selecting for the POC. A variety of effects can be engineered with an objective PTS implementation. However, effects of a subjective implementation are more difficult to predict. A PTS optimization approach could conceptually help AFROTC to meet budget constraints while achieving production goals. In practice, a combination of uncertainty and budget constraints reduces the attractiveness of the optimization option. There are other AFROTC analysis requirements which are more pressing than a PTS optimization model. To save money, AFROTC needs to eliminate marginal students earlier. It also needs a dynamic model to improve its capability to forecast spending and production. Nonetheless, the most fundamental need is for data to include information on scholarship losses and tuition inflation rates. These findings have been well received within AFROTC, and efforts are already under way to implement some of them.

Notes

1. During the course of this study, a number of Headquarters AFROTC personnel have indicated that professors of aerospace studies tend to be protective of their cadets. Professors of aerospace studies often argue against scholarship terminations because the individuals in question will make good officers. The assumption is that losing scholarships will drive cadets away from the AFROTC program.

2. A simple steady-state model written for this study produced these estimates. Chapter 4 offered a discussion of steady-state models.

3. Most engineering and scientific academic programs require that students enroll in a "separator" class during the first two years of college. This class tends to be intensive and intellectually challenging. The department's goal is to eliminate individuals with less desire and ability early enough in their college careers so they can switch to other majors. The dilemma in this case is that, in changing majors, cadets forfeit their AFROTC scholarships. They struggle for four years in a technical major only to be placed into nontechnical jobs because of poor academic performance.

4. One of the Air Force Military Personnel Center's responsibilities is to assign officers to jobs. Low academic performers are not generally assigned engineering or scientific duties. These cadets are often placed in nontechnical jobs.

5. In the spring of 1990, the Officer Accession Division and AFROTC conducted a test to estimate the subjective weight WPSS boards would give PTS information. Cadet records that had been scored previously were presented to a mock board with random PTS scores assigned. The mock-board results are currently being analyzed to see how much subjective difference PTS information made in individual scores. Headquarters Air Force Recruiting Service, April 1990.

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