Research Report

Air Force–Wide Needs for Science, Technology, Engineering, and Mathematics (STEM) Academic Degrees

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Library of Congress Cataloging-in-Publication Data is available for this publication.
ISBN: 978-0-8330-8712-6

Published by the RAND Corporation, Santa Monica, Calif.

Preface

This report documents research examining requirements across all Air Force functional areas for science, technology, engineering, and mathematics (STEM)-degreed officers and officer-equivalent civilians. It documents current STEM requirements, classifies disciplines as STEM or non-STEM, summarizes the prevalence of STEM degrees in the current officer-level workforce, and presents STEM requirements gathered from Air Force career field managers (CFMs) through a structured interview process. Based on the study findings, this report makes recommendations for improvements to the determination, documentation, and projection of STEM degree requirements.

The research reported here was commissioned by the Air Force Deputy Assistant Secretary for Acquisition Integration, Office of the Assistant Secretary of the Air Force for Acquisition (SAF/AQX), and by the Director, Force Development, Deputy Chief of Staff for Personnel, Headquarters U.S. Air Force (HQ USAF/A1D) as part of fiscal year 2012 project "Science, Technology, Engineering and Mathematics (STEM)," and was conducted within the Manpower, Personnel, and Training Program of RAND Project AIR FORCE. This report should be of interest to Air Force leadership and staff involved in the policy and execution of officer accessions, civilian hiring, and the management of the STEM workforce.

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Purpose and Summary

Evaluating STEM Needs and Populations

In evaluating the health of its science, technology, engineering, and mathematics workforce, the U.S. Air Force has primarily focused on functional areas where STEM degrees are mandatory, such as engineering, physical sciences, and operations analysis. To date there has been no rigorous review of the needs for STEM academic degrees in other functional areas. Understating the needs for officers and civilians with STEM degrees can diminish the Air Force's ability to maintain the technical skills it heavily relies upon to support air, space, and cyberspace operations.

The purpose of this study is to address two key research questions:

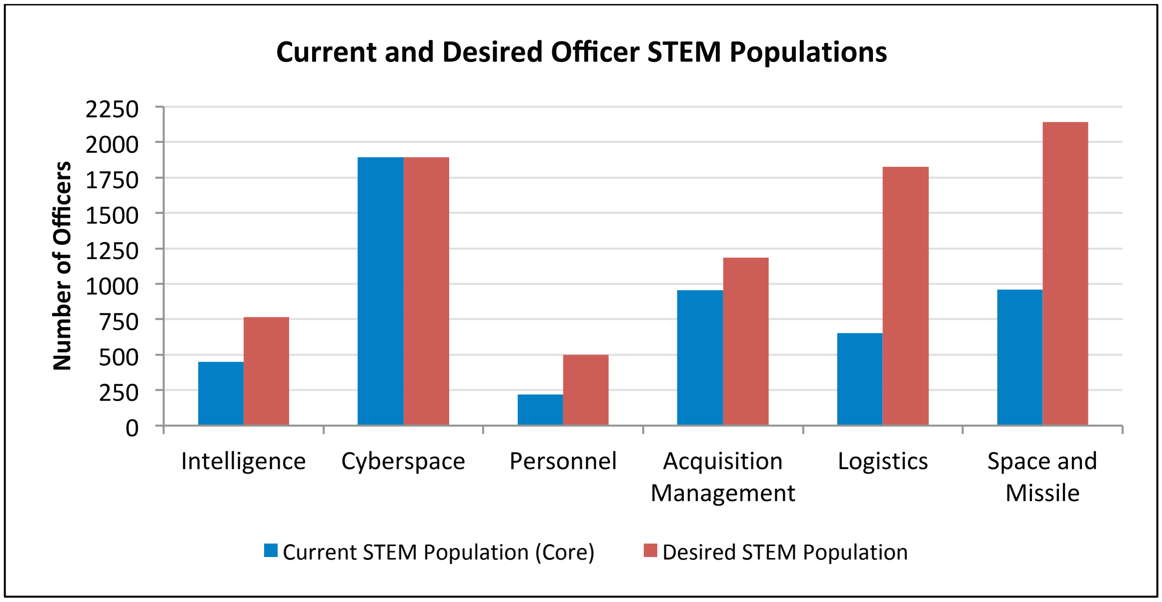
- What are the requirements for officers and officer-equivalent civilians with STEM academic degrees across all functional areas?
- Are sufficient numbers of officers and civilians available to fill these STEM academic requirements?

An analysis of the need for STEM academic degrees must begin with a definition of STEM versus non-STEM degrees. We established a set of broad academic disciplinary groups that should be considered in the set of STEM degrees as well as disciplines at the most detailed levels of degree codes that the Air Force maintains. This categorization has been approved as the Air Force definition of STEM.

We interviewed career field managers across the Air Force and asked them to identify the STEM academic degrees they believed are necessary now and in the future for particular missions in their functional areas. Senior functional authorities at the two- and three-star level reviewed and in some cases revised what their own CFMs identified as STEM needs and validated the overall direction and the specific numbers of these academic degree requirements for their career fields.

Figure S.1 shows career fields where STEM degrees are not mandatory for entry, but where functional authorities validated significant unmet STEM needs (i.e., logistics and space and missile). Even in areas where STEM populations are nearly sufficient at present, such as cyberspace and acquisition management, requirements for these personnel are not documented in the Air Force Officer Classification Directory (AFOCD) or in Office of Personnel Management (OPM) standards for civilians; consequently, the personnel system will not necessarily provide a sufficient inventory in the future. While over 5,100 officers with STEM degrees currently serve in these functional areas, some 3,200 more are required to meet current needs. Functional authorities stated that technological advances will likely increase and alter their STEM degree needs. Even so, few functional areas are willing or able to project their future STEM requirements.

Figure S.1
Summary of Desired Officer STEM Population in Non-STEM Functional Areas



Additional Considerations for STEM Needs

In addition to our central finding that non-STEM career fields have undocumented STEM needs, we uncovered additional areas that need to be addressed to adequately identify STEM degree needs.

Career-Field Consultants

The Air Force uses individuals with STEM degrees to provide STEM expertise either as a member of a nontechnical Air Force specialty code (AFSC) (for example, someone with an operations research degree holding a personnel, 38PX AFSC) or in a STEM AFSC "on loan" to a nontechnical area (for example, someone with an operations research degree holding an analyst 61AX AFSC, assigned to a human resources organization). We found that 31 percent of those holding STEM AFSCs are on loan to non-STEM functional areas serving as what we term STEM consultants. Functional areas are mixed as to the extent to which they use these STEM consultants or require some officers within the specialty to have STEM degrees. We recommend that STEM degrees not be added to the requirements for a career field's accessions unless it has been clearly established that a STEM degree is necessary for performing the function's core processes. If a STEM degree is required for particular technical functions within a functional area, then the position should call for an individual holding a STEM AFSC. For example, it is acceptable for either an appropriately educated logistics officer or an analyst to do the modeling for a new supply chain management application within the logistics functional area. However, only the analyst career fields should be charged with planning for and maintaining enough qualified analysts to cover that demand.

STEM Skills and Critical Thinking

CFMs report that functional areas value officers with STEM degrees. They report that it is not necessarily the STEM-specific knowledge that is necessary to carry out the position's duties, but the accompanying skills that STEM graduates are believed to be more likely to possess such as logical, systematic, critical, and analytical thinking, and problem solving. This preference may be unfounded since the evidence of a difference in critical thinking and problem solving skills between science graduates and graduates in the social sciences/humanities is not conclusive (see, for example, Arum and Roska, 2011). Other measures for identifying high-level STEM skills such as the Air Force Officer Qualifying Test, the SAT, or additional instruments developed specifically for measuring critical thinking/problem solving should be explored.

CFMs expressed a similar focus on hiring civil service STEM graduates. They believe that all other qualifications being equal, STEM graduates are more likely to be hired into positions that do not strictly require a STEM degree. However, in cases where a STEM degree is not required for the occupational series, the Air Force is restricted by law from requiring a technical/STEM degree.[1] Clearly, for both officers and civilians the definitions of qualifications for functional area positions are imprecise.

Future STEM Needs

We also examined sources of information on future needs for STEM degrees. Presumably as technologies mature and change over time, the education requirements for STEM-degreed officers and civilians will also change. Only two of the Air Force CFMs we interviewed are systematically reviewing these future needs and altering requirements to meet them: for civil engineering and developmental engineering.

We also explored a methodology for translating sources that project future technologies and future occupational growth into future Air Force education requirements. Using the U.S. Air Force Chief Scientist *Technology Horizons* report (AF/ST, 2010), we mapped key technology areas to AFSCs and occupational job titles to academic fields/degrees and then examined the academic programs that were required most often to meet future technology needs. Similarly, we mapped occupations from the Bureau of Labor Statistics *Occupational Outlook Handbook* (2012–2013 edition) to academic degree specialties. Although AF/ST prioritizes electrical, mechanical, and systems engineering degrees, we found that the academic degrees most often

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[1] 5 USC §3308 prevents agencies and services from imposing minimum education requirements above those set by the OPM.

required for the key technology areas from these two reviews are physical sciences overall, and, more specifically, biology, systems engineering, and computer technology/science. The officer biology career field was deleted in 2011, systems engineers are not a distinctly managed engineering discipline in the Air Force (whereas aeronautical, electrical, mechanical engineering, etc., are), and the cyberspace functional area does not make computer degrees mandatory for officers.

Recommendations

Looking at the overall process of planning for, determining requirements for, attracting, recruiting, hiring/accessing, classifying, assigning, and promoting STEM human resources in the Air Force, we found that there are disconnects. We recommend ongoing analysis and attention to continue to improve STEM human resource management, including interactions between CFMs and the Air Force science and engineering community, and comprehensive workforce planning, especially in the area of recruiting both officers and civilians.

We concentrated primarily on processes for defining STEM degree requirements and filling those requirements with qualified STEM-degreed officers and civilians. The following recommendations are intended as necessary first steps to address the key issues we discovered during our research.

- Officer Recommendations
    - Develop evidence-based methods to assist CFMs in refining academic degree requirements for their functional areas, including highlighting the need to consider requirements for the future.
    - Develop a more precise and visible framework for documenting the results of this evidence-based method to allow the Air Force to sum up its accession requirements by career field to know more precisely whom it needs to recruit, access, and classify.
    - Transition to a more effective method of coding degree types for officers. We recommend the Department of Education's Classification of Instructional Program codes.
    - Use the data obtained in this analysis and from follow-on work with the evidence-based methods mentioned above to identify "critical" and "high utility" academic degrees for use across all aspects of the accession process.
    - Consider substituting some STEM degree requirements with requirements for individuals with critical thinking skills identified by a minimum Air Force Officer Qualifying Test, perhaps in conjunction with a sufficient level of STEM coursework.
- Civilian Recommendations

    - Synchronize efforts within and across Air Force functional areas to highlight requirements for STEM knowledge, skills, and degrees by carefully delineating specific STEM skills in position descriptions, incentivizing employees to obtain STEM degrees by including them in promotion plans, and seeking relief from OPM prohibitions on requiring specific STEM degrees in nontechnical occupational series.
    - Continue to promote and consider increasing programs that encourage STEM recruiting and retention for civil service positions.
- General Recommendations
    - Continue to garner support for the STEM Advisory Council–approved classification of STEM versus non-STEM academic degrees so that it is accepted for all Air Force accession/hiring processes.
    - Continue to ensure that Air Force–wide STEM needs consider STEM requirements in non-STEM functional areas.
    - Office of the Air Force Chief Scientist and the STEM Advisory Council team to ensure identified future technology needs are communicated to impacted functional areas and translated into appropriate degree requirements.

Acknowledgments

We are grateful to many people who were involved in this research. In particular, we would like to thank our Air Force sponsor action officers for their help and guidance throughout this study: Mr. Patrick Hogan (SAF/AQH) and his staff, as well as Mr. William Hampton (AF/A1DI). We are also grateful to the members of the STEM Advisory Council, chaired throughout this study successively by Lt Gen Mark Shackelford, General Janet Wolfenbarger, and Lt Gen Charles Davis, for their support and guidance. In addition, we appreciate the time and candidness of all of the Air Force Career Field Managers who provided detailed information on their STEM requirements. This research would not have been possible without their contributions. Our colleague Will Canny was key in setting up and tracking the many meetings with career field managers. This research benefited from helpful insights and comments provided by several RAND colleagues, including Chaitra Hardison and Ray Conley. Finally, we would like to thank Al Robbert and Frances Ligler who provided technical reviews of this report. Their comments greatly improved the quality of this work.

Abbreviations

AAD	advanced academic degree
ABET	Accreditation Board for Engineering and Technology
ABM	air battle manager
Acq Demo	acquisition demonstration
AFBMP	Air Force Basic Meteorology Program
AFERB	Air Force Education Requirements Board
AFIT	Air Force Institute of Technology
AFOCD	Air Force Officer Classification Directory
AFOQT	Air Force Officer Qualifying Test
AFPC	Air Force Personnel Center
AFROTC	Air Force Reserve Officer Training Corps
AFSC	Air Force specialty code
AFTAC	Air Force Technical Applications Center
ASC	academic specialty code
BA/BS	bachelor of science/bachelor of art
CAD	critical accession degree
CE	civil engineering
CFM	career field manager
CIP	classification of instructional programs
CSO	combat systems officer
DAFSC	duty AFSC
DAWIA	Defense Acquisition Workforce Improvement Act
DoD	Department of Defense
DOR	dropped on request
DT	development team
FA	functional authority
FAC	functional account code
FFRDC	federally funded research and development center
FM	functional manager
GRE	Graduate Record Examination
GS	general schedule
HCS	human capital strategy
IP	instructional program

IQT	initial qualification training
ISR	intelligence, surveillance, and reconnaissance
KTA	key technology area
MAJCOM	major command
MASINT	measurement and signature intelligence
NASIC	National Air and Space Intelligence Center
NGA	National Geospatial-Intelligence Agency
NRC	National Research Council
NRO	National Reconnaissance Office
NSA	National Security Agency
OOH	Occupational Outlook Handbook
OPM	Office of Personnel Management
OTS	Officer Training School
PAF	Project AIR FORCE
PCA	potential capability area
RDT&E	research, development, test, and evaluation
RDTM	rated distribution and training management
RED HORSE	rapid engineers deployable heavy operational repair squadron engineer
RIF	reduction in force
S&E	science and engineering
S&T	science and technology
SMART	Science, Mathematics and Research for Transformation
SME	subject matter expert
STEM	science, technology, engineering, and mathematics
STEMAC	STEM Advisory Council
UAS	unmanned aircraft system
UCT	undergraduate cyberspace training
USAFA	U.S. Air Force Academy

Chapter One. Introduction and Background

Bright Horizons and Concerns About STEM Capabilities

There have long been concerns about the ability of the U.S. defense sector to ensure and maintain the necessary capabilities in science, technology, engineering, and mathematics (STEM) (NAS, 2007, 2009, 2010). These concerns are particularly salient for the Air Force, which is strongly reliant on the technical skills of its workforce to support air, space, and cyber operations. The Air Force's technologically intensive mission has historically been attractive to individuals educated in the STEM disciplines. The result has been a technically literate force capable of dealing with the development, fielding, operations, and sustainment of technology-intensive systems. STEM-degreed personnel in non-STEM positions have contributed significantly to the overall technical competence of its workforce.

However, in the aggregate, some in the Air Force feel that it may be acquiring too few STEM-educated officers and civilians to provide the technical skills required to maintain full mission effectiveness. Concerns have arisen over the growing technical complexity of both traditional and emerging capabilities required to fulfill Air Force missions and that the environment in which the Air Force now must compete to recruit and retain STEM-educated personnel who are U.S. citizens is becoming much more competitive (NRC, 2010). The Department of Defense (DoD) is one of America's largest employers of STEM workers. Budget cuts, an aging workforce, and a shortage of individuals able to obtain security clearances could create a significant issue for the military services in the future.

To address concerns about the STEM workforce in the Air Force, a 2010 National Research Council study (NRC, 2010) assessed the role of STEM capabilities in achieving the Air Force mission and the adequacy of documented STEM requirements.

One of the NRC report's key recommendations was to "review and revise as appropriate [the Air Force's] current requirements and preferences in every career field and occupational series." In response to the NRC study, the Air Force developed *Bright Horizons* (SAF/AQR, 2011), a strategic plan for implementing the study's recommendations. *Bright Horizons* clarifies the issues around STEM workforce management, assigns responsibilities for overseeing the STEM workforce, and discusses a number of goals and initiatives for ensuring and maintaining a viable STEM workforce. This study primarily addresses Goal 1, Initiative 1 of *Bright Horizons*; however, it also touches on other goals and initiatives. Excerpts of goals and initiatives addressed in this research are listed below.

Figure 1.1
Bright Horizons Goals and Initiatives

- Goal 1: Requirements and Inventory – Develop accurate and timely STEM-related manpower requirements across the Air Force
  - Initiative 1: Determine what academic degrees constitute STEM, establish STEM definition and requirements baseline, and identify future mission requirements. … Establish a process for identifying the "true" STEM requirements of the Air Force through coding of non-technical Air Force Specialty Codes/Occupational Series. *The focus of this effort is on those career fields that are non-technical, but have a partial need for STEM-qualified people, such as pilots and program management.* Upon completion, conduct a thorough STEM-related manpower requirements review through the functionals across the Air Force domains to include space and cyber. (emphasis added)
- Goal 3: Appropriately apply force management practices to build and maintain a highly competent, diversified, and agile force at the right grade levels, at the right time, and the appropriate locations
  - Initiative 1: Review and refine the process used to manage AF STEM personnel with the goal of cutting across Air Force functional domains so STEM can be viewed as an Air Force capability.
  - Initiative 4: Establish yearly military AF STEM accession goals, with prioritization, for recruiting sources.

STEM Policies in the Air Force

There is no widely accepted definition of STEM in the United States, nor in the Air Force—no list of specific disciplines that identify the whole of STEM. Definitions differ depending on the perspective of the researcher or policymaker who may include or exclude specialties such as agriculture or health sciences (Koonce, 2011). Defining STEM can also depend on specifying the domain, either education or occupation, for example. To assess the Air Force–wide STEM needs and the current STEM population, we categorized academic disciplines as STEM or non-STEM. The details of this process can be found in Chapter Two.

In the Air Force, officers are classified by Air Force specialty code (AFSC), designating the type of work they do—pilot, operations researcher, or aircraft maintainer, for example. Similarly, Air Force civil service employees are classified according to governmentwide Office of Personnel Management (OPM) occupational standards. The personnel records of officers and civilians include information on the academic degrees they've earned. The Air Force uses an academic specialty code (ASC) to specify the types of degrees an officer has earned, and an instructional program (IP) code to specify the types of degrees a civilian has earned. For the purposes of our analysis, a "STEM individual" is an officer or civilian with a degree classified as STEM at the bachelor's level or higher.

The Air Force specifies the requirements for a particular academic degree in a particular position in one of two ways for officers. First, the requirements for entry into an AFSC specify particular academic degrees that are acceptable or mandatory. Second, an individual position may require a specific academic discipline or an advanced academic degree (AAD) (AFI 36-2302). For civilians, the requirement for an academic specialty is found in the requirements for an occupational series or as a skill required for a specific position (for example, a job announcement during a hiring action). For the purposes of our analyses, we call these currently documented needs "hard requirements." These needs for STEM individuals are documented and visible to the Air Force personnel process which works to "resource these requirements," attempting to fill these positions with qualified STEM personnel.

The Air Force currently has mandatory STEM degree prerequisites for entry into four officer career fields and three civilian occupations. However, as noted in the NRC report, there is also a need for STEM competencies among a significant portion of the officers and civilians in program management, acquisition, intelligence, and other career fields that lack mandatory STEM degree prerequisites.

There may be other Air Force "needs" for a particular academic specialty that are not documented. The particular position may require special skills not required for the greater functional area, or a functional area may have always been able to find personnel with a particular skill present in its population, without that need being documented. Finally, a career field may not have been aware of a need for STEM-degreed personnel, either because it has traditionally been a non-STEM career field, or a new mission area arises that needs STEM expertise. These undocumented needs we call "soft requirements." These needs are not currently considered mandatory by the personnel system, and there are no processes in place that guarantee that they will be met. It is the identification and documentation of these "soft" or desired STEM needs that is the focus of this analysis.

Past efforts to establish Air Force STEM needs and ensure that there is an adequate workforce to support them have focused on hard STEM requirements. For example, for the STEM science and engineering specialties the career field manager (CFM) monitors STEM workforce health on a day-to-day basis. The Air Force's Studies and Analyses, Assessments and Lessons Learned organization (AF/A9) has published analyses on traditionally STEM career fields (e.g., Knoth, 2012). We found no evidence of analyses that addressed STEM needs in *all* Air Force career fields.

The NRC study (2010) came to no conclusions about specific STEM needs, instead recommending that the Air Force should

- explicitly demark what counts as a STEM degree

- review and revise, or establish as appropriate, requirements and preferences for personnel with STEM capabilities *in every career field and occupational series*, including identifying positions requiring STEM-degreed people throughout the officer career fields and civilian occupational series (emphasis added).

Scope of the Study

The primary purpose of this study is to address two key research questions:

- What are the requirements for officers and officer-equivalent civilians with STEM academic degrees across all career fields?
- Are sufficient numbers of officers and civilians available to fill these STEM academic requirements?

To address these questions, we conducted interviews with CFMs and then verified the information we gathered with functional managers/functional authorities (typically the two- or three-star senior leader in a particular career field or group of career fields). This methodology is described in greater detail in Chapter Two. Results pertaining to STEM degree needs are presented in Chapter Three, as well as additional findings from the interview process.

An assessment of STEM requirements and populations is only a portion of the investigations that may be required to ensure the Air Force has an adequate supply of STEM officers and civilians today and in the future. For example, in this analysis we do not directly tie evolving technology areas to particular career fields, nor do we fully examine recruiting strategies for accessing and hiring STEM individuals. Rather, in this analysis we address important foundational first steps for ensuring sufficient STEM requirements and individuals and highlight three themes that emerged as significant and in need of additional exploration: the use of science and engineering (S&E) consultants, the desire for generic STEM skills, and the lack of CFM focus on future requirements for STEM. These issues are discussed in Chapters Four through Six.

Chapter Two. Definitions, Data, and Methodology

Defining STEM and Non-STEM

To assess the adequacy of STEM requirements and personnel in the Air Force, it is first necessary to define what is meant by a STEM officer/civilian and a STEM-required manpower position.

Classifying STEM Academic Degrees/Individuals

Our review of STEM academic degrees required distinguishing STEM from non-STEM academic degrees. Finding no preexisting categorization of STEM versus non-STEM disciplines,[2] we created one and presented it to the STEM Advisory Council (STEMAC) in February 2011.[3] This classification has been accepted across the analytical community and is now widely viewed as the Air Force–approved designation.

The Air Force officer data system uses ASCs to document the academic specialty for degrees held by individuals. The ASC list uses a four-character, hierarchical structure, with the last three digits breaking out subgroups within the ten broad areas of study listed in Table 2.1.

Table 2.1
Officer Academic Specialty Code (ASC) Broad Areas of Study

4-Digit ASC	Area of Study
0XXX	Inter-area specialization
1XXX	Administration management, military science
2XXX	Arts, humanities, and education
3XXX	Biological and agricultural sciences
4XXX	Engineering
5XXX	Law
6XXX	Mathematics
7XXX	Medical sciences
8XXX	Physical sciences
9XXX	Social sciences

[2] The Air Force Personnel Center (AFPC) does use the similar terms “technical” and “non-technical” when referring to academic degrees; however, we were unable to obtain from them a list of degrees that definitively categorizes technical and nontechnical.

[3] The STEMAC, established by the Chief of Staff of the Air Force, is chaired by the Military Deputy, Secretary of the Air Force for Acquisition. Members represent organizations and career fields with STEM interests across the Air Force.

Similarly, for civilians the Air Force personnel data system documents degrees earned using a list of IPs. IPs use six-digit codes and also have a hierarchical structure (see Table 2.2).

Table 2.2
Civil Service Instructional Program (IP) Broad Areas of Study

6-Digit IP	Area of Study
01XXXX	Agriculture, Agriculture Operations, and Related Sciences
03XXXX	Natural Resources and Conservation
04XXXX	Architecture and Related Services
05XXXX	Area, Ethnic, Cultural, and Gender Studies
09XXXX	Communication, Journalism and Related Programs
10XXXX	Communications Technologies/Technicians and Support Services
11XXXX	Computer and Information Sciences and Support Services
12XXXX	Personal and Culinary Services
13XXXX	Education
14XXXX	Engineering
15XXXX	Engineering Technologies/Technicians
16XXXX	Foreign Languages, Literatures, and Linguistics
19XXXX	Family and Consumer Sciences/Human Sciences
22XXXX	Legal Professions and Studies
23XXXX	English Language and Literature/Letters
24XXXX	Liberal Arts and Sciences, General Studies and Humanities
25XXXX	Library Science
26XXXX	Biological and Biomedical Sciences
27XXXX	Mathematics and Statistics
29XXXX	Military Technologies
30XXXX	Multi/Interdisciplinary Studies
31XXXX	Parks, Recreation, Leisure and Fitness Studies
38XXXX	Philosophy and Religious Studies
39XXXX	Theology and Religious Vocations
40XXXX	Physical Sciences
41XXXX	Science Technologies/Technicians
42XXXX	Psychology
43XXXX	Security and Protective Services
44XXXX	Public Administration and Social Service Professions
45XXXX	Social Sciences
46XXXX	Construction Trades
47XXXX	Mechanic and Repair Technologies/Technicians
48XXXX	Precision Production

Table 2.2—Continued

6-Digit IP	Area of Study
49XXXX	Transportation and Materials Moving
50XXXX	Visual and Performing Arts
51XXXX	Health Professions and Related Clinical Sciences
52XXXX	Business, Management, Marketing, And Related Support Services
54XXXX	History
60XXXX	Dental, Medical and Veterinary Residency Programs

We classified ASCs and IPs as STEM/non-STEM at the finest degree of detail available (four or six digits, respectively). (See Appendix A for a detailed categorization of STEM/non-STEM ASCs/IPs). In general, ASCs/IPs representing academic degrees in engineering, mathematics, and the sciences are classified as STEM. We consider STEM to include academic degrees in life sciences, physical sciences, mathematics and statistics, computing, engineering, and architecture. We do not include social sciences or the management of STEM disciplines in our definition of STEM degrees. We also do not include engineering technologies or engineering sciences since these degrees are typically offered at the associate degree level.[4] Degrees in management, business administration, arts and humanities are classified as non-STEM. Since it is difficult to peruse the entire list of over 1,900 ASCs and IPs used in this analysis, we consolidated the degrees to show which disciplinary groups in general are STEM and which are non-STEM (see Figure 2.1).

It was necessary to create an "Other STEM" disciplinary group to reflect less common STEM disciplines that didn't fall into one of the 25 disciplinary groups. Most of this group's members reflect exceptions to the non-STEM characterization of broader ASCs/IPs; for example, we categorized quantitative Industrial and Organizational Psychology (IP 420901) as "Other STEM" while most of the broader Psychology (IP 42XXX) degrees are categorized as non-STEM. Exceptions within disciplinary group are allowed—e.g., keeping clearly quantitative ASCs and IPs as STEM even though their parent category shifted to non-STEM. For example, quantitative economics (ASC 9BJY, IP 450603) is considered STEM, while the larger economics disciplinary group (ASC 9BXX, IP 4506XX) is considered non-STEM.

In classifying degrees as STEM/non-STEM, the split occurs most often at the two-character level—e.g., ASCs that begin with 4I (electrical engineering) are STEM, while those that begin with 4V (engineering technologies) are not.

For the most part, entire instructional programs fit into either STEM or non-STEM categories; there are, however, exceptions. For example, IP 420201, Clinical Psychology, is non-STEM, while 420901, Industrial and Organizational Psychology, is STEM. IP codes have the advantage over ASCs of being roughly equivalent to the Department of Education's

[4] This was a decision made by the STEMAC based on the importance of attaining a bachelor's degree for officers and administrative and professional civilians.

Classification of Instructional Program (CIP) codes. The CIP is the accepted federal government statistical standard on instructional program classifications and is used in a variety of education information surveys and databases. The CIP is used by state agencies, national associations, academic institutions, and employment counseling services for collecting, reporting, and analyzing instructional program data (Department of Education, 2011).

Some ASCs/IPs are not categorized for this analysis because they are not present in the military/civilian dataset we used.[5] (Many ASCs and IPs are either no longer used or have been subsumed by other ASCs/IPs.) For our analysis 1,085 of the 3,118 total ASCs and 852 of the 1,488 total IPs are classified.

[5] The complete ASC list is available online (Air Force Institute of Technology, 2010), as is the IP list (Office of Personnel Management, undated).

Figure 2.1
Academic Disciplinary Groups

STEM academic disciplinary groups

Inter-area specializations
1 Comp sci/engr, info sys
2 Ops research/management science
3 Space
4 Systems/C3
5 Environmental sciences
Biological and medical sciences
6 Biological and medical sciences
Engineering
7 Aeronautical engineering
8 Aerospace engineering
9 Astronautical engineering
10 Chemical engineering
11 Environmental engineering
12 Civil engineering
13 Electrical engineering
14 Industrial engineering
15 Mechanical engineering
16 Nuclear engineering
17 Systems engineering
18 Architecture
19 Engineering science
Mathematics
20 Mathematics
Physical sciences
21 Chemistry
22 Earth sciences
23 Meteorology
24 Physics
25 Physical sciences
Other
26 Other STEM

Non-STEM academic disciplinary groups

Admin, Management, and Military Science
1 Bus admin/management (generic)
2 Engr/R&D/sys/info-sys management
3 Finance/accounting
4 Logistics/production/acquisition
5 Human resources management
6 Aviation management
7 Transport management
8 Other business/management
9 Public administration
10 Military sciences/strategic studies
Arts, Humanities, and Education
11 Education
12 General/liberal studies/humanities
13 Area studies
14 Chaplaincy/religion/theology
15 Fine and applied arts
16 Foreign language
17 English/communications
Engineering
18 Engr/aero sci/techn
Law
19 Law
Medical/Allied Sciences
20 Medical/allied sciences
Social sciences
21 Economics
22 Geography
23 History
24 Political science
25 Psychology
26 Sociology
27 Criminology/criminal justice
28 Other social sciences
Other
29 Technicians/crafts/trades
30 Other non-STEM

The military personnel data system records degrees earned: associate, bachelor's, master's, and doctoral. No information is recorded as to the coursework taken to obtain these degrees. For the purposes of our analysis, an individual (officer or civilian) is considered a STEM asset if they have at least one degree classified as STEM at the bachelor's degree (BA/BS) level or higher regardless of their AFSC, occupational series or duty AFSC (DAFSC). An individual can have STEM proficiency at levels above and below this basic STEM degree level. For example, some AFSCs and occupational series require a particular amount of coursework in STEM disciplines, but not an entire STEM degree, while some positions require that the individual have a master's or doctoral degree in a STEM discipline. In classifying individuals as STEM- or non-STEM-degreed, we considered not only the most recent degree earned, but all degrees listed in military and civilian personnel records.

Based on the STEM/non-STEM split of ASCs we categorized officers according to their three-character DAFSC, core occupations, and STEM or non-STEM designation. We combed through personnel records in detail in order to confirm or revise officers' occupational cores based on their duty histories and current primary/secondary/tertiary AFSCs. For rated officers, we started with core-like codes that were developed by AFPC reflecting competitive category, weapon system, and rated distribution training and management (RDTM) groups. Civilians are categorized according to the occupational series associated with their current positions.

Any classification of STEM versus non-STEM ASCs/IPs is unlikely to satisfy everyone and can be criticized and revised. In addition, while a broad STEM/non-STEM categorization can help in tracking aggregate trends, stakeholders responsible for officer and civilian accessions, retention, advanced degrees requirements, etc. must consider the specific academic discipline(s) required for the positions in their purview, so a general STEM/non-STEM classification may not always be useful when more discipline-specific knowledge is required.

Identifying STEM Positions

For the purpose of our analysis, we categorized Air Force positions as having either a "hard STEM requirement" or a "soft STEM requirement."

- A *hard STEM requirement* is a documented requirement for the position to be filled by an individual with a STEM degree. Examples of methods of documentation for hard STEM requirements are educational requirements for officer accessions listed in the Air Force Officer Classification Directory (AFOCD), AAD requirements for a particular position,[6] degree requirements for an occupational series, or the requirement in a position description for a civilian hiring action. For a hard STEM requirement there is some demand signal in the Air Force personnel system to fill the requirement.
- A *soft STEM requirement* is an undocumented need for a position to be filled by an individual with a STEM degree or a requirement for a STEM competency in some portion of a functional workforce not necessarily associated with specific positions. Soft STEM requirements are not mandatory, but are desired by a functional area for mission accomplishment. A functional area may currently have a sufficient inventory of individuals with a particular STEM degree but levy no requirement that it continue to be allocated officers with that STEM degree. Soft STEM requirements may also be due to changes in a particular functional area that require additional STEM individuals, before that need has been documented as mandatory.

[6] For officers, each position requiring an AAD is coded as such and is, therefore, a hard STEM requirement (AFI 36-2302).

Some AFSCs and occupational series require STEM degrees for entry and, therefore, all of those positions require a STEM degree. These are called "STEM-mandatory" AFSCs and occupational series. The AFOCD is the official document through which entry-level education for an AFSC is specified. OPM standards are the official method for documenting the need for a specific type of academic degree for civilian occupational series.

Officer, Civilian, and Position Data

Data for this analysis were obtained from snapshot records for all nonmedical officers and officer-equivalent civilians (defined here as all administrative and professional civilians)[7] for May 2010. Data on required (including unfunded) and authorized (funded) manpower positions were from the June 2010 Air Force manpower file.

The DAFSC in an officer or civilian record identifies an AFSC, indicating the type of work an individual does in the position. We used DAFSC only to categorize the career field where officers and civilians worked, not whether they should have STEM degrees or whether individuals are STEM. In some cases it was necessary to also review the functional account code (FAC) or organization of assignment in order to determine the functional area. Most civilian occupational standards allow suitable work experience to substitute for academic credentials, so civilians in the dataset don't necessarily have degrees, even civilians in the occupational series that most would regard as STEM. We counted individuals as STEM only if they had at least a BA/BS in one of the ASCs or IPs that we categorized as STEM, regardless of their DAFSCs, functional areas, occupational series, grades, etc.

Civilian manpower positions identify an associated occupational series, but the occupational series for civilian manpower positions are widely known to be inaccurate. While an occupational series may be listed for a particular position, it is easy to change and depends on the duties of the position, its description, and its classification—factors which may change often. Said another way, a vacant civilian manpower position means that the position can be filled, but the position does not necessarily determine the occupational series.

Due to the difficulties associated with identifying and categorizing civilian requirements, we do not include analysis associated with civilian personnel manpower positions. (Manpower positions are included in our analysis of officer data.) We only look at the individual civilians in the database population.

A functional area is a grouping of individuals on the basis of the overall functions performed. AFI 36-2640, *Executing Total Force Development*, establishes these functional areas and assigns functional authorities (FAs) and functional managers (FMs) for officer and civilian functional areas. We grouped individuals and positions from our data sets into 14 functional areas:

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[7] We used all occupational series 0000-2299 except for the medical, hospital, dental, and public health series 0600-0699. Trade, craft, or labor job families in series 2500-9000 are not included. See U.S. OPM, 2013 for details.

- Rated (Pilot, Combat Systems Officer [CSO], Air Battle Manager [ABM])
- Civil engineer
- Force support
- Intelligence
- Logistics
- Security
- Financial management
- Science/Research
- Developmental engineer
- Acquisition management
- Contracting
- Space and missile
- Cyberspace
- Weather

These functional areas account for 94 percent of the officer force and 86 percent of the officer-equivalent civilian force. The remaining populations are in small, very specialized functional areas, e.g., combat rescue, air liaison officer, and public affairs.

The goal of our research is to address STEM needs in various functional areas; therefore, we needed information beyond officer specialties and civilian occupational series to identify the entirety of populations working in areas such as human resources, logistics, finance, and acquisition management. We identified the specific civilian occupational series, if any, and officer core specialties that logically form each function's core, plus other families of specialties/occupations that contribute notably. Then we tabulated the various contributors' numbers with STEM degrees.

Data are analyzed and presented within these functional areas at three levels:

- Core Career Field: Individuals are classified into a functional area based on their core career field for officers and their occupational series for civilians. This is the area of the officer or civilian's primary expertise. The cyberspace functional area, for example, includes officers with a core of 17D (cyberspace) and civilian occupational series 0334 (computer specialist).
- Duty Career Field: Officers and civilians often serve in duty positions equivalent to their core ID, i.e., they work in jobs that are in their primary area of expertise. There are times, however, when officers and civilians serve in positions outside of their core ID. For example, some officers and civilians will "career broaden" to obtain experience in another functional area or may serve as instructors.
- Functional Area: A particular functional mission is performed by core individuals and, in some cases, by those in AFSCs and occupational series outside the functional area. To fully capture the STEM expertise/needs in a functional area, it was necessary to look at

all those performing within it. An organizational example of the need to look across the entire enterprise is AFPC. AFPC's functional area is force support; however, officers and civilians from career fields other than force support are necessary for AFPC to perform its mission—for example, individuals with cyberspace expertise who design and maintain personnel data systems, and operations researchers who analyze promotion results. We identified individuals in the functional area as those serving in the functional area's FACs, organizations, and DAFSCs.

Information on Soft STEM Needs

Determining the education requirements for officer and civilian positions could be accomplished by an occupational analysis of each position. However, this would be a work-intensive process and beyond the resources available for this analysis. In place of a position-by-position review, we turned to the expertise of the CFMs. CFMs "communicate the education, training and experience requirements of the functional community" (AFI 36-2640). They support accessions and training processes and coordinate all force structure changes with the manpower, personnel, and training community. They review and validate AAD requirements to meet functional area needs. They are in the optimal positions to assess the adequacy of the current STEM population and the need for additional STEM individuals in their functional area.

Figure 2.2 depicts the overall process for obtaining information from CFMs and functional authority/functional managers (FA/FMs). After compiling officer, civilian, and position data and classifying this data into functional areas, we produced summaries showing core DAFSC and functional area populations by grade, organizational level, and any subspecialties within the AFSCs and occupational series. In addition, we listed the most prevalent STEM and non-STEM degrees for officers and civilians and included the current STEM/non-STEM AAD requirements. A summarized version of this information was sent to CFMs prior to our meetings so that they could review their STEM populations. After explaining the purpose of our analysis, we asked CFMs:

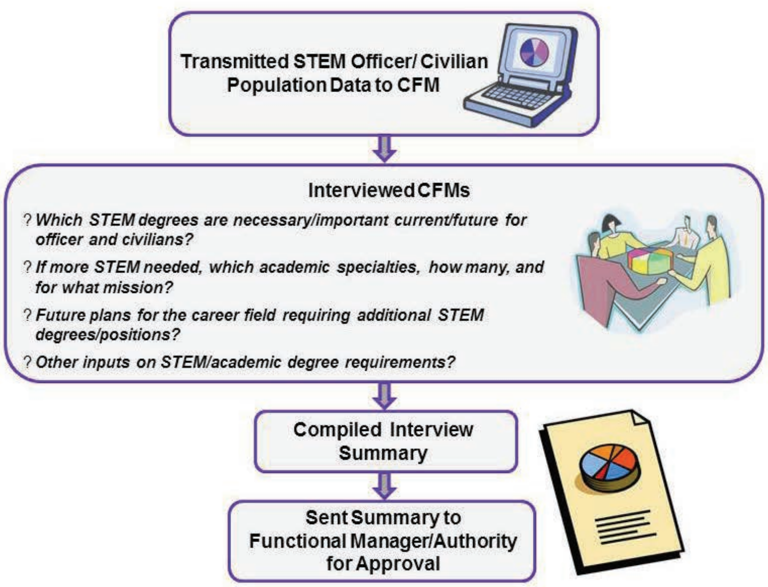
- Which STEM degrees are necessary/important for successful functional performance today and in the future for officer and civilian members doing [*insert career field here*]-related work?
- Are current numbers and types of STEM degrees possessed by your officers/civilians sufficient, less than sufficient, or more than sufficient?
- If more degrees are needed, how many and what types of degrees are needed? What requirement will these degrees support?
- Confirm that the AFOCD guidelines for [*insert career field here*] officers are appropriate.
- What are the "real world" STEM requirements for [*insert career field here*] officers, since it appears (in the officer data we reviewed) that some accessions fall outside the degree types specified in the AFOCD?

- Discuss any future plans for the functional area or career field that might change the desired STEM makeup of the officer and civilian populations.
- Any other inputs for RAND regarding STEM requirements?

CFM meetings generally lasted about one hour. We began by discussing the summary data for the functional area, and then we discussed characteristics of the current STEM population, the desired STEM population, and methods to achieve the needed officers and civilians.

Using summary data and notes from the CFM meetings, we consolidated our findings into a three- to four-page summary outlining the desired STEM degrees, academic specialties, and STEM challenges for each functional area. The CFMs were asked to check the proposed summaries to ensure we accurately represented their STEM needs. The summaries were then forwarded to the FA or FM (depending on the functional area) to ensure the information we received from the CFM reflected senior leaders' views for STEM needs in the functional area. If necessary, we obtained additional information and revised our results. The summaries as approved by each FA/FM are included in Appendix C of this report.

Figure 2.2
Interview Process



From the information we obtained from each functional area, we developed a summary view of the number and disciplinary group of STEM individuals desired by the functional area as well as compiling observations concerning the overall education requirements–determination process.

Chapter Three. Results

This section presents a summary of information obtained on STEM needs from our CFM interviews. First, we show the current STEM/non-STEM officer and civilian positions and populations. Next, we summarize our findings within each of three tiers of functional areas. Finally, we summarize our findings from the overall interview process.

Documentation of Current "Hard" STEM Requirements

The documentation of existing "hard" STEM requirements was a significant first step in this research. Table 3.1 shows officer positions and current officers by DAFSC. Positions in each functional area are categorized by the degree requirements: those positions that require a STEM degree, those where a STEM degree is among the options, and those where a non-STEM degree is required.

Across the Air Force, 10.2 percent of officer positions in our data sample required a STEM degree. Previous analyses by the NRC, Assistant Secretary of the Air Force for Acquisition (SAF/AQ), and AF/A9 have focused on this population; however, 75.6 percent of positions had a STEM degree among the options, which is the population this analysis focuses on.

A bare majority (50.1 percent) of Air Force officer positions are for pilots, CSOs, and ABMs. These rated officers come into the Air Force based on their qualifications for their weapon systems with limited regard to their academic degrees. Few STEM degrees are mandatory for these officers (1 percent). We specifically focused in this research on nonrated officer positions since an academic degree has a significant impact on which functional area an officer joins. Of the approximately 55,000 nonmedical officers in our dataset, 42.4 percent have STEM degrees, while 41.8 percent of nonmedical, nonrated officers have STEM degrees.

Of the 78,657 officer-equivalent civilians in our dataset, Table 3.2 shows the numbers of civilian personnel with STEM degrees in each two-digit occupational series. Since experience and education combine to qualify individuals for civil service positions, some individuals have no bachelor's degree. So in Table 3.2 we include a column for the percent with STEM degrees among those with BA/BS degrees and above. Across all occupational series, 26.3 percent of civilians have STEM degrees, and 40.3 percent of those with at least bachelor's degrees have STEM degrees. Positions for civilians are not shown in Table 3.2 since the occupational series required for each authorized civilian position is very flexible and changes often. The changeability of civilian positions was confirmed by individuals experienced with tracking civilian positions.[8]

[8] Communication with SAF/AQH, January 19, 2012.

Table 3.1
Officer STEM Positions and STEM/Non-STEM Officers by DAFSC (June 2010)

	Positions				Officers		
Career Field	STEM Required	STEM Among the Options	Non-STEM Required	Percent STEM Required	STEM by DAFSC	Non-STEM by DAFSC	Percent STEM
Developmental Engineering (62EX)	2,570	0	0	100	2,581	57	98
Scientific/Research (61XX)	481	314	0	61	732	92	89
Weather (15WX)	96	425	0	18	480	83	85
Civil Engineering (32EX)	1,190	0	0	100	1,116	58	95
Pilot, CSO, ABM (11XX, 12XX, 13BX)	275	18,389	295	1	7,745	10,207	43
Contracting (64PX)	2	0	773	0	66	717	8
Security Forces/Special Investigations (31PX, 71SX)	13	0	956	1	134	899	13
Financial Management (65FX, 65WX)	14	586	0	2	61	624	9
Intelligence (14NX)	19	2,726	0	1	408	2,311	15
Cyberspace (17CX, 17DX)	98	2,345	0	4	1,623	1,392	54
Force Support (38FX)	7	1,364	0	1	196	1,444	12
Acquisition Management (60C0, 63AX)	77	2,599	0	3	1,085	1,137	49
Logistics (20C0, 21AX, 21MX, 21RX)	13	3,065	0	0	607	2,819	18
Space and Missile (13SX)	21	2,758	0	1	838	2,180	28
Career Field Total	4,876	34,571	2,024		17,672	24,020	42
Career Field Percent of Total	12%	83%	5%		42%	58%	
Non-Rated Line Total	4,601	16,182	1,729		9,927	13,813	42
Non-Rated Percent of Total	20%	72%	8%		42%	58%	
Command and Control (13DX, 13LX,13MX) (Note 1)	0	515	0	0	112	356	24
Operations Support (16XX) (Note 2)	14	0	1,313	1	396	562	41
Special Duty/Reporting Identifier (Note 3)	37	1,587	1,089	1	3,049	3,826	44
All Other Non-STEM Mandatory (Note 4)	0	0	2,490	0	381	2,299	14
Air Force Total	4,927	36,673	6,916		21,610	31,063	41
Air Force Percent of Total	10%	76%	14%		41%	59%	

Notes:

1. We did not interview the 13DX/LX/MX CFMs for our analysis. Position and officer data is provided here for completeness
2. Operations support (16XX) positions are primarily for field grade officers. Officers are not this AFSC for a career, but flow in and out as necessary to fill positions
3. Special Duty/reporting Identifier positions such as recruiters, instructors, students, patients, etc. are not managed by any single career field and in some cases span several functional areas. These positions and officers are not included in the functional areas listed above.
4. These are small, specialized career fields such as public affairs, special investigations, etc. and we did not interview their CFMs. All of their positions are non-STEM required. Position and officer data is provided here for completeness.

Table 3.2
STEM/Non-STEM Civilians by Occupational Series (as of May 2010)

Occupational Series	Number with STEM BA/BS or Higher	Number with Non-STEM BA/BS or Higher Only	Number with No BA/BS	Percent with STEM Degree of Total	Percent with STEM degree of Degreed
00 Miscellaneous Occupations	180	1,048	1,983	6	15
01 Social Science, Psychology and Welfare	280	2,104	845	9	12
02 Human Resources Management	121	1,390	1,645	4	8
03 General Administrative, Clerical, and Office Services	1,958	7,757	8,749	11	20
04 Natural Resources and Biological Sciences	146	75	7	64	66
05 Accounting and Budget	352	3,576	2,390	6	9
08 Engineering and Architecture	11,783	795	152	93	94
09 Legal and Kindred	13	483	223	2	3
10 Information and Arts	46	512	572	4	8
11 Business and Industry	1,191	6,418	1,933	12	16
12 Copyright, Patent, and Trademark	5	7	0	42	42
13 Physical Sciences	977	143	64	83	87
14 Library and Archives	15	151	18	8	9
15 Mathematical Sciences	1,303	225	50	83	85
16 Equipment, Facilities and Services	203	523	2,008	7	28
17 Education	344	2,605	884	9	12
18 Inspection, Investigation, Enforcement, & Compliance	50	397	103	9	11
19 Quality Assurance, Inspection , and Grading	42	177	768	4	19
20 Supply	70	571	1,012	4	11
21 Transportation	165	531	1,486	8	24
22 Information Technology	1,432	1,158	2,443	28	55
TOTAL	20,676	30,646	27,335	26	40

Note: We used all occupational series 0000-2299, except for the medical, hospital, dental and public health series 0600-0699. Trade, craft or labor job families in series 2500-9000 are not included. See U.S. OPM, 2013 for details.

Documentation and Analysis for Officers Is Hampered by Current Academic Specialty Codes

Early in our research, it was clear that the existing system for documenting the academic specialty for officer degrees was inefficient for requirement analysis. ASCs were originally intended to be hierarchical with increasing levels of specialization with the addition of each of four digits. As the codes stand today, several degree specializations have been lumped under the 0XXX, inter-area specialization category. Degree types in this categorization range from, for example, biochemistry (0YBY), to telecommunications (0YTY), to Russian studies (0YLC). In addition, several academic degree specializations are outdated; for example, "automatic data processing (ADP)" is used in the titles of several specializations. Instead of regular updates to the list over time, it appears that additions were made without deletions, so that we found only 1,085 ASCs being used in the current population despite over 3,118 available ASCs.

It took significant time and effort to classify and sort ASCs for this analysis. An efficient method of documenting and defining degree requirements would be based on a more organized and succinct list of codes. In addition, an appropriately hierarchical structure would make the classification of STEM degrees much more efficient.

General Findings from the Interview Process

While the goal of interviewing CFMs was to gather information on their STEM requirements, during the actual interview process, we obtained information about functional area processes and management.

Most notably, CFMs have little to rely on to determine which academic degrees and in what numbers are required for mission accomplishment in their career field. CFMs are not in the business of assigning officers to positions and would not necessarily be aware of instances where there was a lack of STEM-educated/experienced individuals in the career field. In fact, for those career fields where STEM degrees are not mandatory, CFMs are not aware of their current STEM populations, nor did they consider STEM experience in their management of the career field. Few career field/functional managers are considering future needs when planning for accession degree types—based on either planned changes to their missions or technologies.

There are significant differences in the level of expertise of the CFMs across all functional areas. Some are military officers from the functional area assigned as a CFM for a two- or three-year tour, many with little training in career-field management practices. Those CFMs we interviewed with the most in-depth knowledge and experience are civil servants with significant time spent in the position, possessing a combination of experience in both their functional areas and human resources.

There are also significant differences in the frequency and quality of the CFMs' engagement with their respective FA/FMs. Some CFMs meet regularly with their FA/FM and receive guidance on senior leaders' strategic direction for their functional areas. In addition, engaged CFMs are seen as the FA's/FM's human resources advisor and are consulted frequently. In contrast, some CFMs operate on their own with little interaction. In those cases, FA/FMs often disagreed with their CFMs during the interview process, making significant changes to the preferences/targets summarized for their career fields.

Overall, CFMs recognized that a greater percentage of officers as compared to civilians have STEM degrees and most agreed that civilians provide the long-term technical continuity in their functional areas. However, few CFMs integrated the requirements for officers and civilians to determine the most efficient way to obtain a particular STEM expertise.

Interview Findings—"Soft" STEM Needs

Figure 3.1 summarizes the results of the interview findings. For each functional area, an assessment is made as to the adequacy of the current STEM requirements for mission accomplishment. We classify these 14 functional areas into three tiers according to STEM/non-STEM requirements and needs. The functional areas of civil engineering, developmental engineering, science/research, and weather have substantial hard STEM requirements. On the other end of the spectrum, we grouped functional areas with substantial hard non-STEM requirements and no stated soft needs for STEM qualifications, including contracting, security, financial management, and the rated force. The third tier includes functional areas with few hard STEM requirements but significant stated needs for soft STEM expertise and includes intelligence, personnel, acquisition management, logistics, space and missile operations, and cyberspace.

Figure 3.1 also includes our findings on whether functional areas appear to be meeting stated STEM needs. Half of the functional areas are meeting stated needs for officers with STEM degrees, and half are not. For those that aren't meeting stated needs for STEM populations, we present the current and desired STEM population percentages. For civilians, the current STEM population is listed for those functional areas that desire STEM graduates. The cells without color coding signify changes that could be made to increase STEM capacity. There are two ways to increase the STEM officer population in a functional area: by increasing STEM-required positions (i.e., designating STEM-required AFSCs for the positions) which will cause personnel processes to attempt to fill these positions with STEM degreed officers, or by increasing the number who enter as accessions with STEM degrees into non-STEM-required AFSCs.

Cells with an "X" designate areas where no change is possible—for example, it is not possible to increase the STEM-required positions for developmental engineers since that requirement is already set at 100 percent. A "+" in Figure 3.1 indicates the method by which the career field envisions increasing its STEM population. Detailed findings for each of these tiers are discussed below.

Figure 3.1
Assessment of Officer and Civilian STEM Populations by Career Field

Tier/STEM Requirements	Career Field	OFFICERS: Officer STEM Population (Current / Desired)	OFFICERS: Increase STEM-Required Positions	OFFICERS: Increase STEM Degrees	CIVILIANS: Civilian STEM Population (Current)	CIVILIANS: Increase Occ Series STEM Degrees (Specific Area)
Tier I Substantial Hard STEM Requirements	Developmental Engineering					
	Scientific/Research					
	Weather	86% / 100%				
	Civil Engineering	93% / 100%			89%	Constr Mgmt
Tier II Little Recognized Need for STEM	Pilot, CSO, ABM					
	Contracting					
	Sec Forces /Spec Invest					
	Financial Management				5%	Cost-Analysis
Tier III Few Hard STEM Requirements & Significant Hard STEM Needs	Intelligence	15% / 25%		+		
	Cyberspace			+ (Note 1)		
	Personnel	12% / 25%		+		
	Acquisition Management	48% / 50%		+	23%	Pgm Mgmt
	Logistics	18% / 47%		+	8%	Logistics Prof
	Space and Missile	28% / 60%	+	+		

Adequate	STEM Need <10% Understated	STEM Need >10% Understated

Note: The cyberspace CFM considers the current population of STEM degreed officers adequate. However, given predictions of future cyberspace needs and the fact that so few hard STEM requirements are present, the CFM believes increased numbers of STEM-degreed officers (specifically in computer-related areas) are needed.

Figure 3.1 is a career field/occupationally oriented assessment of STEM populations. The Air Force manages education requirements for positions and degrees required for officers through FA/FMs and CFMs who are career focused. The NRC (NRC, 2010) recommended a career field–focused assessment, as did SAF/AQ's *Bright Horizons*. Much less attention has been given to assessing STEM populations and requirements from an organizational perspective. In fact, particularly in Tier III, functional areas typically rely on a core career field supported by STEM individuals from career fields such as scientific/research and developmental engineering. To a great extent, it is the scientific/research and developmental engineering CFMs who are actually responsible for ensuring the organizations from other functional areas are staffed with sufficient

STEM-degreed individuals. So, for example, the 61A CFM is responsible for ensuring appropriately degreed analysts are available in logistics organizations.

While many of the CFMs we interviewed considered the presence of these individuals from other career fields in their functional areas/organizations, there was by no means a consistent nor adequate approach to assessing the adequacy of their contributions to functional areas. FA/FM/CFMs for the most part actively manage only their own core career fields. In Chapter Four we consider the "STEM consultant" and discuss his contribution.

Tier I. Career Fields with Substantial Hard STEM Requirements

Our interviews revealed that functional areas with a significant percentage of hard STEM requirements believe their STEM needs are adequately represented in the requirements for officer accessions and specific positions. They have hard STEM requirements in place for officers and civilians, and these requirements are generally applicable to the functional area's entire workforce. There are small numbers of people in these functional areas without STEM degrees. In the Science/Research functional area, this is acceptable since non-STEM degrees such as economics and sociology are necessary. However, CFMs and FA/FMs in developmental engineering, civil engineering, and weather are very interested in understanding the presence of non-STEM officers and civilians in their functional areas. In most cases, non-STEM officers in these specialties had degrees in engineering management/science as opposed to accredited engineering degrees. Some officers and civilians can enter these functional areas with combinations of experience and non-STEM education. The functional authorities in this tier assessed the definitions and documentation of their STEM requirements as adequate.

For the career fields in this tier, CFMs expressed the importance of the quality of the STEM degree—both the individual's success with the degree program (often expressed in terms of a grade point) and the quality of the institution granting the degree. While the civil engineering CFM specifies that engineering degrees for officers must be Accreditation Board for Engineering and Technology (ABET) accredited, other CFMs rely only on completion of the degree. In the case of the scientific/research career field, the CFM mentioned anecdotally (for example in nuclear engineering) seeking accessions with high grade points from schools with nationally recognized programs; however, this is done on an ad hoc basis and not included in the stated education requirement.

Tier II. Career Fields with Little Recognized Need for STEM

Interviews with CFMs in some functional areas revealed little need for STEM skills to accomplish the associated duties and responsibilities. Other skills are more important for rated individuals, for example, such as multi-tasking and the ability to operate under stress. For those rated positions where STEM degrees are required, mandatory requirements are already levied. Given the relatively large percentage of officers with STEM degrees (43.1 percent), there are potentially many rated officers qualified for the STEM positions.

In the contracting functional area, the CFM reported little need for STEM expertise. Contracting duties are focused on adhering to governmental regulations and administrative processing procedures that do not require STEM skills. Despite this information from the CFM, the AFOCD does include the STEM discipline "quantitative methods" among ten degrees, at least one mandatory for officer accessions. The contracting CFM reported that if data/statistical analysis or computer programming skills are required for mission accomplishment, help normally comes from mathematicians or cyberspace specialists from outside the contracting specialty or occupational series.

Similarly, the financial management functional areas listed STEM degrees among those required for accession, yet they do not see specific needs for STEM skills. The financial management career field ensures an adequate level of competency by requiring expertise in non-STEM disciplines such as economics, accounting, finance, and management. As noted in Figure 3.1, the financial management CFM noted the need for a small increase in the number of civilians with STEM degrees in cost analysis. The CFM expressed a desire to shift cost analysis work/positions to the STEM-required operations research (1515) and engineering (08XX) occupational series.

The security CFM does not see a need for STEM expertise in this functional area. In addition, the CFM voiced concern that non-STEM functional areas may be losing out on resources directed to STEM disciplines. For example, AAD quotas may be allocated for STEM degrees versus non-STEM degrees due to the perception that they are more critical. The security functional area looks to other organizations (such as the Electronic Security Command and the Air Force Operational Test and Evaluation Center) and other functional areas (such as engineering, acquisition management, and logistics) to research, procure, and field new security technologies.

The functional areas in this tier see little need for STEM accession and positions and, therefore, currently assess the definition and documentation of their STEM requirements as adequate.

Tier III. Career Fields with Few Hard STEM Requirements and Significant Soft STEM Needs

Interviews with CFMs in Tier III revealed necessary increases in STEM requirements and populations.

The intelligence functional area is the greatest user of STEM expertise from outside the intelligence career field/occupational series (i.e., STEM "consultants"). Ten percent of the functional area's STEM personnel comes from individuals in other career fields. Despite this reliance on STEM consultants, the intelligence CFM believes it is necessary to increase the population of intelligence officers with STEM degrees from 15 percent to 25 percent.

The cyberspace functional area currently has a significant number of STEM-degreed officers and civilians (53 percent and 38 percent, respectively) and the CFM judges these percentages as adequate. However, only 4 percent of cyberspace officer positions require a STEM degree, and the AFOCD does not restrict accessions to those with STEM degrees. Therefore, although the functional area has an adequate STEM presence today, there is no process or mechanism ensuring that the career field will continue to have this level of STEM expertise in the future.

At the time of our interviews, the force support functional area was already contemplating a change to the AFOCD in order to obtain more STEM accessions, including specifying a percentage of accessions that should have degrees in industrial engineering, mathematics, or operations research. This would be the first instance where a career field specified that a percentage (25 percent) of accessions have a particular degree type in the AFOCD. The CFM highlighted the career field's desire to have more force support officers with STEM degrees rather than continuing to rely on other career fields to provide their STEM expertise. This preference has been influenced by a perception that an insufficient number of scientific/research (61AX) officers have been made available for force support duties. Interestingly, the CFM does not intend to increase (or attempt to increase) the number of force support civilians with STEM degrees, which may actually be easier to accomplish.

Similar to the cyberspace functional area, the CFM for acquisition management believes the numbers of STEM-degreed officers and civilians are adequate at this time (40 percent and 24 percent, respectively). However, the CFM contends that the current population was accomplished only through extraordinary measures, including the involvement of the scientific/research (61XX) and developmental engineering (62XX) development teams (DTs),[9] specialized broadening programs, and close attention to STEM accessions. Again, no process is in place that will ensure enough STEM-degreed individuals in the future.

Of all of the CFMs we interviewed, the logistics CFMs reported the greatest need for more STEM officers: 47 percent versus today's 18 percent of logistics. The CFMs pointed to increasing technology and more calls to perform data analysis and reengineering to find efficiencies in the tight fiscal environment. With respect to civilian logisticians, the CFM believes that STEM expertise could be of use in particular logistics positions but pointed to the statute that prohibits government agencies, including the military services, from imposing minimum education requirements over and above those set by OPM.[10] With the Air Force Institute of Technology's (AFIT's) assistance, Deputy Chief of Staff for Logistics, Installations and Mission Support (AF/A4/7) is conducting an analysis to determine the skills required for

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[9] Development teams, staffed part time by colonels experienced in a career field, guide the career paths of the officers in their career fields as well as make recommendations for the overall management of the career field. The Air Force relies on the DTs to be the conduit between the force development systems, frameworks, and policy and translate these into career vectors for individuals (AFI36-2640).

[10] 5 USC §3308 Competitive service; examinations; educational requirements prohibited; exceptions: The Office of Personnel Management or other examining agency many not prescribe a minimum educational requirement for an examination for the competitive service except when the Office decides that the duties of a scientific, technical, or professional position cannot be performed by an individual who does not have a prescribed minimum education. The Office shall make the reasons for its decision under this section a part of its public records.

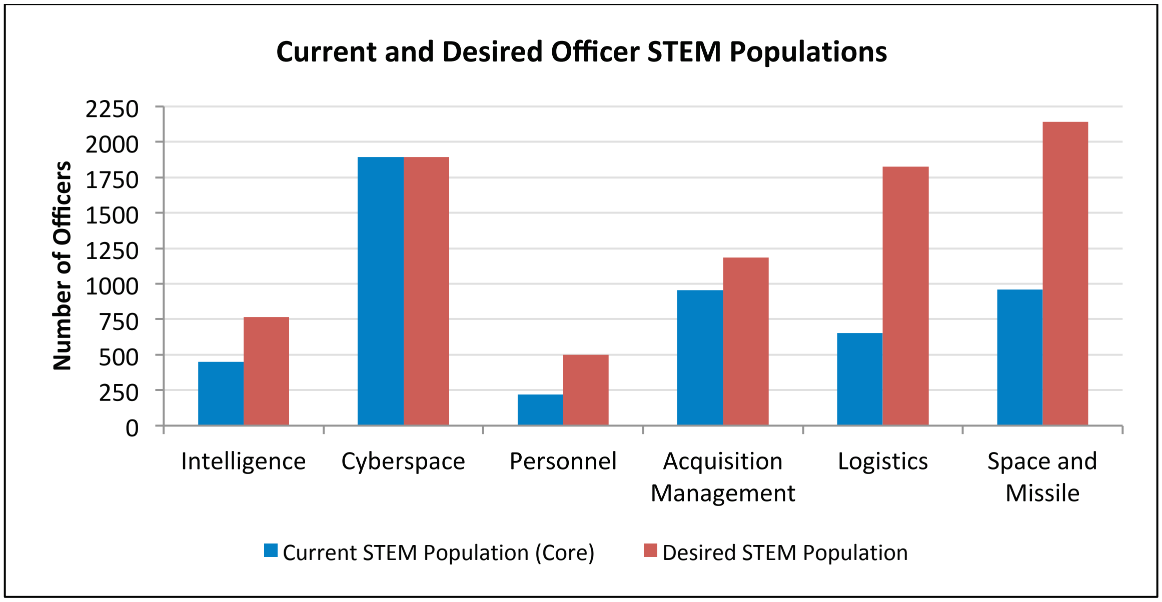
logistics officers. This information will certainly inform requirements for STEM academic degrees.

Finally, in the space and missile operations functional area, we conducted our interviews while the decision was being made to split the officer career field into two. The data/results presented here reflect a single career field. In our interviews, the CFM did not believe that STEM degrees are essential for space and missile officers, pointing to the significant training regime for new space and missile officers. However, we were later informed that the newly separated space career field would require a STEM degree for entry. This seeming disconnect could come from the structure of CFM duties and responsibilities—the Commander, Air Force Space Command is the Air Force Space Professional functional authority, while some functional area responsibilities are borne by the Director, Space Operations, Deputy Chief of Staff for Operations, Plans and Requirements (AF/A3S) on the Air Staff. As it now stands, the space functional area is requiring that all space officer accessions have a "STEM degree"—with no requirement that the degree be in any particular STEM disciplines that might be particularly well suited to duties in space missions and organizations.

Similar to Tier I, Tier III CFMs are relying on graduation with a STEM degree without regard for the quality of that degree. Each of the CFMs interviewed could point to specific key positions where discipline-specific, high quality individuals are required (for example, certain highly technical cyberspace and signals intelligence positions). In these cases quality measures for STEM individuals (such as grade point) and degrees (such as national rankings and accreditation) are critical and may need to be formalized.

Figure 3.2 summarizes the results for officers in these Tier III functional areas. FA/FMs in Tier III identified significant unmet STEM needs. Even in areas where STEM populations are regarded as nearly sufficient at present, such as cyberspace and acquisition management, requirements for these needs are not documented. While over 5,125 STEM-degreed officers currently serve in these functional areas, about 2,300 more are needed.

Figure 3.2
Summary of Desired Officer STEM Population in Non-STEM Functional Areas



Lack of Alignment Between Functional Area Needs, AFOCD, and Current Accessions

When a functional area identifies an insufficient number of STEM officers, or insufficient processes to ensure an adequate number of STEM-degreed officers, there are currently two avenues to pursue:

- Make an AAD STEM degree of a particular type mandatory for an individual position.
- Require that accessions have STEM bachelor's degrees (or particular STEM bachelor's degrees).

At present, no process is in place to make a particular bachelor's degree mandatory for a position (only positions requiring an AAD can be designated), so CFMs must rely on their accessions to bring STEM expertise into the career field at the bachelor's degree level.[11]

To examine the alignment of functional area needs, stated degree requirements and actual accessions, we summed the academic degrees called for in the AFOCD and weighted the degrees by the number of individuals in that career field. The weighted AFOCD percentage A_i is:

[11] Commanders/supervisors can request a particular bachelor's degree when submitting a requisition for filling a position; however, they are normally looking within a particular career field for individuals with the necessary degree.

$$A_i = \frac{\sum_j \frac{1}{deg_j} n_j}{\sum_k n_k} \quad \text{for all } j \text{ that allow for degree } i,$$

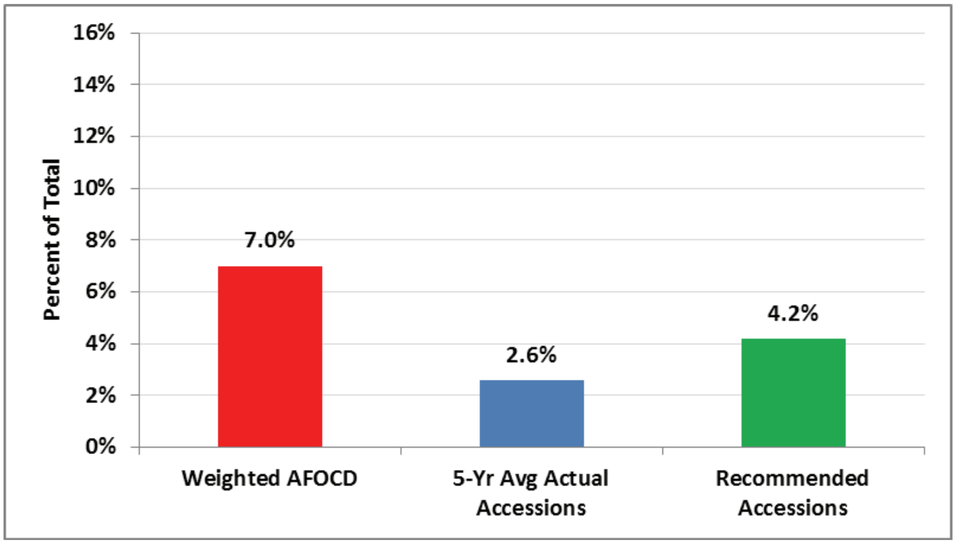
where n_j is the number of positions in career field j, deg_j is the number of degrees that are allowed for career field j, and n_k is the total number of positions in all k career fields. A_i, then, gives one estimate of the percentage of total accessions that should be accessed with degree i. This calculation assumes that each acceptable degree has an equal share of each career field's accessions. This may not represent the "best" set of accession degrees; given the current method of providing acceptable degrees in list form with no indication of priority or quantity, however, we have little additional information with which to determine how many degrees of each type should be accessed.

We also averaged the types of degrees held by line officer accessions over the past five years. Finally we found a weighted average (in the same way we calculated the weighted AFOCD percentage) of the degrees we heard CFMs say they required in their functional areas (denoted "recommended accessions"). Note that aligning these degrees for comparison is not a straightforward process. Very generalized titles are used in the AFOCD in paragraph form, so there is no priority given to particular degrees and no way to tell how many of each degree are required. The degrees held by accessions are coded up to a year after an accession enters the Air Force. In addition, recruiting organizations are not given goals or targets for the types of degrees needed. Air Force Reserve Officer Training Corps (AFROTC) and the U.S. Air Force Academy (USAFA) are aware in a very general way of the degrees that are most critical, and those critical degrees can garner an individual a full or partial AFROTC scholarship. However, for both sources of commissioning, it is up to the individual cadet which degree to pursue.[12]

Few CFMs highlighted the need for mathematicians; however, in a weighted summation of the degrees in the AFOCD, mathematics is the most needed. Figure 3.3 shows that if the AFOCD is used as the source for accessions, 7 percent of accessions to the Air Force should have a degree in mathematics. When we looked at accessions over the past five years, 2.6 percent of accessions had a mathematics degree (i.e., one of the several ASCs that make up all mathematics/statistics degrees). Finally, if we adjust the requirements for mathematics degrees by what we learned in interviews with CFMs, we estimate that 4.2 percent of accessions should have a degree in mathematics. The "correct" percentage for mathematics accessions is actually less important here than the fact that the chain from degree requirement to documentation of that requirement to the recruiting and accession of an individual with that degree is not synchronized.

[12] Some full AFROTC scholarships are contingent upon the cadet earning a particular degree (e.g., electrical engineering). Under this arrangement, if the cadet chooses to pursue a different degree, he or she could forfeit the scholarship, and AFROTC can pursue financial recourse.

Figure 3.3
Nonmedical Officer Accessions with Mathematics Degrees—Weighted AFOCD, Actual Five-Year Average, and CFM-Recommended Percent



Similarly, Figures 3.4 and 3.5 show AFOCD, actual and adjusted accession data for computer science/engineering and information systems, and engineers/electrical engineers, respectively. The recommended accessions shown in Figures 3.4 and 3.5 show that the Air Force should be accessing significantly more computer scientists, computer engineers as well as slightly more electrical engineers.

Figure 3.4
Nonmedical Officer Accessions with Computer Science/Engineering and Information Systems Degrees—Weighted AFOCD, Actual Five-Year Average, and CFM-Recommended Percent

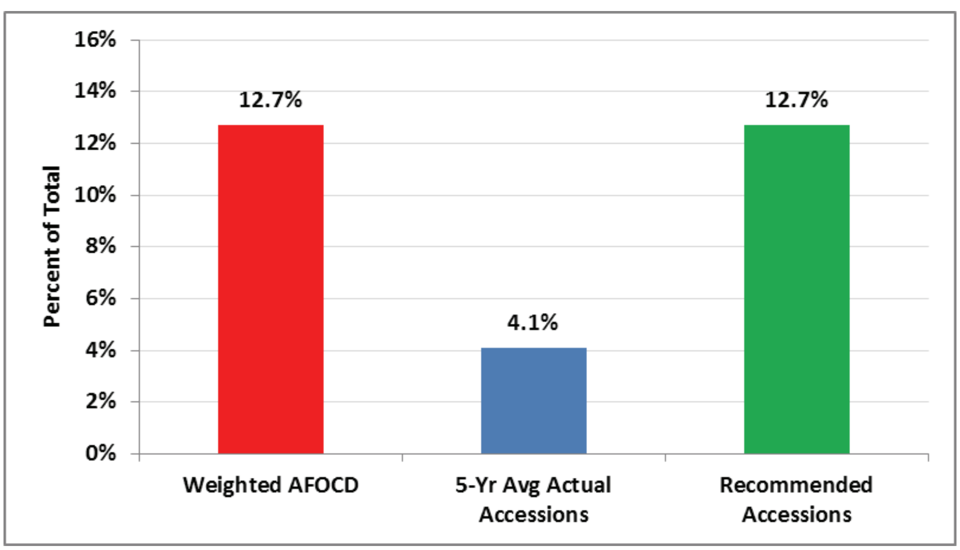
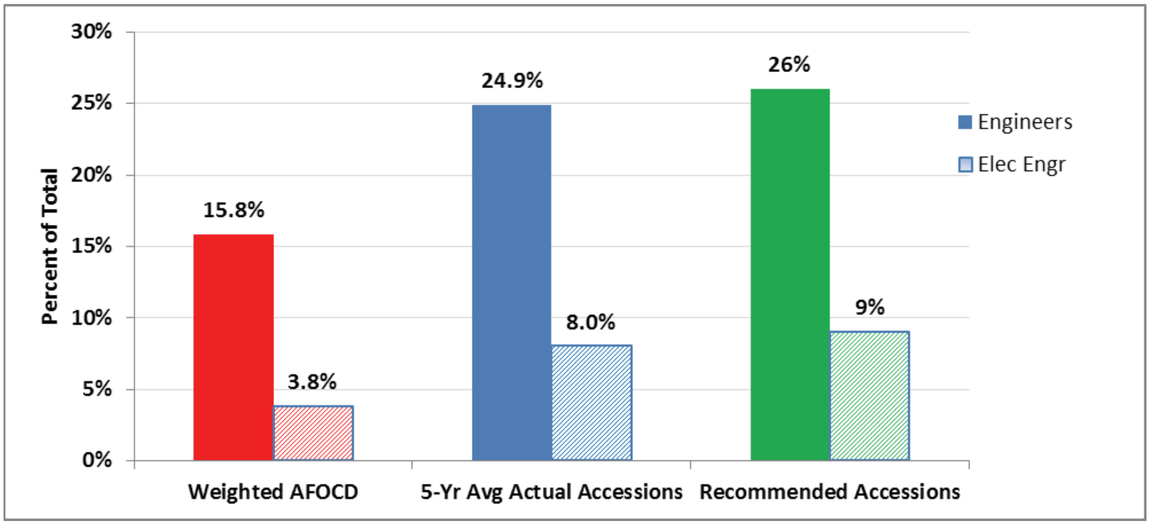


Figure 3.5
Nonmedical Officer Accessions with Engineering and Electrical Engineering Degrees—Weighted AFOCD, Actual Five-Year Average, and CFM-Recommended Percent



Again, these are only estimates for a steady-state environment, and they do not account for special programs that emphasize particular degrees. For example, there has been a significant emphasis on ensuring there are enough electrical engineers accessed in recent years; electrical engineering has been designated as a Critical Accession Degree (CAD). The five-year average accession percentage shown in Figure 3.5 (8.0 percent) may actually be higher than if electrical engineering had been treated as a typical accession degree. In fact, the percentage accessed is much higher than called for in the AFOCD.

While these figures may not definitively specify the types and numbers of academic degrees required for officer accessions, they do illustrate the current disconnects between what the career fields think they need, what the Air Force says it needs for career fields (in the AFOCD), and what is actually being accessed.

General Findings on the AFOCD and OPM Standards

Throughout this research, we observed two issues with respect to the AFOCD for officer education requirements and OPM standards for civilian education requirements. First, the AFOCD lists generalized academic degree titles that do not necessarily correspond to ASCs, nor to degrees granted currently at colleges and universities, including USAFA. There can be multiple degree types with similar names yet widely different specializations—for example, those degrees with *management* in the title such as business management (non-STEM), engineering management (non-STEM), management sciences (STEM), administrative management (non-STEM), etc. Second, efforts to change OPM standards (to include adding STEM requirements) to ensure qualified civilians are hired for positions are ongoing in several functional areas; however, these efforts are not synchronized across the Air Force, so career fields are advocating for changes individually rather than presenting a consolidated Air Force position. In addition, a statutory restriction to these changes is a significant barrier.[13]

[13] 5 USC §3308.

Chapter Four. Career-Field STEM Consultants

STEM-degreed individuals are present in non-STEM functional areas in one of two ways:

- They have a STEM degree and hold the AFSC or occupational series of the particular non-STEM functional area.
- They have an AFSC or occupational series from a STEM career field but are performing duty in the non-STEM functional area.

We call this second type of individual, who comes from outside a functional area to provide STEM expertise and knowledge, a "consultant." As STEM-degreed consultants, they have deeper levels of technical expertise than are feasible for the officers and civilians in the career field most closely associated with a non-STEM functional area to acquire and/or maintain.

As an example, the force-support career field (officers in AFSC 38FX and civilians in 17 occupational series spanning services, personnel, and education areas) has few civilians and offices with STEM degrees (11 percent of officers, 7 percent of civilians), and even fewer with operations research/analysis, industrial engineering, and mathematics degrees (approximately 3 percent overall). To obtain STEM expertise, force-support organizations have positions for operations researchers (AFSC 61AX and occupational series 1515) to perform the resource analysis needed for mission accomplishment. These individuals are STEM consultants in a non-STEM functional area.

As we learned from the interview with the force-support CFM, they plan to make mandatory that 25 percent of their new officer accessions have operations research/analysis, industrial engineering, management engineering, and mathematics undergraduate degrees.[14] The force support functional area will then have a mixture of officers with STEM expertise—some inside the career field and some outside (the consultants). The CFM did not indicate that they intend to focus on hiring STEM-degreed civilians into force support functional area positions. Since civilian hiring is based on the requirements for a particular position, this would be difficult to do unless hiring authorities strongly emphasized analytical duties.

To examine the extent that STEM consultants are serving in nontechnical functional areas, we counted core scientific/research and developmental engineering officers (AFSCs 61XX and 62EX) and civilians in engineering, physical science, and mathematics (occupational series 08XX, 13XX, and 15XX). Table 4.1 shows the numbers of individuals in these STEM areas serving in nontechnical functional areas. STEM specialties are shown on the left with the functional area these consultants serve in across the top. Thirty percent of officers and civilians in these STEM specialties serve as consultants in other functional areas.

[14] The merger of the quantitatively oriented manpower career field with the personnel/services career field partially explains this functional area's desire for STEM expertise among its accessions.

Table 4.1
STEM Consultants in Non-STEM Functional Areas

Core specialty/ occupational series	Rated	Space/missile	Intelligence	Cyberspace	Logistics	Security forces	Force support	Acquisition mgt	Contracting	Financial mgt	Total in Functional Areas	Total strength	Percent Consulting
61A OR analyst	3	3	17	1	11	0	86	15	3	1	140	505	28%
61B Beh/hum factors sci	1	1	14	0	1	0	32	4	0	1	54	166	33%
61C Chemist/biologist	0	2	13	0	8	0	25	2	0	0	50	165	30%
61D Physicist/nuc engr	1	5	23	1	1	0	31	20	0	0	82	310	26%
62E Developmental engr	15	174	218	22	55	2	225	366	3	3	1,083	3,450	31%
Officer Total	20	185	285	24	76	2	399	407	6	5	1,409	4,596	31%
08 Engineering	5	36	575	389	1,852	11	362	561	44	138	3,973	12,730	31%
13 Physical sciences	11	4	39	9	77	1	22	0	1	0	164	1,184	14%
15 Math sciences	7	9	80	20	222	5	55	18	3	157	576	1,578	37%
Civilian Total	5	36	575	389	1,852	11	362	561	44	138	4,713	15,492	30%
Grand Total	43	234	979	442	2,227	19	838	986	54	300	6,122	20,088	30%

Note: The force support functional area includes all human resource functions including officers and civilians working in education, training and recruiting.

In several of our interviews for functional areas lacking STEM-mandatory entry requirements, CFMs said if they need STEM expertise for mission accomplishment, they rely on scientists and engineers to serve in STEM consultant positions rather than requiring a STEM degree for entry into their functional area. This method of garnering STEM expertise was most emphatically voiced by the intelligence functional area (AFSC 14NX and occupation series 0132). Table 4.1 shows the significant contribution of STEM individuals in the intelligence functional area with 285 officers and 575 civilians.

Note also that relatively few officer consultants (24) work in the cyberspace functional area (for which the most closely associated AFSC is 17DX, for which a STEM degree is not mandatory), given the total cyberspace officer population. Our interviews revealed that the cyberspace functional community prefers to access some STEM-degreed officers into AFSC 17DX and then give them the appropriate training to perform duties in the career field. This philosophy is borne out by the 54 percent of core cyberspace officers with STEM degrees.

Clearly, each nontechnical functional area is using its own methods and practices to obtain STEM expertise. There are not clear policies or guidelines to determine which method of obtaining STEM expertise is appropriate for a particular type of manpower position.

The scientific/research and developmental engineering CFM (AFSC 61XX, 62XX) expressed concern about increasing the number of individuals with STEM bachelor's degrees being accessed to non-STEM AFSCs. Concerns include the training and advanced education that these STEM graduates accessed to non-STEM AFSCs would miss. For example, all officers accessed to AFSC 61AX attend an initial operations research course, and all are programmed to get analytical master's degrees as soon as possible. STEM graduates accessed into non-STEM

AFSCs would not receive this foundational instruction. Constraining analysts and engineers to a specific non-STEM functional area was another concern, as analysts and engineers often benefit from the opportunity to apply their skills in a *variety* of functional areas—spending, for example, one tour in a laboratory and the next applying their acquired skills in a functional area such as force support, logistics, or space. Thus, by remaining in a STEM AFSC they become Science and Engineering professionals rather than strictly functional assets.

In addition, career fields must be cognizant of the impacts on job satisfaction and retention when assigning technical degree graduates to nontechnical positions. A new lieutenant who has just completed a rigorous mathematical academic program may not be satisfied with little to no opportunity to apply his or her newly attained skills in a nontechnical functional area.

We recommend that STEM degrees not be added to the requirements for entry into an officer AFSC unless it has been clearly established that a STEM degree is necessary for performing the functional area's core processes. If a STEM-degreed individual is desired to perform analytical or engineering functions, then the position should call for an individual from the STEM career field, i.e., a AFSC 61XA, 62EX, or occupational series 08XX, 15XX, i.e., a STEM consultant. For example, it is acceptable for either an appropriately educated logistics officer or an analyst to do the modeling for a new supply chain management application within the logistics functional area. However, only the analyst CFM should be charged with planning for and maintaining enough qualified analysts to cover that demand. That said, valid uses of nonconsultant STEM-degreed individuals include providing analytical, science, or engineering continuity responsibilities for interacting with consultants, evaluating potential decisions and solutions based on functional area expertise, and ensuring technical solutions are implemented.

This recommendation does not apply to civilian positions because, while civilian positions must use the qualifications set forth in OPM guidance, hiring authorities can hire the type of person who best meets their job-specific requirements.

Chapter Five. STEM Skills and Critical Thinking

STEM degrees are considered to be highly desirable or necessary for many positions in the Air Force, and having a STEM degree can provide a substantial advantage to prospective officer candidates for a position. Yet many CFMs and key Air Force stakeholders report that it is not necessarily the STEM-specific knowledge that is necessary to carry out position duties, but instead a highly desirable set of skills that STEM applicants are believed to be more likely to possess. These skills include logical, systematic, critical, and analytical thinking and problem-solving skills. Several CFMs reported that as long as applicants have these higher-level thinking skills, training can provide the more specific knowledge necessary for most positions. We found this belief to be particularly common in those non-STEM career fields that employ scientific analysts (primarily operations researchers [AFSC 61AX]) to logically develop presentations, analyze methodologies and processes, and provide analysis for problem-solving—all while using very basic, nontechnical methods. By relying on the receipt of a STEM degree as the primary indicator of this desired skill set, there is a risk of missing highly qualified non-STEM prospects and overly valuing STEM degrees that have little connection to position duties.

The Air Force is not alone in lacking clarity on how to define and measure the very desirable set of higher-level skills that make prospective employees easy to train, flexible, and adaptable. Finding ways to quickly identify these often intangible qualities is a key issue of focus in human resources departments across the country. Yet there appears to be no common term in the education, labor, or management literature used to describe these skills. In 1990, the Secretary of Labor appointed a commission to determine the skills that young people need to succeed in the world of work (SCAN, 1991). The commission concluded that a high-performance workplace requires workers who have (1) basic literacy and computational skills; (2) the thinking skills necessary to put knowledge to work; and (3) the personal qualities that make workers dedicated and trustworthy. These *thinking skills* the commission identified are similar to what is understood as the skills necessary for positions where STEM degrees are desired, including creative thinking, decisionmaking, problem solving, organizing and processing information well, knowing how to learn, and reasoning. In addition to *thinking skills*, the literature uses terms like *generic skills*, *21st century skills*, and *higher-order thinking skills* to describe a desirable skill set that extends beyond traditional reading, writing, and arithmetic ability. Yet there is no widely used term to capture this commonly referenced set of skills, and the terms used in the literature tend to vary in meaning and scope depending on the source.

The evidence regarding STEM graduates as uniquely superior in critical thinking skills is mixed. A study of data from the National Longitudinal Study of 1972 (NLSY72) finds that students choosing majors in science have higher math SAT scores than those choosing majors in business, education, or social sciences/humanities (Arcidiacono, 2004). However, there was no difference in verbal scores for those in natural science and those in social science/humanities. Arum and Roska (2011) find that students majoring in hard sciences and math perform better in critical thinking than students in more professionally oriented fields like social work, education, and business. However, they find that graduates in humanities and the social sciences perform equally well as STEM graduates in critical thinking. The study indicates that students choosing professional fields are, on average, of lower ability according to widely used measures of thinking skills. However, the evidence of a difference in critical thinking and problem solving skills between science graduates and graduates in the social sciences/humanities is not conclusive.

In addition to critical thinking and problem-solving skills, there may be a number of other skills the Air Force values but is effectively ignoring if placing a disproportionate focus on STEM-degreed candidates. It is unclear how college major is related to skills like communication, teamwork, writing ability, or any of a number of abilities that may be highly valued by the Air Force for particular positions. To the degree that heterogeneity of backgrounds facilitates creative problem solving and thinking "outside of the box," disciplinary diversity may be of particular value to the Air Force to ensure innovation and broad thinking. So the Air Force may benefit from consideration of highly qualified candidates from a wide range of academic backgrounds, particularly for positions that do not require deep levels of STEM-specific knowledge.

For some positions, it will be necessary to have substantial STEM-specific knowledge in addition to the general higher-level thinking skills, so for these positions the STEM coursework is particularly important. However, it is still not clear that "STEM degree or no STEM degree" is the ideal dividing line for distinguishing the quality of applicants. On one side, there may be students with a sufficient number of credits in related STEM courses to provide the basic knowledge needed for the position (despite not having a STEM degree). On the other side, there may be applicants who have STEM degrees that are unrelated to the position-specific knowledge required for the position (e.g. a biology major applying for an electrical engineering position), and it isn't clear that these prospective officers have any more position-specific knowledge than liberal arts majors who took some STEM courses.

If degree type is not an ideal measure or the appropriate proxy for higher-level thinking skills, it is in the interest of the Air Force to consider if there are other measures or indicators that more accurately identify the desired skills. Introducing other indicators of higher-level thinking skills need not replace STEM degrees as a discriminator between applicants. Instead, a wide range of qualifying factors can be used to create a more complete picture of candidates' skills.

A relatively low-cost option for identifying higher-level STEM skills among Air Force members would be to use Air Force Officer Qualifying Test (AFOQT) scores. The AFOQT measures verbal and math ability, as well as job-specific aptitudes and job-knowledge measures, such as instrument comprehension, aviation information, and table reading. Measures of such position-specific knowledge and ability are used in selecting personnel for specific officer aircrew jobs: pilots, combat systems operators, air battle managers, and emerging unmanned aircraft system (UAS) jobs (Hardison, Sims, and Wong, 2010). Studies have shown the AFOQT to be valid in predicting who will be a successful pilot, as measured by later assessments of pilot ability (Ree, Carretta, and Teachout, 1995; Carretta, 2005). The Air Force could expand the use of AFOQT scores a number of ways to improve selection of officers into various positions beyond the rated career fields.

The Air Force could also use other instruments to measure analytical ability and critical thinking skills. The SAT is a common measure of thinking ability and is frequently used to account for ability in studies of the transition from college to the labor market, and the Graduate Record Examination (GRE) measures a similar set of skills among postgraduate populations. A previous RAND study finds that the SAT should not be used to replace the AFOQT because of the AFOQT's additional position-specific measurement qualities, but SAT scores could provide a second measure to validate AFOQT scores (Hardison, Sims, and Wong, 2010). The Air Force could also use instruments developed specifically for measuring critical thinking skills or problem solving. A number of these instruments exist, including the California Critical Thinking Skills Test (Facione, 1990), the Cornell Critical Thinking Test (Ennis, Millman, and Tomko, 1985), the Watson-Glaser Critical Thinking Appraisal (Watson and Glaser, 1980), and the Collegiate Learning Assessment (Hardison and Vilamovska, 2009). These measures show moderate correlation with scores on both sections of the SAT but are purported to be more valid measures of critical thinking (Erwin and Sebrell, 2003).

In addition to existing assessments, interview and applicant review processes can be modified to improve identification of these higher-level thinking skills among non-STEM candidates. Rather than setting the standard for STEM knowledge by degree, the standard could be more specifically defined as coursework in a particular area (e.g., number of mathematics credits, or student took a class in aeronautical engineering or a science class). This would allow for consideration of qualified candidates who did not achieve a full STEM degree while eliminating STEM-degreed candidates with coursework that is mismatched to position responsibilities. Interviews could also include questions that directly address ability to think critically and/or require candidates to provide evidence of past achievements that demonstrate these skills. A key aspect of the desired Air Force skill set is the ability and flexibility to use these skills successfully in new and unexpected situations, and interview questions/tasks that require candidates to demonstrate skills "on the spot" may provide a better measure of this than standardized tests that many students prepare for. The military regularly used situational judgment tests in World War II, and these tests are used commonly in organizations across the country as a valuable tool for skill measurement in job-specific circumstances. Many employers believe that these more reality-based measurements like situational judgment tests, internships, essay assessments, and portfolios of work are more accurate measures of ability than multiple-choice tests, and these measures could be used in lieu of or to validate AFOQT scores (AACU, 2008; Hardison, Sims, and Wong, 2010).

Civilian hiring also suffers from the imprecise definition of qualifications. Civilians are hired to fill positions with descriptions containing generalized statements about performance such as multi-tasking, analysis of situations, or working as a team member. The issue is that in occupational series where no STEM degree is required, the position can be filled by individuals with little or no STEM expertise despite the need for some level of STEM competence. On the other hand, positions in occupational series that require STEM degrees do not allow for designating specific positions that might not require a STEM degree but rather require management, problem-solving, and critical thinking skills. Consider, for example, Air Force civilian program managers responsible for the management of acquisition programs, Occupational Series 1101, General Business and Industry. This series does not require a STEM degree, and the Air Force cannot make STEM competence a mandatory requirement for the position.[15] Though clearly, for the highly technical acquisition programs that the Air Force undertakes, STEM expertise is highly desirable.

In civilian jobs that do require substantial STEM skills (regardless of whether the occupational series requires a STEM degree), the civil service system provides substantial barriers to hiring the most highly qualified STEM candidates. The civil service hiring and promotion processes have long been based on a strict set of rules designed to ensure internal equity, with somewhat less consideration of workforce quality or equity with external job markets. Based solely on government experience, degree level, and veteran status, the system leaves little room for consideration of nongovernmental experience, subject expertise, or other valuable qualifications. Without considering a wider range of qualifications, hiring managers are likely missing a number of highly qualified candidates for these STEM-related positions. In addition, the inflexibility of the civilian pay and promotion schedule is seen as a barrier to recruiting strong STEM candidates who have high-paying employment options in the private job market. Recent changes to the General Schedule (GS) hiring processes and demonstration projects in the civilian governmental workforce (including the Air Force) indicate that broadening the applicant field and loosening requirements/expectations for applicants can improve the ability to hire the highest quality people (Werber et al., 2012). However, additional ability measures and expanded hiring processes can be costly, so the benefits of these changes must be weighed against the costs.

[15] 5 USC §3308.

Chapter Six. Future Needs

Our work thus far has looked at the current authorizations and inventory available within the Air Force to determine if the current STEM inventory is sufficient to meet its needs. This is a very short-term look with no indication as to how requirements could or should change in the near, mid, or distant future. To investigate future STEM requirements, we looked at two sources: one civilian source that projects future needs based on occupational fields and growth within each occupation, and one military source that discusses future technologies, translated to identify the occupational fields related to each future technology. In both cases, applicable academic fields and/or entry-level academic degrees (expressed as ASCs) were determined for each occupation.

The first source, *Report on Technology Horizons: A Vision for Air Force Science & Technology during 2010-2030,* Volume 1, was published by the Office of the U.S. Air Force Chief Scientist (AF/ST, 2010). The purpose of *Technology Horizons* is to "help guide Science and Technology investments to maximize their impact for maintaining Air Force technological superiority over potential adversaries." The previous technology review occurred 15 years ago, making *Technology Horizons* the most recent vision of the technologies the Air Force will need to enable superior future capabilities.

Technology Horizons identifies 12 overarching themes to shift science & technology (S&T) research; these 12 themes were the output of four working groups comprising members from academia, federally funded research and development centers (FFRDCs), the defense industry, intelligence communities, major commands (MAJCOMs), and the S&T community. The four working groups addressed air, space, cyber, and additional cross-cutting domains, respectively. They considered future strategic changes and global technological advances, trying to assess realistically credible, achievable technologies. One weakness of *Technology Horizons*, although a necessity given the context, is the consideration of budgetary constraints, which limit technologies that the Air Force recommends pursuing. If the civilian and/or academic domain looks to the Air Force (and/or other military services) for occupational growth indicators, this could dampen the signal favoring certain academic disciplines and, in a worst case scenario, could contribute to a shortage of people with desired educational backgrounds.

Through its 12 themes, *Technology Horizons* identifies 30 potential capability areas (PCAs) across the Air Force (e.g. intrusion-resilient cyber systems, augmentation of human performance, and adaptive flexibly autonomous systems). For each PCA, supporting technologies called key technology areas (KTAs) are identified to allow the potential capability to be created, or to increase effectiveness of the potential capability; some examples of KTAs include virtual machine architecture, chip-scale atomic clocks, and automated software generation. A total of 110 KTAs are determined collectively for the 30 PCAs. Each KTA was then mapped to each officer STEM AFSC and civilian STEM occupational series as either a primary, secondary, or unrelated skill. This mapping was conducted by the Military Assistant to the Chief Scientist (AF/ST) in early 2011 and vetted by many individuals from various Air Force organizations including the Air Force Research Laboratory (AFRL), SAF/AQ, and AFIT. While the KTA mapping by AF/ST included civilian occupational series, we focused on occupational job titles that mapped to AFSCs. As an example, the KTA chip-scale atomic clocks project was mapped to eight different AFSCs/occupational series including electronics engineer, electrical engineer, physicist, and nuclear engineer, leading to the occupational job titles electrical/electronic engineer, physicist, and nuclear engineer. Our primary contribution was then to map occupational job titles to STEM academic fields based on the RAND categorization of ASCs to STEM and non-STEM disciplinary groups. We then summed the count of occupational job titles within each STEM academic field to determine the STEM academic fields that are required most often to help meet the future technology needs of the Air Force. Table 6.1 shows the count of the academic degrees required to support the 12 themes/30 PCAs/110 KTAs, and provides a view of those degrees most often needed to support the future technologies expressed in *Technology Horizons*. Note that this approach does not address the future need for STEM expertise in the non-STEM AFSCs/occupational series; the Air Force has only addressed hard STEM requirements in this context.

Physical science comprises many academic fields (chemistry, earth science, meteorology, physics, etc.) and thus it's not surprising that 16 occupational jobs require a specialty that falls within the physical sciences. After the physical sciences, the next three academic fields needed in the next 20 years are within the engineering domain: electrical/electronics engineering, mechanical engineering, and systems engineering. After the engineering fields come fields related to computers or fields that fall within the allied sciences: computer science, computer engineering, basic biomedical sciences, biology, and biophysical specialties.

Table 6.1
List of Academic Degrees Needed in the Mid- to Long-Term Future Based on Projected Technology Capabilities in Technology Horizons

ASC	ASC Title	Count of Job Category
8YYY	Physical Sciences	16
4IYY	Electrical Engineering	5
4MYY	Mechanical Engineering	5
4TYY	Systems Engineering	5
0CYY	Computer Technology, Computer Science	4
0YDY	Biophysical Specialties	4
3AYY	Biology	4

Table 6.1—Continued

ASC	ASC Title	Count of Job Category
4WYY	Computer Engineering	4
7AAY	Basic Biomedical Sciences, Allied Sciences	4
7AAY	Basic Biomedical Sciences, Allied Sciences	4
8HYY	Physics	4
4FYY	Materials Science and Engineering	3
4GYY	Chemical Engineering	3
4HYY	Civil Engineering	3
6YYY	Mathematics	3
8AYY	Astronomy	3
0YBY	Biochemistry	2
0YEY	Operations Research	2
0YKS	Management Science, Systems Management	2
1AFY	Business Statistics and Quantitative Methods	2
3EAX	Biological Engineering	2
4BYY	Aerospace Engineering	2
4DYY	Architectural Engineering	2
4KYY	Engineering Sciences	2
4LYY	Industrial Engineering	2
4NYY	Metallurgical Engineering	2
7ABY	Professional Services, Allied Sciences	2
8CYY	Chemistry	2
8DYY	Earth Sciences	2
9BJD	Statistical Methods, Quantitative Economics, Economics	2
0IYZ	Computer Research/Information Management, Information Systems	1
0YOY	Environmental Sciences	1
0YSY	Strategic and Tactical Science	1
1AKG	Operations Research, Industrial or Production Management	1
1AMD	Logistics Statistics, Logistics Management	1
1BBA	Basic Science USAFA	1
2CAY	Architecture	1
3BYY	Agriculture	1
4GBD	Mathematical Physics, Equipment Design, Chemical Engineering	1
4IDD	Software Engineering, Electrical Engineering	1
4IGG	Statistical Communication Theory, Communications, Radar, Electrical	1
4JYY	General Engineering	1
4LHB	Statistical Quality Control, Quality Control, Industrial Engineering	1
4OYY	Mining and Petroleum Engineering	1
4QYY	Nuclear Engineering	1

Table 6.1—Continued

ASC	ASC Title	Count of Job Category
4RYY	Safety Engineering	1
4SYY	Space Physics Engineering	1
4VOY	Safety Engineering Technology, Engineering Technologies	1
4ZBA	Environic Engineering, Geological Engineering	1
4ZYY	Earth Science Engineering	1
7DTY	Radiobiology, Medicine and Surgery	1
8BYY	Cartographic Sciences	1
8EYY	Hydrospheric Sciences	1
8FYY	Meteorology	1
8GYY	Photographic Sciences	1

The second source used to illuminate future STEM needs is the Occupational Outlook Handbook (OOH) 2012–2013 edition (Bureau of Labor Statistics, 2012). The OOH describes hundreds of occupations, functions performed in each occupational field, the work environment, entry-level education and work experience required for the occupational field as well as necessary training, 2010 median pay, and 2010–2020 employment projections for many occupations. The OOH includes research, data, and analyses on the changes occurring within the population and labor force; employment changes by industry, occupation, and education category; total job openings; and education and training. Reflecting all of these factors makes the OOH one of the most comprehensive and detailed analyses regarding occupational outlook.

The OOH contains information broken out by occupation such as aerospace engineers, architects, and computer and information research scientists, to name a few. We considered all those occupations that mapped to a STEM disciplinary group using the RAND categorization of ASCs to STEM and non-STEM disciplinary groups. This was done to first narrow the list of occupations considered, as the OOH has information for 341 occupational profiles that cover 85 percent of the jobs in the economy (U.S. Bureau of Labor Statistics, 2012). Once we had the STEM subset of occupations, we mapped these occupations to STEM academic fields based on the RAND categorization. For each STEM academic field, we tallied the number of occupations for which that academic field was an entry-level education requirement. Table 6.2 summarizes our findings.

As the OOH covers the entire spectrum of occupations rather than describing fields/domains in general, it’s not surprising to find degrees that are more generally applicable such as biology, computer science, systems engineering, and mathematics at the top of the list. These kinds of degrees allow an individual to go into several occupations and career fields, while degrees in more specific areas (e.g. electrical engineering, meteorology) are applicable to a much narrower set of jobs.

Table 6.2
List of Academic Disciplines Needed by 2020 Based on Occupational Employment Projections

ASC	ASC Title	Count of Job Category
3AYY	Biology	8
0CYY	Computer Technology, Computer Science	7
4TYY	Systems Engineering	7
6YYY	Mathematics	7
0YDY	Biophysical Specialties	6
4HYY	Civil Engineering	6
0YBY	Biochemistry	5
4DYY	Architectural Engineering	5
8CYY	Chemistry	5
4LYY	Industrial Engineering	4
4WYY	Computer Engineering	4
8DYY	Earth Sciences	4
8HYY	Physics	4
2CAY	Architecture	3
4BYY	Aerospace Engineering	3
4GYY	Chemical Engineering	3
4KYY	Engineering Sciences	3
4MYY	Mechanical Engineering	3
4OYY	Mining and Petroleum Engineering	3
4ZYY	Earth Science Engineering	3
8EYY	Hydrospheric Sciences	3
0YEY	Operations Research	2
0YJY	Systems Analysis	2
0YOY	Environmental Sciences	2
1AFY	Business Statistics and Quantitative Methods	2
4CYY	Agricultural Engineering	2
4FYY	Materials Science and Engineering	2
4IYY	Electrical Engineering	2
4PYY	Naval Architecture	2
4RYY	Safety Engineering	2
7DYY	Medicine and Surgery	2
0YFY	Paleontology	1
0YSY	Strategic and Tactical Science	1
3EAX	Biological Engineering	1
4AYY	Aeronautical Engineering	1
4EYY	Astronautical Engineering	1

Table 6.2—Continued

ASC	ASC Title	Count of Job Category
4GBD	Mathematical Physics, Equipment Design, Chemical Engineering	1
4IGG	Statistical Communication Theory, Communications, Radar, Electrical	1
4JYY	General Engineering	1
4LHY	Quality Control, Industrial Engineering	1
4NYY	Metallurgical Engineering	1
4QYY	Nuclear Engineering	1
4SYY	Space Physics Engineering	1
4UYY	Textile Engineering	1
8AYY	Astronomy	1
8FYY	Meteorology	1

The strong future need for biologists according to the OOH raises a specific issue for the Air Force. The Chemistry/Biology (61CX) career field recently changed its entry-level education requirement to no longer include biology. While FMs/CFMs have insight into the needs of their career fields, they don't always have an Air Force-wide view. Therefore it would seem that the Air Force will be short of biology-trained personnel unless there is an Air Force-wide directive to obtain biology-trained personnel or the creation of a biology career field to pool this knowledge.

The methodology of mapping occupations to academic fields based on the RAND categorization can be applied to any document that attempts to forecast future technologies or capabilities. There are two documents, one that has been published and one in the final stage of editing, to which this methodology should be applied: *Energy Horizons* and *Cyber Vision 2025*. *Energy Horizons*, United States Air Force Energy S&T Vision 2011–2026, published by the United States Air Force Chief Scientist office in January 2012, is much like *Technology Horizons* but pertains only to the energy domain. As the purpose and creation of *Energy Horizons* is very similar to *Technology Horizons*, the methodology discussed here could be easily replicated to produce the future STEM requirements based on future energy capabilities. *Cyber Vision 2025: United States Air Force Cyberspace Science and Technology Vision 2012–2025* (AF/ST, 2012) is similar in nature to *Technology Horizons* and *Energy Horizons* and outlines the future capabilities and technologies that will be required for cyber operations in the long-term future. Again, the methodology described here could be applied to ascertain the degrees necessary to aid the Air Force in pursuit of cyber superiority.

But this approach has two broad limitations: a lack of prioritization of the key technologies and our inability to determine the magnitude of any future STEM requirement, whether it be civilian or military. *Technology Horizons* does not prioritize the key technology areas, so it could be interpreted to mean all 110 KTAs are equally important. Secondly, *Technology Horizons* does not discuss whether these KTAs should reside within the officer personnel or the civilian population. These two limitations make it difficult to determine which technologies are the most important to the Air Force and which personnel the Air Force should seek to ensure success in creating the technologies or increasing their effectiveness. Additionally, our analysis cannot determine the magnitude of STEM future requirements because we would need some kind of prioritization and authorization indicators. We can say that the physical sciences and engineering are highly desired academic disciplines within the Air Force, but we can't speak to the number of officer or civilian scientists and engineers that should be in the Air Force inventory. Providing information of this type on future STEM needs to CFMs, however, may inform their degree requirements.

We see it as AF/ST's responsibility to identify and then disseminate emerging technologies, paying particular attention to informing those responsible for providing the human capital to support these future technologies. Given its charter from the Air Force Chief of Staff as the body responsible for ensuring organizations are executing the Air Force STEM vision, goals, and strategy, the STEMAC should then translate these technologies into potential functional area specialties and academic disciplines and ensure they are communicated to functional areas and career fields.

Chapter Seven. 2002 Scientist and Engineer Summer Study

One initiative in the *Bright Horizons* strategic roadmap required an assessment of a previous Air Force study on the S&E workforce to determine if the recommendations were acted on and to compare them to the NRC recommendations (*Bright Horizons*, 2010). Our sponsor (SAF/AQH) requested that we review the study to compare and contrast our results.

We reviewed the findings and recommendations of the *Scientist and Engineer Summer Study Final Report* compiled in August 2002. The objective of the summer study was to provide the Secretary of the Air Force and the Chief of Staff of the Air Force a set of actionable recommendations on ways to improve S&E workforce management. The participants included retired Army, Navy, Air Force, and Coast Guard general officers, directors and commanders of Air Force S&E organizations, and individuals from academia and industry. The participants "endeavored to generate innovative ways to develop an S&E plan that could quickly and efficiently be implemented." The summer study report focuses primarily on the S&E officer workforce.

Of the nine primary findings, several fall outside the scope of this research, and several of the recommended implementations require additional study. For example, the summer study's first recommendation for implementation is that leaders determine if the Air Force needs a small force of technologically *superior* officers or a large force of technologically *familiar* officers. We agree that this should be decided but would add that the Air Force may need both in some quantity, and it is first necessary to define terms such as "superior" and "familiar" and to understand the impact of choosing one or the other of these philosophies. We found no evidence that the Air Force has taken either of these steps. Instead, career fields use a mixture of methods to obtain STEM expertise—both authorizing positions for S&E officers within functional areas and requiring some STEM-degreed officers within functional specialties (see discussion in Chapter Four). Overall, the Air Force has been grappling with STEM competency definitions and questions such as "What is a technologically familiar officer, or when can we say an officer is STEM-cognizant?" To date, no definition for these terms has been adopted.

The summer study's fourth finding recommends that Air Force leaders set priorities to ensure production and accession of the required number of officers with appropriate technical degrees. And it recommends appropriate utilization of these officers in career areas that require those degrees or benefit from them. It places the responsibility on FA/FMs supported by AFPC to ensure an adequate supply of STEM officers.

The summer study's final finding asserts that Air Force leaders have not clearly communicated priorities that ensure accession of enough officers with technical degrees. It recommends that the Air Force establish a continuing process within the personnel system for forecasting S&E skills and needs and identifying emerging S&E disciplines for recruitment. And further, that USAFA, AFROTC and Officer Training School (OTS) become more responsive in matching the degrees of cadets with Air Force needs. Our interviews with CFMs confirmed that priorities for accessing and hiring those with technical degrees are often lacking. Functional managers are responsible for determining the academic degrees required for their officers and for ensuring their requirements are documented in the AFOCD. The method for communicating accession priorities for officers as recommended by the summer study *is* the AFOCD, and functional managers must be clear in stating their requirements. There must also be communication and agreement within each functional area to ensure that senior functional leaders communicate priorities for STEM-degreed individuals to CFMs. We agree that a method for tracking and projecting STEM degree requirements is necessary, not only for S&E specialties but for STEM degrees in all specialties, and we recommend a plan in Chapter Eight.

Chapter Eight. Conclusions and Recommendations

The goal of this research was to examine the requirements for STEM officers and officer-equivalent civilians in all functional areas across the Air Force. In evaluating the health of the STEM workforce, the Air Force has focused primarily on STEM-mandatory functional areas. Understating requirements for STEM-degreed officers and civilians diminishes the ability of the Air Force to maintain the technical skills it heavily relies on to support air, space, and cyberspace operations. We conclude that STEM requirements are currently understated for functional areas we classified as Tier III, those with few hard STEM needs and significant soft STEM needs. Some functional areas in this tier do not have a sufficient STEM inventory, and there is currently no process for sizing or filling this need. Some functional areas in this tier currently have sufficient STEM-degreed individuals; even so, they lack processes to ensure they continue to receive or retain enough STEM-degreed officers or civilians.

We found significant benefits from engaging with CFMs about their STEM needs: They became more knowledgeable about STEM needs, they communicated more with their functional authorities about STEM needs, and they learned about the process for adjusting their degree requirements in the AFOCD. Still, we found that CFMs need more rigorous methods for identifying their current and future degree requirements and a more efficient framework for documenting these requirements. Our research also revealed that some functional areas use STEM degrees as a proxy for quantitative/critical thinking and that the Air Force should consider using some other measures of STEM potential, especially for accessing officers. Some functional areas use individuals from STEM career fields as consultants, rather than requiring their own specialties to have STEM degrees. In addition, Air Force documents on future technologies neither prioritize nor number the types of degrees needed, making it difficult to project future STEM requirements.

Looking only at the total numbers of STEM-degreed officers and civilians masks unmet needs. Given the Air Force's desire for a smaller, more agile technical force (AF/ST, 2010; SAF/AQR, 2011; NRC, 2010), STEM expertise is vital for the accomplishment of the Air Force mission.

Looking at the overall process of planning for, determining requirements for, attracting, recruiting, hiring/accessing, classifying, assigning, and promoting STEM human resources in the Air Force, we found that there are disconnects with several causes—insufficient knowledge, lack of communication, organizational responsibilities improperly placed or performed, external barriers, etc. In particular, we focused on processes for defining STEM degree requirements and filling those requirements with qualified STEM-degreed officers and civilians. We recommend ongoing analysis and attention to continue to improve STEM human resource management, including interactions between CFMs and the Air Force science and engineering community, and comprehensive workforce planning, especially in the area of recruiting both officers and civilians. The following recommendations are intended as necessary first steps to address the key issues we discovered during our research.

Officer-Specific Recommendations

We developed the following five recommendations for officers, two for civilians, and two in general.

Recommendation 1: Develop evidence-based methods to assist CFMs in refining academic degree requirements for their officer career fields

Many functional managers do not track their STEM resources and are not equipped with the tools or processes to adequately assess their areas' education requirements. An evidence-based approach would provide a stronger justification for the resources needed to recruit and retain officers with STEM degrees. Methods for determining education requirements should distinguish between degrees needed for non-STEM-required core officer positions and those positions where officers in STEM specialties serve in nontechnical functional areas as consultants. And functional managers should identify positions that require specific types of undergraduate degrees, not only those requiring advanced academic degrees.

As the Air Force leaders for STEM issues, SAF/AQ and AF/A1 should collaborate to host annual CFM STEM conferences, under the auspices of the Air Force's STEMAC, to increase awareness of the need to clearly define STEM graduate needs and provide instruction/training on the methods for doing so. Summary presentations of Air Force futures documents (such as *Energy Horizons* and *Cyber Vision*) can inform and then energize CFMs to ensure they are planning for long-term STEM degree needs including emerging technology areas as well as planned changes to weapon systems and functional area techniques and procedures.

That said, neither our data analysis nor interviews found that a different form of STEM governance is needed—specifically that the STEM workforce should be managed at the corporate Air Force level versus the functional level. In fact, the wide range of STEM disciplines and the myriad ways STEM-degreed individuals are utilized in functional areas argue that requirement definition and workforce management should remain with the functional areas. So efforts to improve the STEM requirements determination process should focus on methods and tools to assist CFMs and functional managers.

Recommendation 2: Develop a more precise and visible framework for documenting requirements for all academic degrees, particularly STEM degrees

A framework that can be used for all career fields to more precisely document the need for academic degrees should be developed so that the demand for particular STEM degrees will be visible to personnel processes and provide career fields with the STEM-degreed officers they need for mission accomplishment. The AFOCD is the source document for education requirements by career field; however, the AFOCD does not quantify, prioritize, nor precisely identify the degrees required. A more efficient framework would

- be consistent across career fields
- prioritize degree types
- designate required percentages of degree types within career fields
- distinguish between desired versus required degrees
- designate general versus specific STEM knowledge
- accommodate "less-than-full-degree" requirements
- allow for specifying interdisciplinary and cross-disciplinary degrees[16]
- include strategies for avoiding shortages
- permit easy modification when requirements change
- give specific/definitive academic degree titles
- be implementable in the Officer Accession Classification model.[17]

With such a framework, the Air Force could sum up its accession requirements by degree types within and across career fields and know more precisely how many it should recruit and classify. This is not possible with the current methods for defining education requirements.

For example, the acquisition management career field currently states requirements for entry as follows: "For entry into this specialty, undergraduate academic specialization in engineering, engineering science, engineering management, mathematics, analytical science, physical science, business or management is desired" (AFOCD, 2012). A proposed documentation framework that satisfies some of the criteria listed above is shown in Table 8.1. Additional coordination with Air Force offices of primary responsibility for accessions, hiring, recruiting, etc. will be needed to finalize a format that is effective and integrated with current processes.

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[16] A current trend in education is the interdisciplinary and cross-disciplinary degree. At ever-growing rates colleges and universities are offering programs that bring together previously disparate academic areas (see, for example, AACU, 2002). As the Air Force brings in increasing numbers of individuals with these degrees, it will be more complex to understand and classify the capabilities of these individuals. Not considering these types of degrees may mean career fields miss out on well-qualified individuals.

[17] This AFPC-maintained model classifies new Air Force officer accessions into AFSCs based on several characteristics of the individual, one of which is the academic discipline of his or her bachelor's degree. Currently, there is insufficient specificity provided in the AFOCD on each AFSC's degree requirements to model the placement of officers into AFSCs. AFPC must make assumptions about a career field's requirements.

Table 8.1
Example/Proposed Education Requirements Framework
for the Acquisition Management Career Field

Priority	*Target Accession Rate*	*CIP (See Note)*	*Education Program Description*	*Requirement*
Tier 1	> 40%	14.XXXX	Engineering	Mandatory
			or	
		40.XXXX	Physical Sciences	
Tier 2	> 40%	11.XXXX	Computer and Information Sciences	Desired
			or	
		26.XXXX	Biological and Biomedical Sciences	
			or	
		27.XXXX	Mathematics and Statistics	
			or	
		52.XXXX	Business, Management, Marketing, and Related Support Services	
Tier 3	< 10%	15.XXXX	Engineering Technologies and Engineering-Related Fields	Permitted
			or	
		41.XXXX	Science Technologies/Technicians	

Note: Department of Education's Classification of Instructional Program (CIP) codes.

Recommendation 3: Use Classification of Instructional Programs codes for designating academic degree types

A significant first step in developing the framework in Recommendation 2 would be to do away with officer ASCs and instead use Department of Education CIP codes. Switching to the CIP coding system would use unique six-digit codes and a hierarchical structure for degree types. CIP codes correct the problems with the current nonhierarchical organization of the ASC list. The Department of Education maintains the CIP code list, ensuring that new degrees are added and that outdated degrees are either removed or translated to more current terminology. CIP codes use easily recognizable titles and descriptions; civilian colleges and universities (as well as USAFA and AFIT) routinely categorize the degrees they grant according CIP codes. In addition, little to no coordination would be necessary to determine what academic degree codes should be added to officers' records at accession, since the CIP codes would already be noted by the schools or universities. The list of CIP codes already includes many interdisciplinary academic degrees, and the combination of two or more CIP codes could adequately describe cross-disciplinary degrees.

Recommendation 4: Identify "critical" and "high-utility" academic degrees for use across all aspects of the officer accession process

We recommend establishing a process for career fields to identify those "critical" degrees that are consistently difficult to recruit and access. Identifying a critical degree should then trigger all phases of the accession process to recruiting degrees of this type. For example, the disciplines designated for applicants to the OTS CAD program should be aligned with degrees for which AFROTC awards scholarships. We recommend a visible means for identifying this critical degree need to accession sources so it is clear which degrees they should be focused on recruiting. Our research identified electrical engineering and meteorology as critical accession degrees. Refining requirements under Recommendation 1 might identify additional critical degrees.

"High-utility" degrees are academic specialties that can satisfy multiple requirements within or across career fields and should be accessed when possible. Our analysis identified mathematics as a high-utility degree.[18]

Recommendation 5: Consider measures and proxies other than "STEM degrees" to define officer requirements for career fields

For example, a portion of positions in a functional area could be designated as requiring "high STEM potential," which could be defined as sufficient STEM coursework plus a minimum AFOQT score. A full STEM degree would not be required but would still satisfy the functional area's requirements. The option for these alternative types of STEM-like measures should be a part of the CFM tools/methods developed in Recommendation 1.

On the other hand, more focused quality measures are needed in cases where the quality and rigor of the degree and the discipline-specific skills of the individual are necessary. While implementing a quality measure such as this may be difficult for all positions, it must be available for critical positions.

Civilian-Specific Recommendations

Recommendation 6: Synchronize efforts within and across functional areas to highlight requirements for STEM knowledge, skills, and degrees within the constraints of civilian personnel policies and statutes.

For civilians, OPM standards define education minimums rather than desired education levels, allow experience to substitute for education, and prohibit requiring particular degree types; therefore, civilian occupational series may not adequately reflect the true STEM need. It is

[18] Math's designation as high utility here may be an artifact of the current education requirements. Degree requirements will need to be monitored over time to designate "high utility."

currently left to organizations and local hiring authorities to ensure their STEM populations are adequate.

We recommend increased use of three opportunities to ensure STEM-qualified civilians are hired at all levels from entry levels to mid-career to senior leader positions:

- **Careful writing of position descriptions to delineate the STEM-specific skills and knowledge that will be required for the position.** This ensures candidates demonstrate experience or education as evidence of their STEM abilities when applying for a position. It also allows the candidate to highlight nongovernmental expertise, subject expertise, or other valuable qualifications.
- **For those already in civilian positions, inclusion of a position-appropriate STEM degree in the promotion plan.** This encourages employees to pursue degrees to obtain STEM skills and knowledge, making them more qualified for their position. They may be more likely to compete for government-sponsored degree programs or obtain the degree on their own.
- **For particular technical occupational series, career fields should work together in conjunction with the other military departments to obtain relief from statutory restrictions on education requirements.** During our interviews, the civil engineering and cyberspace functional areas expressed their desire to add education requirements to relevant OPM standards and have attempted to obtain relief individually. We recommend a concerted effort detailing how technical competence has become increasingly important over time for these positions, and how organizations would benefit from specific degree requirements.

Recommendation 7: Continue to promote and consider increasing programs that encourage STEM recruiting and retention.

We recommend supporting and, when possible, increasing programs such as Science, Mathematics, and Research for Transformation (SMART) and acquisition demonstration projects (Acq Demo) that encourage the recruitment, hiring, and retention of STEM-degreed civilians. For current STEM-degreed civil servants, retention can be improved by emphasizing the importance of STEM skills by, for example, including STEM expertise in promotion criteria.

General Recommendations

Recommendation 8: Adopt standard lists of STEM and non-STEM academic disciplines.

We found multiple lists across personnel processes for what was considered a STEM degree—e.g., “technical” degree lists considered engineering technology as a STEM degree, while the SAF/AQ process for tracking STEM populations did not consider engineering technology a STEM degree. We also heard differing views from CFMs on what constituted a

STEM degree. Adopting an approved Air Force list would help align analyses on STEM degrees, align personnel processes, and aid in understanding exactly where STEM resources reside. However, we do not recommend that any functional area use the broad STEM/non-STEM classification alone for documenting its degree requirements. This designation would be too broad for useful degree designations, since STEM degrees vary so greatly. For example, consider the different skills and knowledge of a biology major as compared to an electrical engineer.

Recommendation 9: Continue the work begun in this research to track STEM populations (numbers, grades, specialties, etc.) across all functional areas.

Current practices focus efforts on STEM officers and civilians in STEM-mandatory functional areas, but significant STEM requirements and personnel reside in functional areas where STEM degrees are not mandatory. To ensure the Air Force has sufficient STEM assets, it should monitor the various STEM disciplines in all functional areas. We recommend that the STEMAC be responsible for this monitoring.

Recommendation 10: AF/ST and STEMAC team to ensure identified future technology needs are communicated to impacted functional areas and translated into appropriate degree requirements.

We see it as AF/ST's responsibility to identify and then disseminate emerging technologies, paying particular attention to informing those responsible for providing the human capital to support these future technologies. Given its charter from the Air Force Chief of Staff as the body responsible for ensuring organizations are executing the Air Force STEM vision, goals, and strategy, the STEMAC should then translate these technologies into potential functional area specialties and academic disciplines and ensure they are communicated to functional areas and career fields.

Appendix A. STEM/Non-STEM Categorization of ASCs and IPs

Officer Academic Specialty Codes (ASC)

The Air Force uses a list of 3,118 academic disciplines (labeled using four-character ASCs) that RAND obtained from AFIT. Collectively, the 55,148 nonmedical active-duty officers in the May 2010 personnel file exhibited 1,067 ASCs at the BA/BS level or higher. AAD requirements in the manpower file include 18 ASCs that are not among those 1,067. SAF/AQH and RAND staff categorized as STEM or non-STEM only those 1,067 + 18 = 1,085, not the remaining 3,118 – 1,085 = 2,033. Rather than listing the ASCs in detail, this appendix displays only our general categorizations, plus any exceptions (see Table A.1). For example, the current manpower and personnel files presented 235 distinct engineering ASCs (4 is the first character in engineering ASCs) whose categorizations are summarized here in two lines, one showing engineering ASCs as STEM and another showing 4V (engineering technologies) ASCs as non-STEM.[19] Gray shading marks ASCs where one or more subordinates (in the disciplinary hierarchy) has a different STEM category. For example, 4 (engineering) is shaded gray because its blanket category is STEM and its subordinate 4V (engineering technologies) is non-STEM.

Our categorizations are mainly at the two- or even one-character ASC levels—e.g., ASCs beginning with 1A (business administration and management) are non-STEM, those beginning with 5 (law) are non-STEM, and those beginning with 6 (mathematics) are STEM. We use more characters primarily for exceptions—e.g., 2BBE and 2BBF (college teaching of mathematics and physics, respectively) are STEM exceptions under the non-STEM 2B (education) heading. We also display four instead of three characters when no instance of the three-character ASC appeared in the manpower or personnel file. We display more ASCs under the 0Y heading because it has been used as a catch-all; its contributing disciplines are less homogeneous than those under most two-character headings.

Civilian Instructional Programs (IPs)

For civilians, OPM uses a list of 1,891 academic disciplines (labeled using six-digit codes based on a listing maintained by the Department of Education's National Center for Education Statistics (OPM, undated). Of the 78,657 nonmedical administrative and professional civilians in the May 2010 personnel file, they collectively exhibited 627 IPs at the BA/BS level or higher. SAF/AQH and RAND staff categorized these IPs as STEM or non-STEM. Similar to the

[19] The 4V ASCs emphasize technical, vocational, hands-on, "shop-level" skills, not the underlying engineering and scientific theory and principles. Two examples are 4VEB (construction trades technology) and 4VJY (industrial engineering technology). The Air Force employs mainly civilians and enlisted personnel for such work, not officers.

convention described above for ASCs, Table A.2 lists our general categorizations plus any exceptions with gray shadowing indicating IPs where one or more subordinates in the hierarchy has a different STEM category.

Table A.1
STEM/Non-STEM Academic Specialty Codes

ASC Group	TITLE	STEM	Non-STEM
0	INTER AREA SPECIALIZATION		x
0C	COMPUTER TECHNOLOGY COMPUTER SCIENCE	x	
0G	GENERAL STUDIES LIBERAL STUDIES LIBERAL ARTS REGENTS AMERICAN STUDIES		x
0I	INFORMATION SYSTEMS (U MD U COLL: COMPUTER AND INFORMATION SCIENCES)	x	
0S	AEROSPACE SAFETY		x
0W	COMBATING WEAPONS OF MASS DESTRUCTION		x
0Y	Untitled		
0YA	AGRICULTURE AND FOOD CHEMISTRY	x	
0YB	BIOCHEMISTRY	x	
0YC	BIOGEOGRAPHY		x
0YD	BIOPHYSICAL SPECIALTIES, INTER AREA SPECIALIZATION	x	
0YE	OPERATION RESEARCH, INTER AREA SPECIALIZATION	x	
0YH	SOCIAL PSYCHOLOGY, INTER AREA SPECIALIZATION	x	
0YI	SOIL SCIENCE, INTER AREA SPECIALIZATION	x	
0YJ	SYSTEMS ANALYSIS, INTER AREA SPECIALIZATION	x	
0YK	SYSTEMS MANAGEMENT, INTER AREA SPECIALIZATION (NON AFIT)		x
0YKS	MANAGEMENT SCIENCE	x	
0YL	AREA SPECIALIST		x
0YM	FORENSIC SCIENCE AFIT , PATHOLOGY	x	
0YN	ELECTRONIC WARFARE SYSTEMS TECHNOLOGY	x	
0YO	ENVIRONMENTAL SCIENCES (CONSERVATION)	x	
0YR	SPACE OPERATIONS	x	
0YS	STRATEGIC AND TACTICAL SCIENCES	x	
0YT	TELECOMMUNICATIONS	x	
0YU	STRATEGIC INTELLIGENCE		x
0YV	NATIONAL SECURITY AND STRATEGIC STUDIES		x
0YW	SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT		x
0YX	INTER AREA SPECIALIZATION, OTHER		x
1	ADMINISTRATION MANAGEMENT AND MILITARY SCIENCE		x
1A	BUSINESS ADMINISTRATION AND/OR MANAGEMENT		x
1AF	BUSINESS STATISTICS AND QUANTITIVE METHODS	x	
1AKG	OPERATION RESEARCH, INDUSTRIAL OR PRODUCTION MANAGEMENT	x	
1AME	MANAGEMENT INFORMATION SYSTEMS	x	
1AMG	SYSTEMS ANALYSIS, LOGISTICS MANAGEMENT	x	
1APA	QUALITY ASSURANCE TOTAL QUALITY	x	
1B	MILITARY SCIENCE		x
1BBA	BASIC SCIENCE USAFA	x	
1C	ADMINISTRATION AND MANAGEMENT TECHNOLOGIES		x
1EDM	EMERGENCY DISASTER MANAGEMENT		x
1FRS	FITNESS, RECREATION AND SERVICES MANAGEMENT		x

Table A.1—Continued

ASC Group	TITLE	STEM	Non-STEM
2	ARTS HUMANITIES AND EDUCATION		x
2B	EDUCATION		x
2BBE	MATHEMATICS, COLLEGE TEACHING	x	
2BBF	PHYSICAL SCIENCES, COLLEGE TEACHING	x	
2C	FINE AND APPLIED ARTS		x
2CA	ARCHITECTURE	x	
2G	PHILOSOPHY		x
2GH	LOGIC	x	
3	BIOLOGICAL AND AGRICULTURAL SCIENCES	x	
3B	AGRICULTURE		x
3BA	AGRICULTURE AND FOOD CHEMISTRY	x	
3BG	SOIL SCIENCE, AGRICULTURE	x	
4	ENGINEERING, GENERAL AREA OF STUDY	x	
4V	ENGINEERING TECHNOLOGIES		x
5	LAW		x
6	MATHEMATICS	x	
7	MEDICAL SCIENCES XAVIER UNIVERSITY: NATURAL SCIENCES	x	
7C	HOSPITAL ADMINISTRATION		x
7E	GENERAL DUTY NURSING		x
7F	VETERINARY MEDICINE	x	
7FE	ANIMAL TECHNICIAN AND ANIMAL TECHNOLOGY		x
7FX	VETERINARY MEDICINE OTHER		x
7G	HEALTH CARE SCIENCES OCCUPATIONAL TECHNOLOGIES		x
8	PHYSICAL SCIENCES	x	
8D	EARTH SCIENCES		x
8G	PHOTOGRAPHIC SCIENCES		x
8GAC	OPTICAL INSTRUMENTATION PHOTOGRAPHY	x	
9	SOCIAL SCIENCES		x
9B	ECONOMICS		x
9BJ	ECON, QUANTITATIVE	x	
9F	PSYCHOLOGY		x
9FE	PSYCHOLOGY, EXPERIMENTAL	x	
9FIY	PSYCHOMETRICS	x	
9FKA	PSYCH, BEHAVIORAL SCIENCE, HUMAN FACTORS	x	
9FKY	PSYCHOLOGY, BEHAVIORAL SCIENCES	x	
YY	NO ACADEMIC SPECIALTY		x
ZZ	ACADEMIC SPECIALTY UNKNOWN		x

Table A.2
STEM/Non-STEM Instructional Programs

IP	TITLE	STEM	Non-STEM
01	Agriculture		x
03	Natural Resources and Conservation		x
030104	Environmental Science	x	
04	Architecture and Related Services, Other	x	
0403	City/Urban, Community and Regional Planning		x
0406	Landscape Architecture (BS, BSLA, BLA, MSLA, MLA, PhD)		x
0408	Architectural History and Criticism, General		x
0409	Architectural Technology/Technician		x
05	Foreign, Ethnic, Cultural Minority, and Gender Studies		x
09	Communication, Journalism, and Related Programs		x
10	Communications Technologies/Technicians and Support Services		x
11	Computer and Information Sciences and Support Services	x	
1101	Computer and Information Sciences	x	
110103	Information Technology		x
1103	Data Processing and Data Processing Technology/Technician		x
1106	Data Entry/Microcomputer Applications		x
1110	Computer/Information Technology Services Administration and Management, Other	x	
111004	Web/Multimedia Management and Webmaster		x
111099	Computer/Information Technology Services Administration and Management, Other		x
12	Personal and Culinary Services		x
13	Education		x
14	Engineering	x	
15	Engineering Technology		x
16	Foreign Languages and Literatures		x
19	Family and Consumer Sciences/Human Sciences		x
22	Legal Studies		x
23	English Language and Literature		x
24	Liberal Arts and Sciences, General Studies and Humanities, Other		x
25	Library Science		x
26	Biological and Biomedical Sciences	x	
2612	Biotechnology		x
27	Mathematics and Statistics	x	
29	Military Technologies		x
30	Multi/Interdisciplinary Studies		x
3001	Biological and Physical Sciences	x	
3006	Systems Science and Theory	x	
3008	Mathematics and Computer Science	x	
3010	Biopsychology	x	
3016	Accounting and Computer Science	x	
3018	Natural Sciences	x	
3024	Neuroscience	x	
3025	Cognitive Science	x	
31	Parks, Recreation, Leisure and Fitness Studies, Other		x
38	Philosophy and Religious Studies, Other		x
39	Theology and Religious Vocations, Other		x
40	Physical Sciences, Other	x	
41	Science Technologies/Technicians, Other		x
42	Psychology		x
4203	Cognitive Psychology and Psycholinguistics	x	
4209	Experimental Psychology	x	
4209	Industrial and Organizational Psychology	x	
4211	Physiological Psychology/Psychobiology	x	
4219	Psychometrics and Quantitative Psychology	x	
43	Security and Protective Services, Other		x
4301	Corrections and Criminal Justice, Other		x
430106	Forensic Science and Technology	x	

Table A.2—Continued

IP	TITLE	STEM	Non-STEM
44	Public Administration and Social Service Professions, Other		x
45	Social Sciences		x
4506	Economics		x
450603	Econometrics and Quantitative Economics	x	
46	Construction Trades, General		x
47	Mechanics and Repairers, General		x
48	Precision Production, Other		x
49	Transportation and Materials Moving, Other		x
50	Visual and Performing Arts, General		x
51	Health Professions and Related Clinical Sciences, Other		x
5111	Pre-Medical Studies		x
511102	Pre-Medicine/Pre-Medical Studies	x	
511103	Pre-Pharmacy Studies	x	
511104	Pre-Veterinary Studies	x	
511201	Medicine (MD)	x	
5117	Optometry (OD)	x	
5120	Pharmacy, Pharmaceutical Sciences, and Administration	x	
5122	Public Health		x
512205	Health/Medical Physics	x	
5124	Veterinary Medicine (DVM)	x	
5125	Veterinary Sciences/Veterinary Clinical Sciences, General (Cert, MS, PhD)	x	
52	Business, Management, Marketing, and Related Support Services, Other		x
5212	Management Information Systems and Services		x
521201	Management Information Systems, General	x	
521299	Management Information Systems and Services, Other	x	
5213	Management Sciences and Quantitative Methods, Other	x	
54	History, General		x
60	Medicine	x	

Appendix B. Summary Data by Functional Area

The data tables in this appendix provide detailed information on the Air Force functional areas we examined. Each table details the STEM versus non-STEM officer positions and officer/civilian population in our snapshot dataset. Populations are given for those in core occupations, those currently serving in duty AFSCs, and in the functional area. (See the Chapter Two section “Officer and Civilian Position Data” for the definitions of these various populations.) In addition, the comments section provides information on current AFOCD degree requirements, AAD requirements, OPM standards, core and noncore AFSCs, and the prevalent occupational series in the functional area.

Table B.1
Civil Engineering Functional Area

OFFICER/CIVILIAN MIX: 43%/57% CORE OCCUPATIONS
20%/80% DUTY AFSC
21%/79% FUNCTIONAL AREA

Counted | Academic discipline | OFFICER | CIVILIAN[1]

POSITIONS — June 2010

1190 of 1190 officer authorizations = 100% authorized STEM degrees

Counted	Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Regardless of suffix	Total	1,341	1,190	209	13	1	184	13	1	89%	88%	100%	100%
	STEM rqd	1,341	1,190	45	11	1	43	11	1	89%	96%	100%	100%
	Engr sci/engr	711	652	44	10		42	10		92%	95%	100%	-
	Non-STEM rqd	166	143	164	2		141	2		86%	86%	100%	-
	Bus/public admin/mgt	164	141	162	2		139	2		86%	86%	100%	-
For specific suffixes	A architecture/arch engr	16	15	1			1			94%	100%	-	-
	B readiness engr	25	24							96%	-	-	-
	C civil engr	84	82	25	7		25	7		98%	100%	100%	-
	D readiness (non-engr)	8	8							100%	-	-	-
	E electrical engr	36	36	4			4			100%	100%	-	-
	F mechanical engr	42	42	4			4			100%	100%	-	-
	G general engr	541	484	92	5		81	5		89%	88%	100%	-
	H EOD (explsv ordn dspsl)	40	39	1						98%	0%	-	-
	J environmental engr	52	25	22			13			48%	59%	-	-
	K EOD (non-engr)	5	5							100%	-	-	-

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010, Civilians Sep 2010 (Highest academic credential)

Civilian: Largest[1]: environmental engr (0819), civil engr (0810), environmental protection spclst (0028), general natural resources mgt and biological sci (0401), realty (1170), architecture (0808), community planning (0020)

Officer: Core 32E, civil engineer

Counted	Academic discipline	Officer Total	Officer None	Officer < BA/BS	Officer BA/BS	Officer MA/MS	Officer PhD	Officer Prof deg	Officer % BA/BS +	Civilian Total	Civilian None	Civilian < BA/BS	Civilian BA/BS	Civilian MA/MS	Civilian PhD	Civilian Prof deg	Civilian % BA/BS +
CORE OCCUPATIONS	Total	1,367	48	4	586	707	16	6	96%	1,804	191	157	847	550	53	6	81%
	STEM		83	2	1,058	212	7	5	94%		698	37	728	302	37	2	59%
	Engr sci/engr		139	1	1,019	201	7		90%		1,088	17	506	178	14	1	39%
	Architecture/arch engr		1,298		49	15	5		5%		1,636	5	118	44	1		9%
	Civil engineering		623		588	149	7		54%		1,389	8	289	107	10	1	23%
	Electrical engr		1,245		116	6			9%		1,782	1	20	1			1%
	Mechanical engr		1,083	1	268	15			21%		1,725	3	66	10			4%
	Environmental engr		1,280		65	20	2		6%		1,787	2	4	11			1%
	Non-STEM		752	3	33	569	9	1	45%		1,066	178	267	273	16	4	31%
	Bus/public admin/mgt		852	2	11	493	9		38%		1,511	60	88	143	2		13%
CIVIL ENGR DUTY AFSCs (including 32E and enlisted 3E)	Total	1,177	27	3	540	587	15	5	97%	4,617	665	551	2,041	1,289	60	11	74%
	STEM		60	1	923	181	7	5	95%		2,038	104	1,797	635	37	6	54%
	Engr sci/engr		110	1	887	172	7		91%		2,708	53	1,397	432	25	2	40%
	Non-STEM		665	3	35	466	8		43%		2,672	559	648	710	23	5	30%
	Bus/public admin/mgt		747	2	12	408	8		36%		3,758	147	246	462	4		15%
	Numbers with duty AFSC suffixes and with/without *matching* academic credentials																
	A architecture/arch engr	12	5		5	2			58%	141	61	2	57	21			55%
	C civil engr	100	20		59	19	2		80%	279	149		97	27	5	1	47%
	E electrical engr	27	7		19	1			74%	152	78	1	66	7			48%
	F mechanical engr	40	12		26	2			70%	198	76	3	105	14			60%
	J environmental engr	30	18		12				40%	191	170	1	8	9	3		10%
CIVIL ENGR FUNCTIONAL AREA	Total	1,405	49	4	610	720	16	6	96%	5,332	912	740	2,210	1,377	82	11	69%
	STEM		103	2	1,074	214	7	5	93%		2,605	125	1,872	668	56	6	49%
	Engr sci/engr		166	1	1,029	202	7		88%		3,370	59	1,432	442	27	2	36%
	Architecture/arch engr		1,335		50	15	5		5%		5,032	13	217	67	3		5%
	Civil engineering		659		590	149	7		53%		4,504	20	577	210	20	1	15%
	Electrical engr		1,281		118	6			9%		5,091	12	202	27			4%
	Mechanical engr		1,118	1	271	15			20%		4,910	9	371	41	1		8%
	Environmental engr		1,318		65	20	2		6%		5,157	13	69	82	11		3%
	Non-STEM		764	3	47	581	9	1	45%		3,017	748	767	769	26	5	29%
	Bus/public admin/mgt		878	2	14	502	9		37%		4,284	230	312	502	4		15%

Table B.1—Continued

COMMENTS	AFOCD: Undergrad specialization is mandatory in architecture or civil, electrical, environmental, construction, architectural, or mechanical engineering. For suffixes A, C, E, and F, matching specialization is mandatory. Architects may fill A or G suffixes. For suffix J, specialization in environmental engineering is desirable. AADs: authorizations concentrated in engineering and business/public administration/management, the latter mainly in engineering management. Share of core-32E officers with other DAFSCs = 14%, the most in 92S student, 81T instructor, 30C support commander, 16X ops support, 97E executive officer, 62E developmental engineer, 81C training commander (OTS), and 83R recruiting service. 38 officers (3% of those) in the CE FA came from other core specialties, the most from 11M mobility pilot, 21R logistics readiness, 38F force support, 62E developmental engineer, and 17D cyberspace operations.	OPM standards for four largest core-CE occ series: - Environmental engr (0819) and civil engr (0810): professional engineering degree, or combination of education and experience. - Environmental protection spclst (0028), realty (1170): bachelor's degree, any field. - Gen natural resources mgt & biological sciences (0401): degree in biological sciences, agriculture, natural resource mgt, chemistry, or related diciplines appropriate to the position. Or suitable combination of education and experience. Share of core-CE civilians with non-CE duty AFSCs = 10%, the most in enl 3x info/com/cyberspace, 43E bioenvironmental engr, enl 4x medical/health, and 61C chemist/biologist. 3,528 civilians (66% of those) in the CE FA came from other occupational series, the most from general engr (0801), misc admin & program (0301), housing mgt (1173), general physical science (1301), mechanical engr (0830), mgt and prog analysis (0343), electrical engr (0850), budget analysis (0560), and training instruction (1712).

[1] Other, smaller core-CE civilian occupational series, with 22 or fewer members each: archeology (0193), interior design (1008), wildlife biology (0486), forestry (0460), geography (0150), landscape architecture (0807), geology (1350), fire prevention engr (0804), hydrology (1315), public utilities specialist (1130), botany (0430), land surveying (1373), range conservation (0454), agronomy (0471), ecology (00408).

Table B.2
Developmental Engineering Functional Area

OFFICER/CIVILIAN MIX: 23%/77% CORE OCCUPATIONS
21%/79% DUTY AFSC
25%/75% FUNCTIONAL AREA

Counted | Academic discipline | OFFICER | CIVILIAN[1]

POSITIONS — June 2010

= 2,570 of 2,570 officer authorizations
= 100% authorized STEM degrees

Counted	Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Regardless of suffix	Total	2,833	2,570	501	176	4	467	173	3	91%	93%	98%	75%
	STEM rqd	2,833	2,570	478	172	4	449	169	3	91%	94%	98%	75%
	Engr sci/engr	2,328	2,111	435	161	4	416	158	3	91%	96%	98%	75%
	Aeronautical	280	255	70	41		69	41		91%	99%	100%	-
	Astronautical	139	133	22	12	1	22	12	1	96%	100%	100%	100%
	Comp sci/engr, info sys	145	126	67	19		60	18		87%	90%	95%	-
	Electrical	876	781	232	67	2	208	65	2	89%	90%	97%	100%
	Mechanical	176	167	24	17		24	16		95%	100%	94%	-
	Non-STEM rqd	18	15	16	2		13	2		83%	81%	100%	-
	Bus/public admin/mgt	10	8	8	2		6	2		80%	75%	100%	-
For specific suffixes	A - Aeronautical	280	255	60	39		60	39		91%	100%	100%	-
	B - Astronautical	139	133	34	6		34	6		96%	100%	100%	-
	C - Computer systems	145	126	35	7		31	7		87%	89%	100%	-
	E - Electrical/electronic	876	781	198	60		172	58		89%	87%	97%	-
	F - Flight test	127	104	5	2		4	2		82%	80%	100%	-
	G - Project	629	567	72	14		71	14		90%	99%	100%	-
	H - Mechanical	176	167	29	16		29	15		95%	100%	94%	-

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sep 2010

Officer CORE OCCUPATIONS: 62E developmental engineer

Civilian CORE OCCUPATIONS: Largest[2]: electronics (0855), general (0801), aerospace (0861), mechanical (0830), materials (0806), electrical (0850), industrial (0896) … engineering

Counted	Academic discipline	Officer: Total	Officer: None	Officer: < BA/BS	Officer: BA/BS	Officer: MA/MS	Officer: PhD	Officer: Prof deg	Officer: % BA/BS +	Civilian: Total	Civilian: None	Civilian: < BA/BS	Civilian: BA/BS	Civilian: MA/MS	Civilian: PhD	Civilian: Prof deg	Civilian: % BA/BS +
CORE OCCUPATIONS	Total	3,450	98	9	1,543	1,605	194	1	97%	11,727	95	25	6,215	4,742	628	22	99%
	STEM		123	5	1,918	1,214	190		96%		782	47	6,818	3,477	591	12	93%
	Engr sci/engr		148	4	1,954	1,168	176		96%		1,351	42	6,797	3,002	528	7	88%
	Aeronautical		3,012		156	254	28		13%		10,393	4	778	441	111		11%
	Astronautical		3,229		92	113	16		6%		10,397	4	776	439	111		11%
	Comp sci/engr, info sys		3,145	2	151	135	17		9%		10,825	47	495	346	13	1	7%
	Electrical		2,128	2	807	437	76		38%		7,124	43	3,372	1,038	148	2	39%
	Mechanical		2,680		591	152	27		22%		9,493	26	1,609	505	94		19%
	Non-STEM		2,706	15	81	643	4	1	21%		8,055	1,357	726	1,541	38	10	20%
	Bus/public admin/mgt		2,993	3	36	417	1		13%		9,160	1,204	110	1,245	7	1	12%
ENGINEERING DUTY AFSCs	Total	2,638	31	4	1,315	1,135	152	1	99%	10,182	163	82	5,224	4,075	619	19	98%
	STEM		53	4	1,574	857	150		98%		901	57	5,603	3,025	587	9	91%
	Engr sci/engr		87	4	1,589	824	134		97%		1,535	37	5,497	2,600	507	6	85%
	Aeronautical		2,329		111	176	22		12%		8,890	4	762	420	106		13%
	Astronautical		2,474		65	85	14		6%		8,890	4	762	420	106		13%
	Comp sci/engr, info sys		2,394		125	105	14		9%		9,268	42	531	325	15	1	9%
	Electrical		1,614	2	657	307	58		39%		6,139	42	2,920	930	149	2	39%
	Mechanical		2,052		464	102	20		22%		8,354	22	1,253	461	92		18%
	Non-STEM		2,123	7	74	431	2	1	19%		6,797	1,352	692	1,298	33	10	20%
	Bus/public admin/mgt		2,314	2	33	288	1		12%		7,810	1,204	120	1,041	6	1	11%
	Numbers with duty AFSC suffixes and with/without *matching* academic credentials																
	A - Aeronautical	302	199		31	58	14		34%	1,472	878		260	244	90		40%
	B - Astronautical	152	90		15	42	5		41%	25	17		3	2	3		32%
	C - Computer systems	149	53		56	35	5		64%	318	153	2	87	72	4		51%
	E - Electrical/electronic	767	158	1	343	232	33		79%	4,696	1,612	4	1,862	1,075	139	4	66%
	H - Mechanical	212	57		103	42	10		73%	807	268		343	158	38		67%
ENGINEERING FUNCTIONAL AREA	Total	4,267	104	10	1,824	2,107	217	5	97%	13,191	428	220	6,676	5,146	692	29	95%
	STEM		487	6	2,171	1,393	210		88%		1,706	86	7,112	3,632	643	12	86%
	Engr sci/engr		643	5	2,118	1,316	185		85%		2,636	53	6,882	3,065	548	7	80%
	Aeronautical		3,741		172	324	30		12%		11,819	5	799	455	113		10%
	Astronautical		4,017		103	129	18		6%		11,823	5	797	453	113		10%
	Comp sci/engr, info sys		3,931	2	169	147	18		8%		12,044	67	654	407	18	1	8%
	Electrical		2,869	2	854	463	79		33%		8,542	50	3,392	1,052	153	2	35%
	Mechanical		3,433	1	638	167	28		20%		10,941	28	1,616	508	98		17%
	Non-STEM		2,941	15	255	1,044	7	5	31%		8,761	1,577	975	1,811	50	17	22%
	Bus/public admin/mgt		3,414	3	154	693	3		20%		10,192	1,302	239	1,448	8	2	13%

Table B.2—Continued

COMMENTS	AFOCD: Engineering degree, unless member possesses a fully qualified AFSC in a suffix of this specialty. Undergrad degree in the engr specialization identified for suffixes A, B, C, E, and H. Undergrad specialization in engineering, a physical science, or mathematics for suffix F. Engineering for suffix G. AADs: 119 AADs beyond the six disciplinary groups listed above[3] were authorized, including 42 in physical science, 40 in systems engineering, 16 in mathematics, and 11 in aerospace engineering. Share of core-62E officers with other duty AFSCs = 28%, the most in 92S student, 63A acquisition manager, 81T instructor, 13S space/missile operations, and 16X operations support. 817 officers (19% of those) in the engineering enterprise came from other core specialties, the most from 63A acquisition manager, 11E experimental test pilot, 64P contracting, and 13S space/missile ops.	OPM standard: professional engineering degree, or suitable combination of education and experience. The numbers are the same for aeronautical and astronautical engineering because they are named under the same civilian instructional program (IP 140201). Share of core-engineering civilians with non-62E duty AFSCs = 19%, by far the most in 32E (and enl 3C) civil engineering and 17D (and 33S) cyberspace ops (plus enl 3x info/comm/cyberspace), then 61A ops research analyst, 14N intelligence, 61S scientist, 61C chemist/biologist, and 63A acquisition manager. 1,464 civilians (10% of those) in the engineering enterprise came from other occupational series, the most from misc admin & prog (0301), general business & industry (1101), computer science (1550), mgt and program analysis (0343), IT mgt (2210), operations research (1515), and intelligence (0132).

[2]Other, smaller core-engineering civilian occupational series, with 82 or fewer members each: safety (0803), chemical (0893), biomedical (0858), petroleum (0881), ceramic (0892).
[3]That is, beyond aeronautical, astronautical, computer, electrical, and mechanical engineering and business/public administration/management.

Table B.3
Weather Functional Area

OFFICER/CIVILIAN MIX: 82%/18% CORE OCCUPATIONS
74%/26% DUTY AFSC
69%/31% FUNCTIONAL AREA

Counted | Academic discipline | OFFICER | CIVILIAN[1]

POSITIONS — June 2010

96 of 521 officer authorizations
= 18% authorized STEM degrees

	Total Rqd	Total Funded	AADs required MA/MS	AADs required PhD	AADs required Unk	AADs funded MA/MS	AADs funded PhD	AADs funded Unk	Funded vs. required Total	Funded vs. required AADs MA/MS	Funded vs. required AADs PhD	Funded vs. required AADs Unk
Total	615	521	111	17	2	84	15	2	85%	76%	88%	100%
STEM rqd	125	96	106	17	2	79	15	2	77%	75%	88%	100%
Meteorology rqd	116	91	98	16	2	75	14	2	78%	77%	88%	100%
Non-STEM rqd	2	2	2			2			100%	100%	-	-

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sept 2010

OFFICER (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
CORE OCCUPATIONS (Core 15W, weather)	Total	686	13	4	267	372	30		98%
	STEM		95	4	311	246	30		86%
	Meteorology		144	4	279	230	29		78%
	Non-STEM		402	4	82	197	1		41%
WEATHER DUTY AFSC (15W and 1W)	Total	563	5	3	248	283	24		99%
	STEM		79	4	276	180	24		85%
	Meteorology		121	4	246	169	23		78%
	Non-STEM		337	3	73	149	1		40%
WEATHER FUNCTIONAL AREA	Total	707	13	4	276	384	30		98%
	STEM		105	4	318	250	30		85%
	Meteorology		165	4	279	230	29		76%
	Non-STEM		407	4	89	206	1		42%

CIVILIAN (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
CORE OCCUPATIONS (Meteorologist (1340))	Total	154	5	2	34	101	11	1	95%
	STEM		19	1	42	82	10		87%
	Meteorology		34	3	35	72	10		76%
	Non-STEM		115	4	9	24	1	1	23%
WEATHER DUTY AFSC (15W and 1W)	Total	195	18	8	47	111	10	1	87%
	STEM		42	8	50	86	9		74%
	Meteorology		68	9	36	73	9		61%
	Non-STEM		140	7	16	30	1	1	25%
WEATHER FUNCTIONAL AREA	Total	324	52	30	79	149	13	1	75%
	STEM		119	17	76	101	11		58%
	Meteorology		183	11	40	79	11		40%
	Non-STEM		214	23	31	53	2	1	27%

COMMENTS

Officer:

AFOCD: degrees in meteorology or atmospheric science are desirable.
AADs: Most authorizations were in meteorology, mainly specializations therein (others included computer science, ops research, physics, special ops/low-intensity conflict).
Share of core-15W officers with other DAFSCs = 18%, mainly students, instructors,and ops support (16X).
21 officers in the weather FA came from other core specialties: 14N intel, 17D cyber ops, 62E dev engr, 63A acq mgt, 61D physicist/nuc engr, and 61C chemist/biologist.

Civilian:

OPM standard: degrees in meteorology, atmospheric science, or natural science (with meteorology), or a suitable combination of education and experience.
Share of series-1340 civilians with other DAFSCs = 4%: cyber ops, scientist, developmental engineer.
170 civilians in the weather FA came from other occupational series, most from IT mgt (2210), mgt/prog analysis (0343), misc admin/prog (0301), training instruction (1712), and budget analysis (0560).

Table B.4
Scientific/Research Functional Area

OFFICER/CIVILIAN MIX: 38%/62% CORE OCCUPATIONS
30%/70% DUTY AFSC
31%/69% FUNCTIONAL AREA

Counted	Academic discipline	OFFICER											
POSITIONS	June 2010	481 of 795 officer authorizations = 61% authorized STEM degrees								Funded vs. required			
		Total		AADs required			AADs funded				AADs		
		Rqd	Funded	MA/MS	PhD	Unk	MA/MS	PhD	Unk	Total	MA/MS	PhD	Unk
Regardless	Total	875	795	305	137	11	282	130	11	91%	92%	95%	100%
of specialty	STEM rqd	519	481	287	127	11	264	120	11	93%	92%	94%	100%
(i.e., for	Math/ops research	177	162	127	42	8	114	40	8	92%	90%	95%	100%
all 61X)	Physical science	161	149	99	62		91	58		93%	92%	94%	-
	Chemistry	45	43	32	13		30	13		96%	94%	100%	-
	Physics	106	98	61	45		57	41		92%	93%	91%	-
	Engr sci/engr	76	71	50	23	3	45	23	3	93%	90%	100%	
	Nuclear engineering	27	27	17	7	3	17	7	3	100%	100%	100%	100%
	Biology	14	14	9	5		9	5		100%	100%	100%	-
	"Other" STEM[2]	6	5	4	1		4			83%	100%	0%	-
	Non-STEM rqd	25	25	17	8		17	8		100%	100%	100%	-
	Psychology	12	12	6	6		6	6		100%	100%	100%	-
	Bus/public admin/mgt	5	5	5			5			100%	100%	-	-
For specific	61A ops research analyst	492	437	153	49	10	138	47	10	89%	90%	96%	100%
specialties	61B behavioral/hum fact sci	82	74	18	12	1	15	11	1	90%	83%	92%	100%
	61C chemist/biologist	81	79	39	15		38	14		98%	97%	93%	-
	61D physicist/nuclear engr	220	205	95	60		91	57		93%	96%	95%	-

CIVILIAN[1]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

Counted	Academic discipline	OFFICER Total	Highest academic credential: None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +	CIVILIAN Total	Highest academic credential: None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
PEOPLE	Officers May 2010 Civilians Sep 2010																
CORE OCCUPATIONS		61A operations research analyst, 61B behavioral scientist/human factors scientist, 61C chemist/biologist, 61D physicist/nuclear engineer								Largest[3]: ops research (1515), general physical sciences (1301), physics (1310), chemistry (1320), psychology (0180), mathematics (1520)							
	Total	1,146	40	6	411	517	171	1	96%	1,883	64	23	534	739	522	1	95%
	STEM		163		448	382	152	1	86%		451	21	516	464	431		75%
	Math/ops research		710		191	186	59		38%		1,536	28	139	149	31		17%
	Physical science		721		217	137	71		37%		1,054	19	309	165	336		43%
	Chemistry		1,025		54	44	23		11%		1,606	8	126	46	97		14%
	Physics		853		164	85	44		26%		1,550	12	98	59	164		17%
	Engr sci/engr		962		82	81	21		16%		1,543	9	121	138	72		18%
	Nuclear engineering		1,119		3	20	4		2%		1,858		2	13	10		1%
	Biology/medical sci		1,069		45	19	12	1	7%		1,738	10	83	26	26		7%
	"Other" STEM[2]		1,101			37	7	1	4%		1,843	1	1	17	21		2%
	Non-STEM		784	8	99	235	19	1	31%		1,065	163	213	349	92	1	35%
	Psychology		1,034		82	24	6		10%		1,739		52	30	62		8%
	Bus/public admin/mgt		1,021	2	10	111	2		11%		1,468	139	70	203	3		15%
MATH/	Total	824	10	2	326	355	129	2	99%	1,932	72	20	614	732	494		95%
SCIENCE	STEM		92		337	277	117	1	89%		409	13	597	489	424		78%
DUTY	Math/ops research		491		143	144	46		40%		1,603	29	140	129	31		16%
AFSCs	Physical science		508		169	94	53		38%		1,145	9	289	158	331		40%
	Chemistry		725		45	33	21		12%		1,660	4	128	43	97		14%
	Physics		615		123	56	30		25%		1,637	10	83	45	157		15%
	Engr sci/engr		688		55	64	17		17%		1,512	3	170	169	78		22%
	Nuclear engineering		805		2	14	3		2%		1,907		1	13	11		1%
	Biology/medical sci		767		34	13	9	1	7%		1,844	8	42	20	18		4%
	"Other" STEM[2]		792		26	5	1		4%		1,891	1		21	19		2%
	Non-STEM		591	3	73	143	12	2	28%		1,162	205	186	308	71		29%
	Psychology		756		52	13	3		8%		1,810	1	51	29	41		6%
	Bus/public admin/mgt		742	1	6	74	1		10%		1,523	162	65	178	4		13%
	Numbers with specific duty AFSCs and with/without *STEM* academic credentials																
	61A ops research analyst	442	27		170	175	70		94%	901	201	8	333	283	76		77%
	61B behavioral/hum fact sci	93	58		25	8	2		38%	135	75	1	15	22	22		44%
	61C chemist/biologist	107	5		54	32	15	1	95%	280	20		123	47	90		93%
	61D physicist/nuclear engr	181	2		87	62	30		99%	394	15	3	100	73	203		95%
MATH/	Total	1,190	41	6	420	540	181	2	96%	2,686	119	43	884	1,038	601	1	94%
SCIENCE	STEM		173		455	400	161	1	85%		677	30	829	655	495		74%
FUNCTIONAL	Math/ops research		747		192	192	59		37%		2,242	40	191	177	36		15%
AREA	Physical science		748		222	143	77		37%		1,678	21	403	213	371		37%
	Chemistry		1,064		55	46	25		11%		2,362	8	152	55	109		12%
	Physics		888		167	89	46		25%		2,340	12	105	61	168		12%
	Engr sci/engr		983		90	91	26		17%		2,128	11	226	214	107		20%
	Nuclear engineering		1,162		3	21	4		2%		2,660		2	13	11		1%
	Biology/medical sci		1,112		46	19	12	1	7%		2,512	13	93	34	34		6%
	"Other" STEM[2]		1,144			38	7	1	4%		2,640	1	1	23	21		2%
	Non-STEM		810	8	105	245	20	2	31%		1,545	252	309	472	107	1	33%
	Psychology		1,076		83	25	6		10%		2,522	1	61	35	67		6%
	Bus/public admin/mgt		1,056	2	11	119	2		11%		2,105	192	108	276	5		14%

Table B.4—Continued

COMMENTS	AFOCD re 61A: BA/BS in math, statistics, ops research, or related field (such as industrial engr, mgt sci, economics). Min 36 semester hrs of credit in math, statistics, ops research, or industrial engr. AFOCD re 61B: BA/BS in behavioral sci, psychology, sociology, or human factors engineering. AFOCD re 61C: BA/BS in chemistry, biology, or related field. AFOCD re 61D: BA/BS in physics, nuclear engr, or related field AFOCD re 61B, 61C, 61D: min 12 semester hrs in math, statistics, quantitative methods, research analysis/ design/methods, modeling, simulation, systems engr. Share of core officers with non-61X DAFSCs = 31%, the most in 92S student, 63A acquisition manager, 81T instructor, 16X ops support, and 62E developmental engineer. 44 officers (4% of those) in the math/science FA came from other core specialties, the most from 62E developmental engr, 63A acq mgr, 11M mobility pilot, 13S space/missile ops.	OPM standards for four largest core-sci/rsrch occ series: - Ops research (1515): Bachelor's in ops research, or at least 24 sem hrs in ops research, math, probability, statistics, mathematical logic, science, or subject-matter courses requiring substantial competence in college-level math or statistics. Min 3 of the 24 hrs in calculus. - General physical science (1301): degree in physical sci, engr, or math, with 24 semester hrs in physical sci or related engr sci such as mechanics, dynamics, properties of materials, electronics. - Physics (1310): degree in physics or a related degree that included 24 sem hrs of physics. - Chemistry (1320)): degree in physical sci, life sci, or engr w 30 semester hrs in chemistry, plus math through differential and integral calculus, plus 6 hours in physics. - for 1301, 1310, and 1320: or suitable combination of education and experience. Share of core civilians with non-61X duty AFSCs = 37%, the most in 32E civil engineering, 65W cost analysis, and 62E developmental engineer. 803 civilians (30% of those) in the math/sci FA came from other occupational series, the most from computer science (1550), mgt & prog analysis (0343), misc admin & program (0301), general engr (0801), computer engr (0854).

[2] Uses numbers for "Other STEM" academic specialties, substantially quantitative psychology disciplines.

[3] Other, smaller core-math/science civilian occupational series, with 27 or fewer members each: geophysics (1313), microbiology (0403), statistics (1530), health physics (1306), astronomy and space sci (1330), anthropology (0190), mathematical statistics (1529), general math (AFIT faculty only), metallurgy (1321), actuarial science (1510).

Table B.5
Rated Functional Area

OFFICER/CIVILIAN MIX: 99.98%/0.02% CORE OCCUPATIONS
95.42%/4.58% DUTY AFSC
95.55%/4.45% FUNCTIONAL AREA

Counted	Academic discipline	OFFICER	CIVILIAN[1]

POSITIONS — June 2010

313 of 19,154 officer authorizations
= 1.6% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	20,156	19,154	176	71	10	173	71	9	95%	98%	100%	90%
STEM rqd	321	313	71	37	6	69	37	6	98%	97%	100%	100%
Engr sci/engr	54	54	31	22	1	31	22	1	100%	100%	100%	100%
Physical sciences	6	6	2	4		2	4		100%	100%	100%	-
Mathematics	49	47	38	6	5	36	6	5	96%	95%	100%	100%
Non-STEM rqd	142	141	105	33	4	104	33	4	99%	99%	100%	100%
Bus/public admin/mgt	29	28	24	5		23	5		97%	96%	100%	-
Engr/aero sci/techn	2	2	1	1		1	1		100%	100%	100%	-
Military/strategic	18	18	18			18			100%	100%	-	-
Political science	12	12	5	6	1	5	6	1	100%	100%	100%	100%

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE (excluding trainees) — Officers May 2010, Civilians Sep 2010

Highest academic credential

CORE OCCUPATIONS — Officer: Cores 11X, 12X, 13B, & 18X: pilots, CSOs, & ABMs. Civilian: Air safety investigating (1815), aircraft operation (2181), and air navigation (2183)

Counted	Academic discipline	Officer: Total	Officer: None	Officer: < BA/BS	Officer: BA/BS	Officer: MA/MS	Officer: PhD	Officer: Prof deg	Officer: % BA/BS +	Civilian: Total	Civilian: None	Civilian: < BA/BS	Civilian: BA/BS	Civilian: MA/MS	Civilian: PhD	Civilian: Prof deg	Civilian: % BA/BS +
CORE OCCUPATIONS	Total	20,458	239	45	10,173	9,927	58	16	99%	5	1	1	1	2	0	0	60%
	STEM		11,584	19	7,573	1,256	22	4	43%		5						0%
	Engr sci/engr		15,045	9	4,620	768	16		26%		5						0%
	Physical sciences		19,001	5	1,317	130	5		7%		5						0%
	Mathematics		19,345		762	350	1		5%		5						0%
	Non-STEM		4,212	40	6,750	9,407	37	12	79%		1	1	1	2			60%
	Bus/public admin/mgt		13,498	6	2,559	4,378	7		34%		4		1				20%
	Engr/aero sci/techn		16,263	26	1,700	2,469			20%		3			2			40%
	Military/strategic		16,954	2	364	3,134	4		17%		5						0%
	Political science		18,113	6	1,301	1,026	12		11%		5						0%
RATED DUTY AFSCs	Total	17,847	206	41	9,631	7,913	46	10	99%	856	187	30	175	461	3		75%
	STEM		10,122	18	6,696	988	20	3	43%		677	3	75	101			21%
	Engr sci/engr		13,081	8	4,145	599	14		27%		763	2	41	50			11%
	Physical sciences		16,577	5	1,162	97	6		7%		825	1	24	6			4%
	Mathematics		16,873		682	292			5%		817	1	13	25			4%
	Non-STEM		3,911	37	6,401	7,464	27	7	78%		303	35	144	371	3		61%
	Bus/public admin/mgt		11,939	6	2,381	3,514	7		33%		536	14	62	244			36%
	Engr/aero sci/techn		14,264	24	1,604	1,955			20%		778	13	23	42			8%
	Military/strategic		15,407	2	337	2,098	3		14%		833	4	1	18			2%
	Political science		16,062	6	1,147	626	6		10%		803	1	21	31			6%
RATED FUNCTIONAL AREA	Total	20,608	246	45	10,265	9,971	64	17	99%	959	213	42	203	498	3		73%
	STEM		11,686	19	7,613	1,261	25	4	43%		752	7	91	109			21%
	Engr sci/engr		15,165	9	4,645	771	18		26%		857	3	44	55			10%
	Physical sciences		19,141	5	1,325	131	6		7%		916	1	33	9			4%
	Mathematics		19,493		763	351	1		5%		917	1	16	25			4%
	Non-STEM		4,257	40	6,810	9,448	40	13	79%		346	46	161	403	3		59%
	Bus/public admin/mgt		13,616	6	2,579	4,399	8		34%		610	16	69	264			35%
	Engr/aero sci/techn		16,397	26	1,708	2,477			20%		872	14	26	47			8%
	Military/strategic		17,089	2	365	3,148	4		17%		932	5	1	21			2%
	Political science		18,235	6	1,320	1,034	13		11%		901	1	21	36			6%

Table B.5—Continued

COMMENTS	AFOCD: Undergraduate degree is desirable (mandatory for experimental test pilots and combat systems officers) in physical sciences, mathematics, administration, or management. Rated positions with STEM duty AFSCs--viz., 11E, 12E, 13A, 61C, 61D, and 62E--require STEM degrees. AADs: Only 5 AADs were authorized in STEM disciplines beyond those listed above: 2 in computer science, 2 in biology, and 1 in experimental/engineering psychology. Beyond the disciplines listed above, non-STEM AAD authorizations concentrated in other social sciences, education, and humanities. 39 AAD authorizations specified neither STEM nor non-STEM. Share of core-rated officers with non-rated DAFSCs = 13%, the most with 92S student, 16X ops support, 10C ops commander, 90G general officer, 91W wing commander, 91C commander, 63A acq mgr, 81T instructor, 97E exec officer, and 30C support commander. 150 officers (0.7% of those) in the rated FA came from other core specialties, most from 14N intel, 13D control and recovery, 13S space/missile ops, and 62E developmental engineering.	OPM standard for air safety investigating (1815): bachelor's degree with major study in aviation, engr, math, physical science, safety, human factors, other fields related to the position, or suitable combination of education and experience. OPM standards for aircraft operation (2181) and air navigation (2183): no education requirements. Share of series-1815/2181/2183 civilians with non-rated DAFSCs = 20%: one series-2183 had a 32E civil engr DAFSC. 954 civilians (99.5% of those) in the rated FA had other occupational series; most had mgt & prog analysis (0343), miscellaneous admin & program (0301), transportation operations (2150), or transportation specialist (2101).

Table B.6
Contracting Functional Area

OFFICER/CIVILIAN MIX: 14%/86% CORE OCCUPATIONS
12%/88% DUTY AFSC
13%/87% FUNCTIONAL AREA

OFFICER

POSITIONS — June 2010

2 of 775 officer authorizations
= 0.3% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required: AADs MA/MS	Funded vs. required: AADs PhD	Funded vs. required: AADs Unk
Total	842	775	77		1	77		1	92%	100%	-	100%
STEM rqd	2	2	2			2			100%	100%	-	-
Non-STEM rqd	76	76	75		1	75		1	100%	100%	-	100%
Bus/pub admin/mgt rqd	76	76	75		1	75		1	100%	100%	-	100%
Logs/prod/acq rqd[2]	56	56	56			56		1	100%	100%	-	-
Finance/acctg rqd	1	1	1			1			100%	100%		
Law	0	0							-	-	-	-

[2]Logs/prod/acq includes contracting-specific academic specialty codes

CIVILIAN[1]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sept 2010

OFFICER (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
CORE OCCUPATIONS (Core 64P, contracting)	Total	913	29	3	366	508	5	2	96%
	STEM		846		58	9			7%
	Non-STEM		54	3	344	505	5	2	94%
	Bus/pub admin/mgt		186	1	262	460	4		80%
	Logs/prod/acq		736		8	168	1		19%
	Finance/accounting		845		60	8			7%
	Law		899		12			2	2%
CONTRACTING DUTY AFSCs (including 64P and 6C)	Total	784	10	1	325	442	4	2	99%
	STEM		718		55	10	1		8%
	Non-STEM		37	1	304	437	3	2	95%
	Bus/pub admin/mgt		153		230	399	2		80%
	Logs/prod/acq		630		8	145	1		20%
	Finance/accounting		727		51	6			7%
	Law		770		12			2	2%
CONTRACTING FUNCTIONAL AREA	Total	970	29	3	378	548	6	6	97%
	STEM		882		73	14	1		9%
	Non-STEM		63	4	351	541	5	6	93%
	Bus/pub admin/mgt		208	1	267	490	4		78%
	Logs/prod/acq		786		8	175	1		19%
	Finance/accounting		899		63	8			7%
	Law		952		12			6	2%

CIVILIAN (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
CORE OCCUPATIONS (Contracting (1102) and industrial property mgt (1103))	Total	5,653	164	341	2,364	2,640	81	63	91%
	STEM		5,160	81	301	110		1	7%
	Non-STEM		305	370	2,282	2,553	81	62	88%
	Bus/pub admin/mgt		1,026	371	1,874	2,371	8	3	75%
	Logs/prod/acq		4,790	369	88	405		1	9%
	Finance/accounting		5,188	74	323	68			7%
	Law		5,472	13	22	13	71	62	3%
CONTRACTING DUTY AFSCs (including 64P and 6C)	Total	5,747	203	386	2,379	2,634	83	62	90%
	STEM		5,219	91	319	117		1	8%
	Non-STEM		367	412	2,283	2,541	83	61	86%
	Bus/pub admin/mgt		1,125	383	1,868	2,359	9	3	74%
	Logs/prod/acq		4,933	349	84	380		1	8%
	Finance/accounting		5,302	67	311	67			7%
	Law		5,577	12	18	12	70	58	3%
CONTRACTING FUNCTIONAL AREA	Total	6,285	290	486	2,555	2,802	86	66	88%
	STEM		5,659	99	380	145	1	1	8%
	Non-STEM		513	517	2,423	2,682	85	65	84%
	Bus/pub admin/mgt		1,404	427	1,963	2,479	9	3	71%
	Logs/prod/acq		5,422	369	88	405		1	8%
	Finance/accounting		5,820	74	323	68			6%
	Law		6,104	13	22	13	71	62	3%

COMMENTS

Officer:

AFOCD: at least 24 semester credit hours is mandatory in any of accounting, business finance, law, contracting, industrial management, marketing, quantitative mehods, or organization and management.

AADs: authorizations concentrated in business and contracting disciplines that fall into the broad business/public admin and logistics/production/acquisition categories. One STEM AAD authorization called for an interdisciplinary master's in business admin/mgt and ADP/EDP, the other for a master's in any engr discipline.

Share of core-64P officers with other DAFSCs = 17%, mainly instructors, students, ops support (16X), and a dozen acquisition managers (63A).

57 officers in the contracting FA came from other core specialties, most from 63A acq mgt, 21R logistics readiness, and 51J judge advocate.

Civilian:

OPM standard: same credit hours as for officers, or any 4-year bachelor's degree, or equivalent combinations of education and experience.

Share of series-1102 civilians with non-contracting DAFSCs = 2%, the most in acq mgt, info/comm/cyberspace, finance, and engineering.

632 civilians in the contracting FA were in other occupational series, most in general business & industry (1101), quality assurance (1910), mgt & prog analysis (0343), misc admin/prog (0301), IT mgt (2210), and logistics mgt (0346).

Table B.7
Security Functional Area

OFFICER/CIVILIAN MIX: 33%/67% CORE OCCUPATIONS
30%/70% DUTY AFSC
30%/70% FUNCTIONAL AREA

POSITIONS — June 2010

OFFICER

13 of 969 officer authorizations
= 1.3% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	1,067	969	145	1	3	140		3	91%	97%	0%	100%
STEM required	14	13	13	1		13			93%	100%	0%	-
Non-STEM required	124	119	121		3	116		3	96%	96%	-	100%
Criminology/crim justice	112	108	110		2	106		2	96%	96%	-	100%
Bus/public admin/mgt	4	4	4			4			100%	100%	-	-
Area studies	8	7	7		1	6		1	88%	86%	-	100%

CIVILIAN[1]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010, Civilians Sept 2010

CORE OCCUPATIONS

OFFICER: Cores 31P security forces, 71S special investigations

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	1,244	47	6	547	634	5	5	96%
STEM		1,091	1	113	39			12%
Non-STEM		111	6	500	617	5	5	91%
Criminology/crim justice		742	3	302	195	2		40%
Bus/public admin/mgt		932		74	238			25%
Political science		1,023		127	92	2		18%
Psychology		1,154		58	31	1		7%
Sociology		1,181		60	3			5%
Area studies		1,168		7	69			6%

CIVILIAN: Security administration (0080), criminal investigating (1811), correctional institution admin (0006), general investigating (1810)

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	2,494	890	482	708	402	9	3	45%
STEM		2,339	40	75	38	2		5%
Non-STEM		981	472	663	368	7	3	42%
Criminology/crim justice		1,819	288	318	67	2		16%
Bus/public admin/mgt		1,810	164	288	228	4		21%
Political science		2,383	11	48	52			4%
Psychology		2,424	5	53	12			3%
Sociology		2,464	4	24	2			1%
Area studies		2,486		5	3			0.3%

SECURITY DUTY AFSCs (31P, enl 3P, 71S, enl 7S)

OFFICER

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	1,043	27	6	490	513	2	5	97%
STEM		908	1	101	33			13%
Non-STEM		84	6	447	499	2	5	91%
Criminology/crim justice		606	3	267	166	1		42%
Bus/public admin/mgt		786		63	194			25%
Political science		864		106	73			17%
Psychology		970		51	21	1		7%
Sociology		991		50	2			5%
Area studies		977		5	61			6%

CIVILIAN

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	2,452	854	474	697	415	10	2	46%
STEM		2,305	32	73	40	2		5%
Non-STEM		944	464	654	380	8	2	43%
Criminology/crim justice		1,800	286	299	65	2		15%
Bus/public admin/mgt		1,753	167	288	240	4		22%
Political science		2,343	10	47	52			4%
Psychology		2,386	5	53	8			2%
Sociology		2,423	3	24	2			1%
Area studies		2,445		4	3			0.3%

SECURITY FUNCTIONAL AREA

OFFICER

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	1,320	47	7	586	666	5	9	96%
STEM		1,157	1	122	40			12%
Non-STEM		118	7	533	648	5	9	91%
Criminology/crim justice		808	4	309	197	2		38%
Bus/public admin/mgt		987		81	252			25%
Political science		1,087		133	98	2		18%
Psychology		1,226		62	31	1		7%
Sociology		1,257		60	3			5%
Area studies		1,243		7	70			6%

CIVILIAN

Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	3,018	1,069	564	840	527	15	3	46%
STEM		2,793	51	109	63	2		6%
Non-STEM		1,203	549	777	473	13	3	42%
Criminology/crim justice		2,283	318	341	74	2		14%
Bus/public admin/mgt		2,184	198	343	289	4		21%
Political science		2,884	11	57	66			4%
Psychology		2,937	6	61	12	2		2%
Sociology		2,985	4	27	2			1%
Area studies		3,009		5	4			0.3%

COMMENTS

OFFICER

AFOCD re 31P: academic specialization in sociology, criminology, polic admin, criminal justice, or a related area is desirable.
AFOCD re 71S: academic specialization is desirable in criminology, police/public/business admin, administration of justice, accounting, business or criminal law, comparative govt, area studies, general mgt, political theory, or behavioral or social psychology.
AADs: 10 of the 13 authorizations for STEM AADs, all in 71S special investigations, called for the inter-disciplinary forensic science/pathology discipline.
Share of core-security officers with other DAFSCs = 17%, the most with 92S student, 81T instructor, 30C support commander, and 16X ops support.
76 officers (6% of those) in the security FA came from other core specialties, the most from 14N intelligence, 38F force support, 17D cyberspace ops, and 51J judge advocate.

CIVILIAN

OPM standards:
- Security admin (0080), general investigating (1810), and criminal investigating (1811): bachelor's degree, any field.
- Correctional institution admin (0006): major study in correctional admin, criminology, psychology, social work, sociology, or other fields related to the position, or suitable experience.

Share of core-security civilians with other DAFSCs = 10%, the most with 14N (& enl 1N) intelligence, 17D/33S/3x comm/info/cyberspace, and 16X operations support.
524 civilians (17% of those) in the security FA came from other occupational series, the most from training instruction (1712), misc admin & program (0301), intelligence (0132), IT mgt (2210), mgt and prog analysis (0343), and budget analysis (0560).

Table B.8
Financial Management Functional Area

OFFICER/CIVILIAN MIX: 11%/89% CORE OCCUPATIONS
10%/90% DUTY AFSC
12%/88% FUNCTIONAL AREA

Counted | Academic discipline | OFFICER | CIVILIAN[1]

POSITIONS — June 2010

14 of 602 officer authorizations
= 2.3% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	720	602	114	3	11	107	3	11	84%	94%	100%	100%
STEM required	14	14	7	1	6	7	1	6	100%	100%	100%	100%
Non-STEM required	99	92	92	2	5	85	2	5	93%	92%	100%	100%
Bus/public admin/mgt	97	90	92	1	4	85	1	4	93%	92%	100%	100%
Finance/accounting	54	48	49	1	4	43	1	4	89%	88%	100%	100%
Economics	2	2		1	1		1	1	100%	-	100%	100%

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sept 2010

OFFICER (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
CORE OCCUPATIONS (65A auditing, 65F financial management, 65W cost analysis)	Total	808	29	3	274	490	12		96%
	STEM		744	0	52	11	1		8%
	Non-STEM		58	3	251	485	11		92%
	Bus/public admin/mgt		151	1	190	464	2		81%
	Finance/accounting		499		205	103	1		38%
	Economics		729		61	10	8		10%
FINANCIAL MANAGEMENT DUTY AFSCs (65A, 65F, 65W, enl 6C financial)	Total	690	11	3	249	418	9		98%
	STEM		629		52	8	1		9%
	Non-STEM		39	3	225	415	8		94%
	Bus/public admin/mgt		120	3	167	398	2		82%
	Finance/accounting		423		173	93	1		39%
	Economics		624		55	6	5		10%
FINANCIAL MANAGEMENT FUNCTIONAL AREA	Total	1,052	31	5	338	664	14		97%
	STEM		865		133	51	3		18%
	Non-STEM		105	5	295	636	11		90%
	Bus/public admin/mgt		246	3	217	584	2		76%
	Finance/accounting		728		211	112	1		31%
	Economics		971		62	11	8		8%

CIVILIAN (Highest academic credential)

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
CORE OCCUPATIONS (Fin admin & prog (0501), fin mgt (0505),accounting (0510) auditing (0511), tax specialist (0526), budget analysis (0560))	Total	6,318	1,205	1,185	2,146	1,765	14	3	62%
	STEM		5,854	112	236	113	3		6%
	Non-STEM		1,389	1,174	2,072	1,669	11	3	59%
	Bus/public admin/mgt		2,160	743	1,841	1,571	3		54%
	Finance/accounting		4,216	570	1,299	233			24%
	Economics		6,220	13	69	16			1%
FINANCIAL MANAGEMENT DUTY AFSCs	Total	6,453	1,209	1,167	2,200	1,850	21	6	63%
	STEM		5,891	115	288	154	5		7%
	Non-STEM		1,458	1,165	2,089	1,719	16	6	59%
	Bus/public admin/mgt		2,302	722	1,825	1,601	3		53%
	Finance/accounting		4,424	535	1,265	229			23%
	Economics		6,342	14	79	18			2%
FINANCIAL MANAGEMENT FUNCTIONAL AREA	Total	8,067	1,508	1,464	2,721	2,337	30	7	63%
	STEM		6,973	209	550	323	12		11%
	Non-STEM		2,094	1,439	2,454	2,055	18	7	56%
	Bus/public admin/mgt		3,256	856	2,095	1,857	3		49%
	Finance/accounting		5,878	592	1,348	249			20%
	Economics		7,941	19	86	21			1%

COMMENTS

Officer:

AFOCD re 65A: academic specialization (at least 24 semester credit hours) in accounting is mandatory.
AFOCD re 65F: academic specialization in business administration is desirable. At least 12 semester credit hours in economics, accounting, and statistics subjects (at least 6 in accounting) is mandatory.
AFOCD re 65W: academic specialization in a business-related or quantitative-oriented discipline is mandatory, or at least 18 semester hours in any combination of business admin, economics, accounting, engr, math, statistics, mgt sci, ops research, or computer science.
AADs: 13 of 14 STEM AAD authorizations were for business statistics and quantitative methods, an exception to our categorization of business academic specialties as non-STEM.
Share of core-FM officers with other DAFSCs = 17%, the most with 92S student, 81T instructor, 16X ops support, 97E executive officer, and 40C support cmdr.
244 officers (23% of those) in the FM FA came from other core specialties, the most from 17D cyber-space ops, and 63A acquisition management.

Civilian:

OPM standards:
- Fin admin & program (0501), fin mgt (0505), and budget analysis (0560): bachelor's degree in any field. Some fin mgt (0505) positions need series 0510's education.
- Accounting (0510) and auditing (0511): degree in accounting or related field such as business amin, finance, or public admin [including] 24 semester credit hours in accounting; the 24 hrs may include up to 6 hrs in business law. Or a suitable combination of education
- Tax specialist (0526): bachelor's degree (any field) plus major graduate study in accounting, auditing, taxation, business admin, law, or other related fields. Or suitable experience, CPA certificate, or bar membership.

Share of core-FM civilians with other DAFSCs = 7%, the most with 38F force support, enl 4x medical/health, enl 3x info/comm/cyberspace, enl 2x supply/transporta-tion/logistics plans, 17D cyberspace ops, 41A health services administration.
1,749 civilians (22% of those) in the FM FA came from other occupational series, the most from IT mgt (2210), mgt and program analysis (0343), misc admin and program (0301), ops research (1515), and computer engineering.

Table B.9
Intelligence Functional Area

OFFICER/CIVILIAN MIX: 70%/30% CORE OCCUPATIONS
63%/37% DUTY AFSC
55%/45% FUNCTIONAL AREA

Counted | Academic discipline | OFFICER | CIVILIAN[1]

POSITIONS — June 2010

19 of 2745 officer authorizations = 0.7% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	3,009	2,745	84	3	4	81	3	3	91%	96%	100%	75%
STEM rqd	19	19	16		3	16		3	100%	100%	-	100%
Engr sci/engr	9	9	7		2	7		2	100%	100%	-	100%
Non-STEM rqd	72	68	67	3	1	64	3	1	94%	96%	100%	100%
Area studies	41	39	41			39			95%	95%	-	-
Military/strategic	12	11	10	1	1	10	1	0	92%	100%	100%	0%
Political science	7	7	6	1		6	1		100%	100%	100%	-

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010, Civilians Sep 2010

Officer: Core 14N, intelligence. Civilian: Intelligence (0132), foreign language (1040), photographic technology (1386)

Counted	Academic discipline	Officer Total	Officer None	Officer < BA/BS	Officer BA/BS	Officer MA/MS	Officer PhD	Officer Prof deg	Officer % BA/BS +	Civilian Total	Civilian None	Civilian < BA/BS	Civilian BA/BS	Civilian MA/MS	Civilian PhD	Civilian Prof deg	Civilian % BA/BS +
CORE OCCUPATIONS	Total	3,063	137	27	1,470	1,398	27	4	95%	1,290	339	124	459	358	8	2	64%
	STEM		2,613	1	383	63	3		15%		1,102	19	103	64	1	1	13%
	Engr sci/engr		2,918		123	21	1		5%		1,232	3	32	23			4%
	Non-STEM		337	26	1,302	1,370	24	4	88%		443	125	407	307	7	1	56%
	Area studies		2,815		45	203			8%		1,259	1	23	6	1		2%
	Military/strategic		2,354	1	96	611	1		23%		1,230	14	2	43		1	4%
	Political science		1,996		743	314	9	1	35%		1,051	8	124	106	1		18%
INTELLIGENCE DUTY AFSCs (including 14N and 1N)	Total	2,733	76	20	1,453	1,165	17	2	96%	1,588	414	149	552	459	10	4	65%
	STEM		2,321	1	354	55	2		15%		1,324	23	144	93	3	1	15%
	Engr sci/engr		2,595		117	21			5%		1,543	1	26	18			3%
	Non-STEM		285	20	1,277	1,134	15	2	89%		568	152	475	383	7	3	55%
	Area studies		2,543		35	155			7%		1,561	1	19	6	1		2%
	Military/strategic		2,152	1	93	486	1		21%		1,526	16	2	43		1	3%
	Political science		1,800		680	248	4	1	34%		1,347	10	117	113	1		15%
INTELLIGENCE FUNCTIONAL AREA	Total	4,429	156	31	2,006	2,184	40	12	96%	3,564	748	328	1,410	1,036	36	6	70%
	STEM		3,302	3	859	249	16		25%		2,474	65	662	343	19	1	29%
	Engr sci/engr		3,903	1	395	123	7		12%		2,927	13	434	182	8		18%
	Non-STEM		723	30	1,605	2,035	24	12	83%		1,560	329	924	729	17	5	47%
	Area studies		4,112		51	266			7%		3,526	1	27	9	1		1%
	Military/strategic		3,515	1	110	802	1		21%		3,465	23	4	71		1	2%
	Political science		3,199		829	391	9	1	28%		3,222	14	164	162	2		9%

Table B.9—Continued

COMMENTS	AFOCD: Undergraduate specialization is desirable in physical, earth, computer, social, or information sciences; engineering; math; or foreign area studies. AADs: STEM authorizations beyond engineering disciplines included geodesy, ops research/math, and one each in physics and computer science. Non-STEM AAD authorizations concentrated in area studies, military/strategic studies, and political science. Share of core-14N officers with other DAFSCs = 35%, the most in 92S student, 81T instructor, 16X ops support, and 10C operations commander. 1,366 officers (31% of those) in the intelligence enterprise came from other core specialties, most from 71S special investigations, 17D cyberspace ops, 62E developmental engineer, 63A acquisition manager, 13S space/missile operations, and 11F fighter pilot.	OPM standard for intelligence (0132): bachelor's in any field, or a suitable combination of education and experience. OPM standard for language specialist (1040): major study in the appropriate foreign language from an English-speaking college/university, English from a college/univ in the other country, or suitable experience. OPM standard for photographic technology (1386): degree in scientific or engr field with 6 semester hrs in college-level math and 24 semester hrs in photographic technology, photographic science, photogrammetry, engineering, physics, or chemistry. Share of series-0132/1040/1386 civilians with DAFSCs other than 14N or 1N = 14%, the most in 62E developmental engineering and 16X operations support. 2,274 civilians (64% of those) in the intelligence FA came from other occupational series, most from engineering (08xx), criminal investigating (1811), security admin (0080), IT mgt (2210), misc admin and program (0301), and mgt and program analysis (0343).

Table B.10
Space/Missile Functional Area

OFFICER/CIVILIAN MIX: 100%/0% CORE OCCUPATIONS
91%/9% DUTY AFSC
90%/10% FUNCTIONAL AREA

POSITIONS — June 2010 — OFFICER

21 of 2799 officer authorizations
= 0.8% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	3,022	2,799	43	2	3	42	2	3	93%	98%	100%	100%
STEM required	21	21	17	1	3	17	1	3	100%	100%	100%	100%
Engr sci/engr	10	10	7	1	2	7	1	2	100%	100%	100%	100%
Physical sciences	2	2	2			2			100%	100%	-	-
Biol & medical sciences									-	-	-	-
Mathematics	8	8	7		1	7		1	100%	100%	-	100%
Non-STEM required	24	23	23	1		22	1		96%	96%	100%	-
Bus/public admin/mgt	5	5	5			5			100%	100%	-	-

CIVILIAN[1,2]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010, Civilians Sept 2010

OFFICER — Highest academic credential

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
CORE OCCUPATION (Core 13S, space/missile ops)	Total	3,572	148	16	1,398	1,982	24	4	95%
	STEM		2,611	3	779	174	5		27%
	Engr sci/engr		3,204		263	101	4		10%
	Physical sciences		3,385	1	158	27	1		5%
	Biol & medical sciences		3,367	1	197	7			6%
	Mathematics		3,421		117	34			4%
	Non-STEM		503	13	1,125	1,908	19	4	86%
	Bus/public admin/mgt		2,195	3	283	1,086	5		38%
SPACE/ MISSILE OPS DUTY AFSC (13S and 1C6)	Total	3,021	108	13	1,384	1,502	12	2	96%
	STEM		2,181	2	692	141	5		28%
	Engr sci/engr		2,689		249	80	3		11%
	Physical sciences		2,855	1	140	22	3		5%
	Biol & medical sciences		2,841	1	174	5			6%
	Mathematics		2,903		88	30			4%
	Non-STEM		478	11	1,094	1,429	7	2	84%
	Bus/public admin/mgt		1,928	2	287	803	1		36%
SPACE/ MISSILE OPS FUNCTIONAL AREA	Total	3,942	154	16	1,586	2,152	30	4	96%
	STEM		2,737	4	941	250	10		30%
	Engr sci/engr		3,363	1	406	164	8		15%
	Physical sciences		3,708	1	194	36	3		6%
	Biol & medical sciences		3,734	1	200	7			5%
	Mathematics		3,779		124	39			4%
	Non-STEM		670	13	1,201	2,034	20	4	83%
	Bus/public admin/mgt		2,428	3	331	1,175	5		38%

CIVILIAN — Highest academic credential

[2]The space/missile ops functional area has no "core" civilian occupational series.

Counted	Academic discipline	Total	None	< BA/ BS	BA/ BS	MA/ MS	PhD	Prof deg	% BA/ BS +
SPACE/ MISSILE OPS DUTY AFSC (13S and 1C6)	Total	266	106	28	53	77	1	1	50%
	STEM		215	7	17	26		1	17%
	Engr sci/engr		247	5	5	9			5%
	Physical sciences		253	2	7	4			4%
	Biol & medical sciences		265		1				0%
	Mathematics		255		4	7			4%
	Non-STEM		146	22	42	55	1		37%
	Bus/public admin/mgt		200	9	25	31	1		21%
SPACE/ MISSILE OPS FUNCTIONAL AREA	Total	389	134	39	89	123	3	1	56%
	STEM		288	10	50	38	2	1	23%
	Engr sci/engr		336	6	28	18	1		12%
	Physical sciences		349	4	25	9	2		9%
	Biol & medical sciences		387		2				1%
	Mathematics		368	2	12	7			5%
	Non-STEM		208	34	56	90	1		38%
	Bus/public admin/mgt		280	17	33	58	1		24%

COMMENTS

OFFICER:

AFOCD: undergrad specialization in … engineering, physical science, life science, or math is mandatory.
AADs: Only one position was authorized a STEM AAD beyond the STEM disciplinary groups listed above: in computer science. But 18 positions were authorized ADDs in other non-STEM disciplines: 14 in space ops, one in space systems mgt, one in history, and two in political science.
Share of core-13S officers with other DAFSCs = 21%, mainly 92S student, 81T instructor, 16X ops support, 63A acquisition manager, 91C commander, 10C operations commander, and 62E developmental engineer.
370 officers (9% of those) in the space/missile ops FA came from other core specialties, mainly 62E developmental engineer and 63A acquisition manager.

CIVILIAN:

The 389 civilians in the space/missile ops FA came from 28 different occupational series, the most from miscellaneous admin and program (0301), mgt and program analysis (0343), engineering (08xx), and information technology management (2210).

Table B.11
Acquisition Management Functional Area

OFFICER/CIVILIAN MIX: 98%/2% CORE OCCUPATIONS
44%/56% DUTY AFSC
34%/66% FUNCTIONAL AREA

POSITIONS (June 2010) — OFFICER

76 of 2,593 officer authorizations
= 2.9% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	2,726	2,593	106	31		95	30		95%	90%	97%	-
STEM rqd	87	76	62	22	1	54	21	1	87%	87%	95%	100%
Engr sci/engr	61	54	49	11	1	42	11	1	89%	86%	100%	100%
Physical sci	15	14	6	9		6	8		93%	100%	89%	-
Non-STEM rqd	47	45	41	5	1	39	5	1	96%	95%	100%	100%
Bus/public admin/mgt	39	37	35	4		33	4		95%	94%	100%	-

CIVILIAN[1]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — OFFICER (Officers May 2010)

Core 63A, acquisition manager

Counted	Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
CORE OCCUPATIONS	Total	2,366	64	6	823	1,431	35	7	97%
	STEM		1,412		644	293	17		40%
	Engr sci/engr		1,716		422	216	12		27%
	Physical sciences		2,159		174	27	6		9%
	Non-STEM		404	7	621	1,309	18	7	83%
	Bus/public admin/mgt		831	2	463	1,059	11		65%
ACQ MGT DUTY AFSCs (including 63A and 60C)	Total	2,222	26	3	640	1,476	72	5	99%
	STEM		1,137		608	418	59		49%
	Engr sci/engr		1,424		414	341	43		36%
	Physical sciences		2,008		152	41	21		10%
	Non-STEM		447	6	478	1,273	13	5	80%
	Bus/public admin/mgt		888	2	351	971	10		60%
ACQ MGT FUNCTIONAL AREA	Total	3,042	65	6	981	1,894	88	8	98%
	STEM		1,570		868	538	66		48%
	Engr sci/engr		1,937		624	433	48		36%
	Physical sciences		2,749		211	59	23		10%
	Non-STEM		686	9	673	1,644	22	8	77%
	Bus/public admin/mgt		1,284	2	490	1,253	13		58%

PEOPLE — CIVILIAN (Civilians Sep 2010)

Program management (0340), industrial specialist (1150), and clothing design (0062)

Counted	Academic discipline	Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
CORE OCCUPATIONS	Total	46	6	2	19	18	1	0	83%
	STEM		34	0	6	5	1		26%
	Engr sci/engr		41		5				11%
	Physical sciences		41		3	1	1		11%
	Non-STEM		14	2	17	13	0	0	65%
	Bus/public admin/mgt		33	2	5	6	0	0	24%
ACQ MGT DUTY AFSCs (including 63A and 60C)	Total	2,827	385	289	739	1,368	33	13	76%
	STEM		2,007	61	409	335	15		27%
	Engr sci/engr		2,434	24	210	152	7		13%
	Physical sciences		2,567	25	170	57	8		8%
	Non-STEM		741	341	615	1,099	18	13	62%
	Bus/public admin/mgt		1,270	207	426	920	4		48%
ACQ MGT FUNCTIONAL AREA	Total	5,799	954	1,031	1,738	2,020	40	16	66%
	STEM		4,195	179	928	478	19		25%
	Engr sci/engr		4,833	65	636	254	11		16%
	Physical sciences		5,090	57	515	126	11		11%
	Non-STEM		1,795	1,081	1,266	1,620	21	16	50%
	Bus/public admin/mgt		3,154	437	832	1,370	5	1	38%

COMMENTS

Officer:

AFOCD: Undergrad specilization in engr, engr sci, engr mgt, math, analytical sci, physicial sci, business, or mgt; or at least 24 semester credit hours among accounting, business finance, law, contracts, purchasing, economics, industrial mgt, marketing, quantitative methods, and org & mgt is mandatory.

AADs: authorizations concentrated in specific engineering and physical science disciplines, plus ops research/math and one each in experimental psychology and microbiology.

Share of core-63A officers with other DAFSCs = 27%, the most in 13S space/missile ops, 81T instructor, 92S student, 21A aircraft maintenance, 60C program director, and 62E developmental engineer.

676 officers (22% of those) in the acquisition enterprise came from other core specialties, most from 62E developmental engineer, 13S space/missile ops, 11M mobility pilot, 61D physicist/nuclear engr, 21R logistics readiness, 12M mobility combat systems officer, 61A ops research analyst, 64P contracting.

Civilian:

OPM standard for clothing design (0062): major study in textile technology, tailoring, clothing design, clothing production, anthropometry, anatomy, or physiology, or suitable experience.

OPM standard for industrial specialist (1150): major study in business admin, industrial mgt, engineering, applied sciences, or other related fields.

OPM standard for program management (0340): bachelor's in any field, or a suitable combination of education and experience.

Share of series-0062/0340/1150 civilians with DAFSCs other than 63A or 60C = 70%, somewhat more in comm/info/cyber, intelligence, and civil engineering.

5,753 civilians (99% of those) in the acquisition FA came from other occupational series, most from general business and industry (1101), logistics mgt (0346), engineering (08xx), equipment services (1670), misc admin and program (0301), inventory mgt (2010), mgt and prog analysis (0343), quality assurance (1910), contracting (1102), and IT mgt (1910).

Table B.12
Logistics Functional Area

OFFICER/CIVILIAN MIX: 39%/61% CORE OCCUPATIONS
21%/79% DUTY AFSC
20%/80% FUNCTIONAL AREA

OFFICER

POSITIONS — June 2010

13 of 3078 officer authorizations
= 0.4% authorized STEM degrees

Academic discipline	Total Rqd	Total Funded	AADs required MA/MS	AADs required PhD	AADs required Unk	AADs funded MA/MS	AADs funded PhD	AADs funded Unk	Funded vs. required Total	Funded vs. required AADs MA/MS	Funded vs. required AADs PhD	Funded vs. required AADs Unk
Total	3,473	3,078	126	14	1	113	14	1	89%	90%	100%	100%
STEM required	13	13	11	1	1	11	1	1	100%	100%	100%	100%
Comp sci/engr, info sys	2	2	2			2			100%	100%	-	-
Engr sci/engr	7	7	6		1	6		1	100%	100%	-	100%
Non-STEM required	129	116	115	14		102	14		90%	89%	100%	-
Bus/public admin/mgt	124	111	111	13		98	13		90%	88%	100%	-
Logs/prod/acq mgt	121	108	109	12		96	12		89%	88%	100%	-

CIVILIAN[1]

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sept 2010

CORE OCCUPATIONS — Officer: Cores 21A aircraft maintenance, 21M munitions and missile maintenance, and 21R logistics readiness. Civilian: Logistics management (0346), supply (20xx), transportation specialist (2101), and traffic management (2130)

Counted	Academic discipline	Officer Total	Officer None	Officer < BA/BS	Officer BA/BS	Officer MA/MS	Officer PhD	Officer Prof deg	Officer % BA/BS +	Civilian Total	Civilian None	Civilian < BA/BS	Civilian BA/BS	Civilian MA/MS	Civilian PhD	Civilian Prof deg	Civilian % BA/BS +
CORE OCCUPATIONS	Total	3,883	110	23	1,576	2,146	27	1	97%	6,098	1,439	1,381	1,788	1,473	13	4	54%
	STEM		3,230	2	572	78	1		17%		5,417	175	372	131	1	2	8%
	Comp sci/engr, info sys		3,838	1	37	7			1%		4,991	301	604	183	9	10	13%
	Engr sci/engr		3,651	1	195	36			6%		5,877	50	122	49			3%
	Non-STEM		314	24	1,406	2,112	26	1	91%		1,720	1,365	1,640	1,359	12	2	49%
	Bus/public admin/mgt		2,161	7	357	1,343	15		44%		3,265	637	1,051	1,143	2	0	36%
	Logs/prod/acq mgt		3,487	1	21	367	7		10%		4,732	334	126	223	0	683	17%
LOGISTICS DUTY AFSCs (20C, 21A, 21M, 21R, enlisted 2X)	Total	3,429	67	9	1,483	1,850	20		98%	13,070	3,431	3,986	3,296	2,322	27	8	43%
	STEM		2,821	1	532	73	2		18%		11,551	518	756	238	5	2	8%
	Comp sci/engr, info sys		3,390		31	8			1%		12,542	224	228	73	1	2	2%
	Engr sci/engr		3,203	1	191	34			7%		12,484	180	308	96	2		3%
	Non-STEM		281	11	1,303	1,816	18		91%		4,100	3,889	2,942	2,111	22	6	39%
	Bus/public admin/mgt		1,936	3	335	1,163	11		44%		8,223	1,281	1,816	1,746	3	1	27%
	Logs/prod/acq mgt		3,093	1	20	310	5		10%		12,134	467	156	313			4%
LOGISTICS SUPPORT FUNCTIONAL AREA	Total	4,362	115	25	1,780	2,404	35	3	97%	17,662	4,104	4,587	5,463	3,438	58	12	51%
	STEM		3,492	2	727	134	7		20%		13,786	625	2,529	692	27	3	18%
	Comp sci/engr, info sys		4,289	1	59	13			2%		16,590	294	597	176	2	3	4%
	Engr sci/engr		4,007	1	283	70	1		8%		15,276	218	1,732	422	14		12%
	Non-STEM		425	26	1,538	2,342	28	3	90%		6,626	4,549	3,638	2,809	31	9	37%
	Bus/public admin/mgt		2,443	8	416	1,499	15		44%		11,649	1,520	2,186	2,300	6	1	25%
	Logs/prod/acq mgt		3,966	1	21	367	7		9%		16,523	589	170	380			3%

Table B.12—Continued

COMMENTS	AFOCD re 21A acft maint: degree in mgt, engr, or physical sciences is desirable. AFOCD re 21M mun & missile maint: degree in mgt, bus admin, economics, math, science, engr, computer sci, logistics mgt, or space ops is desirable. AFOCD re 21R logistics readiness: academic specialization in logistics management, economics, bus admin, computer sci, info mgt systems, finance, accounting, petroleum engr, chemical engr, or industrial mgt is desirable. AFOCD re 20C logistics commander: academic specilization in logistics mgt, engineering, or business is desirable. AADs: most were in business/mgt specializations, especially logistics mgt, transport mgt, supply mgt, acq logistics mgt, and air mobility mgt. Share of core-logistics officers with other DAFSCs = 15%, the most with 81T instructor, 92S student, 16X ops support, 30C support commander, 97E executive officer, 63A acq mgr, and 83R, recruiting service. 498 officers (11% of those) in the logistics FA came from other core specialties, the most from 63A acq mgr, 62E dev engr, 38F force support, 13S space/missile ops, 17D cyberspace ops, 11M mobility pilot, and 64P contracting.	OPM standard for logistics mgt (0346) and supply (20xx): a 4-year course of study leading to a bachelor's degree. OPM standard for transportation specialist (2101) and traffic mgt (2130): major study in accounting, business admin, business or commercial law, commerce, economics, engineering, finance, industrial mgt, statistics, traffic mgt, transportation, motor mechanics, or other field related to the position, or suitable education and experience. Share of core-logistics civilians with other DAFSCs = 9%, the most with 16X ops support, 63A acquisition mgr, 3x (enl) info/comm/cyberspace, 11M mobility mgr, 1C (enl) C2 systems ops, and 17D cyberspace ops. 11,564 civilians (65% of those) in the logistics FA came from other occupational series, the most from miscellaneous admin & program (0301); engineering (08xx); eqpmt & services (1670); mgt & prog analysis (0343); general business & industry (1101); quality assurance (1910); training instruction (1712); eqpmt, facilities, & services (1601); IT mgt (2210); computer science (1550), budget analysis (0560); fin admin & prog (0501); and transportation ops (2150).

Table B.13
Force Support Functional Area

OFFICER/CIVILIAN MIX: 19%/81% CORE OCCUPATIONS
28%/72% DUTY AFSC
33%/67% FUNCTIONAL AREA

Counted | Academic discipline | | CIVILIAN[1]

POSITIONS — June 2010

= 7 of 1,371 38F officer authorizations
= 0.5% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	1,878	1,371	32	3	7	27	2	7	73%	84%	67%	100%
STEM required	11	7	10		1	6		1	64%	60%	-	100%
Math (includes O.R.)	4	2	4			2			50%	50%	-	-
Industrial engineering	5	4	5			4			80%	80%	-	-
Non-STEM required	30	28	21	3	6	20	2	6	93%	95%	67%	100%
Bus/public admin/mgt	21	20	16		5	15		5	95%	94%	-	100%
Education	1	1		1			1		100%	-	100%	-
Social science	2	1		1	1			1	50%	-	0%	100%

[1]Civilian authorizations not tallied because they're widely regarded as unreliable

PEOPLE — Officers May 2010; Civilians Sept 2010

CORE OCCUPATIONS

Officers: Core 38F force support only (2000)

Civilians: Human resources mgt (02xx), education (17xx), social sci (0101), recreation spclst (0188), sports spclst (0030), ...[2]

Academic discipline	Officers: Total	Officers highest academic credential: None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +	Civilians: Total	Civilians highest academic credential: None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	2,000	51	6	717	1,208	12	6	97%	8,531	1,472	1,526	2,652	2,513	358	10	65%
STEM		1,782		193	23	2		11%		7,821	189	288	153	80		6%
Math (includes ops research)		1,973	1	15	10	1		1%		8,386	24	72	40	9		1%
Industrial engineering		1,988		11	1			0.6%		8,525	1		2	3		0.1%
Non-STEM		140	8	637	1,199	10	6	93%		1,815	1,489	2,555	2,384	278	10	61%
Bus/public admin/mgt		982	5	161	850	2		51%		5,868	536	1,093	1,004	29	1	25%
Education		1,752		144	101	3		12%		6,363	404	880	803	76	5	21%
Social science		819	4	557	614	3	3	59%		6,032	326	960	1,076	131	6	25%

FORCE SUPPORT DUTY AFSCs (38F, 11K, 81T, 80C, 82A, 83R, 81C & enlisted force support/educ/trng)

Academic discipline	Officers: Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +	Civilians: Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	4,156	35	7	1,773	2,253	78	10	99%	10,576	2,188	1,870	3,162	3,008	329	19	62%
STEM		2,977	1	978	184	15	1	28%		9,665	211	410	222	67	1	7%
Math (includes ops research)		4,032	1	89	32	2		3%		10,383	29	95	63	5	1	2%
Industrial engineering		4,128		18	9	1		0.7%		10,535	2	32	4	3		0.4%
Non-STEM		582	11	1,339	2,152	63	9	86%		2,638	1,837	3,001	2,820	262	18	58%
Bus/public admin/mgt		2,363	3	484	1,293	12	1	43%		6,688	839	1,573	1,442	30	4	29%
Education		3,817	1	176	154	8		8%		8,564	317	799	823	68	5	16%
Social science		2,363	4	952	796	35	6	43%		7,557	470	1,133	1,280	123	13	24%

FORCE SUPPORT FUNCTIONAL AREA

Academic discipline	Officers: Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +	Civilians: Total	None	< BA/BS	BA/BS	MA/MS	PhD	Prof deg	% BA/BS +
Total	7,184	80	15	2,800	4,000	242	47	99%	14,632	2,793	2,568	4,752	4,078	419	22	63%
STEM		4,779	2	1,750	507	137	1	33%		12,807	334	966	425	99	1	10%
Math (includes ops research)		6,839	1	203	114	27		5%		14,308	49	158	104	12	1	2%
Industrial engineering		7,128		33	18	5		0.8%		14,573	3	42	10	4		0.4%
Non-STEM		1,202	18	2,113	3,699	105	47	83%		3,883	2,504	4,202	3,702	320	21	56%
Bus/public admin/mgt		4,200	6	780	2,167	30	1	41%		9,476	1,012	2,158	1,944	37	5	28%
Education		6,682	4	251	233	14		7%		12,059	500	1,050	938	80	5	14%
Social science		4,297	6	1,541	1,246	53	33	40%		10,853	548	1,485	1,574	156	16	22%

Table B.13—Continued

COMMENTS	AFOCD re 38F: academic specialization is desirable in human resource mgt, business admin, sociology, psychology, public admin, industrial engr, industrial engr technology, mgt engr, systems mgt, computer sci, management, org development, behavioral sci, operations research, education, hospitality, restaurant and hotel mgt, recreation, fitness, finance, or accounting. AADs: More than half of the non-STEM AAD auths were for food service and institutional mgt. Share of core-38F officers with other DAFSCs = 17%, the most with 16X ops support, 92S student, 30C support commander, 97E executive officer, 91C commander, and 17D cyberspace ops. 5,184 officers (72% of those) in force support/educ/ training come from specialties other than 38F, at least 200 each from 11M mobility pilot, 11F fighter pilot, 13S space/missile ops, 11K trainer pilot, 17D cyberspace ops, and 62E developmental engr.	OPM standards for five largest civilian "core" occ series: - HR mgt (0201): bachelor's degree - General educ and training (1701) & training instruction (1712): degree [with] major study in education or ... field appropriate to the position, or a suitable combination of education and experience - Instructional systems (1750): degree [with] at least 24 semester hours of appropriate credit in four of (1) learning theory, psychology of learning, educational psychology, (2) instructional design practices, (3) education evaluation, (4) instructional product development, and (5) computers in education and training. - Social science (0101): degree in behavioral or social science or combination of education and experience Share of core-force-support civilians with other DAFSCs = = 19%, the most with 3x (enl) info/comm/cyberspace, 2A (enl) manned aerospace maintenance,17D cyberspace ops, 2A (enl) manned aerospace maintenance, 3P (enl) security forces, 3E (enl) civil engr, 1C (enl) C2 systems ops, 4x (enl) medical/health, 2x (enl) supply/ transportation/logs plans, 2x (enl) maint/maint mgt, 6F (enl) financial, and 61A ops research analyst. 6,101 civilians (37% of those) in the force support/educ/ training FA came from other occupational series, the most from mgt & prog analysis (0343), misc admin & prog (0301), IT mgt (2210), general business & industry (1101), financial admin & prog (0501), budget analysis (0560), and logistics mgt (0346).

[2] Additional, smaller force-support "core" civilian occupational series: funeral directing (0050), sociology (0184), military personnel mgt (0205), equal employment opportunity (0260), theater specialist (1054), art specialist (1056), librarian (1410), laundry operations services (1658), and food services (1667).

Table B.14
Cyberspace Functional Area

OFFICER/CIVILIAN MIX: 34%/66% CORE OCCUPATIONS
25%/75% DUTY AFSC
25%/75% FUNCTIONAL AREA

Counted: POSITIONS — June 2010 — OFFICER

98 of 2443 officer authorizations = 4% authorized STEM degrees

Academic discipline	Total: Rqd	Total: Funded	AADs required: MA/MS	AADs required: PhD	AADs required: Unk	AADs funded: MA/MS	AADs funded: PhD	AADs funded: Unk	Funded vs. required: Total	Funded vs. required AADs: MA/MS	Funded vs. required AADs: PhD	Funded vs. required AADs: Unk
Total	3,372	2,443	145	21	6	110	19	5	72%	76%	90%	83%
STEM required	121	98	103	16	2	83	14	1	81%	81%	88%	50%
Comp sci/engr, info sys	85	69	71	13	1	57	11	1	81%	80%	85%	100%
Engr sci/engr	67	51	61	5	1	46	4	1	76%	75%	80%	100%
Mathematics	9	7	7	1	1	6	1	0	78%	86%	100%	0%
Physics	0	0	0	0	0	0	0	0	-	-	-	-
Non-STEM required	49	35	40	5	4	26	5	4	71%	65%	100%	100%
Bus/public admin/mgt	41	27	36	5	0	22	5	0	66%	61%	100%	-
Engr/R&D/sys mgt	38	24	33	5	0	19	5	0	63%	58%	100%	-
Engr/aero sci/techn	0	0	0	0	0	0	0	0	-	-	-	-

CIVILIAN[1]

[1] Civilian authorizations not tallied because they're widely regarded as unreliable

Counted: PEOPLE — Officers May 2010; Civilians Sept 2010

Officer: Core 13S, space/missile ops

Civilian: Computer specialist (0334), telecommunications (0391), computer engr (0854), computer sci (1550), IT mgt (2210)

Counted	Academic discipline	Officer: Total	Officer: None	Officer: < BA/BS	Officer: BA/BS	Officer: MA/MS	Officer: PhD	Officer: Prof deg	Officer: % BA/BS +	Civilian: Total	Civilian: None	Civilian: < BA/BS	Civilian: BA/BS	Civilian: MA/MS	Civilian: PhD	Civilian: Prof deg	Civilian: % BA/BS +
CORE OCCUPATIONS	Total	3,562	84	14	1,301	2,128	32	3	97%	7,054	1,686	1,338	2,534	1,448	40	8	57%
	STEM		1,663	4	1,394	482	19		53%		3,822	571	1,836	792	31	2	38%
	Comp sci/engr, info sys		2,421	4	826	295	16		32%		4,439	490	1,480	624	20	1	30%
	Engr sci/engr		2,999		412	145	6		16%		5,816	93	806	319	19	1	16%
	Mathematics		3,389		145	28			5%		6,824	49	140	41			3%
	Physics		3,542		19	1			0.6%		7,030	3	18	2	1		0.3%
	Non-STEM		987	14	724	1,821	13	3	72%		3,935	1,233	1,158	713	9	6	27%
	Bus/public admin/mgt		1,641	7	423	1,486	5		54%		5,647	344	567	491	2	3	15%
	Engr/R&D/sys mgt		2,411	5	372	769	5		32%		6,966	25	21	42	0		0.9%
	Engr/aero sci/techn		3,396	8	114	44			4%		6,205	466	276	105	2		5%
CYBER DUTY AFSCs (17D, 17C, 33S, enl 3X)	Total	3,027	40	9	1,207	1,745	23	3	98%	9,196	2,362	2,065	2,898	1,820	41	10	52%
	STEM		1,398	3	1,217	393	16		54%		6,066	658	1,735	717	18	2	27%
	Comp sci/engr, info sys		2,041	3	732	237	14		32%		6,963	517	1,187	517	11	1	19%
	Engr sci/engr		2,548		359	115	5		16%		8,425	130	486	148	6	1	7%
	Mathematics		2,879		124	23	1		5%		8,871	77	182	65	1		3%
	Physics		3,011		15	1			0.5%		9,166	5	23	2			0.3%
	Non-STEM		857	9	669	1,482	7	3	71%		4,459	1,857	1,688	1,161	23	8	31%
	Bus/public admin/mgt		1,410	4	381	1,228	4		53%		7,095	491	844	761	2	3	18%
	Engr/R&D/sys mgt		2,055	4	327	637	4		32%		9,091	29	34	42			0.8%
	Engr/aero sci/techn		2,885	7	101	34			4%		8,195	579	305	115	2		5%
CYBER FUNCTIONAL AREA	Total	3,809	87	14	1,403	2,264	37	4	97%	11,303	2,768	2,351	3,721	2,384	69	10	55%
	STEM		1,830	4	1,456	496	23		52%		7,140	745	2,355	1,021	40	2	30%
	Comp sci/engr, info sys		2,653	4	836	299	17		30%		8,318	591	1,641	729	23	1	21%
	Engr sci/engr		3,197		450	154	8		16%		10,191	147	698	251	15	1	9%
	Mathematics		3,625		152	31	1		5%		10,830	94	271	106	2		3%
	Physics		3,787		21	1			1%		11,260	7	31	3	2		0%
	Non-STEM		1,031	14	799	1,947	14	4	73%		5,600	2,208	2,011	1,447	29	8	31%
	Bus/public admin/mgt		1,782	7	454	1,561	5		53%		8,643	650	1,022	980	5	3	18%
	Engr/R&D/sys mgt		2,645	5	378	776	5		30%		11,180	32	39	52			0.8%
	Engr/aero sci/techn		3,617	8	126	58			5%		10,152	654	355	140	2		4%

Table B.14—Continued

COMMENTS	AFOCD: BS in computer science, cyberspace security, electrical/computer/systems engineering, physics, math, info systems, info security assurance; or at least 24 semester credit hours in 200-level science courses including telecommunications, computer science, math, engineering, or physics. "Some non-technical accessions permitted." AADs: The largest numbers of STEM AAD authorizations were for specific disciplines within computer science and engineering. Share of core-17D officers with non-cyber DAFSCs = 17%, the most with 81T instructor, 92S student, 16X ops support,and 30C support commander. 247 officers (6% of those) in the cyberspace ops FA came from other core specialties, the most from 13B air battle manager, 63A acquisition manager, 62E developmental engineer, 14N intelligence, and 13S space/missile ops.	OPM standard for telecommunications (0391): major study in electr engr, math, physics, public utilities, statistics, computer sci, telecom mgt, info systems mgt, business admin, industrial mgt, or other related field, … or suitable combination of education and experience. OPM standard for computer engr (0854): professional engineering degree, or suitable combination of education and experience. OPM standard for computer scientist (1550): BA/BS in computer science, or 30 semester hours in a combination of math, statistics, and computer sci (at least 15 semester hours of math/statistics that included differential and integral calculus). OPM standard for IT management (2210): degree in computer sci, engineering, info sci, info systems mgt, math, ops research, statistics, or technology mgt, or at least 24 semester credit hours therein that required development/adaptation of applications, systems, or networks. Share of core-cyberspace-ops civilians with other DAFSCs = 19%, the most with 61X scientist, 62E dev engr, force support, logistics, and 16X ops support. 4,249 civilians (38% of those) in the cyberspace ops FA came from other occupational series, the most from misc admin and program (0301), mgt and program analysis (0343), engineering (08xx), training instruction (1710), budget analysis (0560), housing mgt (1173), and general business and industry (1101).

Appendix C. Career Field Interview Summaries

This appendix presents interview summaries for each of the 14 career fields. As described in the methodology section, these summaries have been approved by the FA or FM as an accurate representation of the STEM needs in the functional area. These summaries will be presented in three tiers: substantial hard STEM requirements, little or no stated additional STEM needs, and, finally, those areas with few hard STEM requirements but significant soft STEM needs.

Tier I. Predominantly Hard STEM Requirements

Civil Engineer (CE) Functional Area

In May 2010 approximately 94 percent[20] of the 1,367 core-32E civil engineering officers had one or more STEM degrees (bachelor's or higher), as did approximately 88 percent of the 987 civilians in five engineering and architecture occupational series that we counted as core for civil engineering (listed here from largest to smallest): environmental engineering (occupational series 0819), civil engineering (0810), architecture (0808), landscape architecture (0807), and fire prevention engineering (0804). We registered 1,340 more 08-series civilians in the CE functional area because of their DAFSCs or functional account codes, although we did not regard their occupational series as core-CE. (For example, they included 951 in general engineering [0801], 214 in mechanical engineering [0830], and 150 in electrical engineering [0850].) Some 98 percent of them had STEM degrees. Looking across the entire CE functional area, including everyone in CE DAFSCs (32EX), functional account codes (44xx FACs), and a few others within CE squadrons/flights, STEM prevalence was 93 percent[21] among 1,405 officers and 49 percent among 5,332 civilians. Beyond the other engineering occupational series, substantial numbers of civilians in the CE functional area had these occupational series: miscellaneous administrative and program (0301), housing management (1173), general physical science (1301), management and program analysis (0343), budget analysis (0560), and training instruction (1712).

The current AFOCD (January 2012, p. 97) requires an academic degree in **architecture**, or **civil**, **electrical**, **environmental**, **construction**, **architectural**, **industrial**, or **mechanical engineering**, for officers entering the CE career field (STEM degrees boldfaced). The Air Force

[20] Some 48 core-32E officers showed no academic credentials at all in the May 2010 officer personnel file that we used, mostly second lieutenants whose academic data were not yet loaded. Thirty-five other core-32E officers had non-STEM degrees such as construction management, engineering technology, and industrial technology.

[21] This percentage also reflects the 50 CE officers with missing academic data, the 35 core CE officers with non-STEM degrees, and 16 officers working in the CE functional area from other cores such as logistics and personnel.

STEMAC (chaired by SAF/AQ Military Deputy) approved a RAND-proposed list of degrees from the set of all degrees held by current Air Force officers and civilians that would be considered STEM. CE CFMs agreed with the categorization of engineering management and engineering technology degrees as non-STEM.

CE Officers

CE is a STEM-mandatory AFSC: the AFOCD requires an undergraduate degree in engineering/architecture for entry. The officer CFM emphasized that this is a hard-STEM career field and the goal remains for 100 percent of accessions to have engineering/architecture degrees. Infrequently, some enter the CE career field without an engineering degree, but only if the degree is similar and the individual has prior experience. The few officers currently in the career field without STEM degrees primarily have undergraduate degrees in engineering/industrial/construction technology, which for the purposes of our analysis are non-STEM.

Currently, the career field brings in too few with electrical engineering and architecture degrees for its electrical engineering and architecture positions (AFSCs 32EXE and 32EXA, respectively). When asked if CE had considered converting military positions to civilian positions in areas they find hard to fill, the CFM responded that he believed the "blue-suit requirement" prevented them from additional military to civilian conversions, especially since CE currently deploys very few civilians.

The officer CFM noted that CE also gets too little AAD funding to fill its 163 AAD positions (for which they request 25 annual AAD new-starts). Some of their AAD requirements are for degrees that can be obtained only at civilian universities. For example, three new AADs in pavement engineering are needed for pavement evaluation support: One individual goes on to teach courses at AFIT and two go to the Air Force Civil Engineer Support Agency (AFCESA) or Rapid Engineers Deployable Heavy Operational Repair Squadron Engineer (RED HORSE) units. Individuals with these degrees are in high demand, and lack of funding for their specialized degrees can significantly hamper the CE mission. The CFM saw no need to change current AAD billets either in number or in discipline. Previously, environmental degrees and engineering management AADs were a "growth industry"; that is changing, and energy and asset-management specialties are an emerging requirement.

Even though the CE career field and the developmental engineering career field (AFSC 62EX) both require officers with engineering degrees, there appears to be no coordination between the two CFMs concerning common personnel issues or the distribution of shortage skills (such as electrical engineering). It is worth noting that, in May 2010, 62 (30 percent) of 209 officers with 32E DAFSCs and five suffixes that call for specific STEM degrees lacked degrees in those disciplines: A (architecture/architectural engineering), C (civil engineering), E (electrical engineering), F (mechanical engineering), and J (environmental engineering). Worst off was the J suffix, where 18 (60 percent) of 30 officers lacked degrees in environmental engineering. Best off was the C suffix, where 20 (20 percent) of 100 officers lacked degrees in civil engineering. The shortfalls are despite the fact that, within the civil engineering functional area, the total number of officers with degrees in those disciplines far outnumbered the people whose DAFSCs called for them. For example, although 746 officers functional area–wide had degrees in civil engineering, 20 of the 100 officers whose duty-AFSC suffixes specifically called for them lacked degrees in civil engineering.[22] And although 124 officers CE-enterprise-wide had degrees in electrical engineering, seven of 27 officers and 79 of 152 civilians whose duty-AFSC suffixes specifically called for them lacked degrees in electrical engineering.

CE Civilians

Three occupational series form the majority of core-CE civilians: civil engineering (series 0810), architecture (series 0808), and environmental engineering (series 0819). But they constitute only 19 percent of the civilians working in the overall CE functional area. Eighty-eight percent of the individuals in these three series had STEM degrees in 2010. While 88 percent of the engineers (series 08XX) in the CE functional area had STEM degrees, the percentages are much lower for many other occupational series—e.g., 16 percent for 592 in miscellaneous administration and program (series 0301), 2 percent for 273 in housing management (series 1173), 6 percent for 253 environmental protection specialists (series 0028), 8 percent among 183 in management and program analysis (series 0343), and 4 percent for 180 in realty (1170).

The civilian CFM expressed concern that OPM engineering standards are outdated, and about the need to apply OPM standards consistently across the military departments (OPM, 0800–0899). For example, OPM defines no specific occupational series for construction management, so the Air Force hires construction managers under various series (e.g., facility operations services [1640] and construction control technical series [0809]) that are not the same as the Army and Navy use. In an attempt to resolve the issue, the Army proposes to establish a new professional occupational series for construction managers within the engineering and architecture group (0800s). As the current OPM standards do not have a hard requirement for an engineering or STEM degree for professional engineering-series positions, adding a non-engineering professional series to this group would introduce another avenue for non-STEM degreed individuals to eventually qualify for engineering positions. This reflects the OPM standard's lag; it was created before engineering became a fully degreed academic program and profession.

The civilian CFM commented that some in the CE career field meet the alternate qualification for the professional engineering series that the OPM standards allow, instead of having a STEM degree. Specifically mentioned were retired enlisted personnel, especially those who served in the CE career field while on active duty.

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[22] While the AFOCD education requirements don't necessarily govern civilians, we believe the Air Force would prefer matching academic degrees in positions whose DAFSCs name them.

The CFM indicated that while it is highly desirable for Air Force subject matter experts (SMEs) to hold doctoral degrees, the CE career field currently does not provide tuition assistance for civilians in Ph.D. programs. When asked if a change in emphasis for certain skills is evident or predicted, the CFM indicated that there is a need for (1) acquisition certification in appropriate positions, and (2) engineering economic analysis skills for proper asset management.

Just as with officers, the number of civilians in the CE functional area with specialized degrees usually far outnumbered the DAFSCs that called for them. For example, 229 civilians in the CE functional area had at least bachelor's degrees in electrical engineering, while 152 had duty-AFSC suffixes that called for degrees in electrical engineering. Even so, 79 (52 percent) of those 152 had no degree in electrical engineering. Only environmental engineering had a different pattern: 162 civilians functional area–wide had environmental engineering degrees, somewhat short of the 191 civilians in the functional area whose DAFSCs carried the J suffix. But in this case too, most civilians with the degree had DAFSCs that did not require it. Only 20 of the 162 with environmental engineering degrees are in positions carrying the suffix J.

CE Summary

In summary, the CE officer career field has a hard-STEM requirement, and there are no plans to accept new officers without STEM degrees, even if shortages result. There is some concern over having enough officers and civilians with advanced degrees, given recent funding and current policies. Future mission requirements will shift some demand to engineering design for energy, asset management, and a combination of construction oversight and acquisition knowledge. The fact that so many officers and civilians in the CE functional area lack degrees in the specific academic disciplines that their DAFSCs' suffixes mandate calls into question the significance of those requirements, suggests the need to manage more carefully the utilization of people with those degrees, and/or underlines the need for the number of people with those degrees to further outnumber the positions that require them.[23]

Developmental Engineering Functional Area

Engineering Officers

For officers, the developmental engineering career field (62EX) requires a STEM degree for entry, primarily in engineering (aeronautical, astronautical, computer science, electrical/electronic, or mechanical) (all STEM degrees). For the flight-test shred (62E1F), a degree in engineering, a physical science, or mathematics is required. Ninety-nine percent of the core 62EX officers in our 2010 data had one or more STEM degrees (bachelor's or higher). The

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[23] Previous RAND research demonstrated consistently that the numbers of people with specific backgrounds should exceed the numbers of jobs that require those backgrounds in order to fill the jobs with qualified personnel and allow for professional development (gaining experience in positions that don't require the specific background), attrition, and selectivity (having multiple qualified candidates to choose from when job openings occur). See, e.g., Vernez et al. (2005), Robbert et al. (2005), Moore, Conley, and Thomas (2007), and Moore and Brauner (2007).

very small 0.6 percent of individuals in the career field who did not have STEM degrees had degrees in engineering management/technology. The majority of officers without STEM degrees are between the grades of major and colonel, consistent with lesser entry requirements in the past.

This is the only career field that lists requirements for the schools that entrants' degrees must come from: the school must be accredited by the Accreditation Board for Engineering and Technology (ABET).

The developmental engineering functional area also includes those serving in developmental engineering FACs, DAFSCs, and a few playing specific roles in engineering organizations, incorporating some officers from other core specialties, most notably from cyber operations (17DX), acquisition management (63AX), and contracting (64PX). The prevalence of STEM degrees remained high across the functional area for officers in our 2010 data, at 88 percent.

A significant share of core-62EX officers served in other DAFSCs (28 percent), the most in acquisition management (63AX), instructor duty (81T), space and missile operations (13SX), and operations support (16X). A portion of this 28 percent includes students (92S), including some in initial skills training and others pursuing degrees.

This career field has a significant requirement for STEM AADs: 416 funded positions for engineering master's degrees and 58 for engineering doctoral degrees in 2010. In addition, approximately 31 positions for core 62EX officers required advanced degrees in physical science or mathematics.

In order to retain and promote the officers with specialized academic credentials, the CFM emphasized the need to carefully manage them and repeatedly stressed the influence of the DT in this process. Identification of high-potential officers, selection for developmental education, and vectoring to assignments required for progression are all necessary to retain and promote officers in developmental engineering.

The career-field manager also emphasized that it is essential to target accessions for specific engineering specialties, even though they are classified under a single AFSC. Historically, too few electrical engineers have been accessed to meet requirements (34 percent of 62EX positions call for electrical engineers). In some cases, the shortage was because that academic specialty was not targeted for recruitment. The developmental engineer career field (62EX) and the civil engineer career field (32EX) both require accessions with electrical engineering degrees, but we found no evidence of coordination between the two CFMs on recruiting/accession initiatives.

Some advocate that the cyberspace, space, and intelligence functional areas should employ their own engineers; that is, they should access engineers so that the engineering expertise and knowledge is embedded in their core specialties. The CFM for developmental engineering strongly disagrees, regarding this as a suboptimal method for managing officer engineers' careers and ensuring appropriate professional development. Instead, such non-STEM functional areas should have appropriate numbers of 62EX manpower positions available.

The CFM also highlighted the fact that officers do not remain in positions that require a specific engineering specialty for their full careers. So, although there may be enough core-62E officers with a particular academic specialty across the entire career field, some of the positions may not be filled by individuals with that academic specialty. For example, 438 core-62EX officers in our 2010 dataset had aeronautical engineering degrees. And there are 322 individuals in aeronautical engineering positions (DAFSC 62EXA), but only 103 of them had an aeronautical engineering degree. While it is possible that positions designated as requiring particular academic specialties do not actually require the specialty and that managers/supervisors are satisfied that engineers from other specialties can perform the duties of the position, the CFM believes that these situations reveal shortages of officers with those academic specialties. That is, the numbers of manpower positions alone do not adequately reflect the numbers of engineering officers needed with those specialties.

Engineering Civilians

There are nearly three-and-a-half times as many civilian engineers as officers in our 2010 data: 11,727 civilians vs. 3,450 officers. The largest numbers of civilian engineers are in these seven engineering occupational series: electronics (0855), general (0801), aerospace (0861), mechanical (0830), materials (0806), electrical (0850), and industrial (0896). All professional engineering series (08XX) require a professional engineering degree (ABET-accredited), or a combination of education and experience demonstrated by professional registration, a written test, or specific academic courses (OPM, 0800–0899). Ninety-three percent of core engineering civilians had STEM degrees at the bachelor's degree level or higher in our data. Most who lacked STEM degrees had degrees in engineering technology/management or other technician/trade disciplines. Thirty percent had STEM master's degrees, and 5 percent had STEM doctoral degrees.

Looking across the engineering functional area, also including those serving in engineering FACs, DAFSCs, and a few playing specific roles in engineering organizations, 88 percent of 13,191 civilians had STEM degrees. The functional area included noteworthy numbers of civilians in general business and industry (1101), computer science (1550), management and program analysis (0343), IT management (2210), operations research (1515), and intelligence (0132).

The CFM reported difficulties in hiring exceptionally well-qualified engineers due to OPM rules that require selection of preference-eligible individuals before others. For example, an engineering graduate with a high grade point average in a key academic specialization from a highly desirable university may be bypassed for someone with veteran's preference and experience substituting for academic credentials. There have been demonstration programs at research and laboratory organizations in the Air Force, Army, and Navy that allow for streamlined examining processes and eliminate the "rule of three"[24] and modified term appointments.[25] And programs have been developed that allow laboratories to respond quickly to hiring needs for eminently qualified candidates with distinguished scholastic achievement. The CFM believes that such programs are the key to ensuring that well-qualified civil servants are hired to support the Air Force's engineering requirements.

Engineering Summary

In summary, for officers and civilians, a bachelor's degree in engineering from an ABET-accredited school remains the requirement for entry into the core engineering specialty and occupational series. Degree programs with less rigorous, less technical requirements are not acceptable. For example, even though several colleges aim students toward government service via bachelor's degrees in disciplines like engineering management, these degrees do not meet the entry standards.

Weather Functional Area

The weather career field requires that incoming officers meet one of three criteria: (1) have an undergraduate degree with a specialization in meteorology or atmospheric science, (2) complete an AF Basic Meteorology Program (BMP), or (3) complete 18 semester hours of college-level courses in meteorology, of which nine hours must be in dynamic meteorology and weather analysis/forecasting. The AFOCD does not list the first specifically, and it states a requirement for 24 semester hours for the second, not 18 (AFOCD, 2012). In addition, the career field is currently in the process of making the educational entry requirement more rigorous by requiring a meteorology or atmospheric science degree. Those without the degree but with 24 hours of meteorology-focused college classes will be accepted, but they will be required to complete BMP. Overall, a degree in meteorology or atmospheric science (both STEM disciplines) is most desirable.

The basic education requirement for meteorology-series civilians (1340) is a degree in meteorology, atmospheric science, or other natural science, including 24 hours in meteorology/atmospheric science, six hours of physics, and three hours of ordinary differential equations (OPM 1300–1399). Civilians also can meet the basic requirement through a combination of education and experience.

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[24] This means that when selecting from a certificate of eligibles, a selection must be made from the highest three available candidates. Generally speaking, a candidate below the three top-scoring applicants may not be selected for the position unless an applicant scoring declines or is appointed to the position.

[25] The modified term is based on the existing term appointment but may extend up to five years with a one-year locally approved extension. Reasons for making a modified term appointment include, but are not limited to, carrying out special projects, staffing new or existing programs of limited duration, filling a position in activities undergoing review for reduction or closure, and replacing permanent employees who have been temporarily assigned to another position, are on extended leave, or have entered military service.

Given that meteorology and physical science degrees are categorized as STEM for the purposes of this study, it is not surprising that the observed percentages of weather officers and civilians with STEM degrees are high. In 2010 approximately 86 percent of the nearly 700 core-15W officers and 87 percent of over 150 1340-series civilians had STEM degrees (bachelor's or higher). Seventy-eight percent of core weather officers and 76 percent of weather civilians had meteorology degrees (bachelor's or higher). Officers and civilians who lacked STEM degrees may have earned degrees in non-STEM disciplines and completed the requisite hours of meteorology/physical sciences, they may have been prior enlisted weather technicians with non-STEM degrees, or civilians may have brought appropriate combinations of education and experience. Additionally, civilians may have entered the weather career field years ago when requirements were less stringent.

The weather CFM emphasized the importance of AADs to meet 15W officer core capabilities. Mission qualification training is by far the most important advanced education requirement, as well as key to leveraging/integrating state-of-the-art techniques/capabilities and ensuring that the Air Force is properly represented in inter-agency and inter-department groups. Air Force authorization data in June 2010 reflected 101 positions that required AADs (84 requiring master's degrees, 15 requiring doctorates, and two where the degree level was missing). The weather CFM recently scrubbed and validated all AAD billets, reducing the number of AAD positions to 92: 78 requiring master's degrees and 14 requiring doctorates. To support this AAD requirement, the weather career field estimates the need for 15 officers to start master's degrees and two officers to start doctorates each year. If all who entered AAD programs graduated, this level of new-start degrees implies that graduates must spend an average of 5.2 years in a master's-level position and seven years in a doctorate-level position. This is a significantly longer tour length than the average duty assignment and may signal that more new starts are actually needed for the long-term health of the career field.

Due to funding and manpower shortages for the past several years, the weather career field has experienced severe cuts in AAD quotas, receiving only five doctoral quotas (for 10 required) and 48 master's quotas (for 75 required) cumulatively since FY 2008. Although the weather career field is working to mitigate the impact of reduced AAD quotas, they predict long-term effects including degraded weather support for AF and joint operations and a decline in the ability to develop and integrate sophisticated prediction applications.

When asked about how changes to the weather career field in the future might affect the need for the numbers/types of STEM degrees, the CFM stated that there are no planned changes to the career field. Requirements for STEM degrees will, however, become even more significant, as the World Meteorological Organization now requires that all weather forecasts be issued by degreed meteorologists only.

In summary, while the practicalities of the accession/hiring processes may not currently allow for it, the weather functional area has a requirement for 100 percent of core weather officers and 1340-civilians to have weather/physical science (STEM) degrees. In addition, there is a requirement for approximately 18 percent of the weather officer core to have meteorology (STEM) AADs.

Scientific/Research Functional Area

Scientist/Research Officers

For officers, the scientific/research career field (61XX) has several specialties requiring a STEM degree for entry. The operations research analyst specialty (AFSC 61AX) requires an undergraduate degree in **mathematics**, **statistics**, **operations research,** or related field (**industrial engineering**, **management science**, **decision science,** or economics). The behavioral science/human factors specialty (AFSC 61BX) requires a degree in **behavioral science**, psychology, sociology, or **human factors**. The chemist/biologist specialty (AFSC 61CX) requires a degree in **chemistry**/**biology** or a related field. The physicist/nuclear engineer specialty (AFSC 61DX) requires a degree in **physics**/**nuclear engineering** or a related field (AFOCD, January 2012). (STEM disciplines are in boldface.) So while it is possible to enter this field without a STEM degree, the majority of officers have STEM degrees.

Eighty-six percent of the 1,146 core scientific/research officers in our 2010 dataset had STEM degrees. The majority of the 163 officers without STEM degrees had degrees in various psychology and economics disciplines. This functional area had a significant number of STEM AAD positions in 2010 (264 requiring master's degrees and 120 doctoral degrees), influencing the high number of core officers with advanced STEM degrees: 382 with master's degrees and 152 with doctoral degrees. A significant share (31 percent) of scientific/research officers served outside of their core, the most in acquisition management (63AX), instructor positions (81T), and operations support (16XX). And many are students (92S), pursuing advanced degrees.

The requirements process for determining broadly and strategically the number and type of scientific/research officers needed by the Air Force has recently been reinvigorated through a group sponsored by the Office of the Air Force Chief Scientist. The group determined in 2010 that there is no longer a need for a separate AFSC for biologists, so the CFM is now phasing out 61CX biologists through re-coring and ordinary attrition. Further efforts will attend to new and emerging scientific areas and specialties.

Paralleling what we heard from the developmental engineering CFM, some advocate that non-STEM functional areas employ their own analysts/researchers so that analytical expertise and knowledge are inherent in their functional areas. The scientific/research CFM strongly opposes this practice, arguing that it is not an optimal way of managing officer analysts' careers and ensuring appropriate professional development. To ensure that non-STEM functional areas have the numbers and types of analysts/researchers they need, the CFM recommends that they authorize manpower positions for 61XX officers in their organizations.

The scientist/research functional area—including 61XX officers plus those serving in scientific/research FACs, DAFSCs, and a few playing specific roles in science/research organizations—incorporates some officers from other core specialties, most notably developmental engineering (62EX), acquisition management (63AX), and space and missile operations (13SX). The prevalence of STEM degrees remains high across the functional area, at 85 percent.

Scientist/Research Civilians

The largest civilian core-scientific/research occupational series are operations research (1515), general physical sciences (1301), physics (1310), chemistry (1320), psychology (0180), and mathematics (1520). OPM standards for these occupational series require bachelor's degrees in the series' specialties, including requirements for the numbers of semester hours in mathematics or particular physical sciences (OPM 1300–1399).[26]

Seventy-five percent of the 1,883 civilians in core-scientific/research occupational series, according to our 2010 dataset, had STEM degrees, with about 48 percent holding advanced (master's and doctoral) degrees. There are more civilians in the scientific/research functional area than officers—69 percent were civilians in 2010. It appears that civilians also provide the vast majority of support in this functional area: 803 civilians (30 percent of the functional area) came from other occupational series, primarily computer science (1550), management and program analysis (0343), miscellaneous administration (0301), general engineering (0801), and computer engineering (0854). Some 74 percent of the functional area's civilians had STEM degrees.

Scientist/Research Summary

In summary, for officers and civilians, a STEM degree remains a requirement for particular scientific/research specialties and is highly valued across the functional area. Neither the officer CFM nor the civilian CFM identified a shortage in STEM-degreed individuals in general or in STEM specialties specifically.

The scientific/research functional area must maintain scientific and technical currency to ensure it supports the Air Force mission. New areas of scientific research will necessitate accessing and hiring individuals with degrees in these developing areas. Even so, the CFMs highlighted no plans for changes to the degree types accessed/hired or additional future requirements.

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[26] Smaller core-scientific/research civilian occupations (with 27 or fewer members each) include geophysics (1313), microbiology (0403), statistics (1530), health physics (1306), astronomy and space science (1330), anthropology (0190), mathematical statistics (1529), general math (AFIT faculty only), metallurgy (1321), and actuarial science (1510).

Tier II. Few Stated STEM Needs

Rated—Pilot, Combat Systems Officer (CSO), Air Battle Manager (ABM) Functional Area

Approximately 48 percent of pilots, 35 percent of CSOs, and 22 percent of ABMs had one or more STEM degrees (bachelor's or higher). "Hard" rated STEM requirements included positions for experimental/test pilots/CSOs, astronauts, engineering/analyst positions requiring rated personnel, plus positions in other specialties, special-duty identifiers, and reporting identifiers that call individually for STEM AADs. The total number of "hard" rated STEM requirements was 313 positions, 1.6 percent of the total number of rated positions.

The rated CFM observed that a STEM degree is not necessary for effective performance as a rated officer. While a STEM degree may provide some advantage in the academic portions of initial training, problem-solving, multi-tasking, and stress-management skills are more important for performance and progression. Exceptions are for experimental-test rated personnel and for rated positions that are coded as requiring STEM advanced academic degrees.

Reviewing data provided by the CFM on rated washouts for FY 2009–2011, we investigated the effect of a STEM degree on initial skills training. For those with STEM degrees, 49 percent of wash-outs were for performance deficiency, 28 percent were dropped on request (DOR), and 6 percent were for academic deficiency, compared with 43 percent, 23 percent, and 12 percent, respectively, for trainees without STEM degrees. STEM degrees do appear to help reduce academic washouts, but they do not guarantee academic success.[27]

An increase in STEM-degreed officers is not a goal for the rated functional area. When asked if a reduction in the number of officers possessing a STEM degree would have an impact, the CFM anticipated a macro-level impact but thought it would be difficult to identify specifics. The CFM did not indicate a need for more rated officers with STEM AADs nor believe that more STEM degrees will be desired in the future.

In September 2010, some 959 civilians in the administrative and professional occupational series had a rated DAFSC, a rated FAC[28], or seemed to require flying (rated) credentials. Twenty-one percent of them had bachelor's degrees or higher in STEM academic disciplines. Some 856 civilians had rated DAFSCs, but only five are in occupational series that seemed to require rated credentials: two in air safety investigating (1815), one in aircraft operation (2181),

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[27] We were not able to obtain from the CFM the total number of those entering this initial skills training in order to compare the proportion of STEM-degreed trainees who wash out versus the proportion of non-STEM-degreed trainees who wash out. Additional analysis could shed light on the benefits of accessing STEM-degreed individuals to lengthy, difficult, or expensive initial training.

[28] We regarded the following FACs automatically as part of the rated functional area: 3110 aircraft crew, 31B1 flight crews, 3710 flying training, 3711 undergraduate pilot training, 3713 undergraduate navigator training, 3714 advanced navigator training, 3715 electronic warfare training, 3716 navigator instructor training, 3717 pilot instructor training, 3718 combat crew training, and 3719 other flying training.

and two in aircraft navigation (2183). The most common civilian occupational series in the "rated functional area" are management and program analysis (0343), miscellaneous administration and program (0301), transportation operations (2150), and transportation specialist (2101).

Contracting Functional Area

Approximately 7.3 percent of the 913 core contracting officers (AFSC 64PX) and approximately 7.3 percent of the 5,653 core contracting civilians (series 1102 and 1103) had one or more STEM degrees (bachelor's or higher). Looking across the entire contracting functional area, also including those serving in contracting FACs, DAFSCs, and specific roles within contracting organizations, STEM prevalence in 2010 was 9.1 percent for 970 officers and 8.4 percent for 6,285 civilians. These relatively low percentages are expected because, for the 64P AFSC: "a baccalaureate degree with a minimum of 24 semester credit hours . . . in any of the following disciplines is mandatory: accounting, business finance, law, contracts, purchasing, economics, industrial management, marketing, **quantitative methods**, and organization and management" (AFOCD, January 2012). Similarly, the civilian occupational series requires at least 24 semester hours in any combination of these same academic areas (OPM). Only a quantitative methods degree satisfies this study's definition of a STEM degree. Some 80 percent of 64PX officers and 75 percent of series 1102/1103 civilians had degrees (bachelor's or higher) in business, public administration, and management, including about 7 percent with degrees specifically in finance/accounting.

During discussions, the CFM said that the contracting career field has no STEM requirements but does have Defense Acquisition Workforce Improvement Act (DAWIA)[29] requirements. He also said that in the contracting functional area there is a push for members to have MBAs, business, contracting, and purchasing degrees, but not STEM degrees.

When asked about contracting analysis tasks such as data mining or statistical analysis, the CFM said that in those cases the contracting career field uses scientific analysts or mathematicians (AFSC 61AX or occupational series 15XX, respectively), not its own workforce. When asked if the contracting functional area has personnel doing any analyses of contracting *processes* that might benefit from STEM problem-solving perspectives (in system engineering, for example) the CFM reported no work being done in the functional area with respect to reengineering processes, but access to people with such skills would be useful for process analysis and spending analysis.

When asked if certifications are important for contracting officers or civilians, and if having a STEM degree helps people obtain such certifications, the CFM reported, "No, but it would help

[29] The Defense Acquisition Workforce Improvement Act (DAWIA) was signed into law in November 1990. It requires DoD to establish education and training standards, requirements, and courses for the civilian and military workforce. The DAWIA has been subsequently modified including amendments in 2003, 2004, and 2006 by Public Law PL 1009-163 sec 1056.c.3.

the career field to have a small percentage (perhaps 10 percent) of the workforce with such skills as we contemplate more strategic contracting solutions for the Air Force." The CFM reported that officer AAD requirements for the career field are primarily in strategic purchasing (non-STEM), and that the career field received no funded AAD quotas in FY 2012. They are currently reviewing AAD requirements and positions to assess the true need and the future impact of shortages.

In summary, while STEM degrees are not required for entry into the contracting functional area, they are present in low percentages in both the officer and civilian contracting workforce and bring value to the contracting mission.

Security Functional Area

Approximately 7.9 percent of the 844 core security forces officers (AFSC 31PX) had one or more STEM degrees (bachelor's or higher). The civilian security population is more difficult to identify. Several civilian occupational series are employed in security organizations, functional account codes, and DAFSCs. The greatest number (2,070) is in the security administration series (0006/0080) with only 3.5 percent of those having STEM degrees. Of the remaining security civilians in such occupational series as investigating (1810/11), administration/clerical (03XX), education and training (17XX), and information technology (0132), 10.7 percent had one or more STEM degrees (bachelor's or higher).

The CFM commented that he does not see a STEM requirement in security forces. There are only two STEM security positions, both AADs—one for a degree in operations research and one for a systems engineering degree. The career field is not currently filling these positions, and the owning organizations are not pushing for fills. The CFM also commented that there are few security forces officers with the prerequisites for these advanced degrees and that he has trouble finding volunteers for these degree programs.

A member of the CFM's staff highlighted a perceived concern that non-STEM AADs may be losing out to STEM AADs in the Air Force Education Requirements Board (AFERB) process.[30] The security career field was previously receiving eight AAD quotas for advanced criminal justice degrees, but in recent years they have received only three quotas. The CFM believes STEM degrees, in and of themselves, should not be valued over non-STEM degrees, but rather mission needs should be the basis for prioritizing AAD degree quotas.

When asked if the career field needed officers and civilians with STEM backgrounds for analysis and research or for the implementation of new technologies, the CFM stated that there was no such need. The security forces functional area taps other organizations (such as Electronic Security Command and Air Force Operational Test and Evaluation Center) and other functional areas (such as engineering, acquisition management, and logistics) to research,

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[30] The Air Force Education Requirements Board (AFERB) is responsible for managing AAD quotas across the Air Force within manpower and funding constraints (AFI 36-2302).

procure, and field new security technologies. There have been discussions in the career field recently about how to best structure this support—with loose organizational relationships, or with dedicated personnel within the career field. The CFM does not foresee any changes to the security functional area that will increase the need for STEM-degreed officers or civilians in the future.

Financial Management Functional Area

Approximately 8 percent of the 808 core financial management officers (AFSC 65XX) and approximately 6 percent of the 6,318 civilians in core financial management occupational series (series 05XX, but primarily 0501, 0510, 0511, and 0560) had one or more STEM degrees (bachelor's or higher) in 2010. Based on the desired academic degrees listed in the AFOCD for entry into the 65FX AFSC, one might expect a larger percentage of 65FX officers with STEM degrees:

> Undergraduate academic specialization in business administration, industrial management, business management, management science, operations research, computer science, information management, systems,[31] finance, **engineering**, **mathematics**, accounting, law, economics, marketing, **quantitative methods**, and organization and management is desirable. (AFOCD, January 2012) (Emphasis added for STEM degrees.)

Two factors contribute to the low STEM percentage. First, in the Air Force's overall accession process, STEM-mandatory AFSCs receive priority in the distribution of new STEM-degreed officers. Second, the financial management career field ensures an adequate level of competency by requiring all 65FX officers to have a minimum of 24 semester hours in pertinent disciplines, primarily non-STEM: economics, accounting, finance, management, and **statistics**, six of which must be in accounting.

Education requirements for officers in cost analysis (AFSC 65WX) emphasize STEM disciplines more than financial management (65FX):

> …undergraduate/graduate degrees with business or quantitative focus with a minimum of 24 credit hours of technical related coursework to include, but not limited to, courses in **calculus, integral calculus, differential calculus, statistics, engineering**, finance, economics, **mathematics, scientific theory and/or research, and operations research**. Minimum of three college semester hours of **calculus and statistics**. Alternatively, individuals may possess a **professional engineering degree.** (AFOCD, January 2012)

[31] It is somewhat unclear what is meant by this type of degree. "Information management systems" or "management information systems," are considered STEM in our research; however, "information systems management" we would classify as non-STEM. There is not a specific ASC that matches this degree type—the closest is OIYZ, computer research/information management (STEM). There are 23 ASCs under the STEM disciplinary group "systems/C3." Some 20 ASCs have "systems" spelled out in their abbreviated labels, and 65 ASCs have "sys" in their abbreviated labels. This illustrates the problems associated with listing degree types in the AFOCD.

Despite this requirement, only 6 percent of AFSC 65WX officers had STEM degrees in May 2010. Upon observing the low percentage of STEM degrees among officers in the cost-analysis core AFSC, the CFM noted that STEM degrees are not necessary for analyzing accounting, finance, and cost data because the necessary skills are obtained through non-STEM degrees such as accounting, finance, and economics, in conjunction with Air Force training. Currently, 65XX officers without STEM degrees can "provide commanders/leaders sound, *technical and quantitative information* as a basis for making financial and programmatic decisions, *lead and conduct analysis* and studies, perform cost, economic, and business-case analyses, and *conduct research*" (AFOCD, January 2012, emphasis added). None of the core FM civilian occupational series has mandatory STEM degree requirements (OPM).

Looking across the entire financial management functional area, also including those serving in FM FACs, DAFSCs, and a few others playing specific roles in financial management organizations, 18 percent of officers and 11 percent of civilians had STEM degrees in May 2010. The higher percentages are due to the presence of STEM-degreed officers and civilians from other AFSCs and series. In the financial management functional area in 2010, 50 percent of the 244 non-FM officers (from cyberspace operations, acquisition management, and other core AFSCs) had STEM degrees, and 30 percent of 1,749 civilians from non-FM occupational series (IT management, management and program analysis, engineering, business and industry, computer science, and others) had STEM degrees. The presence of these STEM-degreed personnel in the financial management functional area indicates that this functional area obtains STEM expertise in considerable measure from other core specialties and occupational series.

The CFM identified no future changes in the career field, force structure, or technology that might increase or decrease the need for STEM degrees.

The CFM distinguished between financial management personnel obtaining competencies through attending training courses versus their completing degree programs. The CFM said that there is no shortage of financial management officers and civilians willing to attend functional area–specific training, including training to obtain or supplement the STEM skills needed for specific financial management functions.

The CFM called out one specific area where more personnel with STEM degrees would help bridge the gap between qualitative and quantitative analysis: the civilian cost-analysis workforce. The CFM noted that the civilian workforce provides the detailed "number crunching" capability, institutional memory, and continuity in cost analysis, whereas many officers work there for only relatively short periods, often during broadening tours or in supervisory positions. Our analysis shows 411 civilians in the financial management functional area working in cost analysis FACs 1520, 1525, and 1560, 59 percent from the financial administration and program series (0501) and 19 percent from the operations research and engineering series (1515 and 08XX, respectively). The CFM expressed a desire to shift additional (unspecified amount) cost-analysis work to the 1515 and 08XX civilian occupational series where STEM degrees are required. The

CFM recognizes that it would take a robust recruitment effort to increase the number of civilians with STEM degrees.

The CFM related that some senior financial management leaders believe that the best cost estimators start in operational areas such as information technology, aircraft systems, or space systems, and then move into a cost-estimation position. This type of career path would require an increase in the STEM-graduate population in the career field.

In summary, while only 12 percent of the total officers and civilians in the financial management functional area had STEM degrees in 2010, the CFM stated that this level allows them to meet requirements due to specialized financial management training. The CFM did, however, see the need to increase the number of operations research (series 1515) and engineering (series 08XX) civilians in cost analysis.

Tier III. Few Hard STEM Requirements, Significant Soft STEM Needs

Intelligence Functional Area

Approximately 15 percent of the over 3,000 core 14N officers and 13 percent of the nearly 1,300 series-0132 civilians had STEM degrees (bachelor's or higher) in 2010. It is important to be clear about terminology when discussing the intelligence functional area. The intelligence *functional area* could be narrowly defined to include only officers/civilians in AFSC 14N/Series 0132. But the non-rated intelligence functional area (now more prevalently called the Intelligence, Surveillance and Reconnaissance [ISR] functional area) consists of personnel in various functional areas in positions at National Air & Space Intelligence Center (NASIC), Air Force Technical Applications Center (AFTAC), 70th Intelligence Wing, as well as Air Force positions at other joint organizations such as the National Reconnaissance Office (NRO), National Security Agency (NSA), and National Geospatial-Intelligence Agency (NGA). We calculate that 25 percent of the officers and 29 percent of the civilians in the ISR functional area had STEM degrees in 2010.

If a STEM degree is required for a position's tasks, the intelligence professionals we interviewed indicated that they would require a STEM AFSC for the position. That is, rather than requiring an intelligence officer (AFSC 14N) or series-0132 civilian to have a STEM degree, they would establish a STEM position using AFSC 61X/62X or civilian occupational series 0800/1500.

Only 19 (about 0.7 percent) of the 2,745 14N officer positions in June 2010 are authorized STEM AADs. There are more officer AAD requirements in intelligence organizations for scientists and engineers (AFSC 61X, 62X). While an AAD is seen as good for a 14N career, a STEM degree is not necessary, and an advanced degree in regional/area studies or political science may be even more advantageous.

The CFMs believe that the number of intelligence personnel with STEM credentials far surpasses the actual number of intelligence positions requiring STEM degrees. They noted that hard STEM degree requirements in intelligence are largely in the science/technology and measurement and signature intelligence (MASINT) areas and are met with personnel from science and engineering career fields.

Despite statements that it is not necessary for those in the intelligence functional area to have STEM degrees, there are indications that there is a preference for intelligence leaders to have STEM degrees, and that to be competitive for senior intelligence positions a STEM degree is desired. The current Commander of NASIC has a STEM degree, while the Commander of AFTAC does not.

After presenting the demographics of the current workforce, the intelligence CFMs stated that, across the ISR functional area, about 25 percent of personnel should have a STEM degree. Some organizations may have greater needs, depending on their missions. For example, about half of the 1,200 civilians at NASIC should have STEM degrees. The estimated requirement for AFTAC is even higher, at 80 percent. While any STEM degree is useful for some positions, some academic specialties are especially desired in the ISR functional area: electro optics, electrical/aerospace engineering, chemical engineering/scientist (especially for MASINT work), and atmospheric sciences.

The CFMs recognize that it would be difficult to bring officers with these skills into the 14N career field, considering the competing requirements for the 61X and 62X career fields. On the other hand, when hiring intelligence series 0132 civilians, although the OPM guidelines do not require it, some intelligence organizations reportedly give much higher hiring priority to applicants with STEM degrees.

When asked if they foresaw any changes in the career field, force structure, or technology that might increase or decrease the need for STEM degrees, the intelligence CFMs indicated that they expected requirements to remain roughly constant.

In summary, the nonrated ISR functional area neither identified new “hard” STEM requirements nor recommend changes to the AFOCD for officer accessions or hiring practices for civilians that would place a greater emphasis on STEM degrees. They assessed the current prevalence of officers (25 percent) and civilians (29 percent) with STEM degrees in the ISR functional area as adequate.

Cyberspace Functional Area

In 2010, about 53 percent of the nearly 3,600 cyberspace officers (core 17D, cyberspace operations) and 38 percent of the over 7,000 cyberspace civilians in telecommunications (series 0391), information technology management (2210), computer engineering (0854), and computer science (1550) had STEM degrees (bachelor’s or higher). The CFM judged those percentages adequate. The career field recently revalidated the AAD positions for 17XX officers, reducing the number from 31 to 24, maintaining their electrical engineering and information assurance requirements (STEM) and reducing their information systems requirements (non-STEM). The CFM noted that coordination was ongoing between the Air Force and OPM to establish a set of cyberspace competencies to align with other cyberspace work being accomplished in the federal government. Naturally, ensuring that Air Force cyberspace civilians have the required competencies is a higher priority for the career field than having STEM-degreed civilians.

The CFM commented that “nontechnical” (non-STEM degreed) accessions to the 17XX career field are not a problem because the Air Force provides the necessary training in courses such as Undergraduate Cyberspace Training (UCT), a six- to eight-month-long course. Further, the technical certifications that 17XX personnel possess are of more value to the career field than STEM degrees. In addition, the career field is satisfied with the current educational requirements for 17XX accessions as documented in the AFOCD, which lists STEM degrees as “desired” but not “mandatory.” The career field wants access to a broad base of personnel, including those with nontechnical backgrounds/education.

When asked if they are aware of any career field, force structure, or technology changes that might increase or decrease the need for STEM degrees, the cyberspace CFM’s comments centered on efforts to define the bounds of cyberspace functions/responsibilities: Which civilian occupational skills should be included in cyber? Do cyberspace functions add to the functions that communications squadrons are currently responsible for? What capabilities will U.S. Cyber Command expect from 24th Air Force? Such considerations will have the greatest effect on the optimal characteristics for Air Force cyberspace professionals, and whether more cyberspace professionals should have STEM degrees.

In summary, the cyberspace functional area neither identified new “hard” STEM requirements nor recommended changes to the AFOCD for officer accessions or hiring practices for civilians to emphasize STEM degrees. They assessed the current prevalence of officers (53 percent) and civilians (38 percent) with STEM degrees in the cyberspace functional area as adequate.

Force-Support Functional Area

Approximately 11 percent of 2,000 core force-support officers (AFSC 38F) and approximately 6 percent of the 8,531 core force-support/education/training civilians (those in 22 occupational series spanning services, personnel, and education areas) had one or more STEM degrees (bachelor’s or higher). Looking across the entire force-support functional area, as defined by those serving in force-support FACs, DAFSCs, and in specific roles in force-support organizations, STEM prevalence is 33 percent for officers and 10 percent for civilians. The percentage is higher for the functional area because officers and civilians from other functional areas serve in force-support positions—especially in education positions in Air Force schools and colleges.

The desired education for entry into the force-support functional area, as published in the January 2012 version of the AFOCD, is a mix of STEM and non-STEM degree types:

> For entry into this specialty, undergraduate academic specialization in human resource management, business administration, sociology, psychology, public administration, **mathematics**, **industrial engineering**, industrial engineering technology, management engineering, systems management, **computer science**, management, organizational development, **behavioral science**, **operations research**, education, hospitality, restaurant and hotel management, recreation, fitness, finance, or accounting is desirable (emphasis added on STEM degrees) (AFOCD, January 2012).

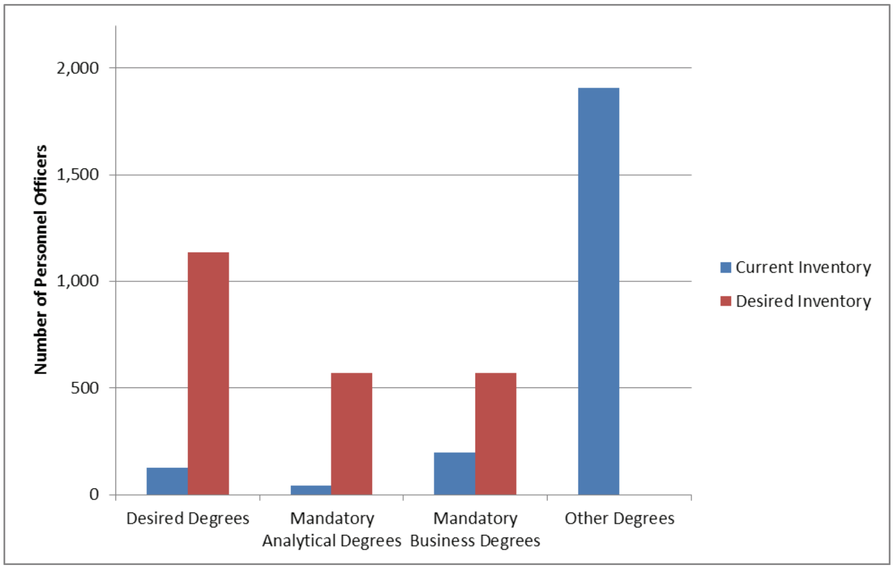
The force support functional area competes with other AFSCs for individuals entering the Air Force with STEM degrees, especially with the AFSCs where STEM degrees are mandatory. The AFOCD lists an analytical suffix ("A") where an undergraduate degree in **mathematics**, **industrial engineering**, industrial engineering technology, or **operations research** is needed. But we found no officers with this duty suffix, and the CFM confirmed that the career field is not accessing to this shred.

Some of the core civilian force-support occupational series, such as education and training, have minimum education requirements, but none requires a STEM degree.

The CFM discussed the career field's desire to increase its officer STEM inventory. The dearth of STEM degrees in the current inventory makes filling manpower and analytically oriented force-support positions more difficult. And the number of STEM AADs in the career field cannot be increased because the current inventory has few members qualified for STEM degree programs. Within the approximately 100 38F accessions per year, the CFM would like to require a number with STEM degrees, guaranteeing a steady inflow of STEM-degreed officers. The CFM recognized the presence of approximately 100 officer scientists and engineers (especially operations researchers) currently employed in force-support missions and the contributions they make. The CFM believes they will continue to rely on these officers in the future for specific force-support roles.

In July 2012, the force-support career field submitted a change to the education requirements for its officers and redesignated the AFSC from 38F, Force Support, to 38P, Personnel, effective October 2012. The new education criterion lists finance, accounting, economics, public administration, and human resource management as desirable. More notable are targeted goals for 25 percent of accessions to have a degree in operations analysis, operations research, industrial engineering, management engineering, or mathematics (all STEM disciplines) and 25 percent in business administration (non-STEM). Over the long run, this change will result in a career field with individuals educated in very different disciplines than the current inventory (Figure C.1). Many of the degrees that current force-support officers have will no longer be named as desirable—e.g., the current top five degree disciplines: psychology, political science, education, general/liberal studies, and English/communications.

Figure C.1
Number of Personnel Officers with Desired/Mandatory Degree Types vs. Current Inventory



Force support (soon to be personnel) will be the first career field to use a mix of specific and flexible criteria to guide the academic disciplines of its incoming officers. Also important is its inclusion of "management engineering" as an acceptable analytical degree. This degree is not mentioned by any other career field as desired, and a review of ASCs for the current inventory did not identify any officers with this degree.

The Air Force lowered this career field's AAD requirements from 33 to 16 in 2011. Five of the remaining 16 are for STEM degrees: four in industrial engineering, one in operational analysis. The CFM intends to maintain a balance of business and research degrees while working to outplace other graduates more effectively.

The CFM identified no additional STEM requirements for force-support civilians. As in other functional areas, civilians from STEM occupational series are employed for specific roles in force-support organizations and missions. For example, there are 41 operations researchers (occupational series 1515) and nine computer scientists (occupational series 1550) spread around the force-support functional area in various staff positions.

In summary, while STEM degrees are present in low percentages in the core officer and civilian force support workforce in 2010, the CFM recognizes the benefits of STEM degrees. Increased STEM officer accessions and targeted assignment of STEM AAD graduates will allow the career field to obtain and employ the needed skills. Since there are no hard-STEM positions for these soft-STEM accessions, it will be worth reviewing in the future how the force-support career field manages, assigns, and develops its STEM graduates.

Acquisition Management Functional Area

The acquisition management career field (AFSC 63AX) requires academic specialization in **engineering**, **engineering science**, engineering management, **mathematics**, **analytical science**, **physical science**, business, or management; *or* completion of a minimum of 24 semester hours in: accounting, business finance, law, contracts, purchasing economics, industrial management, marketing, **quantitative methods**, and organization/management is mandatory. Note that no specific degree is specified (STEM degrees are in boldface) (AFOCD, January 2012).

Forty percent of the 2,366 core acquisition management officers in our dataset have STEM degrees; 13 percent have STEM degrees at the master's and doctoral degree levels. A significant portion of those lacking STEM degrees have degrees in business, public administration, and management. The relatively low STEM percentage is expected given that AFOCD does not strictly require a STEM undergraduate degree.

Only 3 percent of the funded acquisition management positions require a STEM degree, and all of these positions have an AAD requirement. These AAD positions require specific engineering and physical science degrees as well as operations research degrees.

The acquisition management functional area, as defined by those serving in acquisition management FACs, organizations, and DAFSCs (regardless of AFSC), includes developmental engineering (62EX), physical sciences/researchers (61XX), space operations (13SX), and logistics readiness (21RX) officers. The STEM prevalence for the officers in the functional area is even higher than for the core at 48 percent.

A significant share of the core-63AX career field serves in other DAFSCs (27 percent). The majority of these individuals are in space operations (13SX), instructor duty (81T), and aircraft maintenance (21AX), and a portion are students (92S) either in initial skills training or obtaining advanced degrees.

In order to retain and promote these officers with the necessary skills, the CFM emphasized the need to carefully manage core acquisition management officers and repeatedly pointed to the influence of the DT in this process. The CFM also highlighted the very close integration of the developmental engineering and acquisition management officer development processes. The integration of these two career fields was done in an ad hoc manner in previous years, but now business rules and a planning process are in place to review requirements. Integration of the 62EX and 63AX DT allows for better corporate review of officers and allows for movement between the two career fields in ways that support officers' development and the needs of the Air Force. The movement of engineers to acquisition at mid-career allows engineers to practically apply their technical knowledge and provides for acquisition managers with substantial background in the scientific and technical portions of their programs. The goal is that 50 percent of all acquisition managers have STEM degrees/backgrounds, specifically engineering and scientific degrees.

Twenty-three percent of the core acquisition management civilians have STEM degrees at the bachelor's degree level or higher. Among general business and industry civilians (occupational series 1101) who make up the majority of the core, 28 percent have STEM degrees, 50 percent have business degrees, and 11 percent have both.

Civilian acquisition managers are primarily in series 1101; however, acquisition managers are not the only civilians in this series. The CFM is attempting to establish a professional series specifically for acquisition program managers. A change to the occupational series such as this must be vetted through the OPM and will take significant effort to accomplish. An academic degree requirement (STEM or non-STEM) could be added to the hiring requirements for this new separate series. Until this can be accomplished, the civilian DT tries to encourage scientists and engineers to take positions in program management. This is difficult to do, since individuals are reluctant to move from a series that requires a technical degree to one with a lesser requirement. The CFM notes that retired officer engineers fill many of these program management positions, resulting in an increase in the percentage of program managers with engineering degrees.

The CFM emphasized that promotion plans are an effective method to encourage civilian program managers to obtain STEM degrees once hired. In the dataset we reviewed, 24 percent of 1101 GS-12/13s had STEM degrees, 49 percent of GS-14/GS-15s had STEM degrees, and 73 percent of SESs had STEM degrees. STEM degrees appear to contribute to career advancement.

In summary, for officers and civilians, the overall goal for the acquisition management functional area is to increase the number of individuals with engineering and science academic degrees; the goal is 50 percent of 63AX officers and acquisition management representing approximately 1,200 officers and 1,200 civilians.

Logistics Functional Area

Approximately 17 percent of the 3,883 core logistics officers (AFSCs 21AX, 21MS, 21RX) and approximately 8 percent of the 6,098 logistics civilians in logistics management (series 0346), supply (series 20XX), traffic management (series 2130), and transportation specialist (series 2101) had one or more STEM degrees (bachelor's or higher). Looking across the entire logistics functional area, also including those serving in logistics FACs, DAFSCs, and some in specific roles in logistics organizations (regardless of core AFSC or occupational series), 21 percent of 4,362 logistics officers and 18 percent 17,662 logistics officer-equivalent civilians had STEM degrees. The STEM percentages for the functional area are greater due to the presence of STEM-degreed officers and civilians from other AFSCs and occupational series—notably in engineering, mathematics, and information technology.

For officers, entry into one of the three logistics officer AFSCs requires an undergraduate degree in one of the following academic disciplines (STEM disciplines are in bold) (AFOCD, January 2012):

- Aircraft maintenance—management, **engineering**, industrial management, business management, logistics management, or **physical sciences** is desirable
- Munitions and missile maintenance—management, business administration, economics, **mathematics, science, engineering, computer science**, logistics management, or space operations is desirable
- Logistics readiness—logistics management, economics, management, business administration, **computer science,** information management systems, finance, accounting, **petroleum engineering, chemical engineering,** or industrial management is desirable.

Given that these entry requirements are "desired" and that the logistics career field competes for STEM-degreed accessions with STEM-mandatory AFSCs, the STEM share could well be lower than it is.

The 3,078 funded logistics officer positions called for just 13 officers with STEM AADs (of 128 total AAD billets): four with AADs in petroleum engineering, three in operations research, two in computer systems, and one each in logistics systems analysis, human factors engineering, nuclear engineering, and physics.

The logistics CFMs agreed that a mix of STEM and non-STEM degrees is required for logistics positions and missions. There has been some reluctance to ask for additional STEM-degreed accessions because the logistics AFSCs are currently receiving only 80 percent of the accessions required for sustainment, regardless of degree. In the current environment with drawdowns and other priorities demanding accessions, they are concerned that the situation may get worse.

In the past, there was a tendency to rely on officers from other AFSCs for technical expertise in areas such as operations research, engineering, and acquisition. Currently and in the future, the CFMs believe that experiences and education in contracting, acquisition, and analysis will be encouraged and expected for logistics officers. When asked what types of academic disciplines will be required or desired in the future, CFMs highlighted several areas:

- Young aircraft maintainers need "number crunching" abilities, so some math/analytical coursework can be helpful.
- Engineering and systems degrees would be helpful in reengineering processes, as the AF works to do more with less and to provide data on efficiencies gained.
- The logistics readiness AFSC values operations research degrees and is beginning to place analysts in leadership positions.
- Degrees related to energy/fuels will become increasingly important.
- To implement technological solutions/efficiencies for the movement of assets, supply-chain management degrees/expertise will be in demand.

On the civilian side, none of the logistics civilian occupational series has a formal degree requirement per OPM standards. The traffic management occupational series does list specific academic disciplines that qualify in lieu of experience: business administration, business or commercial law, commerce, economics, **engineering**, finance, industrial management, **statistics**, traffic management, transportation, motor mechanics, or other fields related to the position (OPM). While advanced degrees are not required for logistics civilians to advance, 25 percent of logistics-management civilians (series 0346) had master's degrees in business/public administration/management. In contrast, only about 10 percent had any STEM degree at bachelor's level or above.

The civilian logistics CFM believes that, although STEM degrees are not required of logistics civilians, such degrees are preferred. This is especially true in certain organizations and environments such as logistics depots. Many positions in logistics require analytical skills, but the OPM standards have not changed such skills for entry. In some cases, engineering technicians without degrees perform the work, some people have experience rather than degrees, and in some cases individuals from another series are hired to do the STEM work. As civilians move into management, GS-12s are encouraged to get *some* degree, but not necessarily in any specific academic discipline. Advanced degrees in logistics are desired, and some include STEM (analytical) skills. The CFM noted that civilians' degrees do not take priority during reductions in force (RIFs), so STEM-degreed people with critical skills are sometimes cut. Regarding future requirements, the CFM stated that, although Title 5 U.S.C. § 3308 prevents agencies and services from imposing minimum education requirements above those set by OPM (OPM standards do not require formal education degrees for logistics occupational series), STEM-degreed personnel, especially those with strong analytical skills, will be highly desired.

The CFM suggested a review of the DoD Logistics Human Capital Strategy (HCS) to see if it contained education guidelines for logistics civilians across the DoD. The HCS highlights the importance of education for success but says nothing about preemployment education. It does say that the "development of enterprise logistician competencies is supported by education, training and developmental assignments. Education is derived from formal programs established in conjunction with higher education institutions and focused on gaining a body of knowledge." But it does not mention academic disciplines. The strategy document goes on to say that education level is a metric for analyzing the DoD logistics workforce, but again the type of degree is not specified. The HCS does list the need for logistics professionals to be competent in analytical techniques, to be able to review/evaluate engineering processes, and to prepare forecasts, all competencies that could be enhanced by a STEM academic background (Office of the Secretary of Defense, 2008).

In summary, for logistics officers, the CFMs see the need for an increase in the percentage of STEM-degreed officers, targeting 25 percent for core-21M munitions/missile maintenance officers, and at least 50 percent for 21A aircraft maintenance and 21R logistics readiness, compared with FY 2010's 16 percent, 20 percent, and 14 percent, respectively. This translates to about 37 more STEM officers for 21M, 515 more for 21A, and 636 more for logistics readiness. The civilian CFM foresaw no increase in the mandatory requirements for STEM degrees among logistics civilians under OPM standards, although more STEM degrees would be desirable.

Space and Missile Functional Area

In May 2010, 27 percent of the approximately 3,600 space and missile officers (core 13S) had at least one STEM degree (bachelor's or higher). There is no homogeneous occupational series for space and missile civilians, and they come from a variety of occupational series. We identified civilians in this functional area primarily via DAFSCs and FACs listed in their personnel records.[32] Of the 389 civilians identified at the end of September 2010, 23 percent had a STEM degree (bachelor's or higher).

In addition to core 13S officers, we examined the space and missile operations functional area also including those serving in space and missile FACs, DAFSCs, and a few in leadership or operations support roles in space/missile organizations. The largest portion of the additional officers are developmental engineers (AFSC 62E) and acquisition managers (AFSC 63A). About two-thirds of the officers in the functional area and from core specialties other than 13S had STEM degrees.

Less than 1 percent of funded 13S positions required STEM degrees in May 2010, all of them advanced academic degrees. Among the civilian occupational series we identified, even those in engineering (series 08xx) could be entered with suitable combinations of experience and education: engineering or even STEM degrees are not strictly required.

For officers entering the space and missile operations career field, undergraduate academic specialization in management, business administration, economics, **mathematics, science, engineering, computer science**, or space operations is desirable. In addition, for the space surveillance and space warning suffixes, two semesters of **calculus** and one semester of **physics** are desired. According to officer personnel records in May 2010, 38 percent of the 13S officers with STEM degrees had degrees in engineering, 21 percent in bio/medical sciences, 19 percent in physical sciences, and 16 percent in a space-specific academic discipline. The most prevalent non-STEM disciplinary groups are business/public administration/management (where 38 percent of 13S officers had at least bachelor's degrees), military/strategic studies (21 percent), engineering/aerospace science/technology (13 percent), and political science (12 percent).

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[32] Two DAFSCs: 13S (space and missile operations) and 1C6 (space systems operations) as well as 12 FACs: 3120 (missile crew), 3130 (missile launch–aircrew trainer), 3140 (satellite ops), 3141 (satellite ops crew), 3142 (satellite mission planning), 3150 (manned space), 3170 (missile warning), 3171 (missile warning crew), 3180 (space control), 3730 (missile–nuclear weapons), 3731 (missile operations training), and 7330 (AFELM USSPACECOM).

The CFM noted that a STEM degree is not essential for space and missile officers since the Air Force provides significant training: for example, Missile Initial Qualification Training (IQT) is 13 weeks long, and Undergraduate Space Training is 8 weeks long. Even so, the community values the "problem-solving skill set" that comes with STEM degrees.

The CFM also discussed the need for additional acquisition and scientific expertise (military and civilian personnel) across the functional area. He allowed that one particular portion of the space and missile career field could benefit from increased STEM degrees: research, development, testing, and evaluation (RDT&E) positions. In May 2010 RDT&E employed about 7 percent of core 13S officers, and approximately 39 percent of them had STEM degrees.

The career field apparently wants to increase the STEM presence in the space officer population, for several reasons:

- Continued cyber threats require technically experienced personnel.
- Problem-solving and critical-thinking skills are required to advance space/cyber operations.
- Shrinking force structure requires greater capability from a smaller pool of accessions.
- Future budgets will require less dependence on contracted technical support.

While recognizing the need for an increased STEM presence, the career field is reluctant to increase the STEM degree requirement, wanting to maintain maximum flexibility and stay adaptable to the available pool of accessions. They opt instead for *STEM-cognizance* as an entry requirement, defined as 30 semester hours in courses such as **operations research, calculus-based physics, computer science, engineering, probability/statistics,** and **calculus**. All USAFA graduates would satisfy this STEM-cognizance requirement, and AFROTC cadets recruited early in their college years could meet these requirements as well.

When asked about any career field, force structure, or technology changes that might increase or decrease the need for STEM degrees, the CFM noted the increasingly technical environment of space operations and the need for technically competent airmen. However, he did not foresee changes in requirements for academic degree disciplines or for overall percentages of STEM-degreed space officers, missile officers, or officer-equivalent civilians—especially in light of the planned requirement for STEM cognizance.

In summary, the space and missile functional area neither identified new STEM degree requirements nor recommended changes to the AFOCD for officer accessions or to hiring practices for civilians that would place more emphasis on STEM degrees. The CFM assessed the current percentage of STEM-degreed officers and civilians (27 percent and 23 percent, respectively) in the space and missile career field as adequate.[33]

[33] We conducted our interviews while the decision was being made to split this officer career field into two. The information presented here reflects a combined functional area. We were informed in October 2012 that the newly separated space functional area would require a STEM degree for entry. This seeming disconnect could result from the structure of CFM duties and responsibilities—the Commander, Air Force Space Command is the Air Force Space Professional functional authority, while some functional area responsibilities are taken on by the Director, Space Operations, Deputy Chief of Staff for Operations, Plans and Requirements (AF/A3S) on the Air Staff. As it now stands, the space functional area is requiring that all space officer accessions have a "STEM degree"—with no requirement that the degree be in any particular STEM disciplines that might be particularly well suited to duties in space missions and organizations.

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ISBN-10 0-8330-8712-6
ISBN-13 978-0-8330-8712-6

RR-659-AF