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TECHNICAL REPORT

The Acquisition Cost-Estimating Workforce

Census and Characteristics

Georges Vernez, Hugh G. Massey

Prepared for the United States Air Force

Approved for public release; distribution unlimited



RAND PROJECT AIR FORCE

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Preface

The fiscal year (FY) 2007 National Defense Authorization Act (NDAA) requires that cost estimates for major defense acquisition programs (MDAPs) and major automated information system (MAIS) programs be performed by properly qualified members of the armed forces or full-time employees of the Department of Defense (DoD). As one step toward complying with this requirement, the Air Force Assistant Secretary for Acquisition (SAF/AQ) directed the Deputy Assistant Secretary for Acquisition Integration (SAF/AQX) and the Air Force Cost Analysis Agency (AFCAA) to identify the existing cost-estimating workforce, describe its characteristics, and assess its operational needs. In turn, SAF/AQX and AFCAA asked RAND Project AIR FORCE to collaborate with them in conducting a study of the cost-analysis workforce in the Air Force Materiel Command's (AFMC's) product and logistic centers to address these questions. The study was conducted within the Manpower, Personnel, and Training Program of RAND Project AIR FORCE. This technical report contains the study's findings. Other related RAND Corporation cost studies include the following:

- Joseph G. Bolten, Robert S. Leonard, Mark V. Arena, Obaid Younossi, and Jerry M. Sollinger, *Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, MG-670-AF, 2008.
- Obaid Younossi, Mark A. Lorell, Kevin Brancato, Cynthia R. Cook, Mel Eisman, Bernard Fox, John C. Graser, Yool Kim, Robert S. Leonard, Shari Lawrence Pfleeger, and Jerry M. Sollinger, *Improving the Cost Estimation of Space Systems: Past Lessons and Future Recommendations*, Santa Monica, Calif.: RAND Corporation, MG-690-AF, 2008.
- Mark V. Arena, Robert S. Leonard, Sheila E. Murray, and Obaid Younossi, *Historical Cost Growth of Completed Weapon System Programs*, Santa Monica, Calif.: RAND Corporation, TR-343-AF, 2006.
- Obaid Younossi, Mark V. Arena, Robert S. Leonard, Charles Robert Hall, Jr., Arvind Jain, and Jerry M. Sollinger, *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs*, Santa Monica, Calif.: RAND Corporation, MG-588-AF, 2006.

RAND Project AIR FORCE

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Summary

Previous work by PAF has documented both the creeping growth in the cost of military acquisition systems and the factors that contribute to this growth, including inappropriate initial estimated costs, underestimated technical risks, government decisions that led to program changes, and lack of independence of cost analysts from the program offices. Recommendations to improve cost estimation have included instituting independent program reviews, emphasizing technical risk assessment, and requiring major estimates to be led by experienced and qualified government analysts (Arena et al., 2006; Younossi et al., 2006 and 2008; Bolten, 2008).

Echoing some of these recommendations, in 2007 Congress dictated that cost estimates for MDAPs and MAIS programs be performed by properly qualified members of the armed forces or full-time employees of the DoD (U.S. Congress, 2007). To provide information toward eventually meeting this mandate, PAF was asked to collaborate with SAF/AQX and AFCAA to conduct a census of the acquisition cost-estimating workforce, describe its background and competencies, and assess its operational needs.

In January and February 2008, we conducted a comprehensive census of the military, government civilian, and contractor staff who self-reported that they were performing cost-estimation tasks in the Air Force's four product centers and three logistics centers: Air Armament Center (AAC), Aeronautical Systems Center (ASC), Electronic Systems Center (ESC), Space and Missile Systems Center (SMC), Oklahoma City Air Logistics Center (OC-ALC), Ogden Air Logistics Center (OO-ALC), and Warner-Robins Air Logistics Center (WR-ALC). We also conducted interviews with commanders in three of the four product centers.¹ In most instances, these commanders were accompanied by their chief cost estimator and/or chief financial manager. We also held focus groups with a sample of cost estimators.

In the interviews and focus groups, we asked about the adequacy of the size and quality of the cost-estimating workforce, its desirable composition and mix, the background and training requirements for cost estimators, and future requirements for the cost-estimating workforce.

Census Results

As of winter 2008, there were 374 cost estimators in the seven Air Force product and logistics centers, split about evenly between organic (government civilian and military) staff and contractors. In addition, there were 74 unfilled organic cost-estimator positions, comprising

¹ Per agreement with SAF/AQX, we did not interview staff at the smallest of the four product centers and at the logistics centers because of the small number of cost estimators in these centers.

29 percent of all organic positions. Nearly three-quarters of these unfilled positions were for civilians, and one-quarter were for military officers (see pp. 5–6).

About two-thirds of cost estimators reported spending 75 percent or more of their time on cost-estimating tasks over the six months preceding the census. About one-quarter of cost estimators reported spending less than 50 percent of their time on cost-estimating tasks (see p. 12).

A majority (two-thirds) of the cost-estimating workforce had an advanced degree, typically a master's degree in business administration, finance, or accounting. Fifteen percent of cost estimators—nearly all of them contractors—reported having a degree in engineering or mathematics (see pp. 8–9).

One-half of the organic workforce had five or fewer years of cost-estimating experience and 30 percent had 11 or more years of experience. In contrast, one-half of the contractors had more than 11 years of experience, and about one-quarter had less than five years of experience (see pp. 9–10).

Nearly all (80 percent) of the workforce reported having received some formal cost-estimating training, although they reported that this training was not extensive. The organic workforce received most of its training under the Acquisition Professional Development Program (APDP), which offered only two short courses in cost estimation. The centers themselves have no current capability to offer additional training. Contractors received training from multiple sources, including APDP. Two-thirds of the cost-estimating workforce, both organic and contracted, reported having no certification in cost-estimating (see pp. 10–11).

Forty-five percent of cost estimators reported being lead estimators. There were no marked differences between organic lead estimators and organic estimators who were not lead estimators. About 50 percent of both organic lead estimators and those who were not had five or fewer years of cost-estimating experience. In contrast, contractor lead estimators were more likely to have 11 or more years of cost-estimating experience than those contractors who were not lead estimators (68 versus 40 percent) (see pp. 13–14).

Nearly all Acquisition Category I (ACAT I) programs had a lead estimator assigned, as did two-thirds of ACAT II programs and about 40 percent of ACAT III programs (see pp. 15–16).

There were notable variations across product centers in the patterns described for the cost-estimating workforce as a whole, including the following:

- The cost-estimating workforce was primarily contracted at ESC and primarily organic at AAC and ASC.
- ASC had the largest proportion of cost estimators with a master of business administration (MBA) degree (44 percent).
- Sixteen percent or less of the cost-estimating workforce at AAC and SMC had 6 to 10 years of experience, suggesting that these centers may encounter greater difficulties than other centers in filling positions that require senior-level experience.
- ESC's organic and contracted staff were more likely than those of other centers to spend 75 percent or more of their time on cost-estimating tasks.
- Among product centers, AAC and SMC had the lowest proportion of lead cost estimators in their workforce (42 and 27 percent, respectively), and ESC had the highest (65 percent).

- None of SMC's contracted cost estimators were lead estimators, while at ESC, 72 percent of the lead estimators were contractors. AAC and ASC were also more likely to use organic staff than contractors as lead estimators (82 and 61 percent, respectively).
- At SMC, where many lead estimators were military, nearly three-quarters had five or fewer years of experience.
- Only one-third of ACAT II programs were assigned a lead estimator at AAC and SMC. Almost two-thirds of ACAT III programs at ESC had a lead estimator.

Workforce Adequacy, Composition, and Competencies

All three centers where interviews were conducted relied primarily on contractors to meet their cost-estimating requirements, regardless of the share of organic cost estimators at the center. ESC, whose cost-estimating workforce is less than 25 percent organic, has little choice but to rely almost entirely on its contractors to meet its cost-estimating needs. Although nearly two-thirds of ASC's cost-estimating workforce is organic, its groups nevertheless reported relying primarily on contractors to provide leadership and experience to meet their programs' cost-estimating needs. ASC's organic cost-estimating staff are financial management (FM) generalists, reportedly to maintain flexibility to respond to day-to-day work requirements and to facilitate the integration of cost-estimating and FM functions. Similarly, the actual cost estimation at SMC is typically done by contractors, while organic staff are self-described "cost managers" who oversee several contractor cost estimators (see pp. 18–19).

The three centers estimated an aggregate need for a minimum of 70 cost-estimator authorizations, in addition to the 74 vacant authorizations they currently hold. Although wings and groups may hire additional contractors to fill some of these gaps, in practice they said they are constrained by contract cost ceilings set by the center,² higher center or wing priorities on contractors in other functional areas such as engineering, and the need to use program funds to cover the costs of contractors (see pp. 19–20).

Most commanders said they would prefer to have a higher ratio of experienced organic cost estimators to contractors, so that the organic staff would have the experience to take the lead role in performing cost estimates and/or reviewing contractors' estimates. They typically would prefer a 50/50 ratio of organic to contractor staff (see p. 20).

Two workforce-mix issues were raised by our respondents. The first concerns the distribution of the organic workforce by years of experience. One-half of organic cost estimators have five or fewer years of experience and one-third have more than ten years, leaving a gap in the middle. This gap is caused in part by centers' inability to hire mid-level cost analysts to fill currently vacant positions and in part by the low retention rate of organic cost estimators, which is attributed to a lack of career opportunities in this specialty. The cost-estimating workforce forms only a small proportion of the FM field, which offers greater advancement opportunities in other specialties. Thus, it is unattractive for junior staff to enter a cost-estimating career (see pp. 20–21).

The second workforce-mix issue concerns the trend toward the use of organic FM generalists for cost-estimating tasks and the lack of career advancement opportunities for cost esti-

² At ASC, the contract is centerwide. At ESC and SMC, there are separate contracts for each wing, but these centers have authority to set the contracts' dollar ceilings.

maters. Several commanders and chief cost estimators felt that cost-estimating is a specialty that requires more preparation, development, and experience than is feasible for FM generalists (see p. 21).

Nevertheless, respondents were generally satisfied with the competencies of their current organic cost-estimating workforce, and even more so with their contracted cost-estimating workforce (see p. 21).

Most respondents placed a greater weight on years of experience in practicing cost-estimating and detailed knowledge of the programs than on the background of their cost estimators. Still, there was a consensus among respondents that an engineering or technical background is desirable, although it was not deemed absolutely necessary. They also said that greater expertise was needed in risk assessment analysis, systems integration, scheduling, and cost-estimating for software programs (see p. 21–22).

Respondents said that organic cost estimators lacked adequate training. Currently, most of their training occurs on the job as they work with experienced cost estimators who are primarily contractors. Respondents generally estimated that it takes about five years for a cost estimator to become “competent” at performing cost estimates for complex programs. The cost-estimating training courses offered by the Defense Acquisition University were said to be too general and lack depth. Separate training courses are needed in source selection, integrated baseline reviews, program office estimates, risk analysis, scheduling, software cost-estimating, and operations and support. Respondents suggested making greater use of case studies in training courses. In contrast, respondents praised the solid analytical preparation of Air Force Institute of Technology (AFIT) graduates, who needed less time to acquire the knowledge required for cost-estimating (see pp. 23–24).

Two other issues require particular attention in coming years: (1) the continuing trend toward more dependence on software than on hardware, which will increase the demand for cost estimators who specialize in software programs, and (2) the desirability of reengaging in more-systematic collection of cost data and research in cost estimation. The Air Force will need to address most, if not all, of these issues in a concerted manner if it is to eventually meet the requirement of Section 820 of the NDAA for cost estimators.

Acknowledgments

We are grateful to the Air Force wing and group commanders and their staff, the chiefs of the Financial Management Cost (FMC) divisions, and the cost estimators who took time from their busy schedules to meet with us and candidly answered our many questions. We hope we have faithfully represented their responses. We also want to thank Randal Bowen (ASC/FMCE), Dave Morana (ESC/FMC), and Capt Jeffrey Feuring (SMC/FMCC), who arranged for our visits and guided us throughout our stays.

Maj Dale White (SAF/AQXD), s and Katharyn S. Hiebert (AFCAA) contributed to the design of the study by reviewing the census questionnaire and the interview protocols and making useful suggestions that improved them both.

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Finally, we thank RAND colleagues Ellen M. Pint and Obaid Younossi for their thoughtful technical reviews and suggestions for revisions, which significantly improved the document.

Abbreviations

AAC	Air Armament Center
ACAT	acquisition category
ACEIT	Automated Cost Estimating Integrated Tools
AF	Air Force
AFB	Air Force Base
AFCAA	Air Force Cost Analysis Agency
AFIT	Air Force Institute of Technology
AFMC	Air Force Materiel Command
AFPC	Air Force Personnel Center
AFSC	Air Force Specialty Code
APDP	Acquisition Professional Development Program
ASC	Aeronautical Systems Center
CARD	Cost Analysis Requirements Description
CCE/A	Certified Cost Estimator/Analyst
CDFM	Certified Defense Financial Manager
DAU	Defense Acquisition University
DCAA	Defense Contract Audit Agency
DoD	Department of Defense
ESC	Electronic Systems Center
EVM	earned value management
EWI	education with industry
FM	financial management
FMC	Financial Management Cost (division)
FMS	foreign military sales

FY	fiscal year
GS	General Schedule
IBR	integrated baseline review
IPAO	Independent Program Assessment Office
ISPA	International Society of Parametric Analysts
MAIS	major automated information system
MBA	master of business administration
MDAP	major defense acquisition program
NATO	North Atlantic Treaty Organization
NDAA	National Defense Authorization Act
O&M	operation and maintenance
O&S	operations and support
OC-ALC	Oklahoma City Air Logistics Center
OO-ALC	Ogden Air Logistics Center
OSD	Office of the Secretary of Defense
PAF	Project AIR FORCE
PEO	program executive officer
PM	program manager
POE	program office estimate
POM	program objective memorandum
SAF/AQ	Secretary of the Air Force, Assistant Secretary for Acquisition
SAF/AQX	Secretary of the Air Force, Deputy Assistant Secretary for Acquisition Integration
SAF/AQXD	Secretary of the Air Force, Acquisition Career Management
SCEA	Society of Cost Estimating and Analysis
SMC	Space and Missile Systems Center
TDY	temporary duty
WR-ALC	Warner-Robins Air Logistics Center

Introduction

Background

The reliability of cost estimates for new weapon systems has long been the subject of debate. Previous work by RAND Project AIR FORCE (PAF) has concluded that the Department of Defense (DoD) and the military departments have historically underestimated the cost of new weapon systems. It has also showed a trend of cost development growth over the past three decades (Arena et al., 2006; Younossi et al., 2006). More recently, two RAND studies, one on 35 completed major acquisition programs and the other on Space and Missile Systems Center's (SMC's) cost-estimating procedures and requirements, identified several factors that led to cost growth, including inappropriate initial estimated costs, underestimated technical risks, government decisions to increase requirements, increases in the quantity of systems built, changes in the program schedule, and lack of independence of cost analysts from the program offices (Younossi et al., 2008; Bolten et al., 2008). Recommendations offered to improve cost estimation included instituting independent program reviews, placing special emphasis on technical risk assessment, standardizing cost data collection, and requiring major estimates to be led by experienced and qualified government analysts (Younossi et al., 2008).

In 2007, Congress had reached a similar conclusion: that major estimates need to be led by independent, experienced, and qualified government analysts. Section 820 of the John Warner National Defense Authorization Act (NDAA) for fiscal year (FY) 2007 set the following goal:

It shall be the goal of the Department of Defense and the military departments to ensure that within five years after the date of the enactment of this Act, for each Major Defense Acquisition Program (MDAP) and each Major Automated Information System (MAIS), each of the following positions is performed by a properly qualified member of the Armed Forces or full-time employee of the Department of Defense: (1) Program Manager; (2) Deputy Program Manager; (3) Chief Engineer; (4) Systems Engineer; (5) Cost Estimator.

In preparation to comply with this requirement, the Air Force Assistant Secretary for Acquisition (SAF/AQ) directed the Deputy Assistant Secretary for Acquisition Integration (SAF/AQX) and the Air Force Cost Analysis Agency (AFCAA) to “identify the existing cost-estimating work force and capture the competencies of cost estimators supporting AF acquisition programs” (Durante, undated). SAF/AQX and AFCAA, in turn, asked RAND PAF to collaborate in conducting studies addressing these two concerns. Our mandate was (1) to conduct a census of military personnel, government civilians, and contractors performing cost estimations and (2) to describe these cost estimators’ qualifications and experience and the

challenges they face. The Air Force intended to use the findings from this information gathering in support of its decisionmaking to comply with the requirement of Section 820 of the FY 2007 NDAA and to improve the quality and reliability of cost estimates.

Approach

The study was conducted in two phases. In the first phase, a comprehensive census of all personnel engaged in cost-estimating activities (military, civilian, and contractors) was conducted in January and February 2008 in the seven Air Force acquisition product and logistics centers: Air Armament Center (AAC), Aeronautical Systems Center (ASC), Electronic Systems Center (ESC), Space and Missile Systems Center (SMC), Oklahoma City Air Logistics Center (OC-ALC), Ogden Air Logistics Center (OO-ALC), and Warner-Robins Air Logistics Center (WR-ALC). We asked that the following personnel be included in this census:

Any military or government civilian engaged in acquisition cost estimating, cost analysis and modeling, and/or cost/risk assessment, either full-time or part-time; or any contractor personnel or consultant working in similar positions for an AF organization in support of acquisition programs; or any authorized but vacant position supporting similar cost analysis and estimating (e.g., AFSC [Air Force Specialty Code] 65W military positions in acquisition offices). Individuals providing data in support of cost analysis should only be counted in this category if they participate in the analysis of that data to produce cost estimates. Earned value management¹ activity should only be counted in this category if it directly supports cost estimating activities. Also include cost analysts assigned to the office who are temporarily assigned elsewhere for training, short-term details or other TDY.

A survey questionnaire was developed to acquire the following type of information from cost estimators:

- Air Force organization and office symbol
- acquisition category (ACAT)² or other programs they were currently working on
- whether they were working full-time, part-time, or deployed
- contracting organization (for contractor employees only)
- whether they were a lead estimator, and if so, for which program
- duty AFSC
- percentage of work time spent on acquisition cost-estimating, earned value management (EVM) other than in support of cost analysis, and other FM tasks during the past six months
- total number of years of cost-estimating and other FM experience
- total number of years of acquisition experience

¹ *Earned value management* is a project management technique that measures project progress in an objective manner. It combines the measurement of project scope, schedule, and cost in a single integrated manner. EVM is designed to provide an early warning of performance problems.

² ACAT is an acronym for a defense program acquisition category. The DoD divides acquisition programs into four acquisition categories: ACAT I, ACAT II, ACAT III, and ACAT IA. The differences among these categories depend on size and programmatic differences.

- education and field of study
- formal cost-estimating training
- certification type and source.

We also collected the relevant subset of this information for vacant military or civilian positions. The survey (see Appendix A) was administered at each center by a point of contact in the center's FM office. Survey responses were entered into a spreadsheet to facilitate analysis.

In the second phase of the study, we conducted supplemental face-to-face interviews with selected commanders (or deputy commanders if the commander was not available) of up to seven wings or groups at each of three product centers: ASC, ESC, and SMC. The wings and groups interviewed are listed in Appendix B. In addition, we conducted two focus groups at each of these centers, one with up to four lead cost estimators and one with up to four other cost estimators. Interviews were conducted over two days at each center during the months of May, June, and July 2008. For consistency across centers and groups, two RAND interviewers conducted all the interviews using semi-structured protocols that covered the following set of topics (see Appendix C):

- characteristics and functions of the center's Financial Management Cost (FMC) division
- needs for additional cost estimators, by type
- implications of not having a sufficient number of cost estimators of the needed composition, mix, and experience
- adequacy of the competencies of current cost estimators and views of future requirements
- adequacy of and need for training.

Organization of the Report

Chapter Two describes the characteristics of the current cost-estimating workforce based on the census conducted in January and February of 2008. Chapter Three discusses the current and future needs for additional staff and for specific competencies and training identified during our on-site interviews. The last chapter presents our overall conclusions.

The Current Cost-Estimating Workforce

This chapter presents the results of a census of staff who reported that they worked on cost-estimating tasks in the Air Force's four product and three logistics centers. The census was held during January and February of 2008. First, we discuss the composition of the cost-estimating workforce. Next, we describe the qualifications of the cost-estimating workforce and the amount of time cost estimators spent performing cost estimations around the time of the census. Finally, we discuss the characteristics of lead estimators and the ACAT program to which they were assigned.

The reader should be cognizant of the limitations of this census. First, it counted the cost-estimating workforce at a single point in time in the Air Force Materiel Command's (AFMC's) four product and three logistics centers.¹ In these centers, the number of personnel engaged in cost estimating can fluctuate due to rotations, attrition, hiring, and workload variations over the programs' acquisition cycles.² Second, the census counted everyone—military, civilian, and contractor—who spent any time on cost-estimating tasks, regardless of the amount of time spent on these tasks and regardless of the AFSC or other characteristics of the staff included. Finally, each staff member self-reported whether he or she met our definition of a cost estimator and determined whether he or she was working on cost-estimating tasks.

Composition of the Cost-Estimating Workforce

As of February 2008, there were 374 military, government civilian, and contractor personnel working on cost-estimating tasks, hereafter referred to as "cost estimators." ASC, ESC, and SMC each had about 100 cost estimators, AAC had 26 cost estimators and the three logistics centers had 15 or fewer cost estimators each (Table 2.1).

Overall, about half of the cost-estimating labor force was organic (military and government civilian) and the other half was contracted (Figure 2.1). There were, however, sharp variations across centers. At ESC, three-quarters of the cost-estimating labor force was contracted, whereas at AAC and ASC, 73 and 66 percent of the cost-estimating labor force was organic, respectively. At SMC, the cost-estimating workforce was about evenly divided between organic and contracted.

¹ In addition to AFMC's product and logistics centers, cost estimators are also assigned to other Air Force organizations, including AFMC Headquarters and AFCAA. Cost estimators in these other organizations are not included in this study.

² For a description of program acquisition cycles, see Department of Defense, 2008.

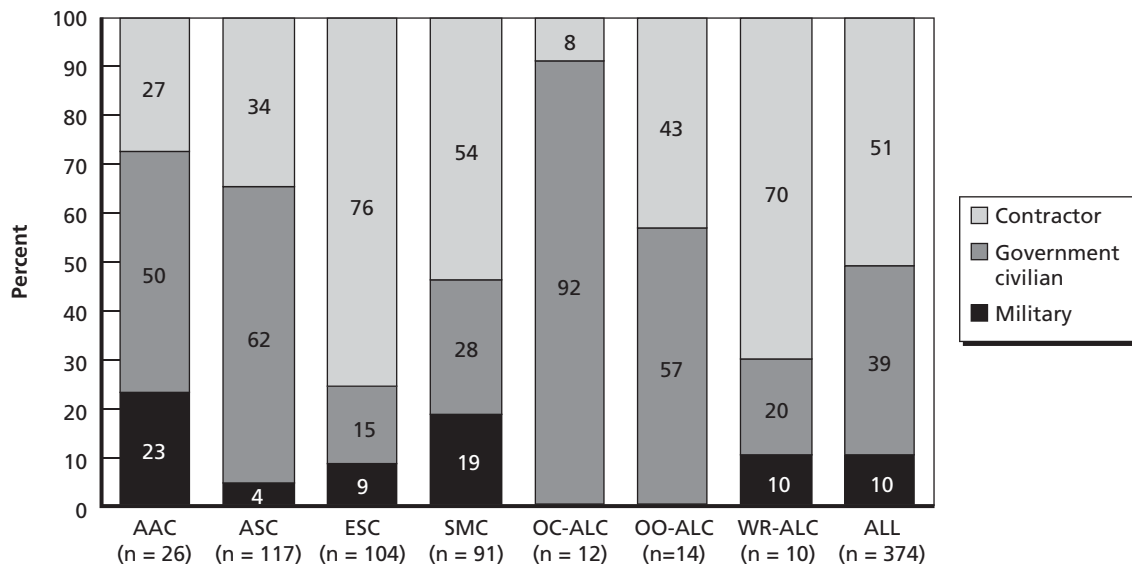
Table 2.1
Number and Percentage of Cost Estimators and Vacant Cost-Estimating Positions,
by Center, 2008

Center	Filled Positions		Vacant Positions		Total	
	Number	Percent	Number	Percent	Number	Percent
AAC	26	7	3	4	29	7
ASC	117	31	21	28	138	31
ESC	104	25	10	15	114	26
SMC	91	24	26	35	117	26
OC-ALC	12	3	5	7	17	4
OO-ALC	14	4	0	0	14	3
WR-ALC	10	3	9	12	19	4
Total	374	100	74	100	448	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Figure 2.1
Composition of the Cost-Estimating Workforce, 2008



SOURCE: RAND census, 2008. See also Appendix D, Table D.1.

NOTE: Percentages may not add to 100 because of rounding.

RAND TR708-2.1

The distribution of the organic force between the FM office and program wings³ at each center differed as well. At AAC and SMC, about one-third of the organic cost estimators were assigned to the FM office and provided support to the program wings as center priorities dictated. At ASC, a slightly higher share (42 percent) of the organic cost-estimating force was assigned to the FM office. In contrast, ESC had only 10 percent of its cost estimators assigned

³ A wing is a military organizational unit with a specified mission. It is typically headed by a colonel. A wing may be divided into several subunits named groups.

to the FM office. Furthermore, nearly half of its organic staff was off-site, i.e., located at Maxwell Air Force Base (AFB) and Wright-Patterson AFB rather than at Hanscom AFB, which is ESC's headquarters. In all centers, the central staff had an oversight function as well.

At two of the logistics centers, OC-ALC and OO-ALC, the cost-estimating workforce was predominantly organic; at WR-ALC, it was predominantly contracted.

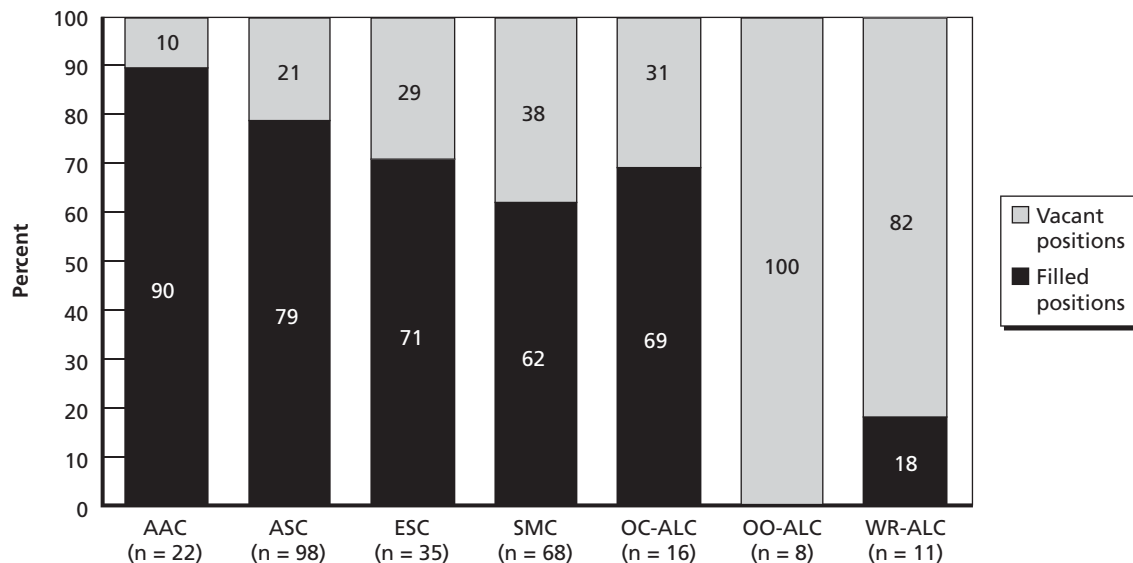
One out of five organic cost estimators was military, with a somewhat larger military presence at AAC and SMC than at the other five centers (see Figure 2.1).

Vacant Positions

In winter 2008, the centers reported having a large number (74) of authorized but vacant positions for organic cost estimators—approximately one-third of all their organic positions. Almost two-thirds of these vacant positions were at ASC and SMC (Table 2.1). At SMC, 38 percent of the organic positions were reported to be vacant; at WR-ALC, more than 80 percent of organic positions were vacant (Figure 2.2). As discussed in the next chapter, respondents attributed this large number of vacancies primarily to difficulty in hiring organic staff at the desired level of experience.

Seventy-seven percent of vacancies were in civilian positions and 23 percent in military positions (see Appendix D, Table D.2). The majority (two-thirds) of the vacant positions for military cost estimators were at the captain level, the others were distributed between O-2 (1st lieutenant) and O-4 (major) with one vacancy for an O-5 (lieutenant colonel). On the

Figure 2.2
Percentage of Filled and Vacant Organic Positions for Cost Estimators, 2008



SOURCE: RAND census, 2008.

RAND TR708-2.2

civilian side, the largest number of vacancies were at what used to be the GS-12 (20) and GS-13 (12) levels.⁴ Five vacant positions were for GS-11 and five for GS-14. Only a few vacant positions (12) were at the entry level (GS-09 or below).

Qualifications of the Cost-Estimating Workforce

Education

About two-thirds of cost estimators had either a master of business administration (MBA) degree (21 percent) or a master's degree in some other field (42 percent).⁵ The remaining cost estimators had bachelor's degrees; only 1 percent had a PhD. There were no marked differences between the organic workforce and contractors in their educational attainment (Table 2.2).

Nor were there any marked differences in the share of cost estimators with master's degrees across centers. The only major exceptions were at AAC and SMC, where none of the cost estimators had an MBA. In contrast, ASC had the largest share of organic cost estimators with MBAs (44 percent) (see Appendix D, Table D.3).

Few cost estimators had either an engineering background (8 percent) or a mathematic background (7 percent); nearly all those who did were contractors located at ESC and SMC. One-third of contractors at SMC and 20 percent at ESC had engineering or mathematics backgrounds. About half of the remaining cost estimators had studied business or management, and one-quarter had studied finance or accounting. About one in every ten cost estimators reported having an academic degree in cost analysis (Figure 2.3).

Grade

About two-thirds of government civilian cost estimators were at the GS-12 and GS-13 levels. Only about one in ten was a GS-14 or GS-15. Similarly, most military cost estimators were in the early years of their career. Nearly two-thirds were captains and another 23 percent were

Table 2.2
Cost Estimators' Educational Attainment, by Personnel Type, 2008 (%)

Personnel Type	Bachelor's	Master's	MBA	PhD	Total
Organic (n = 180)	32	44	23	0	100
Contractor (n = 186)	39	40	20	1	100
All (n = 366) ^a	36	42	21	1	100

SOURCE: RAND census, 2008.

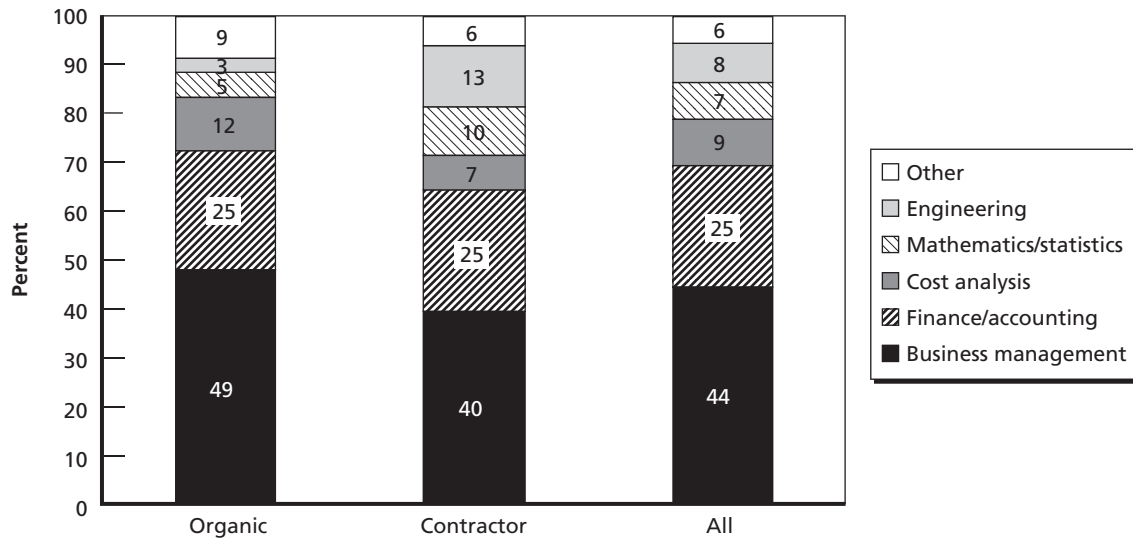
NOTE: Percentages may not add to 100 because of rounding.

^a In this and other tables and figures in the remainder of this document, "All n" may not add to 374 cost estimators because some respondents did not provide all the information asked for in the census survey.

⁴ The U.S. Government General Schedule (GS) system used to have a pay scale from a minimum of 1 to a maximum of 15, depending on qualifications and experience. It has been replaced by the National Security Personnel System (NSPS), which has five pay schedules and up to three pay bands within each pay schedule. The NSPS was still being implemented as of the time of this study.

⁵ The Air Force has no specific educational background requirements for cost estimators other than a bachelor's degree.

Figure 2.3
Backgrounds of Cost Estimators, 2008



SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

RAND TR708-2.3

lieutenants. Fewer than 10 percent of military cost estimators were lieutenant colonels or colonels (Figure 2.4). The tendency of the organic cost-estimating workforce to be concentrated in relatively low grades reflects the lack of advancement opportunities said to be available in this career field. In our interviews, the lack of a career path and advancement opportunities were frequently mentioned by respondents as problems for recruiting, hiring, and retaining cost estimators (see Chapter Three). However, three-quarters of contractors rated themselves as senior, with only about one in four contracted cost estimators rating themselves as junior or mid-level.

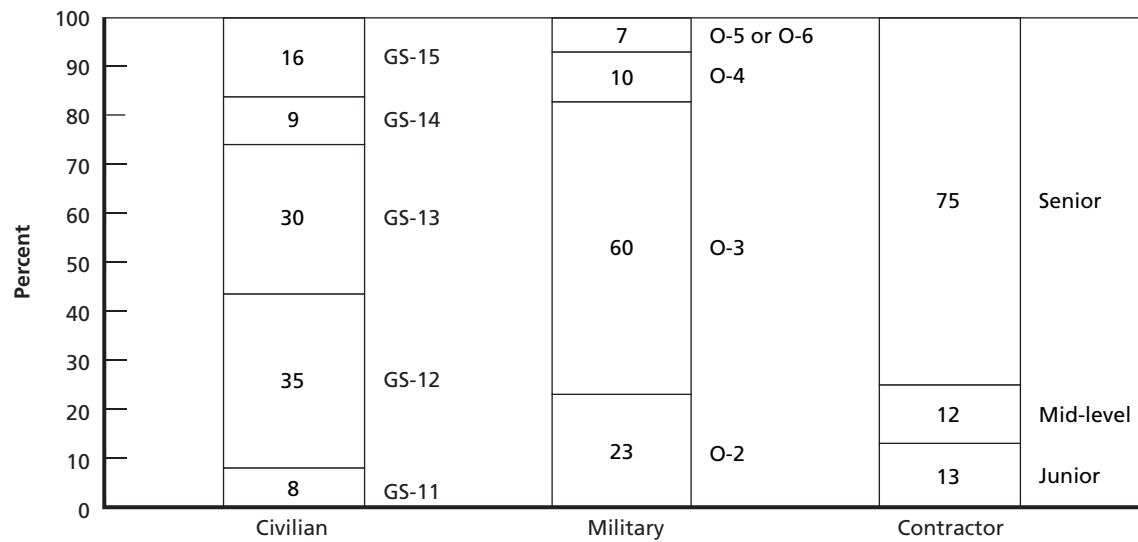
Experience

There were sharp differences in the amount of cost-estimating experience of organic and contractor cost estimators. About 50 percent of the organic workforce had five or fewer years of experience; of those, two-thirds had two or fewer years of experience. In contrast, half of the contractors had 11 or more years of experience, and half of these had 21 or more years of experience. About 20 percent of both the organic and contractor workforce had about 6 to 10 years of experience (Table 2.3).

Military personnel tended to have the fewest years of cost-estimating experience. Two-thirds of military cost estimators had less than two years of experience and only 16 percent had six or more years of experience (Table 2.4).

Across centers, there were only two notable exceptions to the pattern described above: Sixteen percent or less of the organic cost-estimating workforce at AAC and SMC had 6 to 10 years of experience, suggesting that they may encounter greater difficulties than other centers in filling positions requiring senior-level experience in the future (see Appendix D, Table D.4).

Figure 2.4
Grades and Types of Cost Estimators, 2008



SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

RAND TR708-2.4

Table 2.3
Cost Estimators' Years of Experience, by Personnel Type, 2008 (%)

Personnel Type	0–2	3–5	6–10	11–20	21+	Total
Organic (n = 180)	33	18	19	18	11	100
Contractor (n = 178)	13	14	23	26	24	100
All (n = 358)	23	16	21	22	17	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table 2.4
Military Cost Estimators' Years of Experience, by Product Center, 2008 (%)

Center	0–2 (n = 26)	3–5 (n = 7)	6–10 (n = 3)	11–20 (n = 11)	21+ (n = 2)	Total
AAC (n = 6)	17	0	33	17	33	100
ASC (n = 7)	100	—	—	—	—	100
ESC (n = 9)	67	22	11	0	0	100
SMC (n = 17)	71	29	—	—	—	100
All (n = 39)	67	18	8	3	5	100

SOURCE: RAND census, 2008.

Training

About 80 percent of the cost-estimating workforce reported having received some type of formal training in cost estimation. Nearly all civilians (96 percent) reported having received formal training, but only two of every three contractors did so (Table 2.5).

Table 2.5
Cost Estimators' Training, by Personnel Type, 2008 (%)

Training	Military (n = 40)	Civilian (n = 144)	Contractor (n = 178)	Total (n = 362)
APDP I	48	13	5	13
APDP II	13	21	5	12
APDP III	5	47	13	25
Air Force Institute of Technology (AFIT)	15	3	3	4
Automated Cost Estimating Integrated Tools (ACEIT)	0	1	12	6
Tecolote ^a training	0	0	10	5
Other	3	13	24	18
No training	18	4	29	18
Total	100	100	100	100

SOURCE: RAND census, 2008.

NOTE: When respondents indicated more than one type of training, we selected the highest level of training provided. Percentages may not add to 100 because of rounding.

^a Tecolote is the name of the contracted company providing cost estimators.

Training provided under the Acquisition Professional Development Program (APDP)⁶ was the most frequent form of formal training received by military (66 percent) and civilian (81 percent) cost estimators. Whereas most military personnel had received APDP I training only, the majority of civilians had received APDP III training because they had been in the field long enough to become trained and certified at Level III. Most of the military did not have the experience to go beyond Level I.⁷

Contractors, in contrast, reported receiving several types of training if they had received any. About one in four reported receiving APDP training, probably when they were in the military or were government civilian employees.⁸ About half had received training from other sources, including AFIT, ACEIT,⁹ or the contracting agency that employed them. The remaining 29 percent reported having received no training.

Certification

Two-thirds of the cost-estimating workforce, including military, civilian, and contractor personnel, reported having no certification in cost-estimating. The remainder reported various types of certification, the most frequent being Certified Cost Estimator/Analyst (CCE/A,

⁶ APDP is a certification process involving required training and years of experience to be certified at the different levels. It offers Air Force personnel courses and certification in FM, contracting, systems, engineering, program management, logistics, information technology, and scientific research and development. It has basic, mid-level, and advanced courses (Levels I through III) in these areas.

⁷ We did not collect information on what courses they had taken or the content of the courses. It is probably fair to say that the training in cost estimating received from the APDP programs was minimal because few courses in cost estimating are offered by APDP.

⁸ Contractors are not eligible for APDP training.

⁹ Automated Cost Estimating Integrated Tools are software programs that support cost and financial analysts and program managers (PMs). Training for using these tools may have been provided by ACEIT and by the Air Force product and logistics centers.

awarded by the Society of Cost Estimating and Analysis) (15 percent) and Certified Defense Financial Manager (CDFM, including Certified Government Financial Manager) (5 percent). Again there were some variations among the military, civilian, and contractor cost estimators (Table 2.6).

Time Spent on Cost-Estimating Tasks

Respondents were asked how much of their work time they spent doing cost-estimating tasks over the previous six months. This is, of course, a single-point-in-time estimate. The amount of time spent over the years on cost-estimating tasks by our respondents may have varied greatly, depending on the status of the program(s) they worked on. But, when averaged over all programs and cost estimators, as we did here, these estimates should be good indicators of the aggregate time the workforce as a whole spent on cost-estimating tasks.

About one in every three cost estimators, either organic or contractor, had worked full-time on cost-estimating tasks over the previous six months. Of the remainder, contractors generally reported spending more time on cost-estimating tasks than did organic cost estimators. Contractors were more than three times more likely to have spent 75 to 99.9 percent of their time on cost-estimating tasks than were the organic staff (47 versus 14 percent). And they were half as likely as organic cost estimators to have spent less than 25 percent of their time on cost-estimating tasks (Table 2.7).

Table 2.6
Cost Estimators' Certification, by Personnel Type, 2008 (%)

Certification	Military (n = 40)	Civilian (n = 144)	Contractor (n = 190)	Total (n = 374)
None/unknown	75	69	67	69
AFIT	5	3	3	3
CCE/A	10	11	19	15
CDFM	8	8	2	5
Other	3	8	10	5
Total	100	100	100	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table 2.7
Time Spent Doing Cost Estimation Over Previous Six Months, by Personnel Type, 2008 (%)

Personnel Type	None	Less Than 25	25 to 49.9	50 to 74.9	75 to 99.9	100	Total
Organic (n = 184)	5	17	17	12	14	35	100
Contractor (n = 190)	1	10	2	8	47	32	100
All (n = 374)	3	13	9	10	32	33	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

While the pattern at each individual center is generally similar to that of the cost-estimating force as a whole, there are a number of notable exceptions. In ESC, both organic and contractor staff were more likely than in other product centers to spend most of their time on cost-estimating tasks. In that center, more than 75 percent of the organic staff and more than 90 percent of contractors spent 75 percent or more of their time on cost-estimating tasks. And at SMC, organic cost estimators were the least likely of the organic staff at any center to spend more than 75 percent of their time on cost-estimating tasks; only about one-third did so (see Appendix D, Table D.5).

Finally, at two of the logistics centers, OO-ALC and WR-ALC, most (50 percent or more) of the organic cost-estimating staff were spending less than 25 percent of their time on cost-estimating tasks, as were contractors at the WR-ALC center.

Lead Estimators¹⁰

Overall, about half of the cost-estimating staff reported that they were lead cost estimators, i.e., the person responsible for ensuring the completeness and reliability of the cost estimates. Most military cost estimators (75 percent) reported that they functioned as lead estimators while about half (45 percent) of government civilians and contractors reported being lead estimators.

The composition (military, government civilian, and contractor) of lead estimators and their proportion of the cost-estimating workforce varied greatly across centers. Among product centers, AAC and SMC had the lowest proportions of lead estimators in their cost-estimating workforce (43 and 27 percent, respectively) and ESC had the highest share (66 percent). Among logistics centers, OC-ALC had one lead estimator (9 percent) while 50 and 30 percent of the cost-estimating workforce at OO-ALC and WR-ALC, respectively, reported they were lead estimators (Figure 2.5).

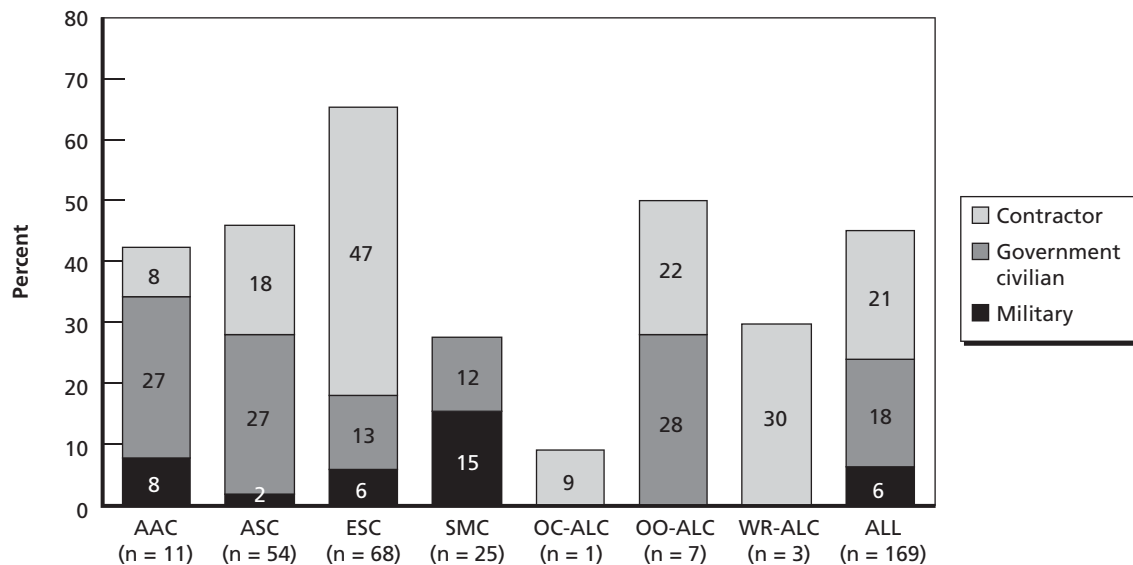
The proportion of contractors functioning as lead estimators varied across centers as well. None of the contracted cost estimators at SMC reported functioning as lead estimators; this center relied primarily on military personnel, and secondarily on civilians, to perform its lead-estimating functions. In contrast, 72 percent of ESC's lead cost estimators were contractors (see Appendix D, Table D.6). Both AAC and ASC relied primarily on their civilian labor force to perform lead cost-estimating functions, with ASC less likely than AAC to use civilian staff (57 versus 64 percent).

Experience of Lead Estimators

The distribution of organic lead estimators' years of experience mirrored that of organic cost estimators who were not lead estimators. About 40 percent of lead and other cost estimators had fewer than five years of experience. In contrast, contractor lead estimators were generally more experienced than other contractor estimators; about two-thirds of contractor lead estimators had 11 or more years of experience compared with 40 percent of other contractor estimators (Table 2.8).

¹⁰ Although Section 820 of the FY 2007 NDAA specifies that cost estimators' functions must be performed by "a properly qualified member of the Armed Forces or full-time employee of the Department of Defense" within five years after enactment of the Act, SAF/AQX staff indicated that the intent of the legislation is to apply mainly to lead cost estimator functions.

Figure 2.5
Cost Estimators Who Are Lead Estimators, by Center and Type of Personnel, 2008



SOURCE: RAND census, 2008.

RAND TR708-2.5

Table 2.8
Lead Estimators' Years of Experience in Cost Estimation, by Center and Personnel Type, 2008 (%)

Personnel Type	0-2	3-5	6-10	11-20	21+	Total
Organic						
Lead estimator (n = 89)	34	22	18	15	10	100
Other estimator (n = 91)	36	12	20	23	9	100
Contractor						
Lead estimator (n = 78)	4	12	22	35	28	100
Other estimator (n = 100)	19	15	25	19	21	100
All						
Lead estimator (n = 167)	20	17	20	24	19	100
Other estimator (n = 191)	27	14	23	21	15	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

At SMC, where many lead estimators are military, three-quarters had five or fewer years of experience. In contrast, ESC's lead estimators were primarily contractors, and over half of them had 11 or more years of experience (see Appendix D, Table D.7).

Time Worked on Cost-Estimating Tasks

Overall, lead cost estimators were slightly more likely to work full-time on cost-estimating tasks in the previous six months than were other cost estimators (37 percent versus 29 per-

cent). Similarly, lead cost estimators were less likely to spend less than 25 percent of their time on cost-estimating tasks than were other cost estimators (10 percent versus 24 percent) (Table 2.9).

ACAT Programs and Lead Estimators

We examined the proportion of ACAT I, II, and III programs that had an assigned lead estimator, based on a list of ACAT programs provided by SAF/AQX as of January 2008. Of the 196 ACAT programs on this list, 53 were ACAT I,¹¹ 29 were ACAT II, and 114 were ACAT III (Table 2.10).

Overall and at the time of our survey (winter 2008), 57 percent (112) of the ACAT programs listed had a lead estimator.¹² All ACAT I programs at AAC and SMC had a lead cost estimator assigned to them, and nearly all such programs had a lead estimator at ASC and ESC (87 and 94 percent, respectively) (Table 2.11).

ACAT II programs were less likely than ACAT I programs to have a lead cost estimator assigned—just over 60 percent had one. However, there were large variations across centers: At ASC, 80 percent of ACAT II programs had a lead estimator; only one-third of ACAT II programs at AAC and SMC had a lead cost estimator assigned.

About 40 percent of ACAT III programs had a lead cost estimator assigned—again with large variations across centers. At ESC, nearly two-thirds of ACAT III programs had a lead cost estimator, compared with 43 and 22 percent of ACAT III programs at SMC and ASC, respectively. Fewer than one of every six ACAT III programs at AAC had a lead cost estimator assigned.

Table 2.9
Lead Estimators' Time Spent Doing Cost Estimation, by Personnel Type, 2008 (%)

Personnel Type	None	Less Than 25	25 to 49.9	50 to 74.9	75 to 99.9	100	Total
Organic							
Lead estimator (n = 90)	1	10	9	19	19	42	100
Other estimator (n = 94)	9	24	25	4	10	28	100
Contractor							
Lead estimator (n = 79)	0	4	3	10	52	32	100
Other estimator (n = 111)	1	15	3	6	44	31	100
All							
Lead estimator (n = 169)	1	7	6	15	34	37	100
Other estimator (n = 205)	4	20	13	6	28	29	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

¹¹ These ACAT I programs include ACAT I and ACAT IA.

¹² Of the 169 self-reported lead estimators, 126 reported working on an ACAT program (a program may have more than one lead estimator), three led resource selection, and five were branch or section chiefs. The remaining number reported being lead estimators on programs not included on the SAF/AQX list provided for this study.

Table 2.10
Number of ACAT Programs, by Center and ACAT Program Level

Center	ACAT I	ACAT II	ACAT III	Total
AAC	5	3	12	20
ASC	15	15	49	79
ESC	18	5	39	62
SMC	15	6	14	35
All	53	29	114	196

SOURCE: List of programs provided by SAF/AQX, January 2008.

Table 2.11
ACAT Programs with a Lead Estimator, by Center and ACAT Program Level, 2008 (%)

Center	ACAT I (n = 53)	ACAT II (n = 29)	ACAT III (n = 114)	All
AAC (n = 20)	100	33	17	40
ASC (n = 79)	87	80	22	46
ESC (n = 62)	94	60	64	73
SMC (n = 35)	100	33	43	66
All (n = 196)	94	62	39	57

SOURCE: RAND census, 2008.

Cost-Estimating Workforce Adequacy, Composition, and Competencies

We conducted face-to-face interviews in the spring and summer of 2008 with wing or group commanders at three of the seven centers included in the study: seven group or squadron commanders at ASC, five group commanders at ESC, and six wing commanders at SMC.¹ In most instances, these commanders were accompanied by their chief cost estimator and/or chief financial manager. In addition, we interviewed the chief of the FMC division and held two focus groups in each center, one with up to four lead cost estimators and the other with up to four other cost estimators.

In the interviews and focus groups, we asked for the participants' assessment of the adequacy of their cost analysis workforce, both quantitatively and qualitatively. If wing and group commanders indicated that their needs for cost estimators were not being met, we asked how they coped to meet their programs' cost-estimating needs. Respondents were also asked about their perspectives on their cost-estimator workforce composition and mix; the desirable competencies, hiring and training requirements for cost estimators; and future requirements for the cost-estimating workforce (see interview protocol in Appendix C).

When interpreting the findings below, the reader should keep in mind that they reflect the opinions of our respondents. With few exceptions, we did not make independent checks. Also, we focus in this report primarily on characteristics and issues for which there was relatively strong agreement across most respondents and across all three centers. In the few instances where there was a marked diversion of opinions, we indicate so. Our purpose is to provide an aggregate overview of the reported strengths and weaknesses of the cost-estimating workforce as a whole; it is not to expose individual views, however strongly held.

This chapter first describes the characteristics of the three product centers' cost divisions, which are designed to support and oversee the cost-estimating activities of wings and groups on behalf of their respective program executive officers (PEOs). Next, we discuss the adequacy of the cost-estimating workforce in terms of its quantity, mix, and competencies, and look at the coping mechanisms used to address problems in any of these areas. We then outline a set of issues raised by our respondents that should be addressed in order to improve the effectiveness of the cost-estimating workforce. These include hiring, training, data collection, and maintenance. We conclude with a brief discussion of future trends mentioned by our respondents that will need to be addressed in coming years.

¹ Per agreement with SAF/AQX and AFCAA, we did not conduct interviews at AAC and the logistics centers because they have fewer cost estimators.

Roles and Capabilities of the Central Cost-Estimating Divisions

All three product centers maintain a central cost staff (the FMC division) that is responsible to the center's PEO, although the manning of the divisions differs significantly. ASC's cost staff is the largest, with 32 organic cost estimators; SMC's has 12 cost estimators, 75 percent of whom are organic; and ESC's is the smallest with only ten cost estimators at the time of our interviews. ESC's division was being reestablished after having been abolished when authority and responsibilities over staff were transferred from the functional chiefs to the wing commanders (Air Force Materiel Command, 2004).

The cost staff described their main functions in an overlapping manner, including

- formulating and implementing center policy on cost-estimating
- conducting peer reviews and serving as an honest broker
- conducting independent cost studies and analyses
- assisting wings during surge needs for cost estimates.

Although manned at widely different levels, all three centers reported that they did not have a sufficient number of staff to perform these and other functions. To fill these gaps, ESC/FMC reported that it had received authorizations to hire 15 additional organic staff over the next three years and indicated needing another 5 to 15 additional staff. ASC/FMC reported that it had obtained authorizations for ten staff in addition to the ten vacancies it currently had. SMC personnel said they needed 30–35 additional positions centerwide.

Respondents identified three issues related to their estimated shortages of cost estimators:

First, the FMC divisions are unable to provide sufficient cost-estimating surge assistance to their respective wings and groups. Even ASC/FMC, which reported that it typically assigns 85 to 90 percent of its relatively large staff of cost estimators to surge activities at any one time,² said it was unable to meet all requests from wings and groups. SMC/FMC and ESC/FMC indicated that they were not able to provide surge assistance, an assessment that was also confirmed by their centers' wings and groups.

Second, none of the centers had developed an internal capacity to train newcomers or provide ongoing training to keep cost estimators abreast of new cost-estimating practices and to share "best practices."

Third, the centers' cost staff had little or no capacity to do research and collect, update, and share cost data to provide a better basis for future cost models. The only exception was SMC/FMC, which had recently assigned two organic cost estimators to form a research unit with the primary function of collecting and normalizing cost data on newer technologies.

Adequacy of the Cost-Estimating Workforce

All three centers rely primarily on contractors to meet their cost-estimating requirements, regardless of the proportion of organic cost estimators at the center. ESC, whose cost-

² Reportedly, ASC/FMC devotes little time to its other functions including cost studies and analyses, updating cost processes and tools, and the like.

estimating workforce is less than 25 percent organic, has little choice but to rely almost entirely on its contractors to meet its cost-estimating needs. Even ASC, where nearly two-thirds of the cost-estimating workforce is organic, nevertheless relies primarily on contractors to provide leadership and experience to meet their cost-estimating needs. The organic cost estimators in ASC's groups are FM generalists, reportedly to maintain flexibility to respond to day-to-day work requirements and to facilitate the integration between cost-estimating and FM functions. Half of this staff has less than two years of cost-estimating experience. Similarly, at SMC the actual cost-estimating is typically done by contractors. Organic staff are self-described "cost managers" who oversee several contractor cost estimators to make sure that cost estimates are done on time; however, they also perform other FM functions as well.

In our interviews, several respondents told us that the depletion of their organic cost-estimating capability originated with a decision made in the 1990s to contract out the acquisition cost-estimating functions. Since then, a cost-estimating career has become unattractive for organic staff because of the lack of advancement opportunities in the small organic cost-estimating workforce and the low esteem in which this specialization is held, according to our respondents. As a result, more than 50 percent of organic cost estimators have five or fewer years of experience and only 30 percent have more than ten years of experience. Organic staff tend to leave cost-estimating positions after a few years if they desire to improve their promotion opportunities.

Need for Additional Cost Estimators

Nearly all our respondents said they needed additional staff to fully meet all their cost-estimating needs. A few respondents, however, were reluctant to say they needed more cost estimators, indicating that they were able to "get things done" or that "it is a subjective matter whether or not they had enough staff." Currently, there is no objective yardstick or methodology to assess the need for cost estimators that accounts for an acquisition program's type, size, and stage in the acquisition life cycle.³

Together, the three centers estimated an aggregate need for a minimum of 70 additional organic staff. ASC estimated that it needed 14 to 34 additional authorizations; SMC estimated a need for 30 to 35 additional organic staff. ESC did not provide a centerwide estimate, but estimates from individual commanders totaled about 27 additional positions. These needs were in addition to the 57 vacancies at the three centers that they were already having difficulties filling.⁴

The additional staff was needed for a variety of tasks, including

- performing pre-Milestone A and B estimates
- ensuring that all estimates are updated annually

³ One commander volunteered that it takes one person-month to do a program objective memorandum (POM) request, three to four person-months for a Milestone A program office estimate (POE), and seven to eight months for a Milestone B POE with a Cost Analysis Requirements Description (CARD). Milestone A is a review occurring after a material solution has been adopted and prior to the technology development strategy phase. Milestone B is a review occurring at completion of the technology development strategy phase and prior to the engineering and manufacturing development phase. CARD describes the system's mission, certification, relationship to other systems, and the major factors that influence its costs.

⁴ We discuss barriers to hiring in greater detail below.

- supporting all ACAT programs
- supporting source selection
- providing surge support to wings
- independently verifying and validating all estimates and reviewing their documentation
- verifying contractor cost estimates
- overseeing contractor cost systems and procedures
- collecting, normalizing, and storing cost data
- providing recurring, focused, in-house training
- enabling more specialization.

Although wings and groups may hire additional contractors to fill some of these gaps, in practice they said they are constrained by center-level cost ceilings on contracts;⁵ higher center or wing priorities on contractors in other functional areas, such as engineering; and the need to use program funds to cover the costs of contractors.

Force Composition

Most commanders said they would prefer to have a more balanced ratio of experienced organic and contractor cost estimators so that the organic staff would have the experience to take the lead role in performing cost estimates and/or reviewing contractors' estimates. They typically preferred a 50/50 ratio of organic to contractor staff, with a few respondents preferring a 75/25 ratio.

Some commanders also indicated a preference for an all-civilian organic cost-estimating workforce. Military cost estimators were seen as less experienced, prone to be deployed (mostly as financial officers rather than as cost estimators), and less likely to pursue a career in cost estimation. There was recognition, however, that cost-estimating experience may be useful for officers who later fill military command positions.

Several reasons were offered in support of a higher share of experienced organic cost estimators. They are needed to lead and direct cost estimates, exercise oversight, provide continuity,⁶ and improve control of requests. In addition, organic staff can be moved more easily, as needed (especially to meet surges), and have greater credibility with other organizations, especially with the Office of the Secretary of Defense (OSD).

Force Mix

A Mid-Level Gap? Commanders expressed concern that there were too few mid-level cost estimators, not only among the organic workforce but also among contracted cost estimators, to replace those who will soon retire. The organic cost-estimating workforce is split between the junior level (51 percent) and the senior level (29 percent), and the contracted workforce is primarily tilted toward the senior level (50 percent), as discussed in Chapter Two. SMC's organic cost-estimating workforce is even more unbalanced with 66 percent at the junior level and only 10 percent at the mid level.

⁵ At ASC and SMC contracts are centerwide and at ESC there are separate contracts for each wing. However, the center has authority to limit the dollar value of the contracts.

⁶ However, it is not uncommon for contracted cost estimators to stay for several years in a specific program or wing.

The seniority distribution of the organic cost-estimating workforce raises two issues. First, to the extent that there is a real mid-level gap in the distribution of cost estimators, it could be reduced by ensuring the retention and greater specialization of the current disproportionate reservoir of junior-level cost estimators.⁷ Second, the small reservoir of mid-level staff will make it very difficult, if not impossible, to fill vacancies (and to meet needs for additional staff).⁸ As noted in Chapter Two, the mid-level organic cost-estimating positions are disproportionately vacant. Because there are too few potential candidates at this level, at least under the current pay scale, one center's wing or contractor loss is another center's wing or contractor gain.⁹

Generalists Versus Specialists. Respondents held different preferences as to whether cost estimators should be generalists, i.e., those who can perform cost-estimating as well as other FM tasks, or specialists, i.e., those who have more years of experience and in-depth knowledge of cost estimation. Some commanders and FM chiefs valued the flexibility of generalists, who can be allocated to a variety of FM functions according to day-to-day program needs. Other commanders and chief cost estimators felt that cost estimation requires more preparation, development, and experience than is feasible for generalists, especially as the complexity of the systems being developed increases. They also value cost estimators who can "ask the right in-depth questions" and perform independent estimates, as well as provide effective oversight over contractors. In practice, organic FM generalists need to be coupled with expert cost estimators, who are now most frequently contractors.

There was consensus that the FM field had become more generalized over the years and seemingly favored FM and budget over cost estimation.

Workforce Competencies

Respondents were generally satisfied with the competencies of their organic cost-estimating workforce—even more so with their contracted cost-estimating workforce. Most placed greater weight on years of experience practicing cost estimation and on having detailed knowledge of their programs than they did on the academic background of their cost estimators. Still, there were areas where respondents thought more expertise was needed.

There was a consensus among our respondents that an engineering or technical background, although not absolutely necessary, would be particularly useful for understanding the technologies involved in acquisition programs, staying abreast of new developments, and obtaining more-detailed information from engineers. Estimators with these backgrounds were thought to be able to ask deeper questions than those with an accounting or financial background. A mathematics or operations research background was also seen as good preparation for a cost-estimating career.

In addition, respondents mentioned several areas where more expertise was desirable. These included risk assessment analysis, systems integration, and analytical and conceptual skills. Cost estimators also need to know more about acquisition scheduling because of the key role it plays in making good cost estimates. At SMC, a prior understanding of the space envi-

⁷ Determining whether there are enough mid-level staff to eventually replace retiring senior-level staff would require projecting retention rates and retirement rates over the next 10–20 years.

⁸ We did not ask about the seniority of the additional staff needed, but our sense is that centers typically would prefer to hire candidates with prior experience in cost-estimating.

⁹ We discuss this issue in greater detail below.

ronment was deemed desirable. In all centers, prior experience in acquisition, whether or not in cost estimation, was also deemed important.

Finally, there was a near consensus that the cost-estimating workforce as a whole needs to have more capability, both quantitatively and qualitatively, in the use of cost-estimating software programs.

Coping with an Inadequate Cost-Estimating Workforce

Respondents used numerous methods to cope with an undermanned cost-estimating workforce, including the following:¹⁰

- **Prioritizing.** Respondents frequently reprioritize to meet the most pressing demands for cost estimates. In this process, estimates that go to the PEO get the highest priority. The rest are delayed or do not get done. ACAT III programs get low priority.
- **Tasks left undone.** These include yearly reviews, integrated baseline reviews (IBRs) on major programs, verification of contractors' estimates, cost drills, tracking of ongoing contracts, collection of background data, research and data analysis, and staff development. Also, operations and support (O&S) issues are often left unaddressed.
- **Use of undesirable practices.** These include decisions and budgeting based on back-of-the-envelope estimates; risks and uncertainties not pursued systematically; estimates left unchecked, relying on the Defense Contract Audit Agency (DCAA) to catch potential problems; small programs relying on the cost estimates of the product suppliers; specialization in cost analysis being discouraged; and inexperienced staff serving as lead estimators.
- **Acceptance of increased risks.** As a result, programs may fail to recognize cost overruns on time, and program and requirement inefficiencies may increase.
- **Lower-quality estimates.** Program cost estimates, mid-term IBRs, and cost-risk assessments are less accurate and defensible.
- **Staff burnout.** Rapid operational tempo leads to burnout of some staff.

Barriers to Hiring Cost Estimators

As suggested by the large number of vacancies in cost-estimating positions at the three centers (see Chapter Two), respondents indicated that they had difficulties hiring cost estimators. These difficulties were attributed to several factors.

At ESC and SMC, the foremost factor was the high cost of living in the Boston and Los Angeles areas, respectively. This problem is greatest for entry-level staff, but even senior staff were said to be reluctant to move to these areas.

Competition with contractors for cost estimators was a pronounced issue at all three centers. Many of the civilian vacancies are at the GS-12 level or above, and the centers most often obtain contracted cost estimators at the mid and senior level. Hence, both the centers and their contractors are competing for candidates from the same small pool of experienced cost estimators.

¹⁰ Note that we were not able to ascertain the frequency with which these coping mechanisms were used.

Indeed, the Air Force Personnel Center (AFPC) was said to have difficulties identifying government or outside candidates with the desired cost-estimating experience. This problem was also attributed, in part, to job descriptions that are too general, resulting in candidates with few or none of the specific attributes desired.¹¹ AFPC was also said to take seven or more months to complete the hiring process of outside candidates, so some candidates may take other jobs because they cannot wait that long.

Lack of a career path for cost estimators was also frequently mentioned as a barrier to attracting and retaining civilian cost estimators. Because of the small size of the organic cost-estimating labor force, greater career advancement opportunities are available in other functions, such as budget and FM; this creates an incentive for staff to avoid specializing in cost-estimating. As staff move up the FM career ladder, they were said to have a tendency to leave cost-estimating in favor of other FM functions that offer many more positions throughout government.

The one exception to this pattern is entry-level hiring at ASC. ASC indicated that it had no difficulty hiring recent college graduates at the junior level. The center has established close relationships with colleges in the region from which it gets most of its entry-level hires. But, at the mid and senior levels, ASC reported having difficulties similar to those at the other centers. The only option it saw was to hire from other centers or programs—a procedure that, if successful, only transfers the problem from one location to another within the acquisition community.

Training

The centers currently provide neither formal training nor mentoring to develop the skills of cost estimators. Reportedly, they do not have the resources to support an ongoing internal training program.¹²

In practice, training of organic staff occurs mostly on the job, as they work with mid- and senior-level cost estimators. The “trainers” were said to be most frequently senior-level contracted cost estimators. But because of the high operations tempo, respondents also said that senior cost estimators had little time to mentor younger colleagues or permit trainees to shadow more-experienced cost estimators. Respondents typically estimated that it takes up to five years to train a junior staff member to become competent to perform complex independent cost estimates. Some said that it takes even longer.

The consensus of our respondents was that organic cost estimators are not adequately trained. Although all staff in the FM specialty are encouraged to participate in the Air Force Financial Management Training Program, not all do so because it is not mandated. And even if they do participate, courses in cost-estimating are currently offered only at the basic or intermediate level as required courses. Although the Defense Acquisition University (DAU) offers

¹¹ Our reviewer indicated that part of the problem is that AFPC identifies candidates who do not have the experience needed because their job experiences have been coded incorrectly, e.g., coded as having 30 percent cost, 30 percent EVM, and 30 percent budget experience, when actually their experience was 100 percent budget.

¹² Some respondents indicated that the operations tempo in their center is so high that they typically would not have time to attend training sessions even if they were offered. Also, SMC sponsors basewide training on cost-estimating software programs such as SEER by Galorath, PRICE, ACE Risk Management, and ACEIT.

many other elective courses in its Core-Plus program (i.e., BCF 206, Cost/Risk Analysis; BCF 207, Economic Analysis; BCF 208, Software Cost Estimating; BCF 215, Operating and Support Cost Analysis; and BCF 263, Principles of Schedule Management), they usually are not taken because they are not required for Business, Cost Estimating, and Financial Management (BCEFM) certification. Therefore, there is little evidence to assure the employer that the individual has been trained on the requisite cost knowledge. Consequently, over the past few years DAU and senior leaders across DoD have taken action to improve training across the cost estimating acquisition workforce to assess the needs of the BCEFM community. This resulted in the restructure of the BCEFM acquisition community.

This restructure (effective October 1, 2009) established two separate career paths (Business–Cost Estimating and Business–Financial Management) and renamed the BCEFM career field Business. This will ultimately satisfy the DoD cost community’s internal needs for more robust training in the areas of statistics, cost risk analysis, O&S cost estimating, software cost estimating, data collection, and analysis while complying with Section 820 of the 2007 NDAA, Government Performance of Critical Acquisition Positions.¹³

In contrast, respondents generally praised the solid analytical preparation of graduates of AFIT, which shortened the time it took them to acquire the knowledge needed to perform cost estimates. However, the master’s program offered by AFIT is primarily limited to military personnel, and few are given the opportunity to attend. Also, AFIT-trained military personnel rarely spend more than one tour of duty in cost analysis positions.

Most respondents thought that better training and mentoring is needed in several areas, including source selection, IBR, POEs, risk analysis, scheduling, software cost estimation, and O&S. They recommended that separate courses be developed in these subjects. Respondents also suggested making greater use of case studies in training courses.

Finally, some respondents suggested reestablishing an intern program and providing cost estimators with opportunities for education with industry (EWI) assignments, during which they could obtain a better understanding of budgeting and cost-estimating practices in private industry.

Data Collection and Maintenance

The validity of cost estimates depends in large measure on the availability and quality of data collected from previous acquisition programs and cost estimates. Our respondents said that data collection takes a significant portion of the time involved in making a cost estimate, particularly for estimates done early in the life cycle of a program. Yet respondents indicated that cost-estimate documentation was not being emphasized, shared, and made available as background data for future cost estimates. Also, there was no exchange of data and information across programs. Even when cost information is documented, it is not put in a format that is easily accessible and usable. Another important issue that affects data collection is the elimination of data requirements in acquisition contracts: Contract cost data have thereby lost consistency across programs and are either unavailable or must be purchased from the contractors at additional (and unplanned) expense.

¹³ Communication with the Defense Acquisition University.

Respondents blamed lack of resources in FMC divisions and programs for failure to perform this important task well, if at all. As noted earlier, SMC has set up a small research unit in its FMC division to collect cost data, focusing particularly on new technologies.

Opinions diverged on who should be responsible for data collection and maintenance. Some respondents thought this function should be done centrally at the Air Staff level while others thought it should be done at the center level because the types of programs and technologies used differ across centers.

Looking Ahead

Respondents identified several issues that will need to be addressed in the coming years. Foremost among them is the expected continuing trend toward programs that are more dependent on software than on hardware. This shift, they said, will require the development of new cost-estimating techniques and more-specialized cost estimators. Respondents thought that many cost estimators did not have the required expertise to work on these software programs.

Another issue identified is the need to develop a capability to estimate operation and maintenance (O&M) costs for space systems. Reportedly, O&M costs for operating, troubleshooting, and responding to anomalies in launched space systems have increased rapidly—from 20 percent to 40–50 percent of system costs. Currently, estimates of O&M costs come entirely from contractors, without independent government reviews.

Other forward-looking issues identified by our respondents included the following:

- **A need for niche expertise in the cost-estimating workforce.** Respondents identified risk analysis and scheduling as areas that need specialized expertise that can be shared across programs.
- **Guidance and staff for sufficiency reviews.**¹⁴ Current guidance was viewed as being inconsistent. Some programs (those that do not have much actual cost data) do not really need a sufficiency review. Respondents noted that they did not have enough staff with the required experience to perform sufficiency reviews.
- **Staff development.** Certification for cost analysts should be more rigorous to improve the quality of estimators, and a career path for cost analysis is needed to attract and retain cost analysts. There is also a need for more cost estimators with foreign military sales (FMS) experience to adequately cover the growing numbers of NATO and other programs with FMS.
- **Use of red teams.** ESC has used red teams (which include senior cost estimators not affiliated with the program) in at least four cases in the past and has found them useful as well as insightful. Greater use of red teams, perhaps with industry representatives, was seen as one way of improving the quality and reliability of cost estimates.
- **Data collection.** Data requirements should be included in acquisition contracts¹⁵ to ensure that cost data are available on current programs and for future estimates.

¹⁴ A *sufficiency review* is a review of program office cost estimates for reasonableness, completeness, consistency, and compliance with generally accepted estimating processes. It provides decisionmakers with an assessment of the quality of the cost estimate (Independent Program Assessment Office, undated).

¹⁵ SMC reported that it has started to include data requirements in contracts for new programs.

- **Cost-estimating research.** Research has payoffs in improving cost estimates, especially given the shift toward programs that are more reliant on software. Increasing research is likely to require a combination of more organic staff and more funding devoted to this purpose. Respondents felt that most research should be conducted and supported at the center level rather than at the wing level or at AFCAA.

Closing Thoughts

Cost estimators who participated in our focus groups emphasized that the quality of their cost estimates depended in part on the information and data they received from other team members. Some felt they did not get enough detailed information from engineers to make good estimates, especially in software-development costs, where they have less experience.

At one center, a major complaint was directed at PMs. Respondents said that PMs did not have adequate knowledge of the acquisition process and were poor planners. Respondents at two centers mentioned frequent problems with scheduling (incomplete schedules or frequently changed schedules). As a result, cost estimators were often given too little time to perform quality cost estimates. Some respondents felt that large programs should have a designated scheduler.

Conclusions

This report provides a count of the military, government civilian, and contracted staff engaged in cost-estimating tasks during January and February 2008 at the seven Air Force acquisition product and logistic centers. It also describes the results of interviews with wing and group commanders, selected staff, and cost estimators at three product centers, in which respondents assessed the adequacy of the acquisition cost-estimating workforce, both quantitatively and qualitatively. We draw four overarching conclusions from our descriptive findings.

First, the Air Force acquisition product and logistics centers rely primarily on the experience and knowledge of contractors to perform cost estimates. The organic staff is generally too inexperienced, or is otherwise needed to perform other FM tasks, to take a leading role in developing cost estimates. Although lead estimators for ACAT I programs may be nominally organic, the actual cost estimating may be performed mainly by contractors.

Second, the organic cost-estimating workforce seems to be understaffed. Nearly all our respondents said they needed additional staff to fully meet all their cost-estimating needs. Meeting these needs is hampered for two reasons: (1) The centers do not have enough authorizations for cost estimators, and (2) they are unable to fill the vacant authorizations they already have. Centers encounter multiple difficulties when hiring organic cost estimators. At current salaries, the high cost of living is a major barrier for both junior and senior staff at ESC and SMC. Also, there are simply not enough qualified cost estimators (many of the vacant positions are for mid-level or higher positions). As a result, the centers compete among themselves and with contractors to hire qualified cost estimators. Finally, the Air Force is not developing enough experienced organic cost estimators. Because the cost estimation specialty is small and embedded within the FM field, which offers greater advancement opportunities in other specialties, it is unattractive for junior staff to enter and stay in a cost-estimating career. In addition, the Air Force seems ambivalent between developing FM generalists with some knowledge of cost-estimating or cost-estimating specialists with in-depth knowledge and multiple years of experience.

Third, organic cost estimators are not adequately trained. The centers' FMC divisions do not have the resources to formally train their staff, and the few cost-estimating courses that are available at DAU were said to be inadequate and insufficient. Training of organic cost estimators is done on the job, mainly by the contractors with whom they typically work. Respondents generally estimated that it takes about five years for a cost estimator to become "competent" to perform cost estimates for complex programs. Organic cost estimators need more training in source selection, IBR, POE, risk analysis, scheduling, software cost-estimating, and O&S. Existing training courses could be improved by making greater use of case studies.

Finally, our respondents identified three other issues that appear to need particular attention in the coming years. The first is the expected continuing trend toward programs that are more dependent on software than on hardware. This shift, they reported, will require the development of new cost-estimating techniques and more-specialized cost estimators. Second, the Air Force needs to develop the capability to estimate O&M costs for space systems. O&M costs for operating, troubleshooting, and responding to anomalies in launched space systems have increased rapidly in recent years and O&M cost estimates currently come entirely from contractors, without independent government reviews. Third, the centers should reengage in cost-estimating research and more-systematic collection of cost data. Respondents felt that these activities would have payoffs in improving cost estimates, especially given the trend toward more software-dependent programs.

The Air Force will need to address most, if not all, of these issues in a concerted manner, if it is to meet the requirements of Section 820 of the 2007 NDAA for cost estimators.

Census of Cost Estimators: Questionnaire

Data Elements		Information Requested
1	AF Organization/ Office name	Wing, group, squadron, center or other organization identifier, plus office symbol where the cost analyst works.
2	ACAT Program(s) worked on during past 6 months	Use acronym(s) from Program Acronyms sheet (worksheet 4) or name of other program(s) if not listed there.
3	Name of Employee	Full name of employee.
4	Position Number (MPCN)	Manpower Position Control Number for the employee.
5	Status	Full-time, on-duty (default); Full-time, TDY elsewhere; part-time.
6	Lead Estimator? For what programs?	List program acronyms or names (from worksheet 4) for which this individual is the lead cost estimator. Leave blank or enter "No" if not a lead cost estimator.
7	Mil Grade or Civ Pay Plan-Series-Grade	Current grade (and Occupational Series) for the employee.
8	Duty AFSC	
9	Duty title	Official duty title (will be extracted from personnel database if left blank).
10	% time spent in acquisition cost estimating during past six months	Enter one of the following five categories: 100%; 75% or more; 50% or more; 25% or more; less than 25%. Based on the last 6 months work or since starting current position if less than 6 months.
11	% time spent in doing EVM other than in support of cost analysis during the past six months	Enter one of the following four categories: 75% or more; 50% or more; 25% or more; less than 25%. Based on the last 6 months work or since starting current position if less than 6 months.
12	% time spent doing other financial management during past 6 months	Enter one of the following four categories: 75% or more; 50% or more; 25% or more; less than 25%. Based on the last 6 months work or since starting current position if less than 6 months.
13	Total Years of Cost Analysis Experience	Count all years the individual was employed in cost analysis work at least 50% of the time.
14	Total Years of Other FM Experience	Count all years the individual was employed in FM work at least 50% of the time including cost estimating and analysis.

15	Total Years of Acquisition Experience	Count all years the individual worked in acquisition at least 50% of the time, including both acquisition cost analysis and other acquisition-related assignments.
16	Highest Degree Obtained	
17	Field of Study for Highest Degree	
18	Formal Cost Analysis Training	For example: APDP Level III; CostProf (enter "NONE" if none).
19	Certification(s) and Source	For example: SCEA, ISPA (enter "NONE" if none).
20	Notes	Other information or clarification, if needed.

Instructions for filling out questionnaire:

Purpose

SAF/AQX, in cooperation with the RAND Corporation, is conducting a study of the status of the cost analysis workforce Air Force-wide. The purposes of the study are to develop a reliable count of the current cost analysts working on AF ACAT I, II, III programs and assess the operating needs for cost analysts currently and in the near future. The list of your Center's programs is attached.

To achieve this goal, we need you to fill in the attached spreadsheet requesting specific information on each individual cost analyst working on one or more of your Center's ACAT programs. The information we collect will be kept confidential and none of the information provided on any individual will be released to anyone or be accessible to anyone else other than the RAND staff working on the study. The information collected will be used to describe the characteristics and experience of the current cost analyst workforce in the aggregate.

Three separate worksheet-forms need to be filled out for (1) currently assigned (government employee) cost analysts (see definition below), (2) contractor/consultant cost analysts, and (3) vacant cost analyst positions. Enter the information requested for each individual cost analyst (and vacant position) in successive columns from left to right; you may make duplicate copies of the worksheet-forms and use separate forms for different offices if that is more convenient.

Definition of Costs Analysts for the Purpose of This Census

Any military or government civilian engaged in acquisition cost estimating, cost analysis and modeling, and/or cost/risk assessment, either full-time or part-time; or any contractor personnel or consultant working in similar positions for an AF organization in support of acquisition programs; or any authorized but vacant position supporting similar cost analysis and estimating (e.g., AFSC 65W positions in acquisition offices). Individuals providing data in support of cost analysis should only be counted in this category if they participate in the analysis of that data to produce cost estimates. Earned value management activity should only be counted in this category if it directly supports cost estimating activities.

Please include cost analysts assigned to the office who are temporarily elsewhere for training or other TDY.

Definitions of Requested Information on the Worksheet Form

AF Organization & Office Symbol: The name of the wing, group, or squadron and office symbol of the office the cost analyst is currently working with (or assigned to) (e.g., Hq ESC, FMP; 677th Aeronautical Systems Group, FM).

ACAT Program(s): Enter the acronym for the ACAT program(s) the individual is working on or has worked on during the past six months. Use the acronyms from the list provided in worksheet 4, if applicable, or provide a full program name if the relevant program is not included in the list. You may enter “and other” if the individual is associated in a relatively minor way with programs other than those explicitly listed. It is especially important to identify ACAT programs for which the individual or position is designated as lead cost estimator.

Position Number (MPCN): (for organic employees and vacant positions only): The position number (MPCN) of the position held by the cost analyst. If the employee’s position has no authorized position number (or the position number is unknown), enter “overhire,” “unknown,” or other text indicating the type of position. Please do not leave this cell blank. The MPCN will be used along with the employee name to link data from personnel system databases where possible.

Status (for organic employees only): Enter “full-time on duty,” “full-time TDY, elsewhere,” “Part-time,” “TDY for training,” or other appropriate text if the employee is not full-time and currently on duty.

Contractor Organization (for contractor positions only): Enter the name of the contracting organization that employs the contractor/consultant cost analyst (e.g., Tecolote, MITRE).

Senior, Mid-Level, or Junior (for contractor positions only): Enter one of the three categories to indicate the approximate level of seniority, expertise, or experience of the contractor/consultant analyst.

Lead Estimator and for What Program(s): Enter the acronym or name of ACAT program(s) for which this analyst is the lead cost estimator from the list of ACAT programs included in worksheet 4. It is important that all programs for which the analyst is the lead estimator be included.

Mil Grade or Civilian Pay-Plan-Series-Grade (for organic employees and vacant positions only): Military grade for a military cost analyst or position; pay-plan, occupational series and grade for a civilian cost analyst or position.

Duty AFSC (for organic employees and vacant positions only): Duty AFSC of the cost analyst or authorized AFSC for a vacant position.

Duty Title (for organic employees and vacant positions only): Official duty title for the individual, or for the position. (May not be available for all positions).

Percent Time Doing Acquisition Cost Estimating During the Past Six Months: The percentage of time the cost analyst has worked on cost estimating and cost analysis tasks over the last six months (or since being assigned to the current position, if less than six months). Enter the expected percentage of time that would be devoted to acquisition cost estimating for vacant positions. Enter one of the following five categories: 100 percent; 75 percent or more; 50 percent or more; 25 percent or more; or less than 25 percent.

Percent Time Doing EVM Other Than in Support of Cost Analysis During the Past Six Months: The percentage of time the cost analyst has worked on Earned Value Management work in the past six months other than that counted as “acquisition cost analysis.” (N/A for vacant positions). Enter one of the four following categories: 75 percent or more; 50 percent or more; 25 percent or more; or less than 25 percent.

Percent Time Doing Other FM Work During Past Six Months: The percentage of time the cost analyst has worked on budgeting, programming, or other FM work in the past six months. Enter one of the four following categories: 75 percent or more; 50 percent or more; 25 percent or more; or less than 25 percent.

Total Years of Cost Analysis Experience: The total number of years the individual has worked in cost analysis positions for at least 50 percent of the time, including non-acquisition cost analysis.

Total Years of Other Financial Management Experience: The total number of years the individual has worked in financial management or earned value management other than as a cost analyst.

Total Years of Acquisition Experience: The total number of years the individual has worked in any area of acquisition, including positions both in and outside of financial management and cost analysis.

Highest Degree & Field of Study: Highest educational degree obtained for assigned individuals and contractor personnel.

Field of Study for Highest Degree: Educational field of study for degree listed above, for assigned individuals and contractor personnel.

Formal Cost Analysis Training: Enter formal cost analysis courses or educational program and source for assigned individuals and contractor personnel (e.g., APDP Level III; CostProf).

Certification(s) and Source: Acquisition or cost analysis certification(s) obtained and source of certification(s), for assigned individuals and contractor personnel.

Notes: If needed, enter other explanatory information in this cell.

Wing, Group, and Squadron Interviews

Aeronautical Systems Center

- ASC/FMC (Cost staff)
- 0677 ATL GP (B-2/Training Systems)
- 0303 ATL GP (Global Hawk)
- 0658 ATL GP (MQ-1; MQ-9)
- 0912 OTL GP (F-15)
- 0669 ATL SQ (CSAR-X)
- 0478 ATL GP (F-22A)
- 0516 ATL GP (C-17A)

Electronic Systems Center

- ESC/FMC (Cost staff)
- 350 ELSG (C2 Devices)
- 551 ELSG (Early Warning)
- 653 ELSW (Global Information Grid; Planning Integration; Air Traffic)
- 653 ELSG (Global Information Grid)
- 951 ELSG (Mission Planning)

Space and Missile Systems Center

- SMC/FMC (Cost staff)
- GPSW Global Positioning Systems Wing
- LRSW Launch and Range Systems Wing
- MSCW Military Satellite Communications Wing
- SCNG Satellite Control and Network Systems Group
- ISSW Space-Based Infrared Systems Wing
- SYSW Space Superiority Systems Wings

Protocol for Interviews with Group Commanders and Wing Commanders

Thank you for your willingness to participate in this study of characteristics and needs for cost analysts. I am XXX and this is YYY with the RAND Corporation. We are conducting this study in collaboration with our sponsor SAF/AQX and AFCAA. With us are ZZZ.

Your participation in this interview is voluntary and you may refuse to participate in this interview or answer any of the questions asked. All information you give us today will be kept strictly confidential. We will not provide or publish any information that identifies you to anyone outside of the study team, except as may be required by law.

1. How many of your group's (wing's) staff are assigned to cost analysis tasks?
2. How were these cost analysts assigned (or selected) to work on your group's (wing's) ACAT programs?
 - a. By what criteria or considerations?
3. How frequently do cost analysts rotate in and out of your group (wing)? How frequently across your group's (wing's) programs? Why?

Adequacy of Workforce

4. Are there enough cost analysts to effectively support your group's (wing's) portfolio of ACAT acquisition programs?
 - a. If yes, any excess cost analysts? How many could you do without?
 - b. If no, how many additional cost analysts are needed?
 1. For what (type of) programs?
 2. Military/civilian/FFRDC/other?
 3. Years of experience in cost analysis?
 - c. Why do you say you need these additional staff? What analytical cost functions do not get done or do not get done as frequently as they ought to be done?
 - d. Are there specific cost analysis activities that you would allocate the additional staff to do?
 - e. What are the implications of not having the right number of cost analysts?

5. How many cost estimators, over how many months, does it take to perform a thorough estimate of the cost of a \$xxx-million new program?
6. How is the quality/accuracy of a cost estimate determined?

Technical Competencies

7. Are you satisfied with the technical competencies of your cost analysis staff?
8. Currently, what kind of technical skill, experience, knowledge or other competencies would you say are generally lacking or not available among the cost analysts in your group?
 - a. What would get done that is *not* now done if your cost analysts had these competencies?
 - b. What would get done *better* if your cost analysts had these competencies?
9. Do you have the right balance of skills, knowledge, and experience among the set of cost analysts you currently have in the group? The right level of breadth and depth?

Future Requirements

10. Looking five years ahead, what kind of different technical skills, experience, knowledge, or competencies may be needed?
 - a. Why? What changes in technology, mix of programs or other changes do you foresee may make this necessary?
11. How many cost analysts were hired specifically to work on your group's programs over the past 12 months? Last 24 months?
 - a. How difficult is it to recruit cost analysts in your area?
12. How many cost analysts left your groups in the past 12 months? Past 24 months?
 - a. Where did they go?
13. What measures would you suggest taking to improve the training and performance of cost analysts?

Supplementary Tables

Table D.1
Number of Cost Estimators, by Type of Personnel and Center, 2008

Center	Military	Civilian	Contractor	Total
AAC	6	13	7	26
ASC	7	70	40	117
ESC	9	16	79	104
SMC	17	25	49	91
OC-ALC	0	11	1	12
OO-ALC	0	8	6	14
WR-ALC	1	1	8	10
Total	40	144	190	374

SOURCE: RAND census, 2008.

Table D.2
Number of Authorized Vacancies for Cost Estimators, by Type of Personnel and Center, 2008

Center	Military	Civilian	Total
AAC	—	3	3
ASC	2	19	21
ESC	5	5	10
SMC	10	16	26
OC-ALC	—	5	5
WR-ALC	—	9	9
Total	17	57	74

SOURCE: RAND census, 2008.

Table D.3
Cost Analysts' Academic Attainment, by Center, and Personnel Type, 2008 (%)

Center	Personnel Type	Associate	Bachelor's	Master's	MBA	PhD	Total
AAC	Organic (n = 19)	0	16	84	0	0	100
	Contractor (n = 6)	0	83	17	0	0	100
	All (n = 25)	0	32	68	0	0	100
ASC	Organic (n = 75)	1	28	27	44	0	100
	Contractor (n = 39)	0	27	47	27	0	100
	All (n = 114)	1	28	33	38	0	100
ESC	Organic (n = 25)	0	44	40	6	0	100
	Contractor (n = 79)	0	43	25	30	1	100
	All (n = 104)	0	43	29	27	1	100
SMC	Organic (n = 41)	0	31	69	0	0	100
	Contractor (n = 49)	0	49	49	0	2	100
	All (n = 90)	0	42	57	0	1	100
OC-ALC	Organic (n = 10)	0	30	60	10	0	100
	Contractor (n = 1)	0	0	0	100	0	100
	All (n = 11)	0	27	55	18	0	100
OO-ALC	Organic (n = 8)	0	75	0	25	0	100
	Contractor (n = 6)	0	17	83	0	0	100
	All (n = 14)	0	50	36	14	0	100
WR-ALC	Organic (n = 2)	0	0	50	50	0	100
	Contractor (n = 6)	0	0	33	50	18	100
	All (n = 8)	0	0	38	50	13	100
All	Organic (n = 180)	1	32	44	23	0	100
	Contractor (n = 186)	0	39	40	20	1	100
	All (n = 366)	0	36	42	21	1	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table D.4
Cost Analysts' Years of Experience Doing Cost Estimation, by Center and Personnel Type, 2008 (%)

Center	Personnel Type	0–2	3–5	6–10	11–20	21+	Total
AAC	Organic (n = 19)	16	26	16	26	16	100
	Contractor (n = 6)	33	0	0	17	50	100
	All (n = 25)	20	20	12	24	24	100
ASC	Organic (n = 75)	39	9	23	19	11	100
	Contractor (n = 34)	3	15	21	21	41	100
	All (n = 109)	28	11	22	19	20	100
ESC	Organic (n = 25)	28	24	28	4	16	100
	Contractor (n = 76)	13	17	26	25	18	100
	All (n = 101)	17	19	27	20	18	100
SMC	Organic (n = 40)	43	23	10	18	8	100
	Contractor (n = 48)	19	13	23	33	13	100
	All (n = 88)	30	17	17	26	10	100
OC-ALC	Organic (n = 11)	18	27	9	46	0	100
	Contractor (n = 1)	0	0	0	0	100	100
	All (n = 12)	17	25	8	42	8	100
OO-ALC	Organic (n = 8)	13	25	50	0	13	100
	Contractor (n = 6)	17	17	17	33	17	100
	All (n = 14)	14	21	36	14	14	100
WR-ALC	Organic (n = 2)	50	0	0	0	50	100
	Contractor (n = 7)	0	0	29	29	43	100
	All (n = 9)	11	0	22	22	44	100
All	Organic (n = 180)	33	18	19	18	11	100
	Contractor (n = 178)	13	14	23	26	24	100
	All (n = 358)	23	16	21	22	17	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table D.5
Time Spent Doing Cost Estimation Over Previous Six Months, by Center and Personnel Type,
2008 (%)

Center	Personnel Type	Zero	Less Than 25	25–49	50–74	75–99	100	Total
AAC	Organic (n = 19)	16	5	32	5	11	32	100
	Contractor (n = 7)	0	14	0	0	14	71	100
	All (n = 26)	12	8	23	4	12	42	100
ASC	Organic (n = 77)	0	17	20	7	12	46	100
	Contractor (n = 40)	0	13	8	13	18	50	100
	All (n = 117)	0	15	15	9	14	47	100
ESC	Organic (n = 25)	0	4	8	12	20	56	100
	Contractor (n = 79)	0	4	0	5	70	22	100
	All (n = 104)	0	4	2	7	58	30	100
SMC	Organic (n = 42)	12	17	14	21	12	24	100
	Contractor (n = 49)	2	12	0	10	53	22	100
	All (n = 91)	7	14	7	15	34	23	100
OC-ALC	Organic (n = 11)	9	18	18	18	36	0	100
	Contractor (n = 1)	0	0	0	0	100	0	100
	All (n = 12)	8	17	17	17	42	0	100
OO-ALC	Organic (n = 8)	0	88	0	13	0	0	100
	Contractor (n = 6)	0	0	0	0	0	100	100
	All (n = 14)	0	50	0	7	0	43	100
WR-ALC	Organic (n = 2)	0	50	0	0	50	0	100
	Contractor (n = 8)	0	75	13	13	0	0	100
	All (n = 10)	0	70	10	10	10	0	100
All	Organic (n = 184)	5	17	17	12	14	35	100
	Contractor (n = 190)	1	10	2	8	47	31	100
	All (n = 374)	3	13	9	10	32	33	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table D.6
Lead Cost Estimators, by Center and Personnel Type, 2008 (%)

Center	Military	Civilian	Contractor	Total
AAC (n = 11)	18	64	18	100
ASC (n = 54)	4	57	39	100
ESC (n = 68)	9	19	72	100
SMC (n = 25)	56	44	0	100
OC-ALC (n = 1)	0	0	100	100
OO-ALC (n = 7)	0	57	43	100
WR-ALC (n = 3)	0	0	100	100
All (n = 169)	14	39	47	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table D.7
Lead Estimators' Years of Experience in Cost Estimation, by Center, 2008 (%)

Center	Personnel Type	0–2	3–5	6–10	11–20	21+	Total
AAC	Organic (n = 9)	11	44	—	11	33	100
	Contractor (n = 2)	—	—	—	50	50	100
	All (n = 11)	9	36	—	18	36	100
ASC	Organic (n = 32)	34	9	16	25	16	100
	Contractor (n = 21)	—	10	19	33	38	100
	All (n = 53)	21	9	17	28	25	100
ESC	Organic (n = 19)	26	26	26	11	11	100
	Contractor (n = 49)	4	14	25	35	22	100
	All (n = 68)	10	17	25	28	19	100
SMC	Organic (n = 25)	52	24	4	20	—	100
	Contractor (n = 0)	—	—	—	—	—	—
	All (n = 25)	52	24	4	20	—	100
OC-ALC	Organic (n = 0)	—	—	—	—	—	—
	Contractor (n = 1)	—	—	—	—	100	100
	All (n = 1)	—	—	—	—	100	100
OO-ALC	Organic (n = 4)	—	50	50	—	—	100
	Contractor (n = 3)	33	—	—	67	—	100
	All (n = 7)	14	29	29	29	—	100
WR-ALC	Organic (n = 0)	—	—	—	—	—	—
	Contractor (n = 2)	—	—	50	—	50	100
	All (n = 2)	—	—	50	—	50	100
All	Organic (n = 89)	34	22	18	15	10	100
	Contractor (n = 78)	4	12	22	39	28	100
	All (n = 167)	20	17	20	24	19	100

SOURCE: RAND census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

Table D.8
Lead Estimators' Time Spent Doing Cost Estimation, by Center and Personnel Type, 2008 (%)

Center	Personnel Type	Zero	Less Than 25	25–49	50–74	75–99	100	Total
AAC	Organic (n = 9)	—	—	11	11	11	67	100
	Contractor (n = 2)	—	—	—	—	50	50	100
	All (n = 11)	—	—	9	9	18	64	100
ASC	Organic (n = 33)	—	12	9	12	21	47	100
	Contractor (n = 21)	—	5	5	19	19	52	100
	All (n = 54)	—	9	7	15	20	48	100
ESC	Organic (n = 19)	—	—	5	16	21	58	100
	Contractor (n = 49)	—	2	—	6	71	20	100
	All (n = 68)	—	2	2	9	57	31	100
SMC	Organic (n = 25)	4	8	12	32	20	24	100
	Contractor (n = 0)	—	—	—	—	—	—	—
	All (n = 25)	4	8	12	32	20	24	100
OC-ALC	Contractor (n = 1)	—	—	—	—	100	—	100
OO-ALC	Organic (n = 4)	—	75	—	25	—	—	100
	Contractor (n = 3)	—	—	—	—	—	100	100
	All (n = 7)	—	43	—	14	—	43	100
WR-ALC	Contractor (n = 3)	—	33	33	33	—	—	100
All	Organic (n = 90)	1	10	9	19	19	42	100
	Contractor (n = 79)	—	4	3	10	52	32	100
	All (n = 169)	1	7	6	15	34	37	100

SOURCE: RAND Census, 2008.

NOTE: Percentages may not add to 100 because of rounding.

References

- Air Force Materiel Command, *Roles and Responsibilities of AFMC Center Line Direct Reports and Functionals*, November 7, 2004.
- Arena, Mark V., Robert S. Leonard, Sheila E. Murray, and Obaid Younossi, *Historical Cost Growth of Completed Weapon System Programs*, Santa Monica, Calif.: RAND Corporation, TR-343-AF, 2006. As of June 17, 2009:
http://www.rand.org/pubs/technical_reports/TR343/
- Bolten, Joseph G., Robert S. Leonard, Mark V. Arena, Obaid Younossi, and Jerry M. Sollinger, *Sources of Weapon System Cost Growth: Analysis of 35 Major Defense Acquisition Programs*, Santa Monica, Calif.: RAND Corporation, MG-670-AF, 2008. As of June 17, 2009:
<http://www.rand.org/pubs/monographs/MG670/>
- Department of Defense, *Defense Acquisition Guidebook*, December 2008. As of June 17, 2009:
<http://www.theriac.org/pdfs/DefenseAcquisitionGuidebook.pdf>
- Durante, Blaise J., Deputy Assistant Secretary (Acquisition Integration), memorandum, undated.
- Independent Program Assessment Office (IPAO), *Cost Estimate Sufficiency Review Checklist*, undated. As of June 16, 2009:
http://ceh.nasa.gov/webhelpfiles/appendix_j_ipao_cost_estimate_sufficiency_review_checklist.htm
- U.S. Congress, John Warner Defense Authorization Act for Fiscal Year 2007, Public Law 109-304, 109th Congress, Section 820.
- Younossi, Obaid, Mark V. Arena, Robert S. Leonard, Charles Robert Hall, Jr., Arvind Jain, and Jerry M. Sollinger, *Is Weapon System Cost Growth Increasing? A Quantitative Assessment of Completed and Ongoing Programs*, Santa Monica, Calif.: RAND Corporation, MG-588-AF, 2006. As of June 17, 2009:
<http://www.rand.org/pubs/monographs/MG588/>
- Younossi, Obaid, Mark A. Lorell, Kevin Brancato, Cynthia R. Cook, Mel Eisman, Bernard Fox, John C. Graser, Yool Kim, Robert S. Leonard, Shari Lawrence Pfleeger, and Jerry M. Sollinger, *Improving the Cost Estimation of Space Systems: Past Lessons and Future Recommendations*, Santa Monica, Calif.: RAND Corporation, MG-690-AF, 2008. As of June 17, 2009:
<http://www.rand.org/pubs/monographs/MG690/>